

**Verification and Calibration of Microscopic Traffic Simulation Using NDS
and Video Data for Alternative Intersections and Freeway Merge and Diverge
Areas**

Final Report

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16. Abstract Traffic microsimulation enables practitioners to model the movement and interactions of individual vehicles, providing a level of detail not achievable with macroscopic or deterministic approaches. Microsimulation replicates vehicle-to-vehicle and driver-to-driver interactions under a wide range of traffic and geometric conditions. This makes it especially valuable for assessing alternative intersection designs, such as roundabouts, Diverging Diamond Interchanges (DDIs), and Restricted Crossing U-turns (RCUTs), as the Alabama Department of Transportation (ALDOT) is starting to incorporate more of these designs into future projects. These facilities offer operational and safety benefits, but they also introduce complex vehicle trajectories and behaviors that are not captured by default microsimulation parameters. This project develops calibration and validation guidelines tailored to Alabama's alternative intersections and freeway merge/diverge areas. Drone video data were collected at 21 locations, including 18 roundabouts, 1 DDI, 1 RCUT, 1 freeway work zone (merging), and 1 freeway exit ramp (diverging). Vehicle trajectories and movement characteristics were extracted from drone videos using the video-based data extraction tool Datafromsky and used to build PTV VISSIM networks. A calibration workflow was implemented using the VISSIM COM interface to automatically determine key parameters to define the priority rule at conflict points and car-following behavior. Model performance was assessed by comparing simulated outputs with field data such as travel time, speed distributions, and traffic volume. The resulting guidelines translated drone-observed driver behavior into recommended VISSIM calibration parameters for alternative intersections and freeway merge/diverge areas.			
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1. INTRODUCTION

Traffic microsimulation enables practitioners to model the movement and interactions of individual vehicles, providing a level of detail not achievable with macroscopic or deterministic approaches. Microsimulation replicates vehicle-to-vehicle and driver-to-driver interactions under a wide range of traffic and geometric conditions. This makes it especially valuable for assessing alternative intersection designs, such as Roundabouts, Diverging Diamond Interchanges (DDIs), and Restricted Crossing U-turns (RCUTs), as the Alabama Department of Transportation (ALDOT) is starting to incorporate more of these designs into future projects.

Microsimulation has been widely applied in ALDOT project-level traffic studies. Among the available simulation platforms, PTV VISSIM is the most frequently used due to its flexibility and advanced behavioral modeling capabilities. For instance, VISSIM was used to simulate Alabama's first DDI in Mobile, supporting design decision-making. However, the accuracy of simulation results depends on proper calibration and validation of driver behavior parameters, including speed distributions, acceleration and deceleration rates, headways, and gap acceptance (Xu, 2021; F. Yang & Zhou, 2024). If models are not properly calibrated, they may produce unrealistic estimates of delay, queue length, or level of service. This can lead to under- or overdesign of facilities, affecting both construction cost and operational efficiency.

In Alabama, alternative intersection designs, such as modern roundabouts, DDIs, and RCUT intersections, are being increasingly adopted to address safety and congestion issues. These facilities offer operational and safety benefits, but they also introduce complex vehicle trajectories and behaviors that are not captured by default microsimulation parameters. For example, at non-circular roundabouts, such as those with peanut or elliptical shapes, turning radii vary significantly across approaches, influencing speed and gap acceptance distributions. DDIs' operational performance will be significantly affected by unique geometric features, the signal timing coordination, and traffic control strategies at freeway off-ramp terminals. RCUT maneuvers involve right turns followed by U-turns, requiring careful calibration of deceleration and acceleration profiles (F. Yang & Zhou, 2024). In addition, freeway merge and diverge areas at on/off ramp areas and lane closure work zones involve complex lane-changing behavior and car-following models that are difficult to replicate using default model settings (Xu, 2021).

Developing Alabama-specific calibration and validation guidance will enable ALDOT to conduct consistent, high-fidelity traffic simulation studies that better reflect local driving behavior and environmental conditions. The state-level guideline will improve the accuracy of operational assessments, enhance consistency across consultant-led analyses, and support more informed investment and design decisions for the state's transportation system.

1.1 Objectives

In this study, the latest version of VISSIM 2024 was used for all traffic modeling and calibration analysis. The ultimate goal is to develop calibration and validation guidelines tailored for Alabama's alternative intersections and freeway facilities. The specific tasks are to:

- Collect and process driving behavior data using Unmanned Aerial Vehicles (UAV) and the SHRP2 Naturalistic Driving Study (NDS) database.
- Analyze speed distributions, acceleration and deceleration rates, headways, lane utilization, and gap acceptance across roundabouts, DDIs, RCUTs, and freeway merge/diverge areas.
- Develop and calibrate VISSIM models for the selected study locations in Alabama.
- Develop general guidelines that support key parameter selection for roundabouts, DDIs, RCUTs, and freeway merge/diverge areas, respectively.

1.2 Organization of the Report

The remainder of this report is organized into five chapters. **Chapter 2** reviews relevant literature, calibration practices, and current ALDOT procedures for traffic analysis for alternative intersections. **Chapter 3** describes the data collection efforts, including drone-based video data, roadway geometry data, and NDS data. **Chapter 4** presents the data processing workflow and extracted traffic measures. **Chapter 5** documents the calibration and validation of VISSIM models for roundabouts, DDIs, RCUT intersections, and freeway merge/diverge areas. Finally, **Chapter 6** summarizes key conclusions and discusses the practical application of the study findings for ALDOT.

2. LITERATURE REVIEW

2.1 Overview

In this task, the research team reviewed 17 national or state guidelines and over 110 peer-reviewed technical papers on traffic simulation model calibration methods, guidelines, parameters, data usage, and behavioral models for alternative intersections and freeway merging and diverging areas. For roundabouts, 2 national guidelines, 5 DOT manuals, and 87 research papers were reviewed, focusing on entry speed, gap-acceptance, and headway calibration. For DDIs, 2 national guidelines, 2 DOT manuals, and 6 research papers were reviewed, covering right-turn control strategies, lane utilization, and car-following behavior using field and UAV-derived data. For RCUT intersections, a national guideline and 12 research studies were reviewed, emphasizing NDS- and video-based calibration of acceleration, deceleration, and stop-compliance behavior. For freeway merging and diverging simulation, 4 Federal Highway Administration (FHWA) national guidance volumes, a DOT manual, and 6 research efforts were evaluated to calibrate lane-changing urgency, headway, and deceleration profiles. The following sections summarize the findings from these reviews for each facility type.

2.2 Roundabouts

The FHWA provides foundational roundabout design guidance through its *Roundabouts: An Informational Guide* (Robinson et al., 2000), and the Bureau of Transportation Statistics offers additional modeling and simulation guidance through its *Roundabouts Design, Modeling and Simulation Manual* (Aty & Hosni, 2001). Beyond these national resources, several state transportation agencies have developed documents relevant to roundabout microsimulation calibration, though the level of instruction varies. As summarized in Table 2-1, the Washington State DOT (Protocol for VISSIM Simulation, 2024) and Georgia DOT (Hunter et al., 2024) provide the most detailed calibration guidance, specifying adjustments to operational speeds, priority rules, and Wiedemann-74 car-following parameters. MassDOT (MassDOT Roundabout VISSIM Microsimulation Guidance, 2021) also provides calibration procedures addressing operational speeds, priority rules, and car-following behavior. In contrast, the VDOT *VISSIM User Guide* (Operations, 2020) and the GDOT *Roundabout Design Guide* (Roundabout Design Guide, 2023) offer general modeling direction but no calibration instructions.

Table 2-1 DOT and National Guidance for Roundabout Simulation

Sources	Year	Calibration Instruction	Calibration Parameter
WSDOT (Protocol for VISSIM Simulation, 2024)	2024	Yes	Operational speed and priority rule
GDOT (Hunter et al., 2024)	2024	Yes	Operational speed, priority rule, and car following model

GDOT (Roundabout Design Guide, 2023)	2023	No	-
MassDOT Guidelines for Calibrating Roundabouts in VISSIM Simulation Models (MassDOT Roundabout VISSIM Microsimulation Guidance, 2021)	2021	Yes	Operational speed, car following model, and priority rule
VDOT VISSIM User Guide, VDOT (Operations, 2020)	2020	No	-
Roundabouts Design, Modeling and Simulation, Bureau of Transportation Statistics (Aty & Hosni, 2001)	2001	No	-
Roundabouts: An Information Guide, FHWA (Robinson et al., 2000)	2000	No	-

In addition to state guidelines, the studies summarized in Table 2-2 illustrate the progression of roundabout microsimulation calibration approaches using diverse data sources and modeling tools. The reviewed studies employed a range of simulation tools, including SIDRA and RODEL, analytical roundabout capacity models; PARAMICS and SimTraffic, microscopic simulation tools that model individual vehicle movements; and VISSIM, a widely used microscopic simulator based on the Wiedemann car-following model. (Gagnon et al., 2008) calibrated analytical and microsimulation platforms, including SIDRA, RODEL, PARAMICS, SimTraffic, and VISSIM, using video-based peak-hour delay data for improved correlation with field performance. (Yin & Qiu, 2011) relied on simulated traffic data to evaluate traffic volume calibration in VISSIM and SIDRA, demonstrating the importance of local demand representation in model accuracy. (Lochrane et al., 2013) and (Li et al., 2013) utilized video and radar sensor data capturing critical gap, headway acceptance, speed, and capacity measurements, refining reduced-speed areas, car-following models, and priority rules in VISSIM to replicate observed driver behavior.

Building on these methods, (Gallelli et al., 2019) applied drone video data containing vehicle trajectories, queue lengths, and time-to-collision-based rear-end conflict data to calibrate traffic speed and car-following parameters in VISSIM. Similarly, (Alqahtani, 2019) employed field data to analyze traffic delays using RODEL and Highway Capacity Software (HCS), emphasizing consistency between analytical outcomes and field data. More recent research by (Shoaib Samandar et al., 2022) and (Chun et al., 2023) leveraged drone video data capturing vehicle trajectories, queue patterns, travel times, and gap-acceptance characteristics to calibrate headways, traffic speed parameters in VISSIM and SIDRA 9 under sight-restricted conditions. Finally, (Yavuz & Özen, 2024) integrated video-based turning-movement counts, vehicle-class composition, and spot-speed observations into an open-source SUMO model, adjusting traffic volume and speed parameters to align with field data.

Table 2-2 Studies on Roundabout Simulation Calibration

Sources	Year	Data Source	Type of Data Collected	Calibration Parameter	Simulation Tool
(Yavuz & Özen, 2024)	2024	Video data	Turning-movement counts, vehicle-class composition, and spot speeds	Speed	SUMO
(Chun et al., 2023)	2023	Drone video data	Vehicle trajectories, queue patterns, and approach travel times under sight-restricted conditions	Speed and gap acceptance	SIDRA 9
(Shoaib Samandar et al., 2022)	2022	Drone video data	Traffic volumes, queue lengths, saturation flow rates, vehicle trajectories, delays, and gap-acceptance parameters	Headways	VISSIM
(Gallelli et al., 2019)	2019	Drone video data	Trajectories, queue lengths, and time-to-collision-based rear-end conflict data	Speed and car following model	VISSIM
(Alqahtani, 2019)	2019		Traffic volumes, and delay	Traffic delay	RODEL, HCS
(Lochrane et al., 2013)	2013	Video data	Critical gap and headway acceptance	Traffic delay	VISSIM
(Li et al., 2013)	2013	Video and radar sensor data	Gap acceptance (critical gap & follow-up headway), speed, and capacity data	Reduce speed area, car following model and priority rule	VISSIM
(Yin & Qiu, 2011)	2011	Simulated data	-	Traffic delay	VISSIM, SIDRA

(Gagnon et al., 2008)	2008	Video data	Peak-hour field delay	Gap acceptance	SIDRA, RODEL, PARAMICS, SimTraffic, and VISSIM
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2.3 Diverging Diamond Interchanges (DDIs)

National-level guidance for calibrating DDI simulation models remains limited. The WSDOT Protocol for VISSIM Simulation (Protocol for VISSIM Simulation, 2024) provides the comprehensive DDI-specific direction, detailing calibration parameters for car-following and lane-changing behavior, including standstill distance, desired headway, maximum acceleration, desired deceleration, and look-ahead distance. In addition, the NCHRP Report 959 DDI Informational Guide (Cunningham et al., 2021) and the GDOT VISSIM Simulation Guidance (Hunter, 2021) address general procedures for complex interchange calibration, but do not include DDI-focused methods. The FHWA Alternative Intersections/Interchanges Report (Hughes et al., 2010) provides design and operational information for DDIs but does not include any simulation calibration procedures. These available references are summarized in Table 2-3.

Table 2-3 DOT and National Guidance on DDI Calibration

Source	Year	Calibration Instruction	Calibration Parameters
WSDOT (Protocol for VISSIM Simulation, 2024)	2024	Yes	Car-following parameters (standstill distance, headway time (desired time gap), maximum acceleration, desired deceleration, look-ahead distance, and lane change decision distance) and lane-changing parameters
GDOT VISSIM Simulation Guidance (Hunter, 2021)	2021	Yes	Car-following and lane-changing with local calibration emphasis for complex interchanges
NCHRP Report 959 DDI Informational Guide (Cunningham et al., 2021)	2021	Yes	Car-following and lane-changing
FHWA AIIR Report (Hughes et al., 2010)	2010	No	None

The studies summarized in Table 2-4 present key advancements in calibrating DDI microsimulation models using both field and simulated data. (X. Yang et al., 2014) applied field-measured traffic volumes and queue lengths to calibrate queue discharge behavior in VISSIM. (Molan et al., 2019) used simulated traffic data to adjust running speed parameters for passenger cars and trucks on freeway and arterial links. (Tahmidul Haq et al., 2022) incorporated field data from hourly turning-movement counts, truck percentages, and mean speeds to calibrate average vehicle speeds on freeway and ramp sections. (Tian, 2004) utilized loop-detector and ramp-

metering log data, including traffic volumes and ramp-throughput rates, to calibrate traffic volume and queue-length parameters in VISSIM.

Table 2-4 Studies on DDI Simulation Calibration

Source	Year	Data Source	Type of Data Collected	Calibration Parameters	Simulation Tool
(Tahmidul Haq et al., 2022)	2022	Denver Regional Council of Governments and Colorado Department of Transportation (CDOT)	Hourly turning-movement counts, truck percentage, and mean vehicle speed	Passenger cars and trucks' average speeds on the freeway and ramp	VISSIM
(Molan et al., 2019)	2019	Simulated data	-	Running speeds of passenger cars and trucks on freeways and arterials	VISSIM
(X. Yang et al., 2014)	2014	Field data from MD 295 and Arundel Mills Blvd. in Maryland	Traffic volume and maximum queue length	Queue lengths	VISSIM
(Tian, 2004)	2004	Field data using loop detectors and ramp-metering logs	Traffic volume, ramp-metering rates, and queue length	Queue lengths and ramp-metering throughputs	VISSIM

2.4 Restricted Crossing U-Turn (RCUT) Intersections

2.4.1 Standard RCUT (J-turns)

Vehicles from the minor street must turn right and make a U-turn at the median at RCUT intersections. Calibration requires adjustment of stop compliance rates, deceleration profiles before the U-turn, and acceleration profiles after completing the maneuver (Figure 2-1). The most challenging part of microsimulation is simulating the weaving maneuver from the driveway to a U-turn Bay and the U-turn gap acceptance.

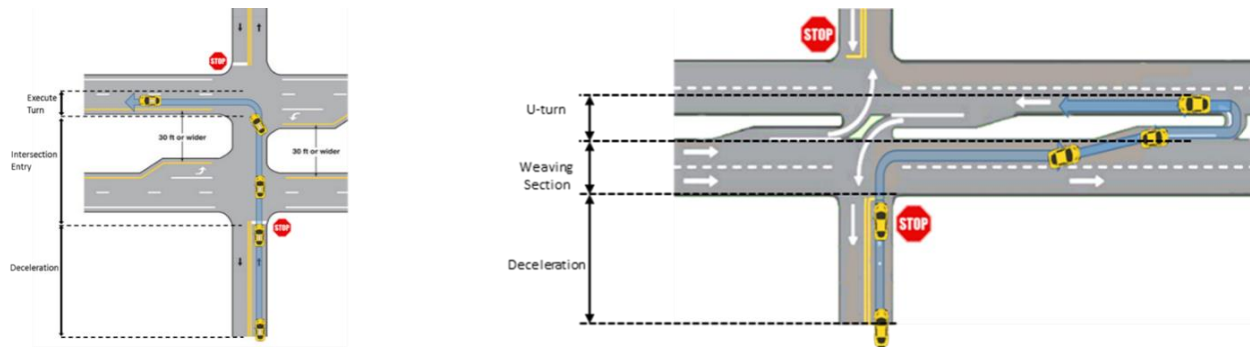


Figure 2-1 Direct Left Turn (Left) and Right Turn followed by U-Turn (Right) Movements

2.4.2 Right-Turn Followed by U-turn Weaving Movements

Weaving calibration focuses on lane utilization, speed selection, and the length of the weaving segment. NDS data show that weaving length strongly influences operating speeds, requiring facility-specific calibration. Table 2-5 summarizes the available national guidance related to RCUT simulation calibration. The FHWA Alternative Intersections/Interchanges Report (Hughes et al., 2010) provides general operational analysis recommendations but does not include specific calibration instructions or parameter adjustment procedures for simulation modeling.

Table 2-5 DOT and National Guidance for RCUT Simulation

Source / Agency	Year	Calibration Instruction?	Calibration Parameters
FHWA AIIR Report (Alternative Intersections) (Hughes et al., 2010)	2010	No	-

The studies summarized in Table 2-6 illustrate the progression of calibration practices for RCUT simulation models using both field and simulated data. (Appiah et al., 2020) used simulated data to calibrate car-following and conflict-area parameters within VISSIM and SSAM for safety evaluation. (X. K. Yang & Zhou, 2004) employed loop-detector and video data containing traffic volumes, delays, and travel times to validate left-turn travel behavior using CORSIM. (Liu et al., 2012) analyzed video, radar, and manual headway observations to calibrate minimum gap time, lane-use behavior, and turning speeds for U-turning vehicles in VISSIM. (Hummer et al., 2010) calibrated speed distribution and conflict-area parameters in VISSIM to capture RCUT operational dynamics. (Molan et al., 2022) further enhanced calibration using video-based measurements of vehicle speeds, headways, and gap-acceptance data to determine average speeds and allowable gaps.

Table 2-6 Studies on RCUT Simulation Calibration

Source	Year	Data Source	Type of Data Collected	Calibration Parameters	Tool
(Molan et al., 2022)	2022	Video data	Vehicle speeds on major and	Average speed, headway,	VISSIM

			minor approaches, headways, and gap-acceptance data	and allowable gap of turning vehicles	
(Appiah et al., 2020)	2020	Simulated data	-	Car-following model parameters and conflict area adjustments	VISSIM and SSAM
(Liu et al., 2012)	2012	Video recordings, radar gun speed measurement, and manual review of headways	Headway acceptance data for U-turning vehicles, turning speeds, traffic volumes, and geometric characteristics	Minimum gap time, lane utilization behavior, and turning speed of U-turning vehicles	VISSIM
(Hummer et al., 2010)	2010	-	-	Speed distribution and conflict area parameters	VISSIM
(X. K. Yang & Zhou, 2004)	2004	Loop detectors and video cameras	Traffic volumes, delays, and travel times	Field-collected travel time of left-turning vehicles	CORSIM

2.5 Diverge/Merge Maneuvers (Freeway Ramps and Work Zones)

2.5.1 Diverge Areas

Diverging vehicles exhibit unique braking and lane-changing patterns. (Xu, 2021) demonstrated that diverging traffic requires calibration of car-following sensitivity, deceleration thresholds, and gap-acceptance rules. Recent studies also highlight the importance of driver familiarity and lane-change urgency when approaching off-ramps. FHWA and some state DOTs, like VDOT and GDOT, also have VISSIM guidelines for freeway diverge calibration processing.

2.5.2 Merge and Work-Zone Areas

Merge and work-zone operations introduce complex and dynamic traffic interactions driven by lane-changing aggressiveness, gap acceptance, headway settings, and cooperative behavior. Prior research demonstrates that accurate microsimulation of these facilities requires careful calibration of driver-behavior parameters. For merge areas, (Ishak et al., 2012) showed that calibrating standstill distance (CC0) and desired headway (CC1) significantly improved the representation of merge-zone safety and throughput. Similarly, (Xu, 2021) confirmed that lane-change urgency and gap-acceptance behavior vary across driver types, reinforcing the importance of field-based and NDS-supported calibration approaches for both freeway merges and work-zone environments.

Work zones create temporary geometric changes and involve abrupt reductions in speed. Table 2-7 outlines VDOT and FHWA guidance relevant to freeway simulation calibration. The FHWA Traffic Analysis Toolbox Volume III (Dowling et al., 2004) provides general procedures for aligning simulated and observed traffic volumes and speeds, while the VDOT Traffic Operations and Safety Analysis Manual (TOSAM) and VISSIM User Guide (VDOT VISSIM User's Guide, Version 2.0, 2020) offers more detailed directions for calibrating lane-changing urgency and merge/diverge behavior, particularly in complex freeway and ramp environments.

Work-zone operations require simulation-based analysis to replicate lane closures, merges, and driver responses that analytical methods cannot fully capture. According to FHWA's Traffic Analysis Toolbox Volumes VIII, IX, and XII, microscopic simulation provides the necessary temporal and spatial detail to evaluate dynamic queues, delays, and speed reductions under varying staging and control scenarios. These volumes emphasize that accurate representation of work-zone mobility and safety performance depends on calibrating driver-behavior parameters, such as standstill distance (CC0), desired time headway (CC1), and following variation (CC2), as well as lane-changing parameters, such as gap acceptance and cooperation factors. Desired-speed distributions and truck-performance characteristics are adjusted to reflect observed speed reductions and capacity losses.

Table 2-7 VDOT and FHWA Guidance for Freeway Simulation

Source	Year	Calibration Instruction	Calibration Parameters
VDOT TOSAM and VISSIM User Guide (<i>VDOT VISSIM User's Guide, Version 2.0, 2020</i>)	2020	Yes	Lane-changing urgency; merge/diverge driver behavior
FHWA Traffic Analysis Toolbox Volume VIII, IX, XII	2017, 2009, 2020	Yes	CC0, CC1, CC2, CC3-CC5, lane changing parameters, vehicle composition, speed
FHWA Traffic Analysis Toolbox Volume III (Dowling et al., 2004)	2004	Yes	General freeway calibration methods; volume & speed alignment

In addition, several studies have noted that, compared with VISSIM, general tools such as QuickZone (a sketch-planning tool for estimating work-zone delays), QUEWZ (a macroscopic model for work-zone capacity and queue prediction), and FREEVAL-WZ (an HCM-based tool for evaluating freeway work-zone performance) demonstrate lower accuracy in replicating realistic traffic conditions, particularly when simulating detailed and complex traffic scenarios ((Xu, 2021); (Edara & Chatterjee, 2010)). In VISSIM, parameters such as CC1, CC2, and the Safety Reduction Factor (SRF) were recommended for calibration to ensure the model accurately reflects driver behavior and safety performance (Edara & Chatterjee, 2010). Table 2-8 summarizes six studies related to freeway merge and diverge calibration using both field and naturalistic datasets. (Xu, 2021) utilized SHRP2 NDS data, including vehicle trajectories, speed profiles, and gap-acceptance behavior, to calibrate speed, deceleration, lane-change urgency, and braking profiles in VISSIM.

(Park & Qi, 2006) employed field data such as traffic volumes, heavy vehicle percentages, travel times, and speed distributions to optimize 21 car-following and lane-changing parameters through genetic algorithms. (Ishak et al., 2012) calibrated standstill distance (CC0) and desired headway (CC1) using field-collected flow and queue data from freeway work zones. (Abuamer et al., 2016) integrated traffic volume, speed, and occupancy data to align ramp metering and driver behavior parameters within VISSIM and MATLAB. (Mehr & Eskandarian, 2021) focused on lane-change warning and diverge urgency calibration using VISSIM with TOSAM. Additionally, (Edara & Chatterjee, 2010) used field data from Ohio work zones to calibrate CC1, CC2, and the SRF in VISSIM, replicating observed lane capacities, truck impacts, and queue lengths under different lane-closure scenarios.

Table 2-8 Studies on Freeway Merge/Diverge Calibration

Source	Year	Data Source	Type of Data Collected	Calibration Parameters	Tool
(Xu, 2021)	2021	NDS data from SHRP2 database	Vehicle trajectories, speed and headway profiles, lane-change initiation, deceleration points, and gap-acceptance behaviors	Speed/deceleration distributions; gap tables; lane-change urgency; change-point braking profiles	VISSIM
(Mehr & Eskandarian, 2021)	2021	-	-	Lane-change warning calibration; diverge urgency	VISSIM + TOSAM
(Abuamer et al., 2016)	2016	Remote Traffic Microwave Sensor (RTMS)	Traffic volumes, speed, and lane occupancy	Ramp metering integration with driver behavior	VISSIM + MATLAB
(Ishak et al., 2012)	2012	Field data	Traffic volume, vehicle composition, and queue discharge flow rate	CC0 (standstill); CC1 (headway time)	VISSIM
(Edara & Chatterjee, 2010)	2010	Ohio Department of Transportation	Traffic volume, vehicle composition (truck %), lane distribution, speed, occupancy, and queue length	CC1(headway time), CC2(following variation), SRF, speed, vehicle compositions	VISSIM

(Park & Qi, 2006)	2006	Field data	Traffic volumes, vehicle compositions (HV%), compliance rates, travel times, and speed distributions	Car-following and lane-changing parameters	VISSIM
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2.6 Current ALDOT Practice for Traffic Analysis and Simulation

ALDOT currently integrates traffic analysis and simulation into the geometric design process. Traffic analysis is conducted iteratively during the preliminary, intermediate, and final design stages to evaluate operational performance, test design alternatives, and support decision-making for projects such as interchange modifications, alternative intersection treatments, traffic impact studies, and work-zone planning. The focus is on assessing measures such as delay, queue length, level of service, and overall operational feasibility under existing and projected traffic conditions.

In practice, ALDOT utilizes a combination of traffic analysis tools depending on the level of detail required, with microscopic simulation software such as VISSIM used for detailed operational evaluation when warranted. Model development typically follows standard modeling procedures, relying on default or commonly accepted parameter settings and available project data. Detailed, facility-specific calibration is not consistently performed, particularly for alternative intersection forms, due to the absence of unified calibration guidance.

2.7 Summary

For roundabouts, the review found that the three state DOTs (WSDOT, MassDOT, and GDOT) have established microsimulation calibration procedures. These guidelines primarily address adjustments to operational speed, priority rules, and Wiedemann-74 car-following parameters, validated against field-observed travel times and queue lengths. Research efforts expanded on these approaches using video, radar, and UAV-based data to calibrate entry speeds, headway distributions, and gap-acceptance parameters. However, these resources may not capture and apply to Alabama driver behavior. In addition, no structured calibration framework exists for non-circular configurations, such as turbo, peanut, or elliptical designs, that were recently built in Alabama.

For DDIs, the available calibration guidance varies in scope and specificity. The WSDOT Protocol for VISSIM Simulation is the only source providing DDI-specific calibration guidance, detailing required adjustments to car-following and lane-changing parameters, including standstill distance, desired time gap, maximum acceleration, desired deceleration, look-ahead distance, and lane-change decision distance. The NCHRP Report 959 and GDOT's VISSIM Simulation Guidance also include calibration recommendations; however, they address complex interchanges in general and do not specify DDI-specific behavioral parameters. The FHWA AIIR Report offers an operational analysis method for DDIs but includes no simulation-related calibration instructions. Consistent with these gaps in national guidance, existing DDI research relies heavily on field-

collected traffic volumes, turning-movement counts, truck percentages, mean speeds, loop-detector data, and queue-length observations to calibrate queue discharge behavior, running speeds, and ramp-metering throughput in VISSIM.

For RCUT intersections, the FHWA AIIR Report discusses RCUT benefits and operational features but does not provide calibration parameters for traffic simulation procedures. Consequently, past research has depended on field data such as loop-detector traffic volumes, video-based delays and travel times, radar-measured turning speeds, and manual headway observations to calibrate key behaviors. These studies primarily focus on gap-acceptance, minimum gap time, lane-utilization patterns, acceleration and deceleration profiles, turning-speed characteristics, and conflict-area dynamics. More recent work uses simulated data to tune car-following, while video-based speed and headway measurements have been applied to refine allowable gaps and weaving performance at the RCUT intersection.

For freeway diverge and merge (work-zone) areas, calibration direction is available through the FHWA Traffic Analysis Toolbox (Volumes III, VIII, IX, and XII) and VDOT's TOSAM-VISSIM Guide, emphasizing CC0–CC2, lane-changing urgency, and desired-speed parameters. Field-based, and SHRP2 NDS trajectory studies further enhanced these models through genetic algorithms and behavior-specific calibration. The well-established calibration guidance in other states can be validated using Alabama data to develop a general simulation calibration guideline for freeway merge/diverge areas.

3. DATA COLLECTION

This task involved collecting and compiling a comprehensive set of field and naturalistic data to support calibration of roundabouts, DDIs, RCUTs, and freeway merge/diverge maneuvers. For roundabouts and the DDI site, high-resolution drone videos were collected at peak and off-peak periods to capture each vehicle trajectory (speed, travel time, acceleration/deceleration rates), car following, and gap-acceptance behavior. For RCUTs, driver-behavior data, including second-by-second speeds, accelerations, and video-verified traffic environments, were obtained from the SHRP2 NDS data. For freeway merge analysis, the team incorporated field measurements from previous ALDOT-supported studies using portable traffic counters and supplemented these with new drone footage at a two-to-one lane-closure site.

3.1 Data Collection Methods

3.1.1 Drone Video Data Collection

Drone-based video data collection served as the primary field data collection method for this study. UAV footage provided a comprehensive overhead view of traffic operations, enabling the extraction of detailed microscopic traffic parameters, including vehicle trajectories, traffic volumes, headways, gap-acceptance behavior, queue lengths, and turning movements, under real-world conditions. These data are essential for calibrating and validating microsimulation models across multiple facility types.

All drone data were collected using a DJI Mavic Mini 2 equipped with a 1/2.3-inch CMOS sensor (*DJI Mini 2*, 2025, p. 2). Although the drone supports 4K recording, all videos were captured at 1080p resolution and 30 frames per second to balance image clarity with data storage and processing efficiency. A three-axis mechanical gimbal ensured stable footage by minimizing motion blur caused by wind or vibration, and the integrated GPS system provided geolocation accuracy within a few meters, supporting geometric mapping and spatial alignment.

Flight altitude was adjusted based on site geometry and surrounding conditions to ensure full coverage of traffic movements. For roundabouts, altitudes were selected to capture both circulating and approach lanes, while for the DDI, higher altitudes were used during peak periods to capture system-level performance, and lower altitudes were used during off-peak periods to observe detailed right-turn merging behavior. All drone recordings were conducted under clear weather conditions to maximize behavioral detail and data quality.

3.1.2 Roadway Geometry Data Collection

Roadway geometry data were collected using Google Earth. Measurements included lane widths, approach and exit angles, curvature, inscribed circle diameters, and reference coordinates. These data were used to accurately reconstruct facility layouts within VISSIM.

3.1.3 Naturalistic Driving Study (NDS) Data Collection

NDS data collected under a previous research project were used as an additional data source for RCUT driver behavior. The NDS dataset includes time-stamped vehicle positions, speeds, accelerations, braking events, radar measurements, and synchronized video. These data were referenced to support calibration method development, while drone data from a selected site were used for case-study verification.

3.1.4 Additional Data Resources

Additional data resources included an ALDOT-provided VISSIM model for the DDI, from which key driver-behavior and lane-change parameters were extracted, and cloud-based traffic data (ClearGuide) used to supplement freeway lane closure work-zone analysis where drone coverage was limited.

3.2 Data Collection for Roundabouts

3.2.1 Site Description

For this study, 18 roundabouts across Alabama (Figure 3-1) were selected for drone-based data collection. The sites were chosen to provide a representative sample of geometric configurations and to ensure that findings could be generalized across diverse driving behaviors within the state. Appendix A contains more detailed information for each roundabout, including location, type, video data, and construction year.

The sites were identified using the Roundabout Map – A Database of Roundabouts in the United States, developed by Kittelson & Associates, Inc. (Kittelson & Associates, 2024). This database is one of the most comprehensive nationwide inventories of modern roundabouts, offering detailed attributes such as type, operational status, functional classification, lane configuration, number of approaches, inscribed circle diameter (ICD), geographic coordinates, and jurisdictional information. It also documents historical control types and notes on land use or special site contexts.

Several selection criteria were applied. Preference was given to roundabouts located near state highways or arterial roads to ensure continuous vehicle flow and varied traffic interactions. Sites had to be in legally permissible and technically feasible drone flight zones, which exclude areas near restricted airspace such as airports, military facilities, or dense utility corridors. Low-volume and rural intersections were not included to focus on locations with higher traffic complexity. Mini roundabouts were also omitted due to their smaller scale and distinct operational behavior.

The final dataset included a diverse set of roundabout geometries. A total of 13 circular roundabouts were selected, consisting of three with ICDs less than 120 ft, seven with ICDs between 120 ft and 150 ft, and three with ICDs greater than 150 ft. In addition, five non-circular roundabouts were included, comprising two peanut-shaped, one turbo, one elliptical, and one egg-shaped design. This geometric diversity supports a comprehensive assessment of how roundabout size and shape influence approach speeds, turning paths, lane utilization, and other operational characteristics essential for calibration.

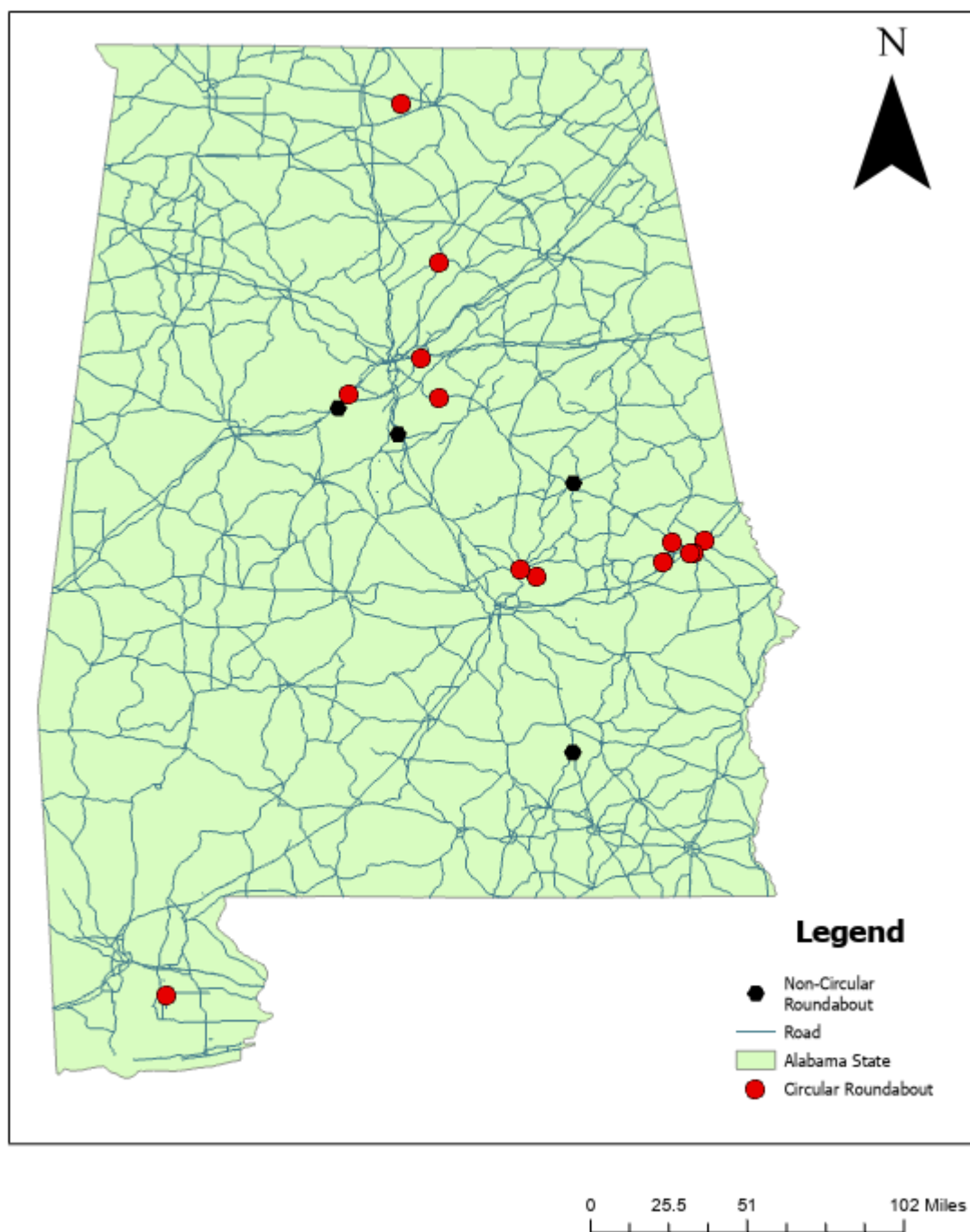


Figure 3-1 Study Roundabout Locations

3.2.2 Drone Video Data

Drone video data was used to obtain operating speeds, traffic volumes, accepted gap times, critical headways, and other measures describing traffic flow dynamics and car-following behavior at roundabouts. The roundabout video dataset includes recordings ranging from 15 to 75 minutes and covers three-leg, four-leg, and five-leg roundabouts. The dataset also includes five non-circular designs (Figure 3-2), such as a newly constructed peanut-shaped roundabout in Spring Hill and a turbo roundabout in McCalla, Jefferson County.



Figure 3-2 Non-Circular Roundabout Layout

3.2.3 Roadway Information

Roundabout geometric design features directly affect traffic operations and driving behavior. In VISSIM, accurate modeling of roadways, particularly roundabouts, requires detailed geometric inputs, including lane widths, entry and exit angles, curvature, and precise location coordinates. These parameters are essential for correctly drawing links, connectors, and conflict areas. The following steps are taken to extract geometric information using Google Earth:

1. Identify the Roundabout: Use the search or map navigation features to locate the roundabout of interest in satellite view.
2. Use the Ruler Tool:
 - Click the ruler icon in the toolbar to activate the distance measurement tool.
 - Set the units to meters or feet.
 - Click and drag to measure lane widths, island diameters, entry/exit lane lengths, and overall roundabout diameter.

3. Measure Angles:

- Use the ruler to draw vectors for entry and exit paths.
- Calculate the entry and exit angles by drawing two connected lines and observing the angle between them.
- These angles help define how sharply vehicles must turn and are important for setting vehicle behavior parameters like deceleration and gap acceptance.

4. Export Coordinates:

- Right-click on specific points (e.g., lane centerlines, island center, entry/exit points) and select "View Coordinates" or "Copy Coordinates."
- These can be used to geo-reference the layout when recreating the roundabout in VISSIM or when aligning background images.

5. Capture Screenshots:

- Screenshots of the roundabout with measurement overlays can be saved and imported as background images in VISSIM, aiding in the accurate placement of links and connectors.

3.3 Data Collection for DDI

3.3.1 Site Description

The study site, located at the I-10 and AL-181 interchange in Mobile, was constructed in 2020 (Figure 3-3).



Figure 3-3 DDI Layout (Mobile, AL)

3.3.2 Drone Video Data

To calibrate the simulation model for capacity analysis, it was important to ensure it reproduced real-world delays and queue lengths. The study team first used the “typical traffic” feature on Google Maps to identify three peak periods for video recording:

- AM Peak (6:30–7:30 AM): Video length 60 minutes
- Noon Peak (2:00–3:00 PM): Video length 60 minutes
- PM Peak (6:00–7:00 PM): Video length 60 minutes

During these periods, drones were used to record traffic flows at the DDI to obtain average speeds for crossroads/bridges and traffic volumes. At this DDI, the right-turn movement is another important part of calibration and was operated under a Stop-on-Red (SOR) control strategy. In this setup, vehicles must stop at the stop bar during the red phase and then merge into the mainline traffic when a gap becomes available. During peak hours, this method was inefficient because high traffic volumes left very few gaps. To better understand driver behavior, the team collected an extra 180 minutes of right-turn footage during off-peak hours, when more natural merging patterns could be observed. This additional footage was collected at a lower altitude. This approach ensured that both system-level performance (delays and queues) and detailed driver behavior (right-turn merging under SOR) were represented in the calibration dataset.

3.3.3 Other Data Resource

Besides the drone videos, the ALDOT also provided their original VISSIM models for analysis of the design alternatives, which include the four main traffic scenarios: PM peak, Midday, Off peak, and Christmas. Because the traffic control and operational methods in the original model differed from the existing built condition, the team used only key parameters, such as lane change distance and driving behavior settings, from the model shown in Figures 3-4 and 3-5. The lane change distance was set as a fixed value of 2656.2 (distance between ramp terminal and upstream intersection) that applies to per lane change. For the driving behavior setting, the original model selected cooperative lane change.

Connector ? X

No.: 10048 Name:

Intermediate points: 3 Link behavior type: 1: Urban (motorized) v

Link length: 86.148 ft Display type: 1: Road gray v

☐ Reverse parking

from link to link

No.: 4 No.: 32

At: 449.722 ft At: 1.923 ft

☐ Lane 1
☐ Lane 2
☒ Lane 3

☒ Lane 1

Lanes Lane Change Meso Display Dyn. Assignment Others

Desired Direction: All v

Emergency stop position: 16.4 ft

Lane change distance

☒ Applies per lane change

☒ Fixed value: 2656.2 ft

☐ Distribution: v

Specific for vehicle classes:

Number: 0	VehClass	LnChgDistDistr
There are no elements in this list. You can add new elements through the context menu.		

OK Cancel

Figure 3-4 ALDOT Original VISSIM Model Lane Change Setting

Driving Behavior

No.: 106 Name: DDI User Defined (Cross)

Following Car following model **Lane Change** Lateral Signal Control Autonomous Driving Driver Errors Meso

General behavior: Free lane selection

Necessary lane change (route)

	Own	Trailing vehicle
Maximum deceleration:	-13.12 ft/s ²	-9.84 ft/s ²
- 1 ft/s ² per distance:	100.00 ft	100.00 ft
Accepted deceleration:	-3.28 ft/s ²	-3.28 ft/s ²

Waiting time before diffusion: 60.00 s ☐ Overtake reduced speed areas

Min. clearance (front/rear): 1.64 ft ☒ Vehicle routing decisions look ahead

To slower lane if collision time is above: 11.00 s

Safety distance reduction factor: 0.60

Maximum deceleration for cooperative braking: -9.84 ft/s²

☒ Cooperative lane change

Maximum speed difference: 6.71 mph Maximum collision time: 10.00 s

☐ Zipper merging ⓘ

Minimum speed: 12.43 mph Overtaking time distribution: [dropdown]

☐ Rear correction of lateral position

Maximum speed: 1.86 mph

Active during time period from 1.00 s until 10.00 s after lane change start

OK Cancel

Figure 3-5 ALDOT Original VISSIM Model Behavior Setting

3.4 Data Collection for Restricted Crossing U-Turn (RCUT)

3.4.1 Drone Video Data

For the RCUT intersection, 35 minutes of drone video data during peak hour were collected to extract traffic volumes, speed, and acceleration/deceleration rates for developing and validating the simulation models. The study site is located on Highway 72 between Dug Hill Road in Brownsboro, Alabama (Figure 3-6).

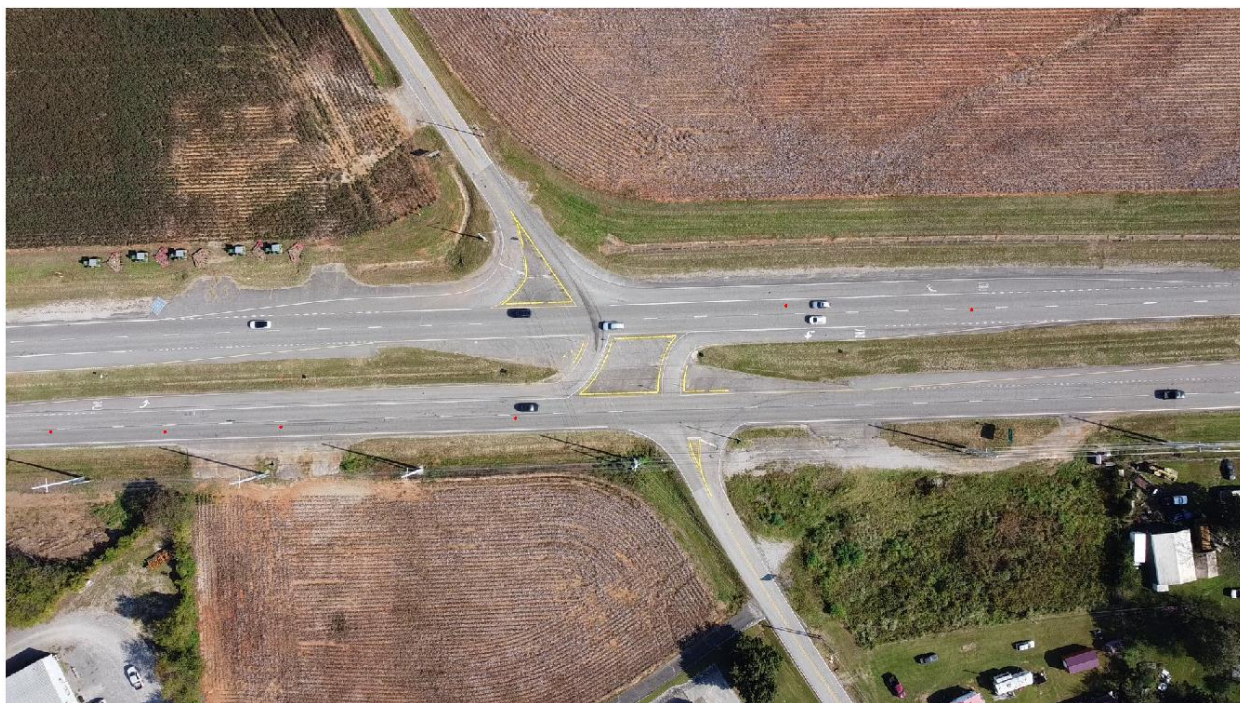


Figure 3-6 RCUT Layout (Brownsboro, Alabama)

3.4.2 Second Strategic Highway Research Program (SHRP2) Naturalistic Driving Study

The NDS data provides continuous records of vehicle position, speed, acceleration, and braking activity at 0.1–1 second intervals, along with forward radar measurements and multi-angle video views (front roadway, rear roadway, and driver). In this study, the guidelines developed from previously collected NDS data from Florida and North Carolina were verified using the speed trajectories and acceleration patterns collected in Alabama. The NDS collected a total of 453 trip data by 79 different drivers at seven RCUT intersections (F. Yang & Zhou, 2024).

3.5 Data Collection for Merge/Diverge Maneuvers (Freeway Ramps and Work Zones)

Extensive research has been conducted on work zone operations and simulation calibration techniques. However, due to the limited flight duration and spatial coverage of drones, it is impractical to rely solely on drone data collection for developing a comprehensive calibration dataset for work zone simulations. Therefore, drawing on insights from prior studies, the research team used established calibration findings from existing literature to initially calibrate the VISSIM model and then applied drone-based data at a selected location in Alabama to validate model performance.

A guideline for calibrating the VISSIM model for a 2-to-1 lane closure was developed in a recent study by Auburn University (Turochy et al., 2022; Jehn & Turochy, 2019). This study identified key adjustments to default driver-behavior parameters, including time headway and truck acceleration, and demonstrated that a calibrated simulation can accurately replicate observed field conditions in Alabama freeway work zones.

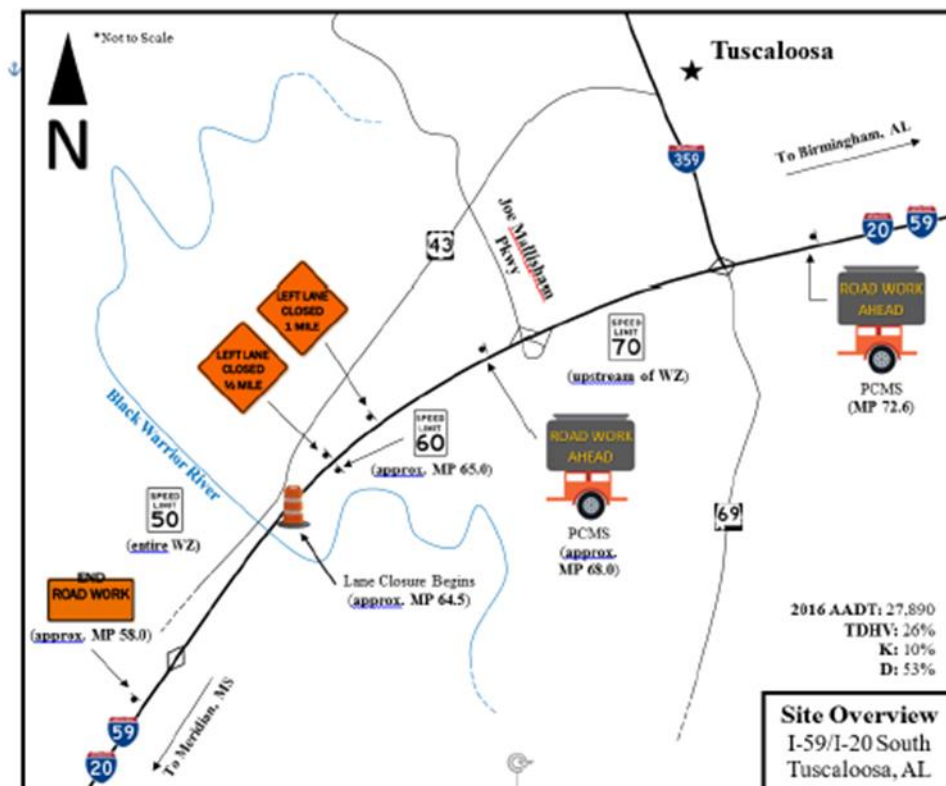


Figure 3-7 Reference Data Collection Location (Turochy et al., 2022)

The study site is on I-59/20 near Tuscaloosa, AL (Figure 3-7). The traffic data were collected over the 14-day period from October 3, 2016, to October 16, 2016, using 9 traffic sensors deployed as shown in Figure 3-8. Each sensor could collect speed, volume, length, and headway data at 1-second intervals for up to 300,000 vehicles or 21 days, whichever occurred first. The product information specifies that each sensor is also accurate to within 4 mph for vehicle speeds, 4 feet for vehicle lengths, and 1% for vehicle counts.



Figure 3-8 Traffic Sensor Deployment Scheme

3.5.1 Drone Video Data



Figure 3-9 Work Zone (Merge) Field Data Collection Location (I-20, Lincoln, AL)

The research team selected a freeway work zone site at 33.593760° N, -86.181883° W along I-20 in Lincoln, Alabama. (Figure 3-9) and collected one hour of field data using drones on October 3, 2025. The work zone was implemented in the westbound direction and featured a two-to-one lane-closure configuration. The traffic data obtained from this location will serve as the validation dataset for the simulation model. As for the diverging movement, the team chose westbound exit 51 off ramp of Interstate 85 in Auburn to collect field data (Figure 3-10).



Figure 3-10 Diverge Field Data Collection Location (I-85 Exit 51, Auburn, AL)

3.5.2 Other Data Resource

Due to the limited spatial coverage and recording duration of the drone trajectories, the research team incorporated cloud-based traffic data as supplementary data sources. ClearGuide data were employed to support the work-zone merging analysis and exit ramp diverging study. Figure 3-11 shows the distribution of average speeds across the work zone. The results showed that during the road construction period, the average vehicle speed was approximately 10-20 miles per hour from 6:00 AM to 10:00 PM and approximately 55 miles per hour during other periods.

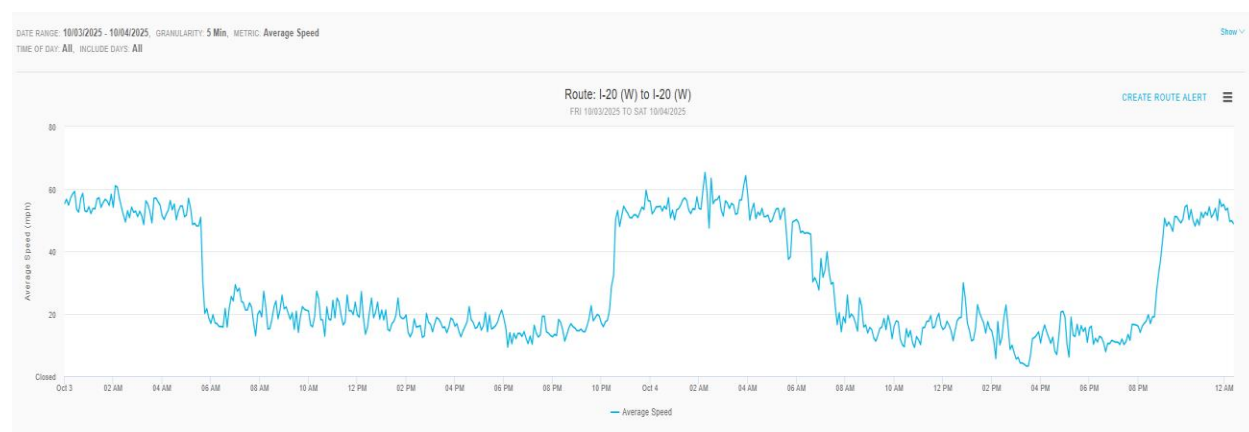


Figure 3-11 Work Zone (Merge) ClearGuide Speed (I-20, Lincoln, AL)

3.6 Summary

This chapter describes the data sources and collection methods for roundabouts, DDIs, RCUTs, and freeway merge/diverge facilities in Alabama. Drone video served as the primary data source for roundabouts and the DDI, providing detailed vehicle trajectories, speeds, traffic volumes, and gap-acceptance behavior under real-world conditions. Supplementary roadway geometry data were obtained from Google Earth to support accurate reconstruction of geometric layouts in VISSIM.

For RCUT intersections, SHRP2 NDS data were incorporated to capture detailed driver behavior, including second-by-second speed, acceleration, and braking characteristics, and were verified using drone data collected at an Alabama site. For freeway merge/diverge areas, the study combined insights from prior ALDOT-supported studies, portable traffic sensor data, cloud-based traffic data, and drone video observations to develop and validate representative datasets.

4. DATA PROCESSING

A standardized data-processing framework was developed to convert raw drone video into traffic data for roundabouts, DDI, RCUT, and freeway merge/diverge areas. All drone footage was processed using the DataFromSky platform, which performs camera correction, geo-registration, lane and gate configuration, and automated vehicle tracking. This workflow transformed aerial imagery into high-resolution trajectory records, gate-based crossing data, and origin–destination matrices. The same procedure was applied across all facility types, with site-specific adjustments to reference points, lane geometry, and gate placement. The following subsections describe the DataFromSky platform and the processing steps for extracting speed profiles, headways, gap acceptance, and turning-movement patterns from collected drone video data.

4.1 DataFromSky Overview

DataFromSky is a platform that analyzes drone videos using artificial intelligence to understand traffic conditions and measure traffic behavior (Gheorghe & Filip, 2022). Previous studies have used UAV-collected video processed with automated video analysis tools, including the DataFromSky platform, to examine traffic operational and safety characteristics. These studies indicate that such tools can extract high-resolution vehicle trajectory and behavioral data from drone footage. Past studies that have applied the DataFromSky algorithm since 2021 are summarized in Table 4-1. Data automatically extracted from drone videos include trajectories, traffic counts, time-to-collision, headways, and gap acceptance.

Table 4-1 Summary of Studies Using DataFromSky in Transportation Research

Source	Year	Data Source	Measurement
(Van Tonder et al., 2023)	2023	UAVs	Trajectory paths, traffic counts, and turning movements
(Hasanvand et al., 2023)	2023	UAVs	Time-to-Collision (TTC), the maximum speed difference of the two vehicles involved in a collision
(Gbologah et al., 2022)	2022	UAVs	Critical headway
(Campbell IV et al., 2021)	2021	UAVs	Roundabout capacity models
(Rodgers et al., 2021)	2021	UAVs	Gap acceptance

In this study, the DataFromSky platform was used to process UAV-collected video at alternative intersection configurations and freeway merging and diverging areas, replacing traditional manual data extraction methods. This approach supports detailed analyses of driver behavior, lane

discipline, and interaction patterns, contributing to an improved understanding of traffic operations at study locations.

4.2 Workflow

The DataFromSky workflow is illustrated in Figure 4-1. Drone videos are first processed using the DataFromSky online platform, where video frames are preprocessed, geo-registered, and vehicle detection and tracking are performed in an integrated pipeline. Following processing, vehicle trajectory outputs can be reviewed and analyzed using the DataFromSky Viewer software.

As the raw outputs are initially referenced in image (pixel-based) coordinates, a geo-reference frame must be defined and calibrated to transform pixel-based data into real-world metric coordinates consistent with field conditions. Once geo-registration is properly calibrated, the software displays detailed vehicle trajectories at each time frame, enabling accurate spatial and temporal analysis of traffic movements. Below is the detailed description of each step in the workflow defined in Figure 4-1.

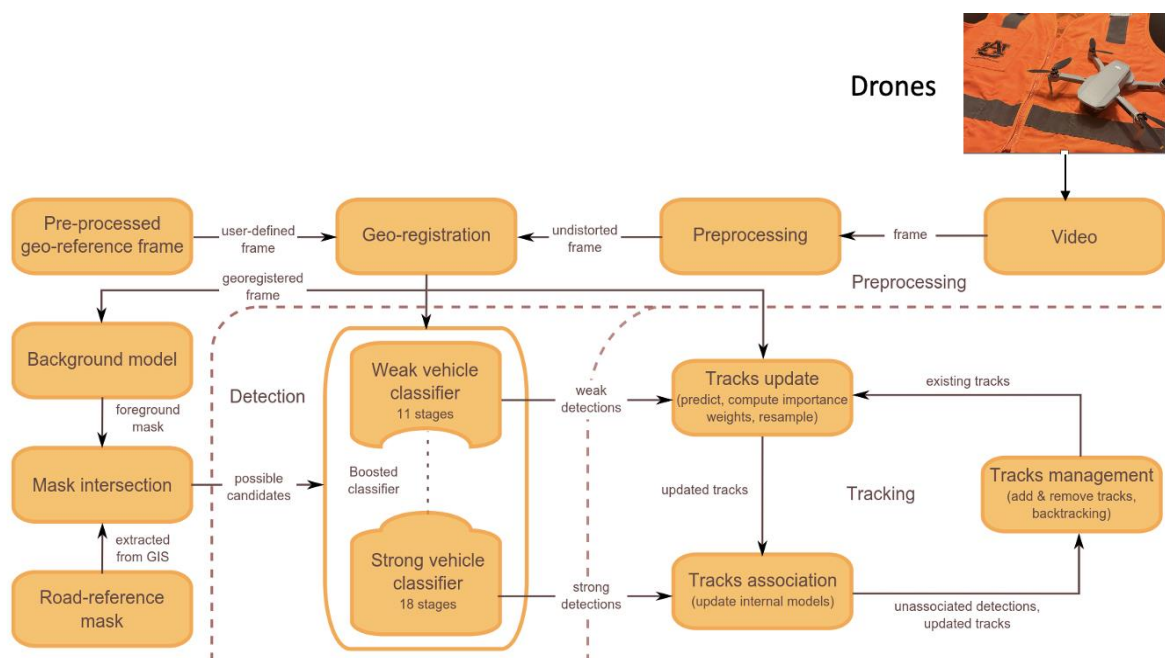


Figure 4-1 DataFromSky Workflow

4.2.1 Pre-Processing

The pre-processing phase is the initial step in handling drone videos using the DataFromSky online platform. In this step, the raw drone footage is corrected to remove camera movement and distortion. This prepares the video so vehicle trajectories can be reliably extracted.

4.2.2 Geo-Registration

The geo-registration stage was performed using DataFromSky Viewer software. During this step, selected control points from the UAV video frames were aligned with corresponding real-world coordinates obtained from Google Maps (Figures 4-2 and 4-3). This process transformed video data from pixel space into a metric reference frame, enabling accurate distance, speed, and trajectory measurements. Figure 4-2 shows an example of four control points at a roundabout selected for geo-registration. Figure 4-3 shows an example of eight control points at a DDI.

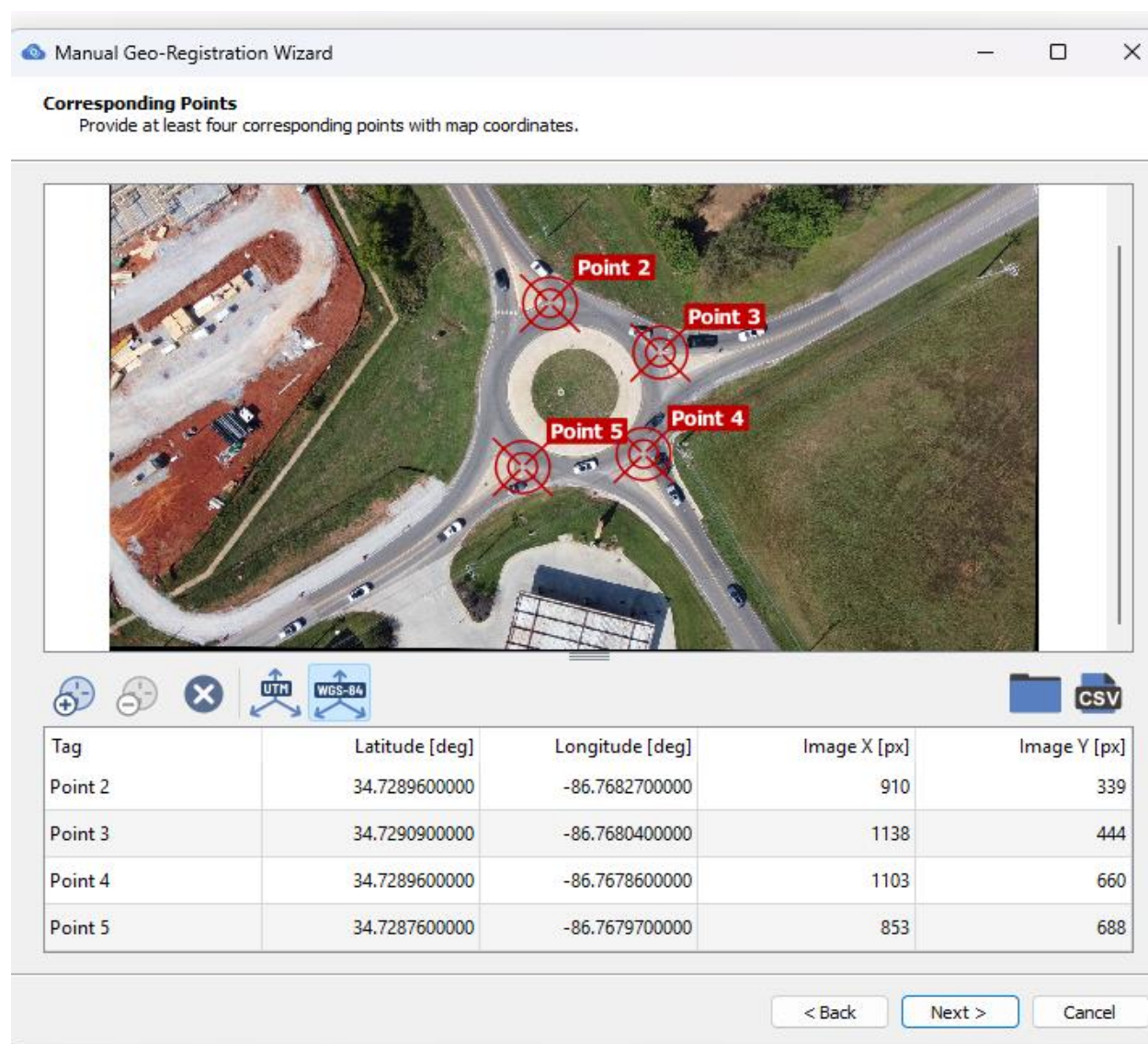


Figure 4-2 An Example of Geo-registration of Control Points for a Roundabout

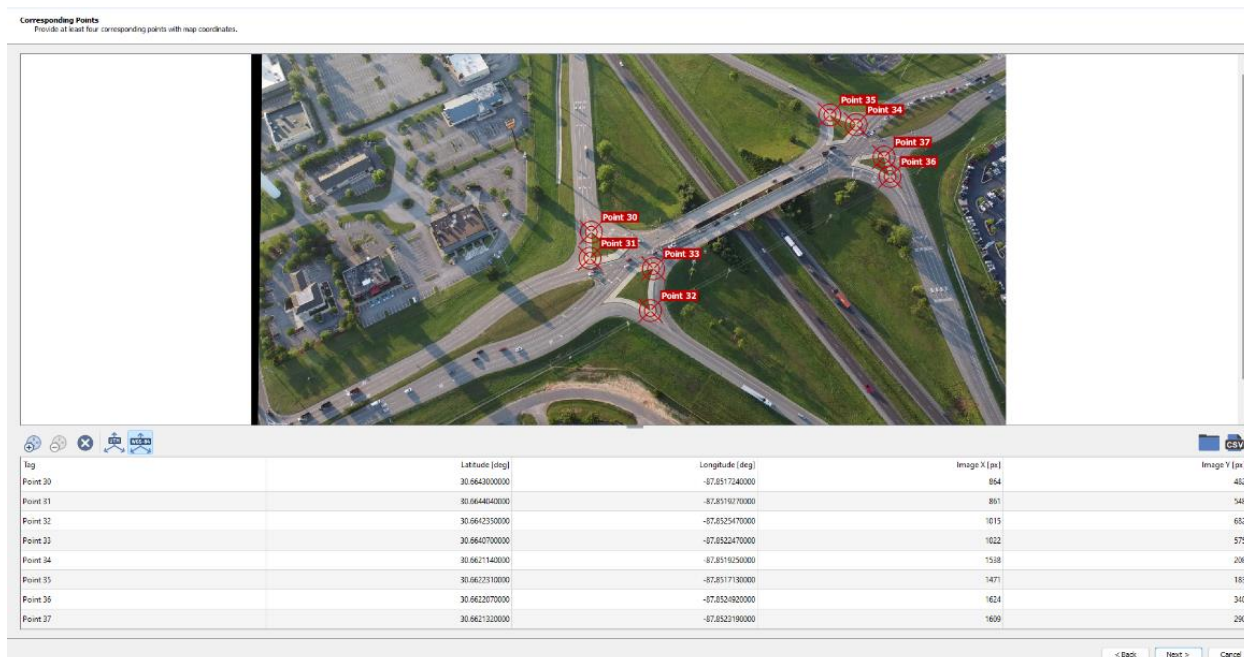


Figure 4-3 An Example of Geo-registration of Control Points for DDI

Once geo-registration was completed, gates, lanes, and traffic regions were defined to support trajectory-based traffic measurements. A gate is a virtual counting line placed across a roadway segment to record traffic volume, headway, and movement types. A lane is a user-defined traffic movement path used to assign vehicle trajectories and support lane-level operational analysis. A traffic region is a polygonal zone encompassing one or more lanes and is used to summarize vehicle trajectories and behavior within a defined area. To define traffic regions, each entrance and exit is assigned functions based on site-specific traffic conditions and analysis requirements; different intersections, therefore, utilize different configurations. Figure 4-4 shows the entrance regions in green color, exit regions in red, and a circular region in blue for a traditional roundabout. Figures 4-5 and 4-6 illustrate the different regions in green for a DDI.



Figure 4-4 Roundabout Lanes

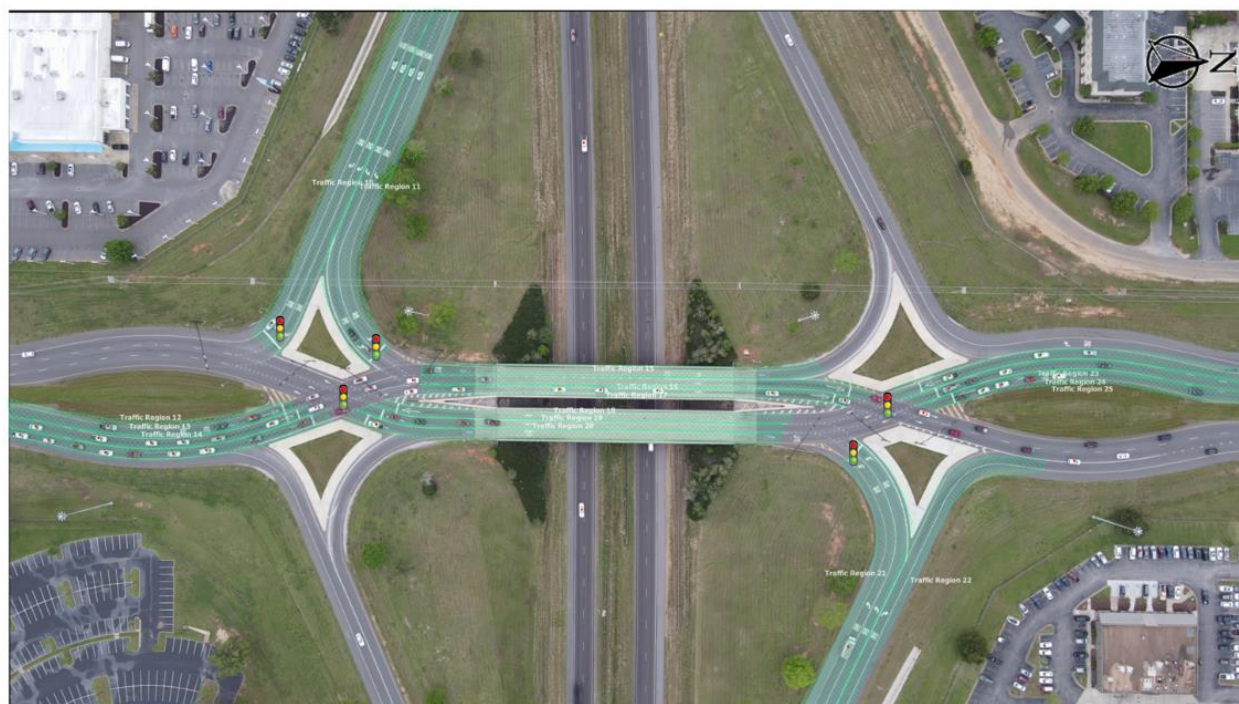


Figure 4-5 DDI Traffic Regions

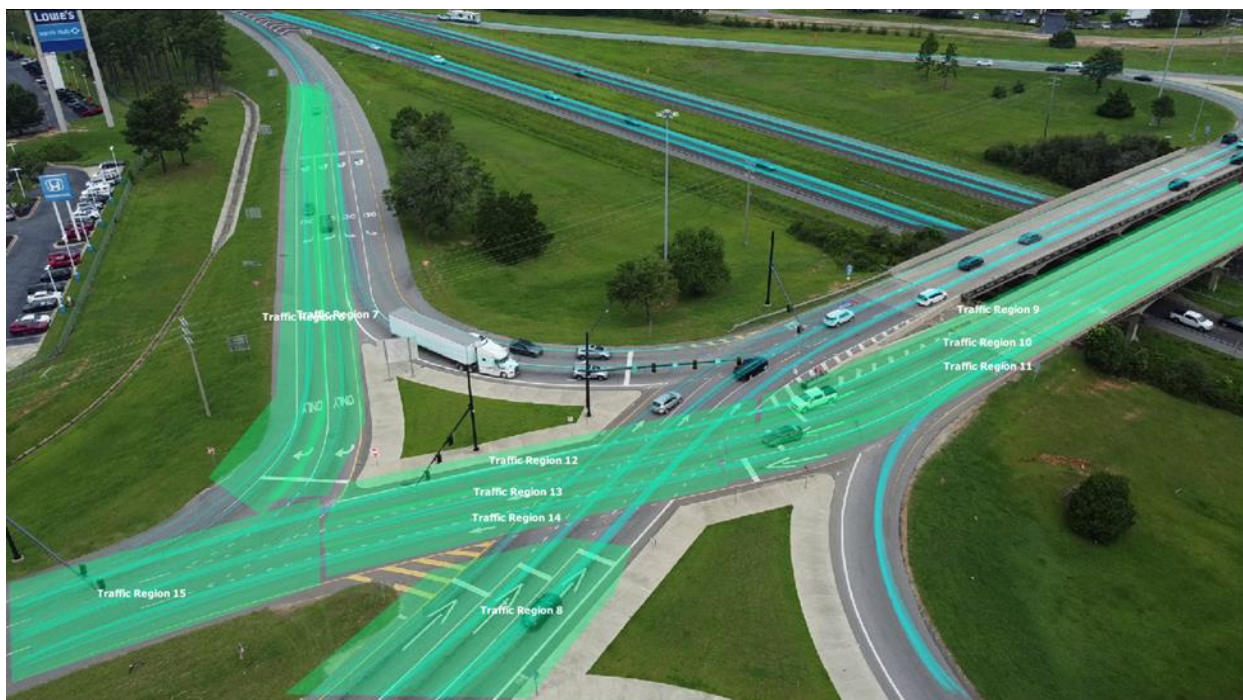


Figure 4-6 DDI Traffic Regions

4.2.3 Data Extracted from Drone Videos

After defining the gates, lanes, and regions, the DataFromSky Viewer can export the trajectory, region, and gate data in Excel format. To improve readability and support efficient downstream analysis, the research team developed Python scripts to load, clean, and restructure the exported data, as illustrated in Figures 4-7 and 4-8.

In Figure 4-7, the trajectory data contains detailed characteristics for each vehicle. The first 8 columns show the overall information for this vehicle, which includes Track ID, Vehicle Type, Entry Gate, Entry Time [s], Exit Gate, Exit Time [s], Traveled Dist. [m], Avg. Speed [km/h], and the remaining 7 columns contain the Trajectory(x [deg], y [deg], Speed [km/h], Tan. Acc. [ms⁻²], Lat. Acc. [ms⁻²], Time [s] for each timeframe.

This dataset enabled the calculation of speed profiles, lane-changing behavior, and priority rules.

- At roundabouts, trajectory data were used to estimate traffic flow, speed distribution, clearance, and car following behavior.
- At the DDI, trajectory data captured speed at ramps, crossroads, and the bridge, as well as right-turn maneuvers from off-ramp to crossroads.

ctory - DataFrame

Track ID	Type	Entry Gate	Entry Time [s]	Exit Gate	Exit Time [s]	Traveled Dist. [m]	Avg. Speed [km/h]	Trajectory(x [deg]	y [deg]	Speed [km/h]	Tan. Acc. [ms ⁻²]	Lat. Acc. [ms ⁻²]
2	Car	"Gate 37"	17.650967	"Gate 38"	29.963267	160.21	46.842572	30.663878	-87.85	45.1267	0.5439	1.1169
4	Car	"Gate 35"	0.633967	"Gate 38"	41.975267	370.47	32.260273	30.665696	-87.85	45.2027	-0.3541	-0.0042
11	Car	"Gate 37"	18.551867	"Gate 38"	30.797433	162.24	47.695245	30.663876	-87.85	41.8627	0.4587	0.5880
14	Car	"Gate 37"	14.714700	"Gate 38"	27.093733	160.12	46.564403	30.663876	-87.85	39.0850	0.8606	0.5978
15	Car	"Gate 32"	70.603867	"Gate 33"	84.284200	158.04	41.588424	30.662570	-87.85	42.4892	1.0016	1.6378
16	Car	"Gate 37"	13.813800	"Gate 38"	25.725700	160.20	48.416219	30.663878	-87.85	42.1658	1.0620	0.9150
23	Medi	"Gate 32"	75.442033	"Gate 33"	88.922167	158.08	42.215899	30.662570	-87.85	42.5563	0.2430	1.2779
24	Car	"Gate 37"	468.367900	"Gate 38"	514.814300	161.62	12.527148	30.663876	-87.85	47.8620	2.8550	-2.3636
26	Car	"Gate 37"	16.249567	"Gate 38"	28.461767	162.18	47.809953	30.663878	-87.85	41.2263	0.8668	0.6205
28	Medi	"Gate 32"	67.567500	"Gate 33"	81.915167	157.83	39.601588	30.662569	-87.85	38.3380	0.8480	0.7579
34	Car	"Gate 37"	23.456767	"Gate 38"	35.335300	163.71	49.615103	30.663874	-87.85	40.1540	1.8536	0.8069
36	Car	"Gate 37"	16.216200	"Gate 38"	28.528500	159.99	46.779853	30.663878	-87.85	42.5052	0.8097	0.6940
37	Car	"Gate 37"	20.153467	"Gate 38"	32.399033	160.48	47.179520	30.663879	-87.85	42.8787	0.2318	1.0097

Figure 4-7 Trajectory Data

As illustrated in Figure 4-8, the traffic region data provides region-level information for each vehicle, including traffic region ID, track ID, entry and exit times, speed, acceleration, stationary duration metrics, and region-specific scores. By matching track IDs between the traffic region and trajectory datasets, the research team identified relevant vehicles and conducted subsequent detailed trajectory-based analyses.

Track Type	Traffic Region	Track ID	Entry Time [s]	Exit Time [s]	Avg. Speed [km/h]	Tan. Acc. [ms ⁻²]	Lat. Acc. [ms ⁻²]	Total Acc. [ms ⁻²]	Stationary [s]	Post Stationary [s]	Score [%]	Time_Difference [s]
Car	38	14	0	24.7581	1.69011	0.8587	0.136	2.035	20.153	20.153	78	24.7581
Car	38	28	0	30.2302	3.39524	1.1812	-0.1503	2.3914	21.622	10.944	75	30.2302
Car	38	29	0	28.2282	3.0278	1.0778	0.0448	2.5397	20.32	13.514	72	28.2282
Car	38	70	0	22.1555	0.952993	0.787	-0.3798	2.2062	19.52	19.52	76	22.1555
Car	38	1	0	26.8602	2.48832	0.8805	-0.4538	2.1389	20.287	20.287	79	26.8602
Medium Vehicle	38	95	1.96863	32.9996	11.8922	-0.0102	0.6411	3.852	9.076	9.076	58	31.031
Car	38	104	3.3033	13.013	29.3364	-0.2111	0.9428	5.035	0	0	69	9.7097
Car	38	112	5.67233	34.9349	12.6672	-0.0379	0.6024	4.0774	6.64	6.64	65	29.2626
Car	38	43	7.47413	7.6076	1.01182	-3.1145	0.9769	3.2698	0	0	70	0.13347
Car	38	144	13.7137	23.657	28.5064	-1.686	0.108	3.5082	0	0	71	9.9433
Car	38	176	26.5932	37.6376	33.2002	-0.4349	1.5715	3.7079	0	0	76	11.0444
Car	38	43	27.0604	28.5952	11.3466	4.6324	1.9398	5.0339	0	0	70	1.5348

Figure 4-8 Traffic Regional Data

4.2.3.1 Roundabout

For all 18 roundabouts, traffic counts at a 15-minute period were summarized in Table 4-2. Each row represents a specific movement from the entry to the exit approach, along with the ICD for each roundabout.

Table 4-2 Traffic Counts Collected at 18 Roundabouts

Roundabout	Enter Approach	Exit Approach	Traffic Count (veh/15 min)	ICD (ft)
Circular (33.3451, 86.5880)	- Parkmont Way NB	Chelsea Park Dr WB	9	115
	- Chelsea Park Dr WB	Parkmont Way NB	8	
	- Chelsea Park Dr WB	Chelsea Park Dr EB	62	
	- Chelsea Park Dr EB	Chelsea Park Dr WB	59	
Circular (34.7289, 86.7680)	- Gillespie Rd EB	Balch Rd SB	26	132
	- Gillespie Rd EB	Balch Rd NB	48	
	- Gillespie Rd EB	Gillespie Rd WB	59	
	- Balch Rd SB	Gillespie Rd EB	29	
	- Balch Rd SB	Balch Rd NB	55	
	- Balch Rd SB	Gillespie Rd WB	3	
	- Balch Rd NB	Gillespie Rd EB	36	
	- Balch Rd NB	Balch Rd SB	48	
	- Balch Rd NB	Gillespie Rd WB	9	
	- Gillespie Rd WB	Gillespie Rd EB	48	
	- Gillespie Rd WB	Balch Rd SB	3	
	- Gillespie Rd WB	Balch Rd NB	30	
Circular (30.5309, 87.8695)	- Hayfer Rd NB	Oberg Rd WB	5	164
	- Hayfer Rd NB	Oberg Rd EB	6	
	- Oberg Rd WB	Hayfer Rd NB	7	
	- Oberg Rd WB	Oberg Rd EB	27	
	- Oberg Rd EB	Hayfer Rd NB	10	
	- Oberg Rd EB	Oberg Rd WB	31	
Circular (32.6743, 85.3341)	- Anderson Rd SB	SportsPlex Pkwy EB	50	142
	- Anderson Rd SB	Anderson Rd NB	15	
	- SportsPlex Pkwy EB	Anderson Rd SB	43	
	- SportsPlex Pkwy EB	Anderson Rd NB	9	
	- SportsPlex Pkwy EB	SportsPlex Pkwy WB	6	
	- Anderson Rd NB	Anderson Rd SB	12	
	- Anderson Rd NB	SportsPlex Pkwy EB	4	
	- Anderson Rd NB	SportsPlex Pkwy WB	1	
	- SportsPlex Pkwy WB	SportsPlex Pkwy EB	8	
	- SportsPlex Pkwy WB	Anderson Rd NB	1	
Circular	Grants Mill Rd WB	Grants Mill Rd EB	21	176

(33.5354, 86.6735)	-	Grants Mill Rd WB	Karl Daly Rd	2	
		Grants Mill Rd WB	Grants Mill Rd EB	19	
		Grants Mill Rd WB	Old Leeds RD NB	26	
		Grants Mill Rd EB	Grants Mill Rd WB	12	
		Grants Mill Rd EB	Old Leeds RD SB	4	
		Grants Mill Rd EB	Grants Mill Rd EB	3	
		Grants Mill Rd EB	Old Leeds RD NB	41	
		Karl Daly Rd	Grants Mill Rd WB	5	
		Karl Daly Rd	Old Leeds RD NB	5	
		Grants Mill Rd EB	Grants Mill Rd WB	22	
		Grants Mill Rd EB	Grants Mill Rd EB	6	
		Grants Mill Rd EB	Karl Daly Rd	1	
		Grants Mill Rd EB	Old Leeds RD NB	15	
		Old Leeds RD NB	Grants Mill Rd WB	26	
		Old Leeds RD NB	Grants Mill Rd EB	87	
		Old Leeds RD NB	Karl Daly Rd	3	
		Old Leeds RD NB	Grants Mill Rd EB	19	
Circular (32.6659, 85.4900)	-	Lee County Rd 72	N College St NB	7	105
		Lee County Rd 72	W Farmville Rd	30	
		N College St NB	Lee County Rd 72	24	
		N College St NB	N College St SB	35	
		N College St NB	W Farmville Rd	10	
		N College St SB	N College St NB	51	
		N College St SB	W Farmville Rd	2	
		W Farmville Rd	Lee County Rd 72	28	
		W Farmville Rd	N College St SB	2	
Circular (33.9838, 86.5877)	-	AL-160 EB	AL-79 NB	8	170
		AL-160 EB	AL-160 WB	32	
		AL-160 EB	AL-79 SB	21	
		AL-79 NB	AL-160 EB	2	
		AL-79 NB	AL-160 WB	20	
		AL-79 NB	AL-79 SB	29	
		AL-160 WB	AL-160 EB	35	
		AL-160 WB	AL-79 NB	14	
		AL-160 WB	AL-79 SB	10	
		AL-79 SB	AL-160 EB	20	
		AL-79 SB	AL-79 NB	33	

		AL-79 SB	AL-160 WB	4	
Circular (32.6110, 85.3918)	-	Gateway Dr WB	Lee County Rd 54 NB	5	123
		Gateway Dr WB	Gateway Dr EB	75	
		Gateway Dr WB	Society Hill Rd SB	3	
		Lee County Rd 54 NB	Gateway Dr WB	9	
		Lee County Rd 54 NB	Gateway Dr EB	13	
		Lee County Rd 54 NB	Society Hill Rd SB	8	
		Gateway Dr EB	Gateway Dr WB	138	
		Gateway Dr EB	Lee County Rd 54 NB	29	
		Gateway Dr EB	Society Hill Rd SB	22	
		Society Hill Rd SB	Gateway Dr WB	5	
		Society Hill Rd SB	Lee County Rd 54 NB	18	
		Society Hill Rd SB	Gateway Dr EB	22	
Circular (32.5071, 86.1286)	-	Dozier Rd	Redland Rd NB	5	120
		Dozier Rd	Firetower Rd	7	
		Dozier Rd	Redland Rd SB	2	
		Redland Rd NB	Firetower Rd	25	
		Redland Rd NB	Redland Rd SB	16	
		Firetower Rd	Dozier Rd	11	
		Firetower Rd	Redland Rd NB	18	
		Firetower Rd	Redland Rd SB	8	
		Redland Rd SB	Dozier Rd	4	
		Redland Rd SB	Redland Rd NB	47	
		Redland Rd SB	Firetower Rd	10	
Circular (33.3637, 87.0078)	-	Academy Ln EB	Academy Way SB	2	139
		Academy Way SB	Academy Way NB	4	
		Academy Ln WB	Academy Way SB	2	
		Academy Way NB	Academy Way SB	3	
Circular (32.6158, 85.4072)	-	Enterprise Dr	Interstate Dr EB	6	132
		Enterprise Dr	Hamilton Rd	44	
		Enterprise Dr	Interstate Dr WB	80	
		Interstate Dr EB	Enterprise Dr	5	
		Interstate Dr EB	Hamilton Rd	17	
		Interstate Dr EB	Interstate Dr WB	52	
		Hamilton Rd	Enterprise Dr	34	
		Hamilton Rd	Interstate Dr EB	5	
		Hamilton Rd	Interstate Dr WB	48	

		Interstate Dr WB	Enterprise Dr	47	
		Interstate Dr WB	Interstate Dr EB	13	
		Interstate Dr WB	Hamilton Rd	46	
Circular (32.5387, 86.2035)	-	Company St WB	Online St	28	85
		Company St EB	Company St WB	17	
		Company St EB	Online St	14	
Circular (32.5699, 85.5335)	-	Soccer Field	Lee Rd SB	31	128
		Soccer Field	Lee Rd NB	5	
		Lee Rd SB	Soccer Field	93	
		Lee Rd SB	Lee Rd NB	84	
		Lee Rd NB	Soccer Field	4	
		Lee Rd NB	Lee Rd SB	42	
Egg (32.5776, 85.5244)	-	Lee Rd NB	Cox Rd	23	114
		Lee Rd NB	Lee Rd SB	18	
		Cox Rd	Lee Rd SB	69	
		Cox Rd	Lee Rd NB	30	
		Lee Rd SB	Cox Rd	70	
		Lee Rd SB	Lee Rd SB	4	
		Lee Rd SB	Lee Rd NB	48	
Peanut (31.6773, 85.9573)	-	Elba Hwy SB	Carsen Waters RD WB	2	140
		Elba Hwy SB	AL-167	85	
		Elba Hwy SB	Elba Hwy NB	71	
		Carsen Waters RD WB	Elba Hwy SB	13	
		Carsen Waters RD WB	Elba Hwy NB	3	
		AL-167	Carsen Waters RD EB	86	
		AL-167	Carsen Waters RD WB	4	
		Elba Hwy NB	Elba Hwy SB	41	
		Elba Hwy NB	Carsen Waters RD WB	6	
Peanut (32.9435, 85.9536)	-	Lee St	Church St	6	158
		Gate EB entry	Main St	52	
		Church St	Lee St	2	
		Church St	Main St	15	
		Main St	Lee St	30	
		Main St	Church St	27	
		Main St	Tallapoosa St	8	
Turbo		Lowdown Rd NB	4th Ave SW WB	1	250
		Lowdown Rd NB	4th Ave SW EB	18	

(33.2963, 87.0603)	-	4th Ave SW EB	Lowdown Rd NB	7	
		4th Ave SW EB	Lowdown Rd SB	4	
		4th Ave SW EB	4th Ave SW WB	96	
		4th Ave SW EB	J.M. Smucker Entrance	1	
		4th Ave SW WB	4th Ave SW EB	63	
		4th Ave SW WB	Lowdown Rd SB	10	
		4th Ave SW WB	Lowdown Rd NB	5	
Elliptical (33.1733, 86.7790)	-	Shelby W Pkwy SB	Shelby W Pkwy NB	7	163
		Shelby W Pkwy SB	Co Rd 87	5	
		Shelby W Pkwy NB	Shelby W Pkwy SB	9	
		Co Rd 87	Shelby W Pkwy NB	42	
		Co Rd 87	Shelby W Pkwy SB	3	

4.2.3.2 DDI

For the study DDI at I-10 and AL-181, traffic volumes and vehicle compositions were summarized for AM (Table 4-3), Noon (Table 4-4), and PM peak hours (Table 4-5).

Table 4-3 AM Peak Hour Traffic Volumes at the Study DDI

Direction	Discription	Volume Passenger Cars (v/h)	Volume Heavy Vehicles (v/h)	Sum (v/h)	Passenger Cars (%)	Heavy Vehicles (%)
1	Merging to Southbound South	260	28	288	90.3%	9.7%
2	Merging to Northbound South	152	8	160	95.0%	5.0%
3	Diverging from Northbound- North	884	24	908	97.4%	2.6%
4	Diverging from Southbound- North	424	4	428	99.1%	0.9%
5	Southbound	1,104	36	1,140	96.8%	3.2%
6	Merging to Northbound North	136	0	136	100.0%	0.0%
7	Merging to Southbound North	132	16	148	89.2%	10.8%

8	Diverging from Southbound-South	144	16	160	90.0%	10.0%
9	Diverging from Northbound-South	204	0	204	100.0%	0.0%
10	Northbound	1,692	56	1,748	96.8%	3.2%
Sum-Intersection		5,132	188		96.5%	3.5%

Table 4-4 Noon Peak Hour Traffic Volumes at the Study DDI

Direction	Discription	Volume Passenger Cars (v/h)	Volume Heavy Vehicles (v/h)	Sum (v/h)	Passenger Cars %	Heavy Vehicles %
1	Merging to Southbound South	360	16	376	95.7%	4.3%
2	Merging to Northbound South	296	16	312	94.9%	5.1%
3	Diverging from Northbound- North	260	24	284	91.5%	8.5%
4	Diverging from Southbound- North	284	12	296	95.9%	4.1%
5	Southbound	1,368	48	1,416	96.6%	3.4%
6	Merging to Northbound North	216	24	240	90.0%	10.0%
7	Merging to Southbound North	152	12	164	92.7%	7.3%
8	Diverging from Southbound- South	180	12	192	93.8%	6.3%
9	Diverging from Northbound- South	184	12	196	93.9%	6.1%
10	Northbound	1,364	96	1,460	93.4%	6.6%
Sum-Intersection		4,664	272	4,936	94.5%	5.5%

Table 4-5 PM Peak Hour Traffic Volumes at the Study DDI

Direction	Discription	Volume Passenger Cars (v/h)	Volume Heavy Vehicles (v/h)	Sum (v/h)	Passenger Cars (%)	Heavy Vehicles (%)
1	Merging to Southbound South	292	12	304	96.1%	3.9%

2	Merging to Northbound South	288	12	300	96.0%	4.0%
3	Diverging from Northbound- North	260	8	268	97.0%	3.0%
4	Diverging from Southbound- North	336	12	348	96.6%	3.4%
5	Southbound	1,536	64	1,600	96.0%	4.0%
6	Merging to Northbound North	180	8	188	95.7%	4.3%
7	Merging to Southbound North	144	4	148	97.3%	2.7%
8	Diverging from Southbound- South	176	8	184	95.7%	4.3%
9	Diverging from Northbound- South	120	4	124	96.8%	3.2%
10	Northbound	1,532	60	1,592	96.2%	3.8%
Sum-Intersection		4,864	192	5,056	96.2%	3.8%

4.2.3.3 RCUT

For the RCUT at Highway 72 and Dug Hill Road in Brownsboro, Alabama, traffic volumes and vehicle compositions were extracted from the drone videos. Figure 4-9 presents the gate layout used for RCUT analysis, including entry, exit, and neutral gates, defined to extract traffic volumes, movement-specific trajectories, and gap-acceptance measures.



Figure 4-9 RCUT Gate Distribution

Table 4-6 summarizes traffic counts, average speed, 85th percentile speed, and heavy vehicle percentage for the gate-to-gate segments defined in Figure 4-9.

Table 4-6 Traffic Counts and Speed Data at the Study RCUT

Entry Gate	Exit Gate	Total Count (Veh/15 min)	Avg Speed (mph)	85 th Percentile Speed (mph)	Heavy Vehicles (%)
Gate 23	Gate 24	333	65.5	70.98	2.7%
Gate 22	Gate 26	262	67.05	72.05	1.1%
Gate 22	Gate 20	21	68.05	76.44	4.8%
Gate 19	Gate 26	22	22.72	28.06	0.0%
Gate 23	Gate 25	13	23.14	25.63	0.0%
Gate 19	Gate 24	6	22.02	31.28	0.0%
Gate 19	Gate 27	4	21.49	24.58	0.0%

4.2.3.4 Work Zone Merging Area



Figure 4-10 Study Work Zone Location

To simulate the study work zone along I-20 in Lincoln, Alabama, the free-flow demand volume must be determined as VISSIM input. In this study, the westbound (work zone direction) free-flow volume was estimated based on the eastbound non-congested flow rates and directional distribution factors (D-factors) obtained from the ALDOT website. Based on the 2021–2024 D-factors, the westbound directional share for 2025 was assumed to be 54%, indicating a higher westbound demand. Using the observed eastbound free-flow volume of approximately 2,332 v/h, the estimated westbound free-flow demand for the VISSIM model was calculated to be 2,850 v/h. At this work zone, the truck percentage is about 25% during the data collection period.

4.2.3.5 Freeway Diverging Area

This section focuses on simulating traffic operations in the diverging area before vehicles enter the off-ramp. One-hour diverging traffic counts were collected at I-85 westbound (WB)/Exit 51, as

shown in Figure 4-11. Traffic volumes and vehicle classifications were obtained using the DataFromSky platform. The observed hourly flow rate at the study location was approximately 1,947 veh/h, with the corresponding vehicle type composition shown in Table 4-7.



Figure 4-11 Diverging Traffic Counts at the Study Site of I-85 WB Exit 51

Table 4-7 I-85 SB/Exit 51 Traffic Composition

Vehicle Type	Passenger Car (v/h)	Truck (v/h)
Diverge	703	8
Through	952	284

4.3 Summary

This chapter described the data-processing procedures used to convert drone video into traffic datasets for roundabouts, DDI, RCUTs, and freeway merge/diverge areas. All drone footage was processed using the DataFromSky platform, which performed video preprocessing, geo-registration, lane and gate configuration, and automated vehicle tracking.

The extracted data includes traffic volumes, speed distributions, turning movements, headways, gap-acceptance measures, and vehicle composition. Python-based scripts were developed to clean and restructure the output database to support the development and calibration of the traffic simulation model.

5. DEVELOP CALIBRATION AND VALIDATION GUIDELINES

This chapter presents comprehensive calibration and validation guidelines for microscopic traffic simulation models applied to alternative intersections and freeway merge/diverge areas in Alabama. It describes data-driven procedures, drawing on drone-based trajectory data, NDS data, and probe-speed information. The chapter identifies the most influential behavioral and operational parameters, such as speed distributions, gap acceptance, car-following behavior, lane-changing patterns, and acceleration–deceleration functions, and demonstrates how these were adjusted and validated against field observations. Guidelines are developed to calibrate and validate VISSIM simulation models to support planning, design, and operational analysis.

5.1 Roundabout Calibration Guideline

Calibration of the roundabout microsimulation model is based on vehicle trajectory data extracted from drone footage using DataFromSky. The process focuses on three key parameter groups that strongly influence operational realism: speed distributions for approaching, circulating, and exiting vehicles; priority-rule settings governing gap acceptance via minimum gap time and minimum clearance; and car-following behavior represented by the Wiedemann 74 model parameters (W74ax, W74bxAdd, and W74bxMult). After these elements are configured, simulated travel times are compared with field-measured values; closer agreement indicates improved replication of real-world driving behavior. Guided by sensitivity testing and prior research, this approach identifies the most influential parameters needed to accurately represent roundabout operations and driver behavior.

5.1.1 Speed Distributions

Prior studies indicate that roundabout operations can be characterized by three functional speed zones—approach, circulating, and exit areas—which were explicitly modeled in VISSIM using desired speed decisions placed at each entry, within the circulatory roadway, and along exit approaches. Approach and exit speed distributions were assigned at the beginning of each link based on posted speed limits, while a separate desired speed decision inside the circle captured circulating behavior before speeds were restored downstream. A short reduced-speed area (approximately 5–10 ft) was applied near entries to achieve realistic entry speeds, and upstream approach speeds were measured for comparison with regulatory posted speed limits. Analysis of field data (Table 5-1) showed that speeds on approach and exit links generally aligned with posted limits, with 95% confidence intervals (CI) clustered around the speed limit, indicating that VISSIM’s default speed distributions tied to posted limits can reliably represent entry and exit speeds for Alabama roundabouts.

Table 5-1 Observed Approaching and Exit Speed Ranges

Speed Limit (mph)	95% CI speed range (mph)	Deviation from the speed limit
25	22.33–23.40	–10.68% – –6.40%
35	30.73–33.29	–12.20% – –4.89%
40	39.42–42.33	–1.45% – 5.83%
45	44.31–47.33	–1.53% – 5.18%

For circulating speeds, the posted speed limit alone was found insufficient to represent driver behavior, as roundabout geometry imposes additional speed constraints. Table 5-2 shows the speed analysis relative to the ICD reveals that geometric features significantly impact operating speed. For posted speed limit of 15 mph, the smallest roundabout (ICD = 85 feet) had the lowest circulating speed (11.55-18.82 mph), indicating strong speed control by the ICD. For similar ICDs (115-120 feet), the site with a larger posted speed limit (25 mph) has significantly higher speed than those with lower speed limit of 15 mph. The largest roundabouts (ICD $\geq$ 160 feet) with the posted speed limit of 25 mph exhibit the most significant speed deviations, with upper speed limits typically 30-40% above the posted speed limit on approach road.

Table 5-2 Observed Circular Speed Ranges

Roundabout	Speed Limit (mph)	95% Confidence Speed Interval (mph)	Deviation from the Speed Limit	ICD (ft)
Circular (33.3451, -86.588)	25	21.71-27.3	-13.16%–9.2%	115
Circular (34.7289, -86.768)	20	16.27-21.39	-18.65%–6.95%	132
Circular (30.5309, -87.8695)	20	15.63-23.57	-21.85%–17.85%	164
Circular (32.6743, -85.3341)	15	14.95-16.45	-0.33%–9.67%	142
Circular (33.5354, -86.6735)	15	13.65-18.34	-9.0%–22.27%	176
Circular (32.6659, -85.49)	15	12.83-19.56	-14.47%–30.4%	105
Circular (33.9838, -86.5877)	25	18.68-33.24	-25.28%–32.96%	170
Circular (32.611, -85.3918)	15	16.34-19.81	8.93%–32.07%	123
Circular (32.5071, -86.1286)	15	16.37-21.16	9.13%–41.07%	120
Circular (33.3637, -87.0077)	15	14.41-20.43	-3.93%–36.2%	139
Circular (32.6158, -85.4072)	15	16.34-21.8	8.93%–45.33%	132
Circular	15	11.55-18.82	-23.0%–25.47%	85

(32.5387, -86.2035)				
Circular (32.5699, -85.5336)	15	16.86-19.05	12.4%–27.0%	128
Egg (32.5777, -85.5244)	15	16.88-23.79	12.53%–58.6%	114
Peanut (31.6773, -85.9573)	25	23.98-33.71	-4.08%–34.84%	140
Peanut (32.9436, -85.9536)	15	14.27-17.99	-4.87%–19.93%	158
Turbo (33.2964, -87.0604)	25	18.33-33.07	-26.68%–32.28%	250
Elliptical (33.1733, -86.779)	25	25.2-36.17	0.8%–44.68%	163

The influence of geometric design becomes even more pronounced for non-circular roundabouts. Despite having comparable posted speed limits (15-25 mph), these configurations consistently exhibited larger deviations in operating speeds, with upper values often 30% to 60% above the regulatory limit. The irregular curvature and varying deflection angles associated with non-circular layouts appear to provide drivers with greater opportunities to maintain higher speeds, particularly in egg- and elliptical-shaped roundabouts, which demonstrated the most substantial speeding behavior.

Overall, the findings demonstrate that both speed limit and roundabout size/shape play critical roles in controlling vehicle speeds. As roundabouts become larger or depart from a traditional circular configuration, operating speeds increasingly deviate from regulatory posted speed limits. These results highlight that the geometric features function as an implicit speed-control mechanism. When curvature and deflection are reduced or become more irregular, the effectiveness of speed-limit signage in shaping actual driving behavior correspondingly weakens.

Based on these findings, roundabout size and geometric configuration should be treated as primary inputs when simulating operating speeds during the planning and design stages. For smaller roundabouts with an ICD less than 120 ft, posted speed limits alone are generally sufficient to reproduce realistic circulating speeds. For a non-circular roundabout, due to its irregular shape, multiple reduced-speed areas should be set up at links with larger turning radii. For larger roundabouts (ICD>120 ft), additional calibration is required. The desired speed range should be expanded to better reflect observed driver behavior, with the lower and upper limits defined below.

For the lower limit,

$$\text{Desired speed lower} \approx 0.90 \times \text{Speed limit}$$

For the upper limit,

$$\text{Desired speed upper} \approx 1.40 \times \text{Speed limit}$$

To implement these calibrated speed distributions in VISSIM, Figure 5-1 illustrates cumulative speed distribution curves constructed using a linear regression model to summarize the recommended lower and upper bounds, as the observed speeds were not evenly distributed. For locations with a posted speed limit of 15 mph, the default VISSIM circulating speed range of 15–18 mph was found to be overly restrictive; after calibration, an expanded range of 13.5–21 mph produced a substantially better match to observed operating conditions at Alabama roundabouts.

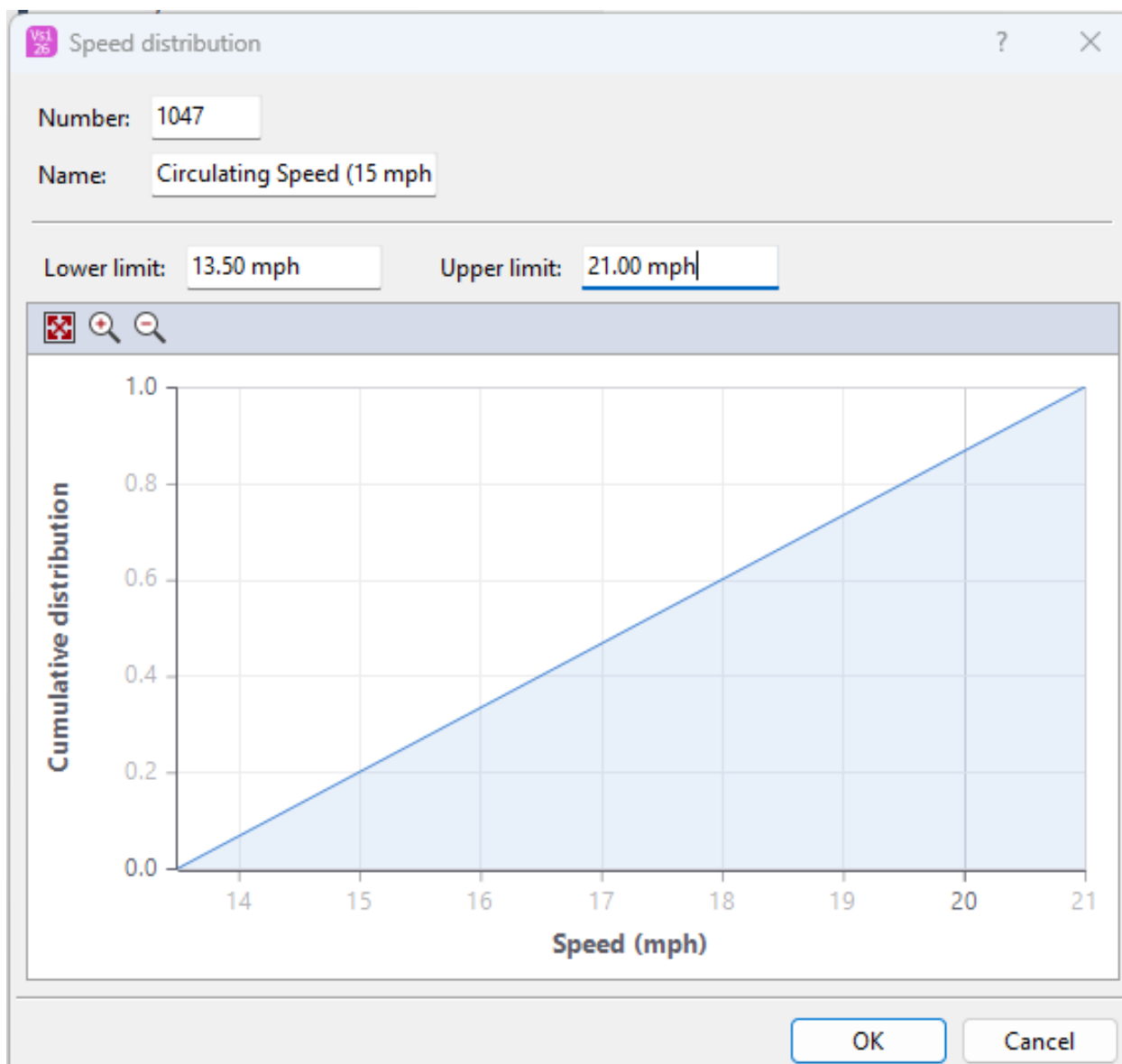


Figure 5-1 Circulating Speed Distribution In VISSIM

5.1.2 Priority Rule

Similar to yield control intersections, entering vehicles must yield to cars already circulating in the roundabout. Drivers need to find a suitable gap to enter the roundabout. VISSIM's Priority Rules simulate gap acceptance behavior using two key parameters: the minimum gap time (the minimum

acceptable time gap in the circulating flow) and the minimum clearance (the minimum separation distance required between successive vehicles).

Minimum clearance describes the minimum upstream distance on the circulatory roadway from the conflict point at which an approaching vehicle can safely enter. In that case, the observed gap is treated as an accepted clearance, and the corresponding distance from the conflict point to the nearest circulating vehicle along the circulatory path is measured and recorded. Figure 5-2 shows that the approach vehicle merges into the traffic circle when the driver accepts the clearance. The smallest such accepted value is defined as the minimum clearance.

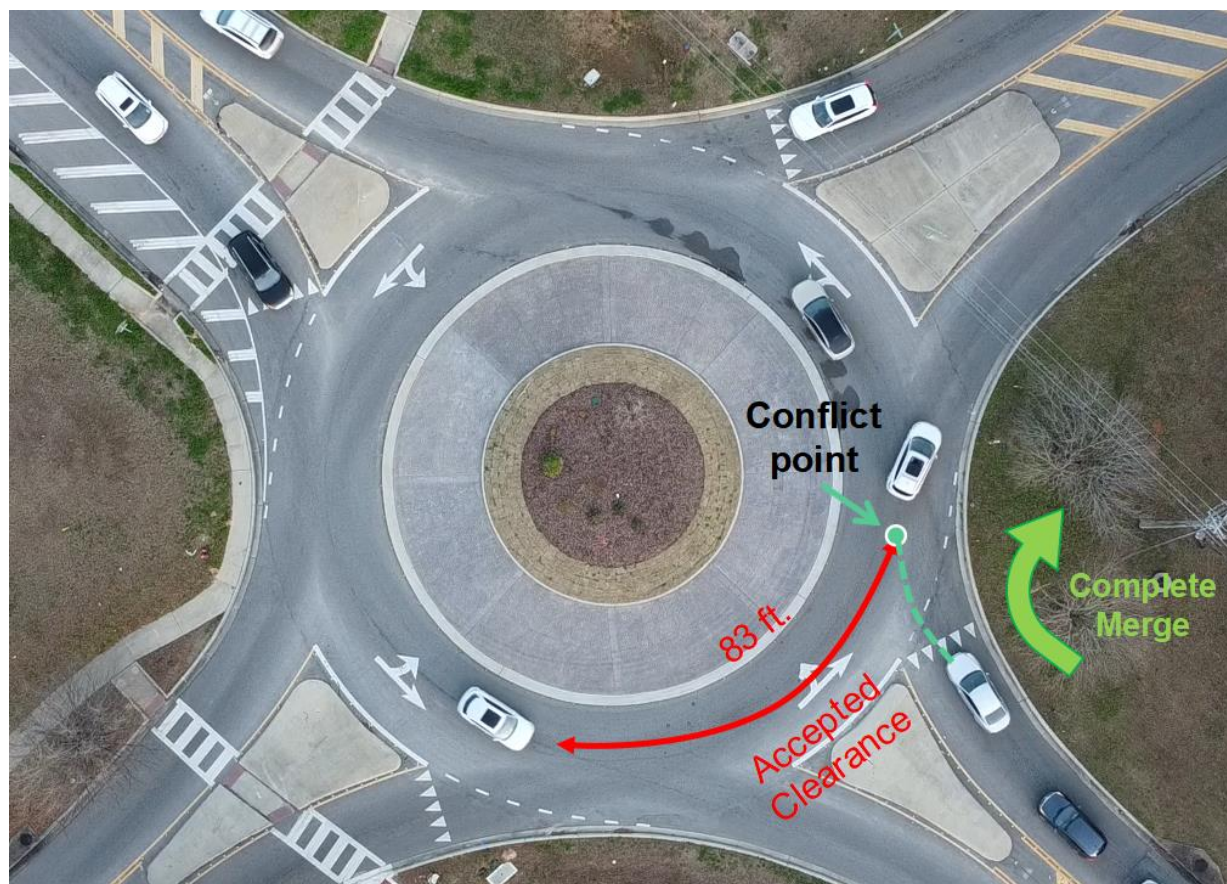


Figure 5-2 Example of Accepted Clearance

Figure 5-3 illustrates the priority rule setup in the VISSIM. First, a yield line is placed at the roundabout entry to define the yielding location for entering vehicles. Next, a conflict marker (green line) is positioned on the circulating roadway to define the conflict point where gap acceptance is evaluated. Finally, the two parameters (minimum gap and clearance) can be changed in the priority rule setting to reflect observed driver behavior.

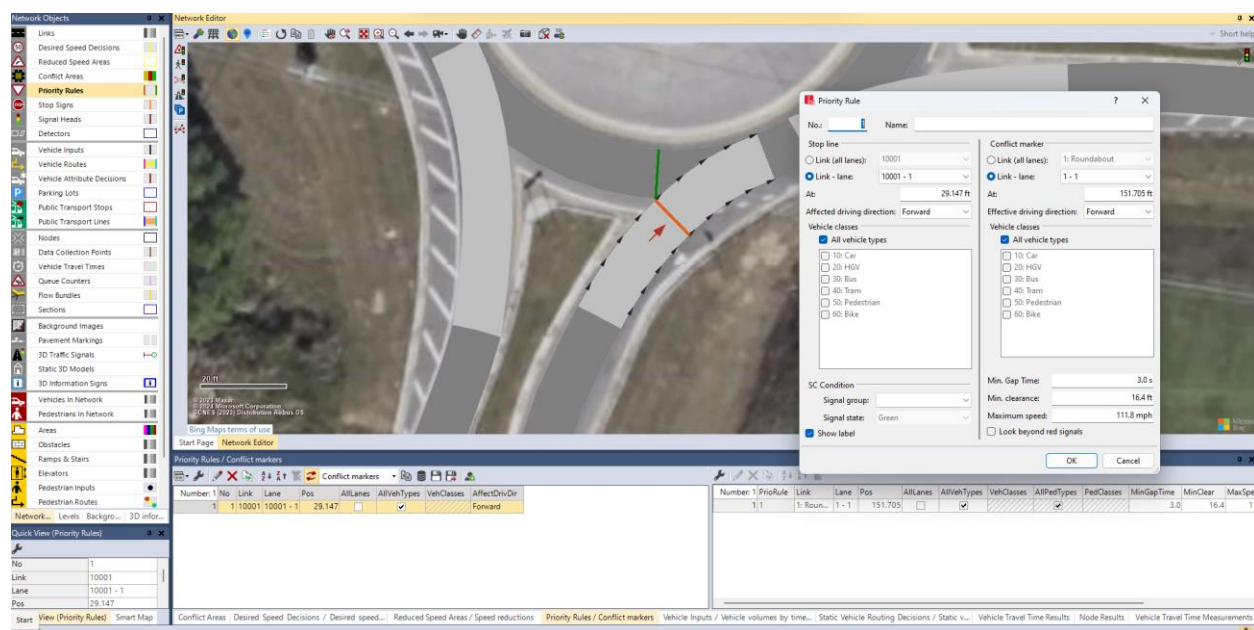


Figure 5-3 Priority Rule Configuration for Yield Control at Roundabout Entry

For most selected roundabouts, not all entry approaches provided sufficient gap-acceptance samples due to low traffic demand. To address this limitation, a subset of higher-volume sites was used to estimate minimum clearance distances and minimum gap acceptance via an iterative refinement process based on drone video extraction.

Table 5-3 presents the estimated minimum gap and clearance values for three circular and five non-circular roundabouts. The minimum gap time at circular roundabouts is approximately 3.0 seconds, consistent with the default VISSIM value, whereas non-circular roundabouts generally exhibit higher gap times, around 4.0 seconds. The results reveal considerable variability within and across roundabouts. Notably, the three-approach circular roundabout exhibits distinct behavior compared to others, while some elongated designs, such as peanut and elliptical roundabouts, also show unique characteristics. To enhance simulation accuracy, the study found that minimum clearance is closely related to the distance between the entering vehicle and the upstream entry approach. A larger ICD generally corresponds to a larger minimum clearance, suggesting a positive correlation. However, minimum clearance also depends on approach-specific geometry, particularly the spacing between successive approaches; thus, the relationship is not absolute. In general, larger roundabouts tend to warrant larger clearance settings to accommodate longer conflict areas and higher operating speeds. Figure 5-4 illustrates an example of setting the minimum clearance at the upstream entry distance using a triangle marker.

Table 5-3 Minimum Gap and Clearance Distances at Selected Roundabouts

Roundabout	Enter Approach	Minimum Gap Time (s)	Minimum Clearance (ft)	ICD (ft)
Egg (32.5776, -85.5244)	Lee Rd NB	4.1 s	80	114
	Cox Rd		86	
	Lee Rd SB		69	
Peanut (31.6773, -85.9573)	Elba Hwy SB	3.8 s	91	/
	Carsen Waters RD WB		88	
	AL-167		82	
	Elba Hwy NB		130	
Peanut (32.9435, -85.9536)	Lee St	3.2 s	79	/
	Gate EB entry		81	
	Church St		78	
	Main St		71	
Turbo (33.2963, -87.0603)	Lowdown Rd NB	4.0 s	147	250
	Lowdown Rd NB		120	
	4th Ave SW EB		154	
	4th Ave SW WB		89	
Elliptical (33.1733, -86.7790)	Shelby W Pkwy SB	3.8 s	81	163
	Shelby W Pkwy NB		68	
	Co Rd 87		86	
	Chelsea Park Dr WB		94	
Circular (32.6659, -85.4900)	Lee County Rd 72	3.1 s	82	105
	N College St NB		76	
	W Farmville Rd		63	
	N College St SB		51	
Circular (33.3451, -86.5880)	Parkmont Way NB	2.8 s	89	115
	Chelsea Park Dr WB		94	
Circular (33.9838, -86.5877)	AL-160 EB	3.2 s	83	170
	AL-79 NB		85	
	AL-160 WB		90	
	AL-79 SB		77	

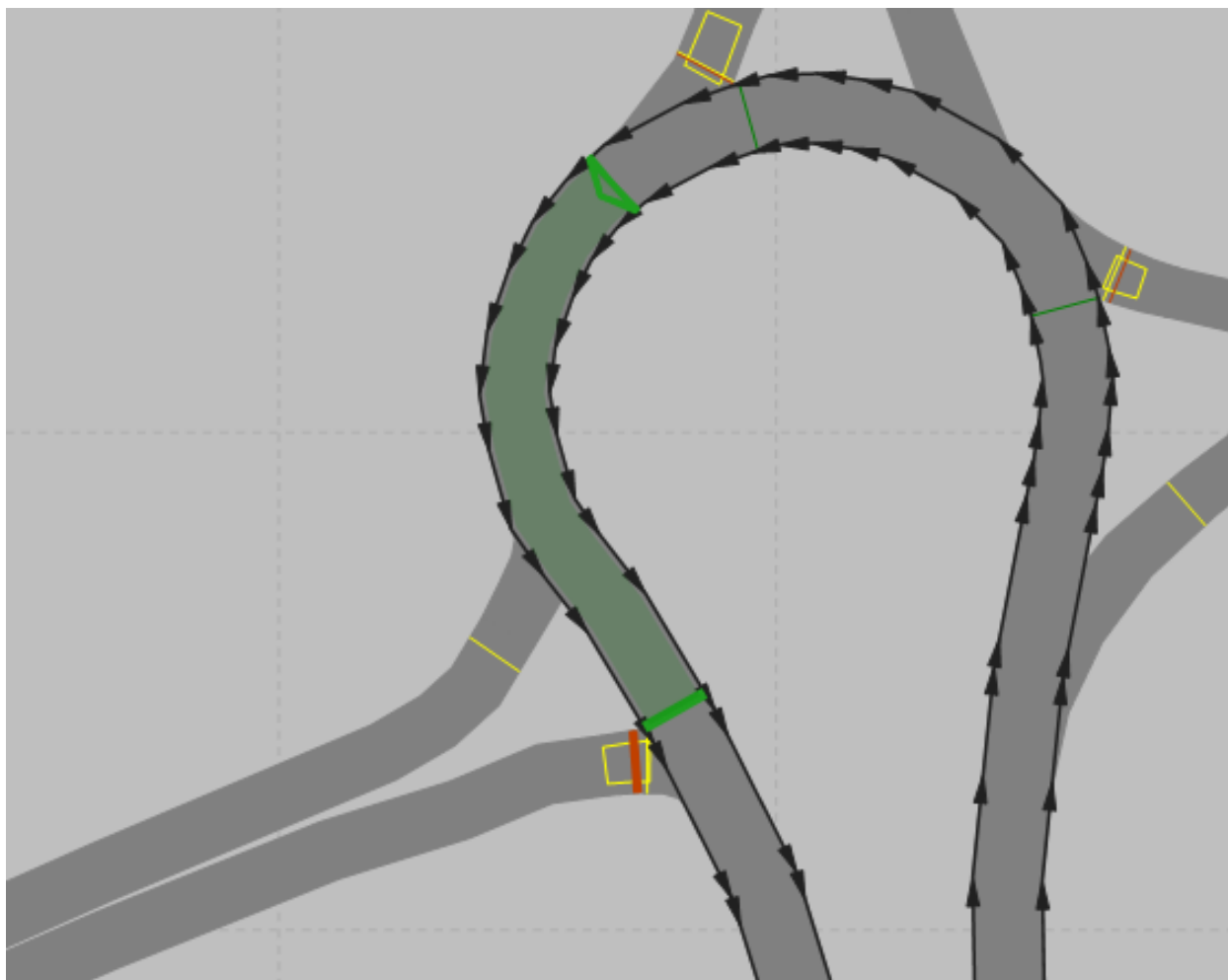


Figure 5-4 Minimum Clearance for Approaches with a Close Upstream Entrance

Based on the extracted data, some roundabouts (e.g., turbo roundabouts) contain multiple conflict areas when building a VISSIM simulation model. In such cases, relying on conflict zones can introduce issues, as overlapping conflict zones create complex interactions that do not accurately reflect real-world roundabout operations. By contrast, the minimum clearance priority approach, rather than the more commonly used conflict-zone method, is better suited for modeling different roundabout types.

For certain roundabout configurations (e.g., three-leg or peanut roundabouts), if an entry is located far from the upstream entry, the minimum clearance should be checked against the distance from the upstream exit (illustrated by the orange line in Figure 5-5). Under this condition, the minimum clearance is approximately 1.2 times the distance to the previous exit.

The proposed equation can be used to set the minimum clearance during calibration of the priority rule for peanut roundabouts with approaches featuring a distant upstream entrance.

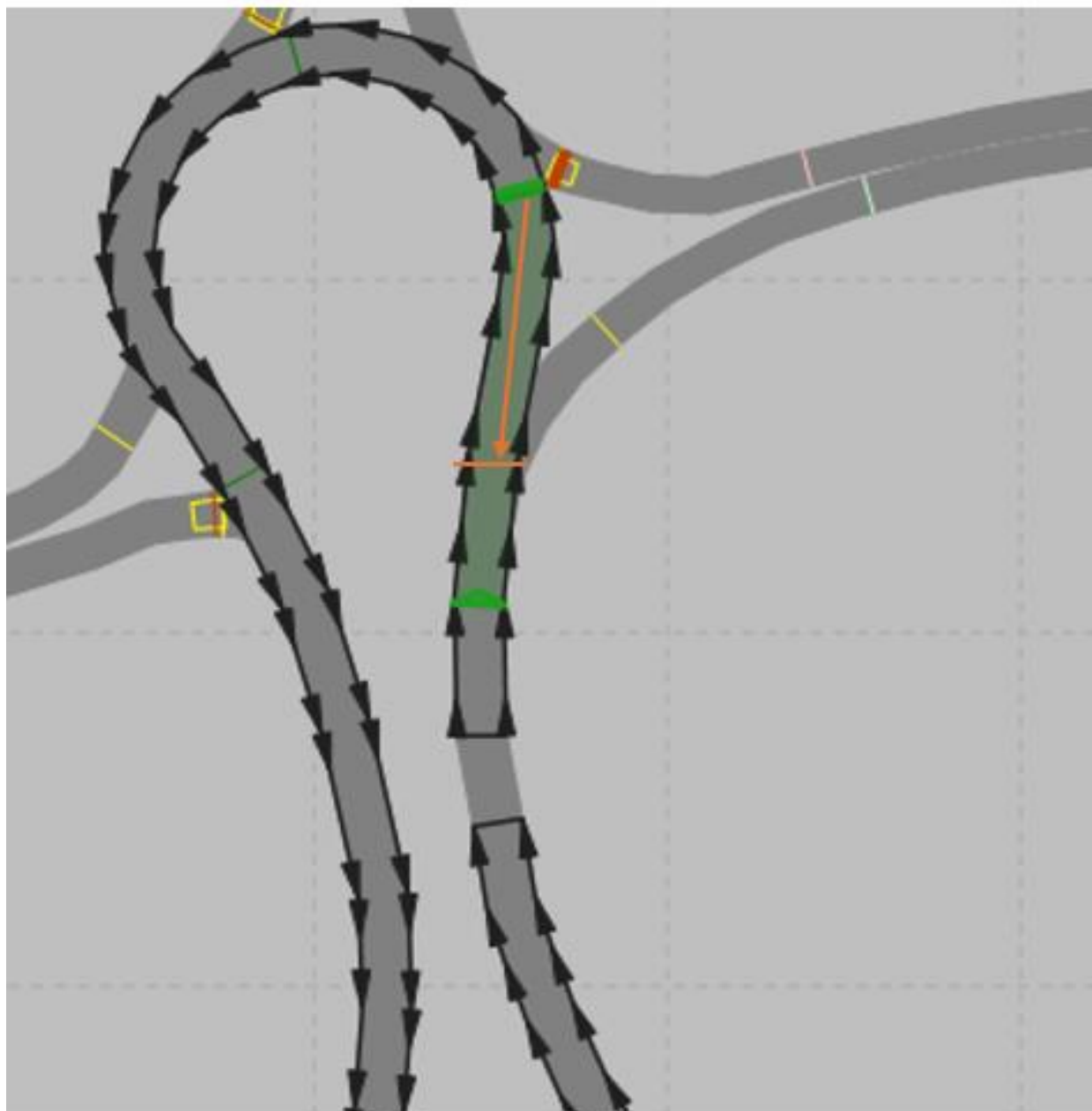


Figure 5-5 Minimum Clearance for Approaches at Peanut Roundabouts

5.1.3 Car-Following Model

VISSIM provides two car-following models: Wiedemann 74, typically used for urban/street traffic, and Wiedemann 99, generally used for freeway traffic. Previous guidance recommends applying Wiedemann 74 for roundabout modeling. Within Wiedemann 74, the spacing between a following vehicle and its leader is governed primarily by: (1) W74ax: the average standstill distance, representing the desired distance between two stopped vehicles, and (2) W74bxAdd: the additive and W74bxMult: multiplicative components of the safety distance, which control the calculation of the desired safety spacing and its scaling with driving conditions.

To calibrate the car-following behavior, five non-circular roundabouts and three circular roundabouts of different sizes were selected. Python scripts and the VISSIM COM interface were used to obtain optimum parameter values. Table 5-4 summarizes the final calibrated car-following parameters for three circular and five non-circular roundabouts, along with the default values for comparison.

Table 5-4 Car-following Model Calibration Results

Roundabout	W74ax (ft)	W74bxAdd (ft)	W74bxMult	ICD (ft)
Circular (32.6659, -85.4900)	6.56	2.00	3.00	105
Circular (33.9838, -86.5877)	6.56	2.00	3.00	170
Circular (33.3451, -86.5880)	6.56	2.00	3.00	115
Egg (32.5776, -85.5244)	5.69	2.04	3.04	114
Peanut (31.6773, -85.9573)	6.15	2.40	3.15	\
Peanut (32.9435, -85.9536)	6.04	2.31	3.07	\
Turbo (33.2963, -87.0603)	5.87	2.12	2.87	250
Elliptical (33.1733, -86.7790)	5.86	2.10	2.85	163
VISSIM Default	6.56	2.00	3.00	\

Overall, the field data are very close to VISSIM's default settings, requiring no adjustments for circular roundabouts. A lower W74ax value of 6.0 ft (compared to the default 6.56 ft) for non-circular roundabouts was recommended.

5.1.4 Model Validation and Comparison

To evaluate calibration effectiveness, the calibrated roundabout model was benchmarked against ground-truth trajectories extracted from DataFromSky. The workflow, illustrated in Figure 5-6, used 80% of the drone-video dataset for calibration. Starting from a base VISSIM model, key parameters were iteratively adjusted until the simulated measures closely matched the field observations and satisfied the predefined statistical criteria. The quality of calibration is typically evaluated using statistical measures, such as the GEH statistics. The GEH statistics are a widely

used goodness-of-fit measure in traffic engineering for comparing simulated and observed traffic volumes, which is defined as:

$$GEH = \sqrt{\frac{(E-V)^2}{(E+V)/2}}$$

Where,

- E is the simulated volume and
- V is the observed volume.

In practice, a GEH value below 5.0 is generally considered acceptable for hourly traffic volumes. After completing the calibration of all selected roundabouts, since each roundabout has multiple traffic flows and each movement has its own GEH value, to better present the results for each roundabout, the total traffic volume entering and exiting the roundabout will be used as the evaluation metric.

Root Mean Squared Normalized Error (RMSNE) measures the percentage deviation of the simulated travel time from observed data and is defined below.

$$RMSNE = \sqrt{\frac{1}{N} \sum_{i=1}^N \left(\frac{V-E}{E} \right)^2}$$

where:

- E is the simulated travel time
- V is the actual travel time
- N is the number of observations

Lower RMSNE values indicate better model performance, but they should be interpreted relative to the data's scale. Travel time was selected as the primary measure of effectiveness (MOE) for the roundabout calibration and validation because of the characteristics of the field data. Since overall delays at the roundabouts studied were relatively low, the level of service (LOS) showed little variation and therefore did not provide a sufficiently sensitive basis for performance comparison. During validation, if any criterion is not satisfied, the calibration parameters are adjusted, and the comparison between simulated and observed results is repeated. Once the calibration converges, the resulting parameter set is fixed and applied to the remaining 20% of the drone video data for validation. The same performance metrics and acceptance thresholds are evaluated during this stage. When the validation results also meet all criteria, the final calibrated parameters are documented as the recommended settings for subsequent analyses.

The validation results are presented in Table 5-5, showing a substantial improvement in the goodness-of-fit for travel times at all eight locations following calibration. Most calibrated RMSNE values fall below the 15% threshold. The results also show slight improvements for circular roundabouts when comparing calibrated models with default models. In contrast, non-circular roundabouts exhibited relatively large discrepancies in the default model, and substantial improvements were observed after calibrating the speed distribution, priority rules, and car-

following parameters. The greatest gains were seen for the turbo and peanut-shaped roundabouts, where the default model produced notably higher errors. Only the elliptical roundabout retained RMSNE values above 15%, likely due to the very low traffic flow observed at that site. Across all eight roundabouts, GEH values remained below the acceptable threshold of 5.0, indicating good agreement in traffic volumes.

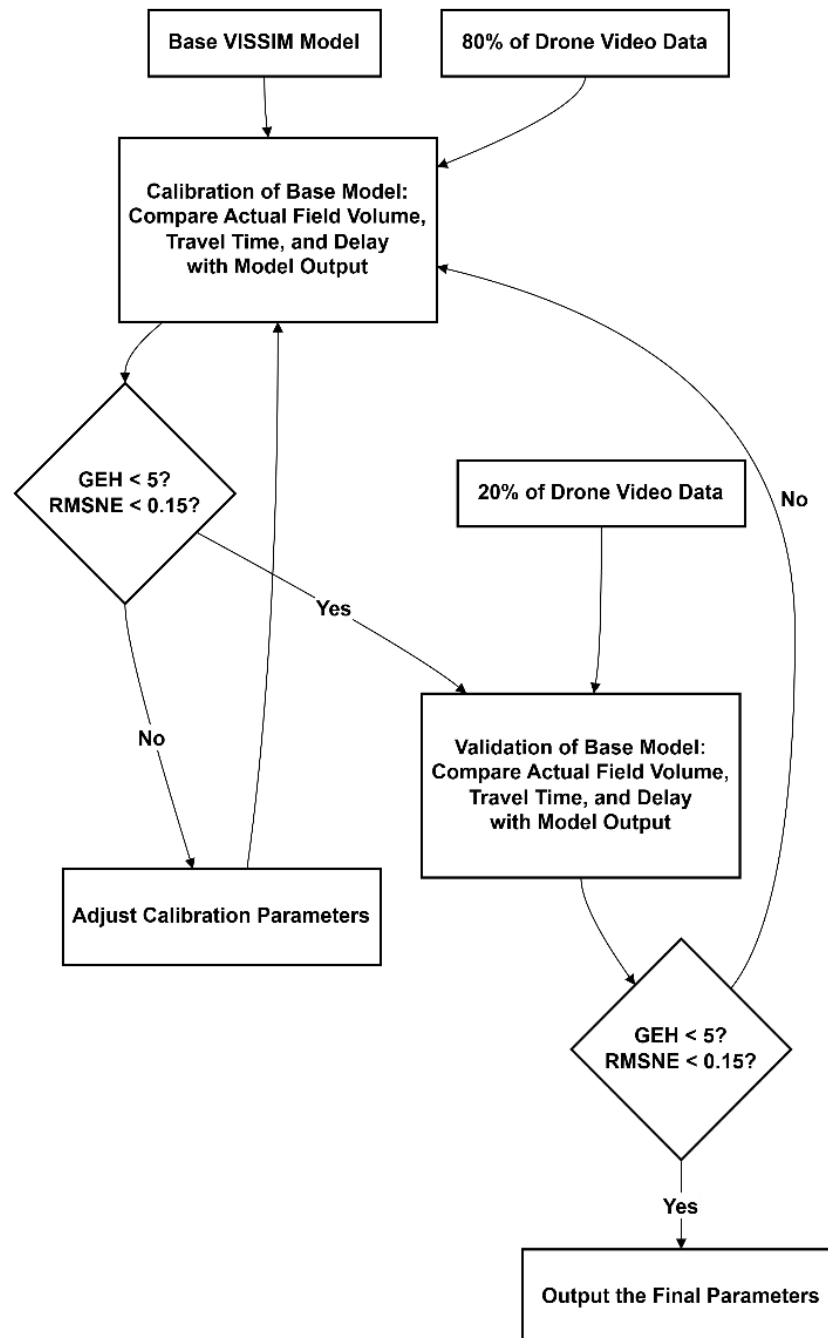


Figure 5-6 Validation Process

Table 5-5 Roundabout Validation Results

Roundabout	Calibrated RMSNE (%)	Default RMSNE (%)	Total GEH
Circular (32.6659, -85.4900)	11.96%	12.11%	1.75
Circular (33.9838, -86.5877)	9.82%	10.23%	1.46
Circular (33.3451, -86.5880)	7.72%	8.22%	1.87
Egg (32.5776, -85.5244)	14.84%	15.16%	1.47
Peanut (31.6773, -85.9573)	14.32%	17.58%	1.31
Peanut (32.9435, -85.9536)	14.24%	20.41%	1.25
Turbo (33.2963, -87.0603)	15.20%	23.80%	2.34
Elliptical (33.1733, -86.7790)	18.56%	20.55%	1.18

5.1.5 Summary of Calibrated Roundabout Parameters

Appendix B summarizes a step-by-step procedure for developing a base simulation model for roundabouts. The final calibrated parameters for the roundabout simulation are summarized in Table 5-6, which presents the recommended VISSIM settings used in this study across three parameter groups.

For the speed distribution, entry and exit links follow the default distributions based on posted speed limits, while circulating speeds are allowed to vary more broadly ($0.90\text{--}1.40 \times$ the posted speed limit) to reflect geometric speed reductions within the roundabout.

For the priority rule, gap-acceptance behavior is calibrated using minimum gap time and minimum clearance. A minimum gap of 4.0 seconds is recommended for non-circular roundabouts, compared with the default value of 3.0 seconds. Minimum clearance is not a fixed parameter; instead, it depends on the approach geometry. For approaches with a close upstream entrance, it is measured along the entering path from the entry yield line to the upstream conflict marker (Figure 5-4). For approaches with a far upstream entrance, such as in the peanut-shaped roundabout, minimum clearance can be approximated as 1.2 times the distance from the upstream exit (Figure 5-5).

For the car-following model (Wiedemann 74), the key parameters (W74ax, W74bxAdd, and W74bxMult) were bounded using ranges derived from field calibration. However, for the Alabama roundabouts examined in this study, these parameters had only a limited influence on overall model performance; therefore, the default values are generally suitable. An adjustment of W74ax to 6.0 is recommended for non-circular roundabouts.

Table 5-6 Roundabout VISSIM Calibrated Parameters in AL

Parameter Grouping	Parameter Name	Default Parameters	Recommended Parameter Range
Speed Distribution	Enter Speed	Speed Limit	Speed Limit (use posted speed-limit default distribution on entry links)
	Circulating Speed	Speed Limit	$0.90 \times \text{Speed limit to } 1.40 \times \text{Speed limit}$ For a roundabout with a large curve, an additional reduced-speed area should be implemented.
	Exit Speed	Speed Limit	Speed Limit (use posted speed-limit default distribution on exit links)
Priority Rule	Minimum gap time (s)	3	3.0 for circular roundabout and 4.0 for non-circular roundabout
	Minimum Clearance (ft)	16.4	For approaches with a close upstream entrance, the minimum clearance should be defined as the distance measured along the entering path from the entry yield line to the upstream conflict marker. (Figure 5-4)
		16.4	For approaches with a far upstream entrance, the minimum clearance should be approximately 1.2 times* the distance to the upstream exit. (Figure 5-5)
Car-following Model	W74ax (ft)	6.56	Circular: Default, Non-Circular: 6.0
	W74bxAdd	2.00	Default
	W74bxMult	3.00	Default

5.2 DDI Calibration Guideline

Calibration of the DDI microsimulation model focused on reproducing observed operating conditions and driver behavior using field-derived data. Based on sensitivity testing and prior research, four key parameters were identified as most critical for accurately representing DDI operations:

1. Speed Distributions: Applied to bridge segments and crossroad segments.
2. Car-Following Behavior: Specifically, the standstill distance (CC0).
3. Lane-Change Behavior: Lane-change distance distribution prior to entering the bridge.
4. Priority Rule: Minimum gap time for the Stop-on-Red (SOR) right-turn control.

5.2.1 Speed Distribution Calibration

Drone-extracted vehicle trajectory data were used to analyze speed distributions. The analyses were conducted separately for the DDI bridge and crossroad segments to capture segment-specific speed characteristics. The posted speed limit at the study site is 35 mph. On-site observations showed that the 85th percentile speed on the crossroad before the intersection was 36.4 mph, while the corresponding value on the bridge was 34.9 mph, demonstrating that vehicle speeds were generally consistent with the posted speed limit (Table 5-7).

Table 5-7 Field Observed Average and 85th Percentile Speeds on Cross Road and Bridge Segments

	Southbound		Northbound		Total	
	Cross Road	Bridge	Cross Road	Bridge	Cross Road	Bridge
Average Speed (mph)	28.5	31.4	31.6	29.7	29.6	30.9
85 th Speed (mph)	34.9	35.2	38.2	34.5	36.4	34.9

However, distributional analysis revealed notable differences between bridge and crossroad speed distributions. While average speeds were similar, the crossroad segment showed greater dispersion than the bridge segment (Figure 5-7). This finding indicates that using one speed distribution would not adequately represent operating speed across the entire DDI.

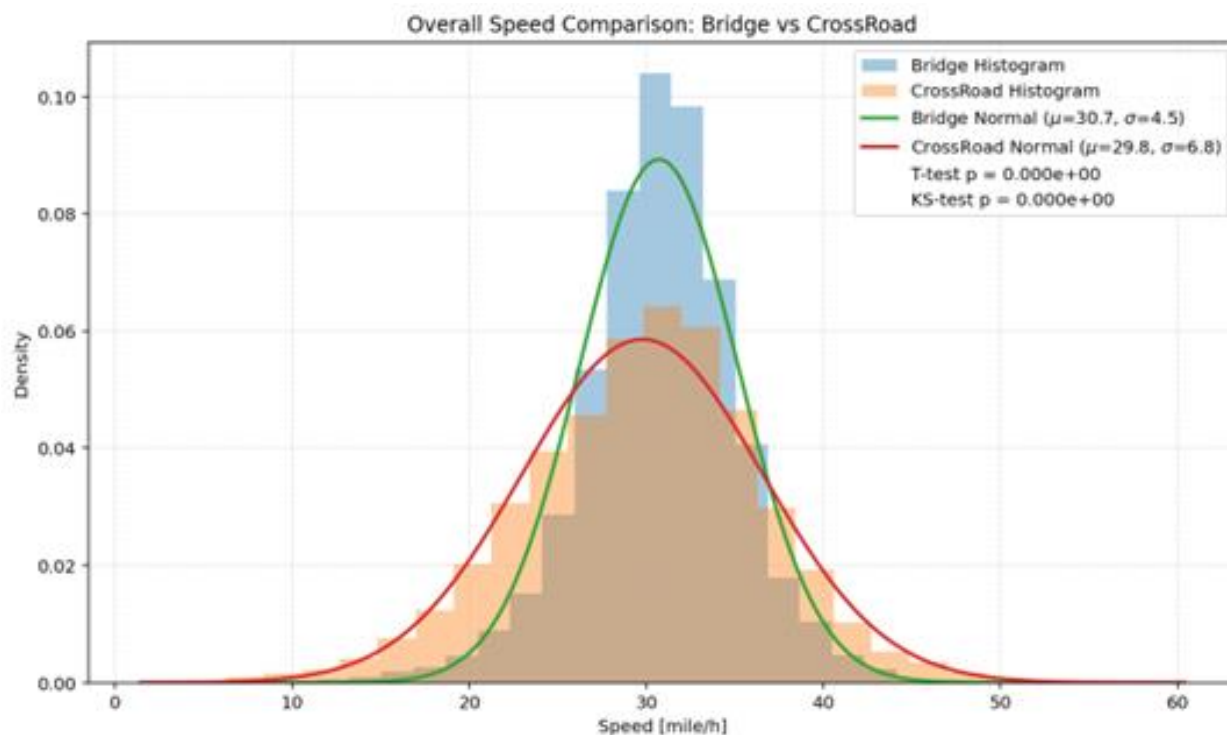


Figure 5-7 Normal Distribution of Crossroad and Bridge Speeds

In VISSIM, speed distributions can be defined using cumulative distribution functions (CDFs). Using the extracted drone-based vehicle trajectory data, the research team identified the best-fit

cumulative speed distributions for each study segment. The analysis showed that a log-normal distribution provided the best statistical fit for both the crossroad and bridge segments. For practical implementation in VISSIM, these cumulative distributions were subsequently simplified through linear regression to derive representative speed distribution functions (Figures 5-8 to 5-11).

Based on the resulting regression models, distinct speed ranges relative to the posted speed limit were established for the bridge and crossroad segments (Table 5-8). The bridge segments adopted a narrower speed range of -37% to +13%, while the crossroad segments exhibited a wider range of -53% to +23%.

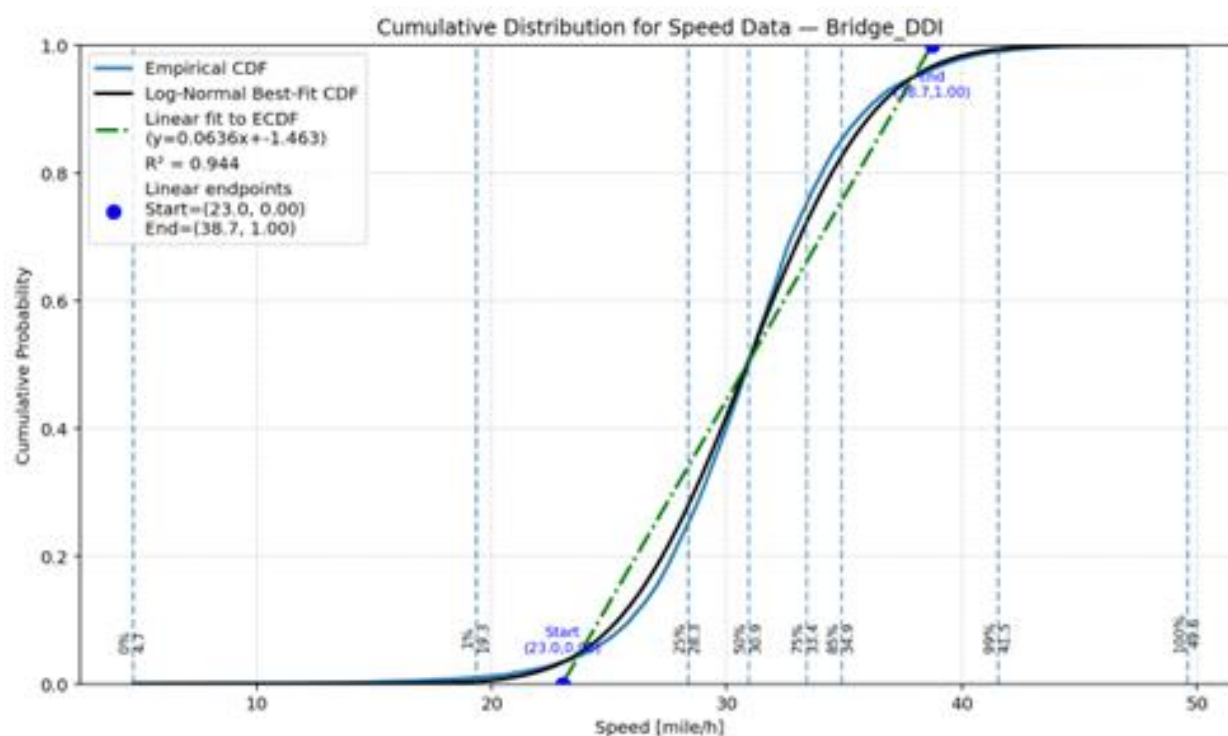


Figure 5-8 Cumulative Best-fit Speed Distributions for Crossroads and Bridges

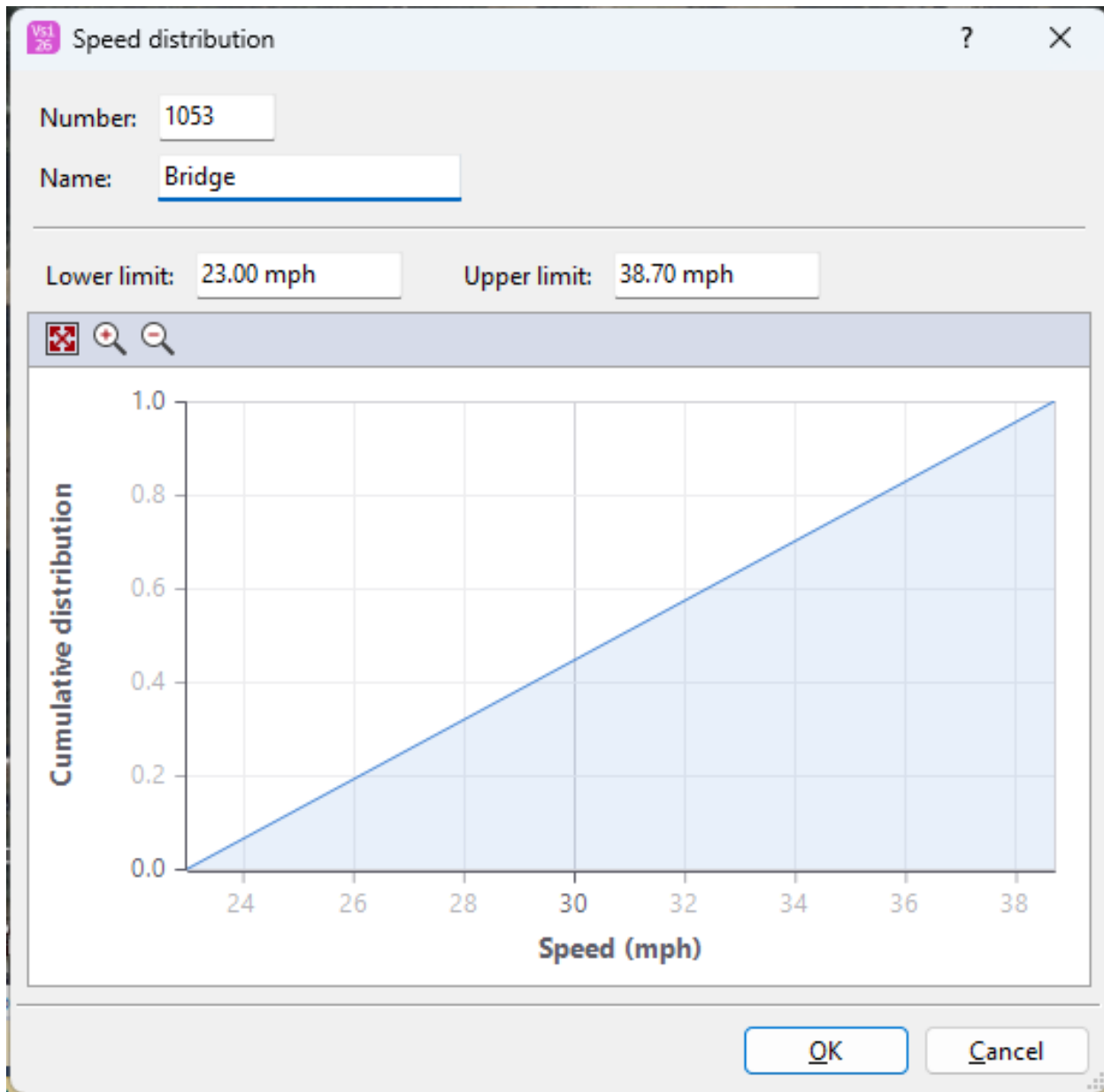


Figure 5-9 Bridge Speed Distribution Chart In VISSIM

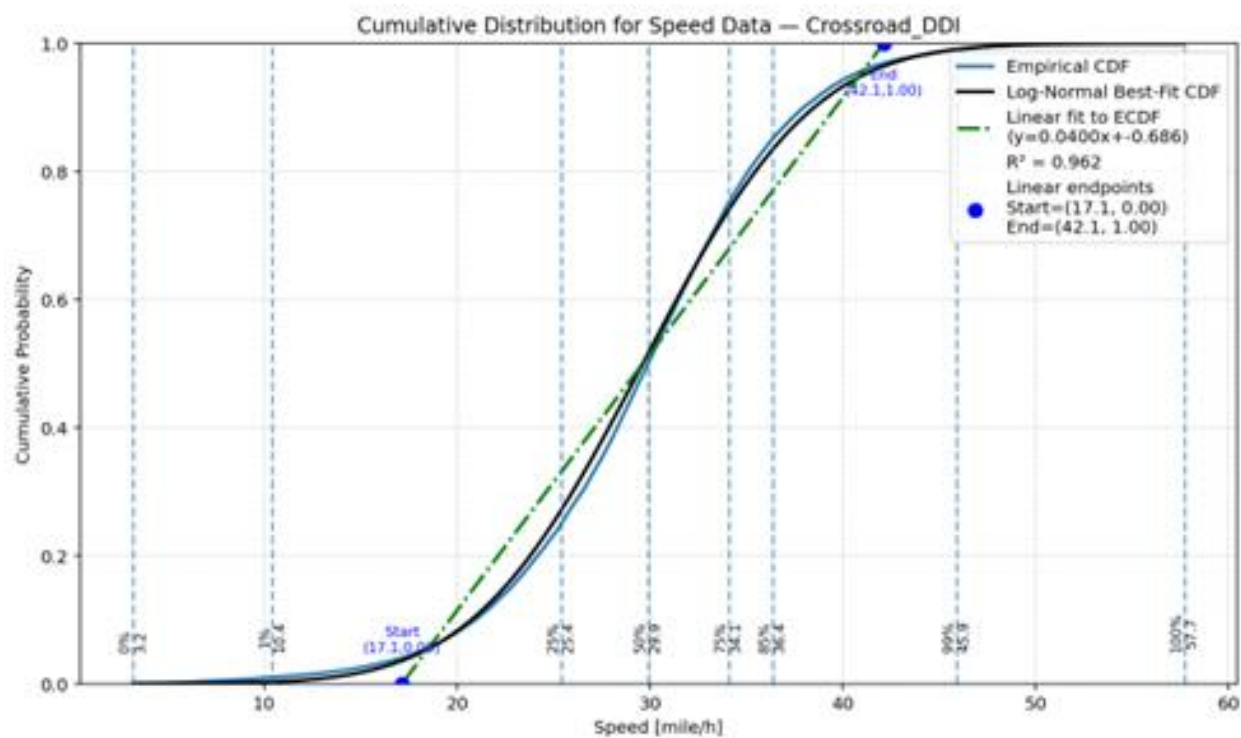


Figure 5-10 Cumulative Best-fit Speed Distribution for Crossroads

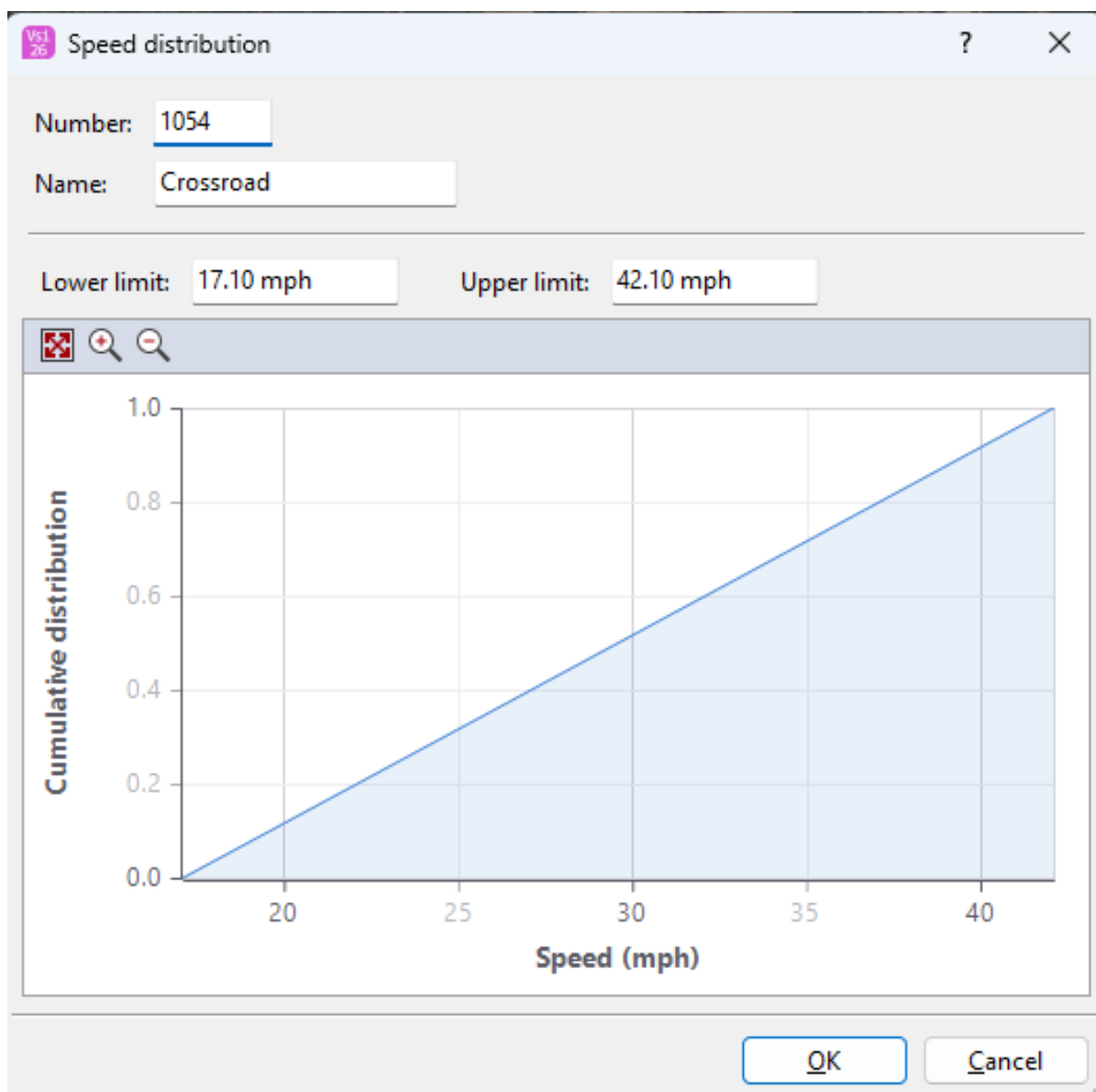


Figure 5-11 Crossroad Speed Distribution Chart In VISSIM

Table 5-8 Speed Range Setting In VISSIM

	95% CI Speed Range (mph)	Deviation from the Speed Limit
Cross Road	16.43 - 43.14	-53% – 23%
Bridge	21.95 - 39.47	-37% – 13%

5.2.2 Car-Following Parameter Calibration

Given the urban context of the DDI and its frequent stop-and-go conditions, the Wiedemann-74 car-following model was selected for calibration. Sensitivity analysis identified the standstill

distance parameter (CC0) as the most influential car-following parameter affecting queue formation and discharge behavior.

Calibration results indicate that vehicles on the crossroad segment maintain a larger average standstill distance (approximately 7.2 ft, Figure 5-12) than vehicles on the bridge segment (approximately 4.8 ft, Figure 5-13). This difference reflects observed driver behavior, where constrained bridge geometry, lower average speed and higher traffic density encourage tighter vehicle spacing.

Driving Behavior

No.: 1 Name: Urban (motorized)-crossroad

Following Car following model Lane Change Lateral Signal Control Autonomous Driving Driver Errors Meso

Wiedemann 74

Model parameters

Average standstill distance: 7.20 ft

Additive part of safety distance: 2.00

Multiplic. part of safety distance: 3.00

Following behavior depending on the vehicle class of the leading vehicle:

Number: 0	VehClass	W74ax	W74bxAdd	W74bxMult	W99cc0	W99cc1Distr	IncrsAccel
There are no elements in this list. You can add new elements through the context menu.							

OK Cancel

Figure 5-12 Crossroad Wiedemann 74 Chart In VISSIM

Driving Behavior

No.: 2 Name: Urban (motorized)-bridge

Following Car following model Lane Change Lateral Signal Control Autonomous Driving Driver Errors Meso

Wiedemann 74

Model parameters

Average standstill distance: 4.80 ft

Additive part of safety distance: 2.00

Multiplic. part of safety distance: 3.00

Following behavior depending on the vehicle class of the leading vehicle:

Number: 0	VehClass	W74ax	W74bxAdd	W74bxMult	W99cc0	W99cc1Distr	IncrsAccel
There are no elements in this list. You can add new elements through the context menu.							

OK Cancel

Figure 5-13 Bridge Wiedemann 74 Chart In VISSIM

5.2.3 Lane-Change Behavior Calibration

Trajectory data extracted from drone video were used to examine lane-changing behavior. Analysis showed that most drivers completed lane changes before entering the bridge section. Specifically, approximately 96% of left-turning vehicles and 95% of through-movement vehicles completed lane changes prior to entering the bridge (Table 5-9). The lane-change distance distribution can be modified in VISSIM, as shown in Figures 5-14 and 5-15.

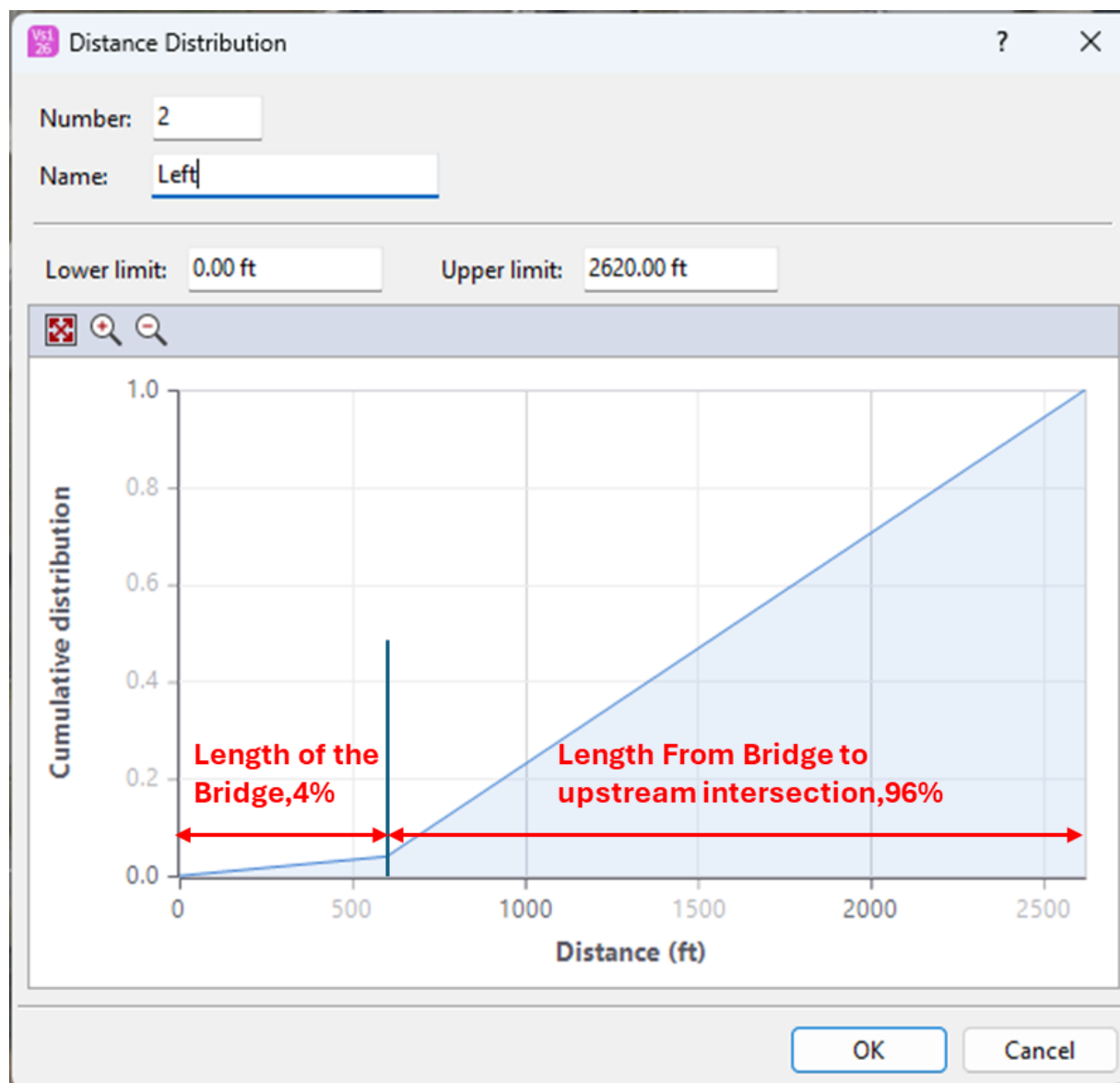


Figure 5-14 Left Turn Lane Change Distance Distribution Chart In VISSIM

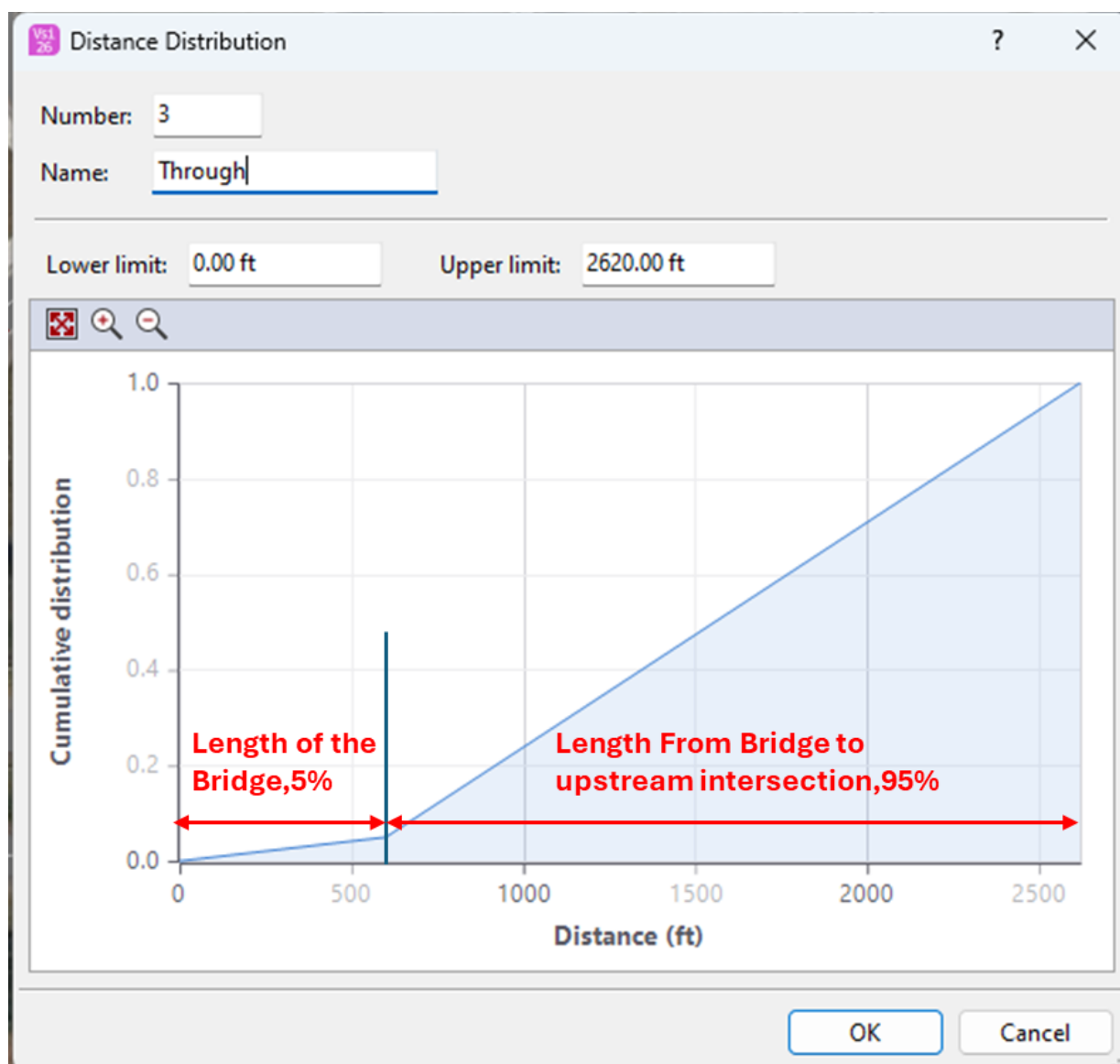


Figure 5-15 Through Lane Change Distance Distribution Chart In VISSIM

Table 5-9 Lane Change Distance Distribution for DDI

	Number of Vehicles	Lane Change before the Bridge	Lane Change Distribution (%)
Left Turn	840	809	96
Through	2,551	2,416	95

5.2.4 Priority Rule Calibration

At the study site, right-turn movements operate under a Stop on Red (SOR) control strategy, requiring vehicles to stop and merge into the through traffic. Field observations indicated that right-turn vehicles accepted relatively large gaps to ensure safety, given limited merging opportunities during peak periods. To replicate this behavior, the minimum gap time was calibrated

to represent the minimum acceptable temporal gap between through-movement vehicles in the major direction that permits a minor road vehicle to merge into the major direction. The results indicate that the minimum time increased from the default value of 3.0 s to 6.1 s (Figure 5-16). This adjustment improved the realism of right-turn merging behavior.

Priority Rule

No.: Name:

Stop line

☒ Link (all lanes): 57: SB merge 2

☐ Link - lane:

At: 20.631 ft

Affected driving direction: Forward

Vehicle classes

☒ All vehicle types

- ☐ 10: Car
- ☐ 20: HGV
- ☐ 30: Bus
- ☐ 40: Tram
- ☐ 50: Pedestrian
- ☐ 60: Bike

SC Condition

Signal group: 1 - 2: South-NB

Signal state: Red

☒ Show label

Conflict marker

☒ Link (all lanes): 10046: SB connector

☐ Link - lane:

At: 98.779 ft

Effective driving direction: Forward

Vehicle classes

☒ All vehicle types

- ☐ 10: Car
- ☐ 20: HGV
- ☐ 30: Bus
- ☐ 40: Tram
- ☐ 50: Pedestrian
- ☐ 60: Bike

Min. Gap Time: 6.1 s

Min. clearance: 16.4 ft

Maximum speed: 111.8 mph

☐ Look beyond red signals

OK Cancel

Figure 5-16 Priority Rule Setting For SOR

5.2.5 Model Validation and Comparison

To evaluate calibration effectiveness, the calibrated DDI model was compared against the original ALDOT VISSIM model under AM peak conditions, which represent the most critical operating period due to the heavy left-turn demand toward Mobile. Results summarized in Table 5-10 indicate substantial differences in queue length for the northbound approach at the south intersection, while both models produced similar queue estimates for the southbound direction. The ALDOT model substantially overestimated queue lengths, with an average queue of approximately 923 ft and a maximum of 1,120 ft. In contrast, the calibrated model yielded a maximum queue length of 433 ft, which closely matches the field-observed maximum of 500 ft (Figure 5-17). These findings confirm that the calibrated model more accurately reproduces observed field conditions.

Table 5-10 Original VS Calibrated VISSIM Model

Parameters	Original Model	Calibrated Model	Difference (%)	Original Model	Calibrated Model	Difference (%)
	South Intersection-NB			South Intersection-SB		
Average queue length (ft)	923	237	-74.3%	22	21	-4.5%
Maximum queue length (ft)	1,119	433	-61.3%	54	51	-5.6%
Average delay(s)	57	36	-36.8%	13	13	0.0%
	North Intersection-NB			North Intersection-SB		
Average queue length (ft)	58	82	41.4%	70	68	-2.9%
Maximum queue length (ft)	157	222	41.4%	153	147	-3.9%
Average delay(s)	2	3	50.0%	27	27	0.0%



Figure 5-17 Maximum Queue Length Measured from Field Drone Footage

5.2.6 Summary of Calibrated DDI Parameters

The final calibrated parameters for the DDI simulation are summarized in Table 5-11. For driving behavior calibration, different standstill distances (CC0) values are recommended for distinct segments of the DDI. A CC0 of 7.2 ft is recommended for the crossroad segment before the bridge, while a CC0 of 4.8 ft is appropriate for the bridge segment.

Lane-change behavior also requires adjustment. For left-turn movements, 96% of vehicles should complete their lane changes before entering the bridge segment. For through movements, 95% of vehicles should complete lane changes prior to the bridge, with the remaining vehicles completing their lane changes on the bridge.

For priority-rule calibration at the SOR right-turn control, the minimum gap time should be set to 6.1 seconds. Other general calibration parameters—including speed distributions, vehicle composition, and signal timing—should be based on field-observed conditions.

For this study location, where the posted speed limit is 35 mph, the calibrated speed distributions may be defined as -53% to $+23\%$ for the crossroad segment and -37% to $+13\%$ for the bridge segment, both relative to the posted speed limit.

This case study provides recommended parameters for DDI modeling in Alabama and may be applied to similar facilities, provided that appropriate site-specific validation is conducted.

Table 5-11 DDI VISSIM Calibration Parameters in Alabama

	Recommended Parameters	DDI
Driving Behavior	CC0 (Standstill Distance)	Cross Road (7.2 ft) Bridge (4.8 ft)
	CC1 (Time Headway)	Default: 0.9 s
Lane Change Distance	Lane Change Distance	Left turn before bridge: 96% Through before bridge: 95%
	Cooperative Braking	Default: No
	Maximum Deceleration for Cooperative Braking	Default
Priority Rule	Minimum gap time for Turning	SOR: 6.1 s
General	Speed range	Cross road: (-53%, 23%) Bridge: (-37%, 13%)
	Vehicle Composition	Local Data
	Timing Plan	Local Data

5.3 RCUT Calibration Guideline

Calibration of RCUT intersections focused on reproducing observed driver behavior for Right Turn followed by U-turn (RTUT) movements. NDS data were used as the primary empirical reference, as they provide high-resolution observations of speed trajectories, stopping behavior, lane utilization, and acceleration–deceleration patterns under real-world conditions.

5.3.1 Lane Utilization

At RCUT intersections along multilane divided highways, vehicles entering from the minor road may merge into either the median-adjacent (left) lane or the shoulder-adjacent (right) lane on the major road. These alternative merging paths create different conflict points and operational outcomes, making an accurate representation of lane utilization essential for both capacity and safety analysis. Analysis of NDS data suggests assigning 92% to left lane and 8% to right lane for right turn movements and 6% to left lane and 94% to right lane for the U-turn maneuvers.

To replicate this behavior in VISSIM, two separate connectors were defined for each turning movement: one connecting to the left lane and one to the right lane. This configuration allows the definition of multiple route choices and enables observed lane-use proportions to be directly applied in the simulation. This approach ensures that lane-specific volumes and conflict interactions are realistically represented.

5.3.2 Stopping Behavior

Analysis of the NDS database indicates that a substantial proportion of drivers do not come to a complete stop at the stop line at the minor road with a stop sign. Approximately 55.5% of drivers slowed significantly but proceeded without fully stopping, while still yielding to major road traffic.

To reproduce this behavior, the conventional modeling approach of combining a stop sign with a conflict area, which enforces a mandatory full stop for all vehicles, was replaced with a reduced

speed area combined with a priority rule. NDS observations show that drivers typically reduce speed to approximately 4.0 mph while assessing acceptable gaps. Accordingly, a reduced-speed area with a target speed distribution centered at 4.0 mph was implemented upstream of the stop line.

Priority rules were used instead of conflict areas to provide greater flexibility in representing driver decision-making under yield conditions. This configuration allows vehicles to either stop or proceed slowly, depending on available gaps, consistent with observed naturalistic driving behavior. The minimum gap of 3.5 seconds was estimated based on the NDS data.

5.3.3 Desired Acceleration and Deceleration Functions

Desired acceleration and deceleration functions in VISSIM define how vehicles (Car Only) accelerate and decelerate across different speed ranges. Each function is characterized by minimum, median, and maximum values at discrete speed levels.

To align these functions with observed RCUT behavior, speed trajectories from the NDS database were analyzed for RTUT movements. Acceleration and deceleration distributions were derived for 6.25 mph speed intervals. Results indicate substantial differences between NDS-derived distributions and default VISSIM settings, particularly at low and moderate speeds where turning and merging maneuvers occur.

Based on these findings, movement-specific desired acceleration and deceleration functions were developed for RTUT movements (Table 5-12). Simulation experiments demonstrate that modifying the desired acceleration and deceleration functions based on NDS observations results in simulated speed trajectories that more closely match the empirical data.

Table 5-12 Calibrated Acceleration and Deceleration Functions for RTUT Movements

Speed (mile/h)	Acceleration Function			Deceleration Function		
	Accel_y (ft/s ²)	Accel_ymin (ft/s ²)	Accel_ymax (ft/s ²)	Decel_y (ft/s ²)	Decel_ymin (ft/s ²)	Decel_ymax (ft/s ²)
0.00	3.94	2.57	4.59	-7.22	-7.87	-6.69
6.25	4.13	2.29	5.36	-7.22	-7.87	-6.69
12.50	4.00	2.27	6.13	-7.22	-7.87	-6.69
18.75	3.87	2.27	6.89	-4.51	-4.92	-4.18
25.00	3.72	2.25	7.65	-4.51	-4.92	-4.18
31.25	3.52	2.20	7.87	-4.51	-4.92	-4.18
37.50	3.45	2.15	7.66	-4.51	-4.92	-4.18
43.75	3.54	2.06	7.37	-4.51	-4.92	-4.18
50.00	3.60	1.96	7.00	-4.51	-4.92	-4.18
56.25	3.63	1.84	6.56	-9.02	-9.84	-8.37
62.50	3.41	1.59	5.68	-9.02	-9.84	-8.37
68.75	3.18	1.48	5.30	-9.02	-9.84	-8.37
75.00	2.95	1.38	4.92	-9.02	-9.84	-8.37
81.25	2.72	1.27	4.54	-9.02	-9.84	-8.37

87.50	2.50	1.16	4.16	-9.02	-9.84	-8.37
93.75	2.27	1.06	3.78	-9.02	-9.84	-8.37
100.00	2.04	0.95	3.41	-9.02	-9.84	-8.37
106.25	1.81	0.85	3.02	-9.02	-9.84	-8.37
112.50	1.59	0.74	2.65	-9.02	-9.84	-8.37
118.75	1.36	0.64	2.27	-9.02	-9.84	-8.37
125.00	1.14	0.53	1.89	-9.02	-9.84	-8.37
131.25	0.91	0.42	1.51	-9.02	-9.84	-8.37
137.50	0.68	0.32	1.14	-9.02	-9.84	-8.37
143.75	0.45	0.21	0.76	-9.02	-9.84	-8.37
150.00	0.23	0.10	0.38	-9.02	-9.84	-8.37

5.3.4 Weaving Speed

For RTUT movements, NDS trajectory analysis revealed that default VISSIM settings tend to overestimate speeds within the weaving section between the right turn and the U-turn maneuver. To address this discrepancy, an independent desired speed distribution was defined for the weaving segment. Regression analysis of field data (Zhou et al., 2003) yielded the following relationship for estimating average weaving speed:

$$S_w = 13.36 + 0.0161L$$

where S_w is the average weaving speed of RTUT movements (mph), and L is the weaving length (ft).

Applying this relationship to adjust the desired speed distribution in the weaving segment substantially improved the alignment between simulated and NDS-observed trajectories, particularly for speed decay and recovery patterns during the weaving maneuver.

5.3.5 Summary of Calibrated RCUT Method

A four-step method was adopted for the RCUT microsimulation calibration: (1) two connectors were configured for both the right-turn lane and the U-turn lane, assigning 92%/8% (left/right) at the right-turn lane and 6%/94% (left/right) at the U-turn lane; (2) a reduced speed area (4 mph) was set at the minor-road stop line and a priority rule was specified with a 3.5 s minimum gap time; (3) the desired acceleration and deceleration functions were updated according to Table 5-12; and (4) the weaving-section desired speed distribution was calibrated by weaving speed function defined in the section 5.3.4.

5.4 Diverging and Merging Calibration Guideline

5.4.1 Merging Calibration Guideline

There were three important parts that needed to be calibrated for the freeway merge behaviors at work zones:

- Driving Behaviors: Standstill distance (CC0) and time headway (CC1)
- Lane Change Behavior: Lane change distance, cooperative braking, deceleration rate, and waiting time before diffusion
- Speed Distribution: Speed distribution for the work zone

5.4.1.1 Driving Behaviors Calibration

In this study, work-zone calibration focuses on reproducing observed congestion and speed reduction under a two-to-one lane closure. The Wiedemann 99 car-following model was selected for calibration because it is well-suited for freeway traffic conditions. Based on the referenced Alabama work-zone study (Turochy et al., 2022), the recommended VISSIM calibration parameters for Alabama conditions are summarized in Table 5-13. CC0 was recommended to increase to 10.00 ft from the default of 4.92 ft. The recommended distribution for the CC1 value is shown in Table 5-14. The work-zone model for a selected site was developed using field-observed traffic volumes and vehicle composition and calibrated using these parameters.

Table 5-13 Work Zone VISSIM Parameters (Turochy et al., 2022)

Parameter	Description	Default Value	Calibrated Value
<i>Car-Following Parameters</i>			
CC0	desired standstill distance	4.92 ft	10 ft
CC1	desired time headway	0.9 s	Empirical Distribution with 0.35 s subtracted ^a
CC2	additional distance over desired safety distance	13.12 ft	Default
CC3 - CC9	--	--	Default
<i>Lane-Changing Parameters</i>			
Lane-Changing Distance	distance upstream of a required lane change that drivers will begin looking for gaps to merge	656.2 ft	3000 ft
SRF	safety distance reduction factor	0.6	Default
Cooperative Braking	check box (yes or no)	No	Yes
Maximum Deceleration for Cooperative Braking	maximum accepted deceleration when braking cooperatively	-9.84 ft/s ²	-20 ft/s ²
Waiting Time Before Diffusion	maximum waiting time before vehicle removed from network	60 s	200 s
All others	--	--	Default

Table 5-14 VISSIM Input CC1 Distributions (Turochy et al., 2022)

Headway (s)	Passenger Cars		Trucks	
	Frequency Below	% Below	Frequency Below	% Below
1	577	1%	0	0%
2	11618	43%	151	2%
3	9545	76%	1845	27%
4	3607	89%	2251	57%
5	1835	96%	1543	77%
6	1246	100%	993	90%
7	--	--	724	100%

5.4.1.2 Lane Change Behavior Calibration

Another important parameter for calibrating the work zone simulation model is the lane change behavior. In the case study, the lane change distance was set to be 3,000 ft (shown in Figure 5-18) based on the recommended value in Table 5-13.

Connector

No.: 10001 Name:

Intermediate points: 0 Link behavior type: 6: WZ

Link length: 594.034 ft Display type: 1: Road gray

☐ Reverse parking

from link No.: 3 At: 4.075 ft to link No.: 4 At: 0.002 ft

Lane Change Meso Display Dyn. Assignment Others

Desired Direction: All

Emergency stop position: 16.4 ft

Lane change distance

☐ Applies per lane change

☒ Fixed value: 3000.0 ft

☐ Distribution:

Specific for vehicle classes:

Number	VehClass	LnChgDistDistr
There are no elements in this list. You can add new elements through the context menu.		

OK Cancel

Figure 5-18 VISSIM Input Lane Change Distance

5.4.1.3 Speed Distribution Calibration

In accordance with ALDOT's Standard Operating Procedure for Determining Speed Limit(s) in a Work Zone, a reduced speed limit is required under Type 2 Lane/Paved Shoulder Closure conditions. At the study site, the posted speed limit is 70 mph; therefore, a work-zone speed limit of 55 mph was applied in simulation (Table 5-15). A temporary reduced speed area was implemented in VISSIM to reflect field conditions, with minimum and maximum speeds set to 45 mph and 55 mph, respectively (Figure 5-19).

Table 5-15 Work Zone Speed Limit for Interstate Highway (ALDOT, 2019)

INTERSTATE HIGHWAY*		
Type of Work	Posted Speed Limit	Work Zone Speed Limit
1	All	No Reduction
2	70 MPH	55 MPH
	65 MPH	55 MPH
	60 MPH	50 MPH
	55 MPH	50 MPH
	50 MPH	No Reduction
3	70 MPH	55 MPH (Desirable), 45 mph (Minimum)
	65 MPH	55 MPH (Desirable), 45 mph (Minimum)
	60 MPH	55 MPH (Desirable), 45 mph (Minimum)
	≤ 55 MPH	45 MPH (Desirable), 35 mph (Minimum)

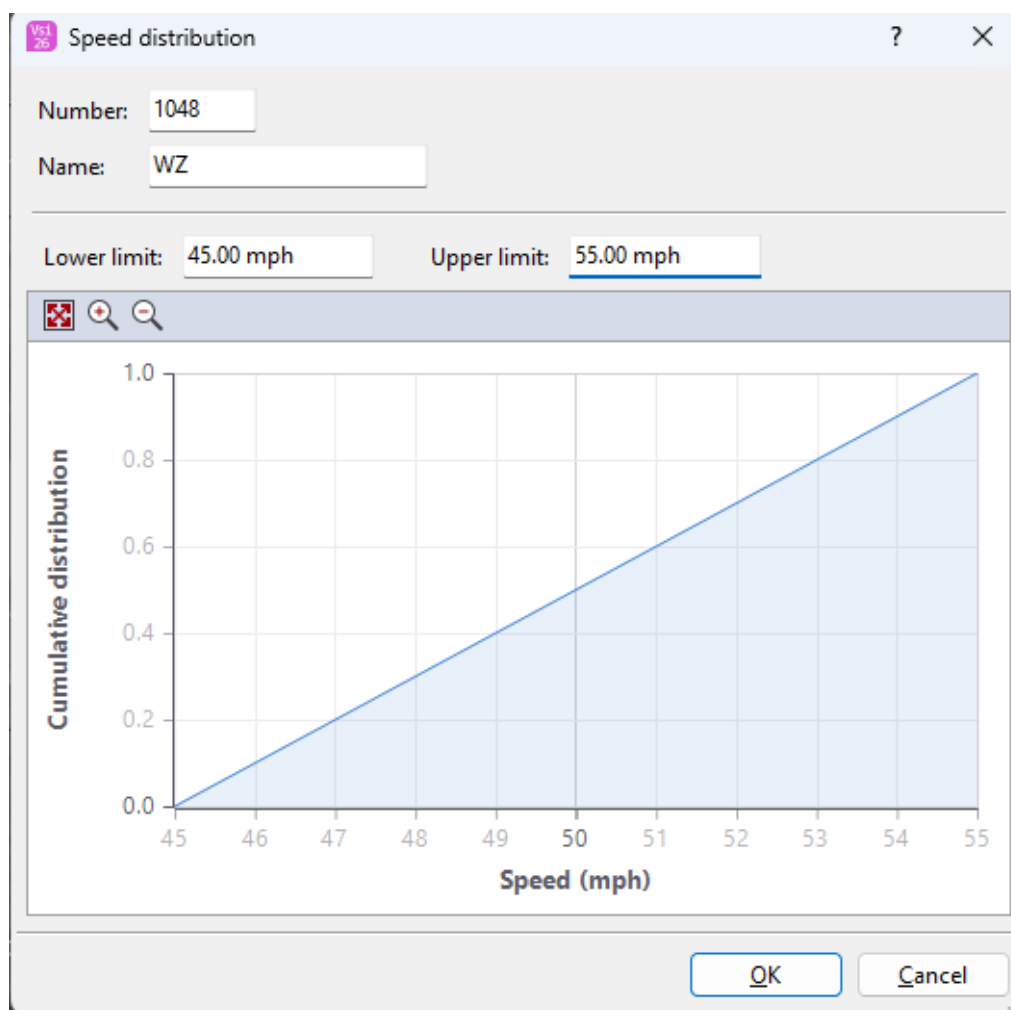


Figure 5-19 Work Zone Speed Distribution Chart In VISSIM

5.4.1.4 Model Validation and Comparison

Because the drone footage covered only a limited portion of the overall work-zone segment, it could not be used to determine an average speed for the entire analysis segment. Therefore, ClearGuide was used as a supplemental data source to establish a baseline field speed for the same segment. During the field data collection period (2:00 p.m. to 3:00 p.m.), the average speed reported by ClearGuide was approximately 11.3 mph (Table 5-16). In the VISSIM model, travel-time detectors were placed along the same length segment used in ClearGuide to ensure consistent, comparable performance measurements.

Table 5-16 Average Speed at the Study Work Zone (Source: ClearGuide)

DATE RANGE: 10/03/2025 - 10/04/2025, METRIC 1: Average Speed, METRIC 2: Average Travel Time, STATISTIC TIME OF DAY: 2:00 PM-3:00 PM, INCLUDE DAYS: All

Route Name	ID	Average Speed (mph)
I-20 (W) to I-20 (W)	4887	11.3

By applying the recommended parameters described above, the simulation model produced an average speed of 10.6 mph within the work-zone area, which more closely matched the ClearGuide field value of 11.3 mph than the uncalibrated model result of 9.8 mph (Table 5-17). This agreement indicates that the calibrated parameter set from Improving Work Zone Mobility through Planning, Design, and Operations (Turochy et al., 2022) is applicable for reproducing realistic work-zone operations in Alabama.

Table 5-17 Work Zone VISSIM Model Results

	Average Speed (mph)	Difference (%)
ClearGuide	11.3	
Work Zone (Calibrated)	10.6	-6.2%
Work Zone (Without Calibrated)	9.8	-13.3%

5.4.1.5 Summary of Calibrated Merge (Work Zone) Parameters

In summary, the development of the merging (work zone) model in VISSIM required modifications to the following parameters: CC0, CC1, the lane-change distance, cooperative braking, the speed distributions, and the deceleration rate applied to the deceleration lane. A summary of these calibration parameters is provided in Table 5-18.

Table 5-18 Summary of the Recommended Work Zone Calibration Parameters

	Recommended Parameters	Merge (work zone)
Driving Behavior	CC0 (Standstill Distance)	10 ft
	CC1 (Time Headway)	Table 5-15
Lane Change Distance	Lane Change Distance	3,000 ft
	Cooperative Braking	Default: No
	Maximum Deceleration for Cooperative Braking	-20 ft/s ²
General	Speed Limit	Work Zone: 55 mph
	Vehicle Composition	Local Data

5.4.2 Diverging Movement Calibration Guideline

Based on the GDOT VISSIM Modeling Guideline (Hunter, 2021) and an NDS study by Auburn University (Xu, 2021), three key parameters are recommended for calibrating diverging maneuvers at freeway off-ramps:

- Lane Change Behavior: Lane change distance for diverging and through movements
- Deceleration Rate: Deceleration rate for diverging vehicles
- Speed Distribution: Speed distribution for diverging and through movements

5.4.2.1 Lane Change Behavior and Deceleration Rate

The GDOT VISSIM Modeling Guideline recommends that the lane-change distances should be 1,200 ft (Figure 5-20) for diverging movements and 1,050 ft (Figure 5-21) for through movements. These adjustments ensure that vehicles can complete mandatory lanes change well in advance of the final exit point, thereby minimizing interference with through-traffic operations. Moreover, a study based on the NDS data by Auburn University (Xu, 2021) recommended that the deceleration rate along the deceleration lane be reduced to 3 ft/s², replacing the VISSIM default value of 6.56 ft/s² (Figure 5-22).

Connector

No.: 10002 Name:

Intermediate points: 0 Link behavior type: 3: Freeway (free lane selection)

Link length: 11.356 ft Display type: 1: Road gray

☐ Reverse parking

from link No.: 4 At: 596.932 ft to link No.: 6 At: 0.303 ft

Lanes Lane Change Meso Display Dyn. Assignment Others

Desired Direction: All

Emergency stop position: 16.4 ft

Lane change distance

☒ Applies per lane change

☒ Fixed value: 1200.0 ft

☐ Distribution:

Specific for vehicle classes:

Number: 0	VehClass	LnChgDistDistr
There are no elements in this list. You can add new elements through the context menu.		

OK Cancel

Figure 5-20 VISSIM Input Lane Change Distance for Diverging Traffic

Connector

No.: 10001 Name:

Intermediate points: 0 Link behavior type: 3: Freeway (free lane selection)

Link length: 7.963 ft Display type: 1: Road gray

☐ Reverse parking

from link No.: 4 At: 597.791 ft to link No.: 5 At: 1.239 ft

Lanes Lane Change Meso Display Dyn. Assignment Others

Desired Direction: All

Emergency stop position: 16.4 ft

Lane change distance

☒ Applies per lane change

☒ Fixed value: 1020.0 ft

☐ Distribution:

Specific for vehicle classes:

Number: 0	VehClass	LnChgDistDistr
There are no elements in this list. You can add new elements through the context menu.		

OK Cancel

Figure 5-21 VISSIM Input Lane Change Distance for Through Traffic

Reduced Speed Area

No.: Name:

Link - lane:

Length: Time From:

At: until:

☒ Show label

Number: 2	VehClass	DesSpeedDistr	Decel
1	10: Car	1049: Freeway Dece_Car	3.00
2	20: HGV	1050: Freeway Dece_truck	3.00

OK Cancel

Figure 5-22 Deceleration Rate at Reduced Speed Area

5.4.2.2 Speed Distribution Calibration

Drone-extracted vehicle trajectory data were used to analyze speed distributions for the diverging lane and the through-traffic movement, with separate distributions developed for passenger cars and trucks. To reduce noise, only data within the interquartile range (Q25%–Q75%) were retained for fitting distribution models.

For cars, the best-fit distribution for car deceleration and through movements were the Weibull distribution (Figure 5-23,25), which yielded the lowest AIC and BIC values compared with the lognormal and gamma distributions. The observed speed range for passenger cars on the deceleration segment was 48-59 mph, and this range was used as the input speed distribution in VISSIM (Figure 5-24). The observed speed range for through movement cars is 64-75 mph, as shown in Figure 5-26.

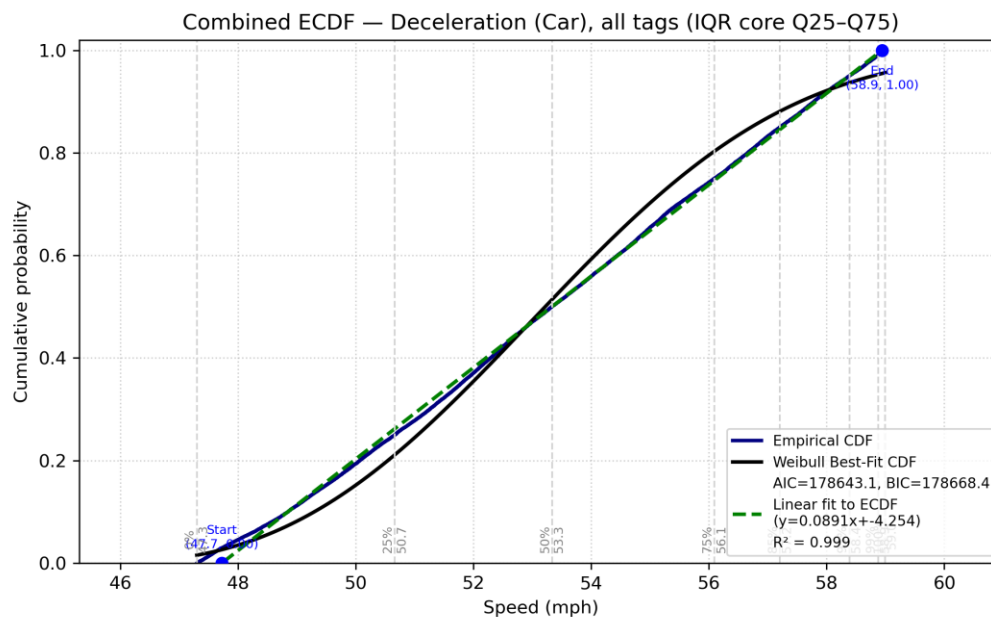


Figure 5-23 Passenger Car Speed Distribution on Deceleration Lane

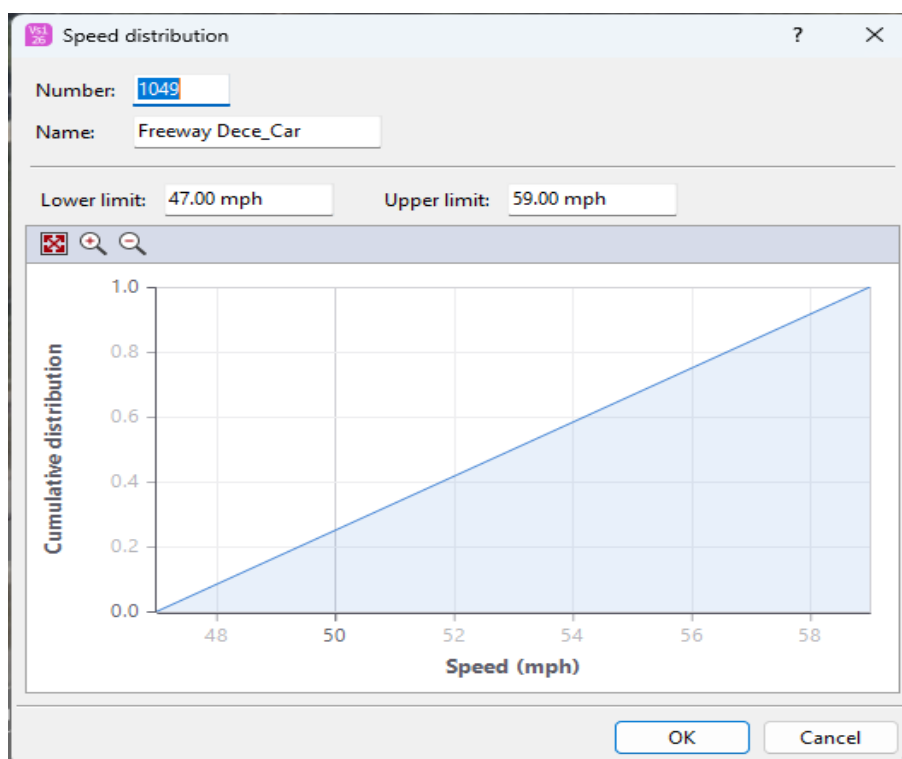


Figure 5-24 VISSIM Input Passenger Car Speed Distribution on Diverging Deceleration Lane

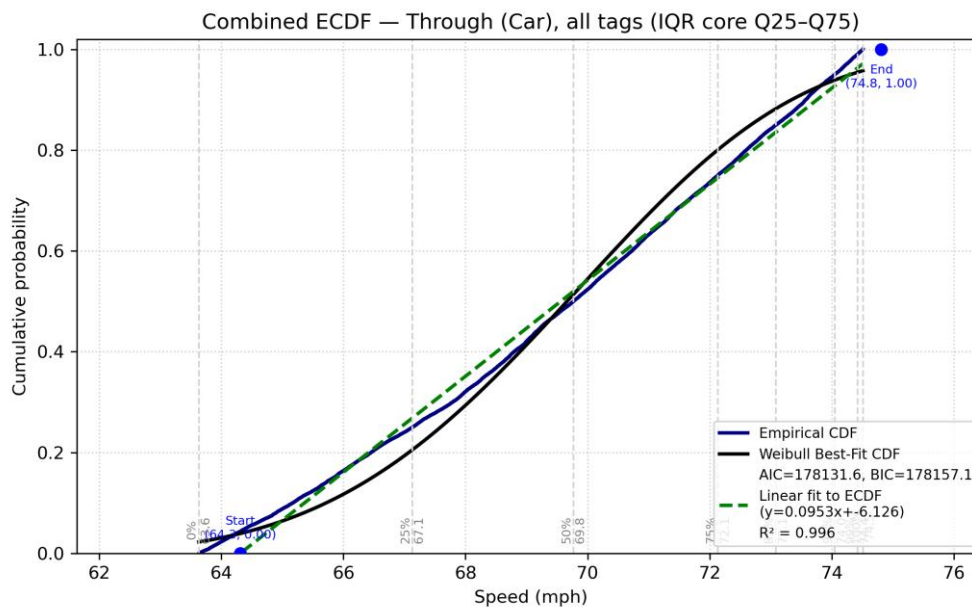


Figure 5-25 Passenger Car Speed Distribution on Through Lane

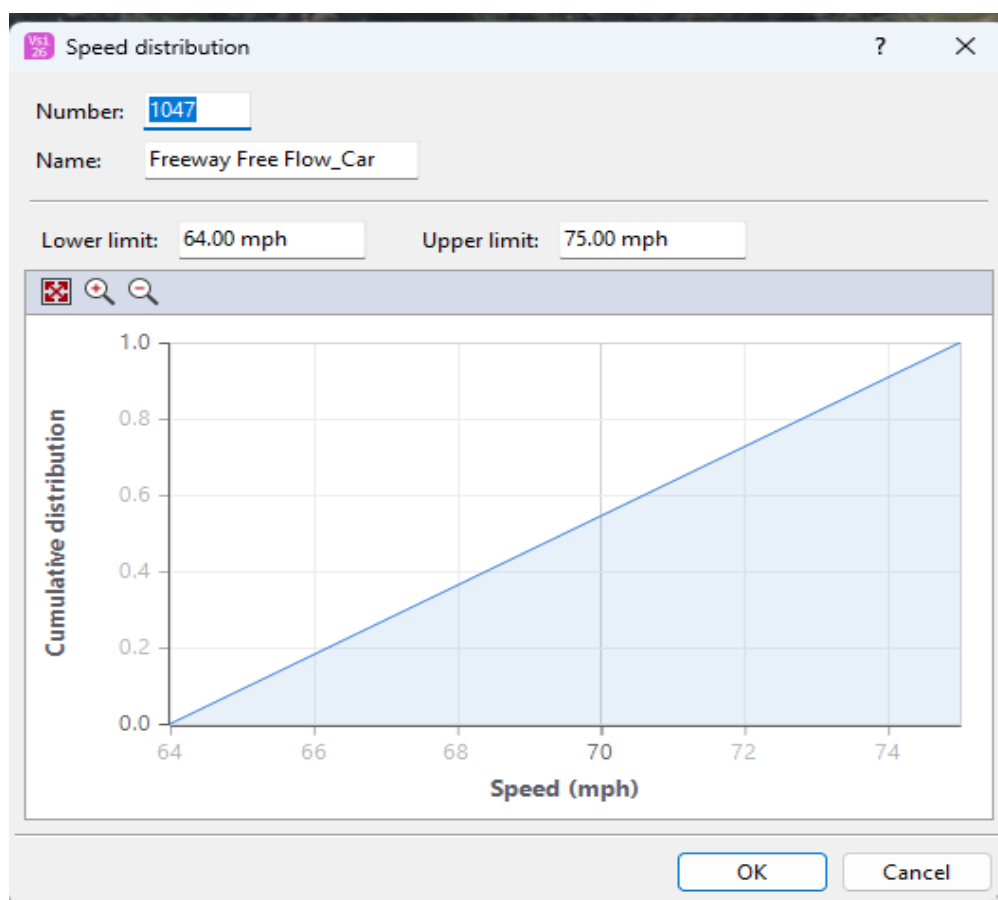


Figure 5-26 VISSIM Input Passenger Car Speed Distribution on Through Lane

For trucks, the best-fit speed distribution for deceleration and through movements were also the Weibull distribution, which produced the lowest AIC and BIC values compared with the lognormal distribution (Figure 5-27,29). The observed truck speed range on the deceleration segment was 41-52 mph, and this range was used as the input speed distribution in VISSIM (Figure 5-28). The observed speed range for truck-through movements is 57-71 mph. Figure 5-30 presents the corresponding speed range inputs for trucks in VISSIM.

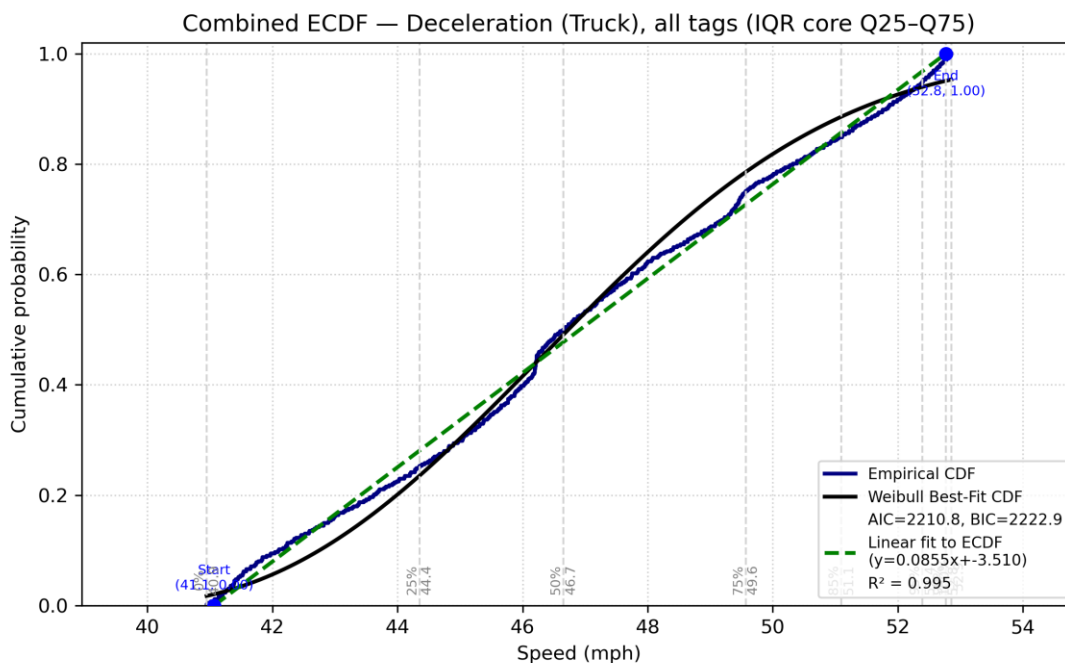


Figure 5-27 Truck Speed Distribution on Deceleration Lane

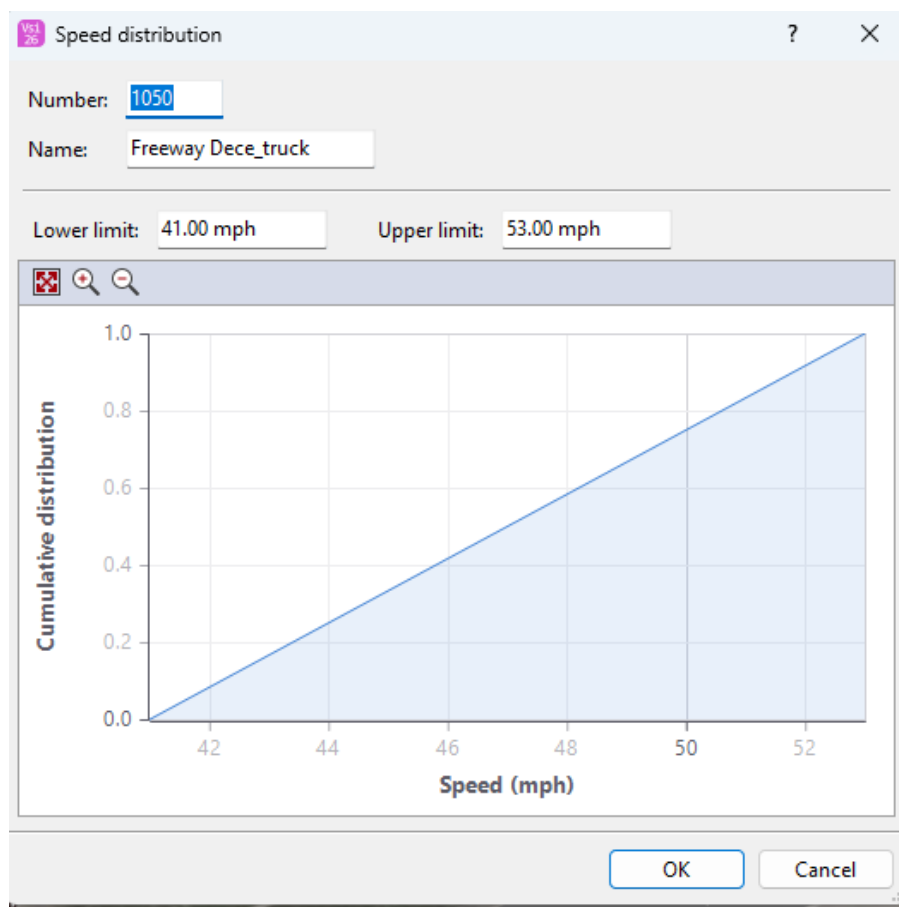


Figure 5-28 VISSIM Input Truck Speed Distribution on Diverging Deceleration Lane

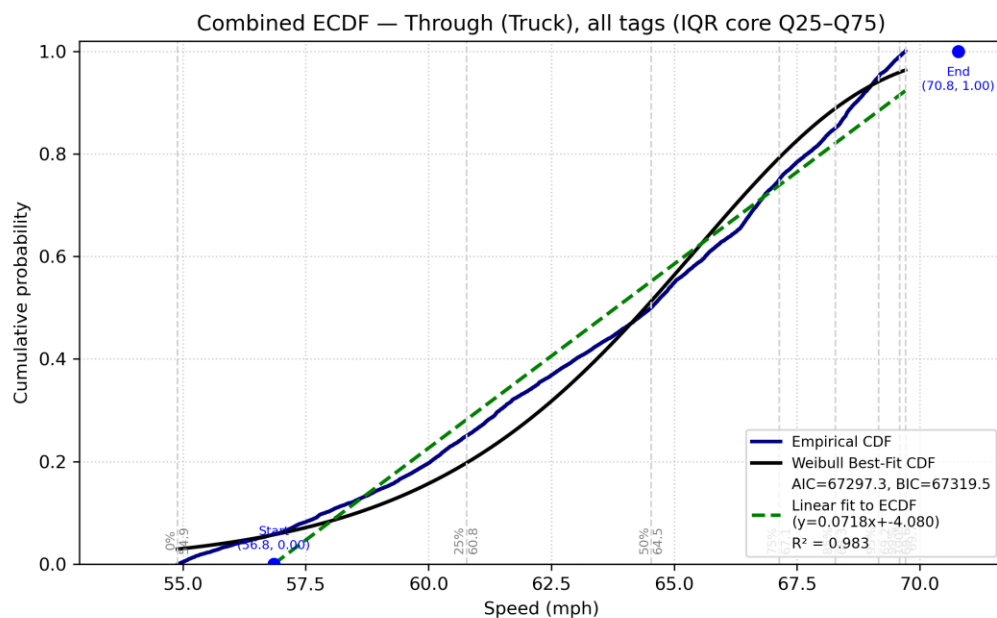


Figure 5-29 Truck Speed Distribution on Through Lane

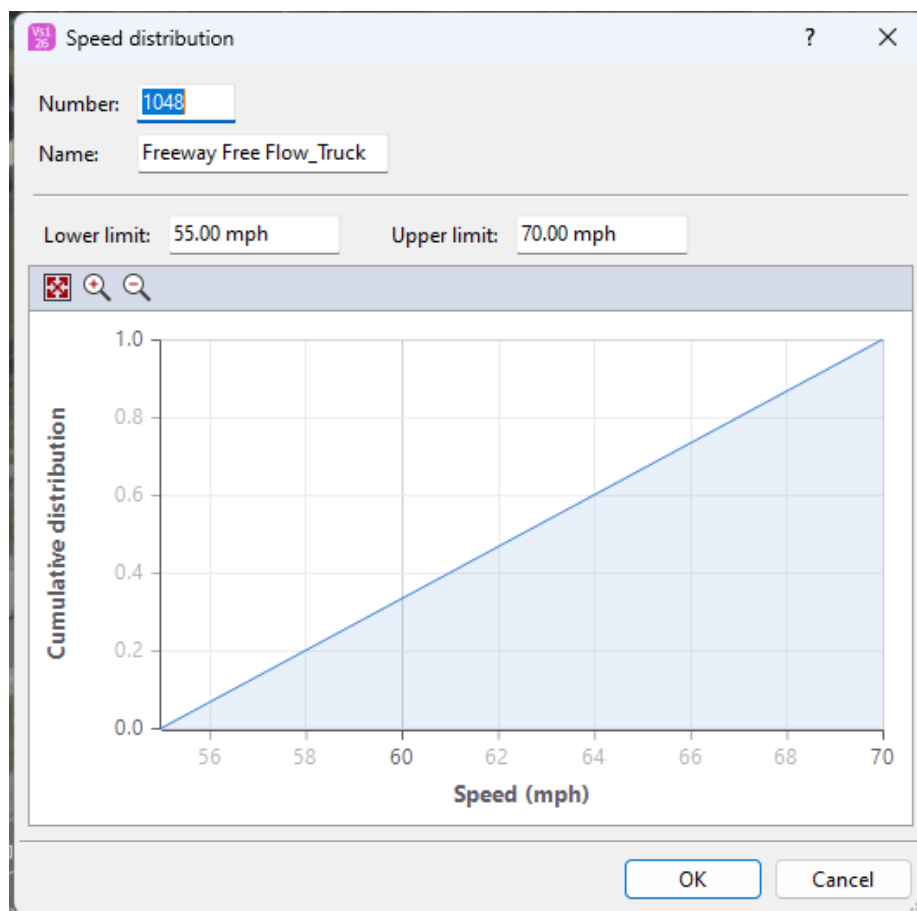


Figure 5-30 VISSIM Input of Truck Speed Distribution on Through Lane

5.4.2.3 Model Validation and Comparison

To validate model accuracy, the team set the travel time analysis zone to the segment from the start of the deceleration lane to its end, as shown in Figure 5-31. A comparative travel-time analysis was conducted using field data, the calibrated models, and the default VISSIM models. The results showed that the calibration process substantially improved model accuracy. For the diverging movement, calibration reduced the speed error from +9% in the default model to -2% in the calibrated model. For the through movement, calibration reduced the speed error from -6% in the default model to -3% in the calibrated model. These findings indicate that the calibrated model more effectively replicates real-world traffic conditions.



Figure 5-31 Travel Time Analysis Zone in VISSIM Model

Table 5-19 Speed Comparison

		Average Speed (mph)	Difference (%)
Field Data	Deceleration lane	53	
	Through lane	68	
Default model	Deceleration lane	58	+9%
	Through lane	64	-6%
Calibrated model	Deceleration lane	52	-2%
	Through lane	66	-3%

5.4.2.4 Summary of Calibration Settings for Diverging Areas

The development of the diverging area model in VISSIM required modifications to three primary parameters: the lane-change distance, the speed distributions, and the deceleration rates. A summary of these calibration parameters is provided in Table 5-20.

For diverging movements, the lane-change distance was set to 1,200 ft per lane; for through movements, it was set to 1,050 ft per lane. Speed distributions were defined relative to the posted speed limit of 70 mph. For through movements, the calibrated speed ranges were -8.6% to 7.1% for passenger cars and -21.4% to 0% for trucks. For diverging movements, the speed ranges were -32.9% to -15.6% for passenger cars and -41.4% to -24.3% for trucks.

Table 5-20 Summary of Diverge Calibration Parameters

Parameters	Default	Recommend
Lane change distance	656.2 ft	Diverge: 1200 ft, per lane Through: 1050 ft, per lane
Speed distribution	VISSIM built-in Speed Distribution	Through Passenger car: 64 – 75 mph, (-8.6%,7.1%) Through Truck: 55 – 70 mph, (-21.4%, 0%) Diverge Passenger car: 47 – 59 mph, (-32.9%, -15.7%) Diverge Truck: 41 – 53 mph, (-41.4%, -24.3%)
Deceleration rate	6.56 ft/s ²	3 ft/s ²

6. CONCLUSION

This report presented a comprehensive assessment of existing national guidance, state DOT practices, and prior research related to the calibration and validation of microscopic traffic simulation models for alternative intersections and freeway merge/diverge areas. The review highlighted that, while general modeling guidance exists, structured and facility-specific calibration procedures remain limited, particularly for roundabouts with non-circular geometries, DDIs, RCUT intersections, and freeway merge/diverge areas. These findings established the need for consistent, data-driven calibration approaches tailored to Alabama traffic characteristics and project applications.

To address these gaps, the study analyzed multiple sources of empirical traffic data to characterize real-world driving behavior in Alabama. Drone-based video data were used to extract operational measures, including speed distributions, travel time, lane utilization, and gap acceptance, at selected field sites. In addition, NDS trajectory data were used to examine detailed driver behavior, including stopping tendencies, acceleration and deceleration patterns, and weaving behavior. These data sources provided objective benchmarks for identifying key parameters influencing simulation performance.

Using the observed behavioral and operational characteristics, facility-specific calibration procedures summarized in Appendix C were developed for roundabouts, DDIs, RCUT intersections, and freeway merge/diverge scenarios. Calibration focused on parameters with demonstrated sensitivity, including speed distributions, car-following behavior, lane-changing distance, priority and yielding rules, and acceleration and deceleration functions. Model performance was evaluated by comparing simulated results with field-observed measures, including speeds, delays, and travel times, demonstrating improved agreement relative to default or minimally calibrated models.

The practical guidance was developed to help traffic engineers improve the reliability and consistency of microscopic simulation in traffic analysis and design. The documented calibration methods, parameter ranges, and validation approaches can be directly applied to future planning, operational analysis, and geometric design studies. By incorporating these practices, simulation models can better reflect Alabama-specific traffic behavior, supporting more informed decision-making and more defensible project evaluations.

These calibration guidelines were developed based on existing references and a limited number of study sites in Alabama. Traffic volumes at most study locations may not reflect near-capacity conditions. As traffic volumes approach capacity, some of the recommended driver-behavior parameters may need to be adjusted to reflect changes in driver response and operational dynamics.

7. DISSEMINATION ACTIVITIES AND IMPLEMENTATION PLAN

The implementation plan for this study emphasizes transferring research findings and calibration guidance into professional practice through project meetings, conference presentations, and training activities. The following efforts have been undertaken to disseminate the results:

1. A technical presentation summarizing the guidelines presented in the final report was delivered at the Alabama Transportation Conference in Huntsville, Alabama, on February 3–4, 2026.
2. A technical presentation on non-circular roundabouts was delivered at the PTV User Group Meeting in Las Vegas, Nevada, in October 2025, and at the TRB Annual Meeting in Washington, D.C., in January 2026.
3. A technical presentation titled “Calibration of Microscopic Traffic Simulation for Roundabouts” was presented at the ALSITE Spring Meeting on March 5, 2026.

These dissemination activities conducted during the project period support implementation by increasing awareness of the research outcomes and encouraging adoption of the proposed calibration guidance among transportation professionals and stakeholders.

The project team also plans to collaborate with the ALDOT Local Technical Assistance Program (LTAP) to develop a training course based on the proposed guidelines. The team will assist ALDOT in incorporating these guidelines into existing ALDOT policies and guidance documents where appropriate. In addition, all developed VISSIM simulation models will be made available for download to facilitate application by practitioners.

Finally, the research findings will be incorporated into a graduate-level traffic simulation course, helping to train the next generation of transportation professionals and supporting long-term workforce development in traffic simulation and roundabout analysis.

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APPENDIX A: Roundabout Information



Turbo (33.2963, -87.0603)

Roundabout Information

- ☐ Location: McCalla, Jefferson County
- ☐ Lane type: Multilane
- ☐ Video date: 10-Oct-24
- ☐ Video Length: 45 minutes
- ☐ Type of Roundabout: 5 Legs approaches Turbo roundabout
- ☐ ICD:250ft
- ☐ Completed Year: 2025

Figure A-1 Turbo Roundabout at McCalla, Jefferson, AL



Elliptical (33.1733, -86.7790)

Roundabout Information

- ☐ Location: Calera, Shelby County
- ☐ Lane type: Single-lane
- ☐ Video date: 10-Oct-24
- ☐ Video Length: 15 minutes
- ☐ Type of Roundabout: 3 Legs approaches Ellipse Roundabout
- ☐ ICD:163 ft
- ☐ Length: 216 ft
- ☐ Completed Year: 2021

Figure A-2 Elliptical Roundabout at Calera, Shelby County, AL



Peanut (31.6773, -85.9573)

Roundabout Information

- ☐ Location: Spring Hill, Pike County
- ☐ Lane type: Single-lane
- ☐ Video date: 24-May-24
- ☐ Video Length: 45 minutes
- ☐ Type of Roundabout: Peanut shaped.
- ☐ Node ICDs are 140 ft.
- ☐ Length is 485 ft.
- ☐ Completed Year: 2024

Figure A-3 Peanut-Shaped Roundabout at Spring Hill, Pike County, AL



Peanut (32.9435, -85.9536)

Roundabout Information

- ☐ Location: Alexander City, Tallapoosa County
- ☐ Lane type: Single-lane
- ☐ Video date: 24-May-24
- ☐ Video Length: 45 minutes
- ☐ Type of Roundabout: Peanut shaped.
- ☐ Node ICDs are 158 ft.
- ☐ Completed Year: 2002

Figure A-4 Peanut-Shaped Roundabout at Alexander City, Tallapoosa County, AL



Egg (32.5776, -85.5244)

Roundabout Information

- ☐ Location: Auburn, Lee County
- ☐ Lane type: Single-lane
- ☐ Video date: 7-Nov-22
- ☐ Video Length: 45 minutes
- ☐ Type of Roundabout: Egg Shape
- ☐ Node ICDs are 114 ft.
- ☐ Completed Year: 2022

Figure A-5 Egg-Shaped Roundabout at Auburn, Lee County, AL



Circular (32.5699, -85.5336)

Roundabout Information

- ☐ Location: Auburn, Lee County
- ☐ Lane type: Single-lane
- ☐ Video date: 7-Nov-22
- ☐ Video Length: 45 minutes
- ☐ Type of Roundabout: Circle.
- ☐ Node ICDs are 128 ft.
- ☐ Completed Year: 2023

Figure A-6 Roundabout at Auburn, Lee County, AL



Circular (30.5309, -87.8695)

Roundabout Information

- ☐ Location: Fairhope, Baldwin County
- ☐ Lane type: Single-lane
- ☐ Video date: 21-May-24
- ☐ Video Length: 15 minutes
- ☐ Type of Roundabout: Circle.
- ☐ Node ICDs are 164 ft.
- ☐ Completed Year: 2017

Figure A-7 Roundabout at Fairhope, Baldwin County, AL

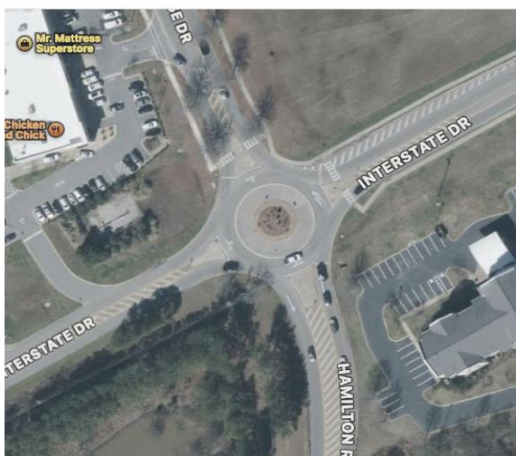


Circular (33.5354, -86.6735)

Roundabout Information

- ☐ Location: Birmingham, Jefferson County
- ☐ Lane type: Single-lane
- ☐ Video date: 31-Jan-23
- ☐ Video Length: 30 minutes
- ☐ Type of Roundabout: Circle.
- ☐ Node ICDs are 176 ft.
- ☐ Completed Year: 2023

Figure A-8 Birmingham Roundabout, Jefferson County, AL

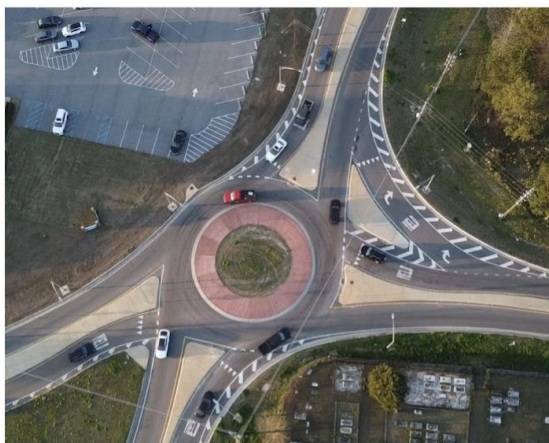


Circular (32.6158, -85.4072)

Figure A-9 Opelika Roundabout, Lee County, AL

Roundabout Information

- ☐ Location: Opelika, Lee County
- ☐ Lane type: Single-lane
- ☐ Video date: 31-Jan-23
- ☐ Video Length: 90 minutes
- ☐ Type of Roundabout: Circle.
- ☐ Node ICDs are 132 ft.
- ☐ Completed Year: 2018



Circular (32.6659, -85.4900)

Roundabout Information

- ☐ Location: Auburn, Lee County
- ☐ Lane type: Single-lane
- ☐ Video date: 7-Nov-22
- ☐ Video Length: 45 minutes
- ☐ Type of Roundabout: Circle.
- ☐ Node ICDs are 105 ft.
- ☐ Completed Year: 2021

Figure A-10 Auburn Roundabout, Lee County, AL



Circular (34.7289, -86.7680)

Roundabout Information

- ☐ Location: Madison, Madison County
- ☐ Lane type: Single-lane
- ☐ Video date: 13-Oct-24
- ☐ Video Length: 15 minutes
- ☐ Type of Roundabout: 4 Legs approaches
- ☐ ICD: 132ft
- ☐ Completed Year: 2021

Figure A-11 Madison Roundabout, Madison County, AL

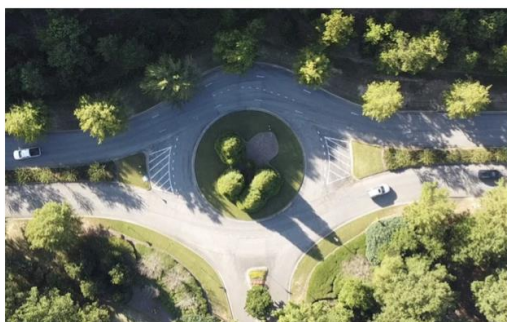


Circular (32.5387, -86.2035)

Roundabout Information

- ☐ Location: Wetumpka, Elmore County
- ☐ Lane type: Single-lane
- ☐ Video date: 13-Oct-24
- ☐ Video Length: 15 minutes
- ☐ Type of Roundabout: Circle.
- ☐ Node ICDs are 85 ft.
- ☐ Completed Year: 2021

Figure A-12 Wetumpka Roundabout, Elmore County, AL



Circular (33.3451, -86.5880)

Roundabout Information

- ☐ Location: Chelsea, Madison County
- ☐ Lane type: Multi-lane
- ☐ Video date: 13-Oct-24
- ☐ Video Length: 15 minutes
- ☐ Type of Roundabout: Circle.
- ☐ Node ICDs are 115 ft.
- ☐ Completed Year: 2002

Figure A-13 Chelsea Roundabout, Madison County, AL



Circular (33.3637, -87.0078)

Roundabout Information

- ☐ Location: Bessemer, Jefferson County
- ☐ Lane type: Single-lane
- ☐ Video date: 10-Oct-24
- ☐ Video Length: 15 minutes
- ☐ Type of Roundabout: Circle
- ☐ ICD: 139ft
- ☐ Completed Year: 2004

Figure A-14 Bessemer Roundabout, Jefferson County, AL



Circular (32.6743, -85.3341)

Roundabout Information

- ☐ Location: Opelika, Lee County
- ☐ Lane type: Single-lane
- ☐ Video date: 21-May-25
- ☐ Video Length: 75 minutes
- ☐ Type of Roundabout: Circle.
- ☐ Node ICDs are 142 ft.
- ☐ Completed Year: 2017

Figure A-15 Opelika Roundabout, Lee County, AL



Circular (33.9838, -86.5877)

Roundabout Information

- ☐ Location: Cleveland, Blount County
- ☐ Lane type: Single-lane
- ☐ Video date: 7-Nov-22
- ☐ Video Length: 15 minutes
- ☐ Type of Roundabout: Circle.
- ☐ Node ICDs are 170 ft.
- ☐ Completed Year: 2020

Figure A-16 Cleveland Roundabout, Blount County, AL



Circular (32.6110, -85.3918)

Roundabout Information

- ☐ Location: Opelika, Lee County
- ☐ Lane type: Single-lane
- ☐ Video date: 7-Nov-22
- ☐ Video Length: 45 minutes
- ☐ Type of Roundabout: Circle.
- ☐ Node ICDs are 123 ft.
- ☐ Completed Year: 2020

Figure A-17 Opelika Roundabout, Lee County, AL



Circular (32.5071, -86.1286)

Roundabout Information

- ☐ Location: Wetumpka, Elmore County
- ☐ Lane type: Single-lane
- ☐ Video date: 7-Nov-22
- ☐ Video Length: 45 minutes
- ☐ Type of Roundabout: Circle.
- ☐ Node ICDs are 120 ft.
- ☐ Completed Year: 2022

Figure A-18 Wetumpka Roundabout, Elmore County, AL

APPENDIX B: VISSIM Roundabout Modeling Guidance

Roundabouts of different shapes differ significantly in their geometry and general design principles; thus, modeling them in VISSIM will yield different results. Some past guidance explains how to model single and multilane roundabouts. This section discusses the entire process of modeling a roundabout and the considerations for modeling and calibrating roundabouts of different shapes.

Background image extraction and setting

For existing roundabouts, the display can be configured by following these steps: Edit Basic Graphic Parameters → Map Provider → PTV Gravelpit, as shown in Figure B-1. For roundabouts in the planning stage, the modeling process can be developed using design files such as AutoCAD drawings.

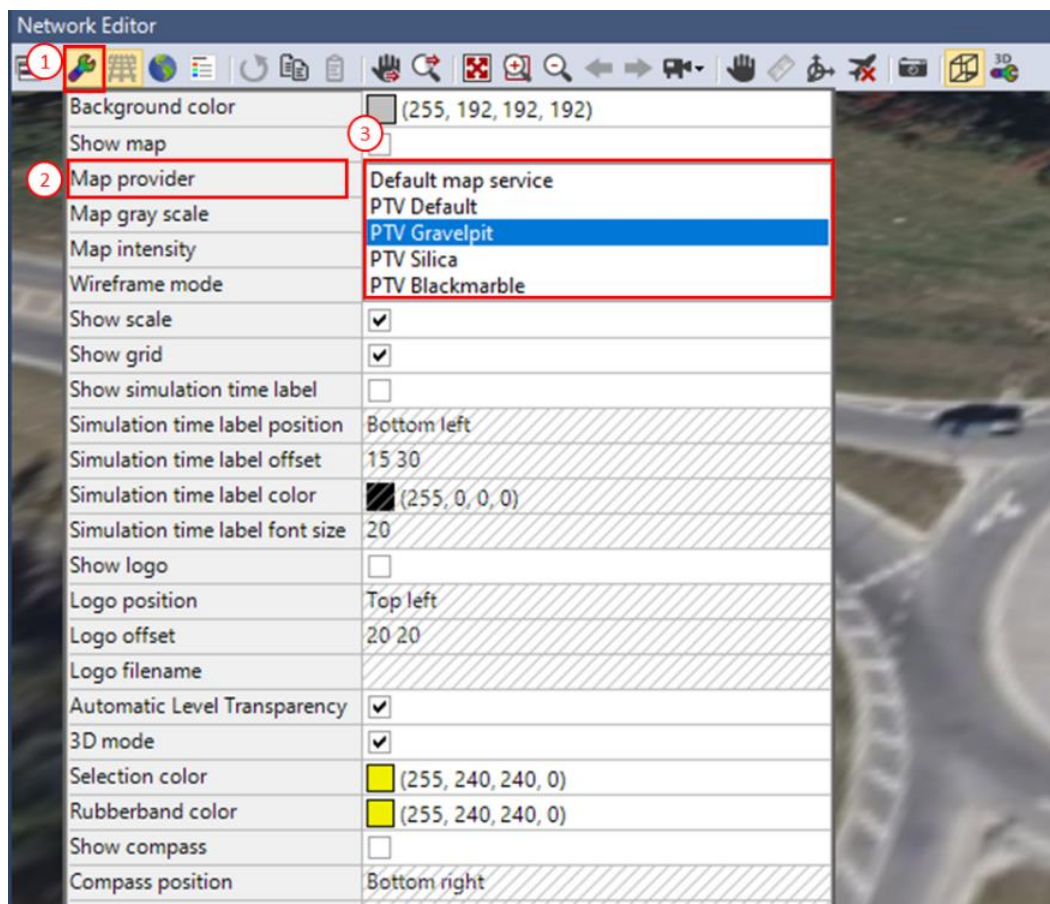


Figure B-1 Use of built-in Aerial Imagery in VISSIM to Support Geometric Network Development

Some VISSIM versions do not include Bing Maps or PTV Gravelpit, and the built-in aerial imagery may be outdated. In that case, create the network using a custom base map: capture a current aerial/satellite screenshot from Google Maps or Bing Maps, save it to your project folder,

and make sure the image includes the scale bar. The screenshot should cover all key site features and extend beyond the expected maximum queue length for accurate modeling (Figure B-2 and Figure B-3).

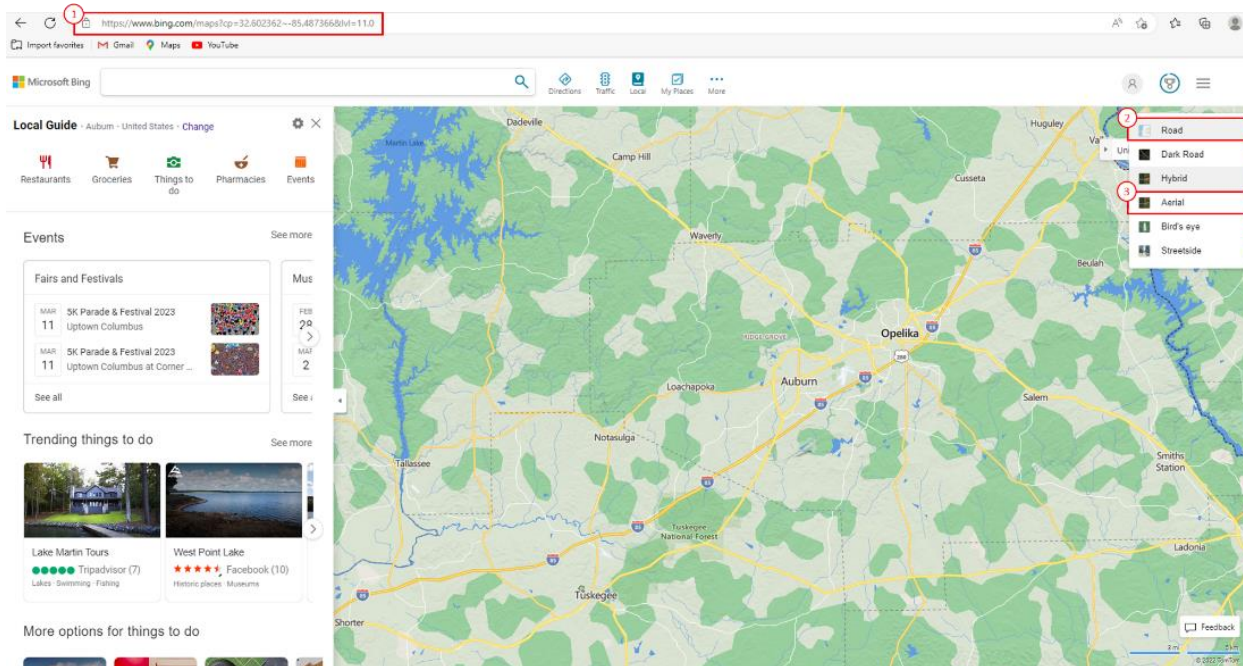


Figure B-2 Example of External Aerial Imagery Used as a Reference

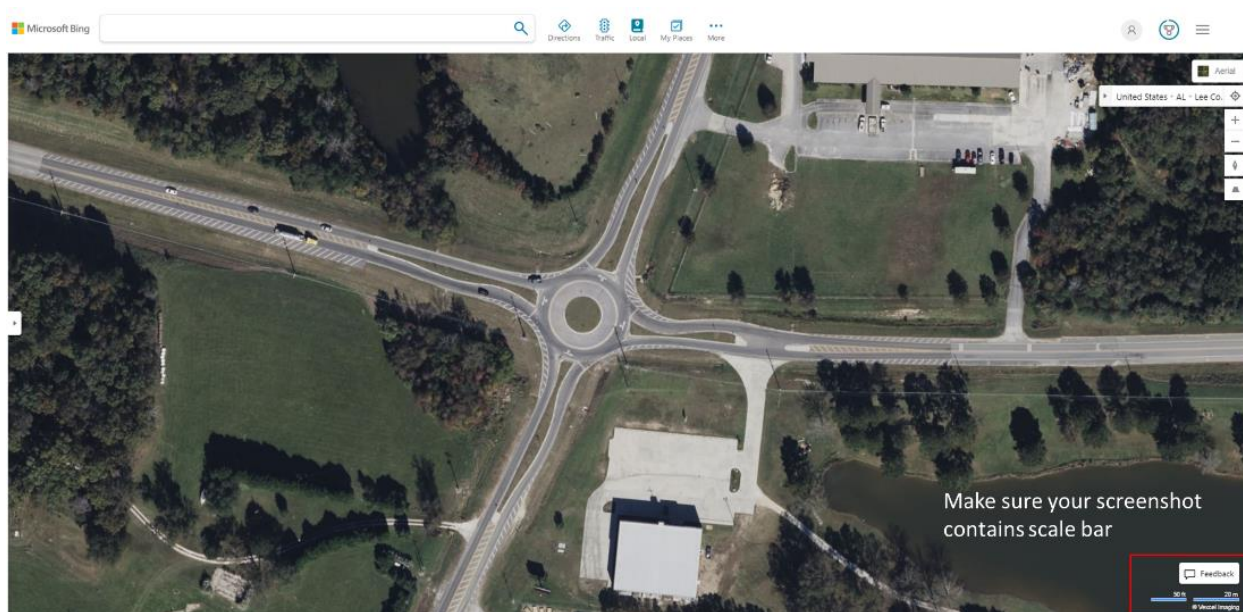


Figure B-3 Captured Aerial Map of Study Site

To set the background image in Vissim, the user should go to Net Objects → Background Image, set a suitable zoom level, then right-click and drag to define the display area, and load the image file. To scale the map, the user should zoom in on the image's scale bar, then press Ctrl and right-click the background image, choose Set Scale, draw a line matching the scale bar, and enter the corresponding real-world length (Figure B-4 and Figure B-5).

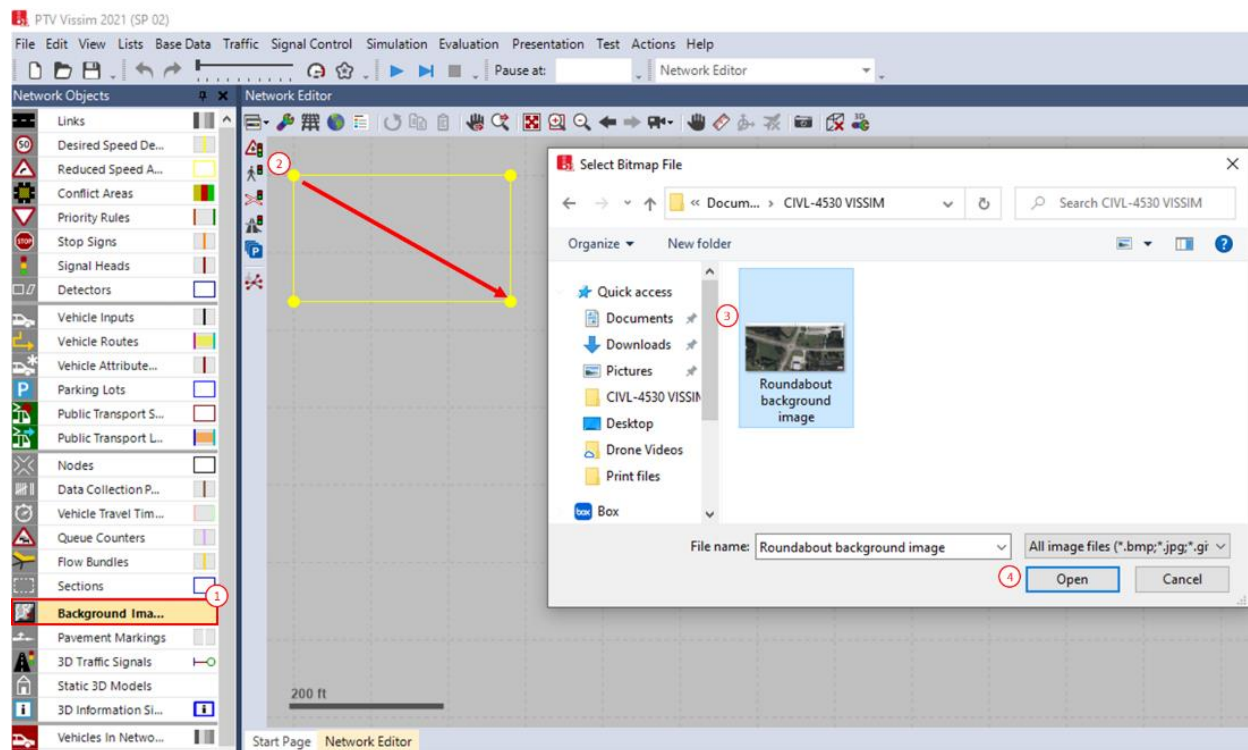


Figure B-4 Import the Background Image

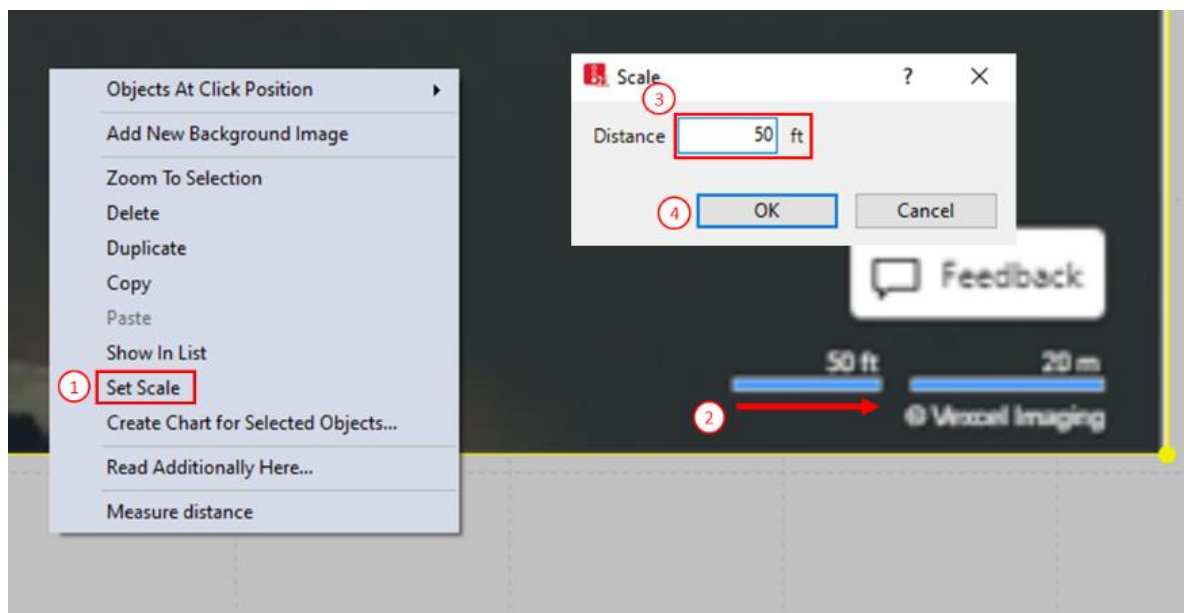


Figure B-5 Set Scale of Background Image

Create the links and connectors

To create link and connectors, go to Net Objects → Links, hold the right mouse button to draw a straight link between two points on the circle, assign a link name, set the lane number (1 for single-lane and 2 or more for multilane circular roundabouts), and specify the link width based on measurements from the base map (16 ft for this roundabout); for non-circular roundabouts, use multiple connected links to follow the actual shape, then confirm to finish (Figure B-6).

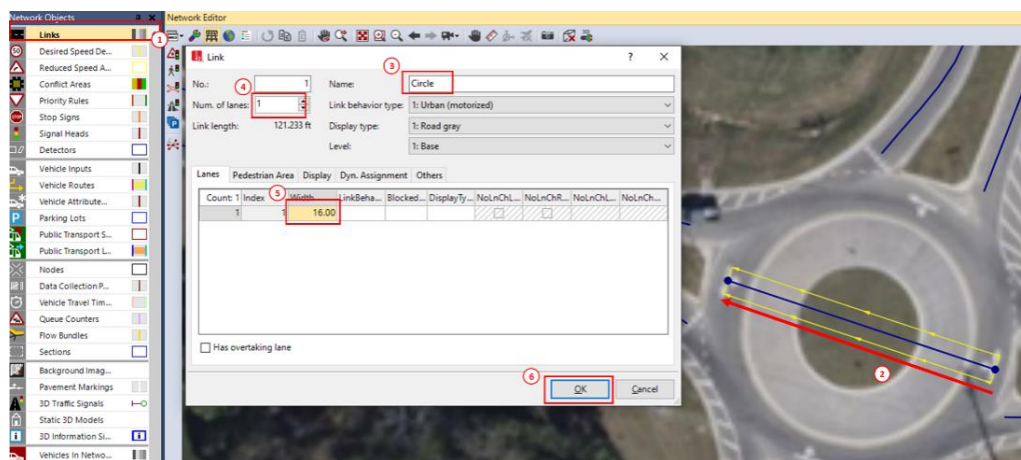


Figure B-6 Draw the Roadway Segment

Right-click on the link segment to create spline points, then drag the points to make an approximate circle. Road segments have directional attributes, so please draw the road along the direction of traffic flow. Note that the end point and the start point should be as close as possible but not touching or overlapping (Figure B-7).

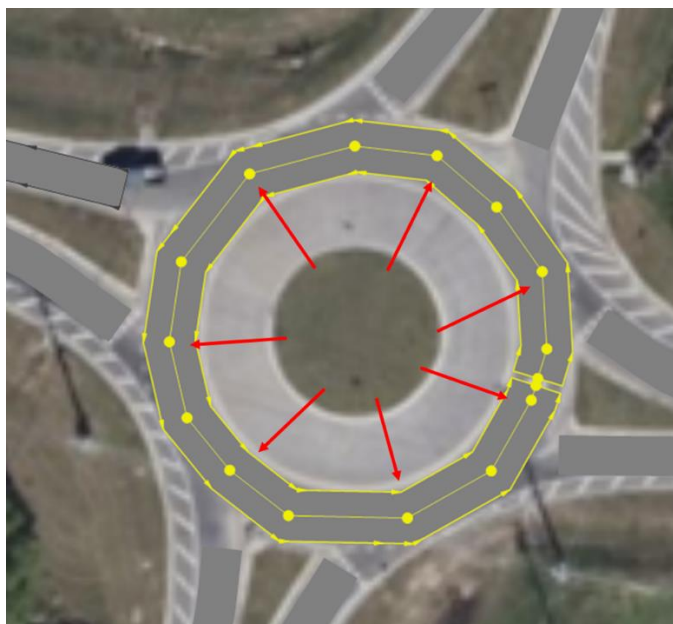


Figure B-7 Adjust the Roadway Segment

Hold down the Alt key and press the left mouse button to select all line segments of the roadway to smooth the curve. The window allows you to select the number of spline points to insert; the more, the smoother the curve (Figure B-8).

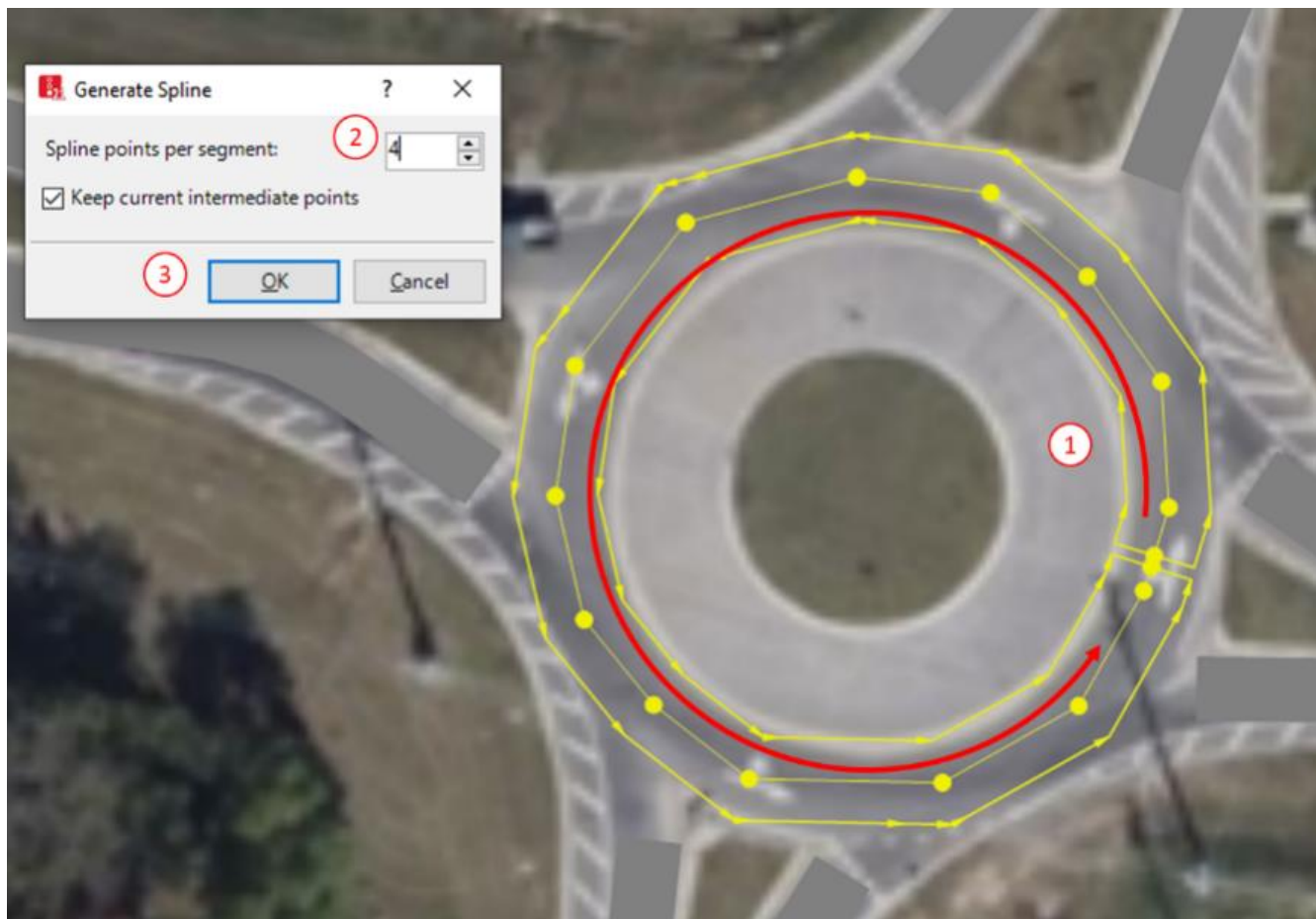


Figure B-8 Smooth the Roadway Segment

Create a connector by right-clicking and dragging from the end point to the start point; the settings window should pop up when you release. After naming and confirming the connector, adjust its start and end points to reduce overlap while keeping a realistic path, since overlaps prevent placing controls and can cause unstable vehicle behavior. Finally, click Toggle wireframe to switch to centerline mode and check that the network is smooth and aligned with the background map (Figure B-9 and Figure B-10). For circular roundabout, right click and add a circulating link based on ICD would also work well.

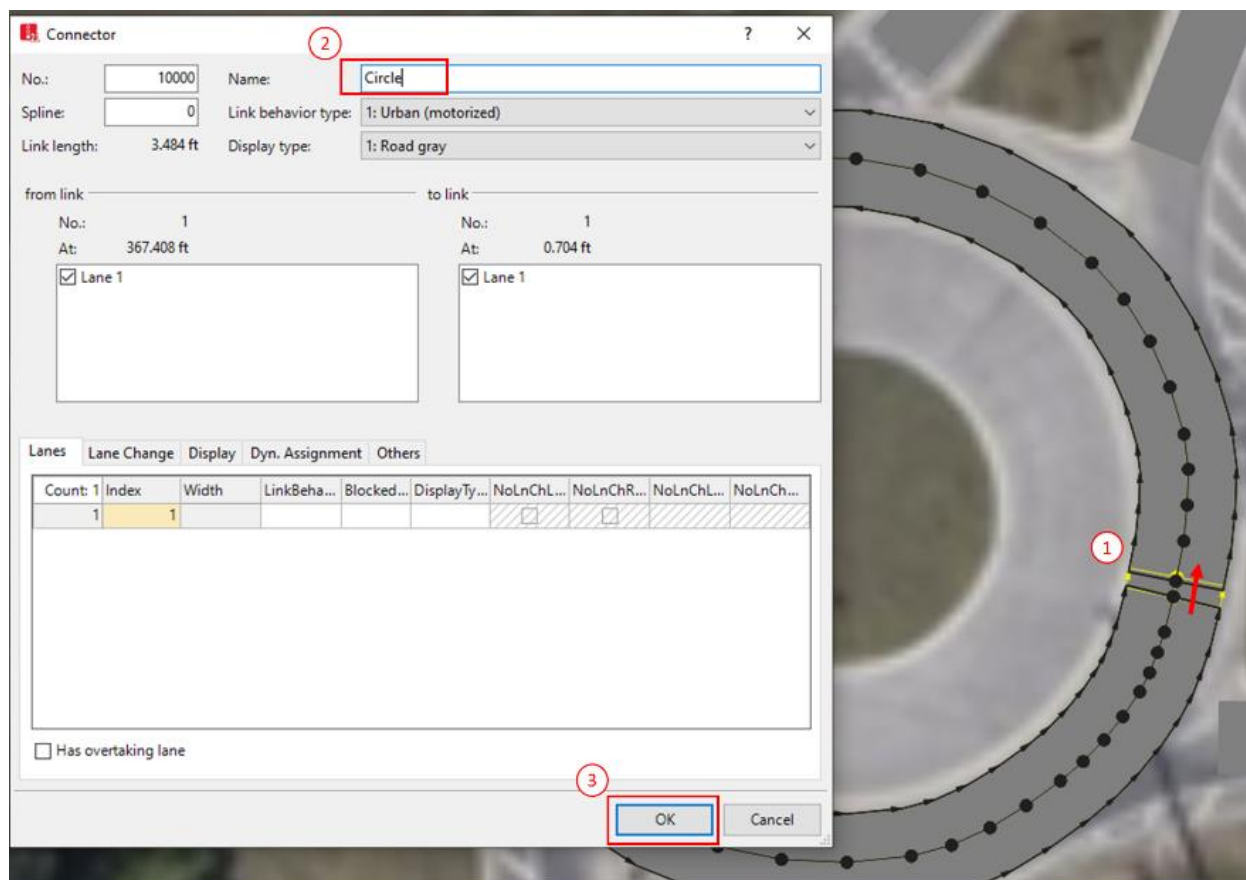


Figure B-9 Smooth the Roadway Segment

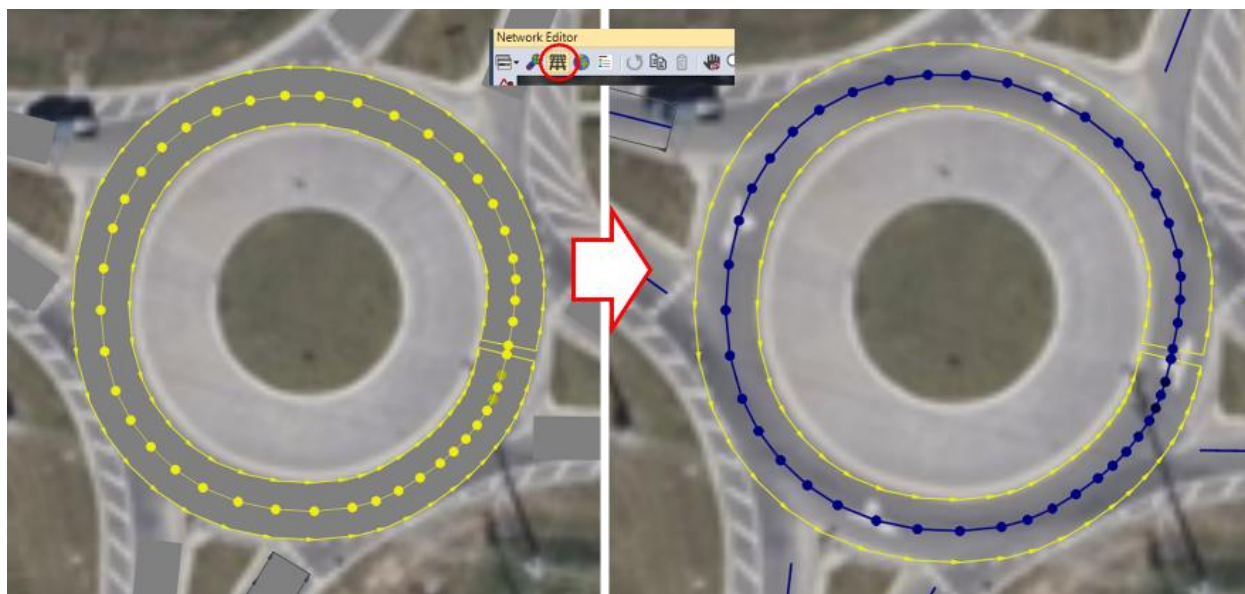


Figure B-10 Centerline Model for Roadway Network

For non-circular roundabouts, geometry can be modified by adding additional shape points and adjusting them as needed. When the roundabout contains multiple circulating lanes, the number of lanes can be increased directly. However, if the roundabout includes an outer lane that primarily serves through traffic rather than circulating traffic, it is recommended that this be drawn as a separate link and connected to the main roundabout using a connector (Figure B-11 and Figure B-12).

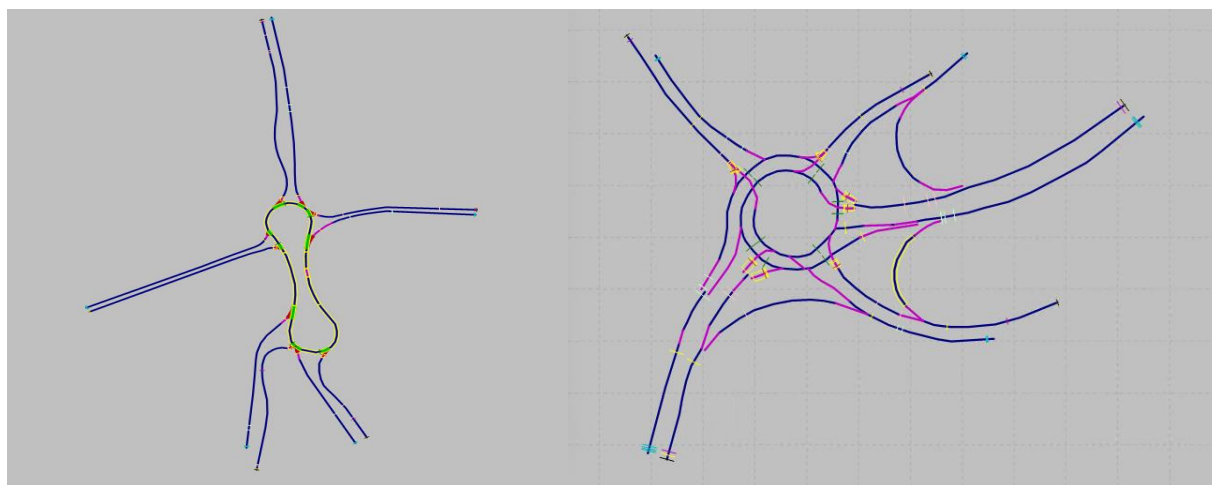


Figure B-11 Centerline Model for Peanuts and Turbo Roundabout

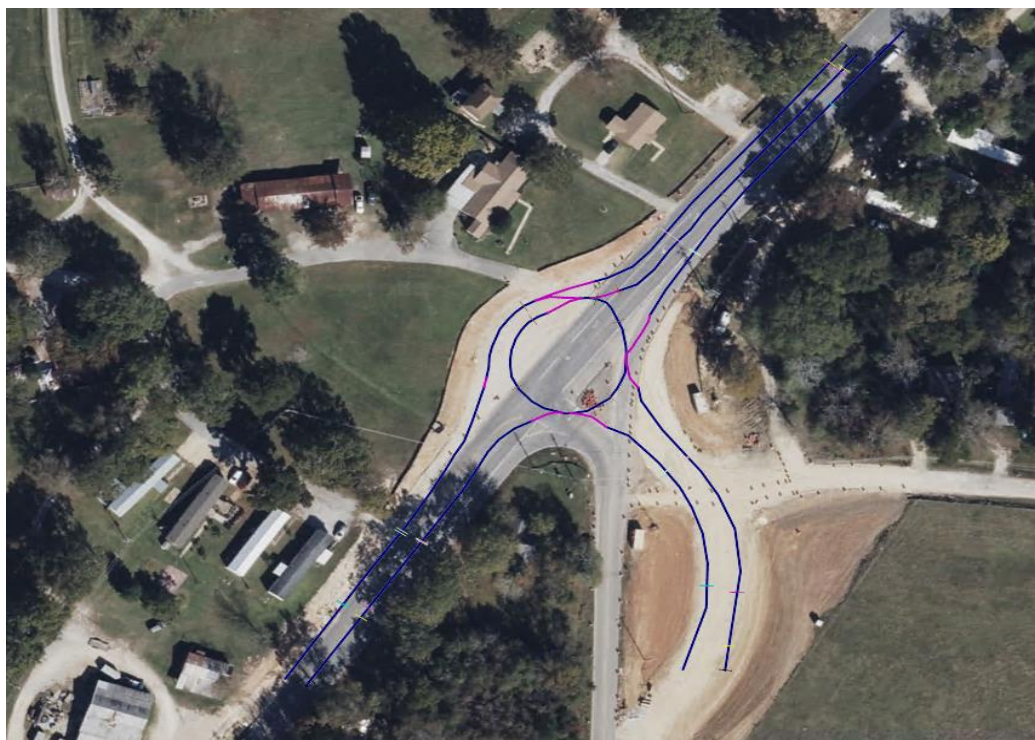


Figure B-12 Centerline Model for Egg Shape Roundabout

Draw link segments for each of the four entrances and exits, then adjust their curves to match the background image. Links should not intersect; when two segments need to connect, use a connector. In Net Objects → Links, draw each link from start to end in the direction of traffic flow, assign a name, set the number of lanes and the real-world width, confirm, and then insert spline points to fine-tune the alignment with the base map (Figure B-13 and Figure B-16).

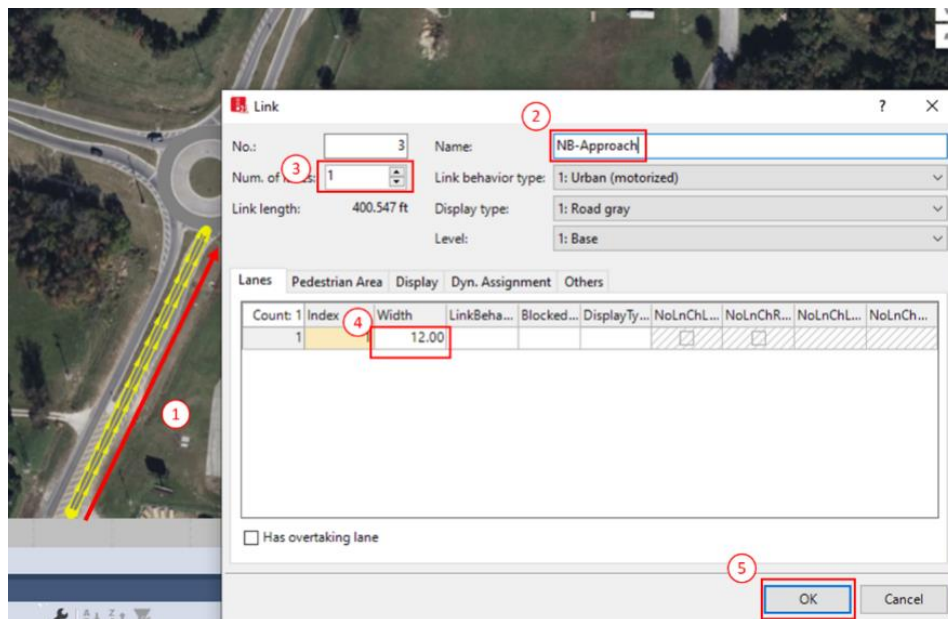


Figure B-13 Create Entrance and Exit Segments

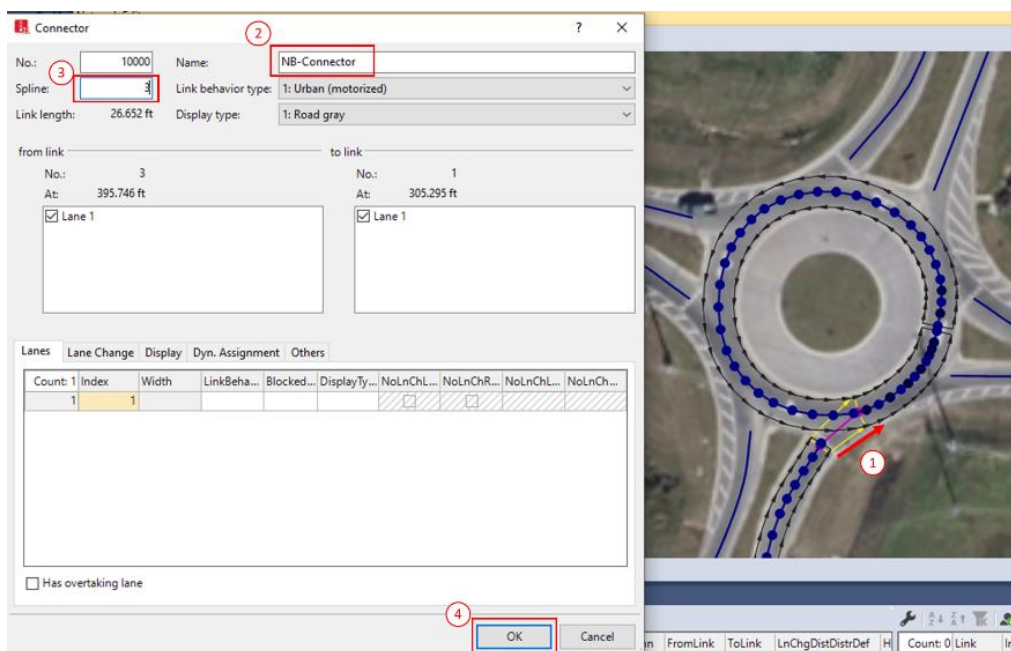


Figure B-14 Create the Connectors

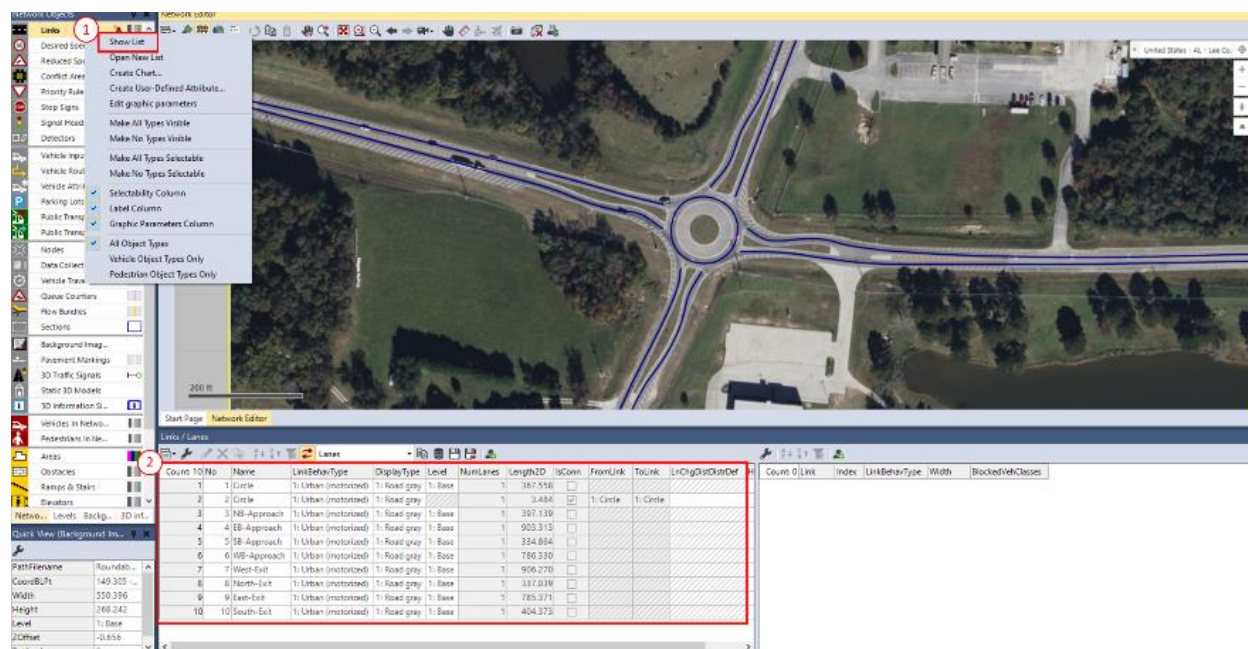


Figure B-15 Review All Link Objects

The completed road network should be as shown in Figure B-16 below.

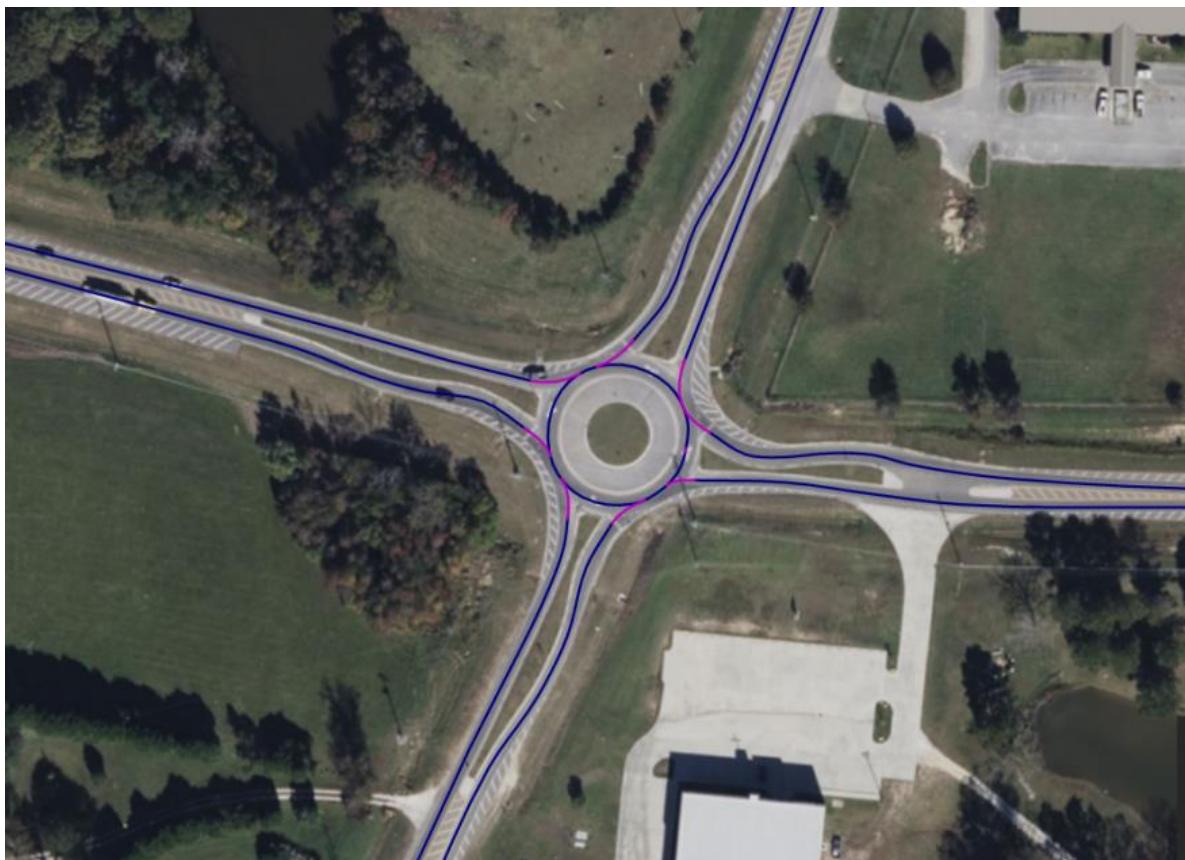


Figure B-16 Completed Road Network

Set the Speed limit

The next step is to set the speed limit for each road segment. Select the Desired Speed tool and the Reduced Speed Area on the upstream portion of the link to place a speed-limit object. Vehicles will follow the specified speed limit only after passing this point. In the pop-up window, assign a name to the speed-limit object, then right-click within the window to add speed-limit rules for different vehicle types. Reduced speed zones were necessary because they allow segment-specific speed reductions and recovery to be modeled explicitly and calibrated to observed field speeds. In contrast, a desired speed decision plus “Speed limitations in curves” provides a more generic curvature-based adjustment and less control over where and how speeds change. For roundabouts, especially non-circular speed behavior is influenced not only by curvature but also by entry control, yielding, lane path, and local geometry. Reduced speed zones, therefore, provided a more realistic representation of entry, circulating, and exit speed transitions.

By default, the desired-speed distributions generally reflect the posted speed-limit signs on the roadway. However, during calibration, engineers must analyze field data to determine the actual vehicle speed distribution and configure desired distributions that more accurately reflect real operating conditions. The calibration process will be discussed in the next section (Figure B17 to Figure B19). To calibrate the speed based on Table 5-6, you just need to adjust that part with a different desired speed distribution function.

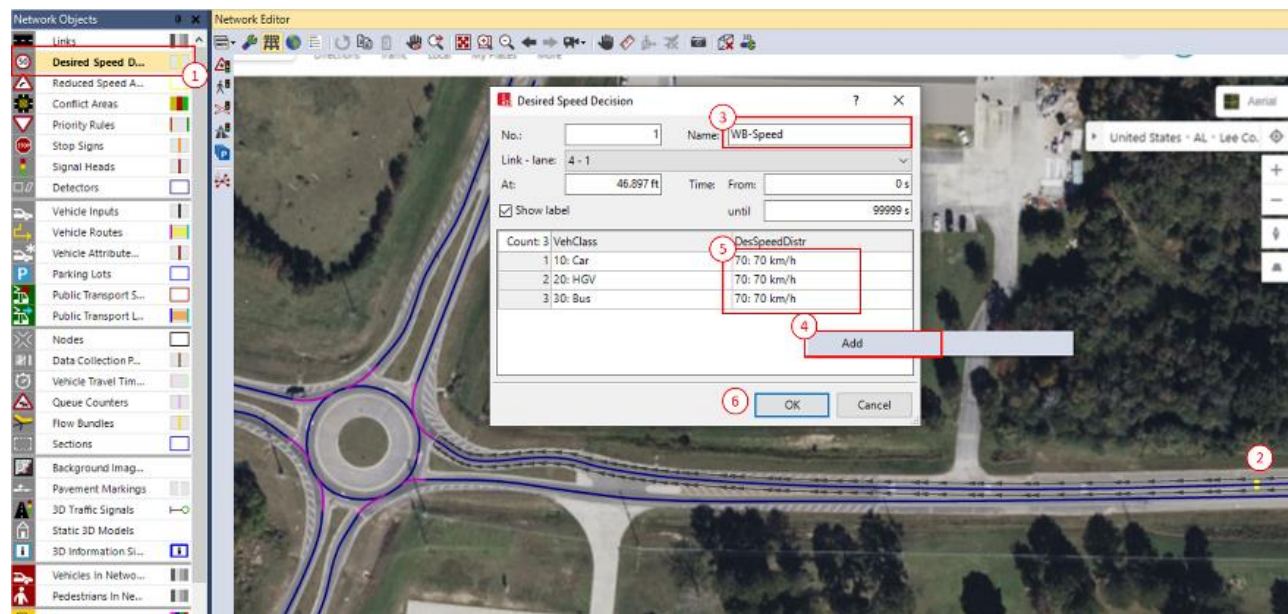


Figure B-17 Configure Desired Speed

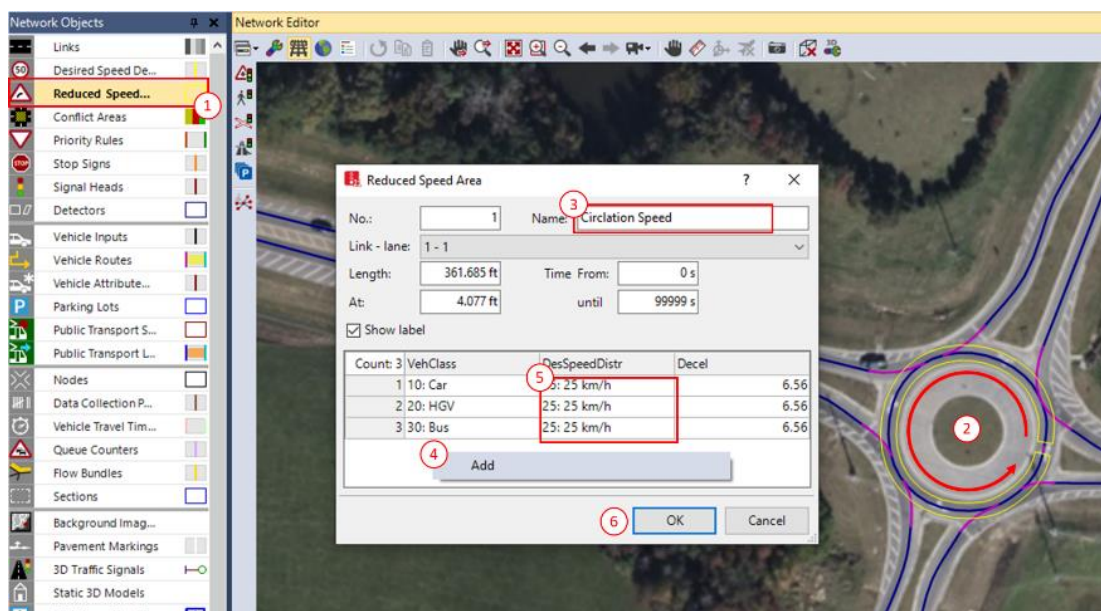


Figure B-18 Configure Reduced Speed Area

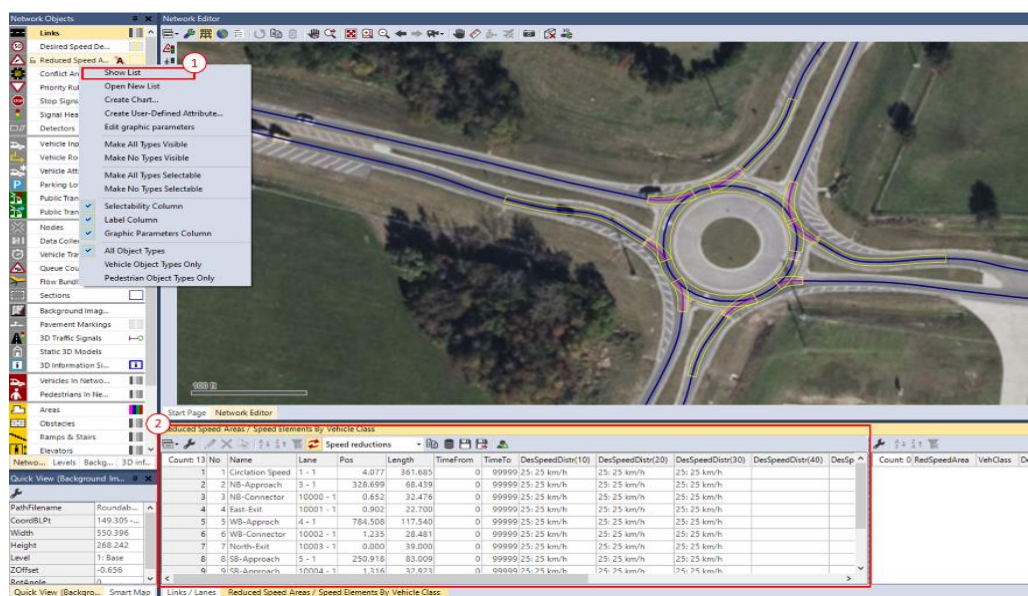


Figure B-19 Review All the Speed Configurations

Input traffic

At this stage, all roadway links have been created. The next step is to define vehicle inputs so vehicles can enter the network. In the Net Objects menu, select Vehicle Inputs. Then, right-click the entrance links where vehicles should be generated to place the vehicle input points. VISSIM will automatically snap each input point to the beginning of the selected link (Figure B-20).

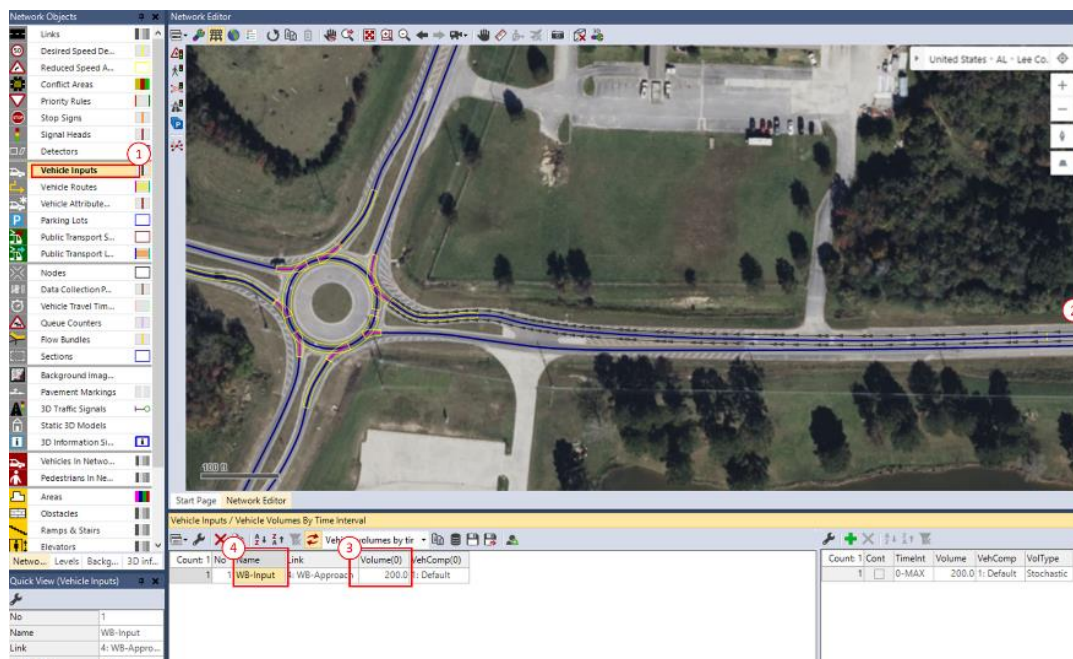


Figure B-20 Configure the Input Vehicles

Vehicle routes (static)

To configure vehicle travel paths using static routing, go to Net Objects → Vehicle Routes, then right-click each entrance link to place a decision point (where vehicles choose their route) and right-click the destination links to define one or more endpoints; VISSIM will automatically compute and display the shortest paths in yellow. One decision point (purple) can connect to multiple endpoints (blue), so you must assign the relative flow for each route option: open Vehicle Routes → Show List → Static, select the decision points and corresponding paths (they will highlight), name each path, and enter the values in RelFlow (Figure B-21 to Figure 22).

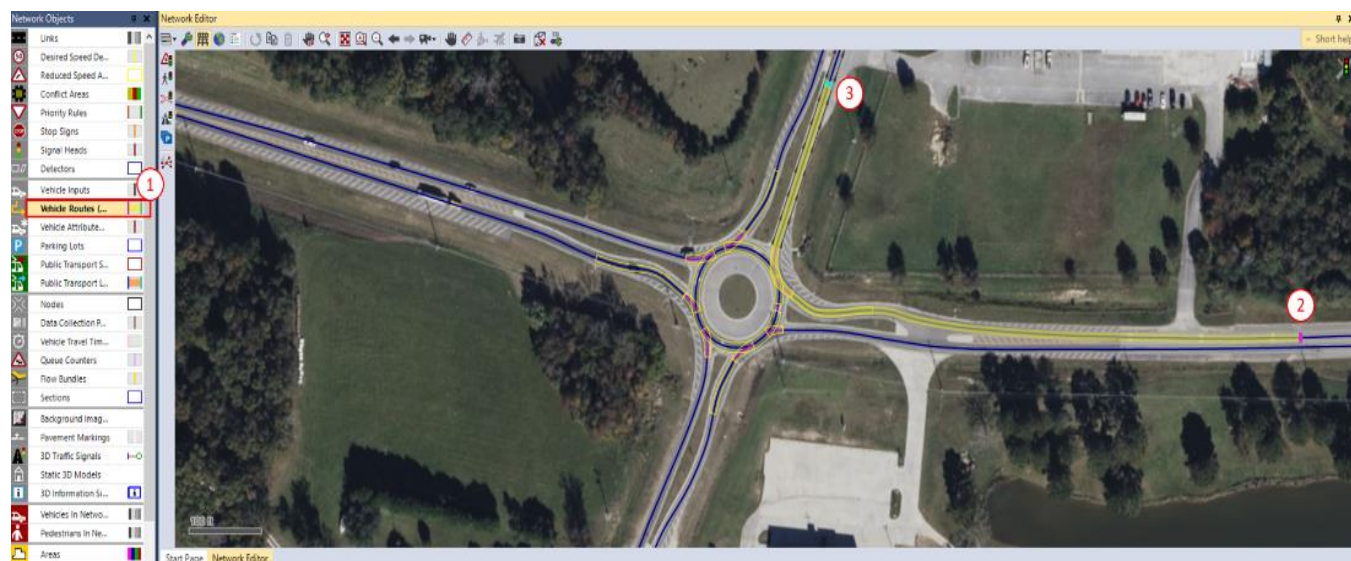


Figure B-21 Configure the Decision Points and End Points

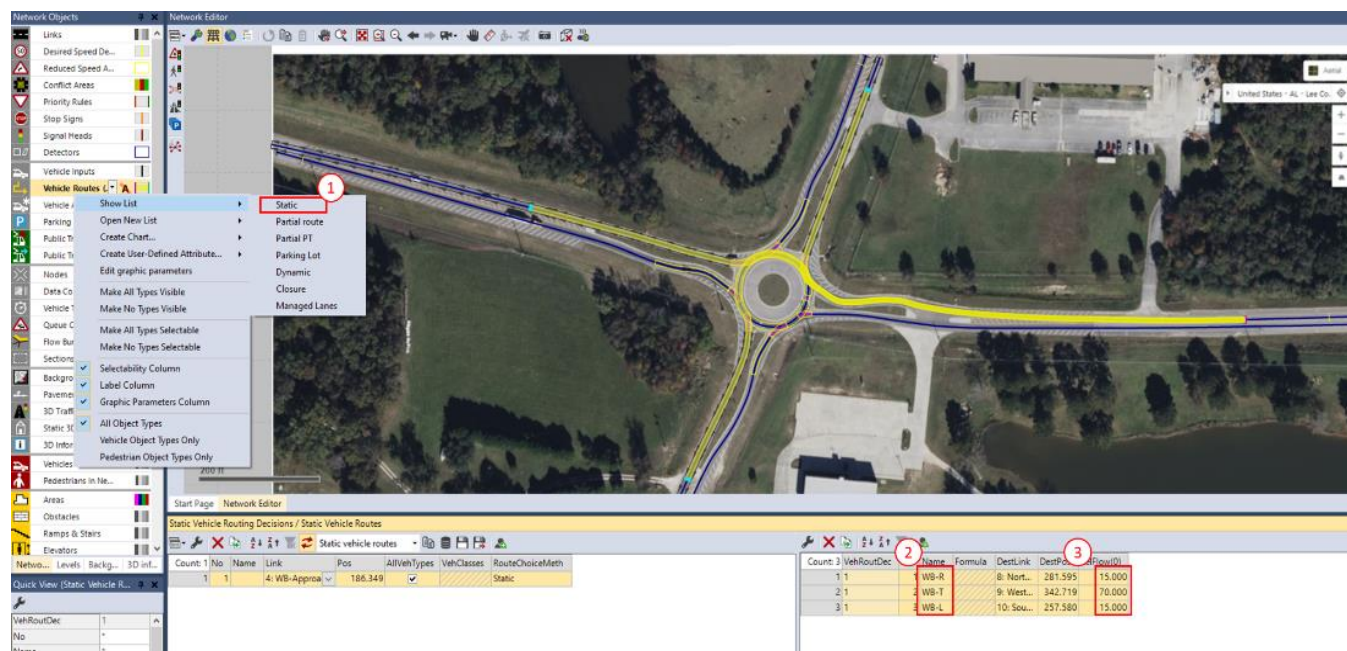


Figure B-22 Configure the Relative Flow of Different Paths

Intersection control

VISSIM provides two approaches for modeling right-of-way: priority rules and conflict zones, each suited to different needs.

VISSIM provides two approaches for modeling right-of-way—priority rules and conflict zones—each suited to different needs. Priority rules are preferred for roundabout simulation. Priority rules include configurable parameters. When setting a priority rule, as discussed in Section 5.2.4 Priority Rule, the red line is placed at the entrance, and the green line is placed at the conflict point, as shown in Figure 5-5 Minimum Clearance for Approaches at Peanut Roundabouts, the definitions of **minimum clearance** and **minimum gap time** should follow the guidance provided in Table 5-6.

Run the simulation

The last step is to run the simulation and evaluate the results. The first step is to click the continuous button at the top of the toolbar to run the simulation model with or without animations in quick mode, completing the simulation and generating results as quickly as possible (Figure B-23).

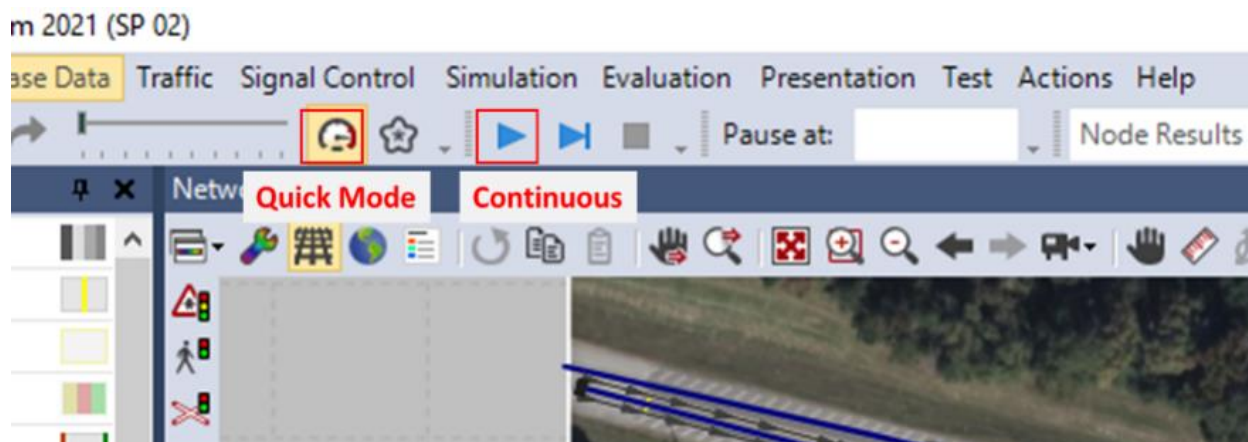


Figure B-23 Run the Simulation Model

The default simulation period is 3600 seconds, and the simulation speed is set to the maximum. The user may open the parameter window to adjust the simulation settings. When the simulation speed factor is set to 1.0, the simulation runs in real time; when set to 10, it runs 10 times faster than real time (Figure B-24).

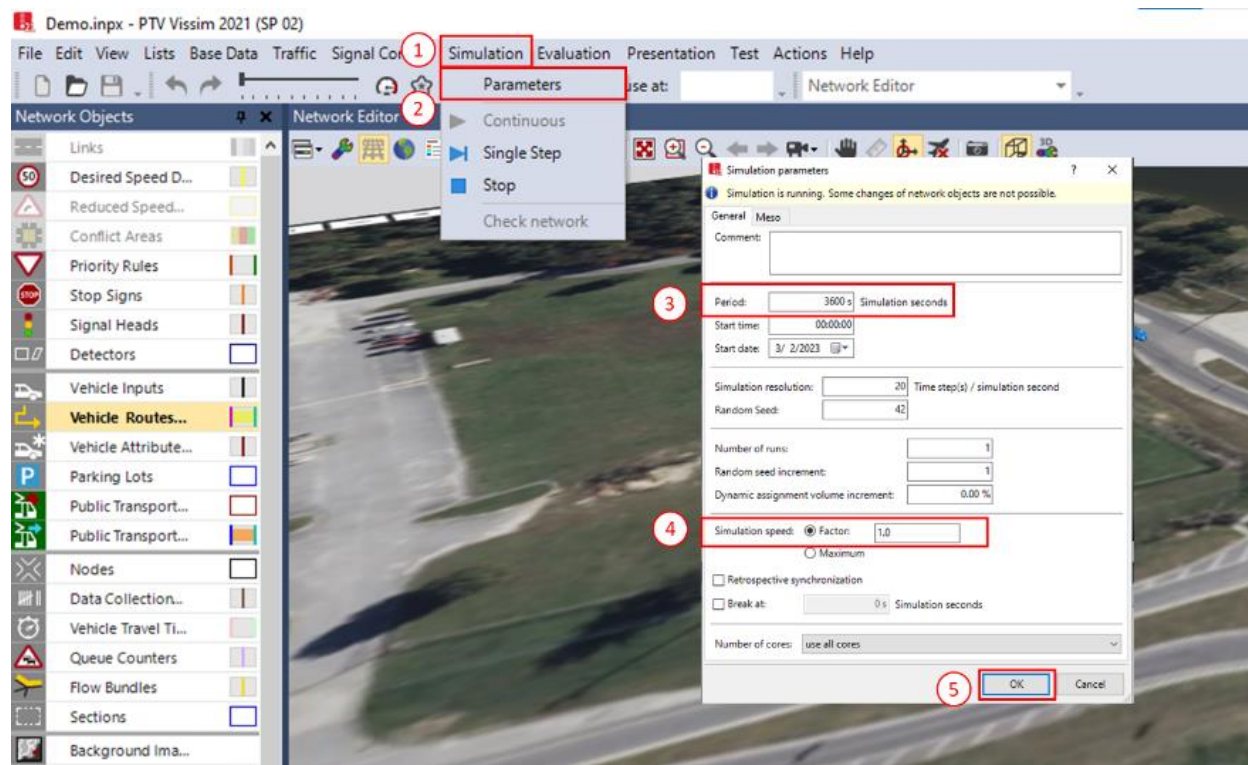


Figure B-24 Configure the Simulation Parameters

APPENDIX C: Summary of Calibration Parameters

Table C-1 Summary of Calibrated Roundabout Parameters

Parameter Grouping	Parameter Name	Default Parameters	Recommended Parameter Range
Speed Distribution	Enter Speed	Speed Limit	Speed Limit (use posted speed-limit default distribution on entry links)
	Circulating Speed	Speed Limit	$0.90 \times \text{Speed limit to } 1.40 \times \text{Speed limit}$ For a roundabout with a large curve, an additional reduced-speed area should be implemented.
	Exit Speed	Speed Limit	Speed Limit (use posted speed-limit default distribution on exit links)
Priority Rule	Minimum gap time (s)	3	3.0 for circular roundabout and 4.0 for non-circular roundabout
	Minimum Clearance (ft)	16.4	For approaches with a close upstream entrance, the minimum clearance should be defined as the distance measured along the entering path from the entry yield line to the upstream conflict marker. (Figure 5-4)
		16.4	For approaches with a far upstream entrance, the minimum clearance should be approximately 1.2 times* the distance to the upstream exit. (Figure 5-5)
Car-following Model	W74ax (ft)	6.56	Circular: Default, Non-Circular: 6.0
	W74bxAdd	2.00	Default
	W74bxMult	3.00	Default

Table C-2 Summary of Calibrated DDI Parameters

	Recommended Parameters	DDI
Driving Behavior	CC0 (Standstill Distance)	Cross Road (7.2 ft) Bridge (4.8 ft)
	CC1 (Time Headway)	Default: 0.9 s
Lane Change Distance	Lane Change Distance	Left turn before bridge: 96% Through before bridge: 95%
	Cooperative Braking	Default: No
	Maximum Deceleration for Cooperative Braking	Default
Priority Rule	Minimum gap time for Turning	SOR: 6.1 s

General	Speed range	Cross road: (-53%, 23%) Bridge: (-37%, 13%)
	Vehicle Composition	Local Data
	Timing Plan	Local Data

Procedure to Calibrate RCUT VISSIM Models

A four-step method was adopted for the RCUT microsimulation calibration:

- (1) Configure two connectors for the right-turn lane and the U-turn Lane, assigning 92%/8% (left/right) at the right-turn lane and 6%/94% (left/right) at the U-turn Lane.
- (2) Set a reduced speed area (7 km/h, $\approx$ 4 mph) at the minor-road stop line, and a priority rule with a 3.5 s minimum gap time.
- (3) Use the desired acceleration and deceleration functions in Table 5-12; and
- (4) Change the weaving-section desired speed distribution by the weaving speed function.

Table C-3 Parameters for Calibrating Merge (Work Zone) VISSIM Models

	Recommended Parameters	Merge (work zone)
Driving Behavior	CC0 (Standstill Distance)	10 ft
	CC1 (Time Headway)	Table 5-15
Lane Change Distance	Lane Change Distance	3,000 ft
	Cooperative Braking	Default: No
	Maximum Deceleration for Cooperative Braking	-20 ft/s ²
General	Speed Limit	Work Zone: 55 mph
	Vehicle Composition	Local Data

Table C-4 Summary of Calibrated Settings for Diverging Areas

Parameters	Default	Recommend
Lane change distance	656.2 ft	Diverge: 1200 ft, per lane Through: 1050 ft, per lane
Speed distribution	VISSIM built-in Speed Distribution	Through Passenger car: 64 – 75 mph, (-8.6%, 7.1%) Through Truck: 55 – 70 mph, (-21.4%, 0%) Diverge Passenger car: 47 – 59 mph, (-32.9%, -15.7%) Diverge Truck: 41 – 53 mph, (-41.4%, -24.3%)
Deceleration rate	6.56 ft/s ²	3 ft/s ²