Attachment C
Model-Based Ozone Response Calculations

The availability of updated emissions information regarding reductions in airport emissions, DERCs, and backup generator emissions will reduce ozone in both the future case and control case. The impact of these changes in NO_X emissions can be calculated using response data from previously run sensitivity tests in order to quantify the differences in ozone expected to result from the adjustments to the NO_X emissions.

Since the calculated response over the relatively small ranges used in the sensitivity tests is linear, these ozone adjustments can simply be added or subtracted from the original numbers in the SIP. However, for larger reductions, the ozone response to NO_X is known to be a downward curve. The CAM_X chemistry (and the real world) demonstrates a stronger response with more NO_X reductions. Adding up the linear estimates understates the cumulative model response, and is therefore a conservative estimate of the total response to reductions.

Additionally, a model-based analysis is provided to estimate the potential ozone reductions that could occur from an estimated TERP funding allotment for the DFW area.

Model Linearity Over Small Ranges

Figure 1: *DFW Response to Non-Road NO_X Reductions at Frisco and Denton* shows the model response using data from EPA Region 6 model replication runs for the two controlling monitors in the DFW area, and indicates that the response is linear over these ranges.

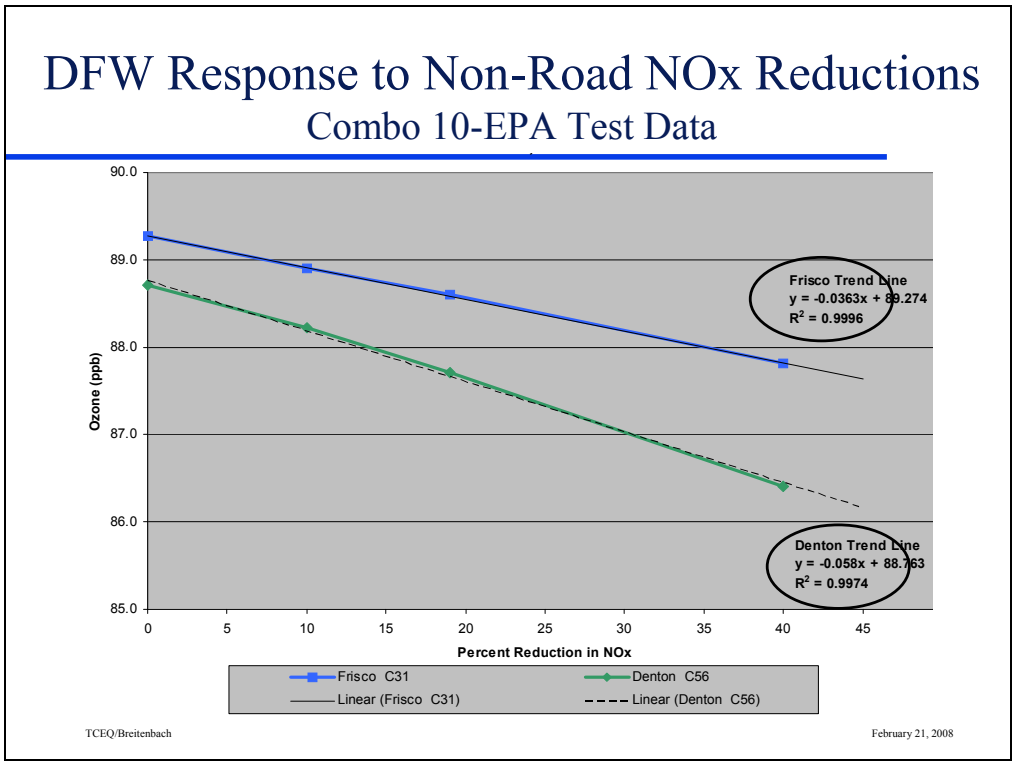

Figure 1: DFW Response to Non-Road NO_X Reductions at Frisco and Denton

In Figure 1: *DFW Response to Non-Road NO_X Reductions at Frisco and Denton* NO_X emissions reductions are calculated as a percentage change. A ten percent reduction corresponds to 10.7 tpd of NO_X, 19 percent corresponds to 20.4 tpd, and 40 percent corresponds to 43 tpd. The colored lines in Figure 1: *DFW Response to Non-Road NO_X Reductions at Frisco and Denton* show the actual model response and the black overprinted lines show the linear best fit to the data. From a visual perspective, the black lines are a very good fit to the data.

From a mathematical perspective, the r^2 for the Frisco data is 0.9996, indicating that 99.96 percent of the variance can be accounted for with a straight line and only 0.04 percent of the variance is associated with curvature or other variables. Similarly, the r^2 for Denton is 0.9974, indicating that 99.74 percent of the variance can be accounted for with a straight line and only 0.26 percent of the variance can be attributed to curvature. Therefore, for all practical purposes, the ozone response is linear over the range of NO_X adjustments in these calculations.

Figure 1: *DFW Response to Non-Road NO_X Reductions at Frisco and Denton* also shows that the response (the slope) at the Denton monitor is steeper than at the Frisco monitor, indicating that the ozone response to NO_X reductions is stronger at the Denton monitor than at the Frisco monitor. Numerically, the Frisco monitor slope is -0.036 and -0.058 at the Denton monitor. The difference in model response occurs because the winds during this episode blow from the urban core toward Denton more frequently than the winds blow toward the Frisco monitor.

Model-based Ozone Response Calculations for Airports and Back-up Generators using EPA Non-Road Sensitivity Tests

The EPA ran several different sensitivity tests to evaluate how the model responded to NO_X reductions in different emissions categories. The TCEQ used the results of EPA Region 6 non-road sensitivity tests to determine the impact of NO_X controls and adjustments in the DFW area for airport emissions and back-up generators.

Table 1: *EPA Non-Road Sensitivity Test Results* shows the results of the EPA non-road sensitivity test. The EPA first replicated the TCEQ 2009 Combo 10 run to make sure the results were the same as those determined by the TCEQ. The second column of the table shows the eight-hour average ozone (in ppb) resulting from the Combo 10 run for every monitor in the DFW area. The third column of the table shows the ozone that resulted from the EPA test with 10.7 tons (10 percent) of NO_X removed from the non-road sources inside the DFW nine-county nonattainment area. The fourth column shows the difference in ppb for every monitor as a result of the 10.7 tpd reduction. The last column of the table shows the model response factor in ppb/ton that results from dividing the ppb differences in the fourth column by 10.7 tpd.

Table 1: EPA Non-Road Sensitivity Test Results

NO_X Change (tpd/Percent)	Ozone Based on Combo 10 Baseline (ppb)		Ozone Difference	Model Response
	0/0	-10.7/-10	ppb	ppb/ton
Frisco C31	**89.270**	**88.903**	-0.367	**0.03427**
Dal Hinton C60	**85.650**	**85.356**	-0.294	0.02743
Dal North C63	84.910	84.593	-0.317	0.02959
Redbird C402	78.760	78.541	-0.219	0.02050
Denton C56	**88.710**	**88.220**	-0.490	**0.04575**
Midlothian C94	83.710	83.612	-0.098	0.00913
Arlington C57	80.730	80.453	-0.277	0.02592
FtW NW C13	**85.420**	**85.031**	-0.389	0.03635
FtW Keller C17	84.840	84.346	-0.494	0.04617
Average	84.667	84.340	-0.327	0.03057

The model response from the last column in Table 1: *EPA Non-Road Sensitivity Test Results* was used to calculate the change in ozone resulting from the emissions controls and adjustments. The results are discussed in the TCEQ response document and shown below in Table 2: *Ozone Response to Airpor Emission Adjustments and Back-up Generators NO_X Reductions.* As a result of the calculations accounting for airport emissions adjustments and back-up generators emission reductions, the ozone at the Frisco monitor is expected to be reduced by 0.353 ppb.

Table 2: Ozone Response to Airport Emissions Adjustments and Back-up Generators NO_X Reductions

DFW Area Monitor	Model Response	Airport Emissions		Backup Generators	
	ppb/ton	Tons	ppb	Tons	ppb
Frisco C31	**0.03427**	-9.39	**-0.322**	-0.9	**-0.031**
Dal Hinton C60	0.02743	-9.39	-0.258	-0.9	-0.025
Dal North C63	0.02959	-9.39	-0.278	-0.9	-0.027
Redbird C402	0.02050	-9.39	-0.192	-0.9	-0.018
Denton C56	**0.04575**	-9.39	**-0.430**	-0.9	**-0.041**
Midlothian C94	0.00913	-9.39	-0.086	-0.9	-0.008
Arlington C57	0.02592	-9.39	-0.243	-0.9	-0.023
FtW NW C13	0.03635	-9.39	-0.341	-0.9	-0.033
FtW Keller C17	0.04617	-9.39	-0.434	-0.9	-0.042
Average	0.03057	-9.39	-0.287	-0.9	-0.028

Model-based Ozone Response Calculations for DERCs using TCEQ Point Source Sensitivity Test

The effect of the DERC adjustments to NO_X emissions was calculated using the same procedures discussed above, except that results from a TCEQ point source sensitivity test were used. The results of Task 8 and Task 11 were used to calculate the DFW response to point source NO_X reductions, and those response factors were then used to calculate the change in ozone expected to result from the corrected DERC emissions.

Table 3: *Point Source Sensitivity Test NO_X Emissions Data* shows the weekday NO_X emissions in tpd for Tasks 8 and 11, calculated for each source category. The last column calculates the difference in NO_X for each emissions category. Since the only changes between the two runs were 15 tpd in point source emissions, and no changes occurred outside of the DFW area, Tasks 8 and 11 provide an accurate basis for evaluating the model response to point sources in the DFW area.

Table 3: Point Source Sensitivity Test NO_X Emissions Data

Source Categories	Task 8	Task 11		Difference (tpd)
Inside DFW Reference area (16-county)				
On-Road Mobile	212	212		0.0
DFW Elevated Points	**80.0**	**69.0**		**-11.0**
DFW Low Level Points	**10.0**	**6.0**		**-4.0**
Area Sources	67	67		0.0
Non-road	123	123		0.0
Inside Sub-total	*280.0*	*265.0*		***-15.0***
Rest of Texas (outside DFW Reference Area)				
On-Road Mobile	691	691		0.0
DFW Elevated Points	1030	1030		0.0
DFW Low Level Points	73	73		0.0
Area Sources	467	467		0.0
Non-road	379	379		0.0
Outside Sub-total	*1949.0*	*1949.0*		*0.0*
Grand Total	2229.0	2214.0		**-15.0**

Table 4: *Model Response to Point Source Reductions* shows how the model responds to the 15 tpd of NO_X reductions in Task 11 allocated to non-EGU, non-kiln point sources inside the DFW area. The calculation procedures are the same as described and used in Table 1. When the change in ozone between the two tasks is divided by the 15 tpd emissions change, the response factor calculated for the Frisco monitor is 0.02250 ppb/ton of NO_X reduced.

Table 4: Model Response to Point Source Reductions

DFW Area Monitor	Task 8	Task 11		Difference (ppb)	Model Response ppb/ton
Frisco C31	91.2	90.9		-0.34	**0.02250**
Hinton C60	87.6	87.2		-0.31	**0.02083**
Dallas N C63	87.0	86.7		-0.31	**0.02083**
Dallas Exec C402	79.7	79.3		-0.41	**0.02750**
Denton C56	89.6	89.3		-0.27	**0.01833**
Midlothian C94	84.5	83.9		-0.57	**0.03833**
Arlington C57	87.2	86.6		-0.59	**0.03917**
FtW NW C13	87.6	87.1		-0.50	**0.03333**
FtW Keller C17	86.0	85.7		-0.33	**0.02167**
Average	86.71	86.30		-0.40	**0.02694**

Table 5: *Ozone Response to DERC Emissions Adjustment* shows how the ozone would respond to flow-controls on DERC usage. The SIP modeling assumed that all the DERCs would be used in 2009, which is conservative and unrealistic. However, with flow control, the DERC usage can be constrained.

Table 5: Ozone Response to DERC Emissions Adjustment

DFW Area Monitor	**ppb/ton**	DERC Tons	**DERC ppb**
Frisco C31	**0.02250**	-17.2	**-0.387**
Hinton C60	**0.02083**	-17.2	**-0.358**
Dallas N C63	**0.02083**	-17.2	**-0.358**
Dallas Exec C402	**0.02750**	-17.2	**-0.473**
Denton C56	**0.01833**	-17.2	**-0.315**
Midlothian C94	**0.03833**	-17.2	**-0.659**
Arlington C57	**0.03917**	-17.2	**-0.674**
FtW NW C13	**0.03333**	-17.2	**-0.573**
FtW Keller C17	**0.02167**	-17.2	**-0.373**
Average	**0.02694**	-17.2	**-0.463**

The TCEQ anticipates that controlling DERC usage will reduce NO_X in the DFW area by 17.2 tpd. At the Frisco Monitor, the ozone change is calculated by multiplying the Frisco response factor (0.02250) by the 17.2 tpd of NO_X reduction, which reduces ozone by 0.387 ppb at the Frisco monitor.

Since each of the individual adjustments is linear, and the aggregate response is not linear, the actual response is expected to be greater than the sum of the individual components. So, when these ozone adjustments are added together, they provide a conservative estimate of the total ozone response.

Model-based Ozone Response Calculations for TERP using EPA Non-Road Sensitivity Tests

In addition to determining the ozone response of NO_X controls and adjustments for airport emissions and back-up generators, the TCEQ used the results of EPA Region 6 non-road sensitivity tests to estimate the possible impact on DFW area ozone by the estimated TERP program emissions reductions.

In the example shown in Table 6: *Estimated Ozone Response to TERP NO_X Reductions* the response factor in ppb/ton for each monitor is multiplied by the 14.2 tpd NO_X reduction anticipated to result from the TERP program. It is anticipated that as a result, the ozone at the Frisco monitor would be reduced by 0.487 ppb.

Table 6: Estimated Ozone Response to TERP NO_X Reductions

DFW Area Monitor	Model Response ppb/ton	TERP (Non-Road) Tons	TERP (Non-Road) ppb
Frisco C31	**0.03427**	-14.2	**-0.487**
Dal Hinton C60	0.02743	-14.2	-0.390
Dal North C63	0.02959	-14.2	-0.420
Redbird C402	0.02050	-14.2	-0.291
Denton C56	**0.04575**	-14.2	**-0.650**
Midlothian C94	0.00913	-14.2	-0.130
Arlington C57	0.02592	-14.2	-0.368
FtW NW C13	0.03635	-14.2	-0.516
FtW Keller C17	0.04617	-14.2	-0.656
Average	0.03057	-14.2	-0.434