SM ROCHA, LLC
TRAFFIC AND TRANSPORTATION CONSULTANTS

March 6, 2024

Krista Moore
APMI, Inc.
3003 N Central Avenue, Suite 1100
Phoenix, Arizona 85012

RE: Chase Bank / Traffic Generation Analysis
Lone Tree, Colorado

Dear Krista,

SM ROCHA, LLC is pleased to provide traffic generation information for the development entitled Chase Bank. This development is located at 9550 Heritage Hills Circle in Lone Tree, Colorado.

This information has been revised to address City Staff review comments dated February 9, 2024, regarding the need for a drive-through queuing analysis.

The intent of this analysis is to present traffic volumes likely generated by the proposed development, provide a traffic volume comparison to previous land use assumptions approved for the development site, and consider potential impacts to the adjacent roadway network.

The following is a summary of analysis results.

Site Description and Access

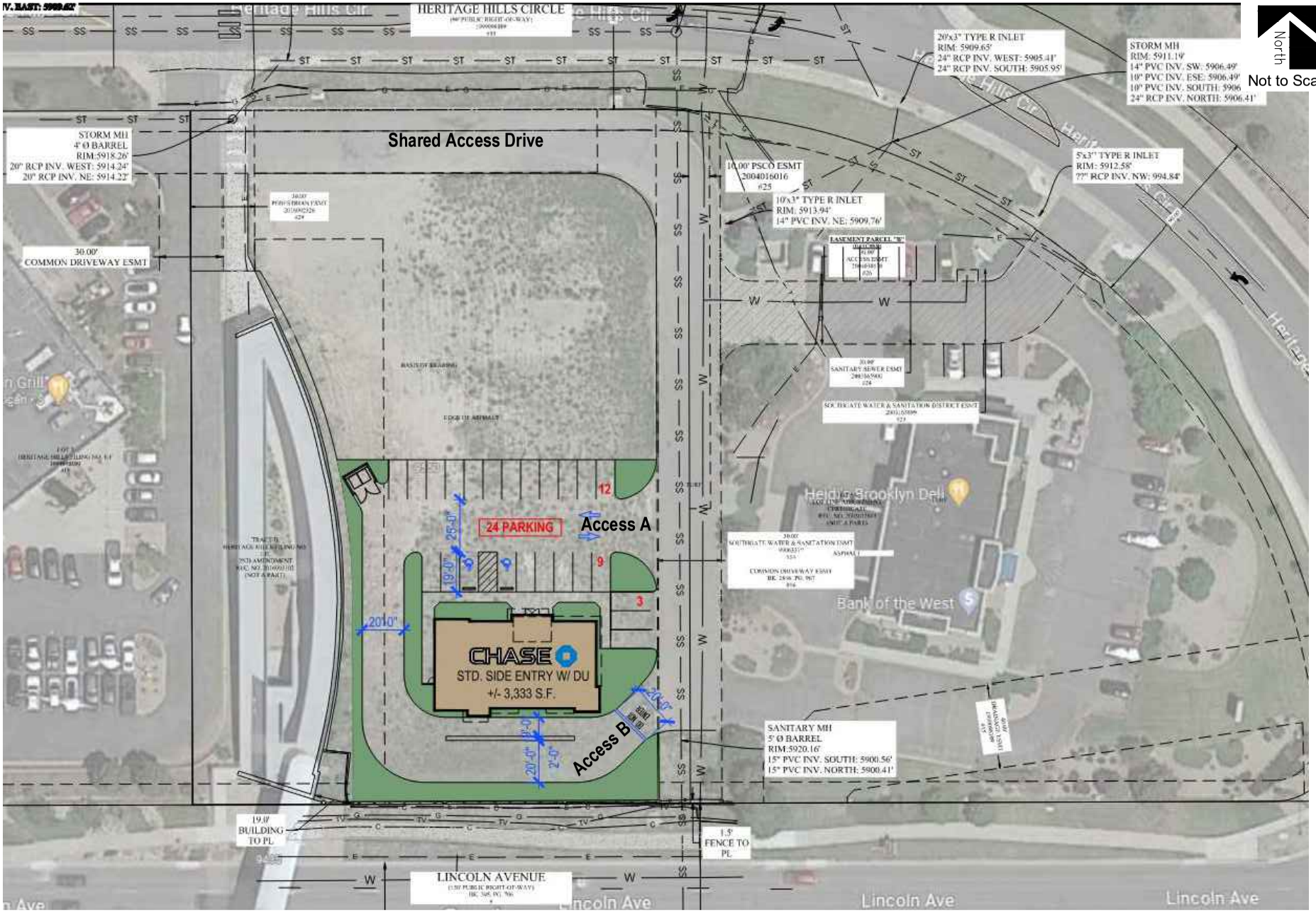
Land for the development is currently vacant and surrounded by a mix of residential, commercial, and institutional land uses. The proposed development is understood to entail the new construction of an approximate 3,300 square foot Chase Bank with a drive-in lane.

Proposed access to the development is provided at the following locations: one full-movement access onto the adjacent shared access drive (referred to as Access A), and one exit-only access onto the shared access drive (referred to as Access B).

General site and access locations are shown on Figure 1.

A site plan, as prepared by APMI, Inc., is shown on Figure 2. This plan is provided for illustrative purposes only.


North
Not to Scale
S Yosemite Street
Heritage Hills Circle
Development Site
Lincoln Avenue
Interstate 25
Commons Street
Park Meadows Boulevard
Ridgegate Parkway
Sky Ridge Avenue


HERITAGE HILLS CIRCLE
Shared Access Drive
STORM MH
4' Ø BARREL
RIM:5918.26'
20" RCP INV. WEST: 5914.24'
20" RCP INV. NE: 5914.22'
30.00'
COMMON DRIVEWAY ESMT
20'x3" TYPE R INLET
RIM: 5909.65'
24" RCP INV. WEST: 5905.41'
24" RCP INV. SOUTH: 5905.95'
STORM MH
RIM: 5911.19'
14" PVC INV. SW: 5906.49'
10" PVC INV. ESE: 5906.49'
10" PVC INV. SOUTH: 5906
24" RCP INV. NORTH: 5906.41'
10.00' PSCO ESMT
2004016016
10'x3" TYPE R INLET
RIM: 5913.94'
14" PVC INV. NE: 5909.76'
5'x3" TYPE R INLET
RIM: 5912.58'
??" RCP INV. NW: 994.84'
24 PARKING
Access A
Access B
CHASE
STD. SIDE ENTRY W/ DU
+/- 3,333 S.F.
SANITARY MH
5' Ø BARREL
RIM:5920.16'
15" PVC INV. SOUTH: 5900.56'
15" PVC INV. NORTH: 5900.41'
19.0'
BUILDING
TO PL
1.5'
FENCE TO
PL
LINCOLN AVENUE
Bank of the West
Lincoln Ave
North
Not to Scale

Vehicle Trip Generation

Standard traffic generation characteristics compiled by the Institute of Transportation Engineers (ITE) in their report entitled Trip Generation Manual, 11th Edition, were applied to the proposed land use in order to estimate the average daily traffic (ADT) and peak hour vehicle trips. A vehicle trip is defined as a one-way vehicle movement from point of origin to point of destination.

The approved traffic study[1] for the overall Heritage Hills Development used trip generation rates from ITE's Trip Generation Manual, 5th Edition and included "Apartment" land use in the same development area as currently proposed with this project.

Table 1 presents average trip generation rates for the development area proposed. Use of average trip generation rates presents a conservative analysis. ITE land use code 912 (Drive-in Bank) was used for analysis because of its best fit to the proposed land use.

Table 1 – Trip Generation Rates

ITE			TRIP GENERATION RATES						
			24	AM PEAK HOUR			PM PEAK HOUR		
CODE	LAND USE	UNIT	HOUR	ENTER	EXIT	TOTAL	ENTER	EXIT	TOTAL
912	Drive-in Bank	KSF	100.35	5.77	4.18	9.95	10.51	10.51	21.01

Key: KSF = Thousand Square Feet Gross Floor Area.
Note: All data and calculations above are subject to being rounded to nearest value.

Table 2 summarizes the projected ADT and peak hour traffic volumes likely generated by the land use area proposed and provides comparison to traffic volume estimates for the previously approved land use.

Table 2 – Trip Generation Summary

ITE			TOTAL TRIPS GENERATED						
			24	AM PEAK HOUR			PM PEAK HOUR		
CODE	LAND USE	SIZE	HOUR	ENTER	EXIT	TOTAL	ENTER	EXIT	TOTAL
Site Development - Previously Approved									
220	Apartment	7 DU	41	1	2	3	2	1	3
	Previously Approved Total:		*41*	*1*	*2*	*3*	*2*	*1*	*3*
Site Development - Proposed									
912	Drive-in Bank	3.3 KSF	334	19	14	33	35	35	70
	Proposed Total:		*334*	*19*	*14*	*33*	*35*	*35*	*70*
	Difference Total:		***294***	***18***	***12***	***30***	***33***	***34***	***67***

Key: DU = Dwelling Units. KSF = Thousand Square Feet Gross Floor Area.
Note: All data and calculations above are subject to being rounded to nearest value.

[1] Heritage Hills Multi-Family and Retail Development: Traffic Impact Analysis Update, Felsburg Holt, & Ullevig, February 1997.

As Table 2 shows, the proposed development area has the potential to generate approximately 334 daily trips with 33 of those occurring during the morning peak hour and 70 during the afternoon peak hour.

Adjustments to Trip Generation Rates

A development of this type is likely to attract pass-by trips from the adjacent roadway system. ITE defines a pass-by trip as an intermediate stop on the way from an origin to a primary trip destination without a route diversion. Due to this behavior, pass-by trips are not considered as "new" traffic generated by the development since the trips are already present on the roadway network enroute to their primary destination.

Pass-by trips are especially common to drive-in bank land uses given the convenience provided by these businesses on the way to another primary destination such as a place of work or home. As example, published ITE pass-by and diverted link trip data indicates an average trip generation reduction rate of 29 percent during the AM peak traffic hour and 35 percent during the PM peak traffic hour as typical to drive-in banks.

Upon consideration of the proposed land use, reductions were applied pursuant to ITE average data to the proposed land use in order to account for the high probability of pass-by trip generation. ITE average pass-by trip percentages used are presented in Table 3.

Table 3 illustrates projected ADT, AM Peak Hour, and PM Peak Hour traffic volumes likely generated by the proposed development upon build-out with reductions applied due to pass-by trips. Average daily (24-Hour) pass-by trip percentages were estimated as the average between the AM and PM peak hour rates indicated by ITE.

Table 3 – Trip Generation Summary with Pass-By Trip Reductions

ITE CODE	LAND USE	SIZE	TOTAL NEW TRIPS GENERATED						
			24 HOUR	AM PEAK HOUR			PM PEAK HOUR		
				ENTER	EXIT	TOTAL	ENTER	EXIT	TOTAL
Site Development - Previously Approved									
220	Apartment	7 DU	41	1	2	3	2	1	3
		Existing Total:	*41*	*1*	*2*	*3*	*2*	*1*	*3*
Site Development - Proposed									
		Pass-By Trip Reduction:	*32%*	*29%*	*29%*	*29%*	*35%*	*35%*	*35%*
912	Drive-in Bank	3.3 KSF	227	14	10	24	23	23	46
		Proposed Total:	*227*	*14*	*10*	*24*	*23*	*23*	*46*
		Difference Total:	***187***	***13***	***8***	***21***	***21***	***22***	***43***

Key: DU = Dwelling Units. KSF = Thousand Square Feet Gross Floor Area.
Note: All data and calculations above are subject to being rounded to nearest value.

Upon build-out and with consideration for pass-by trip reductions, Table 3 illustrates that the proposed development has the potential to generate approximately 227 new daily trips with 24 of those occurring during the morning peak hour and 46 during the afternoon peak hour. Compared to the previously approved land use, this represents a potential increase in site generation of approximately 187 daily trips with 21 of those occurring during the morning peak traffic hour and 43 during the afternoon peak traffic hour.

Trip Generation Distribution and Assignment

Overall directional distribution of site-generated traffic was determined based on existing area land uses, the site location within the City, the available roadway network, and in reference to historical traffic count data provided by the Colorado Department of Transportation's (CDOT) Traffic Count Database System (TCDS)[2]. Site-generated traffic is anticipated to be distributed through each proposed access. Distribution along S Yosemite Street is general and assumed to be 35 percent to/from the north and 10 percent to/from the south. Distribution along Lincoln Avenue is assumed to be 25 percent to/from the east and west. Distribution along Heritage Hills Parkway is assumed to be 5 percent to/from the north. Additional pass-by trip distribution is assumed to include vehicle routes heading east-west along Lincoln Avenue. Distribution percentages utilized for pass-by trips are anticipated to be 50 percent from the east and west.

Traffic assignment is how the site-generated and distributed trips are expected to be loaded on the roadway network. Applying assumed trip distribution patterns to site-generated traffic provides the peak hour trip volume assignments for the proposed accesses. These volumes are then divided further upon travel through adjacent roadways serving the overall development area. Table 4 below uses the difference in trip generation volumes from Table 3 and denotes projected traffic volumes at each proposed access and adjacent intersections.

It is to be noted that the overall site-generated trip assignments shown on Table 4 represent the combination of both primary trip generation and pass-by trips. Due to the application of pass-by trips, some negative site-generated trips are shown at the study intersections. These negative trips are the result of redistributing existing through volumes along Lincoln Avenue to site-generated ingress volumes.

[2] Transportation Data Management System, MS2, 2022.

Table 4 – Site Generated Trip Assignment

DEVELOPMENT ACCESS TURNING MOVEMENTS	AM PEAK HOUR		PM PEAK HOUR	
	Inbound Volume	Outbound Volume	Inbound Volume	Outbound Volume
Shared Access Drive / Heritage Hills Circle				
Eastbound Right	5	-	7	-
Westbound Left	13	-	26	-
Northbound Left	-	3	-	8
Northbound Right	-	9	-	26
Heritage Hills Circle / Heritage Hills Parkway				
Eastbound Left	-	0	-	1
Eastbound Through	-	9	-	25
Westbound Through	12	-	25	-
Southbound Right	1	-	1	-
Lincoln Avenue / Heritage Hills Circle				
Eastbound Left	7	-	14	-
Eastbound Through	-3	-	-6	-
Westbound Through	-2	-	-6	-
Westbound Right	5	-	11	-
Southbound Left	-	4	-	11
Southbound Right	-	5	-	14
S Yosemite Street / Heritage Hills Circle				
Westbound Right	-	3	-	8
Southbound Left	5	-	7	-
Lincoln Avenue / S Yosemite Street				
Eastbound Through	3	-	6	-
Westbound Left	-	1	-	2
Westbound Through	-	2	-	6
Northbound Right	1	-	2	-

Development Impacts

As Tables 3 and 4 show, there is an increase in peak hour traffic volumes anticipated for the proposed development. However, these volumes are considered minor and are not likely to negatively impact operations of Heritage Hills Circle nor other adjacent roadways or intersections.

Drive-Through Queue Length Analysis – Institute of Transportation Engineers (ITE)

Vehicle storage associated with the proposed drive-in bank was evaluated against ITE research, publications and recommendations.

ITE research and associated publications recommend approximately 200 feet of drive-through lane for banks with drive-through lane establishments. Assuming a conservative average vehicle length of 25 feet, this drive-through length provides for approximately eight vehicles of total storage and should be adequate to handle the vast majority of the drive-through lane volumes that might be encountered.

The above recommendations were then applied to the proposed site plan. It was concluded that there is a potential deficit in the on-site drive-through lane length for the proposed drive-in bank by approximately one vehicle. It is noted that in the event of extensive queuing, on-site parking and the provided walk-in facilities may provide an alternative to using the drive-in lane. Based on these considerations, no negative impacts due to drive-through queues are anticipated.

A drive-through storage length exhibit is included for reference in Attachment A.

Drive-Through Queue Length Analysis – Standard Probability Equations

Drive-through vehicle queuing calculations were also performed using standard probability equations based on the highest number of vehicles entering the site during peak hours, assumed drive-through service rate, and the percentage of entering vehicles using the drive-through. An average vehicle length of 25 feet was assumed.

Based on these calculations, a 95th percentile queue length of approximately five vehicles was established for the drive-in bank land use. This equates to drive-through lane lengths of approximately 125 feet. 95th percentile queue lengths only have a five percent probability of being exceeded during the analysis time period.

The above calculations were then applied to the proposed site plan. It is concluded that adequate vehicle storage is provided on-site when considering queuing probability results.

Probability calculation worksheets are provided for reference in Attachment B.

Conclusion

This analysis assessed traffic generation for the Chase Bank development, provided a traffic volume comparison to previous land use assumptions approved for the development site, and considered potential impacts to the adjacent roadway network.

It is our professional opinion that the proposed site-generated traffic resulting from the development is expected to create no negative impact to traffic operations for the surrounding roadway network and proposed site accesses, nor at the Heritage Hills Circle intersection with the shared access drive. Analysis of site-generated traffic concludes that proposed development traffic volumes are minor.

We trust that our findings will assist in the planning and approval of the Chase Bank development. Please contact us should further assistance be needed.

Sincerely,

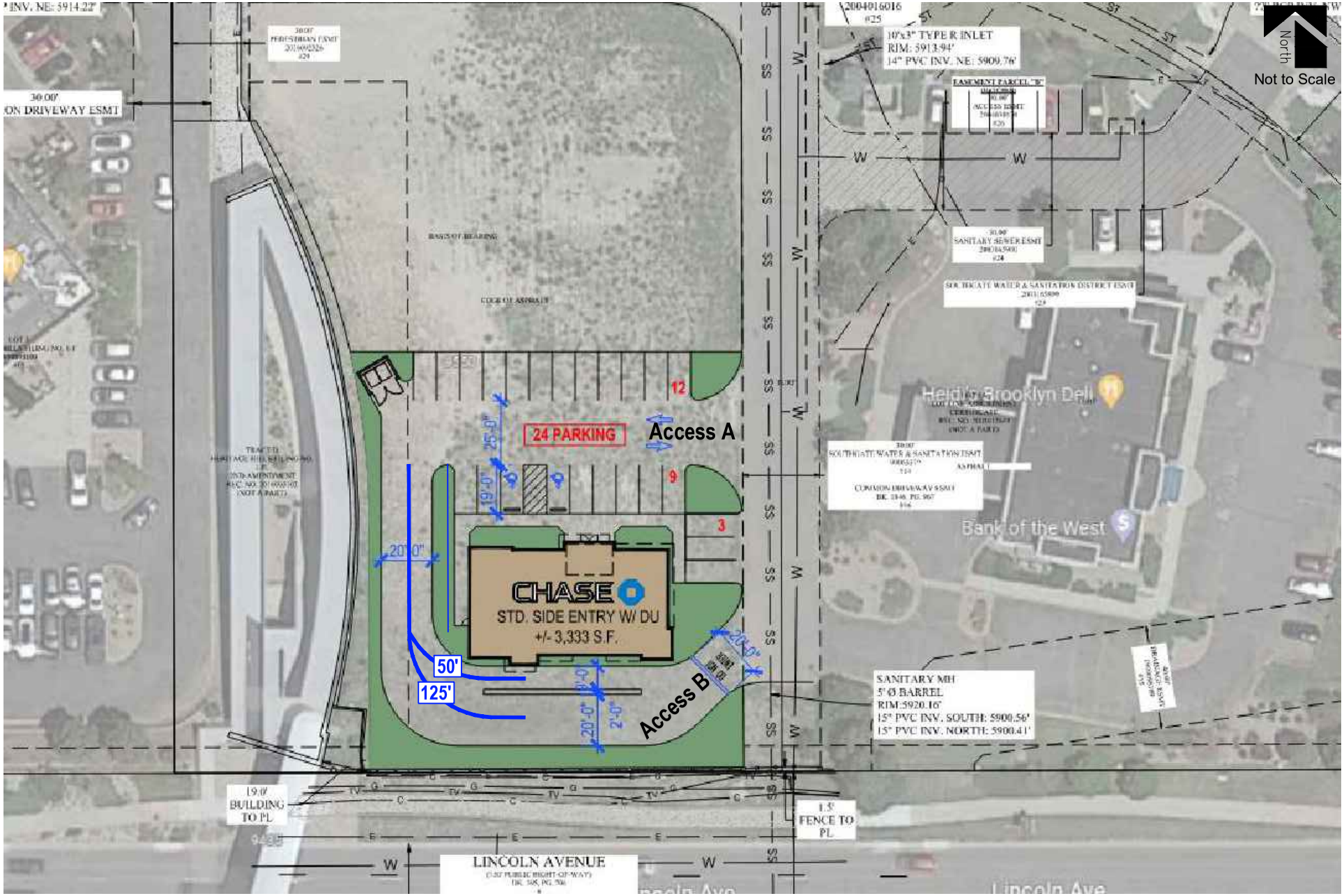
SM ROCHA, LLC
Traffic and Transportation Consultants

Megan Bock, EIT
Traffic Engineer

Fred Lantz, PE
Traffic Engineer

ATTACHMENT A

Drive-Through Storage Length Exhibit



CHASE BANK
Traffic Generation Analysis

DRIVE-THROUGH STORAGE LENGTH

SM ROCHA, LLC
Traffic and Transportation Consultants

March 2024

ATTACHMENT B

Drive-Through Queue Length Analysis Worksheet

SM ROCHA, LLC
TRAFFIC AND TRANSPORTATION CONSULTANTS

Queue Length Probability Analysis Worksheet

Provide input (red) values in the indicated fields. **Input**

Output (blue) values are shown as indicated. **Output**

Values in black are constants and do not change. **Constant**

PM Peak Hour Trips Entering:	23	vehicles
Assumed % Drive-Thru Trips:	80	%
Assumed Service Rate:	120	seconds

Traffic Intensity

$$\rho = \frac{\lambda}{\mu}$$

λ = mean arrival rate per min

μ = mean service rate per min

λ =	0.31	veh/min
μ =	0.5	veh/min
ρ =	0.62	veh/min

Average Vehicle Queue

$$E(n) = \frac{\rho}{1-\rho}$$

ρ =	0.62	veh/min
E(n) =	1.6	veh
Queue =	41	ft

Average Drive-Thru Wait Time

$$E(v) = \frac{1}{\mu(1-\rho)}$$

ρ =	0.62	veh/min
μ =	0.5	veh/min
E(v) =	5.26	min

Average Order Board-Window Wait Time

$$E(w) = \frac{\rho}{\mu(1-\rho)}$$

ρ =	0.62	veh/min
μ =	0.5	veh/min
E(w) =	3.26	min

Queue Probability Equation

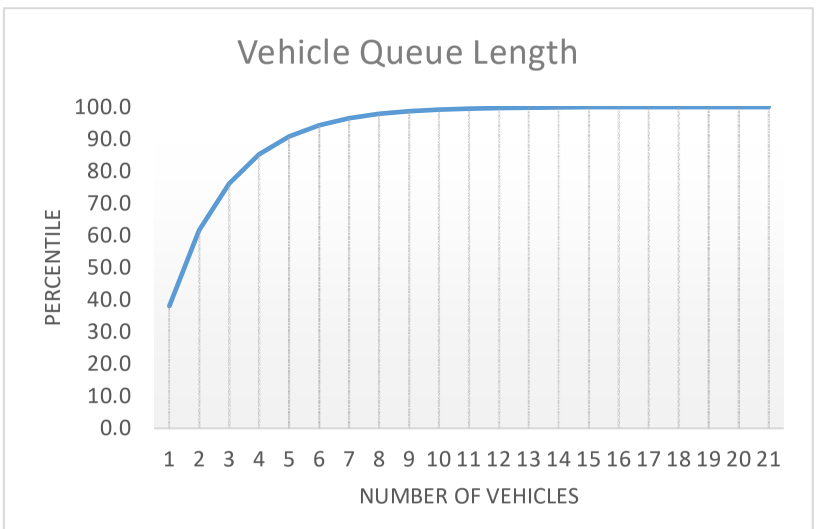
$$P(n) = \rho^n(1-\rho)$$

Percentile

$$\sum_0^n P(n) \geq \%$$

50th Percentile
85th Percentile
95th Percentile

Number of Vehicles in Queue (n)	Probility of Occurance P(n) (%)	Percentile
0	38.00	38.0
1	23.56	61.6
2	14.61	76.2
3	9.06	85.2
4	5.62	90.8
5	3.48	94.3
6	2.16	96.5
7	1.34	97.8
8	0.83	98.7
9	0.51	99.2
10	0.32	99.5
11	0.20	99.7
12	0.12	99.8
13	0.08	99.9
14	0.05	99.9
15	0.03	100.0
16	0.02	100.0
17	0.01	100.0
18	0.01	100.0
19	0.00	100.0
20	0.00	100.0



Notes:

1. The **greatest** volume of entering peak hour trips should be used (AM is shown as it is typically the highest).

2. Percent drive-through trips are determined based on land use, and confirmed (when possible) with client/developer/owner.

3. Service rate is defined as the rate at which vehicles pass a given point in the queue; or, the average time a vehicle spends in a given queue position before progressing to the next position. Pursuant to ITE publications this is typically 30 seconds. However, it may be adjusted for establishments which take longer or shorter to prepare orders. See the **average wait time** outputs for average time spent in the queue as a whole.

4. Traffic intensity must be less than 1. An intensity greater than 1 indicates an over-saturated queue (vehicles arrive faster than they can be served). When a queue is at capacity (intensity = 1) the next vehicle will typically choose to park or go elsewhere to avoid a long delay.

Standard Vehicle Length	
25	Feet

Recommended Queue Design Length

Length	50th Queue	85th Queue	95th Queue
Vehicles	0	3	5
Feet	0	75	125