

US 127 Traffic Analyses: I-64 to Westridge

Item No. 5-80212 | US 127 in west Frankfort | March 2023

The Kentucky Transportation Cabinet (KYTC) tasked Qk4 to examine potential short-term traffic impacts along US 127 and adjacent roadways associated with a proposed commercial development northeast of its interchange with I-64 in west Frankfort. The proposed development includes two big box stores, other retail shops, multi-family housing, restaurants, and a gas station. Combined, this totals over 450,000 square feet of commercial space supported by over 2,400 parking spaces. This memo presents a synopsis of existing traffic, the proposed development, and resulting impacts to mobility.

Microsimulation analyses show:

- **Build 1** (\$11.3 million) includes capacity improvements to US 127 and Westridge Drive, plus a new backage road following Vandalay Drive to Limestone Drive. In this scenario, Westridge Drive is close to capacity; small changes in trip distribution assumptions—or additional volume from future developments—have significant impacts on delays and queue lengths.
- **Build 2** (\$10.5 million) includes Build 1 improvements plus a new signalized intersection with US 127 approximately 500 feet south of Westridge Drive, similar to the access configuration proposed by the developer in 2019. While Build 2 offers some operational improvements over Build 1, the closely spaced signalized intersections lead to left turn queues that block thru traffic lanes and spillback beyond upstream signals. The backage road connection is essential for the network to function in the PM peak hour.

Both Build 1 and Build 2 involve roadway improvements beyond existing right-of-way, requiring a public entity to acquire and improve private property. This increases costs and implementation timelines, moreso if federal funding introduces additional environmental compliance requirements.

- **Build 3** (\$15.3 million) includes Build 1 improvements plus a new signalized intersection with US 127 approximately 1,100 feet south of the Westridge Drive intersection. The northbound-to-westbound I-64 on-ramp shifts north to become the fourth leg of the new intersection. Build 3e (\$14.4 million) adds the new signalized intersection and shifts two ramps as in Build 3 but carries three northbound US 127 lanes to the Leonardwood/Westridge signal. Dual lefts to a widened Westridge Drive plus a new backage road connection to Limestone Drive are also part of this concept.

The following sections present the analysis.

1 EXISTING HIGHWAY NETWORK

Running through the west side of Frankfort, US 127 is an urban principal arterial, part of the National Highway System (NHS), and a federally designated truck route. It has two 12-foot-wide thru lanes per direction with a non-mountable median, 10-foot paved shoulders, and turn lanes at key intersections. Access control is by permit. The terrain is rolling with grades up to 6% and gentle horizontal curves. The posted speed limit is 45 mph north of the interchange and 55 mph through/south of the interchange.

South to north, there are five intersections along US 127 within the study area:

- US 127 at the eastbound I-64 on ramps (approximate milepoint [MP] 4.25)
- US 127 at the westbound I-64 ramps (approximate MP 4.6)
- US 127 at city-owned Leonardwood Drive and Westridge Drive¹ (MP 4.880), signalized
- US 127 at driveway to private Franklin Square (MP 5.040), signalized
- US 127 at KY 676 (East-West Connector) and city-owned Kings Daughters Drive (MP 5.194), signalized

Signals along the corridor are coordinated and actuated, running 170-second cycles during the PM peak hour. While KYTC collected traffic data along US 127 in 2021, the equipment underestimated volumes. Year 2018 turning movement counts showed 24,600 vehicles traveled US 127 just north of the intersection with Leonardwood Drive/Westridge Drive during 7:00 AM to 7:00 PM, factoring up to over 30,000 vehicles per day (vpd). About 3% of this volume represents trucks. There are strong directional splits during peak hours. Volumes have been trending downward since 2002.

The remaining two study intersections are along KY 676. KY 676 is also an urban principal arterial, part of the National Highway System, and a federally designated truck route. It has two 12-foot thru lanes per direction, 12-foot paved shoulders, and a raised mountable median with turn lanes at key intersections. Access is partially controlled. The posted speed limit is 45 mph. Most of the corridor within the study area has a 5% grade and lies within a large horizontal curve. Both study intersections are signalized: at city-owned Limestone Drive (MP 0.205) and city-owned Collins Lane (MP 0.512). Traffic counts during 2019 show 19,700 vpd on KY 676 between US 127 and Collins Lane, including 3.7% trucks.

¹ Westridge Drive east of Vandalay Drive is a city-owned street. The section between US 127 and Vandalay Drive is privately owned but proposed to transfer to city ownership via local ordinance in May 2023.

1.1 EXISTING SCENARIO: PEAK HOUR TURNING MOVEMENTS

The Existing scenario is built from peak hour turning movement counts conducted in March and October of 2018. Year 2018 was selected to represent the base network to minimize the impact of the Covid pandemic, which had a substantial impact on commuting patterns—particularly for public sector employment prevalent throughout Frankfort. Additionally, the county school system released for the summer before the study was initiated, making potential fresh data collection efforts less representative than at other times of the year. The 2018 volumes include school traffic and avoid any ongoing influence from the pandemic. **Figure 2** presents Existing design hour volumes (DHV) for the AM and PM peak hours at each study intersection.

1.2 EXISTING SCENARIO: PEAK HOUR OPERATIONS

Level of Service (LOS) is a qualitative measure that describes traffic conditions based on measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort, and convenience. LOS typically represents a driver’s perspective of traffic conditions based on perceived congestion. Summarized in **Figure 1**, LOS A is associated with free flow conditions with little or no delay. Conditions at or near capacity typically are associated with LOS E. LOS F represents oversaturated traffic conditions beyond capacity, with low travel speeds and lengthy delays. LOS D is generally considered acceptable for urban areas.

A Vissim microsimulation network was created to model traffic operations within the study area. While any model has limitations—particularly in over capacity congested conditions—the model represents the best tool available to approximate current and future traffic scenarios. To calibrate the model, analysts collected information regarding existing traffic conditions: signal timing plans, queue lengths, operating speeds, etc. Additional technical information about the microsimulation modeling tasks is included in **Appendix A**.

In addition to illustrating existing needs within the study area, the microsimulation model forms a baseline to test how proposed improvements would affect traffic operations. **Figure 3** summarizes traffic operations at study intersections during the AM and PM peaks. As shown, left turns north of the interchange operate at LOS E/F during both peak hours. Left turns to the eastbound on-ramp and right turns from the stop-controlled westbound-to-northbound off-ramp are also over capacity in the AM peak hour with the high volume of US 127 traffic headed towards Frankfort.

US 127 maximum queue lengths exceed available spacing between signals for southbound flows in the PM peak hour. However, because of how maximum queue length is calculated within the software, these spillbacks could only last a few seconds. Average queue lengths are shorter—contained within the available spacing between signals.

LEVEL OF SERVICE	INTERSECTION
A	Highly stable, free-flow condition with little or no congestion. Delay: <10 seconds/vehicle
B	Stable, free-flow condition with little congestion. Delay: 10 to 20 seconds/vehicle
C	Free-flow condition with moderate congestion. Delay: 20 to 35 seconds/vehicle
D	Approaching unstable condition with increasing congestion. Delay: 35 to 55 seconds/vehicle
E	Unstable, congested condition. Delay: 55 to 80 seconds/vehicle
F	Stop and go. Delay: >80 seconds/vehicle

Figure 1: Levels of Service

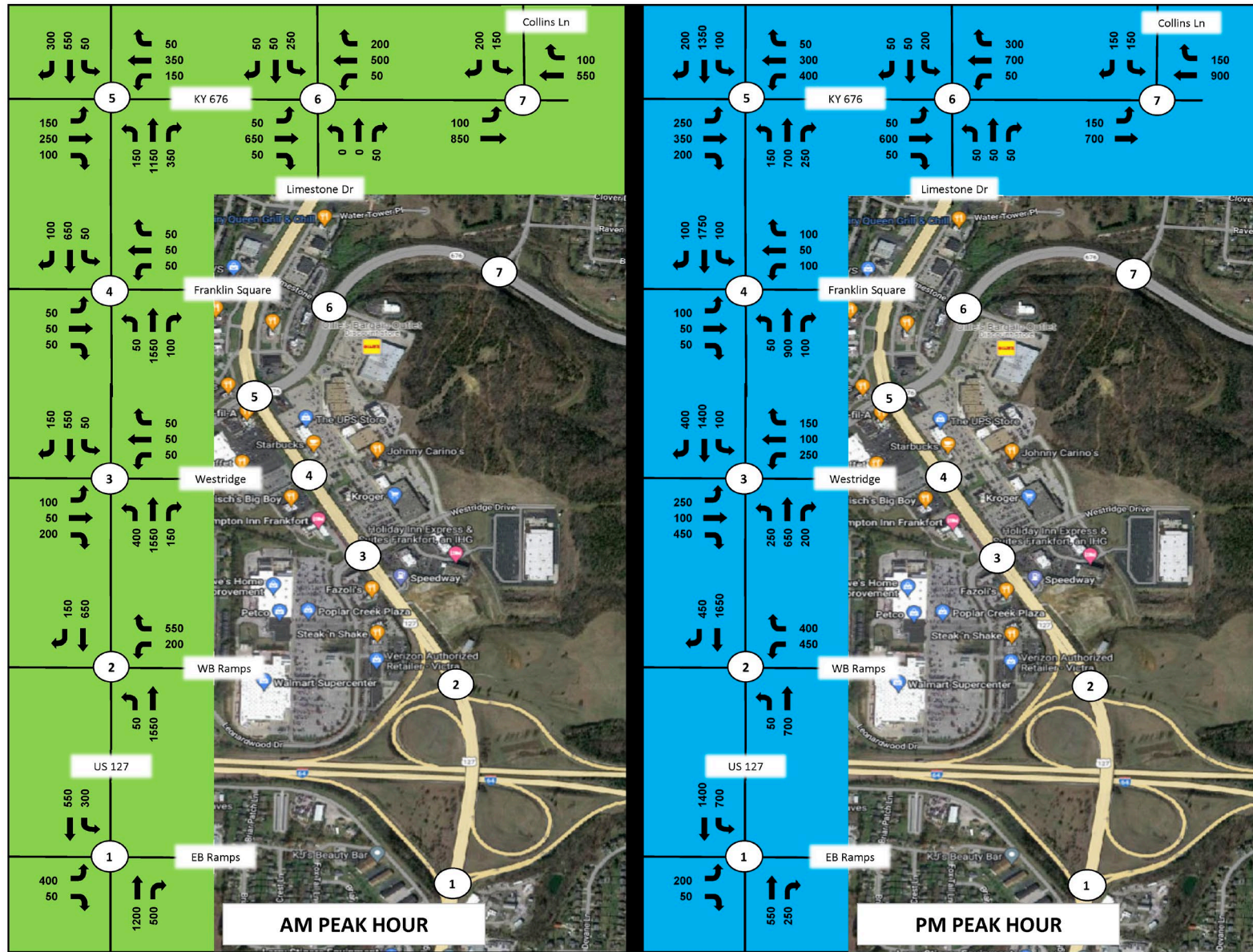


Figure 2: Existing AM/PM Peak Hour Volumes

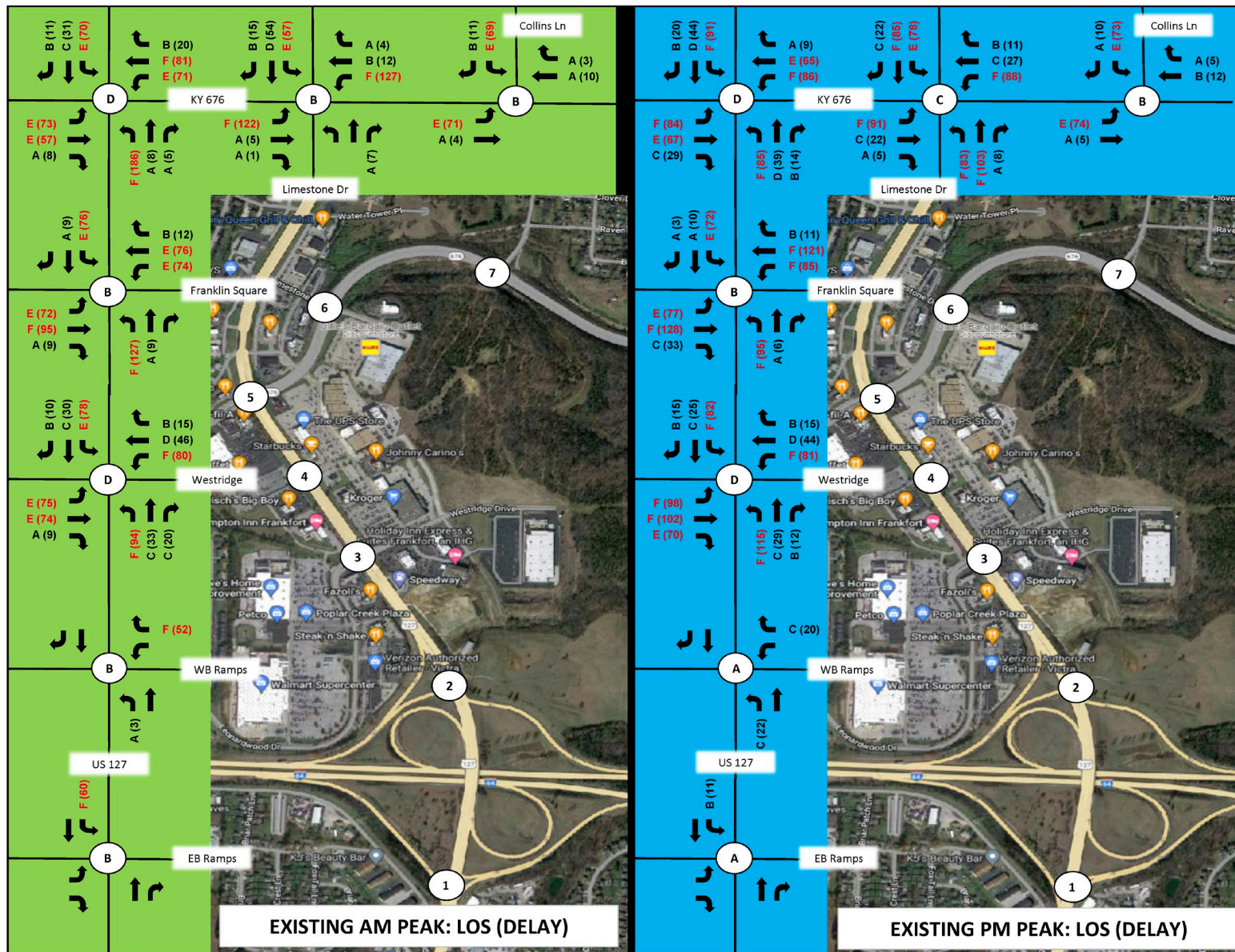


Figure 3: Existing AM/PM Peak Hour Level of Service and Delay in Seconds

1.3 FUTURE TRAFFIC TRENDS

Since 2000, traffic volumes along the study section of US 127 and adjacent segments have been trending downward (**Figure 4**) based on KYTC counts. KY 676 has also been steadily declining though I-64 has seen positive growth averaging 1.1% per year.

Kentucky State Data Center population projections for the county through 2040 are likewise projected to decline, peaking with the 2020 Census (51,541).

Forecasts prepared as part of the 2018 *Frankfort Small Urban Area Study*² showed 1.5% growth—less than 400 vpd—between 2018 and the 2040 analysis year. Forecasts were developed using the statewide travel demand model, incorporating input from local stakeholders about likely future growth patterns.

Properties abutting US 127 are mostly built out north of the interchange (**Figure 5**) but large vacant tracts to the east are zoned for commercial and residential development. Steep terrain constrains development potential for these parcels, limiting access opportunities and increasing costs.

These factors—coupled with shifting employment patterns emerging from the covid pandemic—led the project team to focus traffic analyses solely on the existing (2018) scenario.

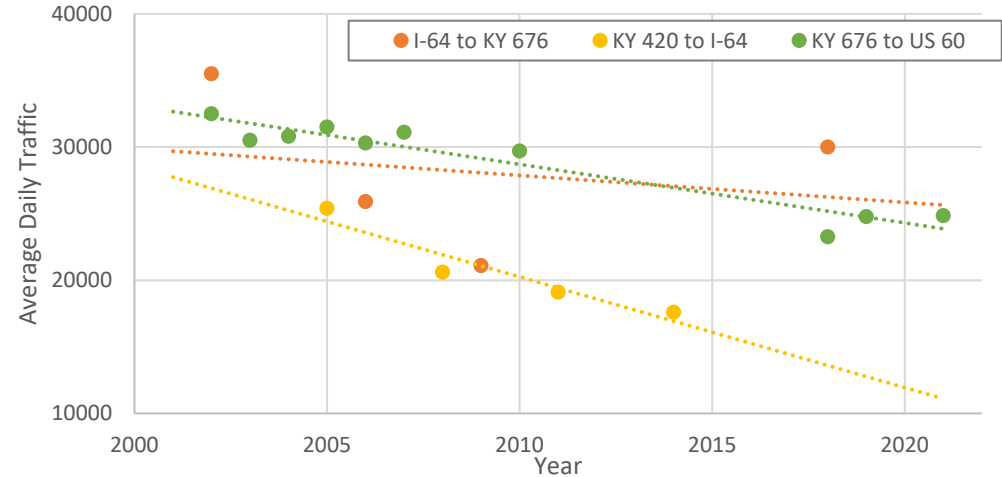


Figure 4: US 127 KYTC Average Daily Traffic Counts since 2000



Figure 5: City Zoning

² Available online through KYTC Division of Planning

2 PROPOSED DEVELOPMENT

Based on the most recent conceptual site plan available (**Appendix B**), the proposed development includes two big box stores, other retail shops, multi-family housing, restaurants, and a gas station. Combined, these total over 450,000 square feet of commercial space supported by over 2,400 parking spaces. No specific tenants have been announced. Site work is ongoing to extend Vandalay Drive south to access the property.

Trip generation rates are derived from the ITE *Trip Generation Manual* (11th Edition) and summarized in **Table 1**. Outparcels are assumed to include 7,500 square feet of retail space unless otherwise noted on the conceptual site plan. For the residential section, 300 apartment units are assumed.



Figure 6: Vandalay Drive Extension, facing South (left) and North (right)

Table 1: Trip Generation Rates

ITE Use				Daily Trips		AM Peak		PM Peak	
Code	Desc.	Size	Unit	In	Out	In	Out	In	Out
820	Shopping Center	467.4	1000 SF	9,033	9,033	253	156	822	891
220	Multi-family Housing	300	Units	999	999	28	88	94	56
944	Gas/Service Station	14	Pumps	1,204	1,204	72	72	97	98
930	Fast Casual Restaurant	2.56	1000 SF	124	124	2	2	18	14
932	Sit-Down Restaurant	9.85	1000 SF	528	528	52	43	54	35
934	Fast Food Restaurant/Drive Thru	2.56	1000 SF	598	598	58	56	44	41
TOTAL				12,486	12,486	465	417	1,129	1,135

Not all generated trips are new to the roadway network. Some represent trips internal to the development—for example, someone stopping for gas before visiting a store. Others are pass-by traffic—someone already traveling along US 127 who detours into the development before continuing their original route.

2.1 PREVIOUS TRAFFIC STUDIES

Two recent traffic impact studies (TIS) have been completed, associated with proposed new connections to US 127.

OCTOBER 2019 TRAFFIC IMPACT STUDY. An analysis was prepared for both the Paddocks and Landings developments, assuming a new signalized intersection with US 127 (approximate MP 4.77) providing the primary access to both. Trip generation rates were based on a 175,000 square foot shopping center, restaurants, 300 apartment units, and a hotel. The development is assumed to draw 750 new trips during the AM peak hour and 605 new trips in the PM peak hour with 50% coming to/from the south. The report concludes, “Based upon the volume of traffic generated by the development and the amount of traffic forecasted for the year 2022 there will be an impact to the existing highway network, but level of service remains within acceptable limits. Dual left turn lanes for the southbound approach and a northbound right turn lane will be constructed.”

The permit application for a new signal was denied. Operational implications for this scenario are discussed further as part of Build 2 analyses below.

NOVEMBER 2021 TRAFFIC IMPACT STUDY. Another TIS was prepared for just the Landings development, accompanying a permit application for a right-in/right-out (RIRO) connection with US 127 (**Figure 7**). Trip generation rates were based on four new restaurants, assumed to draw 151 new trips in the AM peak hour and 125 new trips in the PM peak hour. Again, 50% of the external trips are assumed to travel to/from the south. The report concludes that “the addition of the proposed development and associated traffic will add additional trips to the network, but not substantially to result in the recommendation for any additional lanes or signal modifications by the applicant. The applicant is proposing to construct a new intersection along US 127 that may also divert existing traffic away from the intersection of US 127 at Leonardwood Drive/Westridge Drive. Also, the applicant is proposing to construct an additional northbound lane that would extend the right-turn lane into the adjacent gas station and onto Westridge Drive which would further improve the existing roadway.”

The permit application is under review at the time of this analysis. The proximity of the Paddocks development and its impacts on the highway network are a concern though they are not addressed in the 2021 analysis.

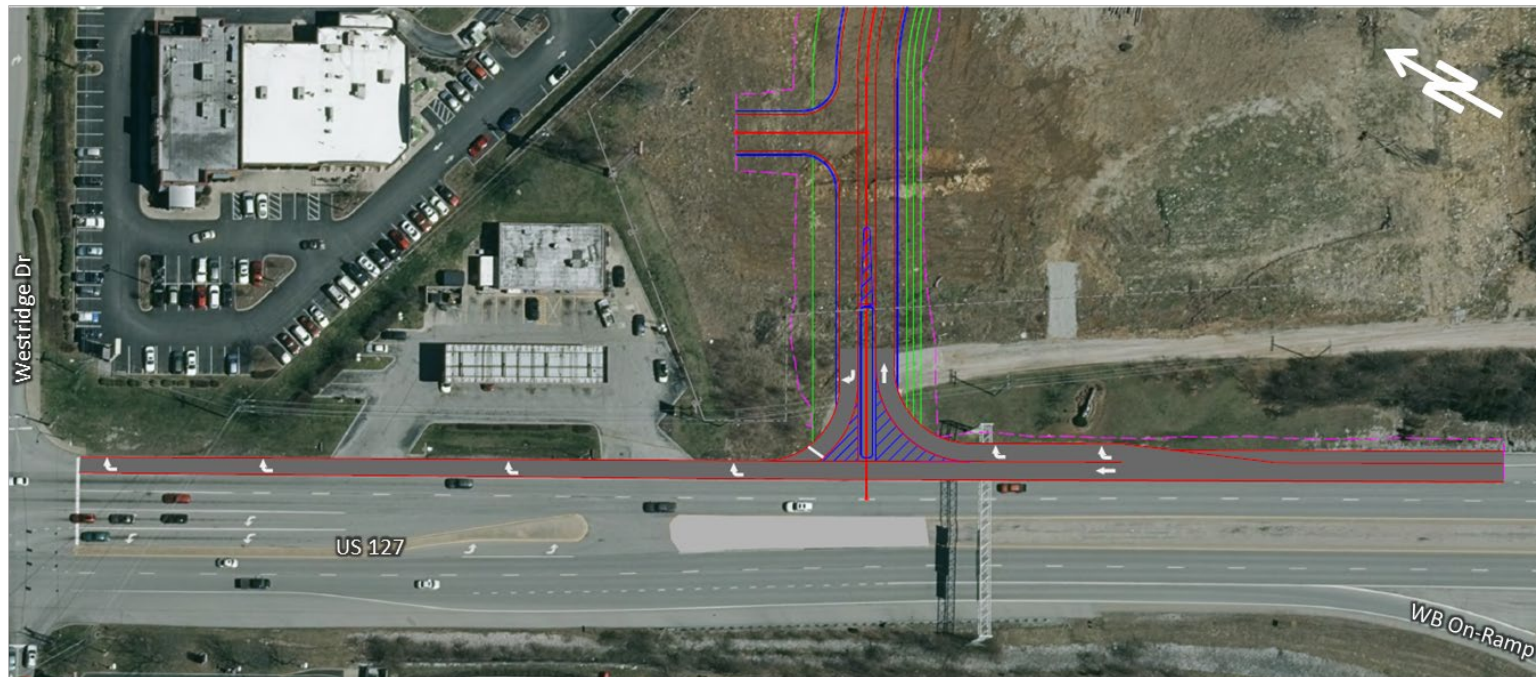


Figure 7: Proposed US 127 Access in 2021 Traffic Impact Study

2.2 CONCEPTUAL SLIP RAMP

While it was not addressed in either TIS, the concept plan also presents a slip ramp from the westbound-to-northbound off-ramp connecting to the proposed development. There are some feasibility concerns for the slip ramp shown (**Figure 8**).

- FHWA's *Policy on Access to the Interstate System* requires the proposed access connects to a public road only. While there are a few instances in Kentucky where exceptions have been granted, all predate the 2017 policy.
- KYTC's *Highway Design Manual* specifies that "for interstate and other freeway-type interchanges, full control of access shall extend along the intersecting crossroad a minimum of 100 feet (desirable 300 feet) in urban areas and 300 feet (desirable 600 feet) in rural areas. However, in areas of high traffic volume where the potential for development exists which would create operational or safety problems, longer lengths of access control should be provided."

- The configuration shown aligns the southbound approach opposite the off-ramp, introducing the potential for wrong-way ramp entries.

Build options discussed in **Section 5** present a “modified slip ramp” that functions like the slip ramp proposed by the developer but represents a more standard configuration with fewer safety concerns.

3 IMPACTS TO EXISTING NETWORK

The distribution of generated trips (**Table 1**) was assumed to be comparable to the traffic split accessing the developments along Leonardwood Drive.

Based on third-party origin-destination data, 45% of Paddocks/Landings site traffic is assumed to travel to/from the south (i.e., 15% on I-64 westbound, 10% on I-64 eastbound, and 20% along US 127 further south), 15% to/from the east along KY 676, and 25% to/from farther north along US 127. The remaining 15% filter in from residential areas northwest of the interchange.

Applying these distributions and reductions to account for pass-by trips and internal capture rates to existing traffic (**Figure 2**) results in the “Existing + Development” traffic scenario shown in **Figure 9**.



Figure 8: Slip Ramp in Site Plan

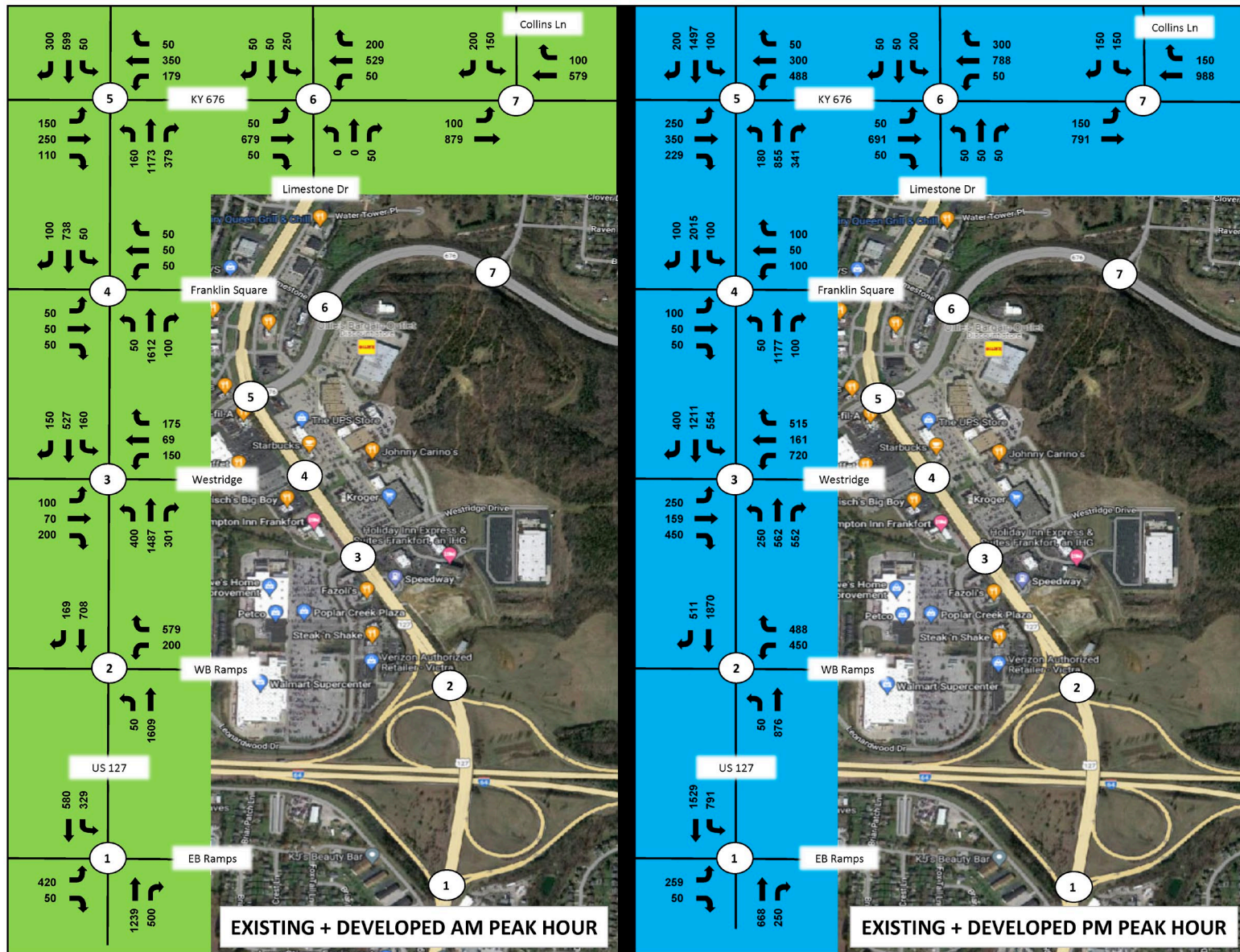


Figure 9: Existing + Development AM/PM Peak Hour Volumes

The Existing + Development scenario assumes all commercial tenants in the Franklin Square vicinity remain in their existing location, included as background traffic—separate from development trips. If any were to relocate to the Paddocks development, it would impact traffic flows. The current assumptions reflect a more conservative (i.e., higher volume) scenario than assuming some existing retail trips shift to become part of the development traffic.

Applying the new external development trips to the existing street network, operations degrade as summarized in **Figure 10**.

- Each intersection sees minor increases in delay during the AM peak, but none of the intersection LOS or LOS E/F movements differ from the existing scenario. The greatest increase is 30 seconds more delay at the over-capacity westbound off-ramp to north US 127. This increases the maximum modeled queue length from 915 feet to 1,670 feet. The existing ramp provides about 1,860 feet of storage space between the stop bar and gore.
- During the PM peak, the volume of added traffic is much greater, resulting in network-wide gridlock. Each of the signalized intersections operates at LOS E/F with the majority of turning movements failing.

With the increased traffic, US 127 maximum queue lengths exceed available spacing between signals at several locations for northbound flows in the AM peak hour and southbound flows in the PM peak hour. Average queue lengths are shorter—though southbound average queue lengths approaching KY 676 and Franklin Square Drive also spillback beyond the upstream signal in the PM peak.

4 PURPOSE AND NEED

The goal of this planning effort is to assess mobility needs for the US 127 corridor near I-64 in west Frankfort. US 127 provides one of two connections between the city and I-64. The regional medical center and consolidated county school campus rely on it for access, as do numerous businesses and residential neighborhoods. It is a principal arterial, NHS route, and federal truck route, making a high level of reliable mobility a critical component to support local and regional traffic flows.

The US 127/Leonardwood Drive/Westridge Drive intersection is already congested, controls operations for the corridor, and is expected to see a substantial increase in PM peak hour traffic volumes in the near future. Any future projects emerging from this study should maintain US 127 mobility, preserving vehicle throughput for the congested arterial corridor despite increasing volumes. Public roads represent the critical element for traffic flow; that is, mobility for the US 127 arterial and other public streets should be prioritized over mobility on private streets and driveways.

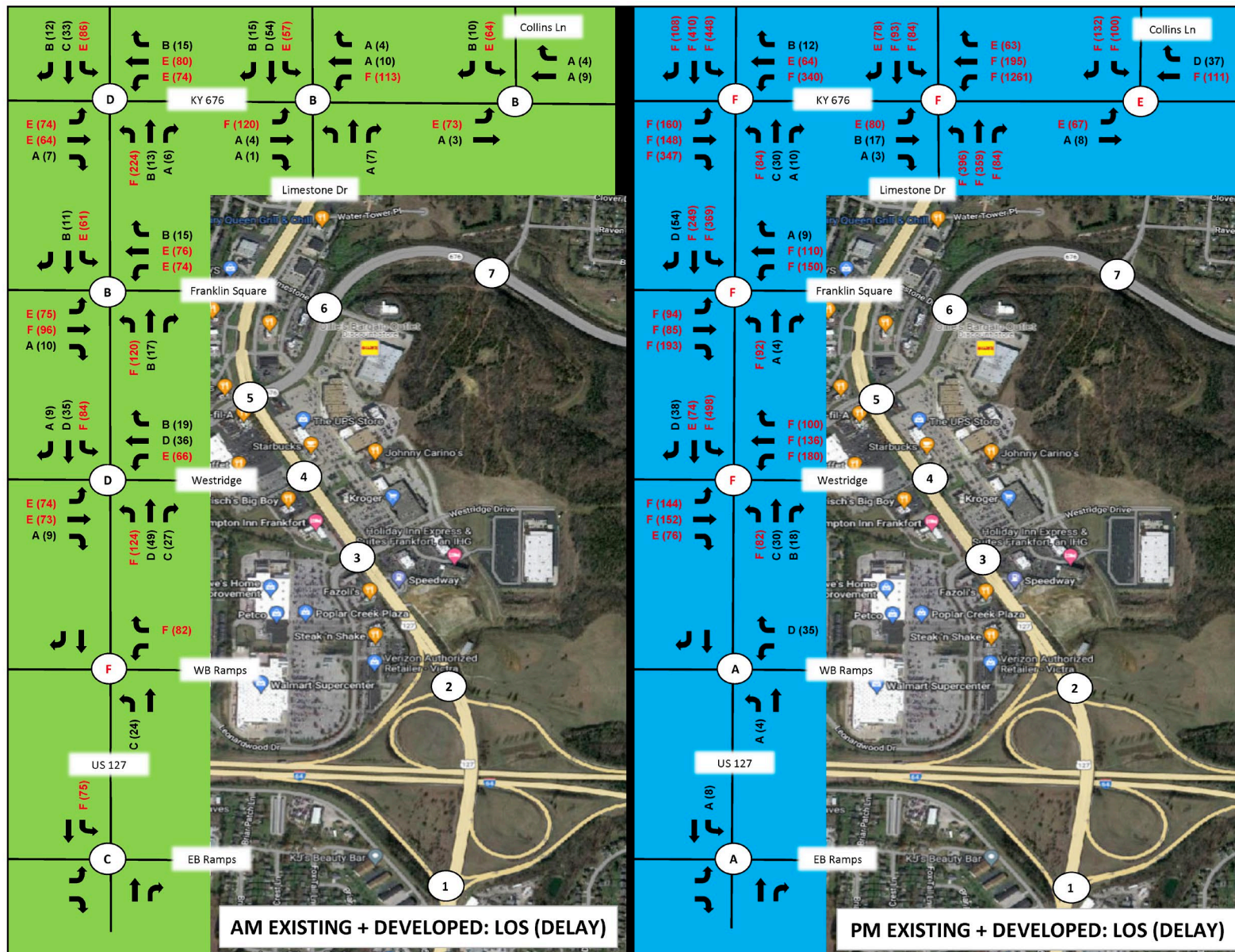


Figure 10: Existing + Development AM/PM Peak Hour LOS and Delay

5 BUILD OPTIONS TO IMPROVE FLOW

Three Build scenarios, with iterations under each, were evaluated to determine how proposed improvements would improve anticipated traffic flows.

5.1 BUILD 1: NO NEW US 127 SIGNALS

The initial Build scenario (“Build 1” shown in **Appendix C**) was developed to streamline anticipated traffic flows, focusing on the state-maintained highway network. Improvements within the existing right-of-way were prioritized to minimize costs and implementation timelines.

The Build 1 scenario includes spot improvements within three distinct geographic areas, in addition to system-wide signal timing adjustments.

IMPROVEMENTS ALONG US 127 TO SOUTH. Along US 127 south of the Leonardwood Drive/Westridge Drive intersection, the following improvements are included in the Build 1 scenario.

- Adjust striping/median to add northbound thru lanes within existing pavement (**Figure 11**). Just north of the I-64 overpass, lanes shift west so the westbound-to-northbound ramp becomes a free-flow movement instead of stopping. This “modified slip ramp” functions like the slip ramp proposed by the developer but represents a more standard configuration with fewer safety concerns. It also addresses current AM peak queueing issues along the ramp. The proposed widening creates a brief seven-lane section immediately north of the ramp—two southbound thru, median, northbound left to westbound on-ramp, four northbound thru—then carries all four northbound thru lanes to the first signal.



Figure 11: Extra Northbound Thru Lane on US 127

- Any access points along the east side of US 127 become RIRO only. The concrete median barrier is extended accordingly. This assumes a RIRO access road to the new development, similar to the configuration shown in **Figure 7**.
- Loops to facilitate u-turns were considered immediately south of the Leonardwood Drive/Westridge Drive signal for northbound traffic and immediately north of the eastbound on-ramp for southbound traffic.

- To aid in navigation, pavement tattoos or overhead signage on the existing truss could be added.

IMPROVEMENTS AT US 127/WESTRIDGE DRIVE. At the intersection with Leonardwood Drive/Westridge Drive, the following improvements are included in the Build 1 scenario.

- Dual northbound left turn lanes to Leonardwood Drive are extended to increase storage lengths (see **Figure 11**).
- A second US 127 southbound left turn lane to Westridge Drive is added to increase storage space, maximizing lengths within the available median.
- Westridge Drive is reconstructed to provide two receiving (eastbound) lanes. Approaching US 127, three westbound lanes serve left, shared left/thru, and right turn movements. Excluding the sidewalk, this increases the pavement width from 60 feet today to 66 feet proposed. The entire length between US 127 and Vandalay Drive becomes a divided section, with driveways on either side operating as RIROs. It should be noted that Westridge Drive west of Vandalay Drive is privately owned (**Figure 12**) but proposed to transfer to city ownership in May 2023.
- Adjusting the signal phasing to run east/west approaches concurrently was considered but rejected as it degrades performance.
- A multi-lane roundabout was considered but rejected as it cannot provide adequate capacity within the available right-of-way.

NEW BACKAGE ROAD. Vandalay Drive currently provides a backage road connection from Franklin Square south. The Build 1 scenario assumes a two to three lane connector from the Paddocks development to KY 676 at Limestone Drive, with a roundabout at Westridge Drive (**Figure 13**). The roundabout facilitates u-turns for Westridge Drive.

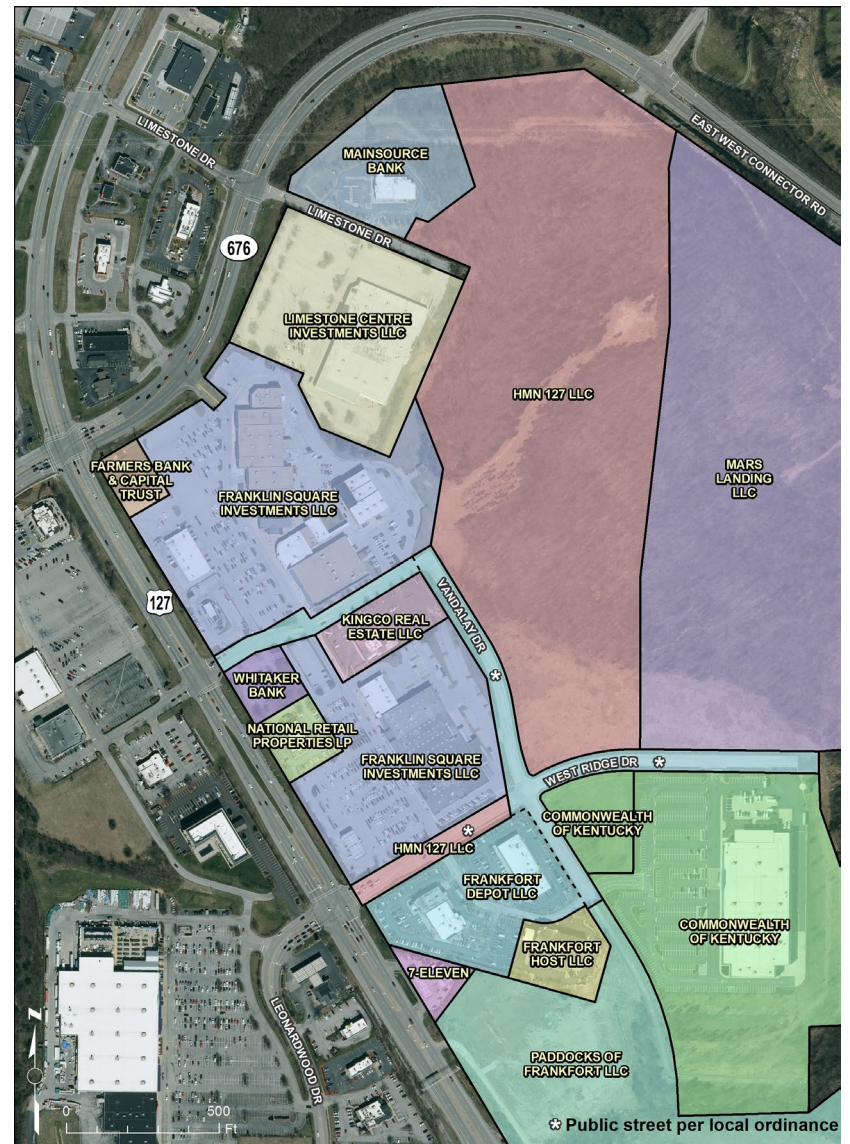


Figure 12: PVA Parcel Ownership

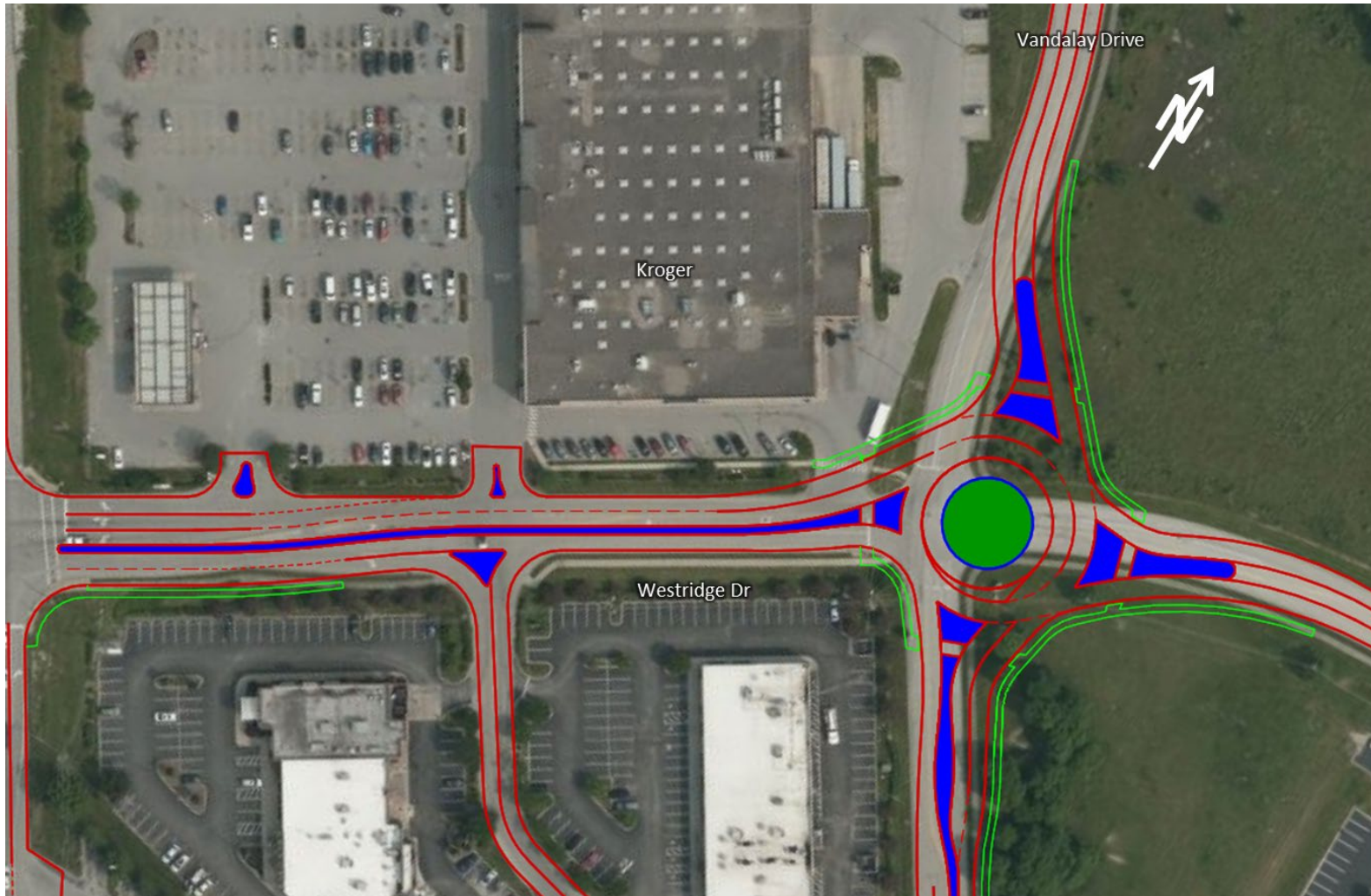


Figure 13: Proposed Westridge/Vandalay Roundabout

At the north end of the backage road, connections to Limestone Drive and/or Collins Lane were considered. A connection opposite Collins Lane (**Figure 14**) involves steeper terrain and would likely impact the transmission line, increasing costs. Limestone Drive is city-owned and provides a convenient cut-through from US 127, helping to divert some of the heavy southbound US 127 left-turn traffic intended for the Paddocks/Landings development.



Figure 14: View South from Collins Ln

5.2 BUILD 2: NEW SIGNAL PER 2019 TIS

For comparison, a new signalized intersection at US 127 and the proposed Landings property access road was also analyzed—approximately 500 feet south of the Leonardwood Drive/Westridge Drive signal. The new westbound approach is assumed to carry four lanes—westbound right, westbound left, plus two receiving—and dual southbound left turn bays as proposed in the 2019 Traffic Impact Study. The build traffic volumes from this 2022 effort are applied, higher than the assumed trips in the 2019 TIS. As shown in **Appendix D**, Build 2 contains a new signalized intersection added into the Build 1 scenario, with two exceptions:

- The longer northbound left turn storage lanes to Leonardwood Drive disappear due to the proximity of the new signal.
- The westbound off-ramp remains a free-flow movement but US 127 carries only three northbound thru lanes.

Two variations on this scenario were also evaluated, also shown in **Appendix D**. Build 2a includes the new Landings signal and US 127 modifications from Build 2 but eliminates improvements along Westridge or Vandalay drives. Without additional access points distributed along the backage road, all development traffic is routed through the Westridge and new southern signalized intersections. Build 2b includes the new Landings signal, US 127 modifications from Build 2, and the backage road connection along Vandalay Drive. It eliminates improvements along Westridge Drive, keeping a single southbound left turn lane and a single receiving lane.

5.3 BUILD 3: NEW SIGNAL AT WESTBOUND ON-RAMP

Build 3 was developed to provide an extra access point to the Paddocks/Landings development, shifting some of the westbound left turns away from the already congested US 127/Leonardwood Drive/Westridge Drive intersection. Shown in **Appendix E**, Build 3 includes the following elements:

- Four northbound thru lanes on US 127, similar to capacity improvements shown in Build 1. The westbound-to-northbound off-ramp is a free-flow movement but is reconstructed approximately 300 feet south of its current location.
- The westbound on-ramp is reconstructed approximately 180 feet north of its existing location. The on-ramp ties to US 127 at a new signalized intersection near MP 4.65, with a fourth approach providing access to the property. It should be noted that the Build 3 conceptual design does

not provide a southbound left turn option to access the development from this intersection; trips from the north are assumed to have turned left at one of the upstream signalized intersections. Fewer phases should improve the efficiency of signal timing.

- Other improvements to Westridge Drive, US 127 turn bays, and the Vandalay Drive backage road connection are identical to Build 1.

Build 3 would require coordination with the Federal Highways Administration (FHWA) and preparation of an *Interchange Modification Report* (IMR) for proposed changes to the interchange.

Five variations on this scenario were also evaluated, also shown in **Appendix E**. Build 3a excludes improvements to Westridge Drive and the backage road, including only modifications to US 127 and the interchange. Build 3b excludes Westridge Drive improvements but includes the backage road. Build 3c is identical to Build 3 but adds the southbound left turn bay at the new signal alongside Westridge drive and backage road improvements. Build 3d is identical to Build 3c but removes the RIRO connection to US 127 at the Landings. Build 3e is identical to Build 3d but merges the eastbound-to-northbound loop ramp south of the westbound-to-northbound off-ramp lane add, carrying three northbound thru lanes to the Leonardwood/Westridge signal.

6 BUILD TRAFFIC OPERATIONS

Each Build scenario was coded into the microsimulation network to measure performance metrics between scenarios. With lower volumes entering the development and less thru traffic headed towards I-64 during the AM peak, PM operations demonstrate more impacts from the development traffic. **Table 2** contains a side-by-side summary of intersection-level delay between Build scenarios during the PM peak hour. **Table 3** compares travel times along US 127 through the study area between scenarios. The following subsections provide more detailed discussions of each scenario, with movement-by-movement metrics at each study intersection in **Appendix F**.

Table 2: PM Peak LOS and Delay (seconds) at Study Intersections

Intersection	Existing	Existing + Developed	Build 1	Build 2	Build 3e
WB Off-Ramp	WBR: C (20)	WBR: D (35)	Free-flow ramp	Free-flow ramp	Free-flow ramp
New US 127 Signal	-	-	-	B (19)	C (34)
US 127 at Leonardwood Dr/Westridge Dr	D (45)	F (96)	E (57)	D (50)	D (49)
US 127 at Franklin Square	B (14)	F (97)	C (26)	C (25)	B (20)
US 127 at KY 676	D (48)	F (141)	E (56)	E (57)	E (67)
KY 676 at Limestone Dr	C (35)	F (99)	D (51)	D (51)	E (58)
KY 676 at Collins Ln	B (20)	E (64)	B (17)	B (16)	B (18)

Table 3: US 127 Travel Times in Seconds through Study Area

Scenario	AM		PM	
	NB	SB	NB	SB
Existing	157	166	197	157
Existing + Developed	343	180	181	424
Build 1 (Section 4)	142	163	197	166
Build 2 (Landings Signal)	146	162	205	163
Build 2a (No Backage, No Westridge)	157	165	197	401
Build 2b (No Westridge)	149	163	198	180
Build 3 (WB Ramp Signal)	157	170	208	171
Build 3a (No Backage, No Westridge)	151	169	219	183
Build 3b (No Westridge)	149	164	201	169
Build 3c (Build 3 + SBL at new signal)	151	169	199	169
Build 3d (Build 3c, no RIRO)	151	169	195	171
Build 3e (Build 3d with loop merge)	173	167	206	167

Note: Best performers shaded green; others within 5 seconds shaded lighter green

6.1 BUILD 1 TRAFFIC OPERATIONS

Build 1 includes extra northbound capacity on US 127 (no new signals), added capacity for Westridge Drive, and a new backage connection. As shown in **Figure 15**, operations degrade versus Existing for the PM peak hour with the increased traffic volumes; individual turn movements operate at LOS F at several study intersections but the overall intersections are not over capacity.

While Build 1 provides among the lowest travel times along US 127 of the build scenarios, maximum queue lengths for peak directional flows continue to exceed available spacing between signals but average queue lengths do not.

Routing of development traffic has been distributed through the existing street network, with some trips cutting across on Limestone Drive or Franklin Square. Because it is close to capacity, Westridge Drive is particularly sensitive to distribution assumptions. Even relatively minor changes in the distribution result in large changes for westbound queue lengths at the US 127 signal backing up into and beyond the roundabout in some cases.

Projections show 470 vehicles leaving the Paddocks/Landings site turning left onto southbound US 127 in the PM peak hour. With limited new connections to the south, most of this traffic is funneled through the already congested US 127/Leonardwood Drive/Westridge Drive signal—backing up queues along Westridge Drive or taking green time from US 127 thru movements, which increases delay for arterial moves. Should other properties in the vicinity develop, the proposed build configuration would likely not be sufficient.

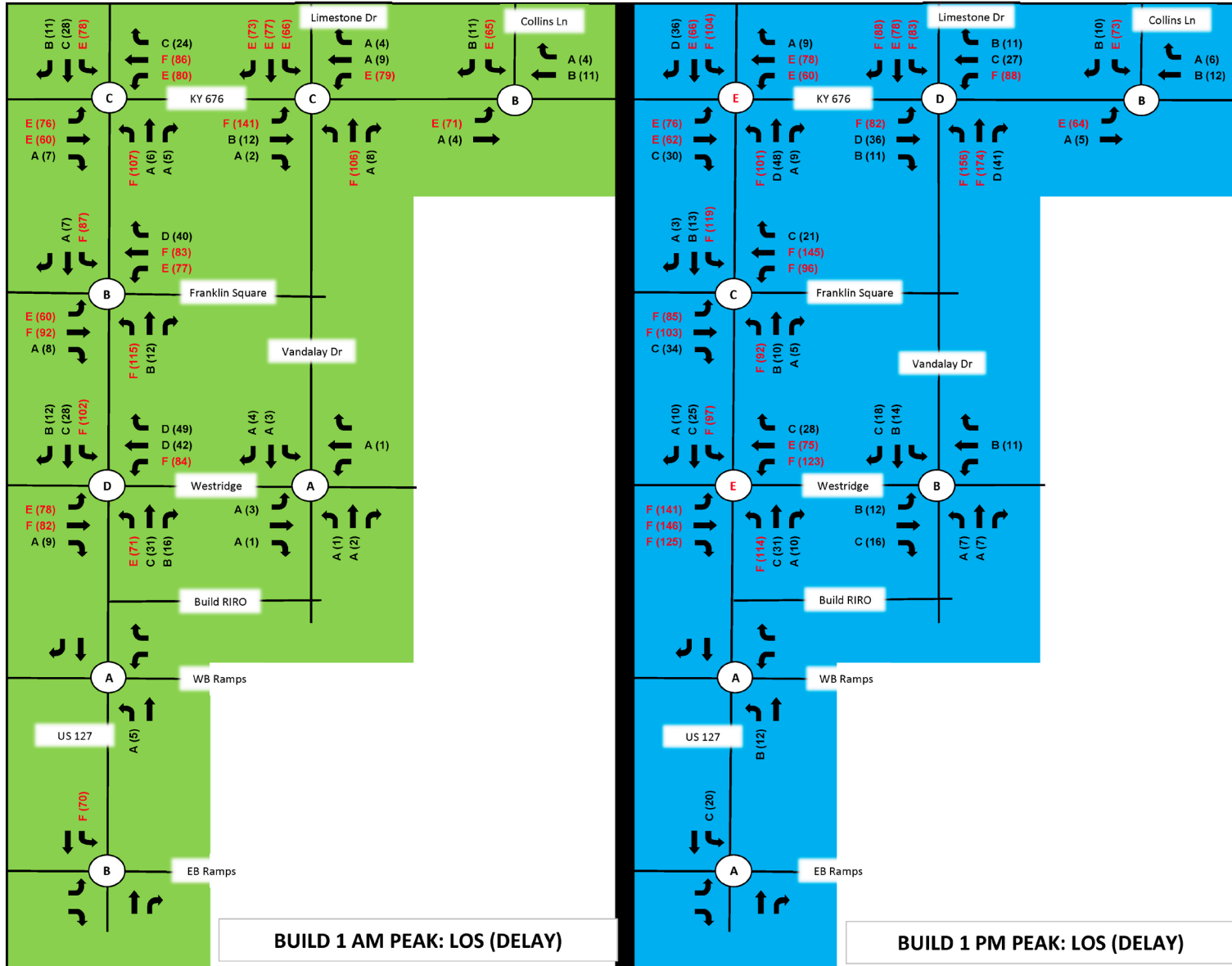


Figure 15: Build 1 AM/PM Peak Hour LOS and Delay

6.2 BUILD 2 TRAFFIC OPERATIONS

Build 2 includes the same Westridge Drive and backage road improvements as Build 1 plus adds a new signalized intersection along US 127 approximately 500 feet south of Westridge Drive. From an operations perspective, delay at the US 127/Leonardwood Drive/Westridge Drive signal is reduced compared to Build 1 as some of southbound and westbound left turn traffic shifts to the new intersection. **Figure 17** on the following page highlights LOS and delay for turn movements at study intersections during both peak hours.

As in previous scenarios, maximum queue lengths for peak directional flows continue to exceed available spacing between signals but average queue lengths do not. US 127 corridor travel times are among the best of the build options considered.

However, queues for left turning traffic spill back beyond the available turn bays for northbound lefts to Leonardwood Drive and southbound lefts into the Landings/Paddocks development, blocking thru lanes. **Figure 16** contains a screenshot from the microsimulation model. Both northbound and southbound queues regularly extend beyond the available 200-foot left turn storage lengths during the PM peak hour, blocking US 127 thru lanes. Maximum queues are over 600 feet, spilling back beyond the upstream signal. During the AM peak, northbound queues exceed capacity but with lower volumes entering the development and less thru traffic headed towards I-64, southbound queues are minimal.

Introducing a new signalized intersection is likely to increase crash rates along US 127, especially rear end crashes as motorists face stop-and-go traffic, grow impatient with lengthy delays, and may not be able to see around queued vehicles when completing left-turn maneuvers. Pulling stop bars back to improve visibility further reduces queue storage space, exacerbating the problem.

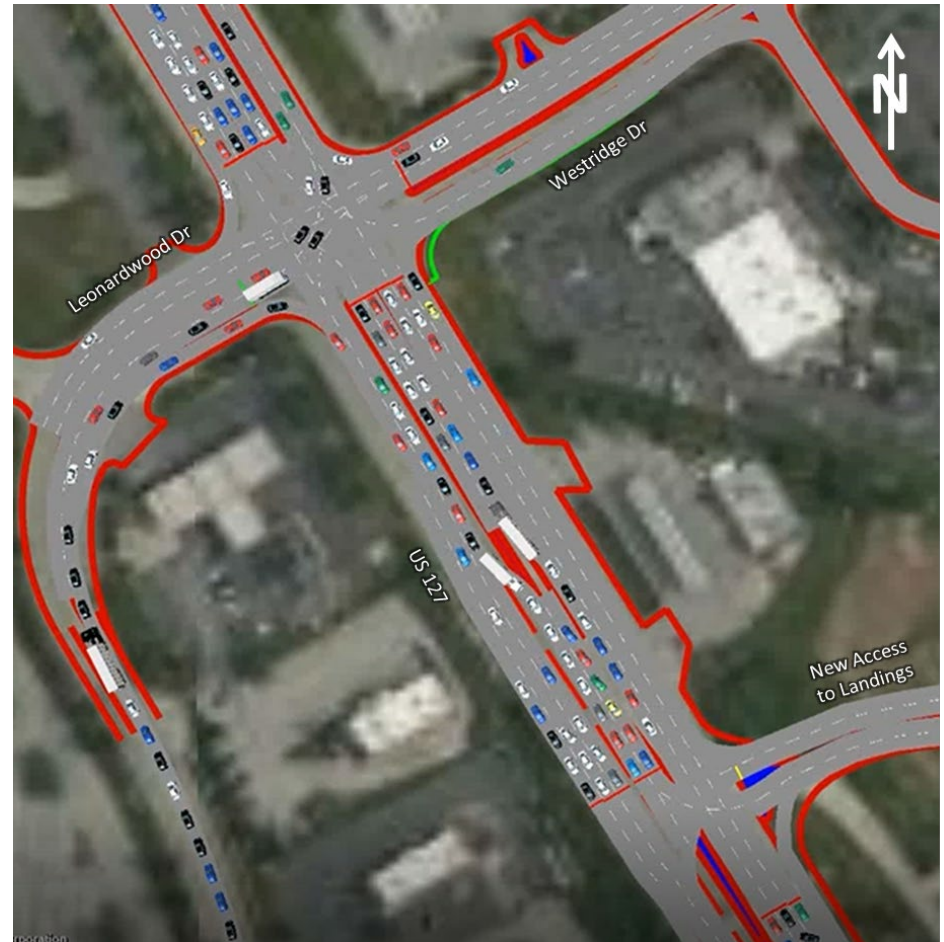


Figure 16: PM Peak Queuing between Closely Spaced Signals

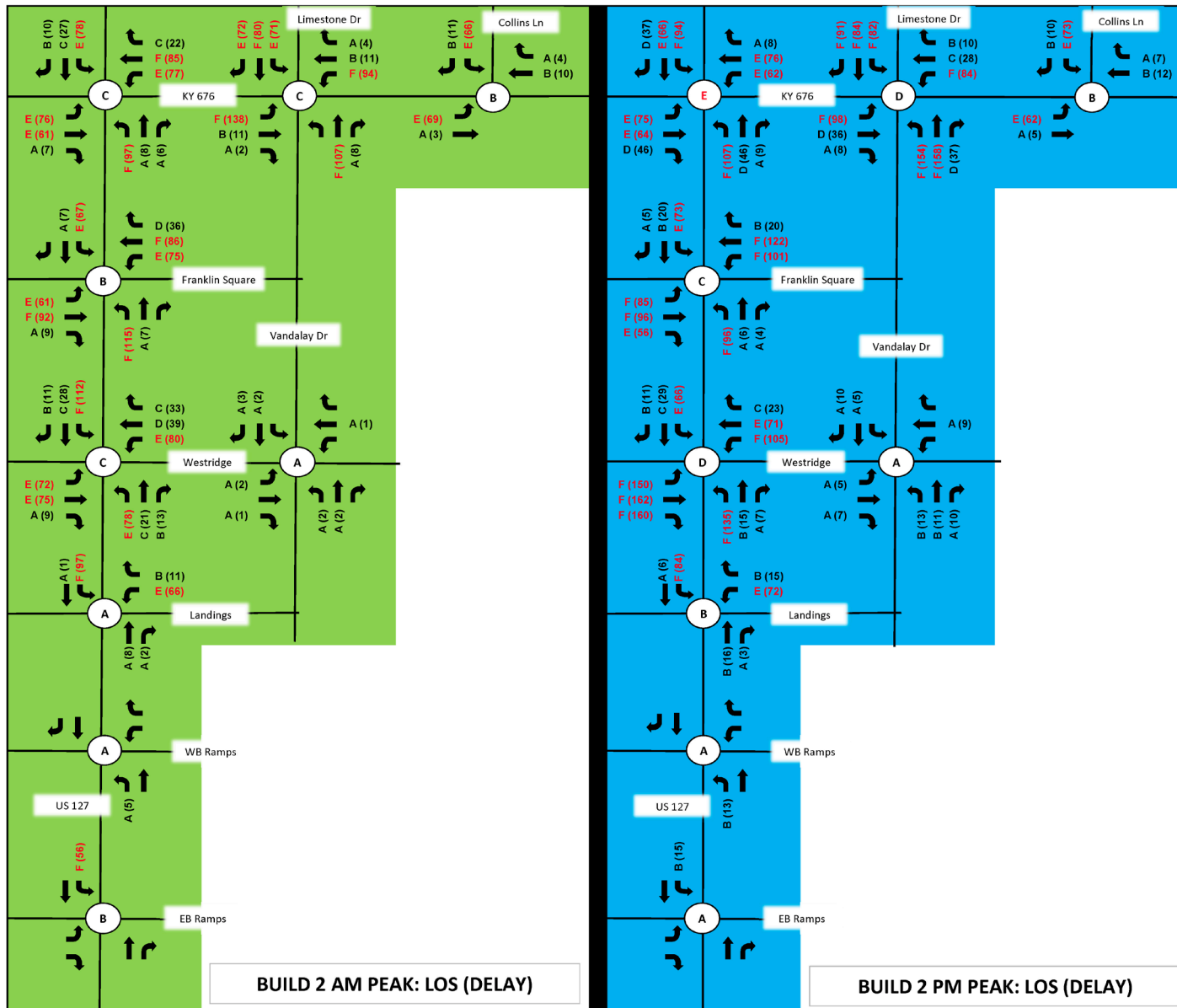


Figure 17: Build 2 AM/PM Peak Hour LOS and Delay

At the new signal, southbound and westbound left turns operate at LOS E/F in both peak hours. Queue lengths along the new westbound approach between the signal and adjacent T-intersection are a concern; increased storage space between these intersections would be beneficial but would impact the conceptual site layout.

While KRS 177.315 establishes 600 feet spacing in urban areas as the minimum between access points, per the 2012 KYTC *Traffic Impact Study Guidelines*, recommended signal spacing along urban arterials is 2,400 feet.

BUILD 2A TRAFFIC OPERATIONS. Build 2a includes the new Landings signal and US 127 modifications from Build 2 but eliminates improvements along Westridge or Vandalay drives. This configuration does not provide adequate capacity for PM peak hour operations; several signalized intersections are over capacity and travel times along US 127 more than double.

- With lower volumes entering the development and less thru traffic headed towards I-64 during the AM peak, the Build 2a network operates as well as Build 2 except for a minor increase in delay at US 127/KY 676, dropping the overall intersection from LOS C to D.
- With heavier traffic flows and turn movements during the PM peak, Build 2a LOS degrades from Build 2 by at least one letter grade at every study intersection. US 127 intersections with Leonardwood/Westridge and KY 676/Kings Daughters operate at LOS F. Southbound lefts onto Westridge Drive operate at LOS F; maximum queues spill back beyond the upstream signal at Franklin Square. The new signalized intersection operates at LOS D but both left turn movements are LOS F and queue lengths for the new westbound approach exceed 1,500 feet.

BUILD 2B TRAFFIC OPERATIONS. Build 2b includes the new Landings signal, US 127 modifications from Build 2, and the backage road connection along Vandalay Drive but eliminates improvements along Westridge Drive. Operationally, Build 2b lies between Build 2 and Build 2a. No intersections reach LOS F but Build 2b offers no travel time improvements compared to Build 1.

During the PM peak, US 127 intersections with Leonardwood/Westridge and KY 676/Kings Daughters operate at LOS E. Maximum northbound and southbound queue lengths between Leonardwood/Westridge and the new Paddocks/Landings signals approach but do not exceed the 500-foot spacing available. Left turns at the new signal operate at LOS E with maximum queue lengths on the new westbound approach less than 500 feet.

6.3 BUILD 3 TRAFFIC OPERATIONS

Build 3 includes the same Westridge Drive and backage road improvements as Build 1 plus adds a new signalized intersection along US 127 approximately 1,100 feet south of Westridge Drive, opposite the westbound on-ramp, that does not provide a southbound left turn option. Build 3 provides similar operations at study intersections as Build 2 but without the queuing concerns associated with the closely spaced Westridge and new access point signals. **Figure 18** on the following page highlights LOS and delay for turn movements at study intersections during both peak hours.

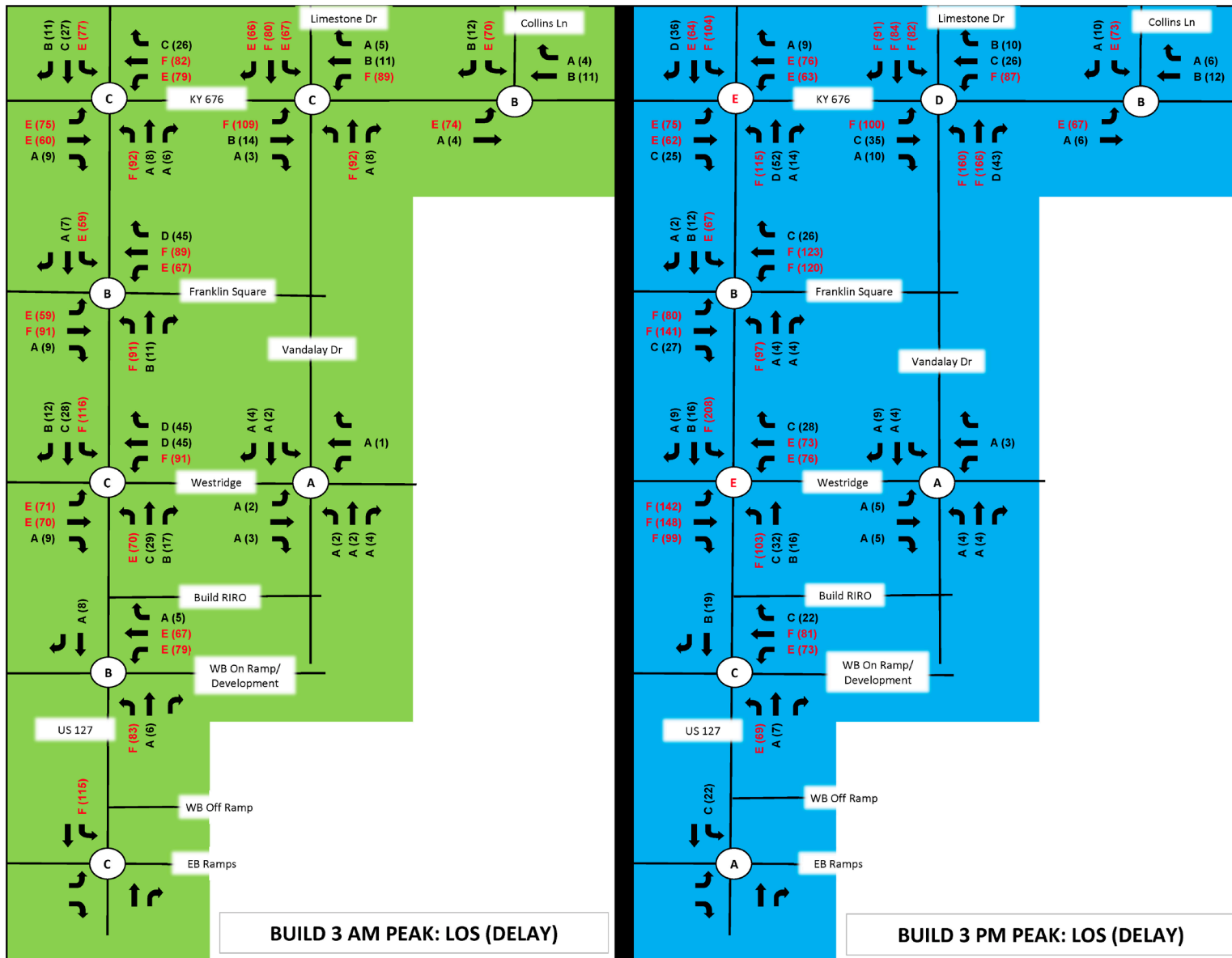


Figure 18: Build 3 AM/PM Peak Hour LOS and Delay

As in previous scenarios, maximum queue lengths for peak directional flows continue to exceed available spacing between some existing signals—northbound at Franklin Square in the AM peak and southbound at Leonardwood Drive and KY 676 in the PM peak. Average queue lengths do not. US 127 corridor travel times are higher than for Build 1 or Build 2.

The US 127/Leonardwood Drive/Westridge Drive signal operates at LOS E in the PM peak hour with northbound and southbound left turns from US 127 and all moves from the eastbound Leonardwood Drive approach over capacity. (Discussed below, variations on Build 3 add a southbound left turn lane at the new signal to address these concerns.)

The new signal at the on-ramp operates at LOS C in the PM peak hour but northbound lefts and thru/left turns from the new westbound property access point are at LOS E/F. Maximum queue lengths for the westbound approach are 460 feet. While the internal roadway network is up to the developer, concept sketches in **Appendix E** show a representative roundabout near the western tip of the development concept, roughly 350 feet east of US 127.

BUILD 3A TRAFFIC OPERATIONS. Build 3a includes the new signal at the shifted on-ramp and US 127 modifications from Build 3 but eliminates improvements along Westridge Drive or the backage road. It also adds dual southbound left turn bays at the new signal with 500+ feet of storage each. This scenario reduces delay at the US 127/Leonardwood Drive/Westridge Drive signal by distributing southbound turning traffic between two intersections instead of just the Westridge Drive signal. As in previous scenarios, maximum queue lengths for peak directional flows continue to exceed available spacing between some existing signals though average queue lengths do not.

The US 127/Leonardwood Drive/Westridge Drive signal operates at LOS D in the PM peak hour.

The new signal at the on-ramp operates at LOS D with westbound thru and left moves (exiting the development) at LOS F with queues over 1,650 feet.

As shown in **Figure 19**, Build 3a demonstrates that improvements contained entirely within existing right-of-way and the proposed development property can provide adequate network capacity for anticipated traffic flows. Build 3a is not a perfect solution: US 127/KY 676 and KY 676/Limestone Drive signals operate at LOS E in the PM peak and US 127 travel times are among the highest of all build concepts aside from Build 2a. But this scenario offers a lower cost, shorter term solution than other options. And, if combined with future improvements to Westridge Drive and the backage road (i.e., as in Build 3c), it may provide additional long-term redundancy benefits, especially if other vacant properties in the vicinity develop.

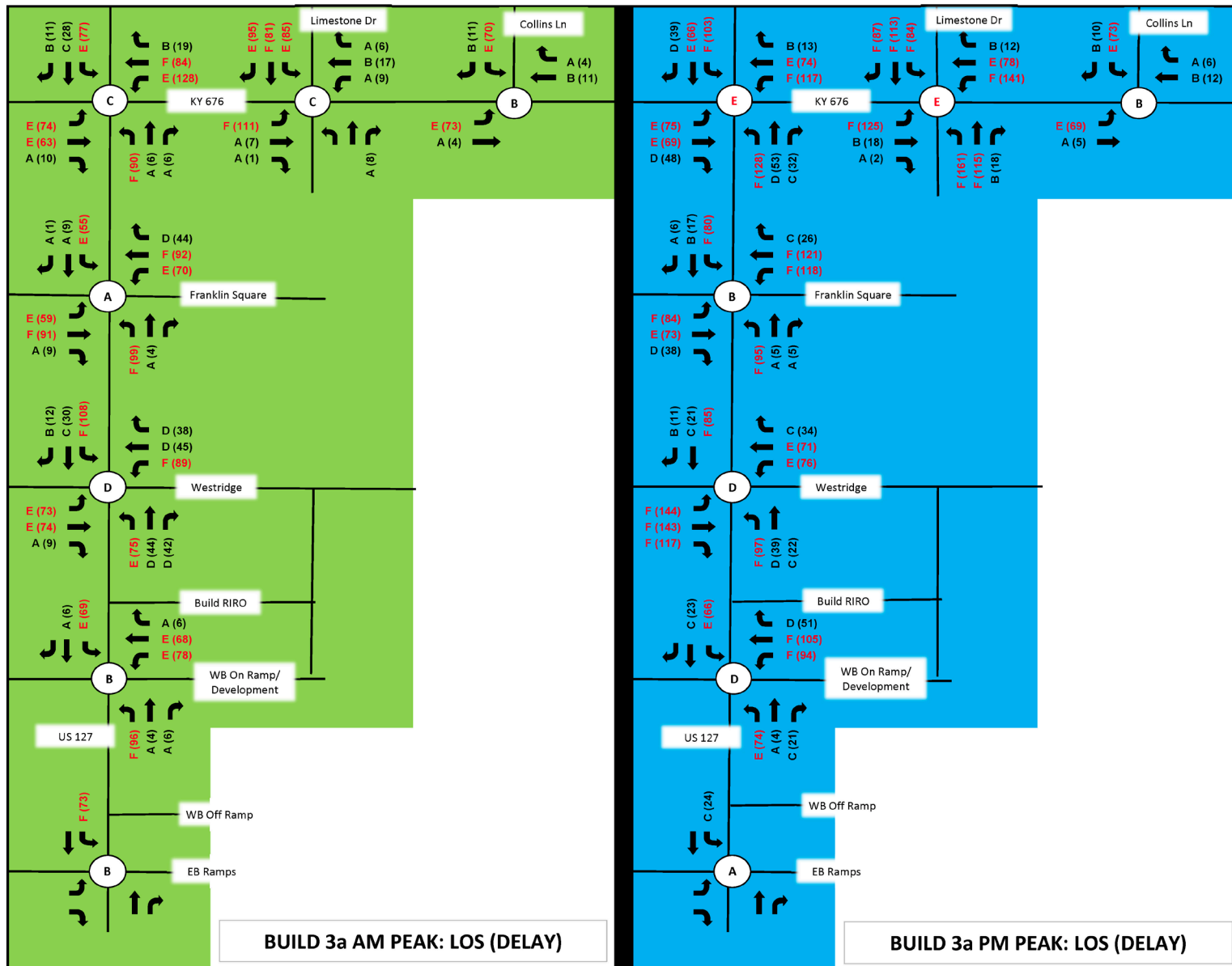


Figure 19: Build 3a AM/PM Peak Hour LOS and Delay

BUILD 3B TRAFFIC OPERATIONS. Build 3b includes the new signal at the on-ramp with the southbound left bays, US 127 modifications from Build 3, and the backage road but eliminates improvements along Westridge Drive. Operationally, Build 3b lies between Build 3 and Build 3a. No intersections reach LOS F but US 127/KY 676 is at LOS E in the PM peak. Build 3b offers slightly higher travel times than top performers Build 1/Build 2.

BUILD 3C TRAFFIC OPERATIONS. Build 3c starts with 3a—entirely within existing right-of-way and the proposed development property—then adds the improvements to Westridge Drive and the backage road. It shows minor improvements in delay over options 3a/3b at both the US 127/Leonardwood Drive/Westridge Drive and new signals. US 127 travel times are slightly higher than for Build 3b. As in previous scenarios, maximum queue lengths for peak directional flows continue to exceed available spacing between some existing signals but average queues do not. Southbound left turns onto Westridge Drive remain at LOS F in both peak hours but with less delay than in Build 3. Only the US 127/KY 676 intersection operates at LOS E in the PM peak hour.

For the new signal, westbound thru/left moves remain at LOS E/F but maximum queue lengths drop from 1650+ feet in Build 3a to 550 feet.

BUILD 3D TRAFFIC OPERATIONS. Build 3d matches Build 3c but loses the connection between the Landings RIRO and US 127. Little traffic was assigned to the Landings RIRO in other Build 3 scenarios, leading to minimal differences in microsimulation results. Operationally, Build 3d is within 5 seconds delay at all study area intersections with no changes in LOS.

BUILD 3E TRAFFIC OPERATIONS. Build 3e starts with Build 3c but loses the connection between the Landings RIRO and US 127 and merges the eastbound-to-northbound loop ramp before the westbound-to-northbound off-ramp so only three northbound thru lanes are carried to the Leonardwood/Westridge signal. Shown in **Figure 20**, LOS at each study intersection along US 127 matches LOS in Build 3c.

The new signal operates at LOS C in the PM peak. Westbound thru/left turns exiting the development operate at LOS F/E respectively, with maximum queue lengths of 1,230 feet backing up into the development. The US 127/Leonardwood Drive/Westridge Drive signal operates at LOS D in the PM peak, with left turn movements at LOS E/F. Maximum queues for both southbound lefts at the new signal and northbound lefts to Leonardwood Drive fit within available turn lane storage lengths, removing turning traffic from thru lanes.

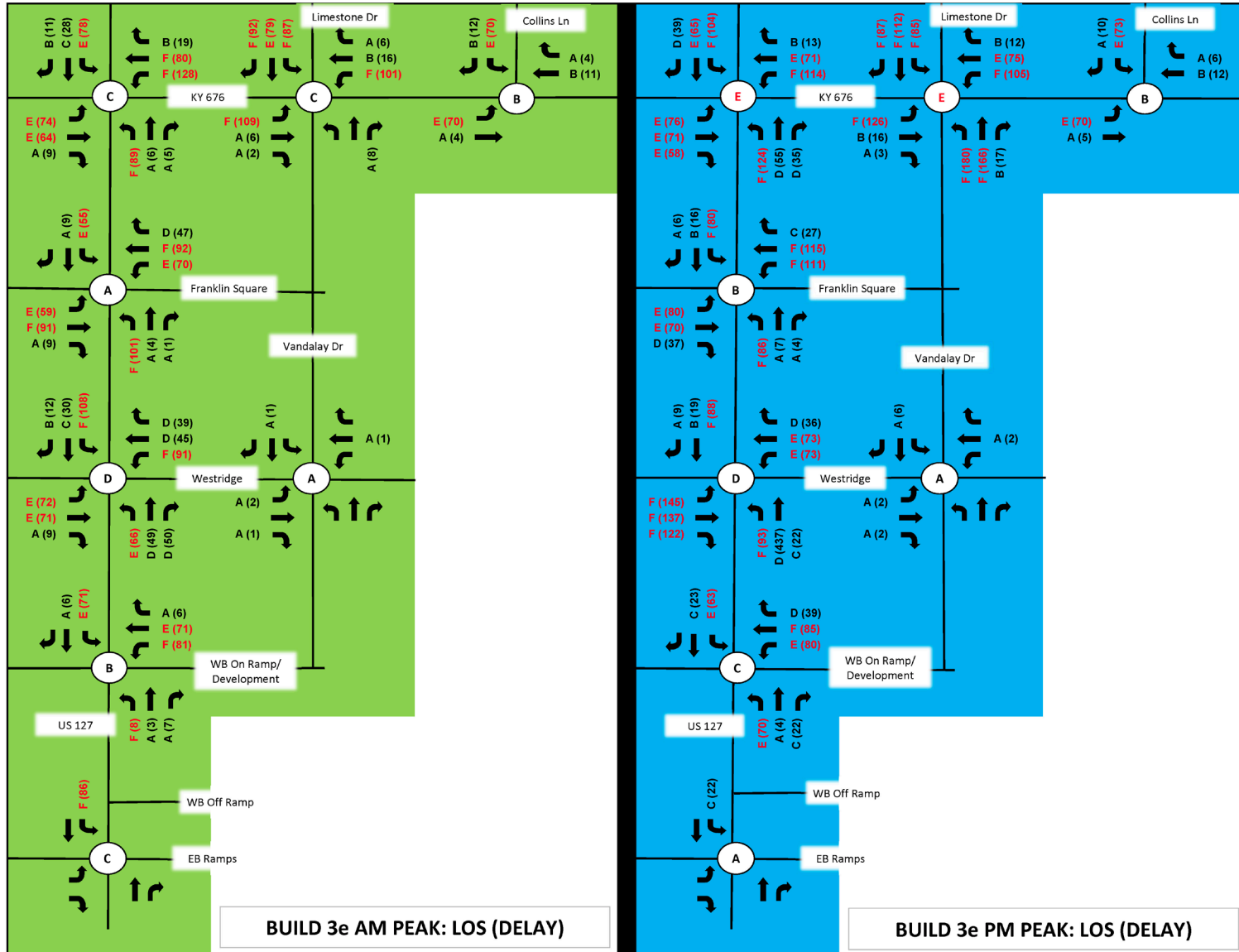


Figure 20: Build 3e AM/PM Peak Hour LOS and Delay

6.4 FHWA CONSIDERATIONS FOR BUILD 3E

Build 3e was analyzed in more detail to document key operational characteristics for the westbound-to-northbound off-ramp and access control along US 127. Shown in **Figure 21**, Build 3e realigns the westbound-to-northbound off-ramp, decreasing the length, but converts the existing stop-controlled intersection with US 127 to a free-flow movement with an added third northbound lane on US 127.

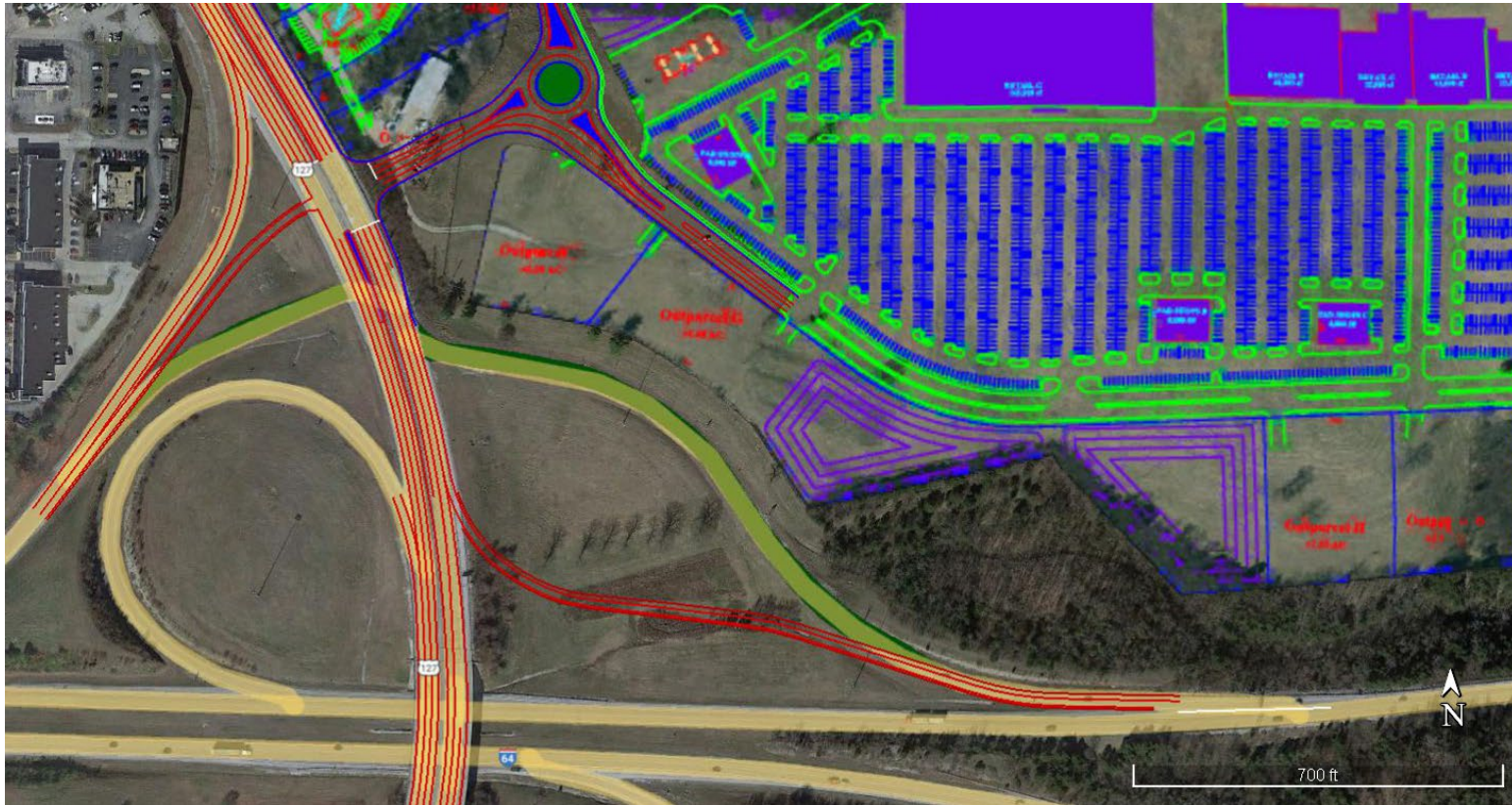


Figure 21: Build 3e at I-64 Westbound Ramps

Today, the ramp is 1,910 feet to the gore. During the AM peak hour, it carries 550 vehicles per hour (vph) compared to 2,360 vph on adjacent I-64 eastbound thru lanes. The westbound diverge segment operates at LOS C with maximum queue lengths of 915 feet backing up onto the ramp per the Vissim microsimulation model.

In Build 3e, the proposed ramp is 1,730 feet to the gore. During the AM peak hour, it carries 579 vehicles per hour (vph) compared to 2,360 vph on adjacent I-64 eastbound thru lanes. The westbound diverge segment operates at LOS C with no queue length approaching US 127 as there is no stop or merge for exiting traffic.

Figure 22 presents a visual summary of vehicular densities by lane during the PM peak hour for the No-Build (bottom) and proposed Build 3e (top) scenarios. As shown, densities increase approaching signals, represented by the darker red shading. Adding a third lane in Build 3e spaces out traffic, introducing more opportunities to change lanes in addition to increasing the available length to complete these maneuvers versus the No-Build scenario.

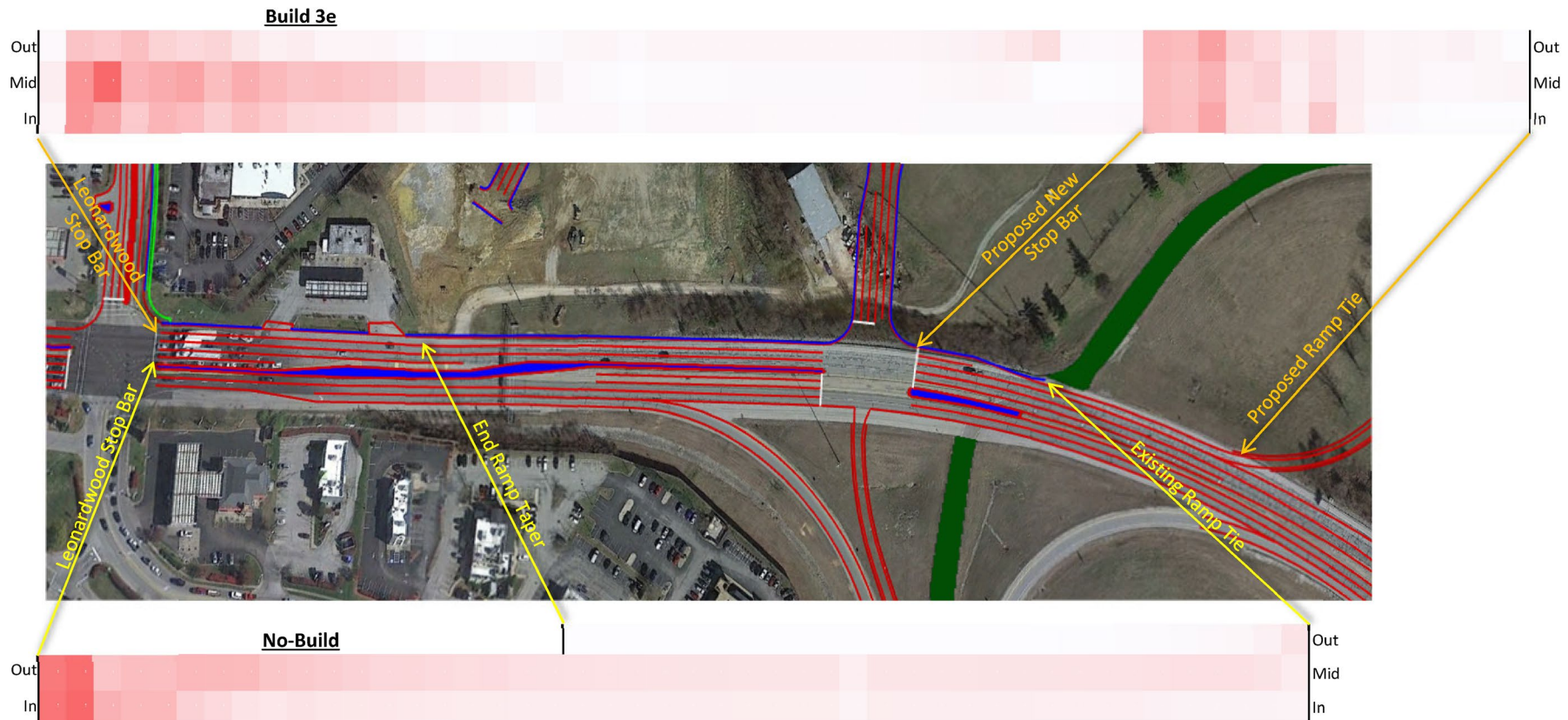


Figure 22: Northbound US 127 Density by Lane

The highest densities approaching the Leonardwood Drive/Westridge Drive stop bar in the No-Build scenario are 110-123 passenger cars per lane per hour (pcplph), highest in the inside lane adjacent to the left turn bays. In Build 3e, the corresponding densities are 91-149 pcplph, highest in the middle lane. The 700 feet just north of the proposed new signal in Build 3e average 13.5 pcplph compared to 16.8 pcplph in the No-Build for the same length.

While the concept provides an estimated 500 feet between the westbound-to-northbound off-ramp tie to US 127 and the northbound stop bar at the new signal, the horizontal curvature of US 127 versus the proposed ramp lead to opposing superelevations. Planning-level drawings show 3% superelevation along US 127 versus -8% superelevation for the ramp, The ramp's superelevation runoff and runout will add approximately 200 feet from the end of the horizontal curve before the cross section is flush with US 127. This effectively reduces the available weave distance between the off-ramp and downstream left turns.

Access control limits are shown in **Figure 23** for Build 3e. Northbound, access control limits drop from 920 feet existing to 550 feet proposed. Southbound, there is no change between the existing and proposed conditions.

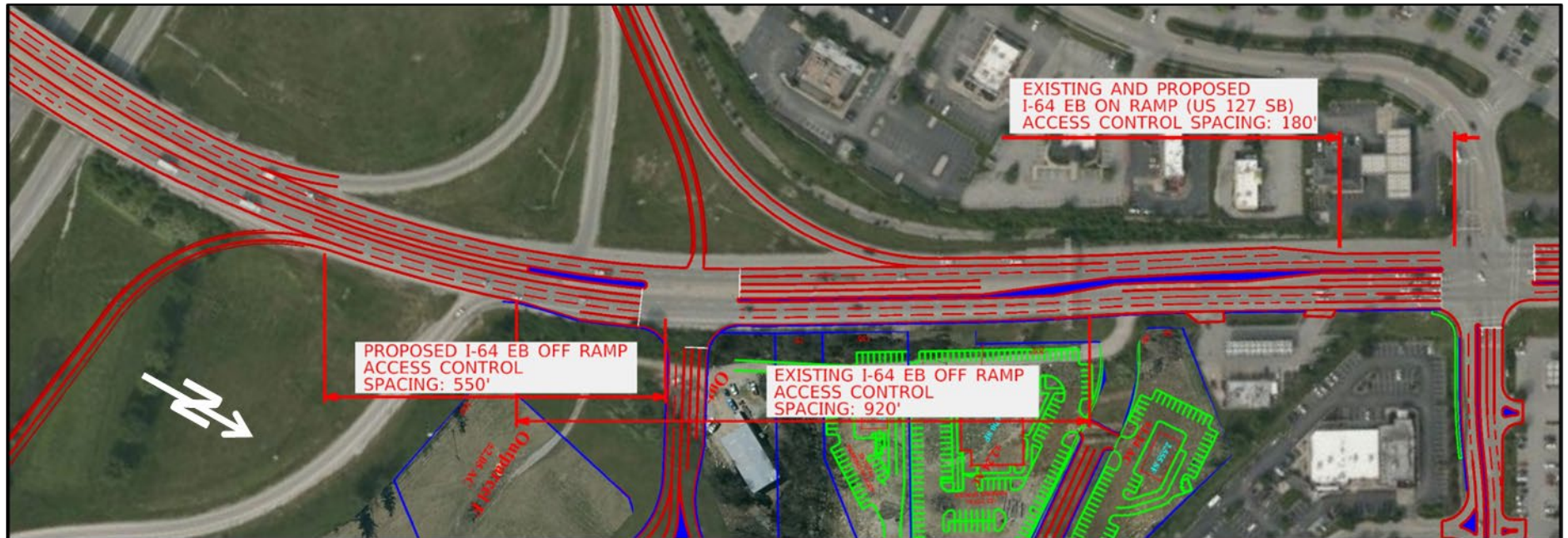


Figure 23: Access Control Spacing

It should be noted that concepts presented herein have been developed at a planning level of detail. Additional design efforts—preliminary and final—will refine the preferred concept, including a Geometric Layout Sheet and any necessary environmental clearances.

7 COST ESTIMATES

Planning-level cost estimates³ were developed using 2021 KYTC average unit bid prices, estimating quantities for pavement and concrete medians, curbs, and sidewalks. Analysts then applied a 1.6 factor to reflect other construction costs and added 30% for contingencies. Including existing privately owned roads, right-of-way was estimated at \$500,000 per acre. Costs for Build 1 are shown in **Table 4**, also breaking out costs for improvements by section.

Table 4: Planning-Level Cost Estimates for Build 1

Cost Estimate	Total Costs	Design	Right-of-Way	Utilities	Construction
Full Build 1 Concept	\$11.3M	\$1.0M	\$5.5M	\$0.7M	\$4.1M
US 127	\$1.8M	\$0.2M	-	-	\$1.6M
Westridge Drive	\$3.8M	\$0.4M	\$2.3M	\$0.3M	\$0.8M
Backage Road	\$4.4M	\$0.3M	\$2.6M	\$0.3M	\$1.2M
Within Development	\$1.3M	\$0.1M	\$0.6M	\$0.1M	\$0.5M

Build 2 costs are summarized in **Table 5**. Build 2 is estimated at \$10.5 million, versus \$2.3 million for Build 2a or \$6.7 million for Build 2b.

Table 5: Planning-Level Cost Estimates for Build 2

Cost Estimate	Total Costs	Design	Right-of-Way	Utilities	Construction
Full Build 2 Concept	\$10.5M	\$0.9M	\$5.5M	\$0.7M	\$3.4M
US 127	\$1.0M	\$0.1M	-	-	\$0.9M
Westridge Drive	\$3.8M	\$0.4M	\$2.3M	\$0.3M	\$0.8M
Backage Road	\$2.2M	\$0.1M	\$1.3M	\$0.2M	\$0.6M
Within Development	\$3.5M	\$0.3M	\$1.9M	\$0.2M	\$1.1M

³ Planning-level estimates are conservatively high, including initial assumptions regarding private ownership of Westridge and Vandalay drives. Updated costs for the preferred concept will be provided as design phases advance.

And Build 3 costs are summarized in **Table 6**. Build 3 is estimated at \$15.3 million. Other variations include \$8.8 million for Build 3a, \$14.2 million for Build 3b, \$15.5 million for Build 3c, \$15.4 million for Build 3d, and \$14.4 million for Build 3e. For reference, planning-level costs by phase for Build 3e are included in **Table 7**. Build 3e without improvements along Westridge Drive or Vandalay Drive north of the development are estimated at \$8.2 million.

Table 6: Planning-Level Cost Estimates for Build 3

Cost Estimate	Total Costs	Design	Right-of-Way	Utilities	Construction
Full Build 3 Concept	\$15.3M	\$1.4M	\$5.5M	\$0.9M	\$7.5M
US 127/I-64 Ramps	\$4.7M	\$0.5M	-	-	\$4.2M
Westridge Drive	\$3.8M	\$0.4M	\$2.3M	\$0.3M	\$0.8M
Backage Road	\$2.2M	\$0.1M	\$1.3M	\$0.2M	\$0.6M
Within Development	\$4.6M	\$0.4M	\$1.9M	\$0.4M	\$1.9M

Table 7: Planning Level Cost Estimate for Build 3e

Cost Estimate	US 127/Ramps	Other Routes
Design	\$0.5M	\$0.9M
Right-of-Way	-	\$5.2M
Utilities	<\$0.1M	\$0.7M
Construction	\$3.9M	\$3.2M
Total	\$4.4M	\$10.0M

Succinct project summary sheets for Build concepts are included in **Appendix G**.

KYTC subject matter experts independently reviewed Build 3a to assess any fatal flaw concerns. A meeting summary and synopsis of design considerations are included as **Appendix H**.

Appendix A: Traffic Microsimulation Technical Report

This technical report summarizes the methodologies to develop the microsimulation network for the 5-80212 analyses. Due to the imminent construction timeline for the developments, all analyses are based on “current” year traffic with no future forecasting component. The following sections document key tasks and model assumptions.

DATA COLLECTION

Numerous data points were collected to facilitate model development:

- Traffic counts were compiled from turning movement counts conducted for KYTC’s 2019 *Frankfort Small Urban Area Study* and the 2019 *Traffic Impact Study* for the Paddocks/Landings developments. Both sets of turning movement counts were collected during 2018: March and October, respectively. Year 2018 was selected to represent the base network as data was readily available for most study intersection; it also served to minimize the impact of the covid pandemic, which had a substantial impact on local commuting patterns. Corridor volumes between both data sets were consistent; raw turning movements are included as **Attachment A1**.
- Peak hour turning movement counts were also conducted in June 2022 at the US 60 intersections with Jett Boulevard and Canty Way in east Frankfort. These intersections provide access to the Parkside mixed use development, similar in size and composition to the proposed Landings/Paddocks development.
- Existing signal timing plans at study intersections were provided by KYTC District 5.
- Fleet mix distributions (i.e., cars versus trucks) were derived from 2018 traffic counts and statewide averages.
- Peak hour travel times were collected via GPS datalogger during June 2022. While these are not an exact baseline for 2018 operations, they provide a comparison point. HERE travel time data for both KY 676 and US 127 were also queried and show similar trends. Both data sets are mapped in **Figure A-1**.



Figure A-1: Travel Speed Comparison

- StreetLight data provided origin-destination flows between external network links. Results were based on weekday (Tuesday through Thursday) trends observed during four months of 2019 data (March, April, September, October)—periods when school was in session and seasonal disruptions (e.g. snow storms, holidays) were minimal. Distributions were reported for 24-hour, AM peak (7-9 AM), and PM peak (4-6 PM) periods. A map of gateway locations and corresponding tables for the AM and PM peaks are included as **Attachment A2**.
- Measures of 2018 queue lengths were not available; however, anecdotal input from commuters familiar with the corridor pre- and post-covid was incorporated.

CALIBRATION OF EXISTING NETWORK

Microsimulation models using the Vissim software package² were developed for the AM and PM peak hours. The AM peak simulated operations 7:15-8:15 AM; the PM peak simulated operations 4:45-5:45 PM. The existing scenario was calibrated using collected data defined in the previous section to ensure models replicate existing performance. Default variables were adjusted as appropriate to reflect Kentucky driver behaviors as discussed below. Once calibrated, development traffic was added and build scenarios were created to test how different improvements impacted traffic operations. Results are presented in the main report for the study.

Vehicle volumes at network entry nodes were input for 15-minute intervals. Peak hour volumes at each intersection were compared between the model network and existing counts; as shown in **Table A-1**, all intersections calibrated to within 10% of the observed volumes.

Vehicle compositions were calculated and input for each entry node from classification data in the traffic counts. Vehicle fleet compositions for cars and heavy vehicles were also assigned by KYTC standards.

Table A-2 summarizes breakdowns for both cars and heavy vehicles.

Table A-1: Model vs Design Hour Volume Comparison

Intersection	AM Comparison	PM Comparison
US 127 & I64 EB Ramps	-1.3%	-4.2%
US 127 & I64 WB Ramps	-3.9%	-4.4%
US 127 & Leonardwood/Westridge	2.7%	8.6%
US 127 & Franklin Square	0.5%	-1.1%
US 127 & KY 676	9.0%	4.7%
KY 676 & Limestone	-5.8%	2.9%
KY 676 & Collins	-8.7%	-4.5%

² PTV Vissim 2022 (SP 01) [236021]

Table A-2: Vehicle Distributions for Cars and Trucks

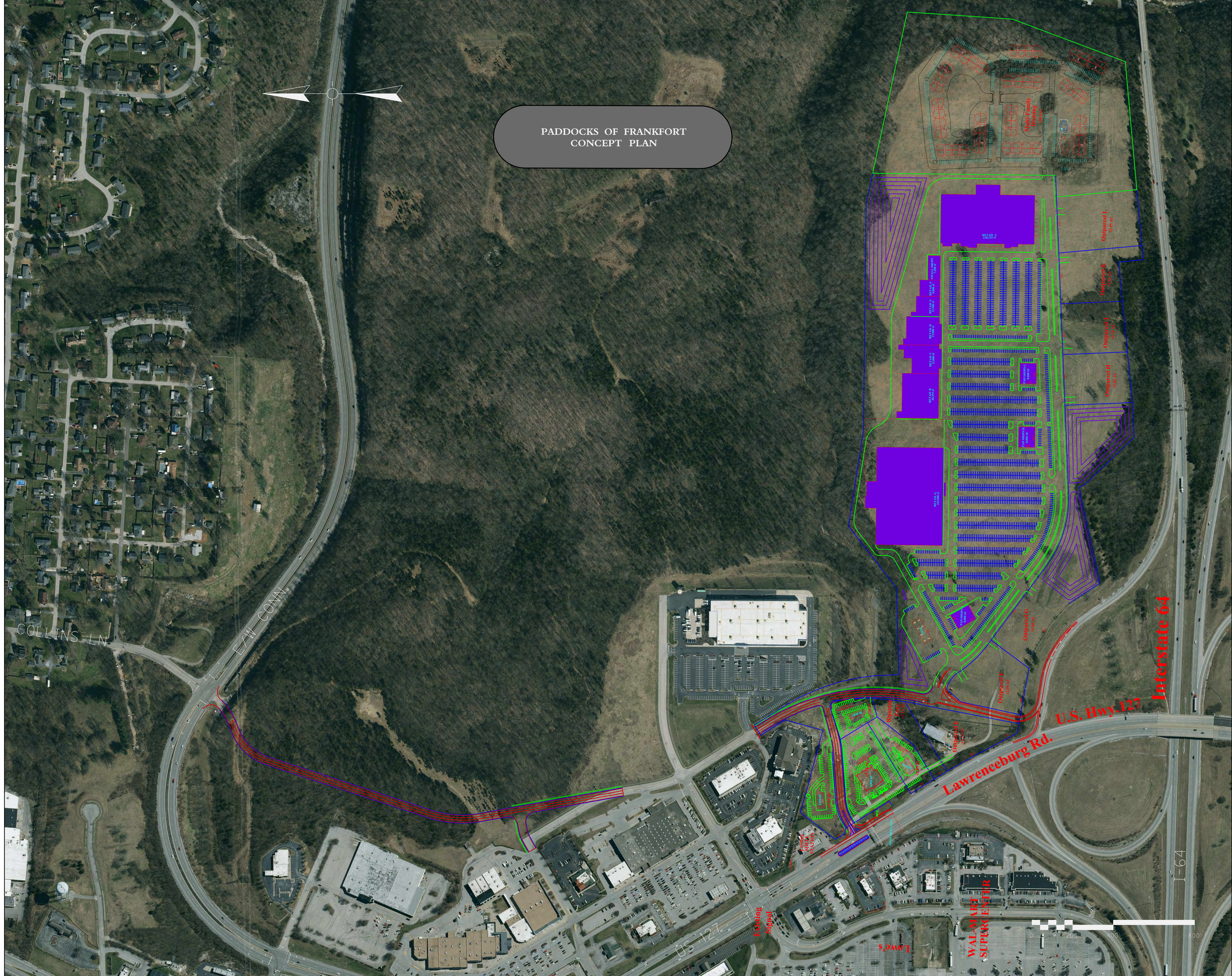
Car Type	Percentage	Heavy Vehicle Type	Percentage
Honda Accord	12.9%	AASHTO WB-40	10.5%
Nissan Altima	6.0%	AASHTO WB-50	48.0%
Nissan Quest	6.4%	AASHTO WB-65	4.5%
Plymouth Voyager	5.5%	AASHTO WB-67	4.5%
Toyota Avensis	13.5%	Flatbed	5.0%
Ford Explorer	10.6%	EU 04	27.5%
GMC Yukon	5.0%		
Jeep Grand Cherokee	5.8%		
Ford F150	19.2%		
Chevrolet Silverado	15.1%		

KYTC's default desired speed distributions were used, following the 45 mph Urban Arterial curve, with travel speeds distributed between 33 and 57 mph.

A virtual meeting was held with KYTC Modal Group on June 16, 2022. After viewing the calibration metrics (summarized herein) and simulation videos, attendees agreed both networks appear reasonable with an adjustment to the traffic control for right turns from Leonardwood Drive.

Appendix B: Conceptual Site Plan, June 2022

PADDOCKS OF FRANKFORT
CONCEPT PLAN



COLLINS LN

E.W. CONN.

US 127

Lawrenceburg Rd.

Lawrenceburg Rd.

U.S. Hwy. 127

Interstate 64

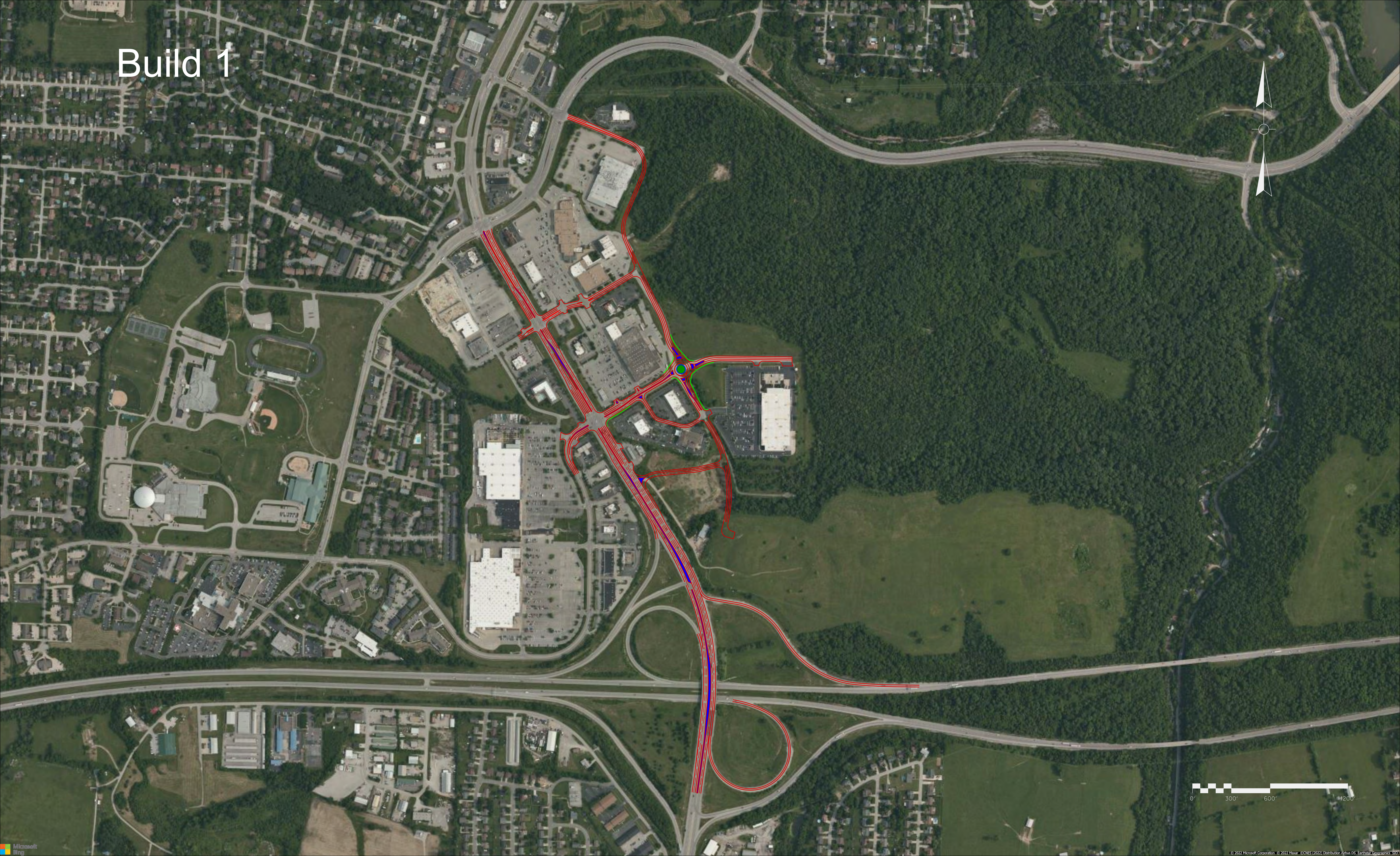
WAL-MART
SUPERCENTER

0 200 400 800

I-64

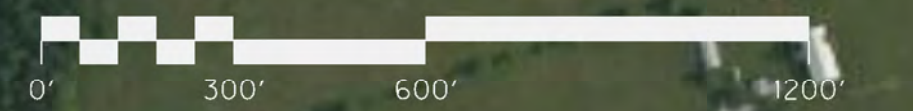
Appendix C: Build 1 Scenario Concept Sketch

Build 1

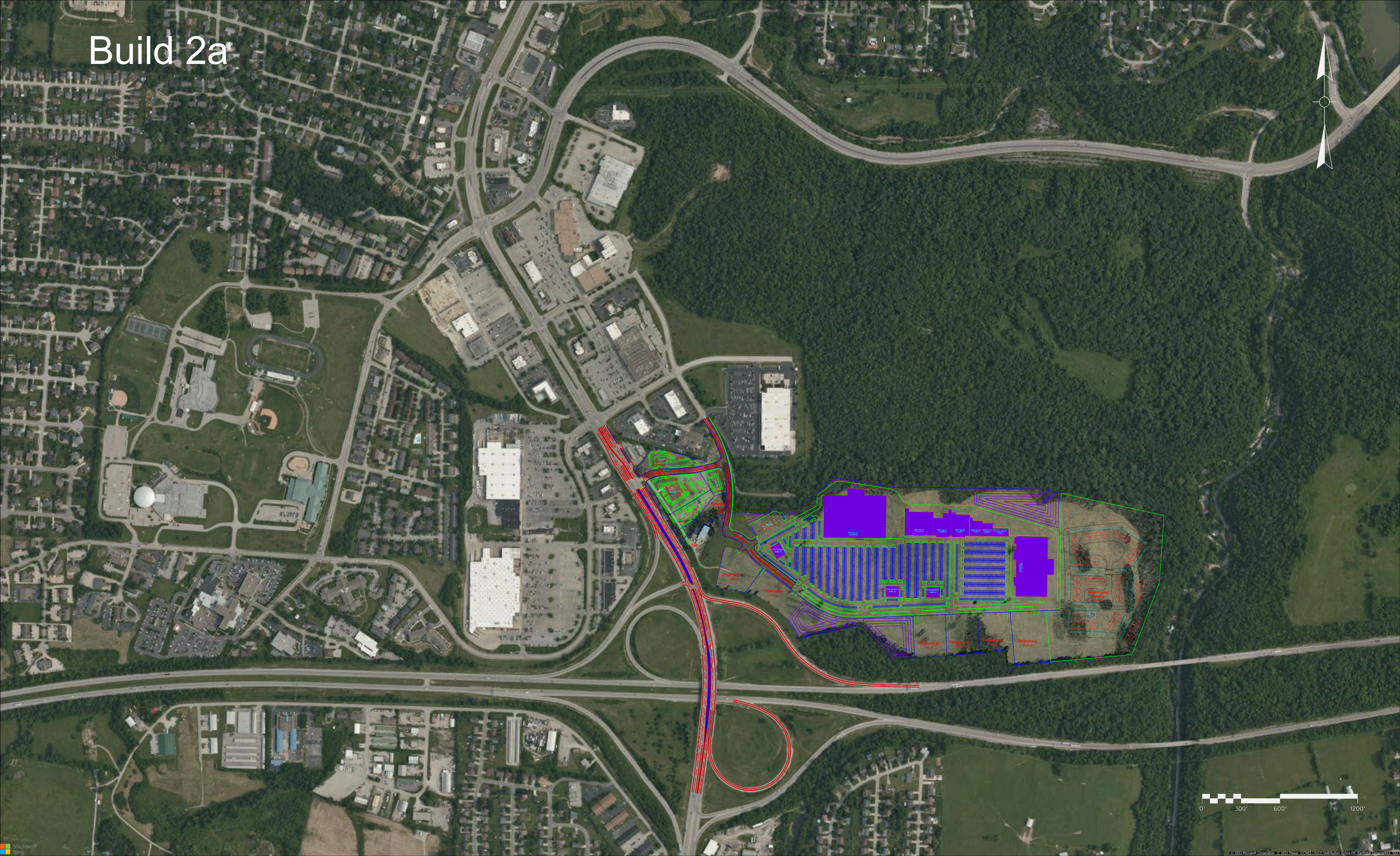


Appendix D: Concept Sketches for Build 2 Scenarios

Build 2



Build 2a

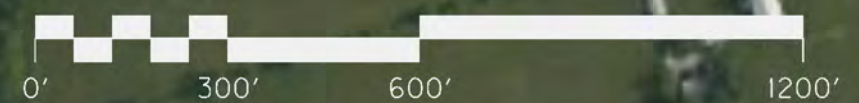
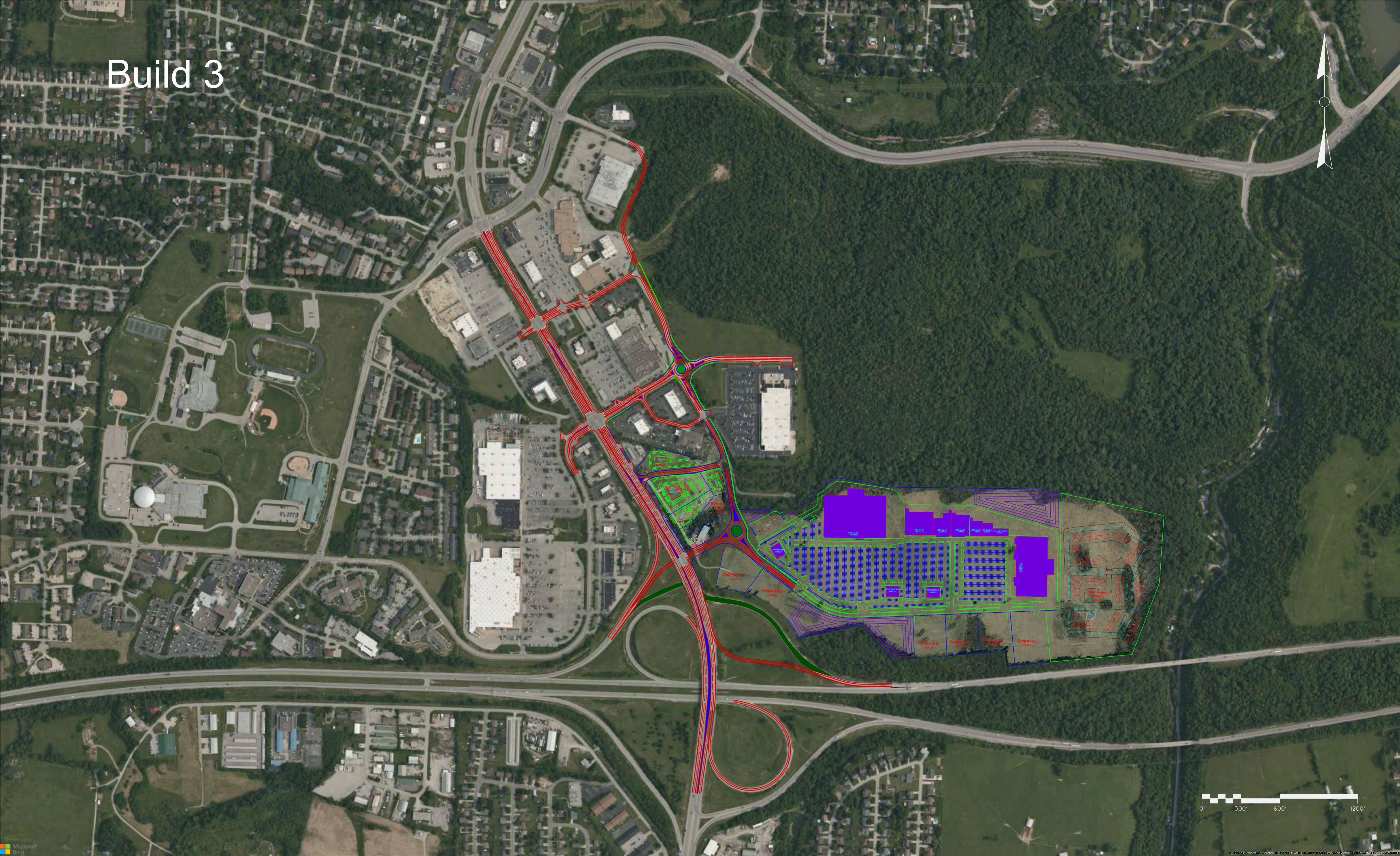


Build 2b

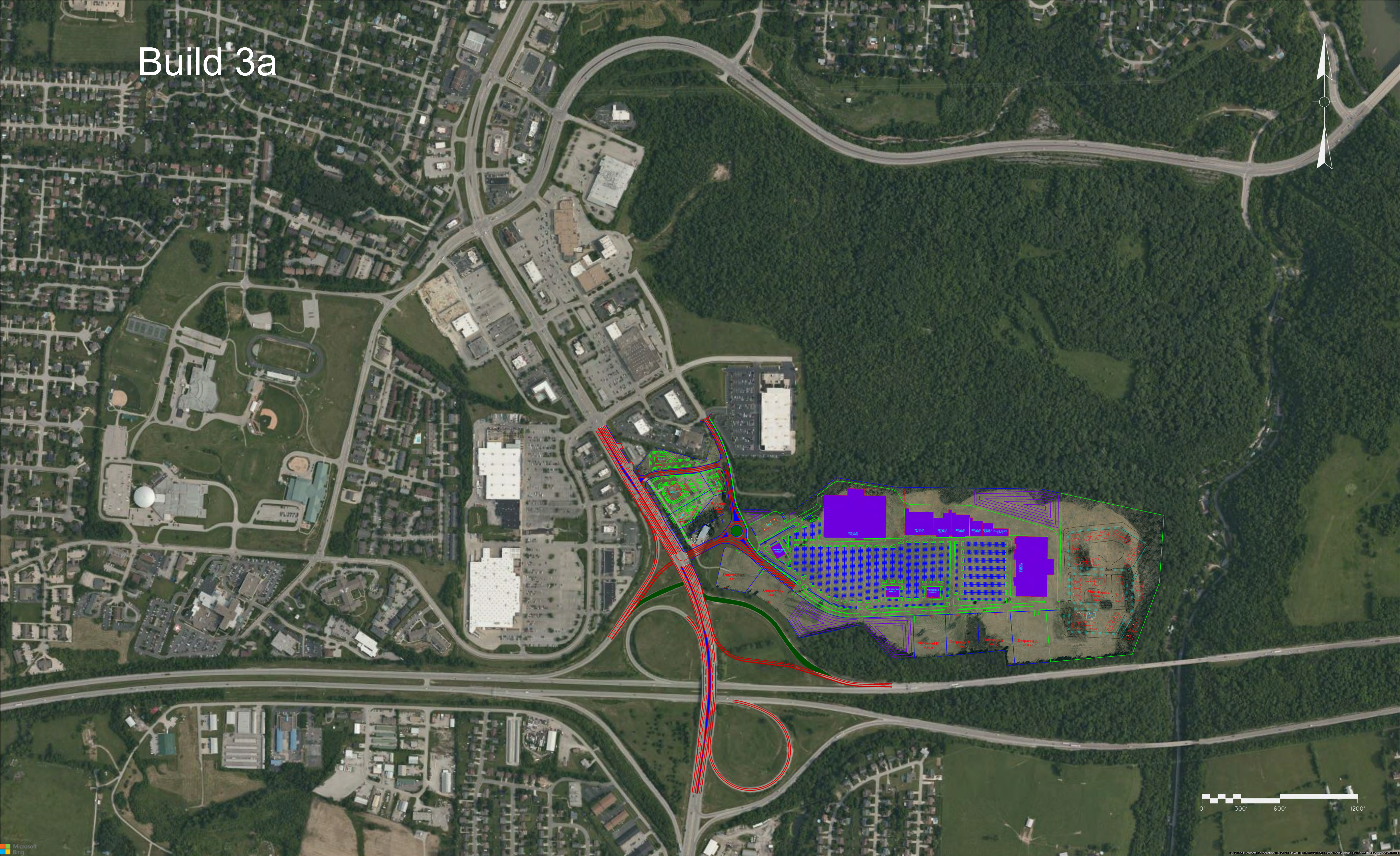


Appendix E: Concept Sketches for Build 3 Scenarios

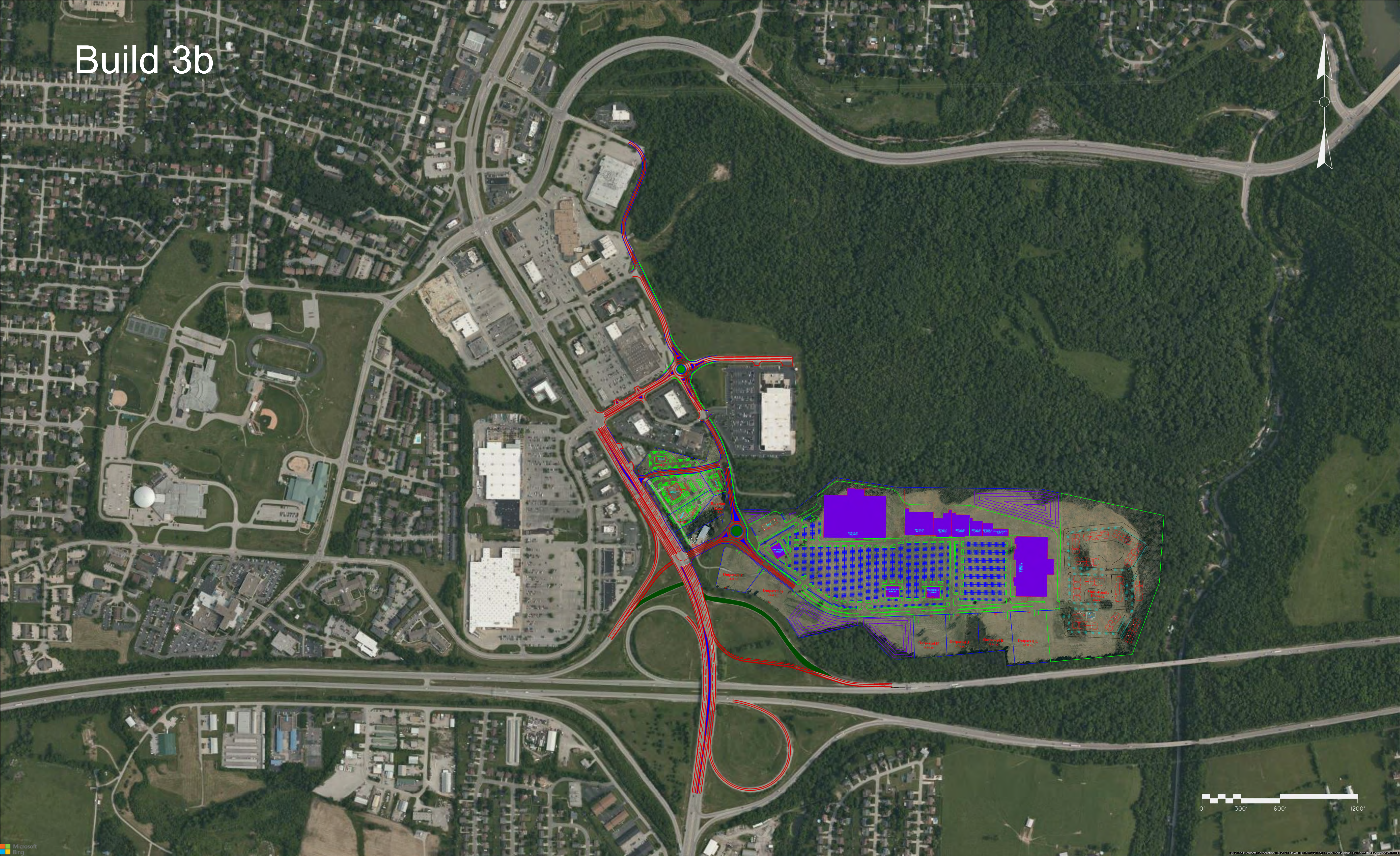
Build 3



Build 3a



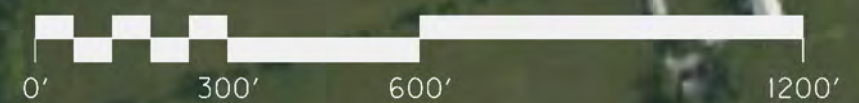
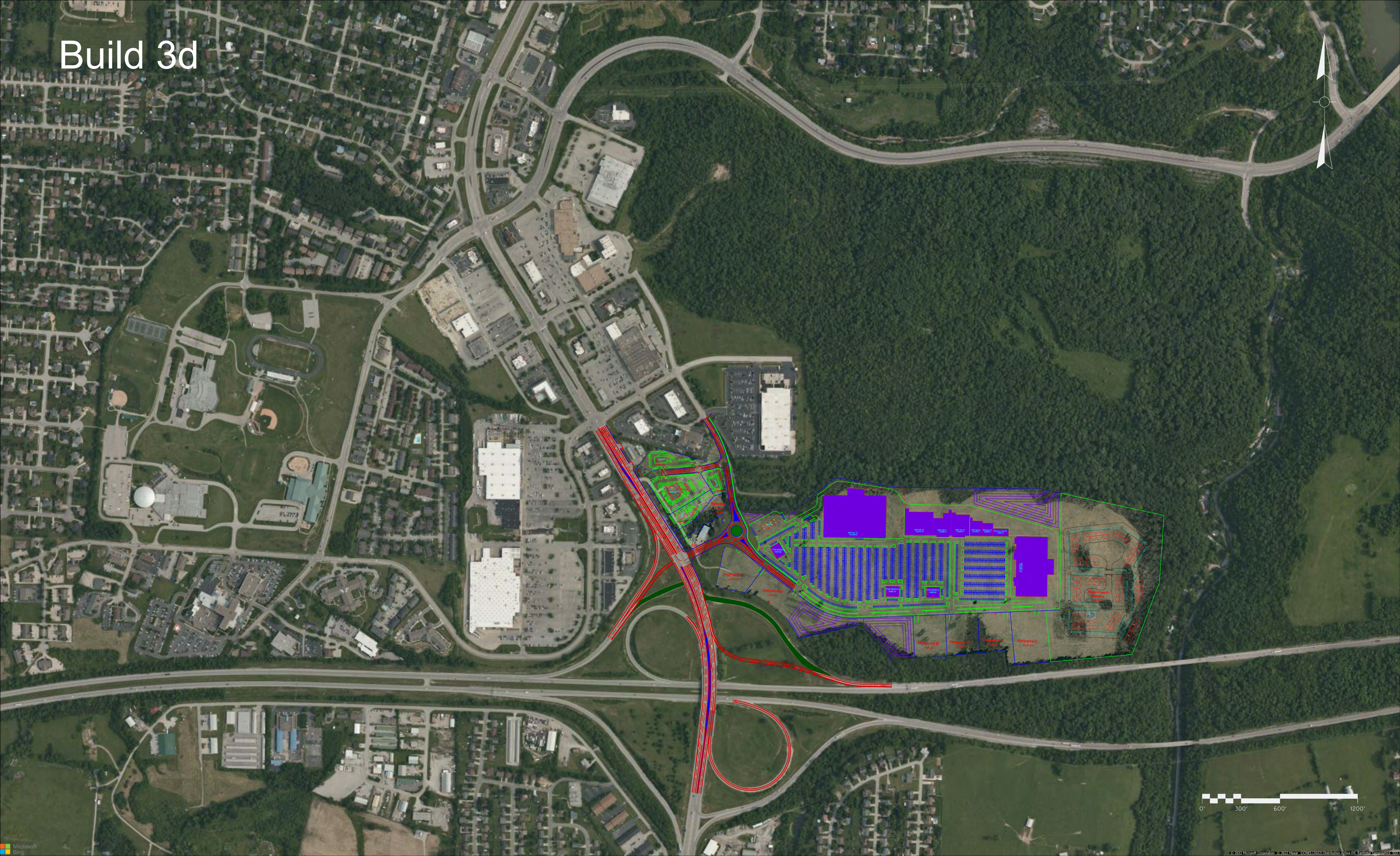
Build 3b



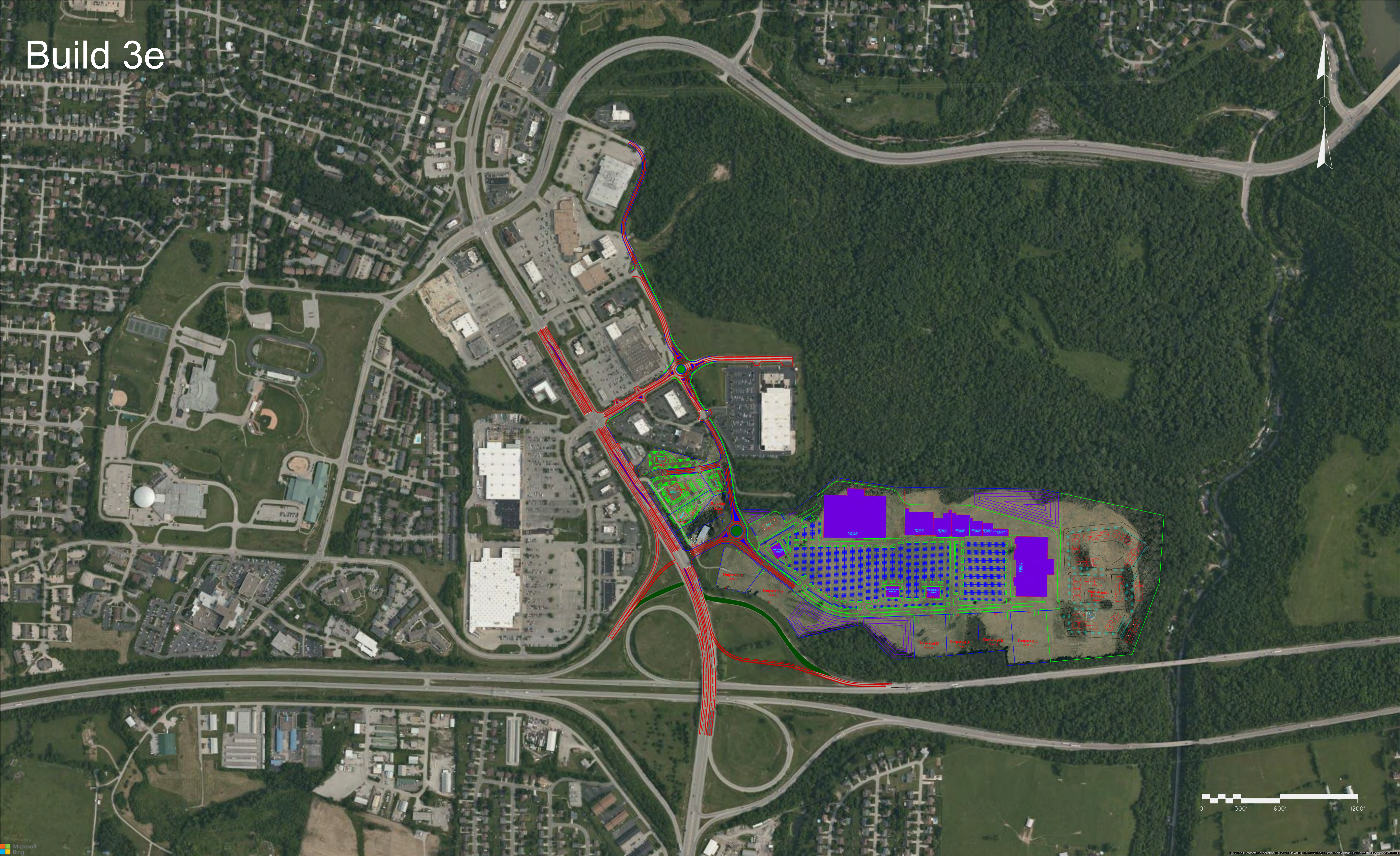
Build 3c



Build 3d



Build 3e



Appendix F: Vissim Output Tables

AM Peak Hour

Existing Scenario

Existing + Developed Scenario

Build 1 Scenario

Build 2 Scenario

Full Build + Landings Signal

Build 2a Scenario

Landings Signal, No Backage/No Westridge

Build 2b Scenario

Landings Signal, No Westridge

Table with 5 columns: Movement, Avg Queue, Max Queue, LOS, Delay. Rows include 7: Limestone & KY 676, 8: Collins & KY 676, 9: New Connector & Westridge (Build Roundabout), and 10: Landings (Build 2 Signal).

Table with 5 columns: Avg Queue, Max Queue, LOS, Delay. Corresponds to Existing + Developed Scenario for each movement.

Table with 5 columns: Avg Queue, Max Queue, LOS, Delay. Corresponds to Build 1 Scenario for each movement.

Table with 5 columns: Avg Queue, Max Queue, LOS, Delay. Corresponds to Build 2 Scenario (Full Build + Landings Signal) for each movement.

Table with 5 columns: Avg Queue, Max Queue, LOS, Delay. Corresponds to Build 2a Scenario (Landings Signal, No Backage/No Westridge) for each movement.

Table with 5 columns: Avg Queue, Max Queue, LOS, Delay. Corresponds to Build 2b Scenario (Landings Signal, No Westridge) for each movement.

AM Peak Hour	Build 3 Scenario Full Build + WB Ramp Signal				Build 3a Scenario WB Ramp Signal, No Backage/No Westridge				Build 3b Scenario WB Ramp Signal, No Westridge				Build 3c Scenario Full Build + WB Ramp Signal (with SBL)				Build 3d Scenario Full Build + WB Ramp Signal (No RIRO)				Build 3e Scenario Full Build + WB Ramp Signal (No RIRO/Loop Merge)									
	Movement	Avg Queue	Max Queue	LOS	Delay	Avg Queue	Max Queue	LOS	Delay	Avg Queue	Max Queue	LOS	Delay	Avg Queue	Max Queue	LOS	Delay	Avg Queue	Max Queue	LOS	Delay	Avg Queue	Max Queue	LOS	Delay					
7: Limestone & KY 676		23	481	LOS_C	27		17	379	LOS_C	24		22	481	LOS_C	26		22	481	LOS_C	26		22	481	LOS_C	26		17	379	LOS_C	23
EB Thru	25	224	LOS_B	14	13	221	LOS_A	7	25	241	LOS_B	14	24	240	LOS_B	14	10	195	LOS_A	6	18	86	LOS_F	109						
EB Left	13	73	LOS_F	111	18	86	LOS_F	111	12	74	LOS_F	102	13	73	LOS_F	109	13	73	LOS_F	109	0	0	LOS_A	2						
EB Right	0	0	LOS_A	4	0	0	LOS_A	1	0	0	LOS_A	3	0	0	LOS_A	3	0	0	LOS_A	2	0	0	LOS_A	2						
WB Thru	20	268	LOS_B	11	33	343	LOS_B	17	24	359	LOS_B	12	21	359	LOS_B	11	21	359	LOS_B	11	34	343	LOS_B	16						
WB Right	5	125	LOS_A	4	10	379	LOS_A	6	6	302	LOS_A	5	6	302	LOS_A	5	6	302	LOS_A	5	10	379	LOS_A	6						
WB Left	66	481	LOS_F	102	0	21	LOS_A	9	58	481	LOS_F	90	58	481	LOS_F	89	58	481	LOS_F	89	1	22	LOS_F	101						
NB Right	5	78	LOS_A	8	2	52	LOS_A	8	5	76	LOS_A	8	5	77	LOS_A	8	5	77	LOS_A	8	2	52	LOS_A	8						
NB Left	3	45	LOS_A		0	0	LOS_A		3	45	LOS_A		3	45	LOS_A		3	45	LOS_A		0	0	LOS_A							
NB Thru	3	45	LOS_F	94	0	0	LOS_A		3	45	LOS_F	94	3	45	LOS_F	92	3	45	LOS_F	92	0	0	LOS_A							
SB Left	67	267	LOS_E	71	81	314	LOS_F	85	65	243	LOS_E	69	65	267	LOS_E	67	65	267	LOS_E	67	81	347	LOS_F	87						
SB Right	67	267	LOS_E	66	81	314	LOS_F	95	65	243	LOS_E	67	65	267	LOS_E	66	65	267	LOS_E	66	81	347	LOS_F	92						
SB Thru	67	267	LOS_F	82	81	314	LOS_F	81	65	243	LOS_E	77	65	267	LOS_F	80	65	267	LOS_F	80	81	347	LOS_E	79						
8: Collins & KY 676		18	384	LOS_B	16		19	360	LOS_B	17		19	385	LOS_B	17		19	385	LOS_B	17		19	385	LOS_B	17		19	361	LOS_B	17
EB Thru	5	216	LOS_A	4	6	169	LOS_A	4	5	196	LOS_A	4	5	212	LOS_A	4	5	212	LOS_A	4	6	186	LOS_A	4						
EB Left	72	384	LOS_E	67	80	360	LOS_E	73	78	385	LOS_E	72	81	385	LOS_E	74	81	385	LOS_E	74	75	361	LOS_E	70						
WB Thru	21	273	LOS_B	11	22	210	LOS_B	11	23	224	LOS_B	11	23	218	LOS_B	11	23	218	LOS_B	11	22	210	LOS_B	11						
WB Right	2	84	LOS_A	5	2	107	LOS_A	4	2	107	LOS_A	4	2	107	LOS_A	4	2	107	LOS_A	4	2	107	LOS_A	4						
SB Left	35	164	LOS_E	64	39	212	LOS_E	70	39	212	LOS_E	70	39	212	LOS_E	70	39	212	LOS_E	70	39	212	LOS_E	70						
SB Right	24	246	LOS_B	12	21	251	LOS_B	11	22	251	LOS_B	12	22	251	LOS_B	12	22	251	LOS_B	12	22	251	LOS_B	12						
9: New Connector & Westrid	0	96	LOS_A	2					0	130	LOS_A	2	0	163	LOS_A	2	0	163	LOS_A	2	0	20	LOS_A	1	0	20	LOS_A	1		
WB Uturn	0	21	LOS_A						0	20	LOS_A		0	20	LOS_A		0	20	LOS_A		0	20	LOS_A							
WB Left	0	21	LOS_A						0	20	LOS_A		0	20	LOS_A		0	20	LOS_A		0	20	LOS_A	1						
WB Thru	0	21	LOS_A	1					0	20	LOS_A	1	0	20	LOS_A	1	0	20	LOS_A	1	0	20	LOS_A							
WB Right	0	21	LOS_A						0	20	LOS_A		0	20	LOS_A		0	20	LOS_A		0	20	LOS_A							
EB Thru	1	96	LOS_A						0	44	LOS_A		0	21	LOS_A		0	21	LOS_A		0	21	LOS_A							
EB Right	1	96	LOS_A	2					0	44	LOS_A	0	0	21	LOS_A	3	0	21	LOS_A	3	0	21	LOS_A	1						
EB Uturn	1	96	LOS_A	2					0	44	LOS_A	2	0	21	LOS_A	2	0	21	LOS_A	2	0	21	LOS_A							
EB Left	1	96	LOS_A						0	44	LOS_A		0	21	LOS_A		0	21	LOS_A		0	21	LOS_A	0						
SB Left	0	66	LOS_A						0	130	LOS_A		1	163	LOS_A		1	163	LOS_A		0	20	LOS_A							
SB Thru	0	66	LOS_A	2					0	130	LOS_A	2	1	163	LOS_A	2	1	163	LOS_A	2	0	20	LOS_A	1						
SB Right	0	66	LOS_A	3					0	130	LOS_A	3	1	163	LOS_A	4	1	163	LOS_A	4	0	20	LOS_A							
SB Uturn	0	66	LOS_A						0	130	LOS_A		1	163	LOS_A		1	163	LOS_A		0	20	LOS_A							
NB Right	0	21	LOS_A	1					0	44	LOS_A	0	0	44	LOS_A	4	0	44	LOS_A	4	0	44	LOS_A							
NB Uturn	0	21	LOS_A						0	44	LOS_A		0	44	LOS_A		0	44	LOS_A		0	44	LOS_A							
NB Left	0	21	LOS_A	2					0	44	LOS_A	1	0	44	LOS_A	2	0	44	LOS_A	2	0	44	LOS_A							
NB Thru	0	21	LOS_A	2					0	44	LOS_A	2	0	44	LOS_A	2	0	44	LOS_A	2	0	44	LOS_A							

Appendix G: Project Summary Sheets



Build 1

Capacity improvements to US 127 and Westridge Drive, plus a new backage road following Vandalay Drive to Limestone Drive.

Pros

- No new signals along US 127
- Modified slip ramp allows for free-flow westbound off-ramp, addressing AM peak queue concerns
- Best northbound travel times for US 127 (both peak hours)

Cons

- Westridge Drive is approaching capacity, with no capacity for future growth if adjacent parcels develop. This makes it especially sensitive to trip distribution assumptions.
- Requires public ownership/additional right-of-way for Westridge and Vandalay drives.
- Two signalized US 127 intersections operate at LOS E in PM peak with all left turns moves from US 127 over capacity.

DRUC Cost Estimate	Build 1
Full Concept	\$11.3M
US 127	\$1.8M
Westridge Drive	\$3.8M
Backage Road	\$2.2M
Within Development	\$3.5M

Build 2

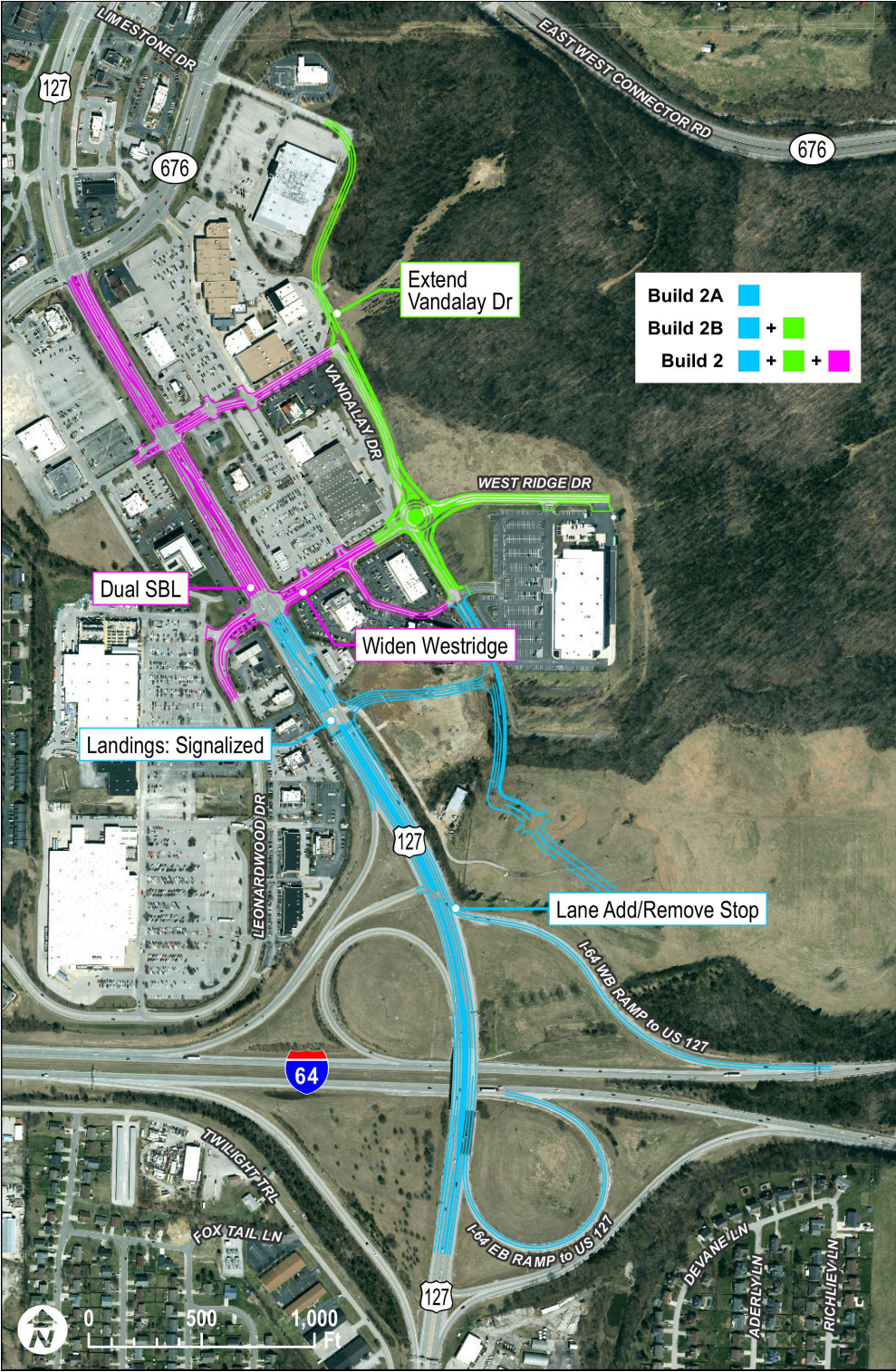
Includes Build 1 improvements plus a new signalized US 127 intersection approximately 500 feet south of Westridge Drive, similar to the 2019 TIS.

Pros

- Modified slip ramp allows for free-flow westbound off-ramp, addressing AM peak queue concerns
- Second signalized entrance diverts some left-turn traffic from congested Leonardwood/Westridge intersection.
- Best southbound travel times for US 127 (both peak hours)

Cons

- Closely spaced signals along US 127 lead to left-turn queues that block thru traffic lanes and spillback beyond upstream signals
- Build 2a fails in PM peak hour without backage road connection
- Requires public ownership/additional right-of-way for Westridge and Vandalay drives.



DRUC Cost Estimate	Build 2	Build 2a	Build 2b
Full Concept	\$10.5M	\$4.5M	\$6.7M
US 127	\$1.0M	\$1.0M	\$1.0M
Westridge Drive	\$3.8M	-	-
Backage Road	\$2.2M	-	\$2.2M
Within Development	\$3.5M	\$3.5M	\$3.5M

Build 3

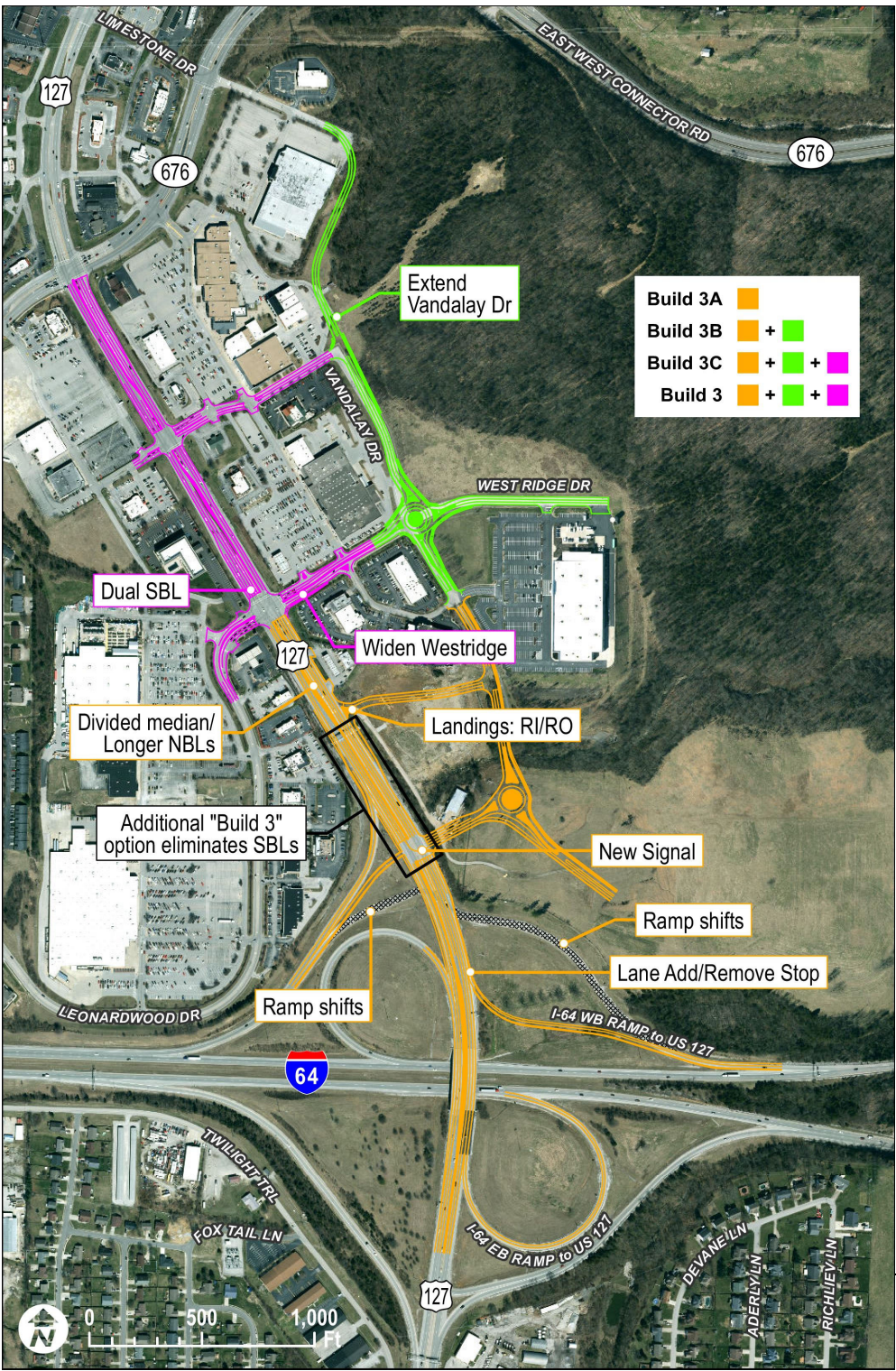
Includes Build 1 improvements plus a new signalized US 127 intersection approximately 1,100 feet south of Westridge Drive. Westbound ramps shift within interchange to improve spacing.

Pros

- Modified slip ramp allows for free-flow westbound off-ramp, addressing AM peak queue concerns
- Second signalized entrance diverts some left-turn traffic from congested Leonardwood/Westridge intersection, without queue spillback concerns of Build 2.
- Build 3a provides functional short-term option with adequate capacity and no additional right-of-way requirements.

Cons

- FHWA-approved IMR required for interchange modifications
- Additional storage length needed for westbound approach at new signal, affecting conceptual site layout. (Roundabout shown is representative of one possible configuration.)



DRUC Cost Estimate	Build 3	Build 3a	Build 3b	Build 3c
Full Concept	\$15.3M	\$8.8M	\$14.2M	\$15.5M
US 127/I-64 Ramps	\$4.7M	\$4.2M	\$4.2M	\$4.9M
Westridge Drive	\$3.8M	-	\$3.2M	\$3.8M
Backage Road	\$2.2M	-	\$2.2M	\$2.2M
Within Development	\$4.6M	\$4.6M	\$4.6M	\$4.6M



Build 3e

Includes a new signalized US 127 intersection approximately 1,100 feet south of Westridge Drive. Westbound ramps shift within interchange to improve spacing. The westbound-to-northbound off-ramp is a free-flow movement with three northbound thru lanes carried to the downstream signal. Dual lefts to a widened Westridge Drive plus a new backage road connection to Limestone Drive are also part of this concept.

Costs by Phase and Section:

Cost Estimate	US 127/Ramps	Other Routes
Design	\$0.5M	\$0.9M
Right-of-Way	-	\$5.2M
Utilities	<\$0.1M	\$0.7M
Construction	\$3.9M	\$3.2M
Total	\$4.4M	\$10.0M

Appendix H: SME Design Considerations

MEETING SUMMARY

Project: Paddocks/Landings Traffic Analyses
Item No. 5-80212

Purpose: Project Team Meeting

Place: Hybrid Meeting: KYTC Central Office and MSTeams

Meeting Date: August 23, 2022 at 11:00 AM

Participants:

Steve DeWitte	KYTC Planning
Beth Niemann	KYTC Planning
Jared Jeffers	KYTC Planning
Kevin Bailey	KYTC D5
Tom Hall	KYTC D5
Pat Matheny	KYTC D5
Andre Johannes	KYTC Design
Patrick Perry	KYTC Design
Karl Sawyer	KYTC Design
Jason Hyatt	KYTC Traffic
Logan Baker	KYTC Traffic
Jason Siwula	KYTC ASHE
Taylor Kelly	Qk4
Rebecca Thompson	Qk4
Jeremy Lukat	Qk4
Cody Davis	Qk4

KYTC tasked Qk4 to examine potential short-term traffic impacts along US 127 associated with a proposed commercial development northeast of its interchange with I-64 in west Frankfort. The proposed development includes two big box stores, other retail shops, multi-family housing, restaurants,

and a gas station. The developer has submitted two past traffic impact studies for access to US 127. Qk4 has examined these and other build concepts to keep US 127 functioning with the proposed addition of 2,000+ peak hour trips.

The team discussed the Build 3A concept (below), including the following topics:

- Do the ramp connections shown maintain adequate access control spacing? *Southbound is unchanged between the taper and Leonardwood Drive. Northbound adds a lane from the ramp but includes almost 600 feet from gore to proposed signal. Though it's not ideal, the case could be made for 100-foot spacing similar to US 60 and Jett Boulevard in East Frankfort.*
- Overhead signs could be added to the back of the existing truss to aid in wayfinding.
- Widening US 127 will make the already steep driveway grades to the gas station steeper.
- Details will need to be worked out as design progresses as mainline US 127 is in a superelevated section to the left and the WB exit ramp is superelevated to the right as they come together. The final design needs to ensure that the maximum rollover is not exceeded for cross slope.
- FHWA has not been involved in discussions to dates since early concepts did not impact the interchange.
- Future year traffic should be examined; FHWA will expect to see it addressed in an IMR.
- The project should provide a benefit for the public, not just accommodate the proposed development. Converting the NB-to-WB off-ramp to a free-flow movement, closing median openings to the gas station, extending the northbound left turn bays to Leonardwood Drive address existing traffic issues independent of the development.
- The team discussed which parties should be responsible for which construction costs.



- Another build option included a similar configuration but without the southbound left turn bays into the development to increase signal efficiency. The southbound left turn bays provided more operational benefits than forcing these turns to upstream signals.
- The area is zoned commercial. Aside from a new/improved connection to US 127, no permit is required for the development. Local planning/zoning could require the developer to coordinate with KYTC to provide input on the internal circulation patterns. The close spacing between the new signal and roundabout is a concern. Likely, the new connection opposite the NB-to-WB on-ramp and Vandalay Drive extension should be public streets.
- The Build 3A option presented only operates with the assumption that project elements are constructed off right-of-way as shown and modeled. If the developer/others do not construct these elements as shown (such as the roundabout) then this alternative “fails” and this would be considered a “fatal flaw.”
- Subject matter experts (SME) noted several comments that would require design modifications as the project advances but these modifications as presented to the team would not significantly alter the operations of the network within the project limits. Comments from the SME’s will be documented in the technical memorandum.

End of Minutes

OTHER DESIGN CONSIDERATIONS

Design considerations raised by various KYTC SMEs are noted below, organized geographically south to north.

INTERCHANGE/REALIGNED RAMP(S)

Does the vertical/horizontal alignment of US 127 provide visibility for the new ramp tie-in?

The modified WB-to-NB free-flow ramp will be parallel to and match the grade of US 127 prior to any vehicle conflict point. Once the ramp aligns with US 127, sight distance should not be an issue and drivers will be permitted to change lanes. The WB-to-NB ramp and US 127 will meet at the outside of their horizontal curves along a vertical tangent, so there are no horizontal or vertical sight obstructions. Tree clearing may benefit vehicle visibility prior to switching lanes.

The EB-to-NB off-ramp is an added lane now. The WB-to-NB off-ramp is proposed as an added lane, adding two lanes in less than 1000 feet to create four northbound thru lanes. Does the first one need to be an added lane? It seems like this adds lanes quickly without a good place to put them. Do volumes warrant four lanes? Merging the EB-to-NB off-ramp but keeping WB-to-NB as a lane add may clean it up.

Build 3e incorporates this modification. US 127 is a partial control of access facility; planners considered Figure 10-70 from the 2018 Green Book which states for an "Entrance to Entrance" ramp configuration along a Collector Distributor Roadway that spacing should be 800 feet and along a freeway it should be 1,000 feet. Current spacing shown as part of the conceptual design could be lengthened as design moves into future phases.

With the realignment of the WB-to-NB off-ramp, it's good that the ramp turns into an added lane. Merging at that steep of an approach angle is not ideal.

Another concern is the inner (left) northbound thru lane becoming a left-only to Leonardwood Drive. A thru lane becoming a turn-only lane is not ideal, especially when it's the fast lane becoming a left turn only lane. Merging the EB-to-NB off-ramp before the WB-to-NB off-ramp lane add could address this concern.

Build 3e incorporates this modification.

Does the added slip ramp to the SB-to-WB on-ramp at the new signalized intersection violate access control spacing requirements (100 ft urban/300 ft rural)?

Build 3 variations increase the access control spacing from 180 feet (existing) to approximately 650 feet (proposed) between Leonardwood Drive and the beginning of the SB-to-WB taper. Control of access will need to be coordinated with FHWA as the project progresses in design. The intent of the concept as presented along the southbound side of US 127 is to preserve access control to the SB-to-WB on-ramp taper as exists today. The slip ramp is within Kentucky's existing controlled access limits along the SB US 127 border.

Has the study considered reconfiguring the interchange as a diamond, urban diamond, SPUI, or double crossover to increase spacing? If the interchange remains as is, KYTC should not provide any new side roads between ramps and Westridge/Leonardwood. KYTC paid federal funds to control access for the existing configuration.

With the developer already moving earth, concise and efficient concepts were prioritized to minimize costs and implementation timelines. Some of the interchange concepts mentioned above may satisfy access control but could also have unintended consequences: e.g., increased costs, additional conflict points, decreased safety, and reduced efficiency. The Build 3 layout satisfies access control spacing requirements for all ramps except potentially for the NB-to-WB ramp directly opposite the proposed property access point. This is a detail that will need to be coordinated with FHWA as design progresses.

If it is determined the relocated slip ramp along SB US 127 breaks the control of access along NB US 127 (which meets control of access spacing requirements along the northbound border) then the project team may consider design refinements—such as leaving the WB I-64 slip ramp offset from the intersection by 100+ feet—as it would exist today. However, the project team strongly believed that the operational benefits justified the configuration as presented, coupled with the precedent of similar configurations across the Commonwealth:



There are several precedents in KY where local roads share intersections with interstate ramps. A local road intersecting with an interstate on-ramp—like the Build 3 variations—will not cause any queuing on to the interstate. It also does not create the wrong-way-entry safety concerns associated with intersections at off-ramps.

The developer may want to acquire any surplus right-of-way from the interchange if the footprint is reduced.

NEW SIGNAL ON US 127

On the southbound approach to the new signalized intersection, there might need to be overhead lane-use signs.

Are dual southbound lefts needed? A single lane approaching the roundabout would simplify those movements (*discussed below*).

Demand for the southbound left turn movement is over 400 vehicles per hour, above the threshold to consider dual turn lanes. Each of the previous TIS for the Paddocks site showed dual lefts towards the site. If the backage road and/or Westridge improvements from Build 1 are included in the final build solution, dual southbound lefts at the new signal may not be critical.

Shortening the dual southbound lefts could increase storage space for the northbound lefts to Leonardwood Drive. Left turn capacities for southbound to the new development and northbound to Leonardwood Drive should be equal—or even favoring existing northbound lefts.

This could be explored as part of future design efforts. Microsimulation for Build 3a estimates the maximum queue lengths at 314 feet southbound versus 527 feet northbound. Leonardwood Drive is having storage issues with short dual lanes now.

NEW ROUNDABOUT

The roundabout shown east of the new signalized intersection would likely operate best to alleviate queuing onto US 127 but needs additional storage capacity between intersections. No one wants to duplicate the Man o' War Boulevard/Sir Barton Way setup at Hamburg in Lexington.

There are dual lefts into the development, but the right-most lane forces drivers to turn right at the roundabout while the left lane has options. Many drivers are going to want to be in the left lane to access the shopping area—either lane will work for that. The bigger issue is people wanting to turn left at the roundabout to get to the restaurants to the north. They have to be in the left lane, but how can that be communicated back on US 127 to avoid them weaving/cutting people off/stopping between the intersection and the roundabout?

The spacing between the roundabout and US 127 is constrained by the gas station in the conceptual site plan. If the developer cannot change the gas station location, the roundabout concept can be improved to address this concern. Multilane roundabout concepts could allow for flexible movements within the constrained area. Options could be explored as part of any future design efforts.

LANDINGS RIRO

The Landings RIRO should be eliminated. It does not provide safety benefits for US 127 but adds conflict points and degrades safety/operations. Unless the gas station access could be reconfigured to tie to the Landings RIRO instead of US 127, in which case it provides a benefit.

Minimal traffic was assigned to the RIRO in the microsimulation network. From a traffic perspective, it is not critical to operations. Delay at US 127 study intersections is within 2 seconds for model runs of Build 3a with and without the RIRO.

Turning right out from the RIRO dumps motorists into the right-only lane onto Westridge Drive.

The biggest concern with the Landings RIRO would be drivers making the right out move then skipping three lanes to turn left onto Leonardwood Drive. The northbound US 127 flows are heaviest in the morning peak when development traffic is lower so maybe it's not a major concern. However, the RIRO is very close to the two gas station entrances, creating closely spaced access points with a high level of "driver workload" at certain times. If the RIRO remains, it should be shifted south to increase spacing and merge lengths to Leonardwood Drive.

MISC

The development should design their traffic patterns internally to enter and exit from the Westridge intersection. Another option could provide a new access from the development to KY 676.

This corresponds to the Build 1 scenario explored in the Tech Memo. The configuration works but puts Westridge Drive close to capacity, making it especially sensitive to trip generation/distribution assumptions. Build 3a could be combined with the backage road and improved Westridge as well to further distribute traffic, represented by Build 3c in the Tech Memo. With the developer already moving earth, improvements within the existing right-of-way were prioritized to minimize costs and implementation timelines.

Are the improvements east of US 127 assumed to be done by the developer as part of the access permit?

Representative connections were shown within the proposed development site, with the assumption that future coordination between the developer and KYTC would occur to find a mutually beneficial solution. The proposed roadway connections could advance as a public street but improvements within the proposed development site could be expected to occur more efficiently than improvements involving other private property owners.

Is the cost difference between the various Build 3 concepts different because of phasing assumptions?

The cost differences between the Build 3 concepts along US 127 and Westridge is due to variable pavement and median needs. The main differences derive from the various SB left turn lane configurations.