McMAHON ASSOCIATES, INC.
835 Springdale Drive, Suite 200
Exton, PA 19341
p 610-594-9995 | f 610-594-9565

PRINCIPALS
Joseph J. DeSantis, P.E., PTOE
John S. DePalma
Casey A. Moore, P.E.
Gary R. McNaughton, P.E., PTOE
Christopher J. Williams, P.E.

ASSOCIATES
John J. Mitchell, P.E.
R. Trent Ebersole, P.E.
Matthew M. Kozsuch, P.E.
Maureen Chlebek, P.E., PTOE
Dean A. Carr, P.E.
Jason T. Adams, P.E., PTOE
Christopher K. Bauer, P.E., PTOE

FOUNDER
Joseph W. McMahon, P.E.

May 15, 2020

Mr. Russell Hatton, Chair
Westtown Township Planning Commission
1039 Wilmington Pike
West Chester, PA 19382

RE: **Robinson Tract Residential Development**
Westtown Township, Chester County, PA
McMahon Project No. 816451.11

Dear Mr. Russell:

McMahon Associates, Inc. is in receipt of the Township's comment letter, prepared by Albert Federico Consulting, LLC in their capacity as the Township traffic engineer, dated March 13, 2020, in regards to the T*ransportation Impact Study for the Robinson Tract*, prepared by our office and last revised December 2, 2019. It is noted that the applicant was not sent a copy of this letter for review. The development is proposed to be located on the Crebilly Farm property along the west side of U.S. Route 202 (Wilmington Pike), between West Pleasant Grove Road and Street Road (S.R. 0926), in Westtown Township, Chester County, Pennsylvania. On behalf of the applicant, below is a summary of the comments in italics, with our responses following each comment.

Comment #1ai: *As previously noted, Table 1 should be updated to identify West Pleasant Grove Road as a Township Collector Roadway. {Westtown Township Comprehensive Plan Update, page 9-7}.*

Status: In consideration of the ongoing coordination the Applicant has yet to submit a revised TIS. The submitted correspondence does not commit to this revision.

Response: West Pleasant Grove Road does not meet the Collector Road standards under the Township's road specifications. The applicant has agreed to widen along the property frontage to meet the Township's Collector Road half-width requirement of 14 feet. Table 1 has been revised to note that the applicant will widen West Pleasant Grove Road along the property frontage to meet the Township's half-width requirement for Collector Roads.

Comment #1aii: *The sections of the TIS discussing improvements should note that the internal Collector Road provides access to the property.*

Status: In consideration of the ongoing coordination the Applicant has yet to submit a revised TIS. The submitted correspondence does not commit to this revision.

Response: Complies. The Collector Road is not necessary for access to the site, but does provide secondary access locations. Page 3 of the TIS has been revised accordingly.

Comment #1aiii: *As previously noted, the Crash Summary only includes data for State "Reportable" collisions. In order to provide a more complete assessment of transportation safety within the study area "Nonreportable" collisions should be included. Note that the Traffic Safety Office is unaware* of *an outstanding request for "more detailed information". The applicant should resubmit the request to the Traffic Safety Office and Township Traffic Engineer, including the specific details being requested.*

Status: Supplemental information has been provided to the applicant. Based on coordination with the Applicant it is anticipated that this information will be considered in the revised TIS.

Response: The Westtown-East Goshen Township Regional Police Department provided additional non-reportable crash data. This data was summarized and provided to the Township Traffic Engineer.

Comment #1aiv: *As previously noted, the scope of physical improvements required to provide acceptable sight distance to public roads should be clearly indicated on the plans.*

Status: The submitted correspondence requests deferring this item until "detailed engineering' is completed.

Response: As documented on page 11 of the transportation impact study, dated revised May 15, 2020, the existing available sight distances at the site accesses meet or exceed the Township and PennDOT requirements.

Comment #1v: *As previously noted, confirm that the sight distance measurements consider the widening (approximately seven feet) of West Pleasant Grove Road required to meet Code. {§149-903.A(2)}*

Status: The submitted correspondence indicates that the measurements are based on the existing roadway.

Response: No further response required.

Comment #1vi: *Provide calculations supporting the assumed diversions associated with Orvis Way and the proposed Collector Road. Additionally, cross reference the Collector Road diversions within the body of the study with the figures in Appendix K.*

Status: Supplemental materials have been submitted in response to this comment. Coordination is on-going.

Response: As documented in the TIS within the conditional use application, based on a conference call conducted on May 14, 2020, PennDOT's consultant reviewer and the Township's Traffic Engineer indicated there are no further comments to address regarding the traffic diversions in the applicant's studies.

Comment #1vii: *The Travel Time Comparisons presented in Appendix K should be revised to address the following:*
(1) Verify the assumed route lengths. The Diversion Routes generally appear to be shorter than the Base conditions.
(2) Ensure that the impacts of the regular queueing along US Route 202 North during the morning peak, extending from the interchange into the study area, is included.
(3) The evaluation of diversions should include an alternate that considerations operations following the completion of the PennDOT improvements planned for US Route 202 and PA Route 926.
(4) The traffic calming anticipated to be installed along Bridlewood Boulevard should be considered.

Status: Supplemental materials have been submitted which address these comments.

Response: No further response is needed.

Comment #viii: *As previously noted, the anticipated increase in larger vehicles traveling along West Pleasant Grove Road and turning to/from New Street increases the possibility of vehicular conflicts. It is noted that*
(1) The applicant has indicated a willingness to widen the roadway along the property frontage, but additional clarification regarding the specific scope of work is warranted.
(2) West Pleasant Grove Road is designated as a Collector Road and the total Right-of-way shall be 60 feet and cartway width shall be 28 feet. {§149-903.A(2)}

Status: The submitted correspondences indicates that the Applicant will widen West Pleasant Grove Road along the frontage to Collector Road standards.

Response: No further response needed.

Comment #ix: *As previously noted, the future operations presented for PA Route 926 and New Street rely primarily on "optimized" traffic signal timings that appear unlikely to be approved by PennDOT. Written confirmation from PennDOT should be provided that the assumed "optimized" timings can be implemented. If confirmation cannot be provided an alternative analysis utilizing a timing approved by the Township should be provided.*

Status: Based on direction from PennDOT, it is anticipated that this analysis will be modified in the revised TIS.

Response: Based on a meeting February 11, 2020, PennDOT required the applicant to revise the signal timings at PA 926 and New Street to provide a minimum of 63 seconds of green time along PA 926. This revision is included in the revised TIS, and results in no changes to the mitigation requirements or recommendations.

Comment #x: As previously noted, the Cross Section Assumptions Exhibit for PA Route 926 and New Street in Appendix I is based on a traditional widening. Alternative alignments that minimize the number of properties from which right-of-way would be needed should be considered. Additionally, the Applicant is not precluded from coordinating with property owners to determine if the right-of-way could be reasonably obtained.

Status: The Applicant committed to PennDOT (and represented to the Planning Commission) that revised improvement concept(s) would be prepared for PennDOT and Township review and would be used to coordinate with the potentially affected property owners.

Response: The applicant has submitted a conceptual plan and is continuing to coordinate with PennDOT, Westtown Township, and Thornbury Township regarding improvements at the intersection of Street Road (S.R. 0926) and New Street. Traffic analysis worksheets documenting the results with the additional intersection improvements illustrated in the conceptual plans are attached.

Comment #xi: As previously noted, Cost Estimates for necessary improvements to accommodate future traffic should be provided. {§149-804.A(10)}

Status: The submitted correspondences indicates that the Applicant will provide this information once there is

Response: No further response needed.

Comment #xii: As previously noted, an Implementation Strategy for necessary improvements to accommodate future traffic should be provided. {§149-804.A(11)}

Status: The submitted correspondences indicates that the Applicant will provide this information once there is

Response: The applicant will provide an implementation strategy upon final land development approval and the HOP process. The transportation improvements will be completed prior to occupancy, as required.

Comment #2a: *The conclusion that the project does not adversely impact the intersection of US Route 202 and PA Route 926 continues to be based in large part on assumed diversions. As noted above, additional supporting information and analyses should be provided.*
Status: Supplemental materials have been submitted and coordination is on-going. The Applicant has yet to submit a revised TIS.

Response: As documented in the revised TIS, based on a conference call conducted on May 14, 2020, PennDOT's consultant reviewer and the Township's Traffic Engineer indicated there are no further comments to address regarding the traffic diversions in the applicant's studies.

Comment #2b: *The Applicant has indicated that turn lanes will be provided to accommodate post development volumes at the following intersections, but these improvements are not reflected on the plans:*
i. US Route 202 at Pleasant Grove Road – Southbound Right Turn
Status: The submitted correspondences indicates that the Applicant will make this improvement and that plans will be provided there is "concurrence" regarding the scope of improvements.
ii. PA Route 926 at New Street – Eastbound Left Turn
Status: The submitted correspondence offers an opinion that this improvement is unwarranted. Based on direction from PennDOT it is anticipated that the analysis will be modified in the revised TIS.

Response: i. No further response is required.
ii. As documented in the TIS, the development has no traffic impact at this intersection, based on PennDOT overall intersection mitigation criteria. PennDOT is requiring the applicant to evaluate the ability to provide dedicated left-turn lanes along PA 926. These lanes are needed based on existing conditions, and require right-of-way not controlled by the applicant to implement. The applicant has submitted conceptual plans to PennDOT, Westtown Township, and Thornbury Township for review, and will coordinate with the impacted property owners regarding the acquisition of right-of-way needed to complete the improvements.

Comment #2ci: *Additional grading and/or traffic management measures appear warranted to enhance safety at the three accesses proposed to have insufficient sight distance or the exact minimum distance (with no margin for error):*

(1) Collector Road at PA Route 926 (grading)
(2) Road M at West Pleasant Grove Road (grading and/or roundabout)
(3) Collector Road at West Pleasant Grove Road (grading and/or roundabout)

Status: The submitted correspondences requests deferring addressing these items until "detailed engineering" is completed.

Response: As documented on page 11 of the transportation impact study, dated revised May 15, 2020, the existing available sight distances at the site accesses meet or exceed the Township and PennDOT requirements. For the intersection of West Pleasant Grove Road and the Connector Road, the transportation impact study demonstrates that this intersection satisfies industry standard PennDOT traffic operations criteria and safety with stop-control on Collector Road approach. Aesthetics are not required by code. However, the applicant offers to install a mini roundabout at the Collector Road/West Pleasant Grove Road intersection, provided the Township acquires any necessary right-of-way to install. Traffic analysis worksheets for a mini roundabout at this location are attached.

Comment #2cii: *In order to minimize external conflict points, promote internal connectivity, reduce the number of cul-de-sacs and enhance overall safety along West Pleasant Grove Road:*
(1) Road M should be removed
(2) Roads L and N should be extended to form a single road

Status: The submitted "Alternate" plan removed the external access without connecting the internal roadways. It has been conveyed to the Applicant on several occasions that these items are intended to be addressed together: connect the internal roads (to remove the cul-de-sacs) and remove the external access.

Response: There is no requirement under the ordinance for these two items to be addressed together. The proposed internal roadway design is safe and has sufficient internal connectivity. Removing Road M and extending roads L and N does not create any additional internal connectivity or enhance safety, rather it unnecessarily adversely impacts the environmentally sensitive areas in the northern portion of the property. This comment violates Section 170-1617.C.(2) of the Zoning Ordinance which provides that "potential development areas also shall be delineated so as to minimize intrusion into secondary conversation areas.

Comment #2ciii: *The design of the internal Collector Road should incorporate suitable traffic calming measures to maintain a 35 mile per hour average travel speed.*

Status: The submitted correspondences requests deferring this item until Land Development.

Response: No further response required.

Comment #2iv: *The submitted plans should be revised to ensure they accurately reflect existing driveways in the immediate vicinity of the site, in particular the exit-only driveway from the Westminster Presbyterian Church.*

Status: The driveway is reflected on the plan but is difficult to discern due to drafting. It appears the proposed site access to West Pleasant Grove Road (via the Collector Road) will impact the

Church Driveway. Provisions should be made for future access from the Westminster Presbyterian Church to the internal Collector Road at a mutually agreed upon location.

Response: As documented in the alternate plan dated February 13, 2020, the applicant is providing an easement for the church to connect an access along the Connector Road.

Comment #2v: *The plans should identify the anticipated limits of required right-of-way and/or easements to accommodate the physical improvements associated with the PennDOT project at US Route 202 and PA Route 926.*

Status: The submitted correspondences indicates that right-of way is being offered. The Applicant does correctly note that the PennDOT project is not fully engineered. The plans should include a note indicating that other reasonable right-of-way and/or easement required for the improvements will be provided to PennDOT as needed.

Response: No further response needed.

Comment #2vi: *The following internal roadways should be reconfigured to remove geometric irregularities:*
(1) Road E and Road F (provide a curve)
(2) Road F and Road G (provide a curve)
(3) Road I and Road J (remove the jog within the intersection)

Status: The submitted materials do not adequately address these comments. The Applicant has represented to the Planning Commission that Stop signs will be used to compensate for these irregular designs. To date no information has been provided documenting that the signs would meet accepted warrants.

Response: The internal intersection design complies with section 149-907.A of the Township SALDO, which does not apply during the conditional use process.

Comment #vii: *Additional facilities should be provided to address non-vehicular connectivity, including:*
(1) A perimeter trail around the portion of the site west of the internal Collector Road. {Westtown Township Comprehensive Plan Update, page 9-15}
(2) Connections to existing and planned facilities along Dunvegan Road and within the Arborview neighborhood. {Westtown Township Comprehensive Plan Update, page 9-15}
(3) Sidewalks along proposed roads, including accessible crossings. {§149-916}
(4) Connectivity to pedestrian attractors, including Stetson Middle School, Westminster Presbyterian Church, and the existing retail uses at US Route 202 and PA Route 926. {§149-916}

Status: The submitted materials do not adequately address these comments. It is noted that a supplemental plan was presented to the Planning Commission which included a partial connection to Arborview and a trail from an internal roadway to the intersection of US Route 202 and PA Route 926.

Response: As documented in the conditional use application, the applicant is providing non-vehicular facilities from the development to the edge of the right-of-way at the Arborview property boundary. Connection to the Arborview trail is an offsite improvement that is not required. As required by PennDOT, non-vehicular facilities will be provided in conjunction with the PA 926 Connector Road/Bridlewood Boulevard signalized intersection within the right-of-way. As documented in the alternate plan, the applicant is provided non-vehicular facilities to connect the development to US 202/PA 926.

Comment #viii: *Provisions should be made for future access from the Westminster Presbyterian Church to the internal Collector Road.*
Status: The Alternate Plan does indicate a location for potential access. To date there is no information indicating that this location has been reviewed with the Church. Based on initial coordination with the Church a location further south along the Collector Road may be preferred.

Response: As documented in the conditional use application plans, the applicant is providing an easement for the church to connect an access along the Connector Road.

Comment #ix: *Provisions should be made for School Bus Stops, including short-term parking for drop-off and pick-up.*
Status: The submitted correspondences requests deferring this item until Land Development.

Response: School Bus Stops are not required pursuant to Township code. However, the applicant is providing designated school bus areas within the development, as documented in the conditional use application on the alternate plan.

If there are any questions or if additional information is needed, please feel free to contact me at nkline@mcmahonassociates.com or (610) 594-9995.

Sincerely,

Nicole R. Kline-Elsier

Nicole R. Kline-Elsier, P.E., PTOE
Regional Service Leader - Traffic

NRKE

cc: Robert Pingar, P.E., Westtown Township
Will Ethridge, Westtown Township
Andrew Semon, Toll Brothers
Michael Downs, P.E., Toll Brothers
Gregg Adelman, Esq., Kaplin Stewart

ATTACHMENTS

Street Road (S.R. 0926) and New Street

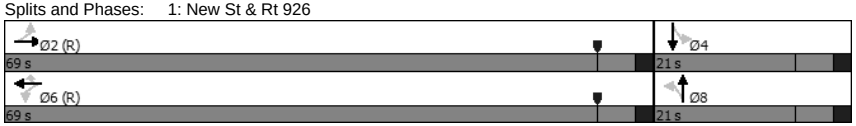
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	84	663	5	12	393	38	10	106	44	8	133	156
Future Volume (vph)	84	663	5	12	393	38	10	106	44	8	133	156
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Lane Width (ft)	10	10	10	10	10	10	10	10	10	10	10	10
Grade (%)		-2%			1%			-2%			1%	
Storage Length (ft)	175		0	150		150	0		0	0		0
Storage Lanes	1		0	1		1	0		0	0		0
Taper Length (ft)	75			75			75			75		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.999				0.850		0.963			0.929	
Flt Protected	0.950			0.950				0.997			0.999	
Satd. Flow (prot)	1580	1630	0	1588	1562	1379	0	1586	0	0	1530	0
Flt Permitted	0.503			0.332				0.910			0.991	
Satd. Flow (perm)	837	1630	0	555	1562	1379	0	1448	0	0	1518	0
Right Turn on Red			Yes			Yes			No			No
Satd. Flow (RTOR)		1				39						
Link Speed (mph)		45			45			25			35	
Link Distance (ft)		819			2436			714			826	
Travel Time (s)		12.4			36.9			19.5			16.1	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Heavy Vehicles (%)	2%	4%	0%	0%	7%	3%	11%	1%	5%	13%	0%	2%
Adj. Flow (vph)	87	684	5	12	405	39	10	109	45	8	137	161
Shared Lane Traffic (%)												
Lane Group Flow (vph)	87	689	0	12	405	39	0	164	0	0	306	0
Number of Detectors	1	1		1	1	1	1	1		1	1	
Detector Template	Left			Left		Right	Left	Thru		Left	Thru	
Leading Detector (ft)	30	6		30	6	30	30	35		30	35	
Trailing Detector (ft)	-10	0		-10	0	-10	-10	-5		-10	-5	
Detector 1 Position(ft)	-10	0		-10	0	-10	-10	-5		-10	-5	
Detector 1 Size(ft)	40	6		40	6	40	40	40		40	40	
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Detector 1 Queue (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Detector 1 Delay (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Turn Type	Perm	NA		Perm	NA	Perm	Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6		6	8			4		
Detector Phase	2			6			8	8		4	4	
Switch Phase												
Minimum Initial (s)	22.0	22.0		22.0	22.0	22.0	3.0	3.0		3.0	3.0	
Minimum Split (s)	28.0	28.0		28.0	28.0	28.0	9.0	9.0		9.0	9.0	
Total Split (s)	69.0	69.0		69.0	69.0	69.0	21.0	21.0		21.0	21.0	
Total Split (%)	76.7%	76.7%		76.7%	76.7%	76.7%	23.3%	23.3%		23.3%	23.3%	
Maximum Green (s)	63.0	63.0		63.0	63.0	63.0	15.0	15.0		15.0	15.0	
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Lost Time Adjust (s)	0.0	-1.0		0.0	-1.0	0.0		-1.0			-1.0	

McMahon Associates, Inc. Robinson Tract
1: New St & Rt 926 2030 with Dev Weekday Morning Peak Hour

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Lost Time (s)	6.0	5.0		6.0	5.0	6.0		5.0			5.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	5.0	5.0		5.0	5.0	5.0	3.0	3.0		3.0	3.0	
Minimum Gap (s)	2.0	2.0		2.0	2.0	2.0	3.0	3.0		3.0	3.0	
Time Before Reduce (s)	42.0	42.0		42.0	42.0	42.0	0.0	0.0		0.0	0.0	
Time To Reduce (s)	21.0	21.0		21.0	21.0	21.0	0.0	0.0		0.0	0.0	
Recall Mode	C-Max	C-Max		C-Max	C-Max	C-Max	None	None		None	None	

Intersection Summary	
Area Type:	Other
Cycle Length: 90	
Actuated Cycle Length: 90	
Offset: 50 (56%), Referenced to phase 2:EBTL and 6:WBTL, Start of Yellow	
Natural Cycle: 55	
Control Type: Actuated-Coordinated	

Splits and Phases: 1: New St & Rt 926



Lanes, Volumes, Timings 2030 with Dev Weekday Morning Peak Hour
I:\eng\816451 - Crebilly Farm\Traffic\Analysis\2020-05 Robinson Tract Revised TIS\Synchro\5 - 2030 with Dev Peak Scenario 2A\Tv

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	84	663	5	12	393	38	10	106	44	8	133	156
Future Volume (veh/h)	84	663	5	12	393	38	10	106	44	8	133	156
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1846	1818	1818	1794	1696	1752	1860	1860	1860	1794	1794	1794
Adj Flow Rate, veh/h	87	684	5	12	405	39	10	109	45	8	137	161
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	4	4	0	7	3	1	1	1	0	0	0
Cap, veh/h	746	1281	9	479	1206	1040	51	220	87	44	134	153
Arrive On Green	0.70	0.71	0.70	0.93	0.95	0.93	0.17	0.18	0.17	0.17	0.18	0.17
Sat Flow, veh/h	985	1802	13	763	1696	1485	47	1240	487	17	756	859
Grp Volume(v), veh/h	87	0	689	12	405	39	164	0	0	306	0	0
Grp Sat Flow(s),veh/h/ln	985	0	1815	763	1696	1485	1773	0	0	1632	0	0
Q Serve(g_s), s	2.8	0.0	15.9	0.4	1.7	0.2	0.0	0.0	0.0	6.0	0.0	0.0
Cycle Q Clear(g_c), s	5.0	0.0	15.9	16.3	1.7	0.2	7.6	0.0	0.0	15.0	0.0	0.0
Prop In Lane	1.00		0.01	1.00		1.00	0.06		0.27	0.03		0.53
Lane Grp Cap(c), veh/h	746	0	1291	479	1206	1040	338	0	0	313	0	0
V/C Ratio(X)	0.12	0.00	0.53	0.03	0.34	0.04	0.49	0.00	0.00	0.98	0.00	0.00
Avail Cap(c_a), veh/h	746	0	1291	479	1206	1040	338	0	0	313	0	0
HCM Platoon Ratio	1.00	1.00	1.00	1.33	1.33	1.33	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.99	0.99	0.99	1.00	0.00	0.00	1.00	0.00	0.00
Uniform Delay (d), s/veh	5.2	0.0	6.1	4.0	0.8	0.9	33.7	0.0	0.0	37.7	0.0	0.0
Incr Delay (d2), s/veh	0.3	0.0	1.6	0.1	0.7	0.1	1.1	0.0	0.0	44.5	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(95%),veh/ln	0.9	0.0	8.1	0.1	1.0	0.1	6.1	0.0	0.0	15.9	0.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	5.5	0.0	7.6	4.1	1.5	1.0	34.8	0.0	0.0	82.2	0.0	0.0
LnGrp LOS	A	A	A	A	A	A	C	A	A	F	A	A
Approach Vol, veh/h		776			456			164			306	
Approach Delay, s/veh		7.4			1.5			34.8			82.2	
Approach LOS		A			A			C			F	

Timer - Assigned Phs	2	4	6	8
Phs Duration (G+Y+Rc), s	69.0	21.0	69.0	21.0
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	63.0	15.0	63.0	15.0
Max Q Clear Time (g_c+I1), s	17.9	17.0	18.3	9.6
Green Ext Time (p_c), s	7.4	0.0	3.5	0.2

Intersection Summary	
HCM 6th Ctrl Delay	21.9
HCM 6th LOS	C

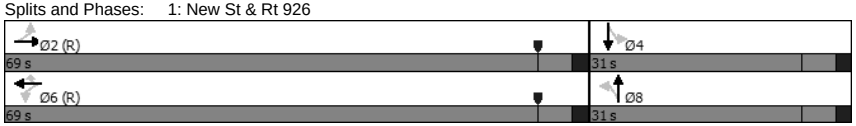
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	66	686	14	23	383	32	10	92	43	52	178	104
Future Volume (vph)	66	686	14	23	383	32	10	92	43	52	178	104
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Lane Width (ft)	10	10	10	10	10	10	10	10	10	10	10	10
Grade (%)		-2%			1%			-2%			1%	
Storage Length (ft)	175		0	150		150	0		0	0		0
Storage Lanes	1		0	1		1	0		0	0		0
Taper Length (ft)	75			75			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.997				0.850		0.960			0.958	
Flt Protected	0.950			0.950				0.997			0.992	
Satd. Flow (prot)	1580	1628	0	1588	1562	1379	0	1579	0	0	1547	0
Flt Permitted	0.488			0.279				0.970			0.928	
Satd. Flow (perm)	812	1628	0	466	1562	1379	0	1536	0	0	1448	0
Right Turn on Red			Yes			Yes			No			No
Satd. Flow (RTOR)		2				33						
Link Speed (mph)		45			45			25			35	
Link Distance (ft)		819			2436			714			826	
Travel Time (s)		12.4			36.9			19.5			16.1	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Heavy Vehicles (%)	2%	4%	0%	0%	7%	3%	11%	1%	5%	13%	0%	2%
Adj. Flow (vph)	68	707	14	24	395	33	10	95	44	54	184	107
Shared Lane Traffic (%)												
Lane Group Flow (vph)	68	721	0	24	395	33	0	149	0	0	345	0
Number of Detectors	1	1		1	1	1	1	1		1	1	
Detector Template	Left			Left			Left	Thru		Left	Thru	
Leading Detector (ft)	30	6		30	6	6	30	35		30	35	
Trailing Detector (ft)	-10	0		-10	0	0	-10	-5		-10	-5	
Detector 1 Position(ft)	-10	0		-10	0	0	-10	-5		-10	-5	
Detector 1 Size(ft)	40	6		40	6	6	40	40		40	40	
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Detector 1 Queue (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Detector 1 Delay (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Turn Type	Perm	NA		Perm	NA	Perm	Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6		6	8			4		
Detector Phase	2			6			8	8		4	4	
Switch Phase												
Minimum Initial (s)	22.0	22.0		22.0	22.0	22.0	3.0	3.0		3.0	3.0	
Minimum Split (s)	28.0	28.0		28.0	28.0	28.0	9.0	9.0		9.0	9.0	
Total Split (s)	69.0	69.0		69.0	69.0	69.0	31.0	31.0		31.0	31.0	
Total Split (%)	69.0%	69.0%		69.0%	69.0%	69.0%	31.0%	31.0%		31.0%	31.0%	
Maximum Green (s)	63.0	63.0		63.0	63.0	63.0	25.0	25.0		25.0	25.0	
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Lost Time Adjust (s)	-2.0	-1.0		-2.0	-1.0	0.0		-1.0			-1.0	

McMahon Associates, Inc. Robinson Tract
1: New St & Rt 926 2030 with Dev Weekday Afternoon Peak Hour

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Lost Time (s)	4.0	5.0		4.0	5.0	6.0		5.0			5.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	5.0	5.0		5.0	5.0	5.0	3.0	3.0		3.0	3.0	
Minimum Gap (s)	2.0	2.0		2.0	2.0	2.0	3.0	3.0		3.0	3.0	
Time Before Reduce (s)	42.0	42.0		42.0	42.0	42.0	0.0	0.0		0.0	0.0	
Time To Reduce (s)	21.0	21.0		21.0	21.0	21.0	0.0	0.0		0.0	0.0	
Recall Mode	C-Max	C-Max		C-Max	C-Max	C-Max	None	None		None	None	

Intersection Summary	
Area Type:	Other
Cycle Length: 100	
Actuated Cycle Length: 100	
Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBTL, Start of Yellow	
Natural Cycle: 60	
Control Type: Actuated-Coordinated	

Splits and Phases: 1: New St & Rt 926



Lanes, Volumes, Timings 2030 with Dev Weekday Afternoon Peak Hour
I:\eng\816451 - Crebilly Farm\Traffic\Analysis\2020-05 Robinson Tract Revised TIS\Synchro\5 - 2030 with Dev\S8enario 2A\Tv

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	66	686	14	23	383	32	10	92	43	52	178	104
Future Volume (veh/h)	66	686	14	23	383	32	10	92	43	52	178	104
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1846	1818	1818	1794	1696	1752	1860	1860	1860	1794	1794	1794
Adj Flow Rate, veh/h	68	707	14	24	395	33	10	95	44	54	184	107
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	4	4	0	7	3	1	1	1	0	0	0
Cap, veh/h	742	1181	23	408	1128	972	51	278	122	88	219	119
Arrive On Green	0.67	0.66	0.65	1.00	1.00	1.00	0.25	0.24	0.23	0.25	0.24	0.23
Sat Flow, veh/h	1000	1776	35	741	1696	1485	53	1184	518	197	930	507
Grp Volume(v), veh/h	68	0	721	24	395	33	149	0	0	345	0	0
Grp Sat Flow(s),veh/h/ln	1000	0	1811	741	1696	1485	1755	0	0	1634	0	0
Q Serve(g_s), s	2.4	0.0	22.2	1.1	0.0	0.0	0.0	0.0	0.0	13.1	0.0	0.0
Cycle Q Clear(g_c), s	2.9	0.0	22.2	23.3	0.0	0.0	7.0	0.0	0.0	20.1	0.0	0.0
Prop In Lane	1.00		0.02	1.00		1.00	0.07		0.30	0.16		0.31
Lane Grp Cap(c), veh/h	742	0	1204	408	1128	972	469	0	0	442	0	0
V/C Ratio(X)	0.09	0.00	0.60	0.06	0.35	0.03	0.32	0.00	0.00	0.78	0.00	0.00
Avail Cap(c_a), veh/h	742	0	1204	408	1128	972	511	0	0	482	0	0
HCM Platoon Ratio	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.97	0.97	0.97	1.00	0.00	0.00	1.00	0.00	0.00
Uniform Delay (d), s/veh	5.8	0.0	9.3	3.8	0.0	0.0	32.0	0.0	0.0	36.9	0.0	0.0
Incr Delay (d2), s/veh	0.2	0.0	2.2	0.3	0.8	0.1	0.4	0.0	0.0	7.4	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(95%),veh/ln	0.8	0.0	12.2	0.2	0.5	0.0	5.5	0.0	0.0	13.5	0.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	6.1	0.0	11.5	4.1	0.8	0.1	32.4	0.0	0.0	44.3	0.0	0.0
LnGrp LOS	A	A	B	A	A	A	C	A	A	D	A	A
Approach Vol, veh/h		789			452			149			345	
Approach Delay, s/veh		11.1			0.9			32.4			44.3	
Approach LOS		B			A			C			D	

Timer - Assigned Phs	2	4	6	8
Phs Duration (G+Y+Rc), s	71.5	28.5	71.5	28.5
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	63.0	25.0	63.0	25.0
Max Q Clear Time (g_c+I1), s	24.2	22.1	25.3	9.0
Green Ext Time (p_c), s	7.4	0.4	3.5	0.4

Intersection Summary	
HCM 6th Ctrl Delay	16.9
HCM 6th LOS	B

West Pleasant Grove Road and Collector Road
Mini Roundabout

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	71	1	165	118	4	93
Future Volume (vph)	71	1	165	118	4	93
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800
Lane Width (ft)	11	11	11	11	12	12
Grade (%)	3%			-3%	0%	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	0.999				0.871	
Flt Protected				0.972	0.998	
Satd. Flow (prot)	1712	0	0	1676	1534	0
Flt Permitted				0.972	0.998	
Satd. Flow (perm)	1712	0	0	1676	1534	0
Link Speed (mph)	35			35	35	
Link Distance (ft)	1878			318	459	
Travel Time (s)	36.6			6.2	8.9	
Peak Hour Factor	0.70	0.70	0.70	0.70	0.70	0.70
Heavy Vehicles (%)	0%	2%	2%	3%	2%	2%
Adj. Flow (vph)	101	1	236	169	6	133
Shared Lane Traffic (%)						
Lane Group Flow (vph)	102	0	0	405	139	0
Sign Control	Yield			Yield	Yield	

Intersection Summary	
Area Type:	Other
Control Type:	Roundabout

Intersection	
Intersection Delay, s/veh	4.9
Intersection LOS	A

Approach	EB	WB	NB
Entry Lanes	1	1	1
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	102	405	139
Demand Flow Rate, veh/h	102	415	142
Vehicles Circulating, veh/h	241	6	101
Vehicles Exiting, veh/h	180	237	242
Ped Vol Crossing Leg, #/h	0	0	0
Ped Cap Adj	1.000	1.000	1.000
Approach Delay, s/veh	4.2	5.4	3.9
Approach LOS	A	A	A

Lane	Left	Left	Left
Designated Moves	TR	LT	LR
Assumed Moves	TR	LT	LR
RT Channelized			
Lane Util	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976
Entry Flow, veh/h	102	415	142
Cap Entry Lane, veh/h	1079	1371	1245
Entry HV Adj Factor	1.000	0.976	0.979
Flow Entry, veh/h	102	405	139
Cap Entry, veh/h	1079	1338	1218
V/C Ratio	0.095	0.303	0.114
Control Delay, s/veh	4.2	5.4	3.9
LOS	A	A	A
95th %tile Queue, veh	0	1	0

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	65	4	414	220	3	162
Future Volume (vph)	65	4	414	220	3	162
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800
Lane Width (ft)	11	11	11	11	12	12
Grade (%)	3%			-3%	0%	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	0.993				0.867	
Flt Protected				0.968	0.999	
Satd. Flow (prot)	1700	0	0	1682	1528	0
Flt Permitted				0.968	0.999	
Satd. Flow (perm)	1700	0	0	1682	1528	0
Link Speed (mph)	35			35	35	
Link Distance (ft)	1811			228	439	
Travel Time (s)	35.3			4.4	8.6	
Peak Hour Factor	0.75	0.75	0.75	0.75	0.75	0.75
Heavy Vehicles (%)	0%	2%	2%	1%	2%	2%
Adj. Flow (vph)	87	5	552	293	4	216
Shared Lane Traffic (%)						
Lane Group Flow (vph)	92	0	0	845	220	0
Sign Control	Yield			Yield	Yield	

Intersection Summary	
Area Type:	Other
Control Type: Roundabout	

Intersection	
Intersection Delay, s/veh	8.7
Intersection LOS	A

Approach	EB	WB	NB
Entry Lanes	1	1	1
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	92	845	220
Demand Flow Rate, veh/h	92	859	224
Vehicles Circulating, veh/h	563	4	87
Vehicles Exiting, veh/h	300	307	568
Ped Vol Crossing Leg, #/h	0	0	0
Ped Cap Adj	1.000	1.000	1.000
Approach Delay, s/veh	5.8	10.1	4.4
Approach LOS	A	B	A

Lane	Left	Left	Left
Designated Moves	TR	LT	LR
Assumed Moves	TR	LT	LR
RT Channelized			
Lane Util	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976
Entry Flow, veh/h	92	859	224
Cap Entry Lane, veh/h	777	1374	1263
Entry HV Adj Factor	1.000	0.984	0.982
Flow Entry, veh/h	92	845	220
Cap Entry, veh/h	777	1352	1240
V/C Ratio	0.118	0.625	0.177
Control Delay, s/veh	5.8	10.1	4.4
LOS	A	B	A
95th %tile Queue, veh	0	5	1

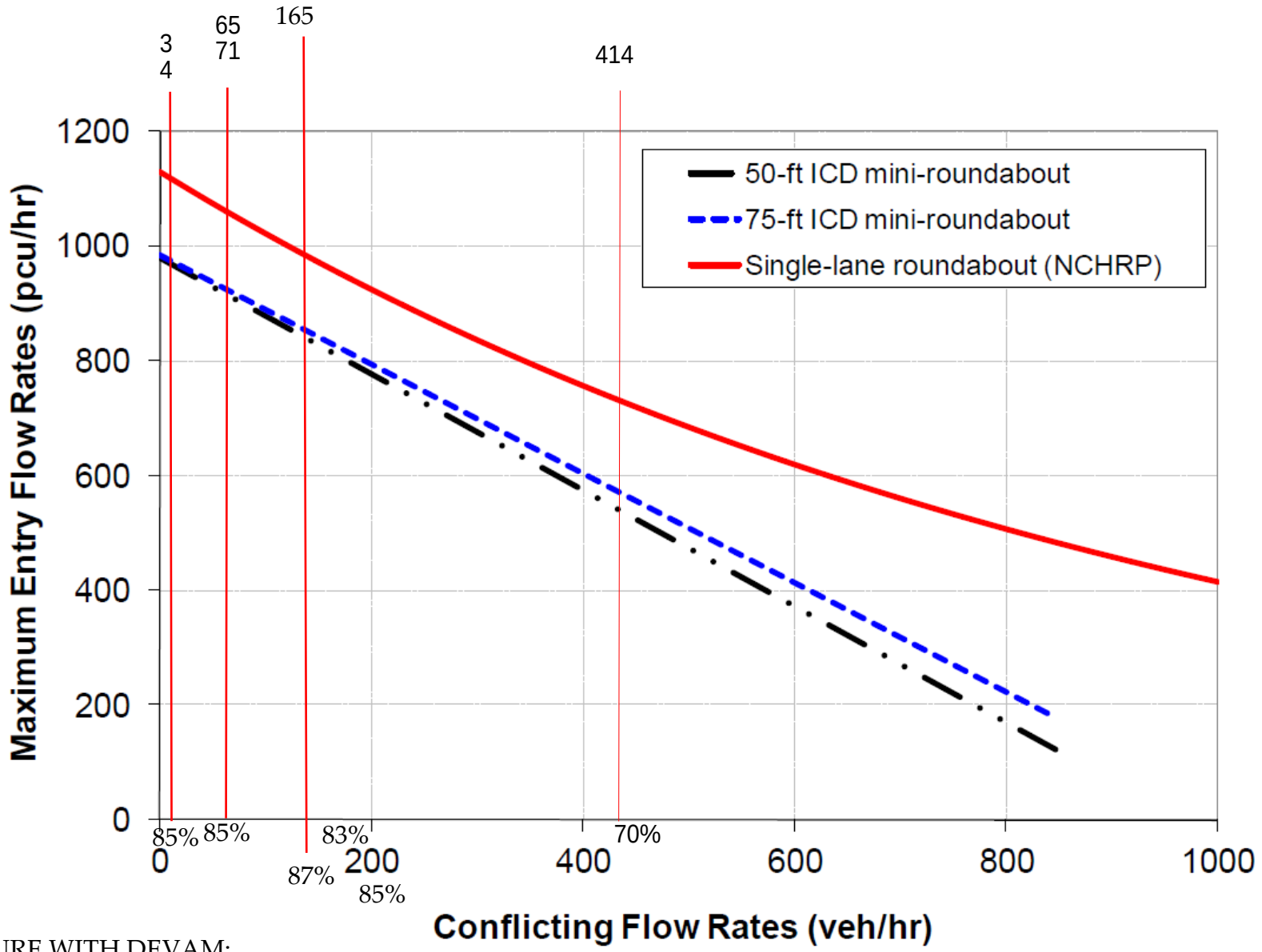
Table 1. Mini Roundabout Delay Calculation - 2030 Future with Development

	Weekday AM			Weekday PM		
	Northbound	Eastbound	Westbound	Northbound	Eastbound	Westbound
Single Lane Roundabout Delay [1]	3.9	4.2	5.4	4.4	5.8	10.1
Capacity Compared to Single Lane [2]	85%	87%	85%	85%	70%	85%
Mini Roundabout Approach Delay	4.5	4.7	6.2	5.1	7.5	11.6
Approach Volume	97	72	283	165	69	634
Mini Roundabout Overall Delay & LOS	5.6		A	10.0		B

(1) Based on HCM 6th Edition Methodology for a traditonal roundabout.

(2) See Figure 1.

FIGURE A



2030 FUTURE WITH DEVAM:
NB = 97 entering, 71 conflicting
EB = 72 entering, 165 conflicting
WB = 283 entering, 4 conflicting

2030 FUTURE WITH DEVPM:
NB = 165 entering, 65 conflicting
EB = 69 entering, 414 conflicting
WB = 634 entering, 3 conflicting

Source: *Determination of Mini-Roundabout Capacity in the United States*, as published within the Journal of Transportation Engineering Volume 140 Issue 10