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# Regional Air Quality Grant Report

*Prepared by the Capital Area Council of Governments*
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## Executive Summary

The Capital Area Council of Governments (CAPCOG) covers 10 counties in Central Texas – Bastrop, Blanco, Burnet, Caldwell, Fayette, Lee, Llano, Travis, and Williamson Counties. Five of these counties – Bastrop, Caldwell, Hays, Travis, and Williamson Counties – constitute the Austin-Round Rock Metropolitan Statistical Area (MSA). As part of its 2016-2017 Rider 7 air quality grant, CAPCOG awarded $210,500 in funding for four different regional air quality grants in 2016. These projects included:

1. The replacement of on-road pickup trucks with smaller non-road utility vehicles by Austin White Lime
2. The purchase and installation of an “electric ear” at one of Austin White Lime’s kilns in order to reduce the fuel consumption rate
3. Subsidized vanpool vouchers for Travis County employees
4. Development of a tracking tool for City of Austin to use in its “Smart Commutes” pilot project

These projects are now complete and this report documents the results of the projects. CAPCOG estimates that these grants achieved a total of 2.895 tons of $NO_X$ emissions between March 1, 2017, and September 30, 2017, with as much as 709 – 1,082 tons of $NO_X$ that could be achieved during the expected 20-30 year life of one piece of equipment funded under this grant. additional emissions expected to continue to be achieved beyond the term of the contracts CAPCOG entered into with the grant recipients.

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# 1 Background

In 2015, CAPCOG was awarded $1,247,165.59 in local air quality planning funding under Rider 7 to the appropriations for the Texas Commission on Environmental Quality (TCEQ) for fiscal year (FY) 2016 and FY 2017. Since this amount was higher than the amount CAPCOG had requested from TCEQ in its proposed work plan for FY 2016-2017 ($1 million), CAPCOG decided to use the surplus funds to award sub-grants within the region to support the region's air quality plan, the Ozone Advance Program (OAP) Action Plan. CAPCOG designed a grant program with the approval of the TCEQ in late 2015, and issued a solicitation for projects in February 2016.

CAPCOG ultimately awarded only $29,450 through this first round of funding requests, so CAPCOG convened a meeting with the officers of the Clean Air Coalition (CAC) Advisory Committee on 4/20/2016 in order to gain input on how to modify the grant program in order to award the remaining funding. CAPCOG submitted a grant plan for the remaining funding to TCEQ for review on May 31, 2016. TCEQ approved this new grant plan on June 2, 2016, and CAPCOG opened up the Request for Applications (RFA) on July 8, 2016. This new RFA provided more flexibility for applicants by not constraining the project types so tightly or constraining the reimbursement amounts, leaving the funding decisions ultimately up to a scoring committee and CAPCOG's Executive Committee.

One key change in eligibility was that CAPCOG specified that only members of the Clean Air Coalition could apply for a grant, but provided enough time for new organizations to request to join the CAC at its August meeting in order to become eligible for the grant. This was designed as a way to both reward organizations already participating in the CAC and to provide a tangible incentive for joining the CAC for organizations that were not already. This eligibility factor became key to CAPCOG's success in recruiting Austin White Lime to join the CAC in August 2016, and was a key incentive that members of the Kyle City Council had identified as a factor in their consideration of joining the CAC (this was ultimately voted down 3-3).

A total of $210,500 was available for this round of funding. Applications were due on August 19, 2016, and CAPCOG received a total of 6 applications for $311,275.75 in funding:

1. An application from the City of Austin Transportation Department for $25,000 to develop a tracking tool to help implement a program to encourage city employees to use alternatives to single-occupancy vehicle commuting
2. An application from the City of Austin Fleet Department for $95,000 to collect data on alternatively-fueled vehicles, including the use of Portable Activity Monitoring Systems (PAMS) and to collect data on diesel emissions from a large sample of the City of Austin's diesel fleet
3. An application from Austin White Lime (AWL) for $36,486 to replace an "electric ear" that could improve kiln efficiency by optimizing the flow of coal fuel into the kiln
4. An application from AWL for $6,798.10 to relocate an oxygen/carbon monoxide equivalent combustion analyzer from its current location at kiln 3 combustion unit to another location in the kiln system to increase kiln combustion efficiency
5. An application from Austin White Lime for $132,991.65 to replace eight tier 1 and older pickup trucks with ten tier-4 off-road utility vehicles

6. An application from Travis County for $15,000.00 to provide subsidies to up to 50 Travis County employees to use CapMetro's vanpool program for 6 months

AWL ultimately withdrew its application to relocate its oxygen/carbon monoxide equivalent combustion analyzer, and a grant review subcommittee of the Clean Air Coalition Advisory Committee recommended awarding funding to the City of Austin's alternative commuting application, Austin White Lime's two remaining applications, and Travis County's vanpool application, for a total of $210,500 (awarding an additional $1,022.35 to the City of Austin based on available funding).

Originally, members of the committee included:

1. Cari Buetow (City of Austin)
2. Patrick Collins (Bastrop County)
3. Trey Fletcher (City of Plugerville)
4. Caren Lee (City of Round Rock)
5. Brooke Leftwich (Hays County)
6. Nannette McCartan (City of Cedar Park)
7. Adele Noel (Travis County)
8. Gary Boyd (Williamson County)

However, Gary Boyd and Patrick Collins ultimately could not make the meeting.

Grant applications were scored based on the following factors:

- To what extent does the proposal reduce the exposure of sensitive populations to peak ozone levels (50 points)
- Feasibility and logistical considerations (30 points)
- Co-benefits of the proposed project (20 points)

CAPCOG's scoring rules required any members of the committee from refraining from scoring an application from their own organization to avoid a conflict of interest and to then average the remaining scores, excluding the highest and lowest scores as an extra measure of fairness. The results of the scoring meeting are shown in the table below.

**Table 1-1. Results of Scoring Meeting**

| Application | Average Score | Amount Requested | Amount Recommended |
|---|---|---|---|
| **City of Austin Alt. Commute** | 89.67 | $25,000.00 | $26,022.35 |
| **Austin White Lime Vehicle Replacement** | 87.25 | $132,991.65 | $132,991.65 |
| **Austin White Lime Electric Ear** | 83.00 | $36,486.00 | $36,486.00 |
| **Travis County** | 81.67 | $15,000.00 | $15,000.00 |
| **City of Austin Truck Study** | 77.00 | $95,000.00 | $0.00 |

CAPCOG's Executive Committee approved these awards in October 2016.

## 2 Austin White Lime Electric Ear Project

This project involved the purchase and installation of an electric ear used for coal measurement for Austin White Lime's (AWL's) kiln #3 coal ball mill. AWL operates three kilns to manufacture lime from limestone. Kiln #3 uses pulverized coal as one of its sources of fuel. Coal is fed to a ball mill where it is pulverized, then to the kiln for fuel. An electric ear, using sonic technology, regulates the coal feed to the ball mill so that it is not too high nor too low. AWL had previously had a ball ear at kiln #3, but it had been inoperable since 2010 and was in need of replacement. Without the electric ear, coal feed had been regulated manually by AWL's kiln operators. Regulating the coal feed automatically instead of manually was expected to result in coal fuel savings for the kiln.

In its application, AWL estimated a maximum of 0.14 tpd of $NO_X$ reductions due to the electric ear if the kiln was producing at maximum permitted capacity and its fuel input was 100% coal. In addition to coal, the kiln is also permitted to burn natural gas and petroleum coke. The maximum 0.14 tpd estimate was based on the following operational assumptions:

- $NO_X$ emissions factor: 0.738 lbs/MMBtu
- Permitted Maximum Heat Input: 156 MMBtu/hr
- Operating Period: 24 hrs/day
- Total Heat Input per Day: 3,744 MMBtu
- % Coal MMBtu (typical): 100%
- Maximum $NO_X$ emissions, tpd: 1.38
- Projected Coal Fuel Savings: 1%
- Projected daily $NO_X$ savings: 0.0138 tpd

The total cost of the project was $39,496.10, $3,010.10 of which was covered by AWL with the remaining $36,486 (92%) covered by the CAPCOG grant.

Austin White Lime had intended for the installation to be complete and the electric ear operational by March 1, 2017, but the project was delayed.

In AWL's report for 11/1/2016 – 2/28/2017, AWL reported that a purchase order for the electric ear had been sent to the manufacturer on 1/21/2017, with delivery projected for the week of 2/27/2017 or 3/6/2017, with installation tentatively scheduled for the week of 3/13/2017.

In AWL's report for 3/1/2017 – 5/31/2017, it reported installation of the electric ear by the vendor on 4/13/2017. On 4/14/2017, the ball mill motor failed when it shorted to ground. Between 4/17/2017 and 5/18/2017, AWL inspected the ball mill motor and clutch to determine the extent of damage, and AWL decided to replace the motor and to replace the clutch with a soft start (reduced voltage) electric starter. AWL obtained quotes from several vendors, and AWL issued a purchase orders for both pieces of equipment on 5/18/2017. The motor's delivery date was 6/1/2017, and the soft start unit's delivery date was 6/29/2017.

In AWL's report for 6/1/2017 – 8/31/2017, it reported that it received a replacement soft start electrical starter unit on 6/29/2017. Unit installation and commissioning occurred on 7/6/2017, but it was determined that it was undersized after it could not turn the ball mill. The unit was exchanged for a properly sized soft start electrical starter unit which was received on 7/11/2017. Unit installation and commissioning was completed on 7/14/2017, which is when the ball mill operation resumed, and thus the electric ear became operational. From 7/31/2017 – 8/4/2017, the ball mill was down due to a faulty gear box. Therefore, the electric ear was not in use during that time-frame. There were also 5 days in August when then kiln was in idle mode, in which no product was made and natural gas was the only fuel burned in reduced amounts. Since coal was not used during those days, the electric ear was also not operational during that time frame.

In AWL's "final" report covering activity through 9/30/2017, it noted that kiln 3's ball mill was not operational between 9/1/2017 – 9/4/2017 for business reasons due to effects from Hurricane Harvey, but that it was operational again between 9/5/2017 – 9/20/2017. AWL noted that from 9/21/2017 – 9/30/2017, the ball mill was down due to a faulty soft start electric starter, and that repairs were not completed until October 2017. The limestone feed rate to Kiln 3 was reduced by over 30% in September compared to June 1 – August 31 due to the effects of Hurricane Harvey. AWL notes that, due to the technical constraints of lime production from limestone, coal heat input could not be reduced without compromising product quality and maintaining kiln operational stability, and as a result, the average lime production energy consumption rate (MMBtu/tons of lime produced) increased during September operations, which in turn increased the average $NO_X$ emissions rate. Based on AWL's reporting, CAPCOG does not believe that the September 2017 data are a reliable indication of the kiln's typical operations.

In order to estimate the emission reductions achieved during this period, CAPCOG worked with AWL to develop a methodology that would provide an "apples-to-apples" comparison of fuel consumption rates during the baseline period to fuel consumption rates while using the electric ear. AWL provided CAPCOG with confidential operational data during the baseline and reporting periods in support of this process for developing an emission reduction quantification methodology. These confidential data included the following data points:

- Date
- Tons of lime produced and accepted under AWL's quality control standards
- Tons of lime produced and discarded under AWL's quality control standards
- Total tons of lime produced
- Total heat input (MMBtu)
- Total coal input (short tons)
- Total petroleum coke input (short tons)[1]
- Total natural gas input (thousand cubic feet)
- Total natural gas heat input (MMBtu)
- % of total heat input from coal
- % of total heat input from gas
- MMBtu/ton of lime produced

[1] There were no days when petroleum coke was used as a fuel in the baseline period, and very few days when it was used on a very limited basis since 3/1/2017

- Stroke count (avg. strokes/hour)
- Operational status of electric ear

The methodology agreed to by CAPCOG and AWL was based on comparing the fuel consumption rate (MMBtu/ton of lime produced) under four sets of conditions during the baseline period (3/1/2016 – 2/28/2017) to the fuel consumption rate under those same conditions in the reporting period. This methodology included consideration of the following factors:

1. Lime production:
    a. Only dates when lime was produced were considered – there are other dates when the kiln was undergoing maintenance, but these are excluded from the analysis
    b. All lime produced that day, including any lime discarded to quality concerns, was used in the denominator
2. Kiln operations:
    a. Days when the kiln's average "stroke count" was <150 per hour were compared to each other[2]
    b. Days when the kiln's average stroke count was ≥ 150 per hour were compared to each other
    c. September 2017 data were excluded due to abnormal conditions related to Hurricane Harvey
3. Fuel mix:
    a. Days when coal made up less than 50% of the heat input were not considered
    b. Days when coal made up at least 50% and up to 70% of the heat input were compared to each other
    c. Days when coal made up 70% - 100% of the heat input were compared to each other
4. Electric ear operational status:
    a. Only days when the electric ear was operational during a reporting period are compared to baseline rates

The decision to exclude consideration of days when coal made up less than 50% of the heat input was intended to better isolate the effect of the electric ear on coal heat input requirements. Of the 306 days during the baseline period that included data on lime production, heat input, and stroke count, on all but four days, coal accounted for at least 50% of the heat input.

The decision to differentiate days when coal accounted for 70% or more of the heat input from days when coal made up only 50-70% of the heat input was based on regression analysis showing that the % heat input from coal had a statistically significant impact on the overall fuel consumption rate (MMBtu/ton of lime) and that there appeared to be a clear break at the 70% mark. The average heat

[2] AWL noted in its reports to CAPCOG that the kiln uses "rams" to stroke limestone into the kiln to heat to make lime, that there are 235 strokes per pound of lime produced, and that there is a low lime production efficiency below 150 strokes/hour compared to 150 strokes/hour, so 150 strokes/hour was used as the demarcation line for comparison purposes.

input rate for days when coal input was 50-60% was identical to the rate when the coal input was 60-70% during the baseline period out to two decimal points: 5.67 MMBtu/ton of lime, while the average fuel consumption rate when coal made up between 70-80% of the heat input was 7.14 MMBtu/ton of lime.

The following equations show the baseline heat input rates.

$$Heat\ Input\ Rate_{Period,Avg.Stroke\ Count,Coal\%} = \frac{Total\ Heat\ Input_{Period,Avg.Stroke\ Count,Coal\%}}{Total\ Lime\ Produced_{Period,Avg.Stroke\ Count,Coal\%}}$$

$$Heat\ Input\ Rate_{Baseline,<150\ strokes\ per\ hour,50-70\%\ Coal} = \frac{6.483\ MMBtu}{Ton\ of\ Lime\ Produced}$$

$$Heat\ Input\ Rate_{Baseline,<150\ strokes\ per\ hour,70+\%\ Coal} = \frac{12.639\ MMBtu}{Ton\ of\ Lime\ Produced}$$

$$Heat\ Input\ Rate_{Baseline,\geq 150\ strokes\ per\ hour,50-70\%\ Coal} = \frac{5.667\ MMBtu}{Ton\ of\ Lime\ Produced}$$

$$Heat\ Input\ Rate_{Baseline,\geq 150\ strokes\ per\ hour,70+\%\ Coal} = \frac{7.142\ MMBtu}{Ton\ of\ Lime\ Produced}$$

The kiln's 0.738 lbs $NO_X$/MMBtu heat input rate used for emissions inventory reporting purposes and AWL's permit conditions was then applied to these baseline heat input rates in order to produce the following baseline emission rates.

**Table 2-1. Baseline $NO_X$ Emission Rates for AWL Kiln 3 (lbs $NO_X$/MMBtu)**

| Stroke Count | 50-70% Coal Heat Input | 70+% Coal Heat Input |
|---|---:|---:|
| <150 Strokes per Hour | 4.784 | 4.182 |
| ≥ 150 Strokes per Hour | 9.328 | 5.271 |

For the June – August reporting period, CAPCOG and AWL then calculated the average $NO_X$ emissions rates for each of the four corresponding conditions on days when: 1) the electric ear was operational, 2) coal input was at least 50%, and 3) the kiln was not under maintenance (i.e., lime was produced). This produced the following emission rates:

**Table 2-2. June – August 2017 $NO_X$ Emission Rates for AWL Kiln 3 with Electric Ear (lbs $NO_X$/MMBtu)**

| Stroke Count | 50-70% Coal Heat Input | 70+% Coal Heat Input |
|---|---:|---:|
| <150 Strokes per Hour | n/a | 4.295 |
| ≥ 150 Strokes per Hour | 4.790 | 4.203 |

CAPCOG and AWL then calculated the total emission impact for the period by applying the difference in the emission rates to the total lime produced under each of the four conditions during the reporting period. The following generalized equation shows how this was calculated.

$$
\begin{aligned}
&NO_X\ Change_{June-August\ 2017} \\
&\quad = \left(Difference\ from\ Baseline\ NO_X\ Rate_{<150\ strokes\ per\ hour, 50-70\%\ coal}\right) \times \\
&\quad \times Tons\ of\ Lime_{June-August\ 2017, <150\ strokes\ per\ hour, 50-70\%\ coal}\Big) \\
&\quad + \left(Difference\ from\ Baseline\ NO_X\ Rate_{<150\ strokes\ per\ hour, 70+\%\ coal}\right) \times \\
&\quad \times Tons\ of\ Lime_{June-August\ 2017, <150\ strokes\ per\ hour, 70+\%\ coal}\Big) \\
&\quad + \left(Difference\ from\ Baseline\ NO_X\ Rate_{\geq 150\ strokes\ per\ hour, 50-70\%\ coal}\right) \times \\
&\quad \times Tons\ of\ Lime_{June-August\ 2017, \geq 150\ strokes\ per\ hour, 70+\%\ coal}\Big) = 2.314\ tons\ NO_X
\end{aligned}
$$

There were a total of 20 days in July and August 2017 that were used for this analysis:

- 12 days with a stroke count of ≥ 150 strokes per hour and coal input of 50-70%
- 7 days with a stroke count of ≥ 150 strokes per hour and coal input of 70% or more
- 1 day with a stroke count of ≥ 150 strokes per hour and coal input of 70% or more

Over these 20 days, daily $NO_X$ emission reductions averaged 0.1157 tpd $NO_X$ reductions.

With AWL's knowledge and consent, CAPCOG has provided copies of the confidential data to TCEQ to enable independent verification, but those underlying data will remain confidential.

The technical challenges that this project faced between March 1, 2017, and September 30, 2017, and the relatively small sample size in terms of the number of days that were useful for analysis make it difficult to draw broad conclusions about the extent to which the project did or did not achieve its goals, although the magnitude of the change in the heat input rate wound up substantially higher than 1%.

Since CAPCOG required an additional year of quarterly reporting after September 30, 2017, CAPCOG also has data available now for October 1, 2017, through December 31, 2017, and will continue collecting data through September 30, 2018. The October 1, 2017 – December 31, 2017, data showed a total of 9.329 tons of $NO_X$ reduced, which CAPCOG used as the basis for the projection of lifetime $NO_X$ reductions cited elsewhere. The total $NO_X$ reductions calculated using the methods described in this report will be included in CAPCOG's quarterly activity reports to TCEQ through the end of the current grant period.

This $NO_X$ reduction estimate for October 1, 2017, through December 31, 2017, is based on 63 days during this three-month period, and therefore represents a substantially larger sample size than the 20 days between June 1, 2017, and August 31, 2017. Using the baseline data, the June – August data, and the October – December data, CAPCOG conducting some additional statistical analysis in order to confirm that the differences in the heat input rates calculated for these periods were statistically significant or not. These included several regression analyses and comparisons of the confidence intervals for the reporting and baseline periods under each set of conditions. These analyses revealed the following:

- There were statistically significantly lower heat input rates when the electric ear was in use in the June – August period when the stroke count was high (≥ 150 strokes per hour) and the coal input was high (≥ 70%)
- There were statistically significantly lower heat input rates for all situations in which coal was at least half of the fuel mix in settings in the October – December period compared to the baseline period
- One fixed –effects regression analysis showed a statistically significant impact from the use of the electric ear in reducing the fuel input rate by approximately 0.74 MMBtu/ton of lime, an 8-13% reduction compared to baseline conditions (adjusted $R^2$ = 0.42)
- Another regression analysis also showed a statistically significant impact in reducing the heat input rate from the use of the electric ear when the average stroke count was treated as a continuous variable rather than a binary variable (<150 strokes per hour compared to ≥150 strokes per hour), but the effect decreased to 0.45 MMBtu/ton of lime (adjusted $R^2$ = 0.49)

Despite the difficulties in getting the project implemented on the timeline initially planned, now that the electric ear is operational, it is substantially exceeding expectations for the degree of efficiency improvement it is enabling. With the grant only costing $36,486, through September 30, 2017, it had already achieved a cost per ton ratio of $15,764, and with the inclusion of the October – December data, the ratio is now $3,134 and will continue to decrease as the equipment continues to operate. Of all of the grant projects awarded during this process, this project appears to be the largest success story.

# 3 Austin White Lime Vehicle Replacement Project

This project involved the replacement of eight older gasoline-fueled pickup trucks, model years 1988 – 2003, with ten smaller, tier 4-certified, off-road utility trucks. The baseline data from the pickup trucks are reported below. The $NO_X$ emissions rates are derived from a 2015 link-based by-model year emissions inventory of a 2018 analysis year produced by ERG using the "SEE" model and MOVES 2014.[3]

**Table 3-1. Austin White Lime Pickup Trucks Replaced**

| Vehicle ID | Model Year | HP | Avg. Monthly Fuel Use (gallons) | $NO_X$ Emissions Rate (lbs/gallon) | Avg. Monthly $NO_X$ Emissions (lbs) |
|---|---|---|---|---|---|
| **37** | 2003 | 350 | 153 | 0.044332 | 6.782796 |
| **38** | 2003 | 350 | 119 | 0.044332 | 5.275508 |
| **33** | 1995 | 255 | 74 | 0.199778 | 14.783572 |
| **35** | 1988 | 255 | 66 | 0.197829 | 13.056714 |
| **77** | 2000 | 160 | 43 | 0.091925 | 3.952775 |
| **79** | 1998 | 255 | 59 | 0.095326 | 5.624234 |
| **82** | 2001 | 350 | 87 | 0.047031 | 4.091697 |
| **85** | 2001 | 350 | 64 | 0.047031 | 3.009984 |
| **AVG./TOTAL** | **2000** | **309** | **665** | **0.085079** | **56.577280** |

[3] http://www.capcog.org/documents/Task_2.1.7_On-Road_Emissions_Inventory_2015_12_28_revised.pdf

Over the six-month reporting period covered by this report, these vehicles would have emitted a total of 339.46368 pounds of $NO_X$ emissions. The following table shows the data reported by Austin White Lime from 3/1/17 – 9/30/17.

**Table 3-2. Austin White Lime Utility Vehicle Fuel Consumption by Reporting Period, 3/1/17 - 9/30/17 (gallons of diesel)**

| Vehicle ID | 3/1/17 – 5/31/17 | 6/1/17 – 8/31/17 | 9/1/17 – 9/30/17 | TOTAL |
|---|---|---|---|---|
| **180** | 11.1 | 24.3 | 7.1 | **42.5** |
| **181** | 46.2 | 12.6 | 3.2 | **62.0** |
| **182** | 6.3 | 28.5 | 11.4 | **46.2** |
| **183** | 8.4 | 22.5 | 7.6 | **38.5** |
| **184** | 12.9 | 18 | 4.5 | **35.4** |
| **185** | 15.6 | 24 | 10.0 | **49.6** |
| **186** | 13.8 | 13.5 | 7.1 | **34.4** |
| **187** | 22.2 | 17.4 | 5.7 | **45.3** |
| **188** | 15.6 | 45.9 | 13.3 | **74.8** |
| **189** | 8.1 | 35.1 | 11.2 | **54.4** |
| **TOTAL** | **160.2** | **241.8** | **81.1** | **483.1** |

CAPCOG used the following assumptions to calculate the emissions from the utility vehicles:

- 0.481 lbs of diesel per hp-hr for a 16-25 hp diesel recreational vehicle (NONROAD model default brake-specific fuel consumption file)
- 7.1 lbs of diesel per gallon
- 0.28 grams of $NO_X$ per brake-horsepower-hour for 16-25 hp diesel recreational vehicle, T4N (NONROAD model default EXHNOX file)
- 0.00220462 pounds per gram
- 0.000617294 lbs $NO_X$ per brake horsepower-hour for 16-25 hp diesel recreational vehicle, T4N
- 14.76091476 hp-hours per gallon of diesel consumed
- 0.009111818 lbs $NO_X$ per gallon of diesel consumed
- TOTAL $NO_X$, 3/1/17 – 9/30/17: 4.401919 lbs

The $NO_X$ reduction for this period therefore was 335.0618 lbs of $NO_X$ (0.1675 tons of $NO_X$).
The grant for this project was $132,991.65. This equates to a cost per ton ratio of $793,834 per ton of $NO_X$ reduced. This ratio does not account for multi-year benefits or fuel savings. CAPCOG calculated these savings based on the current of a gallon of gasoline in Texas ($2.265 for 1st week of December). The following table shows the projected $NO_X$ and fuel reductions by period.

**Table 3-3. Estimation of Cost/Ton Ratio for Austin White Lime Vehicle Replacement Project**

| Period | $NO_X$ Reduced (tons) | Energy Saved (MMBtu) | Gallons of Gasoline Reduced | Cost/Ton $NO_X$ Reduced |
|---|---|---|---|---|
| **6 months** | 0.167531 | 427.61 | 3,448.46 | $747,210.82 |
| **1 year** | 0.335062 | 855.22 | 6,896.92 | $350,294.00 |
| **2 years** | 0.670124 | 1,710.44 | 13,793.84 | $151,835.59 |
| **3 years** | 1.005185 | 2,565.65 | 20,690.76 | $85,682.78 |

| Period | $NO_X$ Reduced (tons) | Energy Saved (MMBtu) | Gallons of Gasoline Reduced | Cost/Ton $NO_X$ Reduced |
|---|---|---|---|---|
| **4 years** | 1.340247 | 3,420.87 | 27,587.68 | $52,606.38 |
| **5 years** | 1.675309 | 4,276.09 | 34,484.60 | $32,760.54 |
| **6 years** | 2.010371 | 5,131.31 | 41,381.53 | $19,529.98 |

# 4 City of Austin Smart Commutes Project

The City of Austin's grant funded the development of software that the City used in a pilot project designed to promote the use of alternative commuting by its employees. As a follow-up to a pilot parking cash-out project, this pilot project, which came to be known as "Smart Commutes: involved offering city employees a financial incentive to use alternative commutes in the form of administrative leave. The goals of the project were to:

- Support the goals of the City's Commute Trip Reduction Program (Commute Connections)
- Improve employee health
- Reduce emissions from motor vehicles, specifically $NO_X$, VOC, and $CO_2$
- Significantly reduce the number of vehicle miles traveled; and
- Increase parking space availability at City building locations

Eligible employees initiated participation by registering with the Austin Transportation Department. Participating employees tracked and logged alternative commutes while the project was underway. The ATD verified the trips, including using passing tracking. If a participating employee took, tracked, and logged an alternative commute for a specific number of days and those trips could be verified, the employee received an reward. The City had anticipated enrolling employees in October 2016 and begin tracking in January 2017.

The funding from this grant was used to pay for the development of a multi-modal tracking tool that would support this effort. The tool was designed to provide efficient, timely, and reliable data from employees, which was essential to the success of the City's program. The application did indicate that is highly likely that the project would have moved forward without grant funding, and that the cost could have been absorbed by the ATD's operating budget for FY 2017, but that the reporting and tracking tool would not have been purchased. Therefore, the main benefit from this grant was to provide the mechanism for performance-tracking from this initiative.

More information on the program can be found at the webpage the City set up for this initiative: http://www.austintexas.gov/smartcommute. The program ultimately launched May 1, 2017, and is expected to run through October 31, 2017. The following table shows the reward structure that the City is offering its employees for participating.

**Table 4-1. Reward Structure for City of Austin Smart Trips Program**

| Six-Month Employee Participation Goal | Comparable to Participating | Employee Reward |
|---|---|---|
| **44 trip points** | 1 day per week | 4 hours administrative leave |

| Six-Month Employee Participation Goal | Comparable to Participating | Employee Reward |
|---|---|---|
| **88 trip points** | 2 days per week | 8 hours administrative leave |
| **132 trip points** | 3 days per week | 12 hours administrative leave |
| **176 trip points** | 4 days per week | 16 hours administrative leave |

The City used the following assumptions in its application:

- Period: 9 months (January – September 2017)
- 1,200 employees would participate (10%)
- Avg. round-trip commute distance: 24 miles
- $NO_X$ emissions rate: 0.03 g/mile (Tier 2, bin 3 $NO_X$ standard)
- # of Alt. commutes logged per person over 9-month period: 35 – 140
- SOV VMT reduced over 9-month period: 1,008,000 – 4,032,000
- $NO_X$ reduced over 9-month period: 67 – 266 lbs

CAPCOG's estimate for the average $NO_X$ emissions rate for a personal vehicle used in 2017 is considerably higher than the 0.03 g/mile level City of Austin used in its application – 0.27 grams per mile (0.000603 lbs/mile), based on the average passenger vehicle $NO_X$ emissions per VMT for 2017 from TCEQ's "Trends" emissions inventories for the Austin-Round Rock MSA.[4] This is a more realistic representation of the average emissions rate for a vehicle used by an average commuter in 2017.

Applying this emissions rate assumption to City of Austin's assumptions, limited to the 7-month period included in the 2017 ozone season (3/1/2017 – 9/30/2017), a revised estimate of the City's assumptions would provide a range of 472.83 – 1,891.32 pounds of $NO_X$ reduced.

Due primarily to the length of time it took for City of Austin to complete its process for procuring a vendor for the software that would be used to log/track commutes, the program did not actually begin until May 1, 2017, meaning that the program ran for only 5 months, rather than the proposed 9 months.

The table below shows the data reported by City of Austin to CAPCOG for this project. Other data may be available from the City, including a further break-down in the "other mode" category. CAPCOG grouped this together since all of these other modes were treated as having zero emissions per mile logged, but further differentiation of the data could help for other planning purposes.

**Table 4-2. Activity Data Reported by (or derived from Data Reported by) City of Austin**

| Data Point | 3/1 – 5/31 | 6/1 – 8/31 | 9/1 – 9/30 | Total/Avg. |
|---|---|---|---|---|
| **Total Employees Organization-Wide** | 12,595 | 12,595 | 12,595 | 12,595 |
| **Total Number of Employees Participating** | 741 | 828 | 674 | 781.33 |
| **% of Employees Logging Commutes** | 5.88% | 6.57% | 5.35% | 6.10% |
| **Commuting Days in Reporting Period** | 22 | 65 | 20 | 107 |
| **Participant Commute – Days** | | | | |

[4] ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/mvs/2017/mvs14_att_tex_254co_2017_summer_weekday.tab_files.zip

| Data Point | 3/1 – 5/31 | 6/1 – 8/31 | 9/1 – 9/30 | Total/Avg. |
|---|---|---|---|---|
| **Passenger-Miles Logged from SOV Commutes** | 42,113 | 69,083 | 18,814 | 130,010 |
| **Passenger-Miles Logged from Carpool Commutes** | 96,063 | 248,422 | 84,097 | 425,582 |
| **Passenger-Miles Logged from Vanpool Commutes** | 80,485 | 159,578 | 51,032 | 291,095 |
| **Passenger-Miles Logged from Other Mode Commutes** | 101,014 | 310,267 | 114,164 | 525,445 |
| **Total Alternative VMT Logged** | 274,562 | 718,267 | 249,293 | 1,242,122 |
| **Total VMT Logged** | 326,766 | 1,291,680 | 323,520 | 1,941,966 |

CAPCOG calculated the emission reductions for these alternative commutes by comparing these activity to baseline data based on the 2010-2014 American Community Survey (ACS) commuting mode data for the Austin-Round Rock MSA for Local Government Employees. The following table summarizes these data.[5]

**Table 4-3. ACS Commuting Data Used for a Baseline to Calculate City of Austin $NO_X$ Reductions**

| Primary Mode of Commuting | Number of Commuters | % |
|---|---|---|
| **Car – Drove Alone** | 52,284 | 83.33% |
| **Car – Carpooled** | 7,366 | 11.74% |
| **Public Transportation** | 951 | 1.52% |
| **Walked** | 542 | 0.86% |
| **Taxicab, Motorcycle, Bicycle, or Other Means** | 927 | 1.48% |
| **Worked At Home** | 671 | 1.07% |
| **TOTAL** | **62,741** | **83.33%** |

CAPCOG calculated the break-down of the carpool mode using the broader commuting by mode data for the region:

- Total carpool commuters region-wide: 96,734
- Commuters in 2-4 person carpools: 92,350 (95.468%)
- Commuters in 5+ person carpools (assumed to be a vanpool): 4,384 (4.532%)

CAPCOG then applied these percentages to the number of local government carpool commuters in order to calculate the estimated number of local government commuters in 2-4 person carpools an 5+ person carpools:

- Total local government carpool commuters: 7,366 (11.74% all local government commuters)
- Commuters in 2-4 person carpools: 7,032 (11.21% of all local government commuters)
- Commuters in 5+ person carpools: 334 (0.53% of all local government commuters)

[5] U.S. Census Bureau. American Factfinder. Table B08128. MEANS OF TRANSPORTATION TO WORK BY CLASS OF WORKER. Universe: Workers 16 years and over. 2011-2015 American Community Survey 5-Year Estimates. Austin-Round Rock, Texas MSA. Available Online at:

CACPOG then calculated the average number of vehicles per passenger for 2-4 person carpools and 5+ person carpools.

**Table 4-4. Calculation of Average Number of Vehicles Used Per Carpool Commuter**

| Size of Carpool | Number of Commuters | Number of Vehicles Used | Vehicles Per Passenger |
|---|---|---|---|
| **2** | 73,008 | 36,504.00 | 0.50 |
| **3** | 13,804 | 4,601.33 | 0.33 |
| **4** | 5,538 | 1,384.50 | 0.25 |
| **2-4** | **92,350** | **42,490.83** | **0.46** |

CAPCOG estimated the number of vanpools used per passenger based on the assumption that the average for 5-6 person carpools was 5.5 and used the minimum of 7 passengers for the 7+ carpool data point.

**Table 4-5. Calculation of Average Number of Vehicles Used Per Vanpool Commuter**

| Size of Carpool | Number of Commuters | Number of Vehicles Used | Vehicles Per Passenger |
|---|---|---|---|
| **5-6** | 3,159 | 574.36 | 0.18 |
| **7+** | 1,225 | 175.00 | 0.14 |
| **5+** | **4,384** | **749.36** | **0.17** |

CAPCOG then used the 2017 emissions rates for passenger vehicles and light commercial trucks to calculate the emission rates for single-occupancy vehicle commuting, carpooling, and vanpooling in terms of pounds of $NO_X$ per passenger-mile:

- SOV: 0.000603 lbs $NO_X$/VMT * 1 vehicle/passenger = 0.000603 lbs $NO_X$/passenger-mile
- Carpool: 0.000603 lbs $NO_X$/VMT * 0.46 vehicles/passenger = 0.000277 lbs $NO_X$/passenger-mile
- Vanpool: 0.0001615 lbs $NO_X$/MVT * 0.17 vehicles/passenger = 0.000275 lbx $NO_X$/passenger-mile

CAPCOG treated all other modes of commuting as having zero incremental impact on emissions. While the use of a taxi or motorcycle is obviously not a zero-emissions mode of commuting, and buses and trains generate emissions too, a motorcycle is technically a single-occupancy vehicle commuting mode, and there is not enough data on the use of taxis in order to directly assess that in this context. Given the difference in how buses are operated and used compared to carpools and vanpools, it is also reasonable to assume that there is zero incremental impact on the emissions from the existing bus and train routes that were used during this time, whereas there is a reasonable chance that this program could have led to the formation of new carpools and vanpools.

Ultimately, CAPCOG compared the VMT logged by participants in the program to the expected VMT based on these commuting assumptions listed above and applying these emissions rates in order to estimate the emissions impact. This produced the following emissions impact assessment.

Table 4-6. $NO_X$ Emission Impact of City of Austin Smart Commutes Program, 3/1/17 – 9/30/17 (lbs)

| Mode | Baseline | Smart Commute | Difference |
|---|---|---|---|
| **SOV** | 1,082.00 | 78.40 | -929.80 |
| **Carpool** | 62.39 | 118.05 | 55.66 |
| **Vanpool** | 2.92 | 79.92 | 77.00 |
| **Other Modes** | 0.00 | 0.00 | 0.00 |
| **TOTAL** | **1,073.51** | **276.36** | **-797.14** |

The total CAPCOG contribution to this project was $26,022.35. This equates to a cost/ton ratio of $65,288.92 per ton of $NO_X$ reduced. The total alternative VMT logged was within the range that City of Austin had identified for a 9-month program, despite the fact that it only was in place for 5 months. As a pilot project, this also provided the City of Austin with valuable data on the efficacy of such a program, and the City is now considering making the program permanent.

# 5 Travis County Vanpool Subsidy Project

Travis County's project involved providing a $50.00 per month subsidy to employees for participating in a CapMetro MetroRideShare vanpool program.[6] MetroRideshare provides eligible groups of 5-12 riders with a month-to-month vanpool lease agreement, including insurance, 24-hour roadside assistance, and an optional fuel purchasing program. These vanpools save money by reducing wear and tear on personal vehicles, parking fees, and insurance, saves time for commuters that would otherwise need to be used for driving that can otherwise be used for other productive uses, reduces traffic and parking congestion, and reduces emissions from personal vehicles. Participants are also eligible to participate in an guaranteed ride home program for an annual membership of $5, which enables them to be reimbursed for up to four taxi rides per calendar year for unexpected emergencies while at work. The total cost of a vehicle for FY 2017 ranged from $769.00 per month for a group riding in a crossover 7-passenger SUV to $1,008.00 per month for a luxury 12-passenger van. CapMetro provides a $500.00 per month subsidy for groups with origin and destination points within CapMetro's service area, and a $450.00 per month subsidy for groups with a commute into or out of the CapMetro service area.

Travis County's application requested $15,000.00 to provide a $50.00 per month subsidy to up to 50 Travis County employees to participate in the MetroRideShare program, effectively making the service free to these employees when considering CapMetro's existing subsidy. Travis County had conducted a "lunch and learn" session in early 2016 in order to gauge interest in participating in an incentive program along these lines, and approximately 35 employees had indicated that they would be interested. As stated in the application, "the goal is that after 6 months of experiencing the benefits of using a vanpool to commute to work, participants will continue the practice even after the grant funds are exhausted."

The following table summarizes Travis County's summary of the assumptions it used for its projected $NO_X$ emissions for this project (439.612 lbs of $NO_X$).

[6] https://www.capmetro.org/rideshare/

**Table 5-1. Travis County Application Assumptions for $NO_X$ Reduction Projections**

| Data Point | Baseline | Vanpool Program |
|---|---|---|
| **Vehicle Type** | Personal Vehicle | Van |
| **Number of Vehicles** | 50 | 10 |
| **Passengers Per Vehicle** | 1 | 5 |
| **Avg. Round-Trip Commute (miles)** | 60 | 60 |
| **Daily VMT** | 3,000 | 600 |
| **$NO_X$ Emissions Rate (lbs/VMT)[7]** | 0.001526 | 0.001526 |
| **Number of Days** | 120 | 120 |
| **TOTAL VMT** | 360,000 | 72,000 |
| **TOTAL $NO_X$ (lbs)** | 549.5154 | 109.9031 |

CAPCOG's estimate of the expected $NO_X$ emissions reduction projection using the same activity assumptions but 2017 emissions rates for personal vehicles (0.000603 lbs NOX/VMT) and light commercial vehicles (0.001615 lbs $NO_X$/VMT) are shown below:

- Baseline SOV commuting $NO_X$ emissions: 217.1159 lbs $NO_X$
- Vanpool $NO_X$ emissions: 116.2845 lbs $NO_X$
- Reduction: 100.8313 lbs $NO_X$ (0.05042 tons)

Ultimately, Travis County encountered delays in implementing this project, particularly in executing its grant agreement with CAPCOG and ILA with CapMetro. This resulted in Travis County not being able to market this opportunity to employees as extensively as it had hoped, but there were also significantly fewer people who ultimately signed up for this opportunity than Travis County had expected. In June, as a result of the veto of CAPCOG's FY 2018-2019 air quality planning funding, Travis County decided to suspend any further marketing of the opportunity and limit the program to the 15 participants who had already signed up by that time. Travis County's report for 6/1/17 – 8/31/17 indicates that they turned away an additional 3 employees who had been interested in participating due to this decision.

Timeline:

- 11/9/2016: CAPCOG awards grant to Travis County
- 12/20/2016: Travis County Commissioners Court approves acceptance of grant

[7] Travis County cited an EPA document located at https://www3.epa.gov/otaq/consumer/420f08028.pdf for this number. This link no longer works, but CAPCOG was able to identify a link for a document that cites the same NOX emissions rate at: https://nepis.epa.gov/Exe/ZyNET.exe/P100EVXP.TXT?ZyActionD=ZyDocument&Client=EPA&Index=2006+Thru+2010&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C06thru10%5CTxt%5C00000033%5CP100EVXP.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL.. This document is dated 2008, however, so the NOX rate is obviously considerably higher than what would be expected for 2017.

- 2/2/2017: Grant agreement between CAPCOG and Travis County executed
- 2/27/2017: Interlocal agreement between Travis County and CapMetro executed
- 4/1/2017: Program begins
- 6/12/2017: Veto of FY 2018-2019 Rider 7 funding announced
- 6/13/2017: CAPCOG issues notice of termination of Travis County grant, effective 6/27/2017
- 6/26/2017: CAPCOG rescinds notice of termination
- 9/30/2017: Grant ends

The following table provides a summary of the number of employees participating by month, along with the cost, the estimated number of SOV commute trips reduced, and the estimated number of VMT from SOV commutes reduced, based on Travis County's assumed 60-mile round-trip commute estimate (although the region-wide average is only 24 miles per hour, CAPCOG is assuming that Travis County's estimate in its application is representative of the commute for these specific participants). The number of trips was based on the number of weekdays in each month minus the Memorial Day, Independence Day, and Labor Day holidays that occurred between March 1 and September 30. The estimated $NO_X$ reduction was based on an average 0.000603 lbs $NO_X$/VMT rate for a typical personal vehicle (personal car or truck, whether gas-powered or diesel-powered) in the Austin-Round Rock MSA in 2017, based TCEQ's "Trends" emissions inventories for the Austin-Round Rock MSA.[8]

**Table 5-2. Vanpool Subsidy Data by Month**

| Month | Employees | Vehicles Used | CAPCOG Subsidy | SOV Trips Reduced | SOV VMT Reduced | $NO_X$ Reduced (lbs) |
|---|---|---|---|---|---|---|
| **April** | 5 | 4 | $250.00 | 100 | 3,000 | 1.81 |
| **May** | 5 | 4 | $250.00 | 110 | 3,300 | 1.99 |
| **June** | 15 | 6 | $750.00 | 330 | 9,900 | 5.97 |
| **July** | 15 | 6 | $750.00 | 300 | 9,000 | 5.43 |
| **August** | 14 | 6 | $700.00 | 322 | 9,660 | 5.83 |
| **September** | 14 | 6 | $700.00 | 280 | 8,400 | 5.07 |
| **TOTAL/Avg.** | **11.3** | **5.3** | **$3,400.00** | **1,442** | **43,260** | **26.09** |

This translates into 0.0052 tons of $NO_X$ reduced during this 6-month period from reduced SOV commuting. This results in an average cost/ton $NO_X$ reduced for this period of $260,635.37.

CAPCOG's reporting mechanism for this project did not directly identify whether the project involved the formation of new vanpools versus getting employees to join existing vanpools. This makes some difference in terms of assessing the emission reductions from the program, since you would need to subtract the added emissions from the vehicle being used for any new vanpools formed in order to fully account for the emissions impact.

CAPCOG's reporting mechanism also did not identify as precisely as intended how many total vanpool members were in vehicles being used by participants in this program. Based on the data that Travis County did report, it appears that the 15 employees who participated during this period were spread

[8] ftp://amdaftp.tceq.texas.gov/pub/EI/onroad/mvs14_trends/

across 6 different vanpool groups, only two of which had a participant as the driver, and only one of which had enough participants (8) to constitute an entire vanpool group on its own accord (a minimum of 5 people are needed). The data reported by Travis County also indicates that the model year of the vehicles used by participants in the program were significantly newer than expected for a light commercial truck (LCT), based on the age distribution for this vehicle type. This means that the added emissions from any new vanpool vehicle being used would be lower than what had been expected (0.00021 or 0.00017 lbs of $NO_X$ per VMT, versus 0.01615 lbs of $NO_X$ per VMT).

**Table 5-3. Travis County Vanpool Vehicle Characteristics**

| Vehicle ID | Make Code | Type | Model Year | Monthly Cost | Capacity | Participants | Participant Driver |
|---|---|---|---|---|---|---|---|
| **40139** | Chevrolet/GM | Crossover SUV | 2014 | $769.00 | 7 | 2 | Yes |
| **47744** | Chevrolet/GM | Crossover SUV | 2017 | $769.00 | 7 | 1 | No |
| **48901** | Chevrolet/GM | Crossover SUV | 2017 | $769.00 | 7 | 2 | No |
| **38988** | Chevrolet/GM | Crossover SUV | 2014 | $769.00 | 7 | 1 | No |
| **48902** | Chevrolet/GM | Crossover SUV | 2014 | $769.00 | 7 | 1 | No |
| **38372** | Chevrolet/GM | Standard Van | 2014 | $849.00 | 12 | 8 | Yes |

CAPCOG also lacks data on the actual amount of vehicle miles traveled for each vanpool for this period.

If the full eight-person vanpool is accounted for as a new source of $NO_X$ emissions, the total added $NO_X$ emissions would have been 1.64 pounds over this period, reducing the total $NO_X$ benefit to 0.0122 tons reduced. Between now and the end of CAPCOG's FY 2016-2017 air quality grant, CAPCOG intends to perform follow-up data collection and determine how many of these participants decided to continue vanpooling after September 30th and report this information in future progress reports.

The following table shows the overall comparison of this projects expected activity and emissions reduction benefits (using CAPCOG's updated $NO_X$ emissions rates).

**Table 5-4. Comparison of Travis County Projected and Actual Activity and Emission Reductions**

| Data Point | Projected | Actual | Difference |
|---|---|---|---|
| **Avg. # Participants for 6-Month Period** | 50 | 11.35 | -38.65 |
| **Money Spent** | $15,000 | $3,400 | -$11,600 |
| **VMT Reduced** | 288,000 | 35,640 | -252,360 |
| **$NO_X$ Reduced (lbs)** | 100.83 | 24.45 | -76.38 |

# 6 Conclusion

The following table shows a comparison of the actual $NO_X$ reductions achieved during the targeted seven-month period from March 1, 2017, through September 30, 2017, compared to maximum projected $NO_X$ emissions reductions estimate identified in the application (with adjustments to the vehicle emission rates identified above).

**Table 6-1. Comparison of $NO_X$ Emission Reduction Targets to Actual Performance, 3/1/17 – 9/30/17**

| Project | Maximum Projected $NO_X$ Reductions Based on Application (tons) | Actual $NO_X$ Reductions Achieved (tons) | % of Maximum Achieved |
|---|---|---|---|
| **AWL Electric Ear**[9] | 2.996 | 2.314 | 77% |
| **AWL Vehicle Replacement** | 0.170 | 0.170 | 100% |
| **City of Austin Smart Commute** | 0.946 | 0.399 | 42% |
| **Travis County Vanpool Subsidy** | 0.050 | 0.012 | 24% |
| **TOTAL** | **4.162** | **2.895** | **20%** |

The total amount spent ultimately was also less than anticipated - $198,900, compared to the $210,500 awarded. This equates to a total cost/ton ratio for this period of $50,457, compared to the $68,705 level based on the maximum projected $NO_X$ reductions based on information in the grant applications. However, if the Oct. – Dec. 2017 quarterly data reported by Austin White Lime for the electric ear project were to continue for the remaining 20-30 year useful life of the electric ear, this project could achieve an additional 709 – 1,082 tons of $NO_X$ reductions, making the overall cost-effectiveness for these grants $183 - $279 per ton of $NO_X$ reduced. This does not account for any longer-term behavior changes that the commuting projects from the City of Austin or Travis County might have achieved or any multi-year benefits from AWL's vehicle replacement project.

As the table above shows, the vast majority of the emission reduction benefits from this project are the result of the AWL electric ear project. The emission reduction benefits were much lower for all of the other grant projects, and the cost/ton of $NO_X$ ratio was much higher for all of the other grant projects. Interestingly, the cost-effectiveness considerations would have presumably been accounted for in the project scoring, but the AWL Electric Ear project ranked 3rd in the scoring, even though it had dramatically larger $NO_X$ benefits than any other application. This highlights a problem with using subjective scoring rather than objective cost/ton criteria in assessing the worthiness of grant applications – there are certain technical assumptions and calculations that should have been factored in more directly, limiting the subjective scoring to truly subjective factors, such as the feasibility considerations. Nevertheless, given CAPCOG's difficulty in the 1st round of grants under Task 7.1, the desire to award all of the funding under Task 7.2, the small number of applications received, and the value in testing out various possibilities for such a grant program, this particular consideration didn't affect how the funding was ultimately awarded, since all 4 of the projects anticipated to achieve actual emission reductions received funding.

One of the other key over-arching lessons from this grant program is that all of the projects took longer to get implemented and faced more logistical hurdles than had been accounted for in the applications, which reduced the emission reduction benefits for the 2017 ozone season. Negotiating the contracts, allowing time for the grant recipients to enter into their own contracts and conduct procurements, and then accounting for other problems in the implementation of the project would have provided CAPCOG staff and the subgrant recipients' project managers with a more realistic set of expectations for what

[9] AWL electric ear application cited 2.11 tons for a 153-day period, or 0.014 tons per day. Applied to the 214 days between March 1 and September 30, this equals 2.996 tons. This number reflected the high end of the estimate.

these grants could have achieved within this time frame. Many of the applications represented high-end projections for reductions in emissions-generating activity, but did not provide more realistic assessments of the actual expectations.

Following the submission of final reports when CAPCOG began analyzing the data for this project, it also became evident that some of the data collection tools CAPCOG had used for these grants did not ultimately provide the exact data CAPCOG would need in order to do the type of emissions reduction estimates desired for this project. For example, the issues with interpreting Austin White Lime’s fuel input data or understanding the extent to which data on carpool and vanpool commuting reflect the formation of new carpools versus joining existing carpools complicated the assessment of the emissions impacts of these projects.

This grant program was an experiment that CAPCOG was able to conduct to assess the value and viability of providing regional air quality grants targeting activities and projects that might not fit well into other grant programs. While there were some significant logistical challenges that the grant recipients faced in implementing their projects in the manner anticipated, the projects all achieved quantifiable and surplus $NO_X$ emissions during the 2017 ozone season, were able to provide valuable programmatic data that can be useful for improving the design of other programs in the future, and was an instrumental factor in bringing Austin White Lime, the second-largest industrial point source of $NO_X$ emissions within the Austin-Round Rock MSA, into the Clean Air Coalition. CAPCOG anticipates that these projects will continue to achieve $NO_X$ benefits beyond the term of these contracts and notes that it has not conducted a full evaluation of all of the co-benefits of these projects in terms of reductions in emissions of other pollutants, energy conservation, etc. As CAPCOG continues to gather information from the grant recipients over the next year, CAPCOG expects to provide new analyses along these lines.

If the state’s local air quality planning grant is ever reinstated with sufficient funding, CAPCOG expects that it would include some version of this grant program in a future work plan, incorporating the lessons learned from this and the 1st grant round into any future regional air quality grant programs that CAPCOG may be involved in.