2018 Transportation Conformity

Appendix 12.18: MoSERS Methodology and Calculation Descriptions

3.0 Improved Public Transit -- Light Rail

3.1 System/Service Expansion

Strategy: Increase ridership by providing new rail system services and/or

Description: Expansion of transit system or service can include the addition of rail services through increased frequency or route extension. Bus or paratransit services can be expanded with new vehicles and/or route extensions.

Application: Large cities or communities with enough population density to support reasonably frequent transit service.

Project Year: 2018

Project Description:

Project Code:

Variables:		Source		NO_X	VOC
EF_B:	Speed-based running exhaust emission factor for affected roadway before implementation (NOx or VOC) (grams/mile) *(assume 34 mph, Light Duty Vehicles in all roadway types)*	MOVES2014a	EF_B:	0.17	0.06
EF_{TV}:	Speed-based running exhaust emission factor for transit vehicle (NOx or	DART	EF_{TV}:	0.00	0.00
$F_{T, SOV}$:	Percentage of people using a transit vehicle that previously were vehicle drivers (decimal)	MOSERS	$F_{T, SOV}$:	0.40	0.40
N_{TR}:	New transit ridership *(total ridership)*	Project Specific	N_{TR}:	36.00	36.00
TEF_{AUTO}:	Auto trip-end emission factor (NOx or VOC) (grams/trip)	MOVES2014a	TEF_{AUTO}:	0.59	0.71
TEF_{TV}:	Transit vehicle trip-end emission factor (NOx or VOC) (grams/trip) *(DART is a zero-emissions electric train)*	DART	TEF_{TV}:	0.00	0.00
TL_W:	Average auto trip length (to work) (miles)	COG Default	TL_W:	16.00	16.00
TL_{TV}:	Route Length of the Transit Vehicle (miles)	DART	TL_{TV}:	0.00	0.00
VT_{TV}:	Daily vehicle trips by transit vehicle	DART	VT_{TV}:	0.00	0.00
VT_R:	Reduction in number of daily automobile vehicle trips		VT_R:	14.40	14.40
$VMT_{TV/BUS}$:	Vehicle miles traveled by transit vehicle		VMT_{TV}:	0.00	0.00
VMT_R:	Reduction in daily automobile VMT		VMT_R:	230.40	230.40
Conversion Factor:	Convert grams per mile of emissions to pounds per mile of emissions		Conversion Factor:	453.60	453.60

Equation:			NO_X	VOC
$A = VT_R * TEF_{AUTO}$	Reduction in auto start emissions from trips reduced	A:	8.50	10.22
$B = VMT_R * EF_B$	Reduction in auto running exhaust emissions from VMT reductions	B:	39.17	13.82
$C = VT_{TV} * TEF_{TV}$	Increase in emissions from additional train starts	C:	0.00	0.00
$D = VMT_{TV} * EF_{TV}$	Increase in emissions from additional train running exhaust emissions	D:	0.00	0.00
	Where,			
$VT_R = N_{TR} * F_{T, SOV}$	Number of new transit riders multiplied by the percentage of riders shifting	VT_R:	14.40	14.40
$VMT_R = VT_R * TL_W$	Number of vehicle trips reduced multiplied by the average auto trip length	VMT_R:	230.40	230.40
$VMT_{TV/BUS} = VT_{TV} * TL_{TV}$	Number of vehicle trips reduced multiplied by the average transit route length.	$VMT_{TV/BUS}$:	0.00	0.00

Results:		NO_X	VOC
Daily Emission Reduction = (A + B – C – D) / Conversion Factor	**Daily Emission Reduction (lbs/day) =**	**0.11**	**0.05**
	Daily Emission Reduction (tons/day) =	**0.00**	**0.00**

Source: The Texas Guide to Accepted Mobile Source Emission Reduction Strategies, Texas Transportation Institute, August 2007
Part C and Part D are both equal to zero because the DART system utilizes electric light rail, which has zero-emission train equipment. Local assumptions are calculated from the Dallas-Fort Worth Regional Travel Model and professional judgment of the Dallas Area Rapid Transit and North Central Texas Council of Governments staff.
Shading denotes input variables specific to the project. Other variables are either standard for the program or calculated using these inputs:
Blue - Project Specific Input
Yellow - Assumptions
Green - Emission Factors

4.0 High-Occupancy Vehicle Facilities

4.1 Freeway HOV Facilities

Strategy: Reduction of emissions by decreasing VMT and increased average speeds on the lane.

Project Year: 2018

Description: Separate lanes on controlled access highways are created for vehicles containing a specified number of passengers. The lane may be concurrent flow, barrier/buffer separated, or have a separate right-of-way.

Project Description:

Application: Highways in areas of traffic congestion with sufficient available right-of-way.

Project Code:

MOSERS Formula: Emission Benefit (lbs/day) =[A + B + C] (grams/day)/CF (grams/lbs)

$A= V_{HOV} * (EF_b-EF_a) * L$	Change in running exhaust emissions due to speed improvement in HOV lanes.
$B= (V_{GP,B} * EF_b - V_{GP,A} * EF_a) * L$ "assume negligible"	Change in running exhaust emissions in general purpose lanes as a result of vehicle shifted away from general purpose lanes.
C= VTr (TEFauto + EF b * TLw)	Reduction of emission from (auto start exhaust + auto running exhaust) from trip reduction.
VTr = Np * { Ft*Ft,sov + Frs*Frs,sov} * (1-1/AVOrs)}	Reduction in daily automobile trips.

Assumptions:		Source	21		21.00	
AVO_{RS}:	Average vehicle occupancy of rideshare (persons/vehicle)	COG Default		**75896**	2.14	2.14
F_{RS}:	Percentage of people attracted to the HOV facility using ride share (decimal)	COG Default		F_{RS}:	0.83	0.83
$F_{RS,SOV}$:	Percentage of people attracted to the HOV facility using ride share that previously were vehicle drivers (decimal)	COG Default		$F_{RS,SOV}$:	0.56	0.56
F_T:	Percentage of people attracted to the HOV facility using a transit vehicle (decimal)	COG Default		F_T:	0.14	0.14
$F_{T,SOV}$:	Percentage of people using a transit vehicle that previously were vehicle drivers (decimal)	COG Default		$F_{T,SOV}$:	0.56	0.56
TL_W:	Average auto trip length (miles)	COG Default		TL_W:	20.00	20.00
P_G	Annual Population Growth Rate assume 2.5%/Year	COG Default		P_G	0.03	0.03
Volume Fraction:						
	24-Hour Volume to Peak Hour Volume Fraction. (peak hour volume / 24-hour volume)	COG Default		V_{FC}	0.38	0.38
VT_{RF}:	(FT * FT,SOV + FRS * FRS,SOV) * (1 - 1/AVORS)			VT_{RF}	0.29	0.29
Conversion Factor:	Convert grams per mile of emissions to pounds per mile of emissions			**Conversion Factor:**	453.60	453.60

Variables:		Source			
$V_{H'}$	Daily Volume of HOV lane	Data Management/ Traffic Counts	$V_{H'}$	1,053.00	1,053.00
V_Y	Daily Volume Year	Project Specific	V_Y	2016	2016
$V_{H,A}$	Projected Daily Volume of HOV lane	Estimate	$V_{H,A}$	1,106.31	1,106.31
$V_{GP,B}$	Volume of general purpose lane, before implementation of HOV.		$V_{GP,B}$	0.00	0.00
$V_{GP,A}$	Volume of General purpose lane, after implementation of HOV.		$V_{GP,A}$	0.00	0.00
N_P	Total number of expected people using the HOV lanes per day. If Restricted HOV use only peak our Volume [$Np =2.14*V_{HOV}$]	Data Management/ DART Traffic Counts	N_P	2,367.50	2,367.50
L	Center Line Miles	Project Specific	L	4.00	4.00

4.0 High-Occupancy Vehicle Facilities

Emission Factors:		Speed		NO_X	VOC
TEF_{AUTO}:	Auto trip-end emission factor (NO_x, VOC, or CO) (grams/trip)		TEF_{AUTO}:	0.59	0.71
EF_B:	Speed-based running exhaust emission factor before implementation of HOV facility (NO_x, VOC, or CO) (grams/mile) (assume 43 mph, Light Duty Vehicles on fwy)	43mph	EF_B:	0.09	0.03
$EF_{H,A}$:	Speed-based running exhaust emission factor on HOV facility (NO_x, VOC, or CO) (estimate) (assume 51 mph, Light Duty Vehicles on fwy)	51mph	$EF_{H,A}$:	0.09	0.03
$EF_{GP,A}$:	Speed-based running exhaust emission factor after implementation of HOV facility (NO_x, VOC, or CO) (general purpose lanes) (estimate) (assume 43 mph, Light Duty Vehicles on fwy)	43mph	$EF_{GP,A}$:	0.09	0.03

Emission Calculations:			NO_X	VOC
$A = V_{H,A} * (EF_B - EF_{H,A}) * L$	Change in running exhaust emissions from vehicles shifting from general purpose lanes to HOV lanes	A:	0.00	0.00
$B = (V_{GP,B} * EF_B - V_{GP,A} * EF_{GP,A}) * L$	Change in running exhaust emissions of vehicles in general purpose lanes as a result of vehicles shifted away from general purpose lanes [assume negligible]	B:	0.00	0.00
$C = (Np*VTRF)*(TEF_{AUTO}+EFB*TLw)$	Reduction in Emissions from Trip reduction- including auto start exhaust emissions and running exhaust emission from the entire trip	C:	1,648.72	903.69
	Where,			
[VTr = Np * VTRF]	Reduction in daily Automobile Vehicle trips	VT_R:	689.84	689.84

Results:		NO_X	VOC
Daily Emission Reduction = (A + B + C) / Conversion Factor	**Daily Emission Reduction (lbs/day) =**	**3.63**	**1.99**
Daily Emission Reduction = (A + B + C) / Conversion Factor	**Daily Emission Reduction (tons/day) =**	**0.00**	**0.00**

Source: The Texas Guide to Accepted Mobile Source Emission Reduction Strategies, Texas Transportation Institute, August 2007
Shading denotes input variables specific to the project. Other variables are either standard for the program or calculated using these inputs:
Blue - Project Specific Input
Yellow - Assumptions
Green - Emission Factors
Speed and average volume on general-purpose lanes before and after implementation of the HOV facility are equal for part B. Local assumptions are calculated from the Dallas-Fort Worth Regional Travel Model, and data provided by the Texas Transportation Institute.

5.0 Employer-Based Transportation Management Programs

5.1 Transit/Rideshare Services - Vanpools

Strategy: Reduction of vehicle trips and emissions through increased used of transit, carpooling, or vanpooling.

Project Year: 2018

Description: Employers or groups of employers in activity centers provide transportation service to and from the work site to transit facilities and homes. The services can include subscription buses, midday and park-and-ride shuttles, and Guaranteed Ride Home programs.

Project Description:

Application: Large companies or groups of cooperating businesses.

Project Code:

Variables:		Source		NO_X	VOC
EF_A:	Speed-based running exhaust emission factor after implementation (NOx or VOC) (grams/mile) *(assume 34 mph, Light Duty Vehicle on all roadway types)*	MOVES2014a	EF_A:	0.17	0.06
EF_B:	Speed-based running exhaust emission factor before implementation (NOx or VOC) (grams/mile) *(assume 34 mph, Light Duty Vehicle on all roadway types)*	MOVES2014a	EF_B:	0.17	0.06
N_{VA}:	Number of vehicles after implementation *(equal to number of vanpools)*	Project Specific	N_{VA}:	180.00	180.00
N_{VOR}:	Vehicle Occupancy	COG Default	N_{VA}:	21.00	21.00
N_{VB}:	Number of vehicles before implementation *(equal to vanpool occupancy * number of vanpools)*		N_{VB}:	3,780.00	3,780.00
TEF_{AUTO}:	Auto trip-end emission factor (NOx or VOC) (grams/trip)	MOVES2014a	TEF_{AUTO}:	0.59	0.71
TL_A:	Average auto trip length after implementation (miles)	COG Default	TL_A:	85.00	85.00
TL_B:	Average auto trip length before implementation (miles)	COG Default	TL_B:	35.00	35.00
VT_A:	Vehicle trips after implementation		VT_A:	360.00	360.00
VT_B:	Vehicle trips before implementation		VT_B:	7,560.00	7,560.00
Conversion Factor:	Convert grams per mile of emissions to pounds per mile of emissions		Conversion Factor:	453.60	453.60

Equation:			NO_X	VOC
$A = VT_B * TL_B * EF_B$	Auto running exhaust emissions before strategy implementation	A:	44,982.00	15,876.00
$B = VT_A * TL_A * EF_A$	Auto running exhaust emissions after strategy implementation	B:	5,202.00	1,836.00
$C = (VT_B - VT_A) * TEF_{AUTO}$	Reduction in start exhaust emissions from reduction in vehicle trips to/from employment center	C:	4,248.00	5,112.00
$VT_A = NV_A * 2$ trips/day	Number of vehicles before strategy implementation multiplied by two trips per day (round trip).	VT_A:	360.00	360.00
$VT_B = NV_B * 2$ trips/day	Number of vehicles after strategy implementation multiplied by two trips per day (round trip).	VT_B:	7,560.00	7,560.00

Results:		NO_X	VOC
Daily Emission Reduction = [(A - B) + C] / Conversion Factor	**Daily Emission Reduction (lbs/day) =**	**97.06**	**42.22**
	Daily Emission Reduction (tons/day) =	**0.05**	**0.02**

Source: The Texas Guide to Accepted Mobile Source Emission Reduction Strategies, Texas Transportation Institute, August 2007.
Local assumptions for vanpool projects are calculated from them monthly performance measures reported by the Dallas Area Rapid Transit and the Fort Worth Transit Authority for fiscal years 2004 to 2010. This analysis also incorporates an assumption of equal emission factors, trips, and trip length before and after implementation of the vanpool programs.
Shading denotes input variables specific to the project. Other variables are either standard for the program or calculated using these inputs:
Blue - Project Specific Input
Yellow - Assumptions
Green - Emission Factors

7.0 Traffic Flow Improvements -- TTI Equation

7.1 Traffic Signalization

Strategy: Traffic signalization projects can measurably reduce CO and HC emissions by decreasing vehicular stops and idling, which would in turn reduce travel times and traffic delays.

Project Year: 2018

Description: Traffic signalization increases the efficiency of traffic flow at intersections by improving interconnection and coordination of signals, leading to reductions in travel times, delays, and stop-and-go driving. Traffic signalization can be as simple as updating the equipment and/or software or improving the timing plan. Because signal improvements reduce travel times and stop-and-go driving conditions, they can measurably reduce CO and HC emissions as well as reducing fuel consumption.

Project Description:

Application: Major arterials or high capacity roadways with uncoordinated traffic signals.

Project Code:

Variables:		Source		NO_X	VOC
EF_I':	Idling emission factor (NOx or VOC) (grams/mile) *(equal to the emission factor at 2.5 mph for all vehicle types on arterials)*	MOVES2014a	EF_I':	0.64	0.33
EF_I:	Idling emission factor (NOx or VOC) (grams/hour) *(equal to the emission factor at 2.5 mph, multiplied by 2.5 miles to get units of grams/hour)*		EF_I:	1.60	0.83
D_B:	Time delay before project implementation (seconds)	COG Default	D_B:	36.00	36.00
D_A:	Time delay after project implementation (seconds)	COG Default	D_A:	21.00	21.00
V:	Bi-directional arterial volume for analysis period	Project Specific	V:	**75,896.00**	**75,896.00**
P,H_R	Peak Hour Ratio	COG Default	P,H_R	0.46	0.46
$V_{D,P}$:	Average daily volume during the peak period		$V_{D,P}$:	34,912.16	34,912.16
$V_{D,OP}$:	Average daily volume during the off-peak period		$V_{D,OP}$:	40,983.84	40,983.84
DR:	Reduction in time delay (seconds)	COG Default	DR:	15.00	15.00
Conversion Factor:	Convert grams per mile of emissions to pounds per mile of emissions	Standard	Conversion Factor:	453.60	453.60

Equation:			NO_X	VOC
$A = (D_B - D_A) * EF_I * V_{D,P}$	Change in exhaust emissions from improved speed during the peak and off-peak periods.	A:	232.75	120.01
$B = (D_B - D_A) * EF_I * V_{D,OP}$	Change in idling exhaust emissions from improved traffic flow during the peak and off-peak periods.	B:	273.23	140.88

Results:		NO_X	VOC
Daily Emission Reduction = (A + B)/Conversion Factor	**Daily Emission Reduction (lbs/day) =**	**1.12**	**0.58**
	Daily Emission Reduction (tons/day) =	**0.00**	**0.00**

Source: The Texas Guide to Accepted Mobile Source Emission Reduction, August 2007.
Local variable calculations utilize data from the Highway Capacity Manual, and the Dallas-Fort Worth Travel Demand Model.
Shading denotes input variables specific to the project. Other variables are either standard for the program or calculated using these inputs:
Blue - Project Specific Input
Yellow - Assumptions
Green - Emission Factors

7.0 Traffic Flow Improvements -- TTI Equation

7.1 Traffic Signalization by Corridor

Strategy: Traffic signalization projects can measurably reduce CO and HC emissions by decreasing vehicular stops and idling, which would in turn reduce travel times and traffic delays.

Project Year: 2018

Description Traffic signalization increases the efficiency of traffic flow at intersections by improving interconnection and coordination of signals, leading to reductions in travel times, delays, and stop-and-go driving. Traffic signalization can be as simple as updating the equipment and/or software or improving the timing plan. Because signal improvements reduce travel times and stop-and-go driving conditions, they can measurably reduce CO and HC emissions as well as reducing fuel consumption. (See MoSERS 2007, page B.7.5-7.6 for more information.)

Project Description:

Application: Major arterials or high capacity roadways with uncoordinated traffic signals.

Project Code:

Variables:		Source		NOx	VOC
EF_{AP}:	Speed-based running exhaust emission factor during peak hours after implementation (NOx or VOC) (grams/mile) (equal to the emission factor at 9 mph for all vehicle types on arterials)	MOVES 2014a	EF_A:	0.25	0.11
EF_{BP}:	Speed-based running exhaust emission factor during peak hours before implementation (NOx or VOC) (grams/mile) (equal to the emission factor at 5 mph for all vehicle types on arterials)	MOVES 2014a	EF_B:	0.36	0.18
$EF_{A,OP}$:	Speed-based running exhaust emission factor during off-peak hours after implementation (NOx or VOC) (grams/mile) (COG assumption: at 9 mph)	MOVES 2014a	$EF_{A,OP}$:	0.25	0.11
$EF_{B,OP}$:	Speed-based running exhaust emission factor during off-peak hours before implementation (NOx or VOC) (grams/mile) (COG assumption: at 5 mph)	MOVES 2014a	$EF_{B,OP}$:	0.36	0.18
L:	Length of roadway affected by signalization project (miles) *(for a corridor, use the length of the entire corridor being retimed in progression, from limit A to limit B*	Project Specific	L:	5.00	5.00
V:	Bi-directional arterial volume for analysis period *(average corridor volume)*	Project Specific	V:	36,665.00	36,665.00
$V_{D,P}$:	Average daily volume during the peak period	Project Specific	$V_{D,P}$:	16,865.90	16,865.90
$V_{D,OP}$:	Average daily volume during the off-peak period	Project Specific	$V_{D,OP}$:	19,799.10	19,799.10
Conversion Factor:	Convert grams per mile to pounds per mile of emissions		Conversion Factor:	453.60	453.60

Equation:			NOx	VOC
$A = V_{D,P}*(EF_{B,P} - EF_{A,P})*L$	Change in running exhaust emissions from improved traffic flow during the peak period	A:	9,276.25	5,903.07
$B = V_{D,OP}*(EF_{B,OP} - EF_{A,OP})*L$	Change in running exhaust emissions from improved traffic flow during the off-peak period	B:	10,889.51	6,929.69

Results:		NOx	VOC
Daily Emission Reduction = (A + B)/Conversion Factor	**Daily Emission Reduction (lbs/day) =**	**44.46**	**28.29**
	Daily Emission Reduction (tons/day) =	**0.02**	**0.01**

Source: The Texas Guide to Accepted Mobile Source Emission Reduction, August 2007.
Before speeds and after speeds are assumed to be the same during peak and off-peak hours. Local variable calculations utilize data from the Highway Capacity Manual, and the Dallas-Fort Worth Travel Demand Model.
Shading denotes input variables specific to the project. Other variables are either standard for the program or calculated using these inputs:
Blue - Project Specific Input
Green - Emission Factors

7.0 Traffic Flow Improvements -- TTI Equation

7.2 Traffic Operations: Intersection Improvements

Strategy: Reduce congestion in corridors and intersections, improving traffic speeds and reducing idling times, leading to lower emission and improved traffic system efficiency.

Project Year: 2018

Description: Traffic operation improvements, similar to traffic signalization improvements primary focus on reducing congestion on local and arterial streets by improving the systems efficiency. Generally, each action will improve traffic flow and safety. Many roadway changes require only signage and pavement marking changes with little new construction and are relatively quick to implement.

Project Description:

Application: Major arterials or high capacity roadways.

Project Code:

Variables:		**Source**		**NO_X**	**VOC**
EF_I':	Idling emission factor (NOx or VOC) (grams/mile) *(equal to the emission factor at 2.5 mph, all vehicles types on arterials)*	MOVES2014a	**EF_I':**	0.64	0.33
EF_I:	Idling emission factor (NOx or VOC) (grams/hour) *(equal to the emission factor at 2.5 mph, multiplied by 2.5 miles to get units of grams/hour)*		**EF_I:**	1.60	0.83
D_B:	Time delay before project implementation (seconds)	COG Default	**D_B:**	31.00	31.00
D_A:	Time delay after project implementation (seconds)	COG Default	**D_A:**	21.00	21.00
V:	Bi-directional arterial volume for analysis period	Project Specific	**V:**	**75,896.00**	**75,896.00**
P,H_R	Peak Hour Ration	COG Default	**P,H_R**	0.46	0.46
$V_{D,P}$:	Average daily volume during the peak period		**$V_{D,P}$:**	34,912.16	34,912.16
$V_{D,OP}$:	Average daily volume during the off-peak period		**$V_{D,OP}$:**	40,983.84	40,983.84
DR:	Reduction in time delay (seconds)	COG Default	**DR:**	10.00	10.00
Conversion Factor:	Convert grams per mile of emissions to pounds per mile of emissions	Standard	**Conversion Factor:**	453.60	453.60

Equation:			**NO_X**	**VOC**
$A = (D_B - D_A) * EF_I * V_{D,P}$	Change in exhaust emissions from improved speed during the peak and off-peak periods.	**A:**	155.17	80.01
$B = (D_B - D_A) * EF_I * V_{D,OP}$	Change in idling exhaust emissions from improved traffic flow during the peak and off-peak periods.	**B:**	182.15	93.92

Results:		**NOx**	**VOC**
Daily Emission Reduction = (A + B)/Conversion Factor	**Daily Emission Reduction (lbs/day) =**	**0.74**	**0.38**
	Daily Emission Reduction (tons/day) =	**0.00**	**0.00**

Source: The Texas Guide to Accepted Mobile Source Emission Reduction, August 2007.
Local variable calculations utilize data from the Highway Capacity Manual, and the Dallas-Fort Worth Travel Demand Model.
Shading denotes input variables specific to the project. Other variables are either standard for the program or calculated using these inputs:
Blue - Project Specific Input
Yellow - Assumptions
Green - Emission Factors

7.0 Traffic Flow Improvements

7.4 Intelligent Transportation Systems - Regional Benefits Calculation Methodology - 2018 Emisssions

County	NO_X (tons/day)	VOC (tons/day)	% ITS Coverage	% Emission (Nonrecurrent)[1]	% Recurrent Congestion Eliminated	% Nonrecurrent Congestion Eliminated[1]
Collin	3.28	0.48	88	N/A	0.05	N/A
Dallas	18.80	3.31	87	N/A	0.05	N/A
Denton	3.75	0.50	89	N/A	0.05	N/A
Tarrant	11.58	1.98	88	N/A	0.05	N/A
Total	***37.42***	***6.27***	-	N/A	0.05	N/A

	Collin	Dallas	Denton	Tarrant	Four County Total (tons/day)	Four County Total (lbs/day)
Reduction in Estimated NO_X Emissions Caused by Peak Hour Nonrecurrent Congestion[1]	N/A	N/A	N/A	N/A	N/A	
Reduction in Estimated NO_X Emissions Caused by Peak Hour Recurrent Congestion	0.14	0.82	0.17	0.51	1.64	3,277.90
Reduction in Estimated Total NO_X Emissions Caused by Peak Hour Congestion	**0.14**	**0.82**	**0.17**	**0.51**	**1.64**	**3,277.90**
Reduction in Estimated VOC Emissions Caused by Peak Hour Nonrecurrent Congestion[1]	N/A	N/A	N/A	N/A	N/A	
Reduction in Estimated VOC Emissions Caused by Peak Hour Recurrent Congestion	0.02	0.14	0.02	0.09	0.27	549.23
Reduction in Estimated Total VOC Emissions Caused by Peak Hour Congestion	**0.02**	**0.14**	**0.02**	**0.09**	**0.27**	**549.23**

DFX = NCTCOG Dallas Fort Worth Travel Demand Model for the Expanded Area
[1]NCTCOG DFX does not include nonrecurring congestion or 0ff-peak emissions benefits.
Shading denotes input variables specific to the project. Other variables are either standard for the program or calculated using these inputs:
Blue - Project Specific Input
Yellow - Assumptions

7.0 Traffic Flow Improvements -- TTI Equation

7.5 Grade Separation (Road-Road)

Strategy: Reduce congestion in corridors by reducing idling times and leading to lower emissions and improved traffic system efficiency.

Description: Grade Separations increases the efficiency of traffic flow at intersections by reduction in travel times, delays, and stop-and-go driving.

Application: Major arterials or high capacity roadways.

Project Year: 2018

Project Description:

Project Code:

Variables:		**Source**		**NO_X**	**VOC**
EF_I':	Idling emission factor (NOx or VOC) (grams/mile) *(equal to the emission factor at 2.5 mph, all vehicles, arterials)*	MOVES2014a	**EF_I':**	0.64	0.33
EF_I:	Idling emission factor (NOx or VOC) (grams/hour) *(equal to the emission factor at 2.5 mph, multiplied by 2.5 miles to get units of grams/hour)*		**EF_I:**	1.60	0.83
D_B:	Time delay before project implementation (seconds)	COG Default	**D_B:**	45.00	45.00
D_A:	Time delay after project implementation (seconds)	COG Default	**D_A:**	21.00	21.00
V:	Bi-directional arterial volume for analysis period	Project Specific	**V:**	**75,896.00**	**75,896.00**
P,H_R	Peak Hour Ration	COG Default	**P,H_R**	0.46	0.46
$V_{D,P}$:	Average daily volume during the peak period		**$V_{D,P}$:**	34,912.16	34,912.16
$V_{D,OP}$:	Average daily volume during the off-peak period		**$V_{D,OP}$:**	40,983.84	40,983.84
DR:	Reduction in time delay (seconds)	COG Default	**DR:**	24.00	24.00
Conversion Factor:	Convert grams per mile of emissions to pounds per mile of emissions	Standard	**Conversion Factor:**	453.60	453.60

Equation:			**NO_X**	**VOC**
$A= (D_B - D_A) * EF_I * V_{D,P}$	Change in exhaust emissions from improved speed during the peak and off-peak periods.	**A:**	372.40	192.02
$B= (D_B - D_A) * EF_I * V_{D,OP}$	Change in idling exhaust emissions from improved traffic flow during the peak and off-peak periods.	**B:**	437.16	225.41

Results:		**NO_X**	**VOC**
Daily Emission Reduction = (A + B)/Conversion Factor	**Daily Emission Reduction (lbs/day) =**	**1.78**	**0.92**
	Daily Emission Reduction (tons/day) =	**0.00**	**0.00**

Source: The Texas Guide to Accepted Mobile Source Emission Reduction, August 2007.
Local variable calculations utilize data from the Highway Capacity Manual, and the Dallas-Fort Worth Travel Demand Model.
Shading denotes input variables specific to the project. Other variables are either standard for the program or calculated using these inputs:
Blue - Project Specific Input
Yellow - Assumptions
Green - Emission Factors

7.0 Traffic Flow Improvements

7.5 Railroad Grade Separation

Strategy: Grade separation of rail lines and arterial streets reduces congestion in corridors by reducing idling times and leading to lower emissions and improved traffic system efficiency.

Project Year: 2018

Description: Railroad grade separations remove periodic traffic delays on major roadways by raising or lowering either the rail line or the roadway and permitting more efficient flow of traffic at major rail crossings.

Project Description:

Application: Arterials with delays cause by at-grade rail crossings.

Project Code:

Variables:		Source		NO_X	VOC
EF_I':	Idling emission factor (NOx or VOC) (grams/mile). (Emission factor at 2.5 mph, all vehicles, arterials).	MOVES2014a	**EF_I':**	0.64	0.33
EF_I:	Idling emission factor (NOx or VOC) (grams/hour) *(equal to the emission factor at 2.5 mph, multiplied by 2.5 miles to get units of grams/hour)*		**EF_I:**	1.60	0.83
t_C:	Average amount of time rail crossing is closed due to train crossing (hours/crossing)	TRE	**t_C:**	21.00	21.00
t_H:	Duration of analysis period (hours)		**t_H:**	24.00	24.00
t_F	Frequency of Train per analysis period.	TRE	**t_F**	**30.00**	**30.00**
$t_{H,C}$:	Hours per analysis period roadway is closed due to train crossing	TRE	**$t_{H,C}$:**	0.90	0.90
V:	Bi-directional arterial volume for analysis period	TxDOT	**V:**	**28,633.00**	**28,633.00**
Conversion Factor:	Convert grams per mile of emissions to pounds per mile of emissions	Standard	**Conversion Factor:**	453.60	453.60

Equation:			NO_X	VOC
$A = t_{H,C} / t_H * V$	The proportion of arterial traffic affected by rail crossing delays	**A:**	1,073.74	1,073.74
$B = t_C / 2 * EF_I$	The idling emissions resulting from affected traffic assumed to be idling half the average time the roadway is closed per train crossing	**B:**	16.80	8.66

Results:		NO_X	VOC
Daily Emission Reduction = (A * B)/Conversion Factor	**Daily Emission Reduction (lbs/day) =**	39.77	20.51
	Daily Emission Reduction (tons/day) =	**0.02**	**0.01**

Source: The Texas Guide to Accepted Mobile Source Emission Reduction Strategies , August 2007.
Local variable calculations utilize data from the Dallas-Fort Worth Regional Travel Model, Federal Railroad Administration, Union Pacific Railroad, the Association of American Railroads (Railroad Facts" 1999 Edition, the Trinity Railway Express June 2003 Schedule, and the Regional Rail Corridor Study Consultant Team: URS Corporation, Carter-Burgess, and Lonnie Blaydes Consulting.
Shading denotes input variables specific to the project. Other variables are either standard for the program or calculated using these inputs:
Blue - Project Specific Input
Yellow - Assumptions
Green - Emission Factors

8.0 Park-and-Ride/Fringe Parking

8.1 New Facilities

Strategy: Reduction of vehicle trips and VMT by enhancements of transit system and ridesharing.

Project Year: 2018

Description: Construction of new park-and-ride facilities in locations remote from the central city area or major business activity centers or on the fringes of major employment centers. Lots or garages are constructed adjacent to or very near transit facilities or heavily traveled corridors. These lots are designed to be conducive to several modes of transportation including pedestrian and bicycle facilities. New facilities will require coordination with other transportation agencies, and political and citizen groups.

Project Description:

Application: Cities with a population density great enough to warrant projects that encourage carpooling.

Project Code:

Variables:		Source		NO_X	VOC
EF_B:	Speed-based running exhaust emission factor before implementation (NOx or VOC) (grams/mile) *(assume 34 mph, Light Duty Vehicles in all roadway types)*	MOVES2014a	EF_B:	0.17	0.06
N_{PK}:	Number of parking spaces	Project Specific	N_{PK}:	**887.00**	**887.00**
U_P:	Parking lot utilization rate (estimate)	COG Default	U_P:	0.85	0.85
TL_W:	Average auto work trip length (miles)	COG Default	TL_W:	20.00	20.00
TL_{PR}:	Average auto trip length from home to parking facility (miles)	COG Default	TL_{PR}:	4.00	4.00
Conversion Factor:	Convert grams per mile of emissions to pounds per mile of emissions		Conversion Factor:	453.60	453.60

Results:			NO_X	VOC
Daily Emissions Reduction=	**$[N_{PK} * U_P * (TL_W - TL_{PR}) * EF_B * 2$ trips/day] / Conversion Factor**	**Daily Emission Reduction (lbs/day) =**	**9.04**	**3.19**
		Daily Emission Reduction (tons/day) =	**0.00**	**0.00**

Source: The Texas Guide to Accepted Mobile Source Emission Reduction Strategies, Texas Transportation Institute, August 2007.
Local assumptions are calculated from data generated by the Dallas-Fort Worth Regional Travel Model, and from professional judgment of the North Central Texas Council of Governments staff.
Shading denotes input variables specific to the project. Other variables are either standard for the program or calculated using these inputs:
Blue - Project Specific Input
Yellow - Assumptions
Green - Emission Factors

11.0 Bicycle and Pedestrian Programs

11.1 Bicycle and Pedestrian Lanes or Paths

Strategy: Replacement of vehicle trips and VMT with bicycle and pedestrian travel.

Project Year: 2017

Description: A wide variety of bicycle and pedestrian projects are available to practitioners for implementation in air quality mitigation efforts. Funding for these types of programs has increased dramatically under ISTEA and TEA-21. Examples of such projects include (but are not limited to): reallocation of right-of-way to accommodate bicycles and pedestrians, new trails, median refuges at key intersections, improved connections between residential areas and transit stops.

Project Description:

Application: Areas where travel distances (residential/work or retail sites, for example) are short enough for bicycle/ pedestrian travel to be practical.

Project Code:

Variables:		Source		NO_X	VOC
EF_B:	Speed-based running exhaust emission factor for participants' trip before participating in the bike/pedestrian program (NO_x or VOC) (grams/mile) *(assume 34 mph, LDV and arterial roadway types)*	MOVES2014a	EF_B:	0.09	0.03
TEF_{AUTO}:	Auto trip-end emission factor (NOx or VOC) (grams/trip)	MOVES2014a	TEF_{AUTO}:	0.59	0.71
TL_B:	Average auto trip length before implementation (miles)	COG default	TL_B:	1.00	1.00
N_{BW}:	Number of trips utilizing the bike/pedestrian facility	BP team	N_{BW}:	2,292.00	2,292.00

Where,
NBW is calculated using bike needs indices (BNI) and pedestrian needs indices (PNI). The BNI is determined by the percentage of total trips that are five miles or less, employment density, population density, and medium income. Each of the Transportation Analysis Process (TAP) zones within the Dallas-Fort Worth Metropolitan Planning Area are ranked for each factor of the BNI and PNI. These rankings are compared against the regional value to generate an "index-to-region" score. Index-to-region scores greater than 1.00 indicate higher than average levels, and scores lower than 1.00 indicate lower than average levels. A ranking weight is then applied to each index-to-region score and summed for each TAP zone. The TAP zone area, population, and scores are compared against a site-specific radius for each bike/pedestrian facility to quantify the number of facility users (NBW) above, with exceptions. Natural and manmade barriers are also considered, including rivers, highways, and other incompatible land uses and street patterns.

			NO_X	VOC
Conversion Factor:	Convert grams per mile of emissions to pounds per mile of emissions	**Conversion Factor:**	453.6	453.6

Results:		NO_X	VOC
Daily Emissions Reduction = $(N_{BW} * TL_B * EF_B) + (N_{BW} * TEF_{AUTO})$/ Conversion Factor	**Daily Emission Reduction (lbs/day) =**	**3.44**	**3.74**
	Daily Emission Reduction (tons/day) =	**0.00**	**0.00**

Source: The Texas Guide to Accepted Mobile Source Emission Reduction Strategies, August 2007.
Shading denotes input variables specific to the project. Other variables are either standard for the program or calculated using these inputs:
Blue - Project Specific Input
Yellow - Assumptions
Green - Emission Factors