



Hilliard High School (Walker Road) Traffic Impact Study

Prepared for:

Hilliard City School District

Prepared By:



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September 2006

Hilliard High School (Walker Road) Traffic Impact Study

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Under the direction of:

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Date



September 2006

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EXECUTIVE SUMMARY

The Hilliard City Schools are proposing to develop a site with a high school (1800 students) and middle school (750 students). The site is located on the east side of Walker Road just south of Morris Road in Brown Township in Franklin County, Ohio. There are three proposed accesses to the site which are all on Walker Road. There is also a plan for two additional access points on a potential extension to Morris Road. As part of getting an access permit, the FCEO requires a traffic impact study (TIS). The scope of the study was defined by the County.

Walker Road is currently two lanes wide and has a speed limit of 55 MPH. Traffic control at the study area intersections are two-way stops. The study was based on the hours of 7-8 AM and 3-4 PM.

2009 and 2019 'No Build' and 'Build' volumes were developed for use in signal warrant, turn lane warrant, and capacity analyses. For the off site intersections, improvements and when the improvements are needed were determined from the analyses. For turn lane improvements, the length of each turn lane was computed for each volume set in which the turn lane was needed. The lengths were computed using the method in Section 400 of the *ODOT L&D Manual*. A design speed of 55 MPH was used. Exhibit A shows a summary of the results of the Analyses for the off site intersections.

For the site access points on Walker Road, the lengths of the warranted turn lanes were computed based on the 2019 'Build' volumes. A sketch of how the improvements may look is shown in Exhibit B.

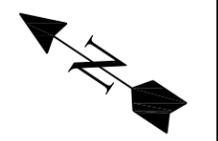
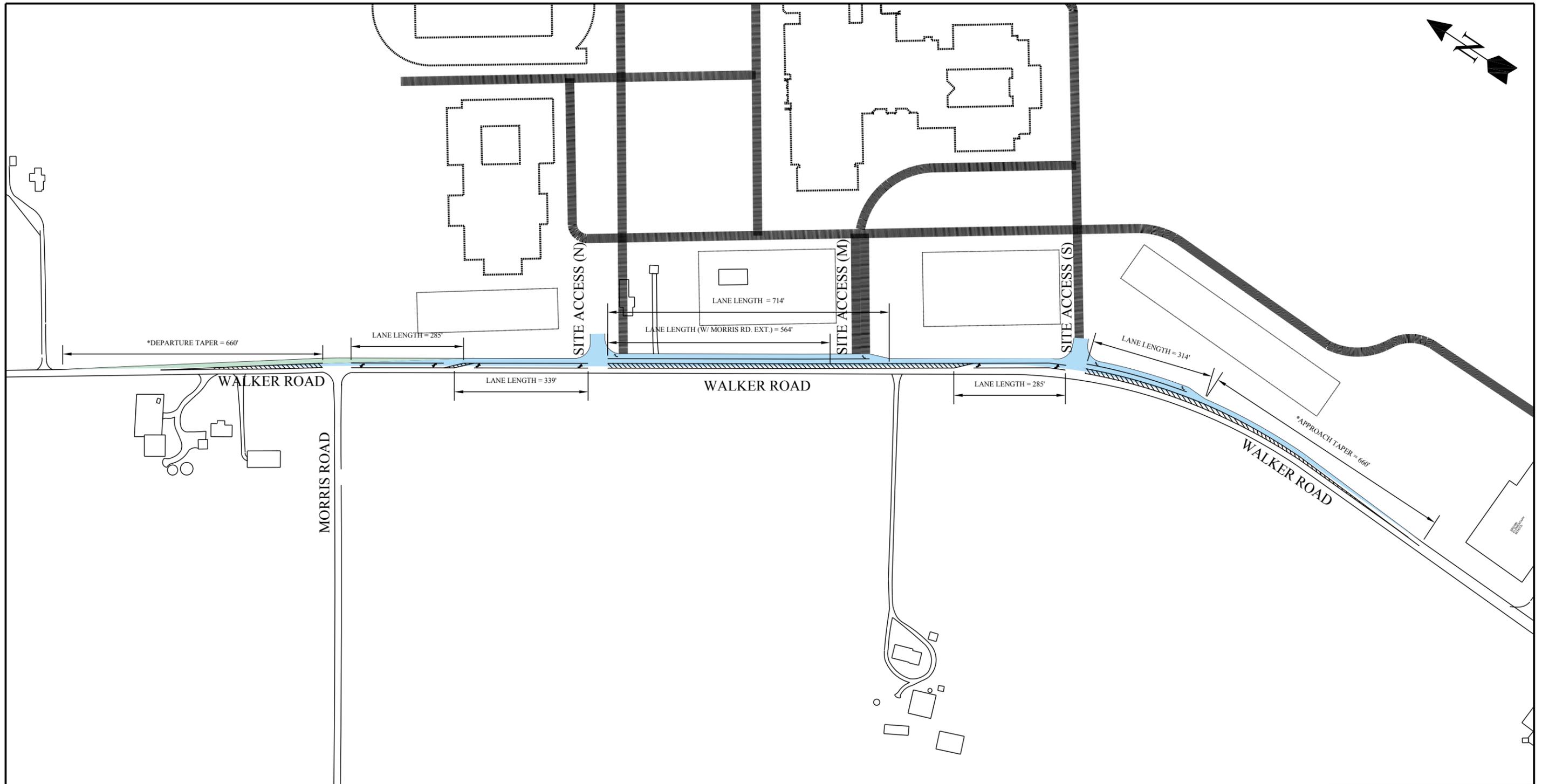
The results showed that three of the study area intersections will warrant signals without the school in 2009 and an additional one will warrant a signal by 2019 without the school. These four intersections are all located on Alton & Darby Creek Road. Per the pre-meeting for the project, a compounded growth rate of 7% per year was to be used. This resulted in a 241% increase in background traffic from 2006 to 2019. Alton & Darby Creek Road currently has in excess of 8,000 ADT.

The unsignalized capacity analysis revealed high delays on several of the stop approaches at two-way stop controlled intersections. There is a limited amount of turn lane improvements that are possible at an unsignalized intersection. Typically, adding the turn lanes does not bring the intersection side street "stop" movement to an acceptable Level of Service. Higher delays at a two-way stop for side street lefts and thru movements are unavoidable until a signal is warranted at the intersection.

The unsignalized capacity also revealed high delays for traffic leaving the site. When projected traffic is used, signals are normally warranted on the basis of the eight hour warrants and not usually warranted on the basis of the Peak Hour warrant. The analysis of the north site access on Walker Road indicates the projected volumes are high enough to meet the Peak Hour warrant for a signal. If traffic volumes reach projected levels, a signal would help reduce the delays for vehicles leaving the site. This intersection should be monitored as school traffic develops.

Intersection	Direction	2009 'No Build'	2009 'Build'	2019 'No Build'	2019 'Build'	2019 'Build' w Morris Rd. Ext
Alton-Darby Creek Rd. & Walker Road	Intersection			Signal Warranted		Volumes not Affected
	Northbound	Add Left Turn Lane (285')	Extend Left Turn Lane to 314'	Add Left Turn Lane with Signal Improvements (364')	Extend Left Turn Lane to 439'	
	Southbound					
	Eastbound		Add Left Turn Lane (285')		Add EB Left Turn (285')	
Alton-Darby Creek Rd. & Roberts Road (W)	Intersection	Signal Warranted		Signal Warranted		
	Northbound	Add Left Turn Lane with Signal Improvements (285')	Extend Left Turn Lane to 339'	Add Left Turn Lane with Signal Improvements (285')	Extend Left Turn Lane to 364'	Extend Left Turn Lane to 364'
	Southbound			Add Right Turn Lane (489')	Extend Right Turn Lane to 664'	Extend Right Turn Lane to 539'
	Eastbound		Add Left Turn Lane (514')	Add Left Turn Lane (439')	Extend Left Turn Lane to 600'	Extend Left Turn Lane to 600'
Alton-Darby Creek Rd. & Roberts Road (E)	Intersection	Signal Warranted		Signal Warranted		
	Northbound			Add Right Turn Lane (439')	Extend Right Turn Lane to 539'	Extend Right Turn Lane to 539'
	Southbound	Add Left Turn Lane with Signal Improvements (364')		Add Left Turn Lane with Signal Improvements (539')		
	Westbound		Add Left Turn Lane (489')	Add Left Turn Lane (439')	Extend Left Turn Lane to 564'	Extend Left Turn Lane to 564'
Alton-Darby Creek Rd. & Davis Road	Intersection	Signal Warranted		Signal Warranted		
	Northbound	Add Left Turn Lane with Signal Improvements (285')		Add Left Turn Lane with Signal Improvements (285')		
	Southbound			Add Right Turn Lane (364')	Extend Right Turn Lane to 439'	
	Eastbound		Add Left Turn Lane (364')	Add Left Turn Lane (439')	Extend Left Turn Lane to 514'	
Walker Road & Roberts Road	Intersection					
	Northbound		Add Right Turn Lane (285')	Add Right Turn Lane (339')		
	Southbound	Existing Left Turn Lane (345')			Extend Right Turn Lane to 489'	Extend Right Turn Lane to 439'
	Westbound		Add Left Turn Lane (289')	Add Left Turn Lane (339')		
Walker Road & Morris Road	Intersection					
	Northbound				Add Left Turn Lane (285')	Add Left Turn Lane (285')
	Southbound					
	Eastbound					
Walker Road & Davis Road	Intersection					
	Northbound			Add Right Turn Lane (339')	Extend Right Turn Lane to 364'	
	Southbound			Add Left Turn Lane (285')		
	Westbound					

Exhibit A - Off Site Intersection Improvement Summary



LEGEND

- ADDITIONAL PAVEMENT NEEDED FOR ACCESS ROADWAY IMPROVEMENTS
- ADDITIONAL PAVEMENT NEEDED FOR FUTURE MORRIS ROAD ROADWAY IMPROVEMENTS

SCALE: 1" = 250'

NOTE:

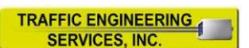
* = EXISTING PAVEMENT DOES NOT HAVE 12 FOOT LANES SO APPROACH AND DEPARTURE TAPERS WILL LIKELY NEED TO BE LONGER IN ORDER TO MATCH EXISTING PAVEMENT.

EXHIBIT B

ROADWAY IMPROVEMENTS

HILLIARD HIGH SCHOOL
(WALKER ROAD)
TRAFFIC IMPACT STUDY

PREPARED BY:



BACKGROUND

The Hilliard City Schools are proposing to develop a site with a high school (1800 students) and middle school (750 students). The site is located on the east side of Walker Road just south of Morris Road in Brown Township in Franklin County, Ohio. Figure 1 shows the location of the site.

There are three proposed accesses to the site which are all on Walker Road. There is also a plan for two additional access points on a potential extension to Morris Road. Figure 2 shows the proposed site plan. The access is controlled by the Franklin County Engineer's Office (FCEO). As part of getting an access permit, the FCEO requires a traffic impact study (TIS). Traffic Engineering Services, Inc. has been retained by the developer to perform the TIS. A TIS pre-meeting was held at the Franklin County Engineer's Office on May 8, 2006. An MOU of the items discussed at the pre-meeting was submitted to the county in a letter dated May 26, 2006. Review comments on the MOU were received and discussed at a meeting at the FCEO offices on July 6, 2006. Follow up information regarding trip generation and distribution was submitted and approved for use in the study. A copy of all correspondence is in Technical Appendix "A".

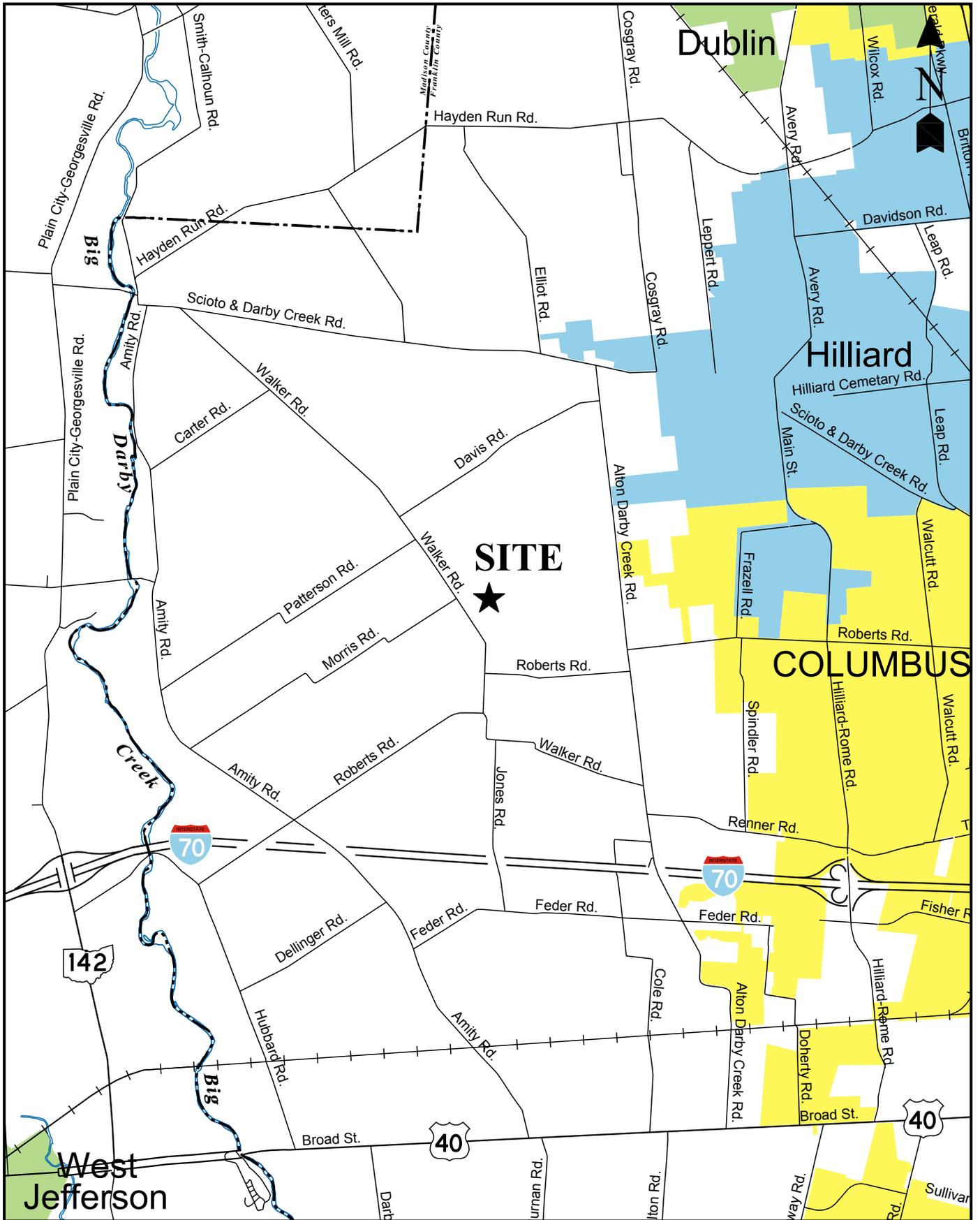
AREA CONDITIONS

Walker Road is currently two lanes wide and has a speed limit of 55 MPH. Traffic control at the study area intersections is as follows:

- Walker Rd. at Davis Rd. (Stop Sign on Davis Road)
- Walker Rd. at Morris Rd. (Stop Sign on Morris Road)
- Walker Rd. at Roberts Rd. (Stop Sign on Roberts Road)
- Walker Rd. at Alton Darby Creek Rd. (Stop Sign on Walker Road)
- Davis Rd. at Alton Darby Creek Rd. (Stop Sign on Davis Road)
- Roberts Rd. (N) at Alton Darby Creek Rd. (Stop Sign on Roberts Road)
- Roberts Rd. (S) at Alton Darby Creek Rd. (Stop Sign on Roberts Road)

EXISTING TRAFFIC

As part of this study, turning movement counts were taken from 7-9 AM and 2-4 PM at all of the intersections in the study area except the two Alton-Darby Rd. & Roberts Rd. intersections which were provided by the FCEO. The count reports are in Technical Appendix "B". Exhibits showing the existing traffic can be found in Technical Appendix "C".



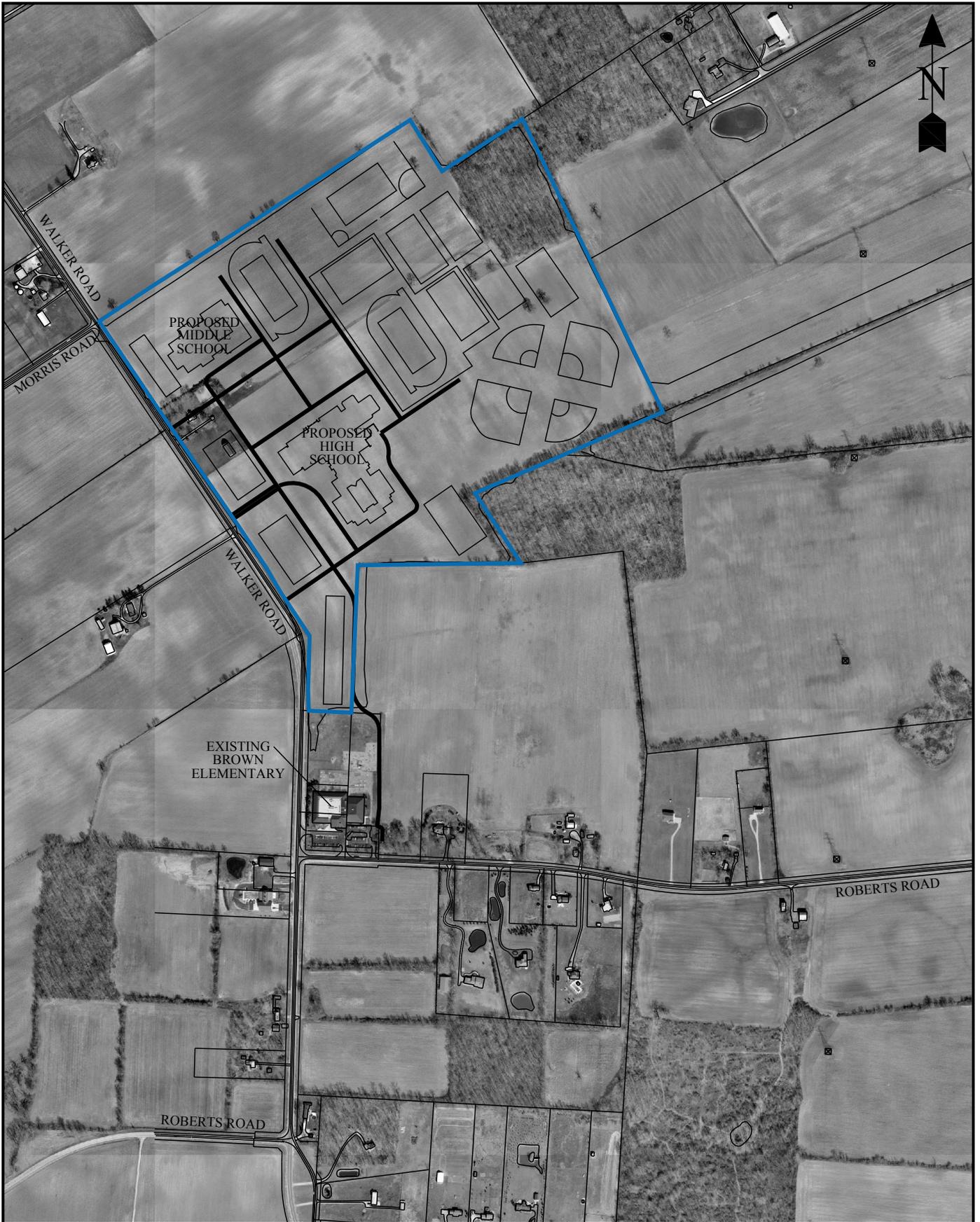
**HILLIARD HIGH SCHOOL (WALKER ROAD)
TRAFFIC IMPACT STUDY**

PREPARED BY:



FIGURE 1

SITE LOCATION



**HILLIARD HIGH SCHOOL (WALKER ROAD)
TRAFFIC IMPACT STUDY**

PREPARED BY: **TRAFFIC ENGINEERING SERVICES, INC.**

FIGURE 2

SITE LAYOUT

TRIP GENERATION AND DISTRIBUTION

The trip rates used for estimating the trip generation are based on data from a study performed by TES for the Chillicothe City Schools and from the data that the Hilliard City Schools provided. This information was submitted to the County and approved for use in the study. The complete description of the data is found in Technical Appendix "A". A summary of the trip generation calculations are shown in Table 1A, 1B, and 1C. Note that the middle school is planned to be built sometime after the construction of the high school so Opening Day (2009) only includes the high school trips.

The distribution of site traffic was based on the locations of the housing units within the school boundary in 2019. This information was submitted and approved for use in the study. A copy of the correspondence is in Technical Appendix "A". Since Morris Road may be extended by others, the scope of the study included two different distribution scenarios. Figure 3 shows the distribution that does not consider an extension of Morris Road. Figure 4 shows the distribution that considers the extension of Morris Road.

Figures showing the corresponding site generated traffic can be found in Technical Appendix "C".

TOTAL TRAFFIC

Per the MOU, the process for expanding the existing traffic to the future years is using a compounded per year growth rate of 7%. The 'Build' traffic for each future year includes the diversion of 12 inbound buses in each peak hour to the proposed southern driveway. There is a planned connection to Brown Elementary School just south of the proposed site to improve circulation.

The 2009 'No Build' is shown in Figures 5-6. The 2009 'Build' traffic is the initial site traffic plus the 2009 'No Build' traffic and is shown in Figures 7-9. The 2019 'No Build' traffic is shown in Figures 10-11. The 2019 'Build' traffic is the 2019 'No Build' traffic plus the Site generated traffic and is shown in Figures 12-14. The 2019 'Build' traffic considering a potential Morris Road extension is shown in Figures 15-17.

Traffic Study Sub Area	ITE Land Use #	Description
1	NA	High School - Buses
2	NA	High School - Drop Off/Pick Up
3	NA	High School - Student Drivers
4	NA	High School - Faculty
5	NA	Middle School - Buses
6	NA	Middle School - Drop Off/Pick Up
7	NA	Middle School - Faculty

TABLE 1 - SITE TRIP GENERATION SUMMARY - DAILY

Traffic Study Sub Area	Rate (Trips/Ind Var.)	Total (Trips)	Entering		Exiting	
			%	Total Trips	%	Total Trips
1	48.00	48	50%	24	50%	24
2	720.00	720	50%	360	50%	360
3	440.00	440	100%	440	0%	0
4	176.00	176	100%	176	0%	0
5	52.00	52	50%	26	50%	26
6	400.00	400	50%	200	50%	200
7	75.00	75	100%	75	0%	0
TOTALS		1911		1301		610

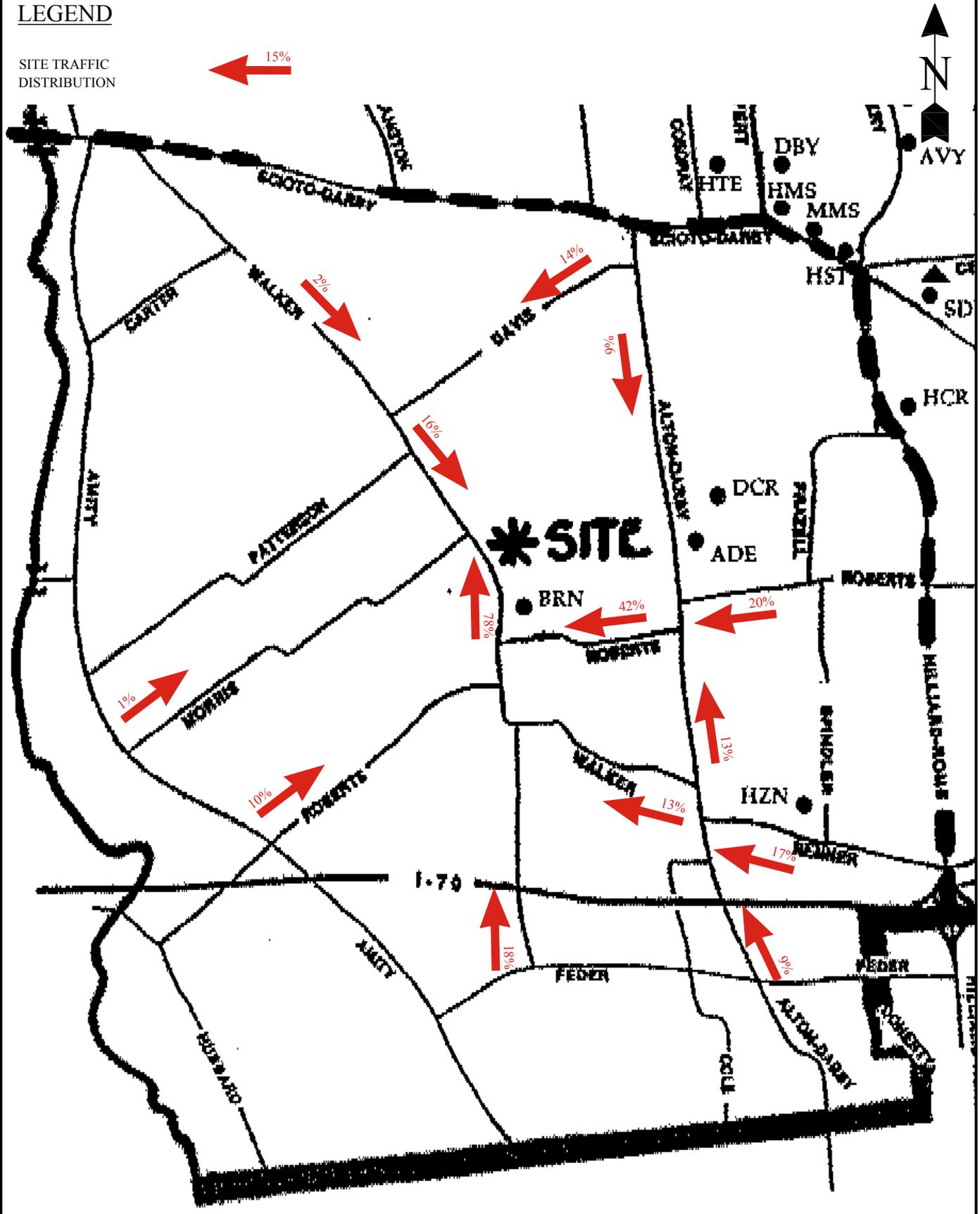
TABLE 2 - SITE TRIP GENERATION SUMMARY - AM PEAK

Traffic Study Sub Area	Rate (Trips/Ind Var.)	Total (Trips)	Entering		Exiting	
			%	Total Trips	%	Total Trips
1	48.00	48	50%	24	50%	24
2	435.00	435	59%	255	41%	180
3	283.00	283	0%	0	100%	283
4	176.00	176	0%	0	100%	176
5	52.00	52	50%	26	50%	26
6	372.00	372	54%	200	46%	172
7	75.00	75	0%	0	100%	75
TOTALS		1441		505		936

TABLE 3 - SITE TRIP GENERATION SUMMARY - PM PEAK

LEGEND

SITE TRAFFIC DISTRIBUTION



**HILLIARD HIGH SCHOOL (WALKER ROAD)
TRAFFIC IMPACT STUDY**

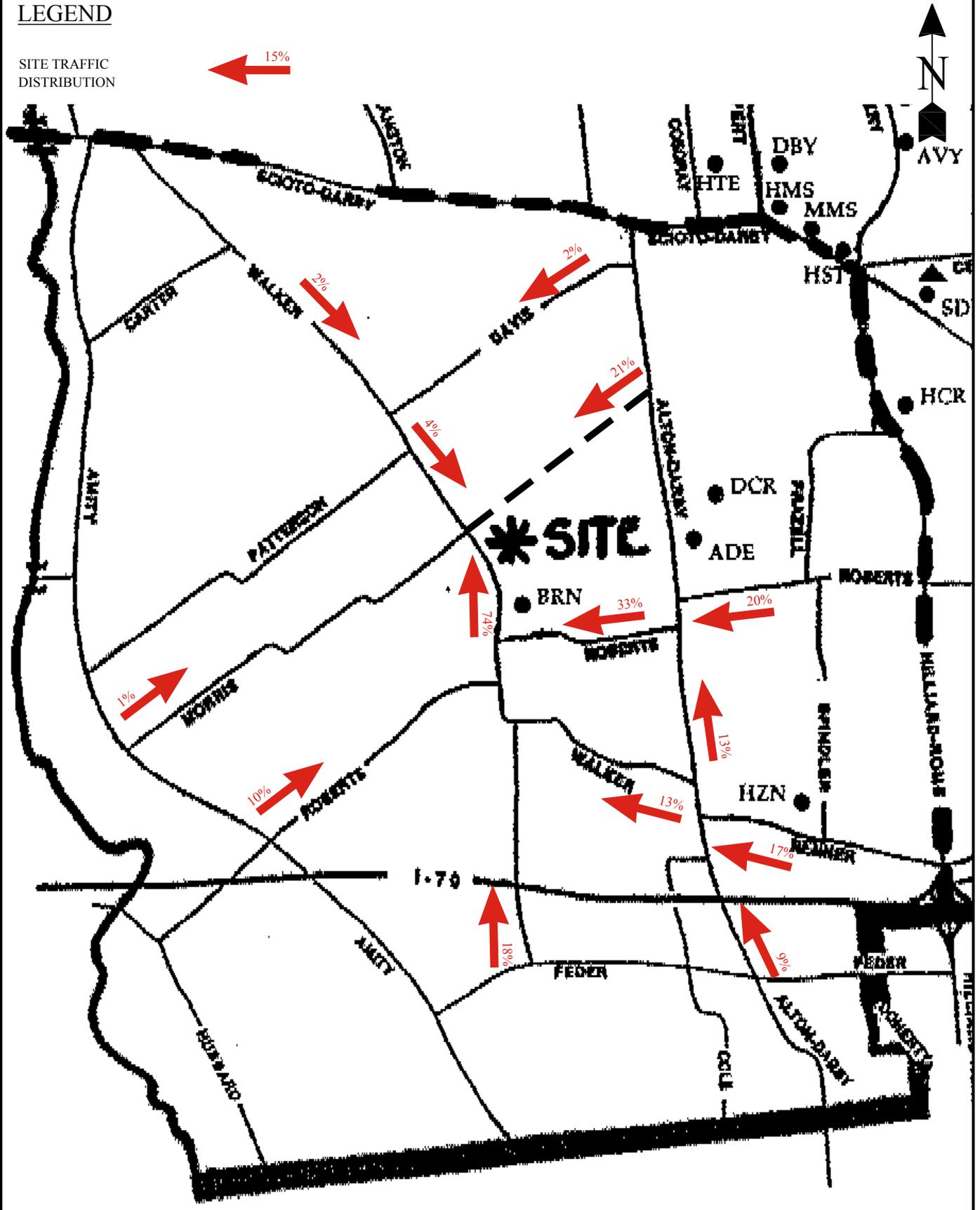
PREPARED BY:



FIGURE 3
SITE TRAFFIC DISTRIBUTION
(WITHOUT MORRIS RD. EXTENSION)

LEGEND

SITE TRAFFIC DISTRIBUTION

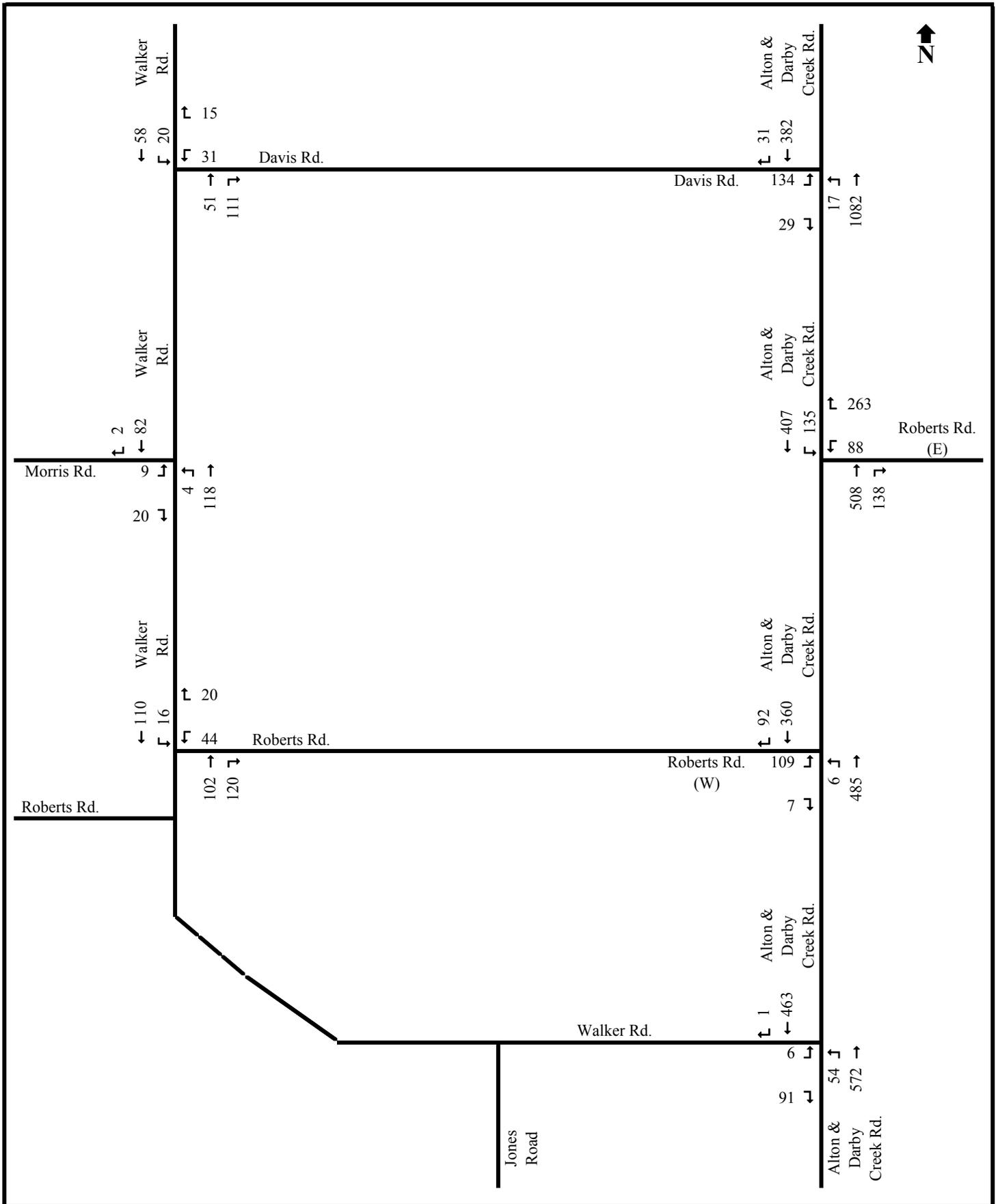


**HILLIARD HIGH SCHOOL (WALKER ROAD)
TRAFFIC IMPACT STUDY**

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FIGURE 4
SITE TRAFFIC DISTRIBUTION
(WITH MORRIS RD. EXTENSION)

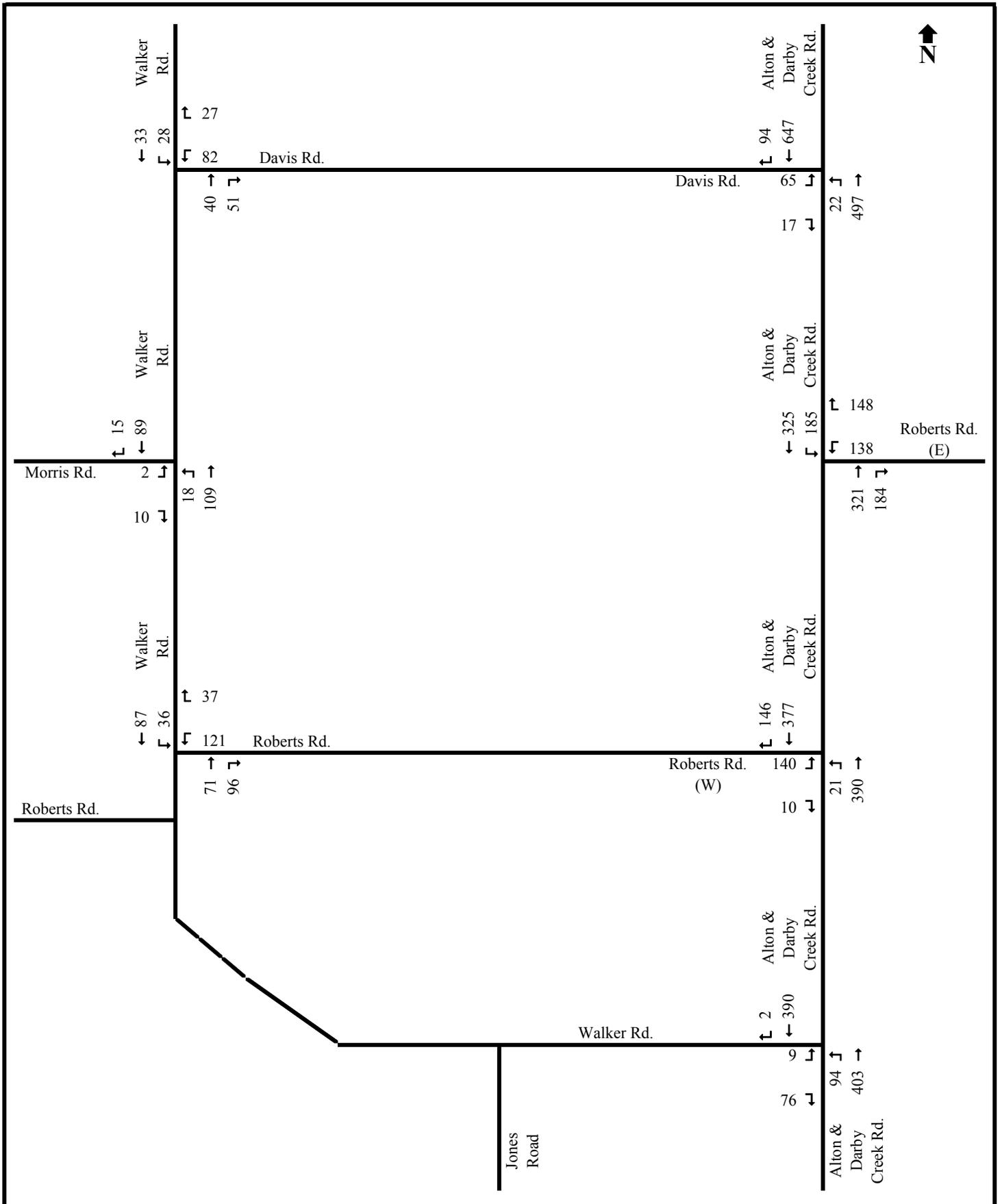


**HILLIARD HIGH SCHOOL (WALKER ROAD)
TRAFFIC IMPACT STUDY**

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FIGURE 5

2009 'NO BUILD' TRAFFIC - 7-8 AM



**HILLIARD HIGH SCHOOL (WALKER ROAD)
TRAFFIC IMPACT STUDY**

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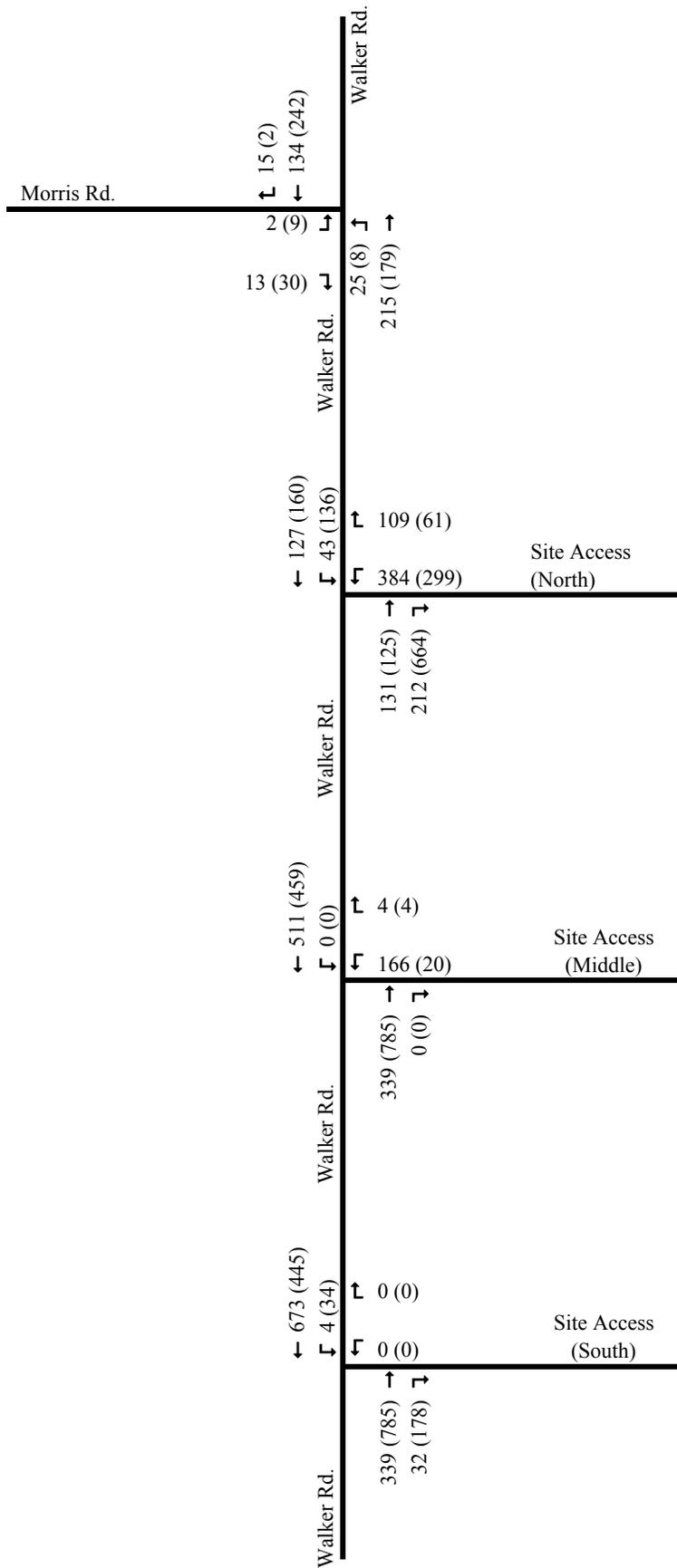
FIGURE 6

2009 'NO BUILD' TRAFFIC - 3-4 PM



LEGEND

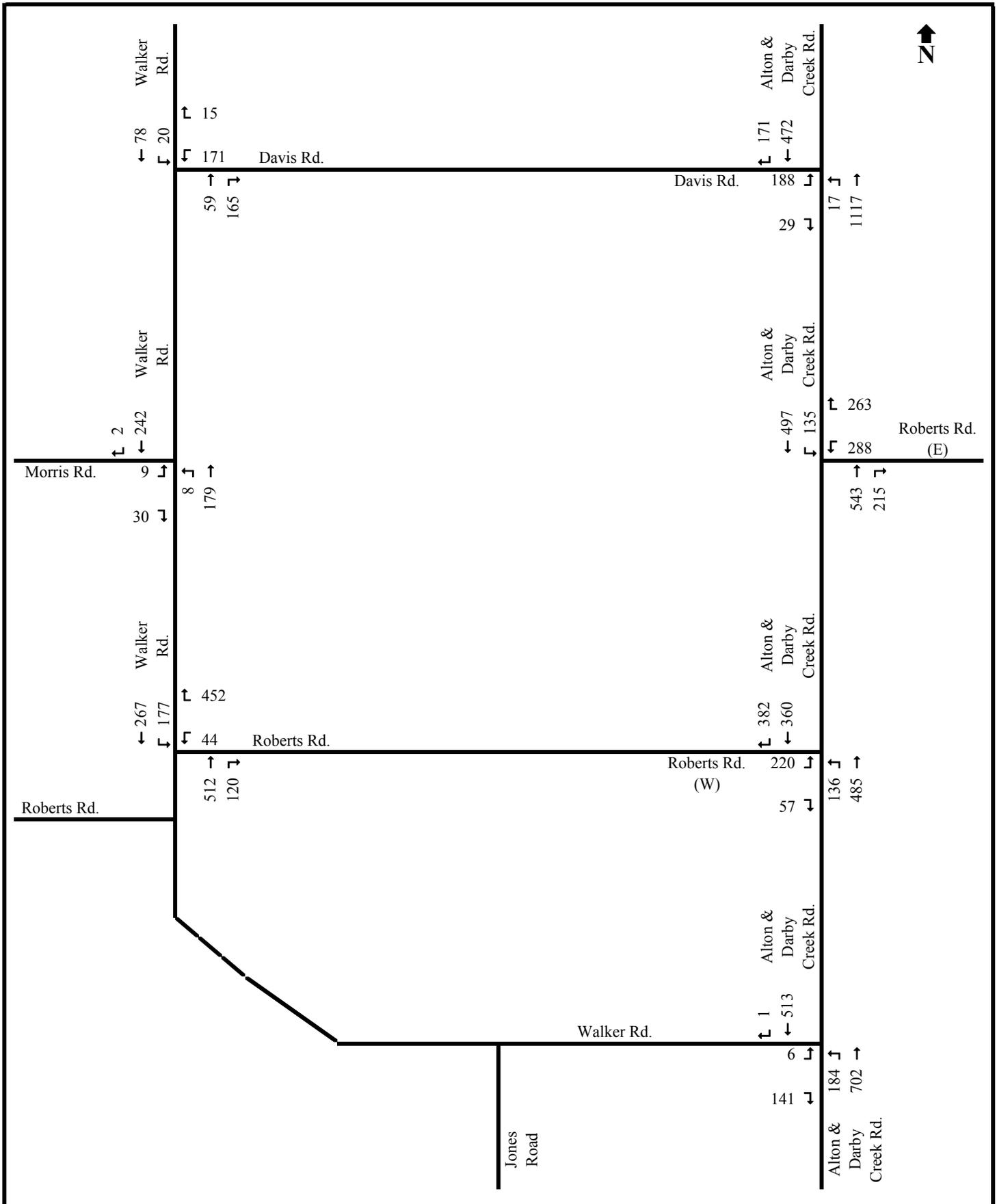
- 222 - 3-4 PM Hour Turning Movement
- (222) - 7-8 AM Hour Turning Movement



**HILLIARD HIGH SCHOOL (WALKER ROAD)
TRAFFIC IMPACT STUDY**

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FIGURE 7
2009 'BUILD' TRAFFIC W/ BROWN ELE.
BUSSES

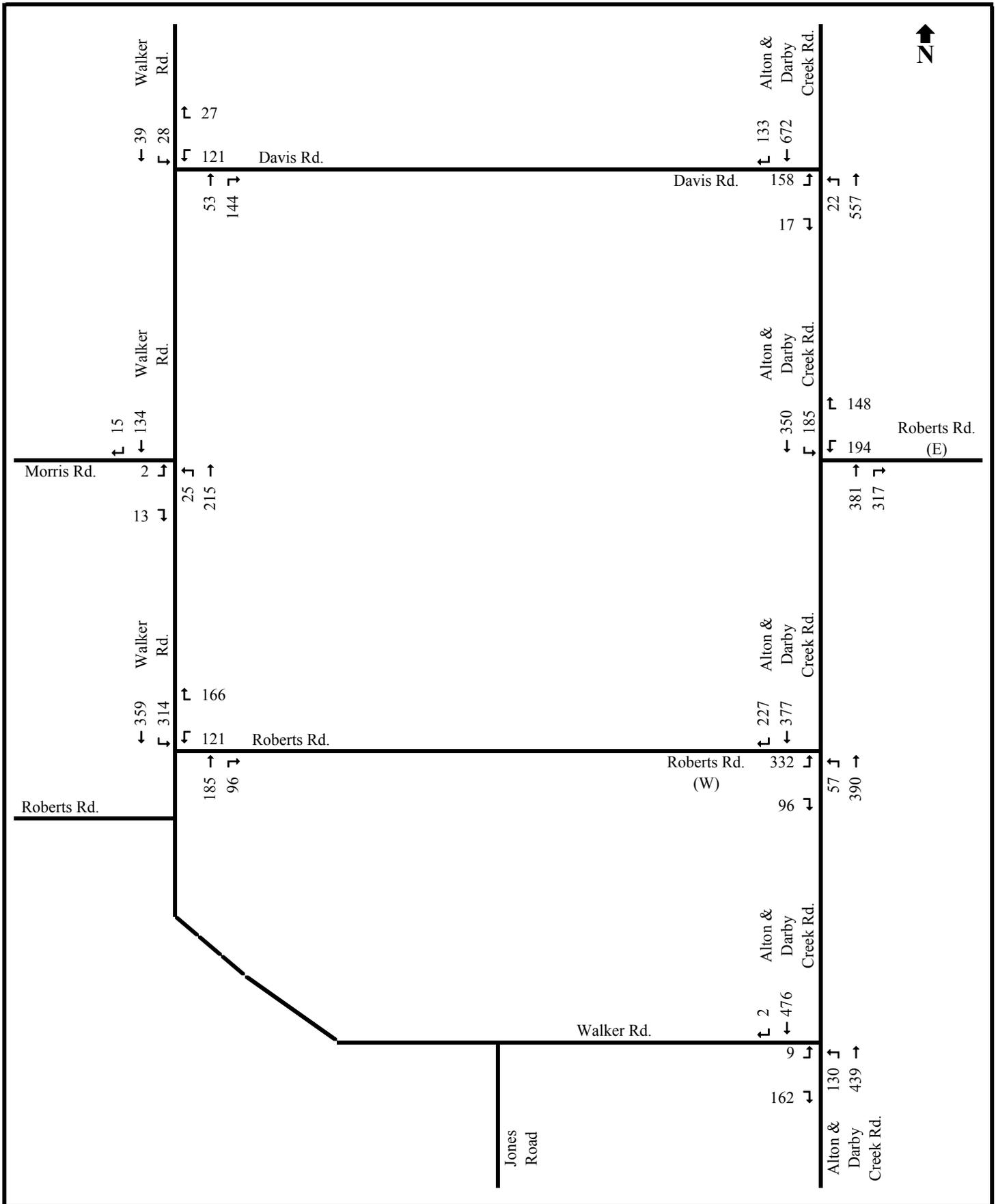


**HILLIARD HIGH SCHOOL (WALKER ROAD)
TRAFFIC IMPACT STUDY**

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FIGURE 8

**2009 'BUILD' TRAFFIC W/ BROWN ELE.
BUSSES - 7-8 AM**

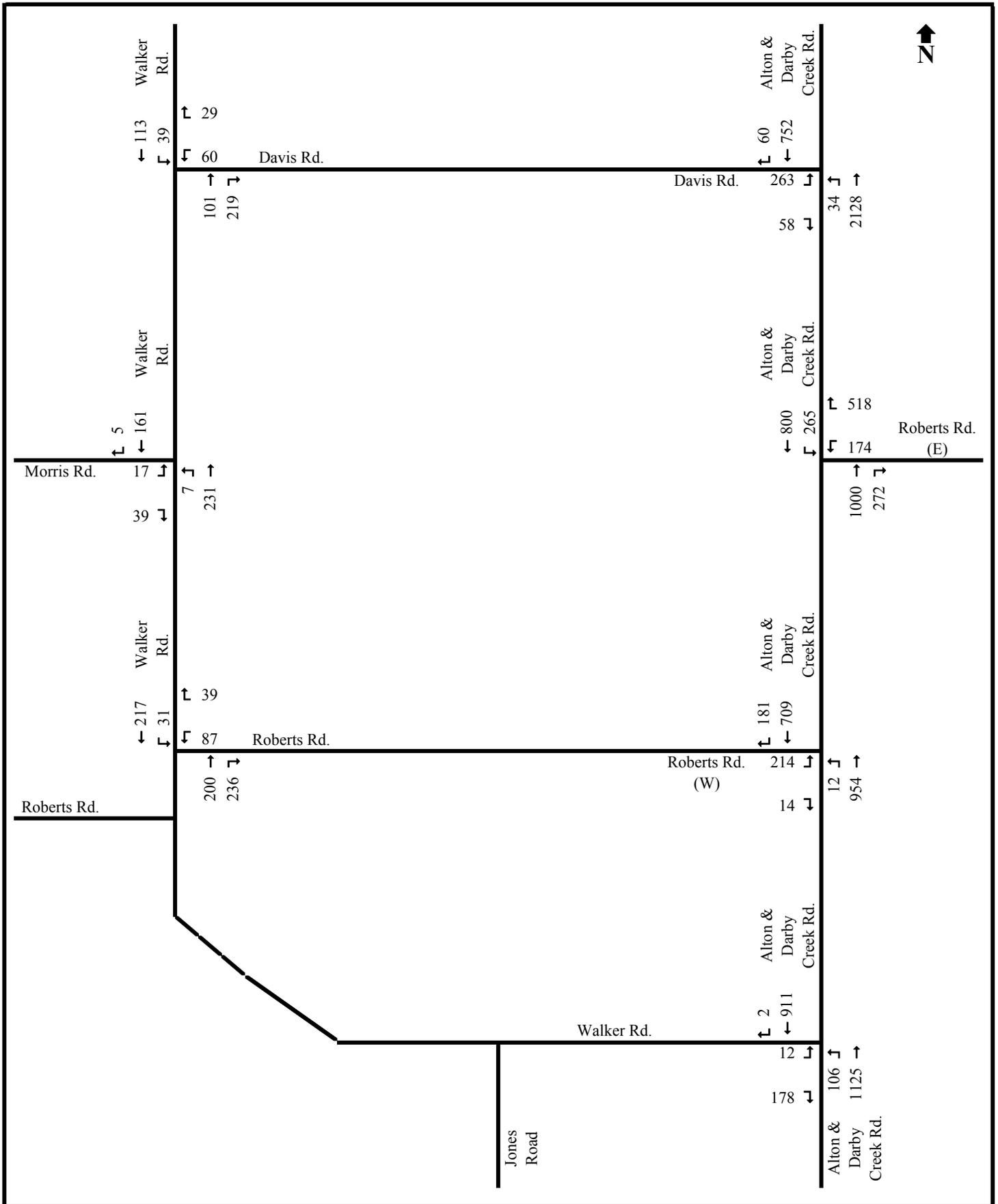


**HILLIARD HIGH SCHOOL (WALKER ROAD)
TRAFFIC IMPACT STUDY**

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FIGURE 9

2009 'BUILD' TRAFFIC W/ BROWN ELE.
BUSSES - 3-4 PM

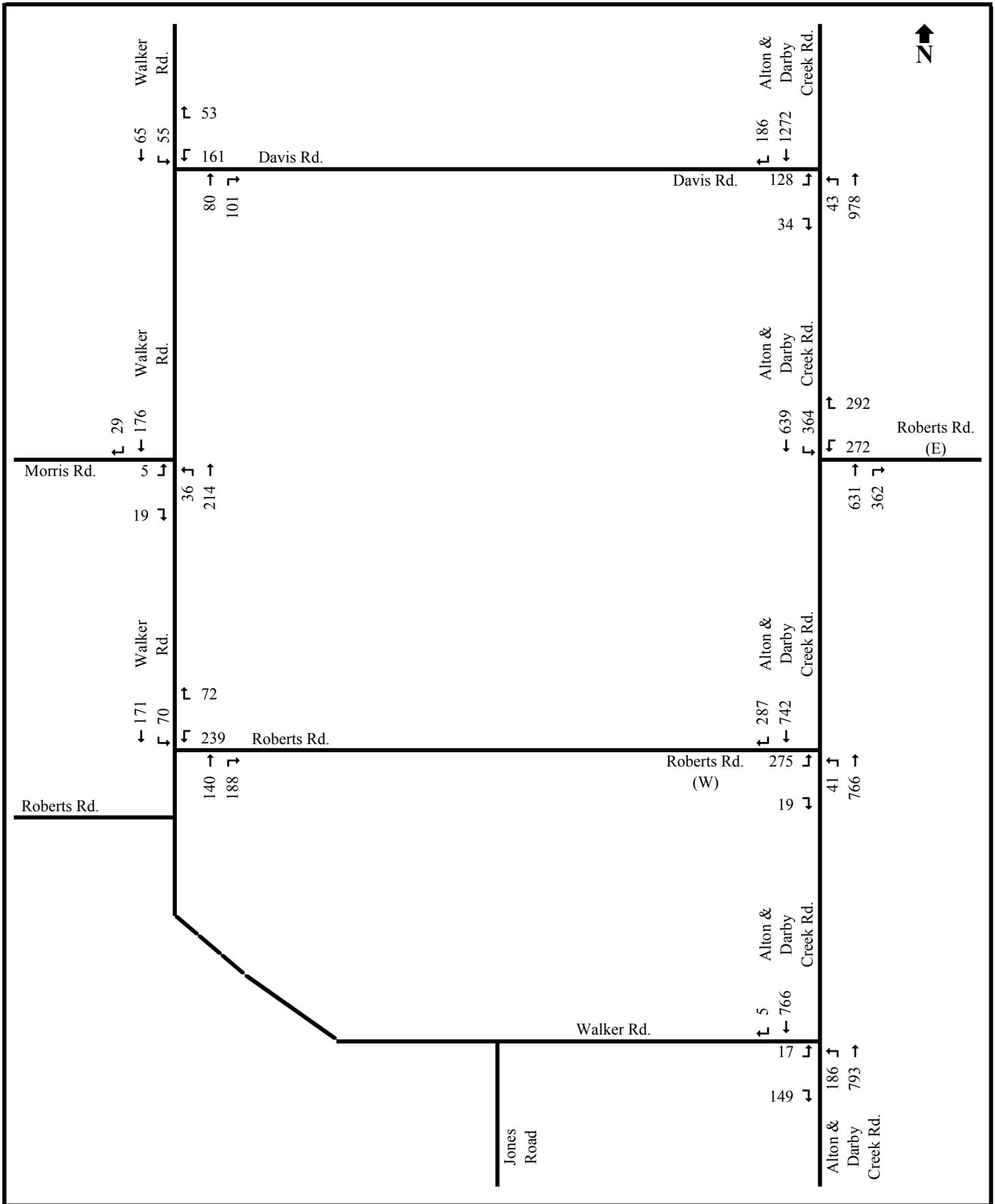


**HILLIARD HIGH SCHOOL (WALKER ROAD)
TRAFFIC IMPACT STUDY**

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FIGURE 10

2019 'NO BUILD' TRAFFIC - 7-8 AM



**HILLIARD HIGH SCHOOL (WALKER ROAD)
TRAFFIC IMPACT STUDY**

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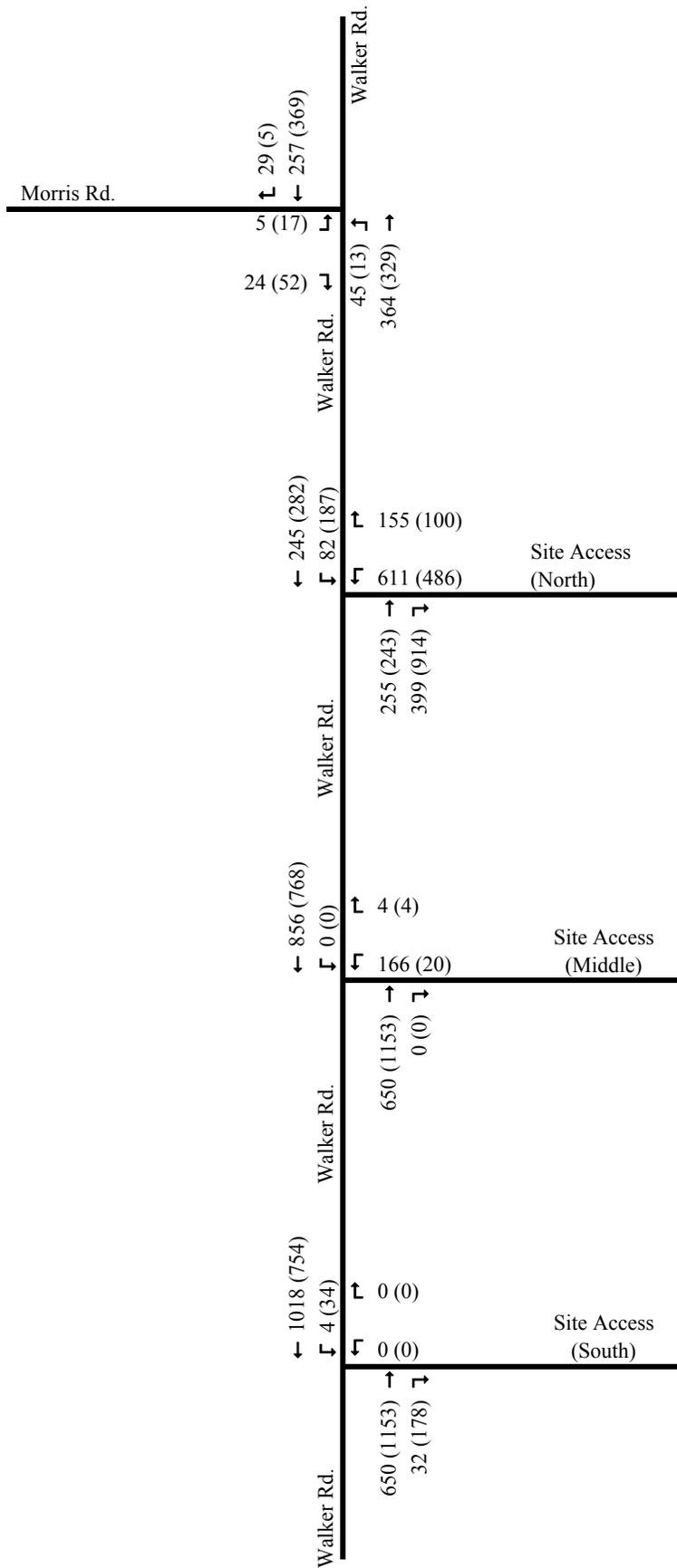
FIGURE 11

2019 'NO BUILD' TRAFFIC - 3-4 PM



LEGEND

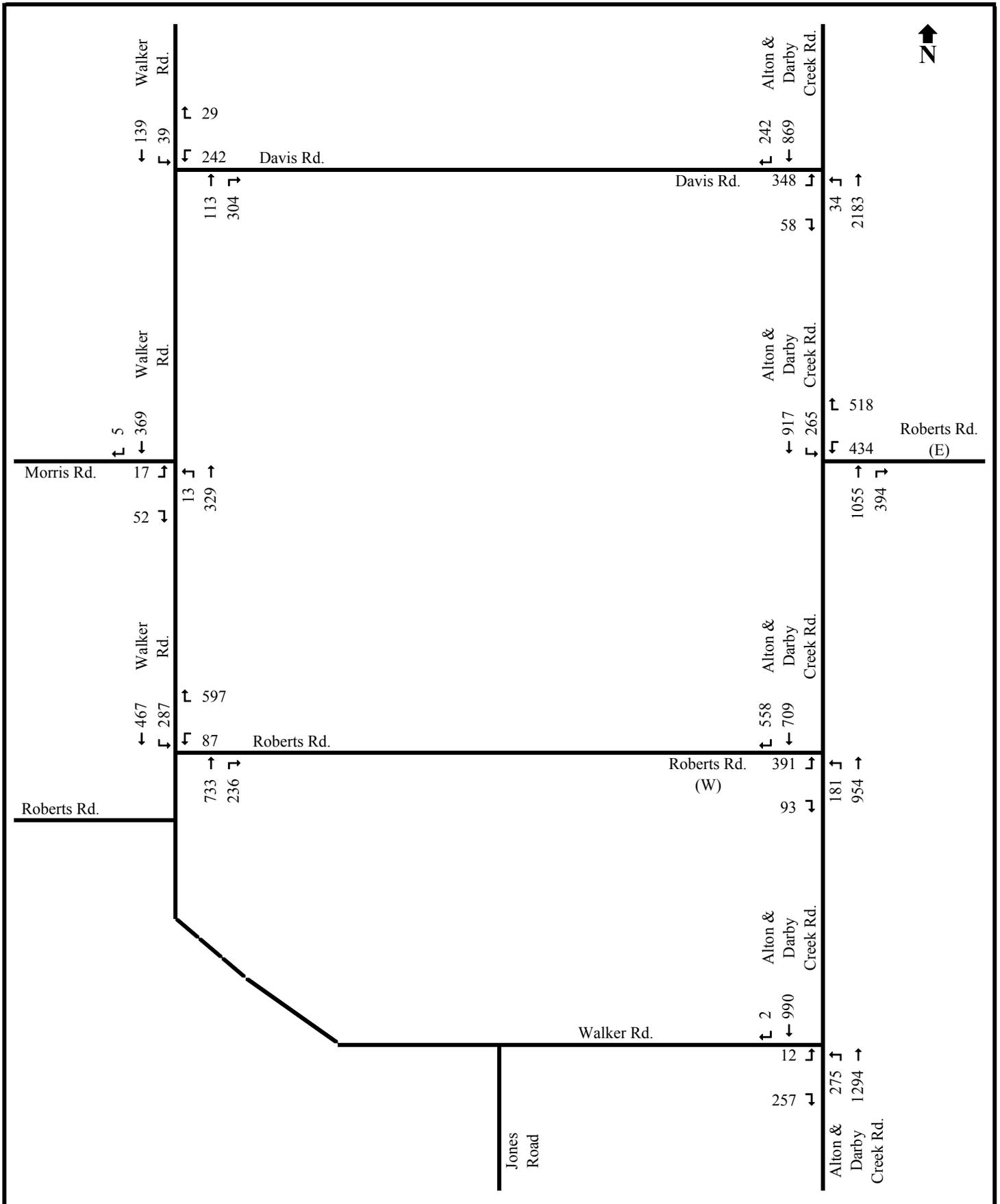
- 222 - 3-4 PM Hour Turning Movement
- (222) - 7-8 AM Hour Turning Movement



**HILLIARD HIGH SCHOOL (WALKER ROAD)
TRAFFIC IMPACT STUDY**

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FIGURE 12
2019 'BUILD' TRAFFIC W/ BROWN ELE.
BUSSES

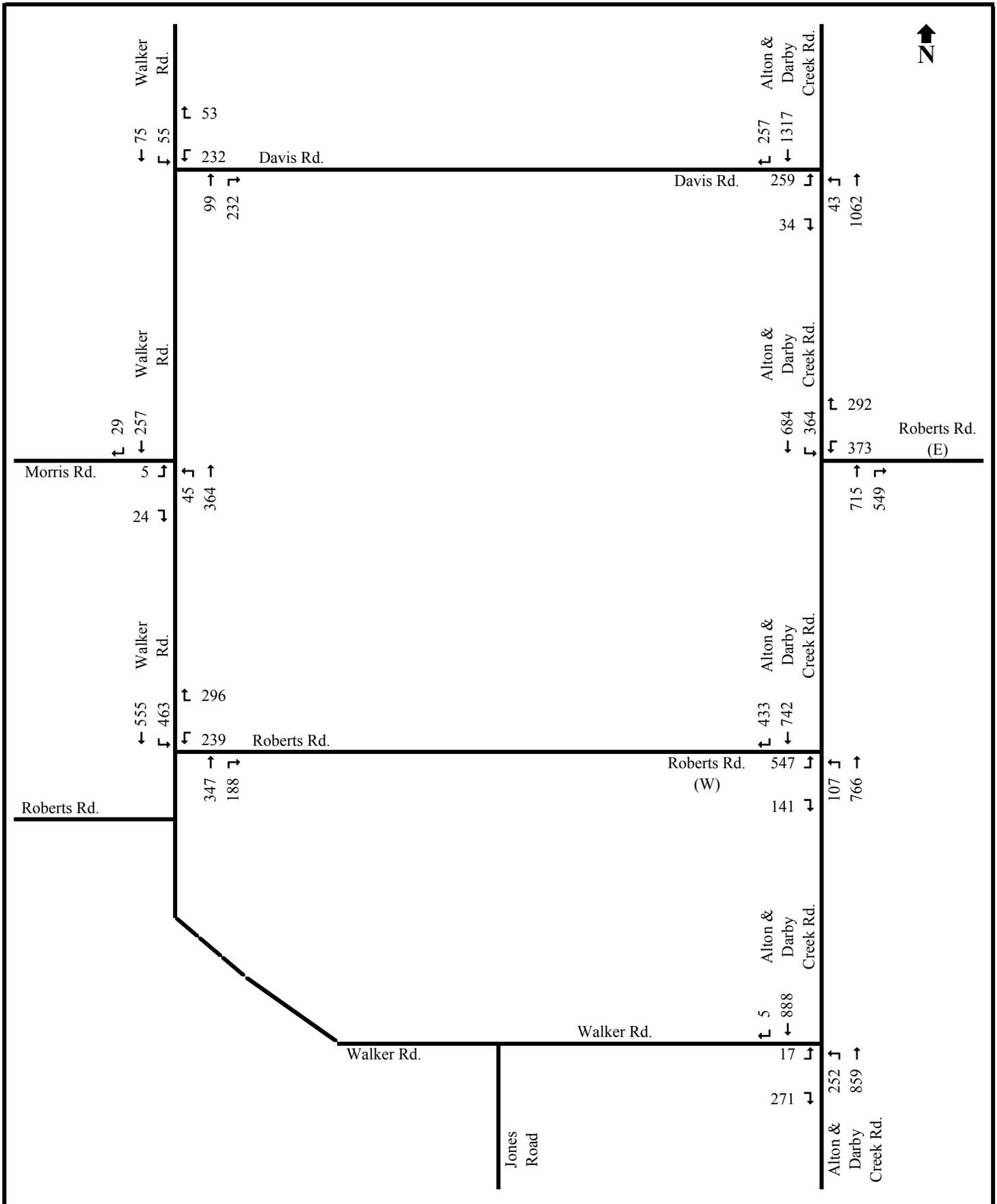


**HILLIARD HIGH SCHOOL (WALKER ROAD)
TRAFFIC IMPACT STUDY**

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FIGURE 13

**2019 'BUILD' TRAFFIC W/ BROWN ELE.
BUSSES - 7-8 AM**



**HILLIARD HIGH SCHOOL (WALKER ROAD)
TRAFFIC IMPACT STUDY**

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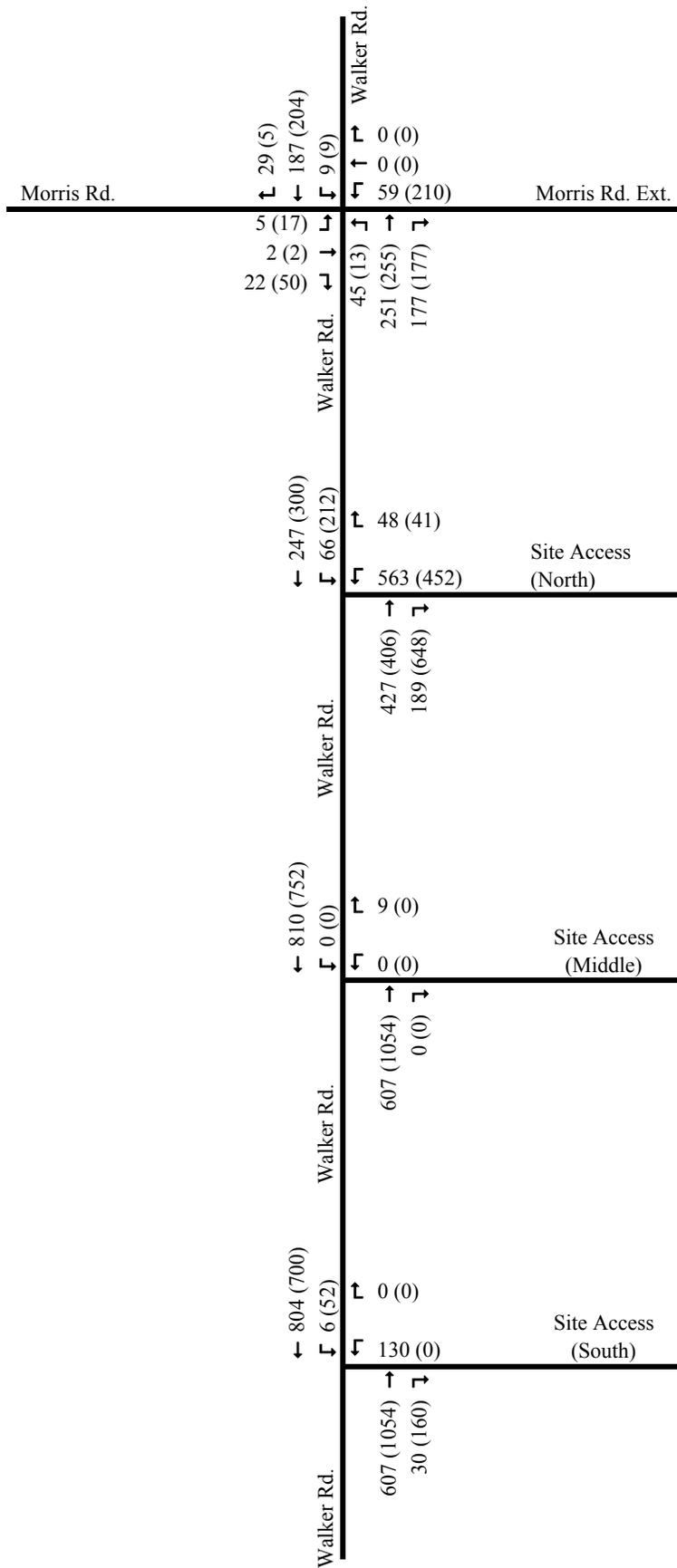
FIGURE 14

**2019 'BUILD' TRAFFIC W/ BROWN ELE.
BUSSES - 3-4 PM**



LEGEND

- 222 - 3-4 PM Hour Turning Movement
- (222) - 7-8 AM Hour Turning Movement

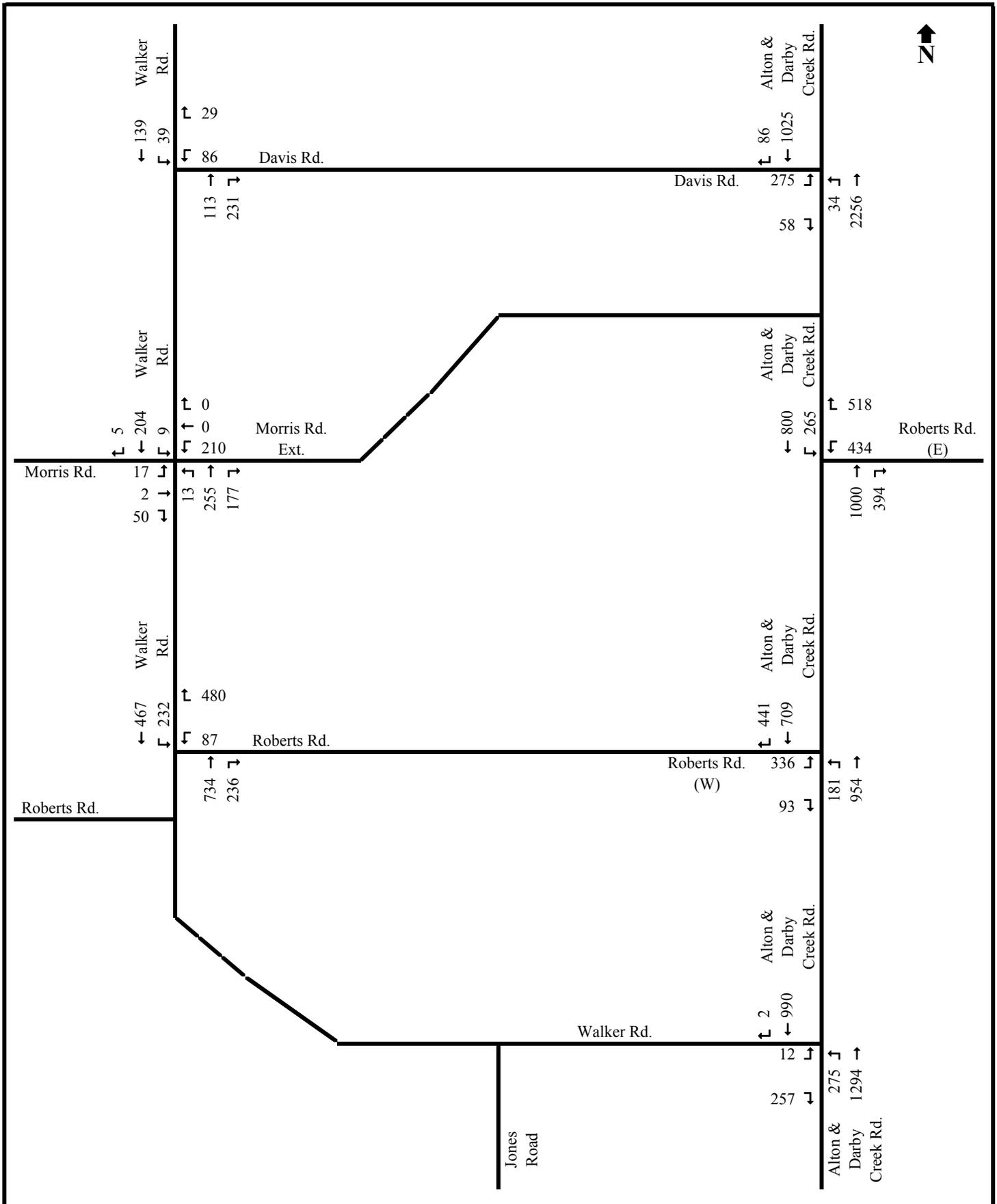


**HILLIARD HIGH SCHOOL (WALKER ROAD)
TRAFFIC IMPACT STUDY**

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FIGURE 15

2019 'BUILD' W/ MORRIS RD. EXTENSION
TRAFFIC W/ BROWN ELE. BUSES

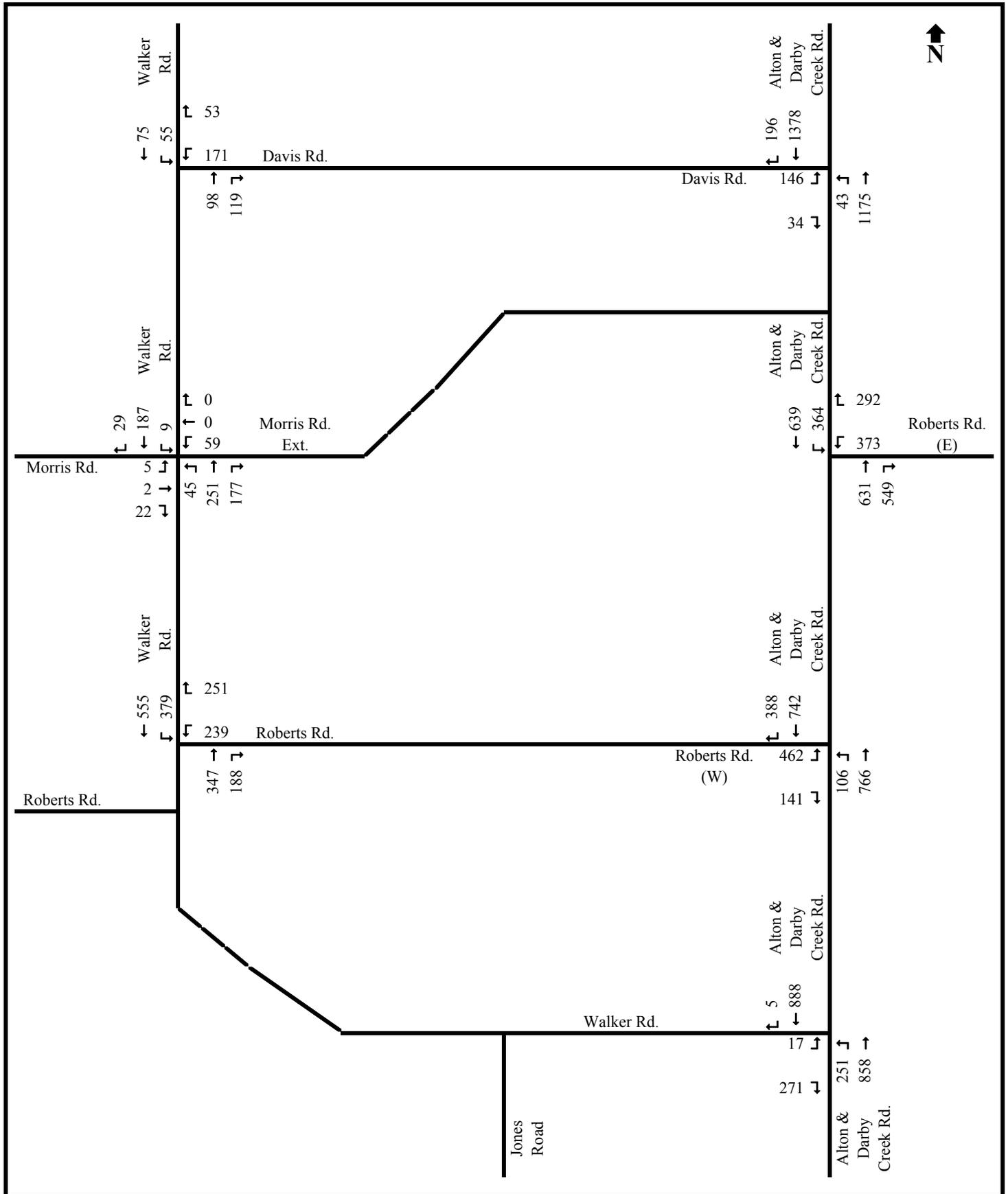


**HILLIARD HIGH SCHOOL (WALKER ROAD)
TRAFFIC IMPACT STUDY**

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FIGURE 16

**2019 'BUILD' W/ MORRIS RD. EXTENSION
TRAFFIC W/ BROWN ELE. BUSES - 7-8 AM**



**HILLIARD HIGH SCHOOL (WALKER ROAD)
TRAFFIC IMPACT STUDY**

PREPARED BY:



FIGURE 17

2019 'BUILD' W/ MORRIS RD. EXTENSION
TRAFFIC W/ BROWN ELE. BUSSES - 3-4 PM

TRAFFIC ANALYSES

Signal Warrant Analysis

Per the scope of the study, any signal warrant analyses had to be using the eight hour warrants. The purpose of the signal warrant analyses was to determine how to analyze each intersection for capacity. There are a total of 8 warrants in the *Ohio Manual of Uniform Traffic Control Devices, 2003 Edition (OMUTCD)*. If any of these are met, a signal is “warranted.” If a signal is warranted, it means it is above the minimum level that a signal is desirable and may or may not be recommended for installation. A listing of the 8 warrants follows:

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

For the warrants requiring volume data, the *OMUTCD* specifies two levels of volume criteria depending on the 85th percentile speed and the population of the municipality. The volumes necessary are lower for speeds greater than 40 MPH or for communities with a population less than 10,000. For the higher speed or lower population criteria, traffic volumes that are required to meet the warrants are typically a percentage of the volumes required for a lower speed or high population community. When speed data is not collected as part of the study, it is common practice to use the speed limit.

The *OMUTCD* states under “guidance” that engineering judgment should be used to determine what portion of the right-turn vehicles from the minor street approach should be deducted in the analysis. When right turns were considered in the analysis, they were discounted by 50%.

The County provided a 12 hour turning movement counts at both Alton & Darby Creek Road intersections with Roberts Road. From this information, it was determined that both of those intersections meet signal warrants under existing conditions. The signal warrants worksheets are in Technical Appendix “D”.

For the remaining intersections in the study area, 24 hour counts were not available. Therefore, it was necessary to calculate a factor for the eighth highest hour. The factor was calculated for any Alton & Darby Creek Road approach using the 12 hour counts provided by the County at the intersections of Alton & Darby Creek Road with Roberts Road. The two counts from the County indicated that the eighth highest hour on Alton & Darby Creek Road was 2-3 PM at one intersection and 9-10 AM at the other. This resulted in an average eighth highest hour factor of 63% of the 3-4 PM traffic. For the remaining approaches, a 2002 12 hour count on the Davis Road approach to Alton & Darby Creek Road was used to determine the factor. The eighth highest hour on the Davis Road approach was 11 AM – 12 PM. The result was an eighth highest hour factor of 54% of the 7-8 AM traffic.

The 2009 and 2019 ‘No Build’ traffic was tested against the eight hour signal warrant. A ‘Build’ analysis was not performed because the eighth highest hour would occur when traffic to and

from the school would be nominal and thus not change the results of the analyses. The results showed that a signal will likely be warranted in the 2009 'No Build' condition at Alton & Darby Creek Road and Davis Rd. Also, a signal is likely to be warranted in the 2019 'No Build' at Alton & Darby Creek Road and Walker Road. The calculations for this analysis are in Technical Appendix "D".

When projected traffic is used, signals are normally warranted on the basis of the eight hour warrants and not usually warranted on the basis of the Peak Hour warrant. The analysis of the north site access on Walker Road indicates the projected volumes are high enough to meet the Peak Hour warrant for a signal. If traffic volumes reach projected levels, a signal would help reduce the delays for vehicles leaving the site. This intersection should be monitored as school traffic develops.

Turn Lane Warrant Analysis

The procedure to determine whether turn lanes are warranted is according to the *State Highway Access Management Manual (AMM)* and the *L&D Manual* both published by the Ohio Department of Transportation (ODOT). According to the ODOT *L&D Manual*, turn lane warrants only apply to unsignalized free flow approaches. Therefore, any time period that a signal is projected to meet warrants, turn lane warrants were not analyzed. Table 2 shows a summary of the results of the turn lane warrant analyses. The graphs from the *AMM* are in Technical Appendix "D".

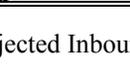
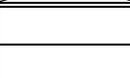
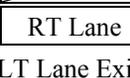
Intersection	Direction	2009 'No Build'	2009 'Build'	2019 'No Build'	2019 'Build'	2019 'Build' w/ Morris Rd. Ext
Walker Rd. & Davis Rd.	NB			RT Lane	RT Lane	RT Lane
	SB			LT Lane	LT Lane	LT Lane
Walker Rd. & Morris Rd.	NB				LT Lane	LT Lane
	SB					
Walker Rd. & Site Access (North)	NB		RT Lane		RT Lane	RT Lane
	SB		LT Lane		LT Lane	LT Lane
Walker Rd. & Site Access (Middle)	NB	No Projected Inbound Traffic				
	SB					
Walker Rd. & Site Access (South)	NB				RT Lane	RT Lane
	SB		LT Lane		LT Lane	LT Lane
Walker Rd. & Roberts Rd.	NB		RT Lane	RT Lane	RT Lane	RT Lane
	SB	LT Lane Exists				
Alton & Darby Creek Rd. & Walker Rd.	NB	LT Lane	LT Lane	Signal Warranted		
	SB					

Table 2 – Turn Lane Warrant Results

In addition to various turn lanes at the site access points, the addition of the site traffic causes the need for a northbound left turn lane on Walker Road at Morris Road. Another result of note is that a northbound right turn lane is warranted in both the 2009 ‘Build’ and the 2019 ‘No Build’.

Capacity Analyses

Peak Hour Factors were calculated for the 2009 and 2019 ‘Build’ conditions at the site access points and used in the capacity analyses. In 2019 there will be two schools separated by a half an hour so that was considered in the peak hour factor calculations. A 15 minute distribution was obtained from an existing count taken by M-E Engineering for the East Orange Road Traffic Study. The southern leg to the E. Orange Road & Rose Park Drive is the only access to Orange Middle School. This distribution data was used to estimate the distribution from the site. The same distribution was used for the middle school and high school but the peak was assumed to occur in interval #2 for the high school and interval #4 for the middle school. The computations are in Technical Appendix “D”.

For the off site intersections, an overall peak hour factor was calculated at the Alton & Darby Creek Road and Roberts Road (W) intersection for both the 2009 and 2019 ‘Build’ conditions. The overall peak hour factor for 2009 and 2019 respectively were 0.77 and 0.9 in the 7-8 AM hour and 0.72 and 0.85 in the 3-4 PM hour. The peak hour factor increases in 2019 because there is more background traffic and two schools are considered. Based on the calculations, a peak hour factor of 0.72 was assumed for all off site intersections during both peak hours in 2009 and 0.85 was assumed for all off-site intersections during both peak hours in 2019.

Signalized Capacity – Signalized Capacity analyses were performed at the off site intersections if signal warrants are expected to be met. In the capacity analyses, delays are computed which correspond to a Level of Service (LOS) “A” through “F”. In an urban area, Level of Service (LOS) “D” and above is generally considered an acceptable LOS. Since driver expectations are different for various types of traffic control, there are different LOS criteria for unsignalized intersections versus signalized intersections. LOS criteria for signalized intersections are shown in Table 3.

Level of Service	Delay Range (seconds/vehicle)
A	≤ 10
B	> 10 and ≤ 20
C	> 20 and ≤ 35
D	> 35 and ≤ 55
E	> 55 and ≤ 80
F	> 80

Source: Highway Capacity Manual 2000

Table 3 - Level of Service Criteria for Signalized Intersections

The purpose of the capacity analyses is to establish the improvements needed to mitigate the site traffic. Since all of the off-site intersections are “T” intersections, a 90 second cycle was assumed. The timing was adjusted to balance the critical approach delays.

For the intersections that met signal warrants in the ‘No Build’ case, it was assumed that the base condition included a signal and a left turn lane on the major street. Table 4 shows a summary of the results of the signalized capacity analyses. The additional improvements (designated by “IMP” in Table 4) determined to be needed by the capacity analyses are discussed in the Conclusions and Recommendations section. The detailed reports are in Technical Appendix “D”.

Unsignalized Capacity – Unsignalized capacity analyses were performed at the site access points and the study area intersections that are not expected to meet signal warrants. The LOS criteria for both two-way stop and all-way stop control are shown in Table 5. For a Two-Way Stop condition, the unsignalized capacity analysis gives LOS results for vehicles that must wait for gaps to make their maneuver. This would include left turns from the main street and both left and right turns from the side street. All other movements are free flowing so they don’t encounter delay. The lane configuration was based on the existing conditions with any warranted turn lanes.

Level of Service	Delay Range (seconds/vehicle)
A	< 10
B	> 10 and ≤ 15
C	> 15 and ≤ 25
D	> 25 and ≤ 35
E	> 35 and ≤ 50
F	> 50

Source: *Highway Capacity Manual 2000*

Table 5 - Level of Service Criteria for Unsignalized Intersections

For the Unsignalized capacity, the *HCS+* software was used. The purpose of the capacity analyses is to establish the improvements needed to mitigate the site traffic. When the capacity showed LOS below ‘D’ feasible improvements were added. In most cases, the possible improvements reduced the delay but did not provide a LOS of ‘D’ or above. A summary of the results of the unsignalized capacity analyses are shown in Tables 6. The additional improvements (designated by “IMP” in Table 6) determined to be needed by the capacity analyses are discussed in the Conclusions and Recommendations section. More detailed summaries of the capacity analyses are found in the Technical Appendix “D”.

It is noted that by observation, the north site access on Walker Road would meet the Peak Hour signal warrants in the 2009 ‘Build’ case so that is one potential solution for the delays exiting the site.

Intersection	Time	Year	Delay (Level of Service)				
			Intersection	Eastbound	Westbound	Northbound	Southbound
Alton & Darby Creek Rd. & Walker Rd.	3-4 PM	2019 'No Build'	19.1 (B)	30.8 (C)		11.5 (B)	26.1 (C)
		2019 'Build'	42.0 (D)	67.1 (E)		21.8 (C)	59.0 (E)
		2019 'Build' - Imp	22.1 (C)	31.3 (C)		12.2 (B)	31.5 (C)
	7-8 AM	2019 'No Build'	35.7 (D)	35.5 (D)		30.5 (C)	42.8 (D)
		2019 'Build'	86.4 (F)	83.2 (F)		92.7 (F)	77.5 (E)
		2019 'Build' - Imp	36.7 (D)	41.3 (D)		39.8 (D)	30.6 (C)
Alton & Darby Creek Rd. & Roberts Rd. (W)	3-4 PM	2009 'No Build'	17.3 (B)	20.6 (C)		13.1 (B)	19.2 (B)
		2009 'Build' W/ Brown Ele. Busses	60.0 (E)	79.4 (E)		12.3 (B)	81.8 (F)
		2009 'Build' W/ Brown Ele. Busses-Imp	36.3 (D)	50.4 (D)		9.6 (A)	46.1 (D)
		2019 'No Build'	52.6 (D)	80.6 (F)		8.0 (A)	79.7 (E)
		2019 'No Build'-Imp	23.0 (C)	28.5 (C)		15.4 (B)	27.5 (C)
		2019 'Build'	52.3 (D)	59.2 (E)		27.0 (C)	67.1 (E)
	7-8 AM	2009 'No Build'	15.9 (B)	19.0 (B)		15.5 (B)	15.1 (B)
		2009 'Build' W/ Brown Ele. Busses	52.2 (D)	79.2 (E)		9.0 (A)	78.2 (E)
		2009 'Build' W/ Brown Ele. Busses-Imp	36.1 (D)	50.1 (D)		7.7 (A)	54.7 (D)
		2019 'No Build'	27.0 (C)	40.6 (D)		13.4 (B)	38.3 (D)
		2019 'Build'	34.2 (C)	43.2 (D)		42.6 (D)	23.3 (C)
		2019 'Build' W/ Morris Rd. Extension W/ Brown Ele. Busses	33.6 (C)	32.1 (C)		42.6 (D)	25.2 (C)
Alton & Darby Creek Rd. & Roberts Rd. (E)	3-4 PM	2009 'No Build'	20.5 (C)		26.4 (C)	24.5 (C)	15.1 (B)
		2009 'Build' W/ Brown Ele. Busses	63.5 (E)		87.1 (F)	86.8 (F)	17.9 (B)
		2009 'Build' W/ Brown Ele. Busses-Imp	30.7 (C)		40.9 (D)	42.2 (D)	9.4 (A)
		2019 'No Build'	217.3 (F)		372.7 (F)	390.9 (F)	23.4 (C)
		2019 'No Build'-Imp	31.4 (C)		40.3 (D)	40.0 (D)	21.1 (C)
		2019 'Build'	49.8 (D)		60.3 (E)	68.8 (E)	20.2 (C)
	7-8 AM	2009 'No Build'	30.7 (C)		46.1 (D)	40.7 (D)	9.6 (A)
		2009 'Build' W/ Brown Ele. Busses	93.5 (F)		149.2 (F)	120.4 (F)	12.6 (B)
		2009 'Build' W/ Brown Ele. Busses-Imp	27.1 (C)		39.2 (D)	35.2 (D)	6.8 (A)
		2019 'No Build'	242.3 (F)		386.1 (F)	354.3 (F)	24.5 (C)
		2019 'No Build'-Imp	46.4 (D)		59.5 (E)	62.5 (E)	19.8 (B)
		2019 'Build'	95.3 (F)		127.6 (F)	131.4 (F)	25.0 (C)
Alton & Darby Creek Rd. & Davis Rd.	3-4 PM	2009 'No Build'	23.5 (C)	18.0 (B)		17.1 (B)	29.2 (C)
		2009 'Build' W/ Brown Ele. Busses	21.4 (C)	31.5 (C)		10.1 (B)	27.4 (C)
		2019 'No Build'	54.8 (D)	87.9 (F)		10.4 (B)	84.6 (F)
		2019 'No Build'-Imp	26.9 (C)	38.1 (D)		14.1 (B)	35.3 (D)
		2019 'Build'	55.1 (E)	73.3 (E)		21.8 (C)	75.1 (E)
		2019 'Build' W/ Morris Rd. Extension W/ Brown Ele. Busses	42.8 (D)	65.1 (E)		19.7 (B)	58.1 (E)
	7-8 AM	2009 'No Build'	28.4 (C)	34.1 (C)		36.4 (D)	6.3 (A)
		2009 'Build' W/ Brown Ele. Busses	61.9 (E)	78.1 (E)		89.0 (F)	8.5 (A)
		2009 'Build' W/ Brown Ele. Busses-Imp	47.2 (D)	72.3 (E)		66.9 (E)	4.2 (A)
		2019 'No Build'	267.4 (F)	350.2 (F)		358.5 (F)	8.2 (A)
		2019 'No Build'-Imp	242.0 (F)	328.1 (F)		323.8 (F)	4.7 (A)
		2019 'Build'	256.0 (F)	336.1 (F)		366.9 (F)	5.6 (A)
2019 'Build' W/ Morris Rd. Extension W/ Brown Ele. Busses	254.6 (F)	366.8 (F)		357.9 (F)	7.9 (A)		

Table 4 - SIGNALIZED CAPACITY SUMMARY (HCS Reports)

Intersection	Time	Year	Delay (Level of Service)			
			Main Street		Minor Street	
			Northbound Left	Southbound Left	Eastbound All	Westbound All
Alton & Darby Creek Rd. & Walker Rd.	3-4 PM	2009 'No Build'	8.9 (A)		15.1 (C)	
		2009 'Build' W/ Brown Ele. Busses	9.8 (A)		28.5 (D)	
	7-8 AM	2009 'No Build'	8.7 (A)		14.8 (B)	
		2009 'Build' W/ Brown Ele. Busses	10.7 (B)		38.6 (E)	
Walker Rd. & Roberts Rd.	3-4 PM	2009 'No Build'		7.6 (A)		11.8 (B)
		2009 'Build' W/ Brown Ele. Busses		9.9 (A)		947.0 (F)
		2009 'Build' W/ Brown Ele. Busses-Imp		9.9 (A)		329.5 (F)
		2019 'No Build'		8.2 (A)		32.9 (D)
		2019 'Build'		13.7 (B)		6639.0 (F)
		2019 'Build'-IMP		13.7 (B)		2410.0 (F)
	7-8 AM	2019 'Build' W/ Morris Rd. Extension W/ Brown Ele. Busses		12.0 (B)		1512.0 (F)
		2009 'No Build'		7.8 (A)		10.9 (B)
		2009 'Build' W/ Brown Ele. Busses		11.8 (B)		686.6 (F)
		2009 'Build' W/ Brown Ele. Busses-Imp		11.8 (B)		228.6 (F)
		2019 'No Build'		8.6 (A)		16.9 (C)
		2019 'Build'		17.8 (C)		2768.0 (F)
Walker Rd. & Site Access (South)	3-4 PM	2019 'Build'-IMP		17.8 (C)		620.4 (F)
		2019 'Build' W/ Morris Rd. Extension W/ Brown Ele. Busses		15.5 (C)		405.8 (F)
		2009 'Build' W/ Brown Ele. Busses		8.6 (A)		
	7-8 AM	2019 'Build'		9.1 (A)		
		2019 'Build' W/ Morris Rd. Extension W/ Brown Ele. Busses		9.1 (A)		
		2009 'Build' W/ Brown Ele. Busses		18.0 (C)		
Walker Rd. & Site Access (Middle)	3-4 PM	2019 'Build'		23.9 (C)		
		2019 'Build' W/ Morris Rd. Extension W/ Brown Ele. Busses		22.6 (C)		
		2009 'Build' W/ Brown Ele. Busses		8.4 (A)		528.0 (F)
	7-8 AM	2019 'Build'		9.0 (A)		1725.0 (F)
		2019 'Build' W/ Morris Rd. Extension W/ Brown Ele. Busses		8.9 (A)		13.2 (B)
		2009 'Build' W/ Brown Ele. Busses		12.7 (B)		149.3 (F)
Walker Rd. & Site Access (North)	3-4 PM	2019 'Build'		15.3 (C)		984.9 (F)
		2019 'Build' W/ Morris Rd. Extension W/ Brown Ele. Busses		7.2 (A)		381.9 (F)
		2009 'Build' W/ Brown Ele. Busses		8.7 (A)		431.1 (F)
	7-8 AM	2019 'Build'		10.5 (B)		1104.0 (F)
		2019 'Build' W/ Morris Rd. Extension W/ Brown Ele. Busses		9.7 (A)		1393.0 (F)
		2009 'Build' W/ Brown Ele. Busses		23.6 (C)		1621.0 (F)
Walker Rd. & Morris Rd.	3-4 PM	2019 'Build'		110.2 (F)		
		2019 'Build' W/ Morris Rd. Extension W/ Brown Ele. Busses		70.2 (F)		43543.0 (F)
		2009 'Build' W/ Brown Ele. Busses		23.6 (C)		
		2019 'Build' - Imp		8.4 (A)		
	7-8 AM	2009 'No Build'		7.5 (A)		9.2 (A)
		2009 'Build' W/ Brown Ele. Busses		7.7 (A)		9.7 (A)
		2019 'No Build'		7.9 (A)		10.6 (B)
		2019 'Build'		8.1 (A)		11.3 (B)
Walker Rd. & Davis Rd.	3-4 PM	2019 'Build' - Imp		7.9 (A)		8.4 (A)
		2009 'No Build'		7.4 (A)		9.4 (A)
		2009 'Build' W/ Brown Ele. Busses		8.0 (A)		11.3 (B)
		2019 'No Build'		7.6 (A)		11.0 (B)
7-8 AM	2019 'Build'		8.3 (A)		13.3 (B)	
	2019 'Build' - Imp		7.8 (A)	8.4 (A)	12.0 (B)	49.5 (E)
	2009 'No Build'		7.5 (A)		10.7 (B)	
	2009 'Build' W/ Brown Ele. Busses		7.9 (A)		12.3 (B)	
Walker Rd. & Davis Rd.	3-4 PM	2019 'No Build'		7.8 (A)		17.0 (C)
		2019 'Build'		8.3 (A)		20.6 (C)
		2019 'Build' - Imp		7.9 (A)		14.9 (B)
		2009 'No Build'		7.8 (A)		10.2 (B)
	7-8 AM	2009 'Build' W/ Brown Ele. Busses		7.9 (A)		14.4 (B)
		2019 'No Build'		8.5 (A)		13.6 (B)
		2019 'Build'		8.5 (A)		25.4 (D)
		2019 'Build' - Imp		8.2 (A)		13.8 (B)

Table 6 - Unsignalized Capacity Summary - (2-Way Stop, North-South Main Street)

CONCLUSIONS AND RECOMMENDATIONS

2009 and 2019 'No Build' and 'Build' volumes were developed for use in signal warrant, turn lane warrant, and capacity analyses. For the off site intersections, improvements and when the improvements are needed were determined from the analyses. For turn lane improvements, the length of each turn lane was computed for each volume set in which the turn lane was needed. The lengths were computed using the method in Section 400 of the *ODOT L&D Manual*. A design speed of 55 MPH was used. The detailed calculations of the turn lane lengths are in Technical Appendix "D". Table 7 shows a summary of the results of the Analyses for the off site intersections.

For the site access points on Walker Road, the lengths of the warranted turn lanes were computed based on the 2019 'Build' volumes. A sketch of how the improvements may look is shown in Figure 18. The detailed calculations of the turn lane lengths are in Technical Appendix "D".

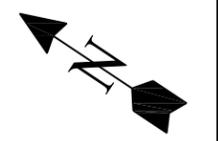
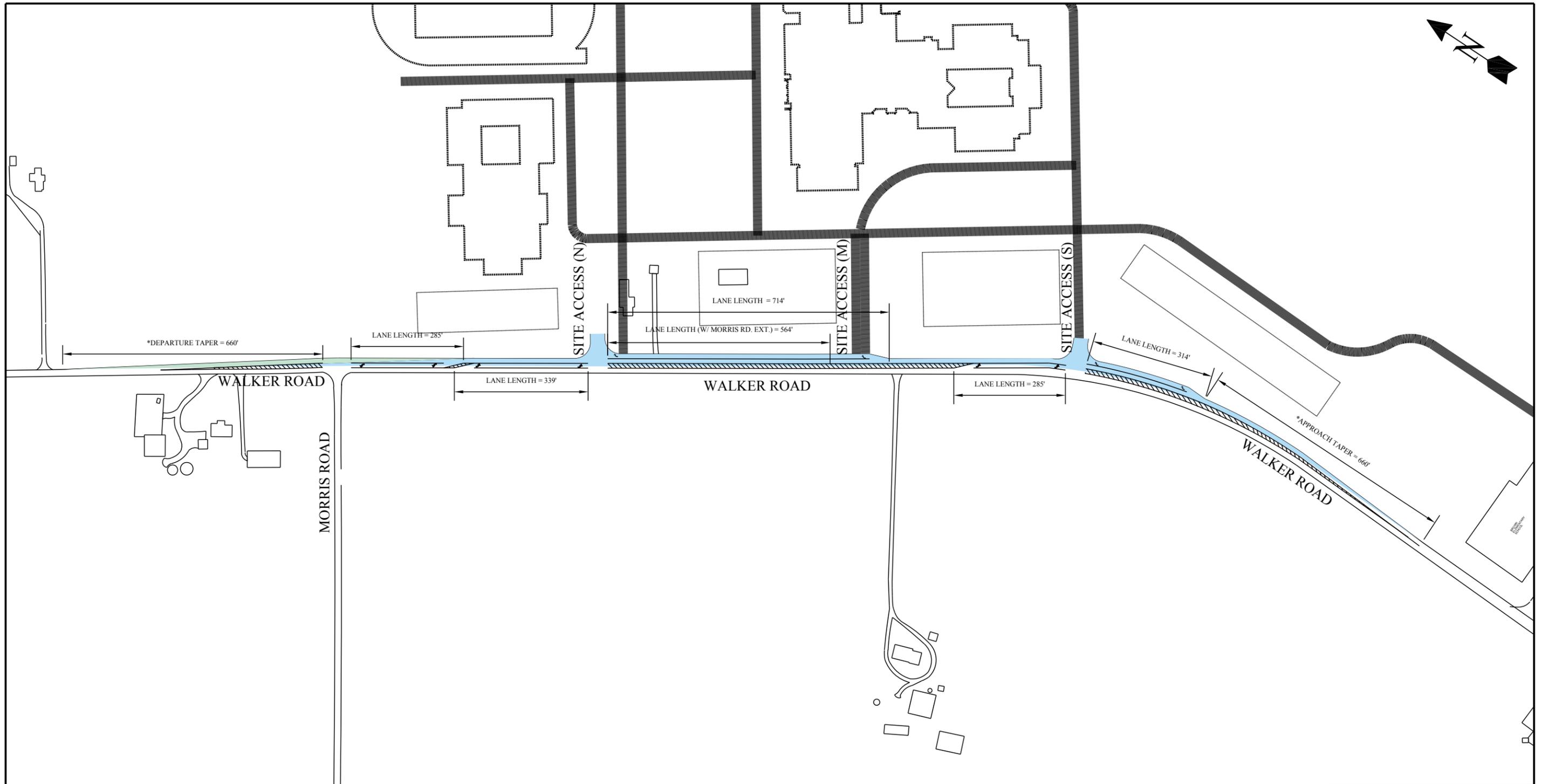
The results showed that three of the study area intersections will warrant signals without the school in 2009 and an additional one will warrant a signal by 2019 without the school. These four intersections are all located on Alton & Darby Creek Road. Per the pre-meeting for the project, a compounded growth rate of 7% per year was to be used. This resulted in a 241% increase in background traffic from 2006 to 2019. Alton & Darby Creek Road currently has in excess of 8,000 ADT.

The unsignalized capacity analysis revealed high delays on several of the stop approaches at two-way stop controlled intersections. There is a limited amount of turn lane improvements that are possible at an unsignalized intersection. Typically, adding the turn lanes does not bring the intersection side street "stop" movement to an acceptable Level of Service. Higher delays at a two-way stop for side street lefts and thru movements are unavoidable until a signal is warranted at the intersection.

The unsignalized capacity also revealed high delays for traffic leaving the site. When projected traffic is used, signals are normally warranted on the basis of the eight hour warrants and not usually warranted on the basis of the Peak Hour warrant. The analysis of the north site access on Walker Road indicates the projected volumes are high enough to meet the Peak Hour warrant for a signal. If traffic volumes reach projected levels, a signal would help reduce the delays for vehicles leaving the site. This intersection should be monitored as school traffic develops.

Intersection	Direction	2009 'No Build'	2009 'Build'	2019 'No Build'	2019 'Build'	2019 'Build' w Morris Rd. Ext
Alton-Darby Creek Rd. & Walker Road	Intersection			Signal Warranted		Volumes not Affected
	Northbound	Add Left Turn Lane (285')	Extend Left Turn Lane to 314'	Add Left Turn Lane with Signal Improvements (364')	Extend Left Turn Lane to 439'	
	Southbound					
	Eastbound		Add Left Turn Lane (285')		Add EB Left Turn (285')	
Alton-Darby Creek Rd. & Roberts Road (W)	Intersection	Signal Warranted		Signal Warranted		
	Northbound	Add Left Turn Lane with Signal Improvements (285')	Extend Left Turn Lane to 339'	Add Left Turn Lane with Signal Improvements (285')	Extend Left Turn Lane to 364'	Extend Left Turn Lane to 364'
	Southbound			Add Right Turn Lane (489')	Extend Right Turn Lane to 664'	Extend Right Turn Lane to 539'
	Eastbound		Add Left Turn Lane (514')	Add Left Turn Lane (439')	Extend Left Turn Lane to 600'	Extend Left Turn Lane to 600'
Alton-Darby Creek Rd. & Roberts Road (E)	Intersection	Signal Warranted		Signal Warranted		
	Northbound			Add Right Turn Lane (439')	Extend Right Turn Lane to 539'	Extend Right Turn Lane to 539'
	Southbound	Add Left Turn Lane with Signal Improvements (364')		Add Left Turn Lane with Signal Improvements (539')		
	Westbound		Add Left Turn Lane (489')	Add Left Turn Lane (439')	Extend Left Turn Lane to 564'	Extend Left Turn Lane to 564'
Alton-Darby Creek Rd. & Davis Road	Intersection	Signal Warranted		Signal Warranted		
	Northbound	Add Left Turn Lane with Signal Improvements (285')		Add Left Turn Lane with Signal Improvements (285')		
	Southbound			Add Right Turn Lane (364')	Extend Right Turn Lane to 439'	
	Eastbound		Add Left Turn Lane (364')	Add Left Turn Lane (439')	Extend Left Turn Lane to 514'	
Walker Road & Roberts Road	Intersection					
	Northbound		Add Right Turn Lane (285')	Add Right Turn Lane (339')		
	Southbound	Existing Left Turn Lane (345')			Extend Right Turn Lane to 489'	Extend Right Turn Lane to 439'
	Westbound		Add Left Turn Lane (289')	Add Left Turn Lane (339')		
Walker Road & Morris Road	Intersection					
	Northbound				Add Left Turn Lane (285')	Add Left Turn Lane (285')
	Southbound					
	Eastbound					
Walker Road & Davis Road	Intersection					
	Northbound			Add Right Turn Lane (339')	Extend Right Turn Lane to 364'	
	Southbound			Add Left Turn Lane (285')		
	Westbound					

Table 7 - Off Site Intersection Improvement Summary



LEGEND

- ADDITIONAL PAVEMENT NEEDED FOR ACCESS ROADWAY IMPROVEMENTS
- ADDITIONAL PAVEMENT NEEDED FOR FUTURE MORRIS ROAD ROADWAY IMPROVEMENTS

SCALE: 1" = 250'

NOTE:

* = EXISTING PAVEMENT DOES NOT HAVE 12 FOOT LANES SO APPROACH AND DEPARTURE TAPERS WILL LIKELY NEED TO BE LONGER IN ORDER TO MATCH EXISTING PAVEMENT.

FIGURE 18

ROADWAY IMPROVEMENTS
 HILLIARD HIGH SCHOOL
 (WALKER ROAD)
 TRAFFIC IMPACT STUDY

PREPARED BY:
 TRAFFIC ENGINEERING
 SERVICES, INC.