TECHNICAL MEMORANDUM

DATE: February 17, 2014

TO: Keith Jones, URS

CC: Jim Harvey, ATG

FROM: Andrea Weckmueller-Behringer and Xuan Liu, ATG

RE: PLDV-2013.0035 NW Arkansas AA – Modeling Methodology, Ridership Forecasting, and Special Market Ridership Assessment

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Overview

This memorandum documents the development of conceptual transit ridership forecasts for use in a comparative evaluation of proposed transit alternatives in the area of Benton and Washington Counties, Arkansas.

The memorandum first covers development of a sketch-planning level transit corridor overlay model designed to supplement the existing Northwest Arkansas Regional Travel Demand Model (NWARK TDM) maintained by the Northwest Arkansas Regional Planning Commission (NWARPC). It then discusses quality control measures employed to determine the reasonableness of the modeled ridership. Lastly, the technical memorandum details the evaluation of special market ridership.

Ridership Analysis Approach

To generate the conceptual transit ridership forecast, the project team developed an approach capable of producing transit trip tables, estimating current transit ridership, and evaluating transit alternatives, using the available information from the existing NWARK model maintained by NWARPC. The approach built upon the existing transit trip generation capabilities of the NWARK TDM model, and developed methodologies to determine where the transit trips begin and to where they are destined. The overlay model then made use of mode specific travel time and cost information to determine a mode of travel and assign trips to a specific transit route. A detailed description of the modeling approach is presented in the sections below.

The starting point for this effort was the existing NWARK TDM. The NWARK travel demand model, while making use of some advanced modeling techniques, was focused on the highway mode and simply set aside transit trips identified in its trip generation step. The original trip generation model of the NWARK TDM produces trip productions by trip purpose that were allocated to car driver, car passenger, public transit, school bus and non-motorized trips using its mode choice model. The existing mode choice model split these trips based on factors such as, household, vehicle ownership, and income. Vehicle attractions were calculated during the trip distribution step and paired with the trip production from the trip generation step for the highway mode. Note that despite the advanced logit structure of these models, the no highway or transit skim (travel time from zone to zone) information, or the availability of transit service was not considered in assigning trip productions to a mode of travel. As the mode choice model did not consider any mode specific travel time information, the model could be described as a mode propensity model. Transit Trip Generation

As mentioned, the NWARK TDM produces transit trips through a series of logit models (generation, mode choice); however, the analysis had to overcome several issues to be able to model transit ridership on a specific route:

- Trip attractions, the location to which trips are going to, were created by the NWARK TDM for highway trips only.
- The transit trips produced by the NWARK TDM are higher than the observed (counted) transit ridership. Exactly 23,704 transit trips were produced by the NWARK trip generation model for 2010; whereas, 11,925 was the documented average daily transit ridership according to the local transit agency, and 10,023 was the surveyed average daily ridership.

As no attractions were produced for transit trips by the NWARK model, Alliance adopted the highway attraction models and balanced the total person trip attractions to public transit trip productions.
The table below depicts the attraction model used.

Table 1: Trip Attraction Model

Purpose	Attraction Model
Home-based Work (HBW)	0.783 * Total Employment
Home-based Other (HBO)	1.764 * Non-Basic Employment + 0.726 * Households (HH)
Home-based School (HBSC)	1.700 * Kindergarten – 12th School Enrollment
Home-based Shopping (HBSB)	2.581 * Retail Employment
Non Home-based Work (NHBW)	0.761 * Total Employment + 1.007 * Non-Basic Employment
Non Home-based Other (NHBO)	5.039 * Retail Employment + 1.821 * Non-Basic Employment + 0.889 * HH

The home-based university (HBU) attractions were fixed at 23,067 internally in the NWARK model. Alliance balanced the HBU attractions to the HBU transit production (total of 8,480) produced by the NWARK model. The original NWARK mode choice model (built into the trip generation step) produced about twice of the number of transit trips reported on the system. The project's initial approach called for an incremental mode choice model, however, it was necessary to build a fully functional mode choice model to split the transit trips from the larger pool of trips identified as transit eligible by the NWARK TDM as described in the following sections.

Trip distribution

The trip generation model produced both highway and non-highway trips. The highway trips were distributed using a traditional gravity model. The non-highway trips were not included in the original distribution model. Alliance determined that the non-highway trips should be distributed based on highway travel time skim using a gravity model for each trip purpose. Two main factors were important for that determination: 1) about half of the non-highway trips actually used highways and 2) many of the transit eligible production-attraction pairs did not have viable transit paths between the location of the production and the location of the attraction. Therefore the use of transit skims for the distribution of transit eligible (non-highway) trips was not an option. For the trip distribution model used to distribute transit eligible trips, Alliance adopted the original NWARK distribution model parameters used for highway trips as there was no other source of information readily available. The highway network skims for 2010 and 2035 were used for distributing 2010 and 2035 transit trips, respectively.

Mode Choice

The purpose of the mode choice model was two-fold: 1) to allocate the transit eligible (non-highway) trips generated in the logit-based generation step to a correct category of transit and highway trips and 2) to help compare potential ridership for several transit alternatives (i.e. bus rapid transit [BRT], light rail transit [LRT], and commuter rail transit [CRT]). With this purpose in mind, Alliance adopted a straight forward multinomial logit model structure to split non-highway trips and test the transit alternatives. Figure 1 illustrates the resulting mode choice model structure. The trips are split among highway, existing local bus and a potential transit alternative. The potential transit alternatives include BRT, LRT, and CRT. With this model structure, Alliance used the same set of mode choice coefficients for each transit alternative. This implies that the mode choice model will differentiate the transit alternatives based on the level of service (LOS) characteristics developed for each alternative by URS, i.e. headways and average speed.

An incremental logit model is a derived form of a linear-in-parameter multinomial logit model. It is typical to use incremental logit models to predict transit share changes due to LOS changes with the advantage of avoiding recalculating the full utilities. However, it also requires the choice probability of all alternatives in the base case and the changes in utilities due to the affected variables. In the case of the NWARK TDM, those transit alternatives did not exist in the base year; thus, Alliance could not directly use the incremental logit model to validate the base year transit model or predict the transit alternatives share changes. However, once the full mode choice model was established, Alliance was able to calculate the shares for transit Alternative A, input the model with new Alternative B LOS variables and the Alternative A base shares, then derive the Alternative B share, which was essentially the incremental logit model application. For this study, it was therefore more appropriate to use a fully functional model choice model.

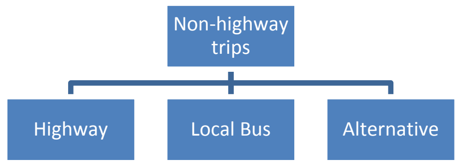
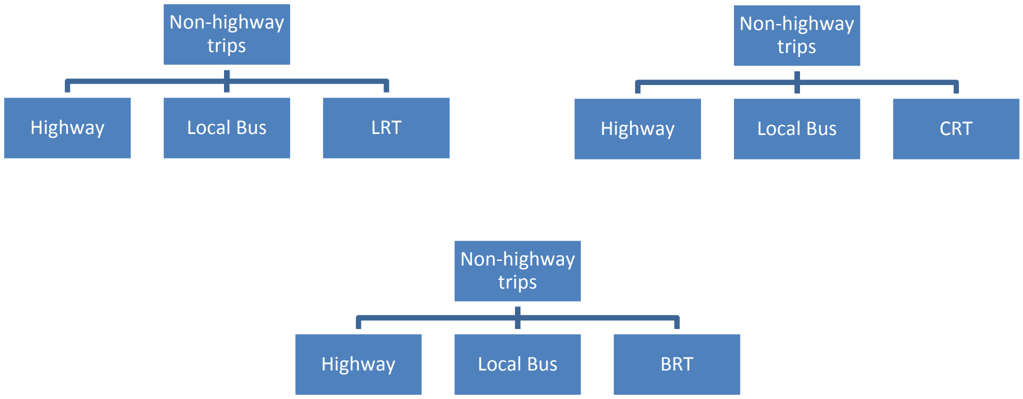


Figure 1: Multinomial Logit Mode Choice Model Structure



The mode choice coefficients were developed based on standard industry practice and adhered to FTA guidance. Alliance asserted mode choice coefficients and validated the model to current local bus ridership. Table 2 shows the mode choice coefficients.

Table 2: Mode Choice Coefficients

	HBW	HBU	HBSC	HBSB	HBO	NHBW	NHBO
Constants							
Highway	0	0	0	0	0	0	0
Local Bus	0	3	0	0	0	0	0
Alternative	0.8	3.3	3769	0.8	0.8	0.8	0.8
LOS Variable							
In-Vehicle Travel Time (IVTT)	-0.02	-0.01	-0.01	-0.01	-0.01	-0.02	-0.01
Out-of-Vehicle Travel Time (OVTT)	-0.04	-0.02	-0.02	-0.02	-0.02	-0.04	-0.02
COST	-0.06	-0.04	-0.04	-0.04	-0.04	-0.06	-0.04

Transit skims

Due to the unique characteristics of both HBU trips and the university circulators, it was reasonable to assume different transit path settings for HBU trips as compared to all the other trips. These transit path settings also followed FTA guidance.

Table 3 presents the transit pathfinder settings. For non-university trips, the following two rules were also implemented:

- Rule: 3 minute IVT minimum on transit (to eliminate very short transit trips)
- Rule: For drive-access trips, transit IVT must be greater than drive access time (to eliminate unlikely drive access transit trips)

Table 3: Transit Path Settings

	HBU		Non-HBU – All Other Trips	
Parameters	BUS	Alternatives	BUS	Alternatives
Max. Access Time	15	30	30	30
Max. Egress Time	30	30	30	30
Max. Drive Time	5	30	30	30
Initial Wait Weight	2	2	2	2
Drive Time Weight	3	3	3	3
Max. Initial Wait	10	10	10	10
Min. Initial Wait	2	2	2	2

Validation of the Transit Model

Using the described modeling approach, the model run resulted in the following bus ridership for the 2010 No Build Alternative:

Table 4: Surveyed vs. No Build Alternative Daily Ridership

Route Name	Surveyed Bus Ridership	No Build Alternative Ridership
RazorBack_Yellow	463	830
Razorback_Tan	783	62
Razorback_56	478	1
Razorback_purple	456	28
Razorback_Pomfret	737	1,360
Razorback_MapleHill	249	804
Razorback_Grey	439	600
Razorback_Blue	2,334	461
Razorback_Green	2,345	2,925
Razorback_Brown	492	818
Razorback_Red	549	320
Razorback Total	9,325	8,209

Route Name	Surveyed Bus Ridership	No Build Alternative Ridership
Ozark_40_NB	120	331
Ozark_40_SB	104	139
Ozark_41_EB	40	31
Ozark_41_WB	21	31
Ozark_42	98	196
Ozark_43_EB	3	188
Ozark_43_WB	3	82
Ozark_44_EB	23	358
Ozark_44_WB	23	57
Ozark_46	76	297
Ozark_47_EB	15	25
Ozark_47_WB	17	-
Ozark_54_SB	86	46
Ozark_54_NB	69	316
Ozark Total	698	2,095
System Total	10,023	10,305

It is worth noting that several razorback routes are inside a single university area traffic analysis zone (TAZ); therefore, some intra-zonal transit trips were beyond the resolution of the model.

Definition of alternatives

This section presents the conceptual definition of the transportation alternatives that were evaluated in the Northwest Arkansas Alternative Analysis project. It provides a general description for each of the following alternatives:

- No Build
- LRT - Light rail with new alignments
- CRT - Commuter rail with existing freight alignments
- BRT - Bus rapid transit along US 71B

No Build Alternative

The No Build Alternative includes the existing transit service in the study area provided by Ozark Regional Transit (ORT) and Razorback Transit. Ozark Regional Transit in the study area provides local bus service operating in the corridor along the US 71 from Bentonville to Fayetteville, AR. Razorback Transit circulates throughout the University of Arkansas campus. The coded No Build Alternative transit service is illustrated in Table 5.

Table 5: Coded No Build Alternative transit service

Study Area Characteristics	Ozark Transit	Razorback Transit
Number of routes		
Local bus	5	-
Express bus	1	-
Circulator	2	12
Weekday service		
Hours of service	6:15 am – 10:10pm	7:00 am – 6:00pm
Peak frequency	60 min	6 min
Off-peak frequency	60 min	30 min

Source: Ozark Transit and Razorback Transit; 2010

Orzark Transit Service

As shown in Figure 2, Ozark Regional Transit (ORT) provides local bus and express bus service from Bentonville to Fayetteville. Eight (8) routes are coded in the model's route system: Five (5) of them are local buses operated in two directions (route #40, #41, #43, #44 and #47), two (2) of them are circulators (route # 42 and #46), and one (1) is an express bus, which operates on I-540 (route #54). There are two types of bus stops for ORT coded in the route system: 191 fixed stops and 238 flag zone stops based on routes and directions. The fare is fixed at $1.25 and free for transfer. The operating speed is set at 20 mph. The headway during peak hour and off-peak hour are both 60 minutes. Since the study area is fairly small, driving and walking are available alternative access modes and only walking is available for egress.

Razorback Transit Service

As shown in Figure 3, Razorback Transit (RT) provides a free shuttle circulator throughout the University of Arkansas campus. Twelve (12) routes are coded in the route system and all 129 bus stops are coded as fixed bus stops. The operating speed is set at 20 mph. The minimum headway is 6 minutes for peak hour and 30 minutes for off-peak hour service. The shuttle is free for all university students and public riders. Since the study area is fairly small, driving and walking are available access modes and only walking is available for egress.

Figure 2: No Build Alternative – Ozark Transit Service

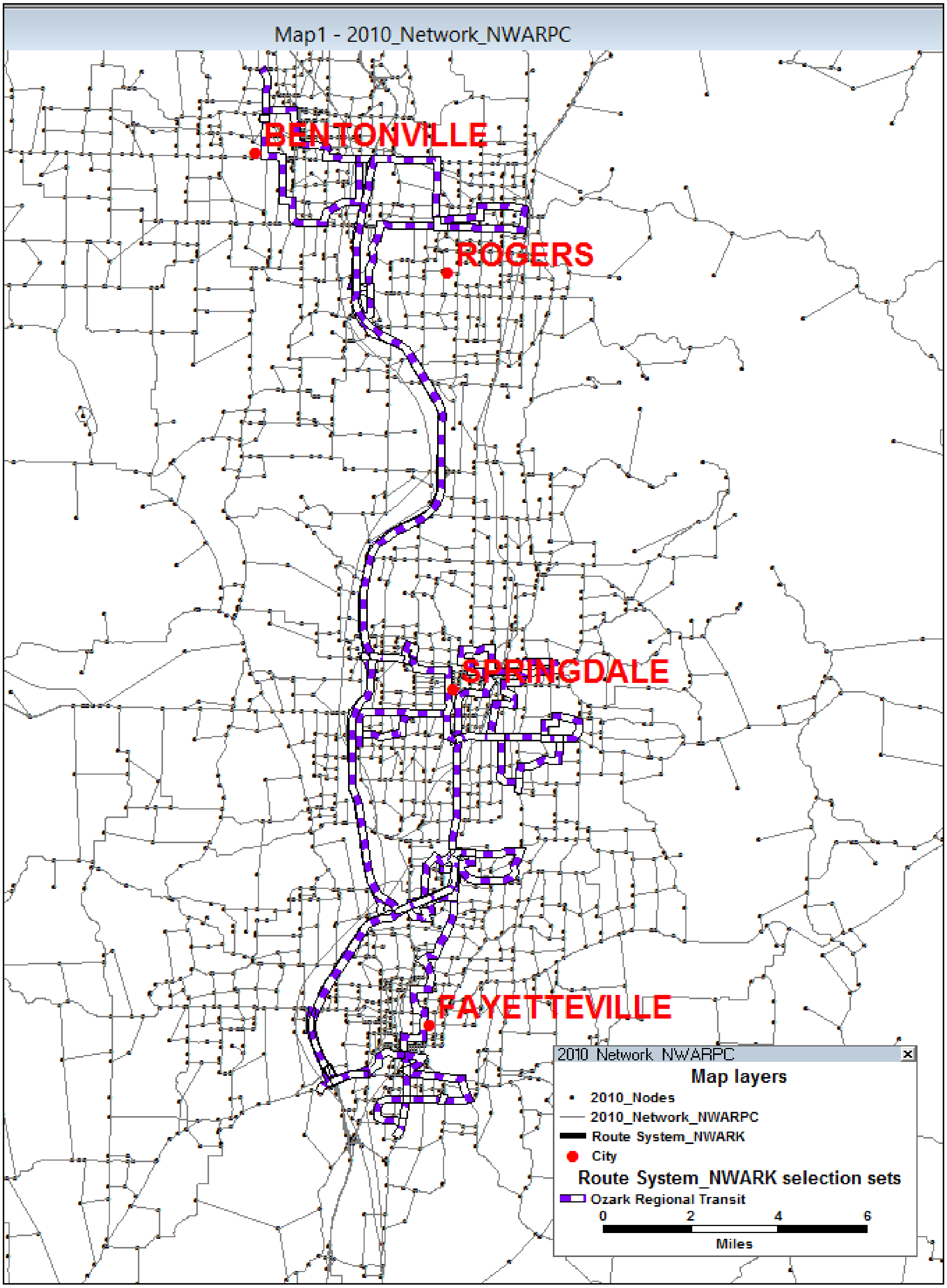
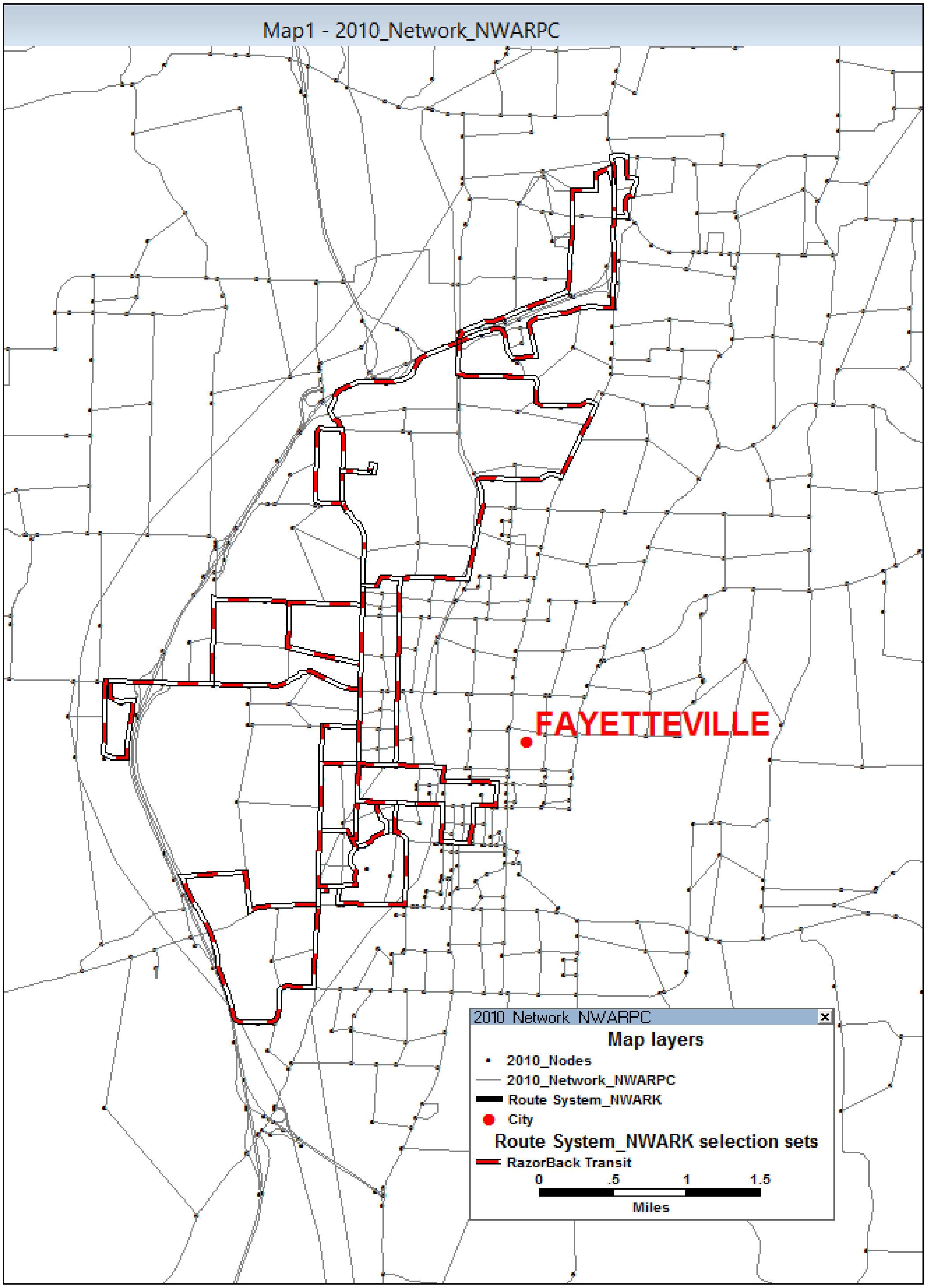


Figure 3: No Build Alternative – Razorback Transit Service



LRT Alternative – Light Rail Transit within New Alignment

Operating Plan

The LRT Alternative on a new alignment is proposed to be operated from 6:00 am to 8:00 pm on weekdays, with 20/60 minute headways for peak/off-peak hours. The allowed access modes are drive, walk, and existing bus service. The allowed egress mode is walk only. The dwell time at each train station is set to 1 minute and the fixed fare for each ride is $3. The light rail is operated at a speed of 50 mph.

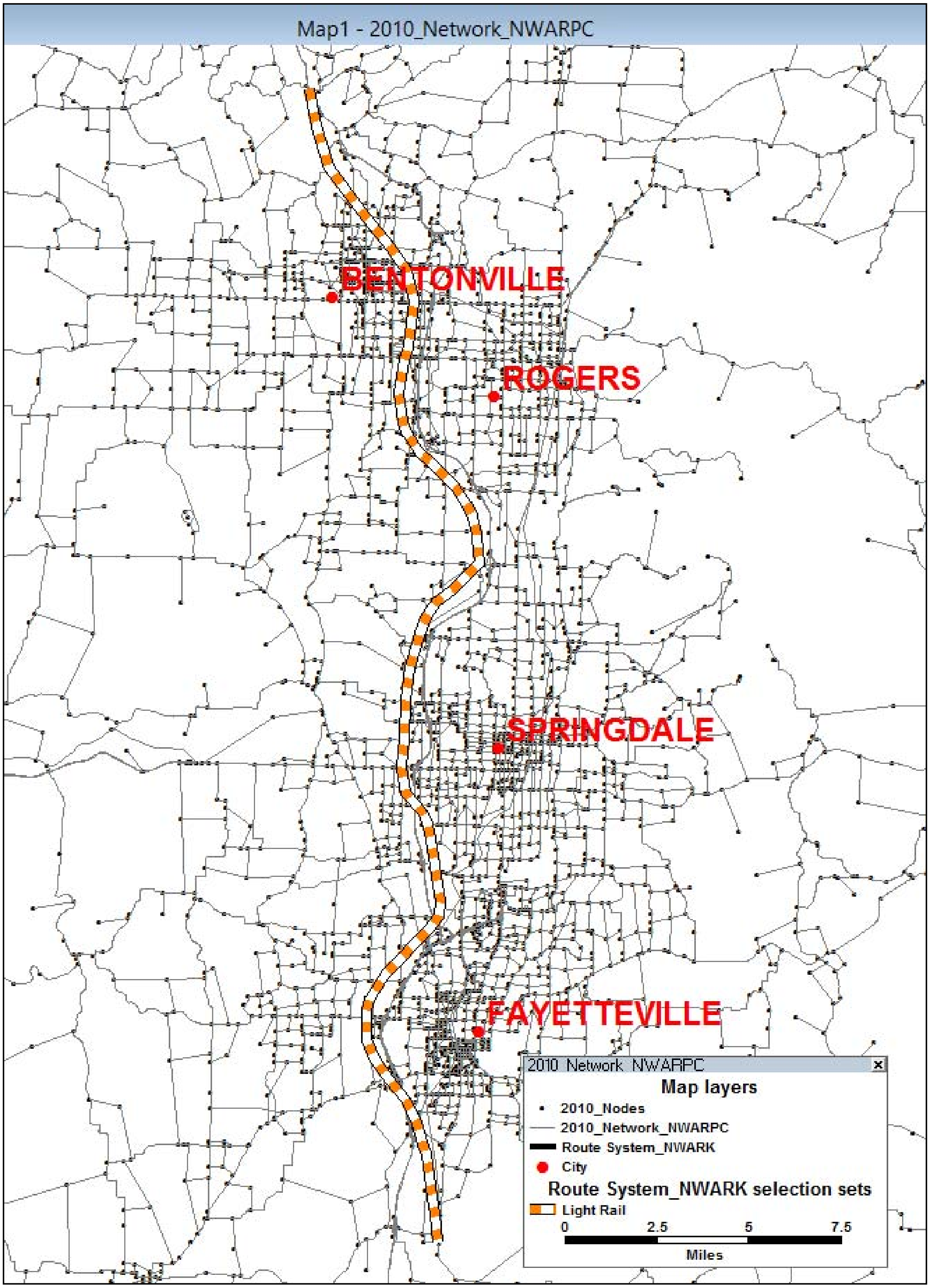
Transit Stops

The LRT stations are located in major cities of the study area. There are eight stations coded in the route system. All stations are identified as park & ride locations. Seven stations are located where the rail tracks intersect major roads, and one station is coded with connectors to the major roads.

Alignment

The light rail is coded along a privately owned alignment near US 71. It starts at Bella Vista Parkway in Bentonville, AR and ends at the transit facility at Frisco Street in Greenland, AR. The proposed alignment is shown in Figure 4.

Figure 4: LRT Alternative within New Alignment



CRT Alternative – Commuter Rail within Existing Freight Alignment

Operating Plan

The CRT Alternative within an existing freight alignment is proposed to be operated from 6:00 am to 8:00 pm on weekdays, with 30/60 minute headways for peak/off-peak hours. The allowed access modes are drive, walk and existing bus service. The allowed egress mode is walk only. The dwell time at each train station is 1 minute and the fixed fare for each ride is $3. The commuter rail is operated at a speed of 40 mph.

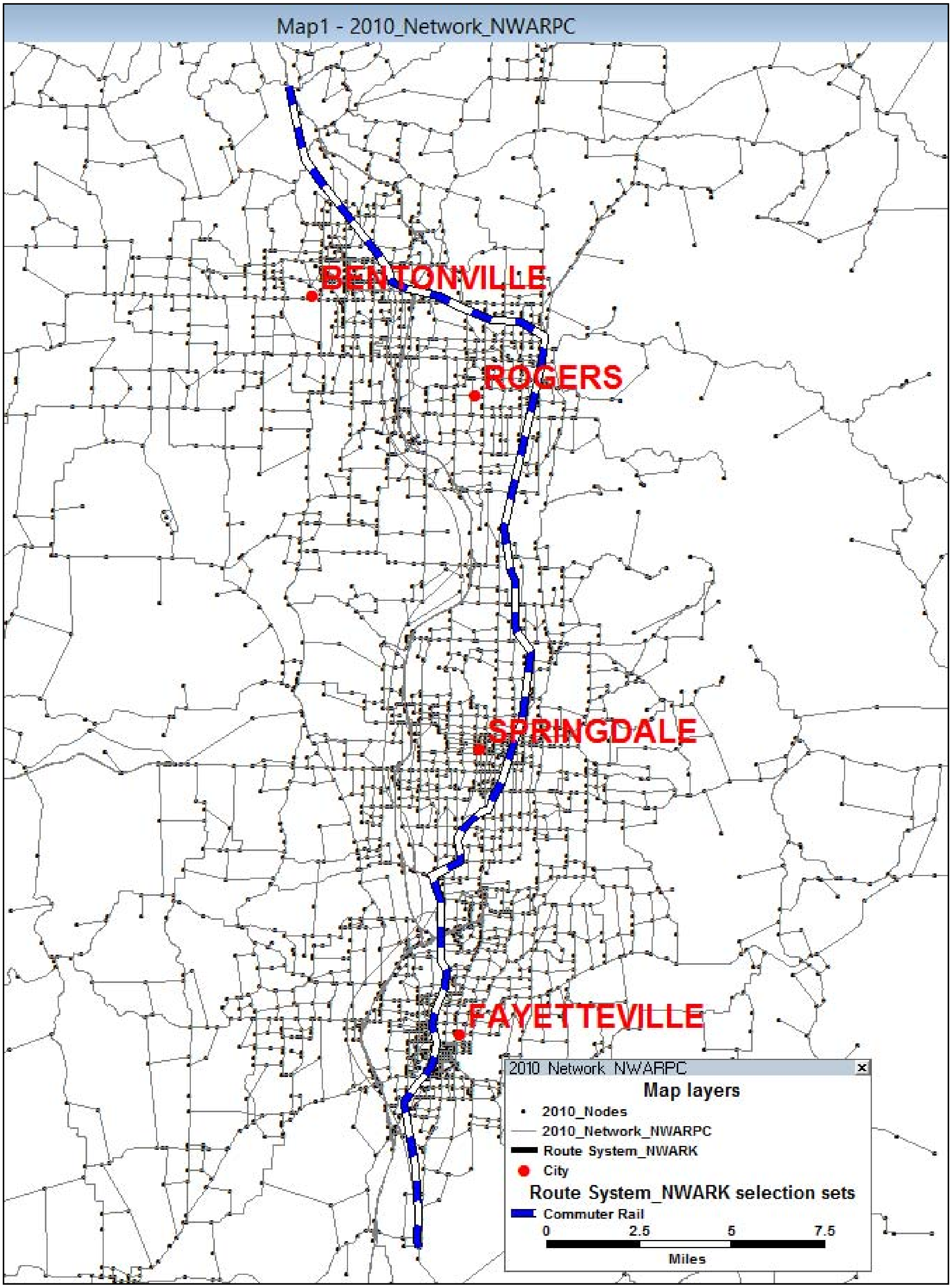
Transit Stops

The commuter rail stations are located in major cities of the study area. There are eight stations coded in the route system. Seven stations are identified as park & ride locations (except Fayetteville station). Seven of the stops are located at the intersection of major roads with the rail tracks, and one station is coded with connectors to the major roads.

Alignment

The commuter rail is coded by following the existing freight alignments. It starts at Bella Vista Parkway in Bentonville, AR and ends at the transit facility at Frisco Street in Greenland, AR. The proposed alignment is shown in Figure 5.

Figure 5: CRT Alternative within Existing Freight Alignment



BRT Alternative – Bus Rapid Transit

Operating Plan

The BRT Alternative along US 71B is proposed to be operated from 6:00 am to 8:00 pm on weekdays, with 20/60 minute headways for peak/off-peak hours. The allowed access modes are drive, walk and existing bus service. The allowed egress mode is walk only. The dwell time at each train station is 1 minute and the fixed fare for each ride is $3. The BRT is operated at a speed of 35 mph.

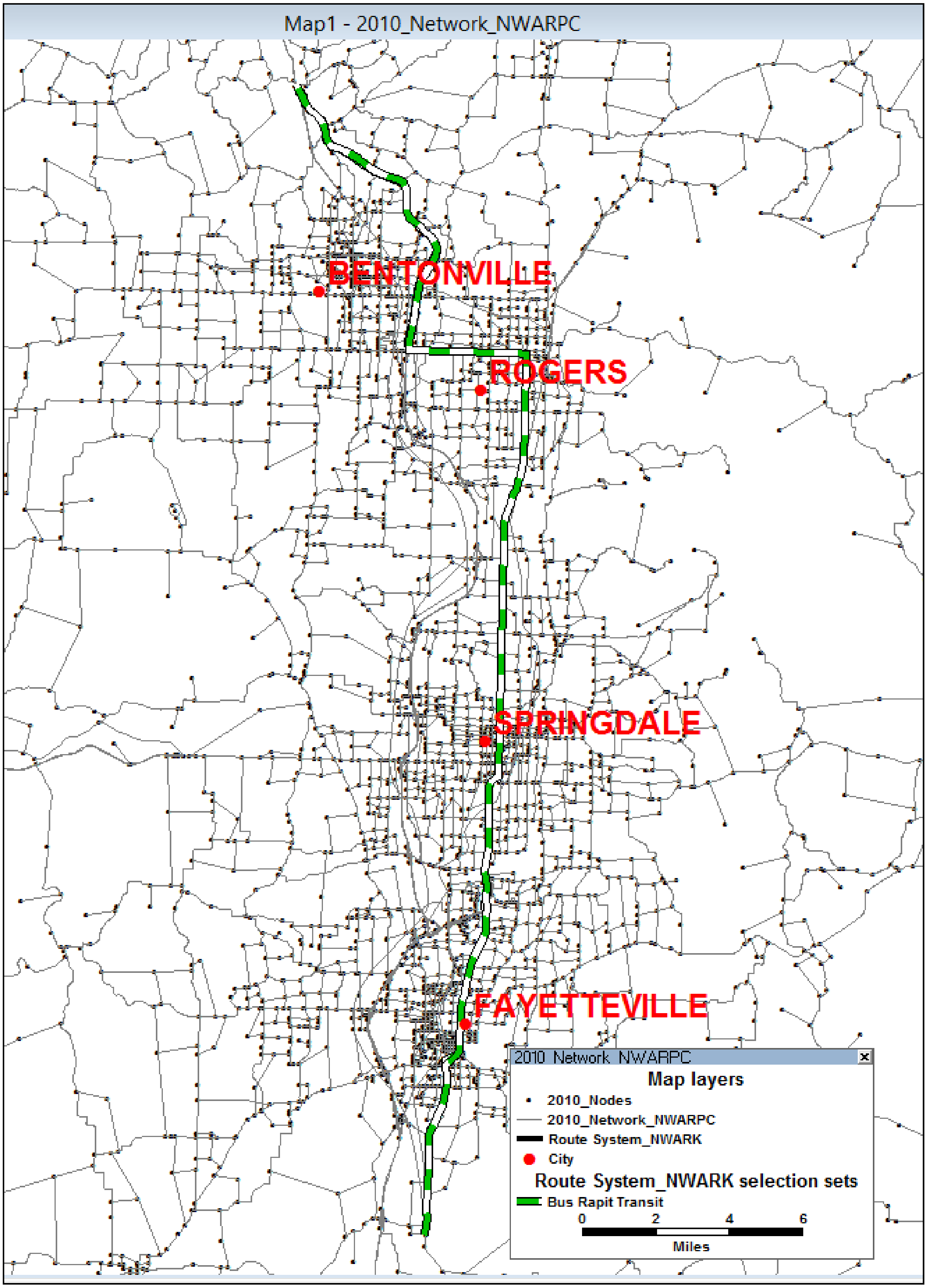
Transit Stops

The BRT stations are located in major cities of the study area. There are eight stations coded in the route system. All stations are identified as park & ride locations and located at the intersection of major roads.

Alignment

The BRT is coded without a privately owned guideway and is therefore proposed to follow US 71B. The alignment starts at Bella Vista Parkway in Bentonville, AR and ends at the transit facility at Frisco Street in Greenland, AR. The proposed alignment is shown in Figure 6.

Figure 6: BRT Alternative along US 71B



Transit Alternative Ridership Results

The following sections show the 2010 and 2035 transit ridership results, as well as station-specific boardings and alightings for each of the various transit alternatives. Generally, the ridership results are a function of service characteristics, such as frequency, hours of operation, fares, and average travel speed, as well as choice of stop location, which determines how many potential riders live or work nearby.

LRT Alternative – Light Rail Transit within New Alignment

The Light Rail Transit Alternative was proposed to operate at the higher average speed than other alternatives, and would therefore have offered the fastest travel time among the transit alternatives considered. However, as it was built on a new alignment with stations often located in less built-up areas, it had lower ridership estimates. The table below shows the daily ridership by route for the Light Rail Transit Alternative. For the base year, 276 daily LRT riders were estimated, whereas 356 daily LRT riders were forecast for the year 2035.

Table 6: LRT Alternative - Daily Transit Ridership for 2010 and 2035

Route Name	2010 Ridership	2035 Ridership
Razorback Yellow	830	1,294
Razorback Tan	60	64
Razorback 56	1	1
Razorback Purple	28	34
Razorback Pomfret	1,360	2,052
Razorback MapleHill	804	865
Razorback Grey	600	674
Razorback Blue	461	499
Razorback Green	2,908	4,369
Razorback Brown	818	1,066
Razorback Red	320	390
Ozark 40 NB	330	416
Ozark 40 SB	138	158
Ozark 41 EB	31	35
Ozark 41 WB	31	40
Ozark 42	194	242
Ozark 43 WB	78	110
Ozark 44 EB	346	505
Ozark 44 WB	57	68
Ozark 46	288	321
Ozark 47 EB	25	28
Ozark 47 WB	0	0
Ozark 54 SB	45	76

Route Name	2010 Ridership	2035 Ridership
Ozark 54 NB	289	431
Ozark 43 EB	187	222
LRT SB	264	340
LRT NB	12	16
All bus	10,229	13,960
LRT	276	356
Total Transit	10,505	14,316

The following tables show the estimated boardings and alightings by station location and direction of travel for the Light Rail Transit Alternative. The directional imbalance of the reported LRT ridership is often confusing to individuals who do not work with travel demand model transit ridership. It is the industry standard to assign transit trips in production-attraction (PA) format. The imbalance is especially noticeable for trips of very directional nature, such as HBW trips. This is due to the fact that the typical commuting pattern of one trip into town in the AM and one trip out of town in the PM is assigned as two inbound trips in PA format. This convention allows transit planners and the models that forecast ridership to know the household characteristics (median income, household size, vehicle availability, area type) of transit riders based on the zone the transit rider starts their trip. This convention also ensures the outbound work trips return to the same zones as the inbound trips. In reality, on a daily basis, the Inbound and outbound ridership will be equal to half of the total ridership of the two directions.

Table 7: LRT Alternative – Boardings and Alightings for 2010

2010 Riders	In bound		Out bound	
	On	Off	On	Off
Bella Vista	7	0	0	1
Bentonville	5	4	1	4
Rogers	171	1	4	2
Lowell	55	4	2	3
Springdale	25	26	3	2
Johnson	0	149	2	0
Fayetteville	1	73	1	0
Greenland	0	7	0	0
Total	264	264	12	12

Table 8: LRT Alternative – Boardings and Alightings for 2035

2035 Riders	South bound		North bound	
	On	Off	On	Off
Bella Vista	11	0	0	1
Bentonville	17	6	1	5
Rogers	213	3	4	4
Lowell	71	12	4	3
Springdale	26	30	3	2
Johnson	0	192	2	0
Fayetteville	2	88	1	0
Greenland	0	10	1	0
Total	340	340	16	16

CRT Alternative – Commuter Rail within Existing Freight Alignment

The table below shows the daily ridership by route for the Commuter Rail Transit Alternative. For the base year, 980 daily CRT riders were estimated, and 1,368 daily CRT riders were forecast for the year 2035.

Table 9: CRT Alternative - Daily Transit Ridership for 2010 and 2035

Route Name	2010 Ridership	2035 Ridership
Razorback Yellow	788	1,223
Razorback Tan	66	71
Razorback 56	6	9
Razorback Purple	28	33
Razorback Pomfret	1,291	1,936
Razorback MapleHill	772	826
Razorback Grey	581	651
Razorback Blue	435	464
Razorback Green	2,779	4,150
Razorback Brown	811	1,058
Razorback Red	301	366
Ozark 40 NB	366	474
Ozark 40 SB	133	156
Ozark 41 EB	37	44
Ozark 41 WB	41	54
Ozark 42	183	229
Ozark 43 WB	78	109
Ozark 44 EB	338	495
Ozark 44 WB	57	68
Ozark 46	297	332
Ozark 47 EB	25	28
Ozark 47 WB	0	0
Ozark 54 SB	26	43
Ozark 54 NB	297	439
Ozark 43 EB	183	218
CRT SB	448	646
CRT NB	532	722
All bus	9,919	13,476
CRT	980	1,368
Total Transit	10,899	14,844

The following tables show the estimated boardings and alightings by station location and direction of travel for the Commuter Rail Transit Alternative.

Table 10: CRT Alternative – Boardings and Alightings for 2010

2010 Riders	South bound		North bound	
	On	Off	On	Off
Bella Vista	14	0	0	7
Bentonville	57	0	1	27
Rogers	39	21	3	169
Lowell	23	5	23	98
Springdale	113	3	118	43
Johnson	202	29	190	19
Fayetteville	0	388	9	169
Greenland	0	1	188	0
Total	448	448	532	532

Table 11: CRT Alternative – Boardings and Alightings for 2035

2035 Riders	South bound		North bound	
	On	Off	On	Off
Bella Vista	23	0	0	9
Bentonville	85	0	2	30
Rogers	61	23	3	217
Lowell	38	5	20	116
Springdale	146	3	157	51
Johnson	293	23	234	17
Fayetteville	0	590	7	280
Greenland	0	1	298	0
Total	646	646	722	722

BRT Alternative – Bus Rapid Transit

The table below shows the daily ridership by route for the Bus Rapid Transit Alternative. For the base year, 305 daily BRT riders were estimated, whereas 379 daily BRT riders were forecast for the year 2035.

Table 12: BRT Alternative - Daily Transit Ridership for 2010 and 2035

Route Name	2010 Ridership	2035 Ridership
Razorback Yellow	830	1,294
Razorback Tan	62	67
Razorback 56	0	1
Razorback Purple	28	34
Razorback Pomfret	1,360	2,052
Razorback MapleHill	803	865
Razorback Grey	600	674
Razorback Blue	455	490
Razorback Green	2,914	4,375
Razorback Brown	836	1,095
Razorback Red	310	377
Ozark 40 NB	319	403
Ozark 40 SB	137	157
Ozark 41 EB	31	35
Ozark 41 WB	31	39
Ozark 42	185	231
Ozark 43 WB	79	111
Ozark 44 EB	346	505
Ozark 44 WB	56	67
Ozark 46	295	330
Ozark 47 EB	25	28
Ozark 47 WB	0	0
Ozark 54 SB	32	52
Ozark 54 NB	301	445
Ozark 43 EB	187	222
BRT SB	46	66
BRT NB	259	312
All bus	10,222	13,949
BRT	305	379
Total Transit	10,527	14,327

The following tables show the estimated boardings and alightings by station location and direction of travel for the Bus Rapid Transit Alternative.

Table 13: BRT Alternative – Boardings and Alightings for 2010

2010 Riders	South bound		North bound	
	On	Off	On	Off
Bella Vista	20	0	0	7
Bentonville	0	0	0	0
Rogers	12	9	2	134
Lowell	6	3	11	56
Springdale	2	2	73	61
Johnson	3	0	54	0
Fayetteville	1	29	119	0
Greenland	0	1	0	0
Total	46	46	258	258

Table 14: BRT Alternative – Boardings and Alightings for 2035

2035 Riders	South bound		North bound	
	On	Off	On	Off
Bella Vista	31	0	0	10
Bentonville	0	0	0	0
Rogers	18	12	2	159
Lowell	10	3	13	67
Springdale	3	2	83	76
Johnson	4	0	69	0
Fayetteville	1	47	145	0
Greenland	0	1	0	0
Total	66	66	312	312

Quality Control Procedure

Introduction

This section provides a summary of the quality control (QC) procedure for Northwest Arkansas Alternative Study. Alliance applied the Census Transportation Planning Package (CTPP) - based Aggregate Rail Ridership Forecasting model (ARRF) to estimate the demand for new proposed light rail and commuter rail alternatives in the northwest Arkansas corridor. The ARRF model was developed by the Federal Transit Administration (FTA) and is recommended by FTA for use on projects such as the Northwest Arkansas Alternatives Analysis study.

The ARRF model estimates weekday unlinked total trips as a function of Journey-to-Work flows documented in the 2000 Census Transportation Planning Package (CTPP 2000) Part 3, disaggregated by auto-ownership class and employment density at the work-end. The model uses 1-, 2- and 6 mile buffers around each rail station to identify the travel markets served by the rail lines. The output of the ARRF is unlinked total daily trips for the entire system, but is not able to provide detailed forecasting information as a travel demand model does. However, the ARRF model can be used as the quality control tool by comparing the forecasted results to those of the travel demand model.

ARRF model setup

In addition to the CTPP 2000, the ARRF model needs the operation and geographical information for the alternatives as well. Table 15 below shows the input information, which was prepared for the ARRF model for the LRT and the CRT alternatives.

Table 15: Input Datasets for ARRF Model

Data Source	Data Set	Data Description
CTPP Package	CTPP part 2	Workers information at the work-end of the work journey
	CTPP part 3	Work journey information
	Block group GIS data	The CTPP available geographic unit for Northwest Arkansas MPO is block group
	Hydro layer	A layer represents water features
Alternative operational information	Rail station with Park-and-Ride (PNR) GIS data	The X,Y coordinates of the rail stations with PNR for the rail alternative
	Directional Route miles	The sum of one-way corridor length for the rail alternative
	Average speed in MPH	The average operating speed
	Trans per day per direction	The frequency of the rail alternative per day

The development of CTPP data for the Aggregate Rail Ridership Forecasting Model has four steps. These steps are:

- Step 1: Obtain basic input data files.
- Step 2: Determine the relationships between rail stations and the geography.
- Step 3: Use Step 1 and Step 2 data to run the RailMarket3 program (the ARRF package) to determine the number of workers in the Year 2000 who both live and work within particular distances of a rail station.
- Step 4: Enter the output information from Step 3 into the model spreadsheet to obtain the ridership.

ARRF model results

Table 16 and Table 17 show the ARRF model results for the potential light rail system and commuter rail system for various average train speeds and frequencies respectively. The frequencies represent trains per day per direction.

Table 16: ARRF Model Estimated Total Daily Light Rail Ridership

LRT Alternative		
Average Speed(MPH)	Trains per day per direction(26)	Trains per day per direction(96)
50	288	524
45	279	507
40	268	488

In Table 16, the 26 trains per day per direction were obtained by using the headway information Alliance received from URS: 1) 18 trains per day per direction for peak hours (6:00am – 9:00am and 3:00pm – 6:00pm) with a headway of 20 minutes and 8 trains for off-peak hours with a headway of 60 minutes; and 2) the operating hours for the light rail alternative is from 6:00am to 8:00pm every day. The table also shows the 96 trains per day per direction, which assumed that the train would operate 24 hours per day, with the constant headway of 15 minutes. The ridership is shown for average train speeds varying from 40 mph to 50 mph, whereas the average speed received from URS is 50 mph.

Table 17: ARRF Model Estimated Total Daily Commuter Rail Ridership

CRT Alternative		
Average Speed(MPH)	Trains per day per direction(20)	Trains per day per direction(96)
45	606	1263
40	583	1215
35	556	1159

In Table 17, the 20 trains per day per direction were obtained by using the headway information Alliance received from URS: 1) 12 trains per day per direction for peak hours (6:00am – 9:00am and 3:00pm – 6:00pm) with a headway of 20 minutes and 8 trains for off-peak hours with a headway of 60 minutes; 2) the operating hours for the commuter rail alternative is from 6:00am to 8:00pm every day. The table also shows the 96 trains per day per direction, which assumed that the train would operate 24 hours per day, with the constant headway of 15 minutes. The ridership is shown for average train speeds varying from 35 mph to 45 mph, whereas the average speed received from URS is 40 mph.

Figure 7 below shows the ARRF model result for the light rail system and Table 18 shows the comparison of Alliance's travel demand model results with the ARRF model estimates.

Figure 7: ARRF Model Result for the LRT Alternative

ARRF II v1 (Combined LRT/CR Model)

Project:	NWA AA STUDY
Alternative:	LIGHT RAIL
Date:	YEAR 2010

Input Data

1. System Operational Characteristics	
1a. Directional Route Miles	69.1
1b. Weekday Train Revenue Miles	
1c. Weekday Train Revenue Hours	
1d. Average Speed in MPH (if blank, computed from 1b and 1c)	50.0
1e. Trains per day per direction (if blank computed from 1a and 1b)	26.0
2. CTPP Flows	
2a. Home within 2 miles of any station and Work within 1 mile of any station	
2.a.i Employment <50,000 / square mile	758
2.a.ii Employment >50,000 / square mile	-
2b. Home within 6 miles of a PNR station and Work within 1 mile of any station	
2.b.i Employment <50,000 / square mile	900
2.b.Ii Employment >50,000 / square mile	-
3. Suburban-CBD Service flag	
3a. Code 1 if service is designed for connecting suburban areas to CBD otherwise, code 0	-

Parameters

1. Elasticity Base Speed	28.072
2. Demand elasticity with respect to speed	0.400
3. Normalization Factor on Speed Adjustment	0.978
4. Minimum Speed to Adjust	1.000
5. Maximum Speed to Adjust	1,000.000
6. Elasticity Base Average Trains/Day (per direction)	58.436
7. Demand elasticity with respect to Trains/Day	0.490
8. Normalization Factor of Trains/Day	0.826
9. Minimum Trains/Day to Adjustment	1.000
10. Maximum Trains/Day to Adjustment	1,000.000
11. Work Trip Train Frequency Adjustment for Infrequent Trains - Definition (Trains/Day)	52.000
12. Work Trip Train Frequency Adjustment for Infrequent Trains - Adjustment	0.550
13. Non-Work Trip Adjustment for Long Corridors - Dir. Rte Miles at mid-point of adj.	140.000
14. Non-Work Trip Adjustment of Long Corridors - Coefficient (slope) on adjustment	0.050
15. Non-Work Trip Adjustment of Long Corridors - Minimum adjustment	0.550
16. Adjustment for predominantly suburban/CBD service	0.680
17. Unlinked Walk/Bus/KNR Access to Work Trips/CTPP Flow - <50,000 / square mile	0.109
18. Unlinked Walk/Bus/KNR Access to Work Trips/CTPP Flow - >50,000 / square mile	0.149
19. Unlinked PNR Access to Work Trips/CTPP Flow - <50,000 / square mile	0.031
20. Unlinked PNR Access to Work Trips/CTPP Flow - >50,000 / square mile	0.128
21. Unlinked Walk/Bus/KNR Access to Non-Work Trips/CTPP Flow - <50,000 / square n	0.205
22. Unlinked Walk/Bus/KNR Access to Non-Work Trips/CTPP Flow - >50,000 / square n	0.158
23. Unlinked PNR Access to Non-Work Trips/CTPP Flow - <50,000 / square mile	0.017
24. Unlinked PNR Access to Non-Work Trips/CTPP Flow - >50,000 / square mile	0.036

Figure 7: ARRF Model Result for the LRT Alternative (continued)

Level-of-Service Service Factor		
Average Speed (Item 1d if coded, otherwise 1b/1c)	50.00	
Minimum Normalized Speed Adjustment	0.2607	
Maximum Normalized Speed Adjustment	1.7954	
Computed Speed Adjustment		1.2247
Normalized Speed Adjustment		1.2519
Bounded Speed Adjustment		1.2519
Trains Per Day (Item 1e if coded, otherwise 1b/1a)	26.00	
Minimum Normalized Trains Per Day Adjustment	0.0641	
Maximum Normalized Trains per Day Adjustment	2.2657	
Adjustment for Trains Per Day		0.6235
Normalized Trains Per Day Adjustment		0.7548
Bounded Trains Per Day Adjustment		0.7548
Total Level-of-Service Factor		0.9449
Other Adjustments		
Infrequent Trains per Day Max Elasticity	1.1413	
Work Trip Train Frequency Adjustment for Infrequent Service		1.2305
Non-Work Demand Adjustment for Long Corridors		0.9874
Adjustment for Non-CBD Trips for suburban-CBD-oriented Services		1.0000
Rail Unlinked Trips		
Daily Work Walk/Bus/KNR Access unlinked trips to employment <50,000/sq mile		96
Daily Work Walk/Bus/KNR Access unlinked trips to employment >50,000/sq mile		-
Daily Work PNR Access unlinked trips to employment <50,000/sq mile		33
Daily Work PNR Access unlinked trips to employment >50,000/sq mile		-
Subtotal Work Daily unlinked trips		129
Daily Non-Work Walk/Bus/KNR Access unlinked trips to employment <50,000/sq mile		145
Daily Non-Work Walk/Bus/KNR Access unlinked trips to employment >50,000/sq mile		-
Daily Non-Work PNR Access unlinked trips to employment <50,000/sq mile		14
Daily Non-Work PNR Access unlinked trips to employment >50,000/sq mile		-
Subtotal Non-Work Daily unlinked trips		159
Total Daily unlinked trips		288

Table 18: Comparison of Travel Demand Model Total Daily Ridership Estimates with ARRF Model Estimates

Alternatives	NWARK TDM	ARRF Model	% Difference
LRTAlternative	276	288	-4.2%
CRT Alternative	980	583	68.1%

As shown in the table, the ARRF model results are almost identical to the forecasted ridership for the Light Rail Transit Alternative, pointing out the reasonableness of the travel demand model forecast. For the Commuter Rail Alternative, the NWARK TDM predicted a slightly higher ridership than the ARRF model, differing by 397 daily riders. However, this higher ridership number is in line with observed commuter rail ridership, such as the Red Line in Austin, TX, which began operations in 2010 with approximately 800 riders per day, and then doubled its ridership within the first year.

Special Market Ridership Evaluation

Populations other than permanent residents may constitute transit trip markets within the study area. Travel associated with special events can have significant location-specific and even region-wide impacts. The potential seasonal or special event transit ridership is assessed "off model", since it is not captured by the NWARK travel demand model. To assess the impact on the study area, the following special trip market populations were taken into account:

- Seasonal residents–which differ in terms of age profile, employment status, household size, as well as household income from permanent residents, will exhibit different travel patterns.
- Visitors – including business travelers or tourists, have different trip purposes, i.e. visiting family, work-related, or vacation, which in turn has an effect on their choice of accommodation location, time of travel and mode of travel. Visitor travel patterns in themselves can differ widely, depending on the type of visited attraction and chosen transportation mode.
- Air passengers – should be considered a special market where transit systems (particularly rail-based transit) provide ground access to airports.
- Special events attendees – should be considered in order to capture travel by residents and visitors to events such as sports games, festivals, convention centers, and other similar venues.

Of importance to the study area are several sports events, the WalMart annual shareholder meeting, and a three-day festival held in downtown Fayetteville, as well as several public-use, general aviation airports located in or near the study area. These special markets and their associated characteristics and specific transit access options are detailed in Table 19 on the following page.

Table 19: Special Markets – Characteristics and Transit Accessibility

Event	Located in TAZ	Annual Events	Week-day	Week-end	Single Day Participants	Additional Comment	Distance to Transit	Route/ Build Alternative	Closest Station Name
Bikes Blues & BBQ	50032	1 (4 days)	x	x	40,000	4-day event along Dickson Street in Downtown Fayetteville	*0 miles* 4.1 miles *0.1 miles* *0.5 miles*	Razorback Brown or Ozark Route 40 LRT CRT BRT	Train Depot or Walton Arts Center Fayetteville " "
LPGA Golf Tournament (Pinnacle)	20254	1 (3 days)	x	x	15,000	3 day event - Friday through Sunday	1.7 miles 3.5 miles 3.8 miles 6.4 miles	Ozark Route 44 LRT CRT BRT	Promenade Mall Rogers Rogers Lowell
University of Arkansas Baseball Games	50120	33	x	x	8,000	Baum Stadium	*0.1 miles* 2.85 miles 2.0 miles 2.5 miles	Razorback Purple LRT CRT BRT	Baum Stadium Fayetteville " "
University of Arkansas Basketball Games	50040	18	x	x	18,000	Bud Walton Arena	*0.1 miles* 2.85 miles 1.1 miles 1.6 miles	Razorback Blue (Purple or Green within 0.2 miles) LRT CRT BRT	California/ Stadium Drive Fayetteville " "

Event	Located in TAZ	Annual Events	Week-day	Week-end	Single Day Participants	Additional Comment	Distance to Transit	Route/ Build Alternative	Closest Station Name
University of Arkansas Football Games	50040	5		x	75,000	67% of attendees are from outside NWA	*0 miles* 3.2 miles 0.7 miles 1.2 miles	Razorback Green or Yellow LRT CRT BRT	Lot 44 Fayetteville " "
University of Arkansas Graduation	50040	1		x	10,000	Bud Walton Arena	*0.1 miles* 2.85 miles 1.1 miles 1.6 miles	Razorback Blue (Purple or Green within 0.2 miles) LRT CRT BRT	California/ Stadium Drive Fayetteville " "
WalMart Annual Shareholders Meeting	50040	1	x		30,000	Bud Walton Arena	*0.1 miles* 2.85 miles 1.1 miles 1.6 miles	Razorback Blue (Purple or Green within 0.2 miles) LRT CRT BRT	California/ Stadium Drive Fayetteville " "

Table 19 (cont.)

Airports	Located in TAZ	2013 Total Enplanement	2013 Total Deplanement	2013 Total Passengers/ Comments	Distance to Transit	Route/ Build Alternative	Station Name
Bentonville Municipal/ Louise M Thaden Field	72063	n/a	n/a	Focus on Cargo and Charter Services	*0.3 miles* 2.1 miles 3.8 miles 2.7 miles	Ozark Route 46 LRT CRT BRT	D St/28th St Rogers Bentonville Rogers
Northwest Arkansas Regional	20513	581,487	578,545	1,160,032	10.4 miles 9.5 miles 11.0 miles 10.5 miles	Ozark Route 44 LRT CRT BRT	Mercy Medical Center Lowell " "
Rogers Municipal/ Carter Field	75040	n/a	n/a	Majority of Operations are Corporate Air Traffic	2.5 miles 5.2 miles 2.7 miles 4.6 miles	Ozark Route 44 LRT CRT BRT	Olive/3rd or Harp's Grocery Bentonville Rogers Bentonville
Springdale Municipal	60552	n/a	n/a	Corporate Air Traffic and Charter Service	*0.4 miles* 4.8 miles 1.1 miles 1.7 miles	Ozark Route 42 LRT CRT BRT	Applegate Apartments Springdale " "

Based on the evaluation of the nearest bus stop/transit station, the following special markets will be considered for further analysis[1]:

- Bike Blues & BBQ;
- University of Arkansas Baseball, Basketball, and Football Games;
- University of Arkansas Graduation; and
- WalMart Annual Shareholders Meeting.

All other venues are more than 0.5 miles from the nearest transit service and, therefore, beyond walking distance; special event shuttle service could be provided, but would require additional transit resources and special operating plans, and as a result, was not considered as part of this analysis.

Venue-specific Transit Shares

To accurately determine special market ridership and associated transit shares, it is generally advised to undertake a visitor intercept survey that provides information on event location, event start and end time, patrons' location of origin, mode of transportation, travel time, day of the week, patrons' ultimate destination after the event, etc. As these travel characteristics are highly dependent on venue type, a complete assessment of region-wide special markets ridership can be prohibitively expensive to undertake.

For the purpose of this study, Alliance researched similar assessments that were undertaken in other areas of the country and found that average transit shares, where bus and rail transit was available, ranged anywhere from less than 5% to over 30%, largely dependent on the type of event and venue.

A recent and very comprehensive assessment, completed by the Maricopa Association of Governments (MAG), was the 2010 *Special Events Travel Forecasting Model and Collection of Special Events Data*.[2] The MAG data was analyzed, by venue, as to availability of and proximity to bus and rail transit service to ensure that a direct comparison with study area venues could be undertaken. Then the average transit share by type of event was determined for use with the special market information identified within the NWARK study area.

In most cases, the total transit share of the expanded (weighted) venue-specific survey data was rounded up or down, based on the unweighted data as well as examples found elsewhere in the nation, resulting in the transit share values shown in the following table:

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[1] Although the Bentonville Municipal Airport-Louise M Thaden Field and the Springdale Municipal Airport are within walking distance (0.5 miles) of a transit stop, these airports will not be evaluated, since their major focus is not on itinerary air passengers, but rather on chartered flights, as well as cargo services and corporate air traffic.

[2] Accessible at: https://www.azmag.gov/Documents/TRANS_2013-03-01_Special-Events-Travel-Forecasting-Model-and-Collection-of-Special-Events-Data.pdf

Table 20: Transit Shares based on MAG Data

Event	Transit - Weighted Share	Transit - Unweighted Share	Transit - Rounded Share	Comment
Music Festival/ Block Party	17.69%	19.13%	18%	
University Baseball	9.21%	11.12%	10%	Based on Pro-Baseball
University Basketball	3.14%	6.42%	5%	Rounded up based on sports-event information found in other cities
University Football	11.34%	13.18%	12%	
University Graduation	8.34%	9.28%	9%	Based on Average of all Events
Shareholder MTG	8.34%	9.28%	9%	Based on Average of all Events

Source: Maricopa Association of Governments, 2010

Special Market Ridership

The attendance and event information used in the estimation of the special market transit ridership was cooperatively developed with NWARPC staff. All listed events are accessible via bus transit; the Bikes Blues & BBQ festival would also be accessible via the proposed Commuter Rail or Bus Rapid Transit alternatives, as detailed in Table 19 above.

Based on the number of annual events and associated event days, the number of visitors per year was determined. Based on the transit shares described in Table 20, the total number of annual riders was calculated. To later determine if the NWARK transit service would be able to accommodate the special event riders, the resulting number of anticipated event day trips was computed. Lastly, the equivalent number of average daily trips was calculated. The resulting values are shown in Table 21 on the following page.

Table 21: Determination of Special Market Ridership and Resulting Daily Trips

Event	Annual Events	Week-day	Week-end	Single Day Participants	Annual Visitors	Transit Share	Visitors choosing Transit
Bikes Blues & BBQ	1 (4 days)	x	x	40,000	160,000	18%	28,800
University of Arkansas Baseball Games	33	x	x	8,000	264,000	10%	26,400
University of Arkansas Basketball Games	18	x	x	18,000	324,000	5%	16,200
University of Arkansas Football Games	5		x	75,000	375,000	12%	45,000
University of Arkansas Graduation	1		x	10,000	10,000	9%	900
WalMart Annual Shareholders Meeting	1	x		30,000	30,000	9%	2,700
Total							120,000

Source: Transit Share values are adapted from – "Special Events Travel Forecasting Model and Collection of Special Events Data", assessable at: https://www.azmag.gov/Documents/TRANS_2013-03-01_Special-Events-Travel-Forecasting-Model-and-Collection-of-Special-Events-Data.pdf; also see Table 20

Based on the assumed transit share, it is anticipated that 120,000 of the yearly special event visitors might chose to use transit to get to their desired event venue, which would encompass 240,000 unlinked passenger trips. When compared to the No Build Alternative's annualized transit trips of 2,576,250, it would account for 9.3% of total ridership, which appears reasonable.

Transit Capacity Assessment

It is important to note that the listed events have been in place for several years and are already served by the existing bus routes in the study area.

Nonetheless, of interest is an assessment of whether the existing bus service and proposed high capacity transit alternatives can accommodate the specific average event day ridership demand with the available and/or proposed resources.

The ability of the fixed route bus, light rail, commuter rail or bus rapid transit vehicles to accommodate the listed events is limited by the vehicle and rail car passenger capacity as well as the service frequency. The following table lists the range of vehicle capacities for fixed-route buses as well as the high-capacity transit vehicles considered for this study, along with the average number of daily buses or trains:

Table 22: Maximum Passenger Capacity by Transit Mode

Transit Option	Typical Vehicle Passenger Capacity*	Number of Buses per Weekday per direction (for a single route)	Maximum Daily Capacity – Weekday	Maximum Daily Capacity – Weekend***
Razorback Transit Bus – low-floor, 40 ft	67 to 93 passengers	49 buses**	1,340 to 6,510	2,077 to 2,883
Ozark Transit Bus – low-floor, 40 ft	67 to 93 passengers	14 buses	940 to 1,300	n/a
Light Rail Transit (2-car consist)	180 to 400 (2*90 to 200)	22 trains	3,960 to 8,800	n/a
Commuter Rail (2-car consist)	200 to 380 (2*100 to 160)	18 trains	3,600 to 6,840	n/a
BRT – Articulated, 60 ft	100 to 120	22 buses	2,200 to 2,640	n/a

** Source: Passenger capacity – seated and standing – TCRP Reports 13, 100 and 165*
*** During the semester, it varies from 29 buses on the Purple Route to 87 buses along the Green Route - daytime and evening combined; during the semester break, routes operate on a reduced schedule with an average of 22 buses per day*
**** Razorback Transit weekend service is only provided during the semester; Ozark Transit operates only Monday through Friday*

Conclusion

Based on available system capacity, the existing bus service can easily absorb the additional special event ridership associated with the University of Arkansas baseball and basketball games, which on game days, could add 1,600 and 1,800 unlinked passenger trips, respectively. The existing bus service would also be able to accommodate the University of Arkansas Graduation Ceremony and the WalMart Annual Shareholders Meeting, which could add 1,800 and 5,400 trips on event days, respectively. As a matter of fact, some special event riders may have been included in the Ridecheck Survey, which was conducted for Razorback Transit routes on September 14 and 15, 2010 and for the Ozark Transit routes on September 16, 2010.

On football game days, 18,000 event day trips could potentially be added to the system over the course of just several hours. The Razorback Green and Yellow routes, which serve the Donald W. Reynolds Razorback Stadium, would be able to carry only a portion of these special event riders, up to route capacity, unless additional buses were made available. The proposed Commuter Rail Alternative is located just outside of walking distance (0.7 miles), but it could be considered to implement a special shuttle service to allow use of the commuter rail passenger capacity on game days, particularly because a large proportion of the game attendees are from out-of-town.

The Bikes Blues & BBQ festival is the only event within walking distance of any of the proposed build alternatives. However, even in combination with the existing bus service, neither the proposed

Commuter Rail nor the Bus Rapid Transit Alternative would be able to accommodate all of the anticipated special event trips (14,400 per day) associated with the festival. Therefore, only the number of special event ridership up to the system capacity limit could be counted towards the overall Commuter Rail Alternative or Bus Rapid Transit Alternative ridership, unless longer trains, additional train cars, or more buses would be made available for this event.

Proposed for an alignment further away from the identified special market venues, the Light Rail Transit Alternative is unlikely to carry any special event riders.