Improving the Spatial Allocation of Construction Equipment Emissions

Steven Smeltzer
Alamo Area Council of Governments, 8700 Tesoro Dr., Suite 700,
San Antonio, Texas, 78217
ssmeltzer@aacog.com

June 5th, 2008

AACOG
Alamo Area Council Of Governments

Spatial Allocation of Construction Equipment Emissions

- The location of construction projects can have a significant impact on pollutant concentrations at down-wind monitoring sites
- Default spatial allocation of construction equipment emission is often inaccurate
- Construction often occurs at the outer edges of urban areas were new housing, commercial development, and roads are being built
- Large mining sites can also account for a significant portion of construction equipment emissions

AACOG
Alamo Area Council Of Governments

Construction Equipment Sectors

- Heavy Highway
- Municipal
- Residential
- State Transportation Agency
- Landscaping Businesses
- Trenches
- Skid Steer Loaders
- Cranes
- Municipal and County-Op. Eq.
- Bore/Drill Rigs
- Agriculture
- Landfills
- Toyota
- Utility
- Commercial Construction
- City/County Roads
- Scrap Recycling Businesses
- Brick and Stone Businesses
- Concrete Businesses
- Special Trade Businesses
- RT Forklifts
- Manufacturing
- Other Construction Equipment
- Pipeline
- Quarries

AACOG
Alamo Area Council Of Governments

Construction Equipment Methodology

1. Conduct surveys and develop surrogate factors to estimate diesel equipment population, usage rates, and equipment characteristics
2. Update the NONROAD 2005 model input files using local data
3. Estimate VOC, NOx, and CO annual emissions from construction equipment using the NONROAD 2005 model
4. **Spatial allocate construction equipment emissions**
5. **Updated spatial allocation of construction emissions in the photochemical model**

AACOG
Alamo Area Council Of Governments

VOC and NOx Emissions from Construction Equipment (2005 tons/weekday)

Sector	VOC	NOx	% of Total Emissions
Heavy Highway	0.06	0.69	8%
Utility	0.04	0.40	5%
Commercial Construction	0.05	0.57	6%
Residential	0.08	0.99	11%
City/County Roads	0.01	0.12	1%
TxDOT	0.06	0.48	6%
Scrap Recycling	0.03	0.18	2%
Landscaping	0.05	0.23	3%
Brick and Stone	0.00	0.04	0%
Concrete	0.01	0.09	1%
Special Trade	0.10	0.83	10%
Municipal and County Eq.	0.19	1.24	15%
Manufacturing	0.00	0.05	1%
Agriculture	0.01	0.09	1%
Toyota	0.00	0.01	0%
Landfill	0.01	0.17	2%
Quarry	0.13	1.88	21%
Other	0.06	0.67	8%
Total	0.88	8.74	100%

Spatial Allocation

- Construction equipment within the San Antonio was spatially allocated for each sector based on type and purpose of equipment used.
- Local department of transportation, utility companies, government agencies, and private companies were contacted to collect data on costs and locations of construction projects.
- Also, residential building permits, commercial building permits, and demolition permits were collected to geo-coded residential and commercial construction emissions.
- GIS software was used to allocate emissions to the 4km grid systems used by photochemical models
- 13 different GIS layers.

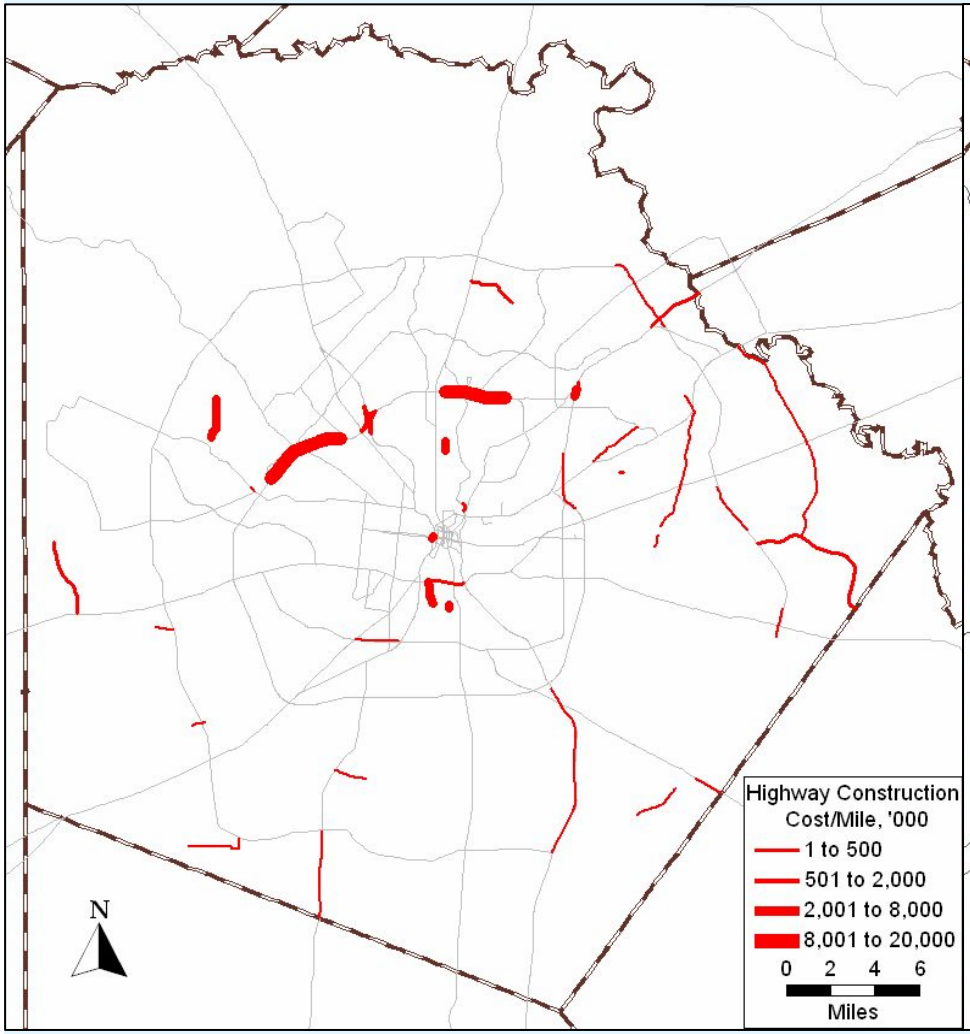
AACOG
Alamo Area Council Of Governments

Spatial Surrogates used to Allocate Construction Equipment Emissions

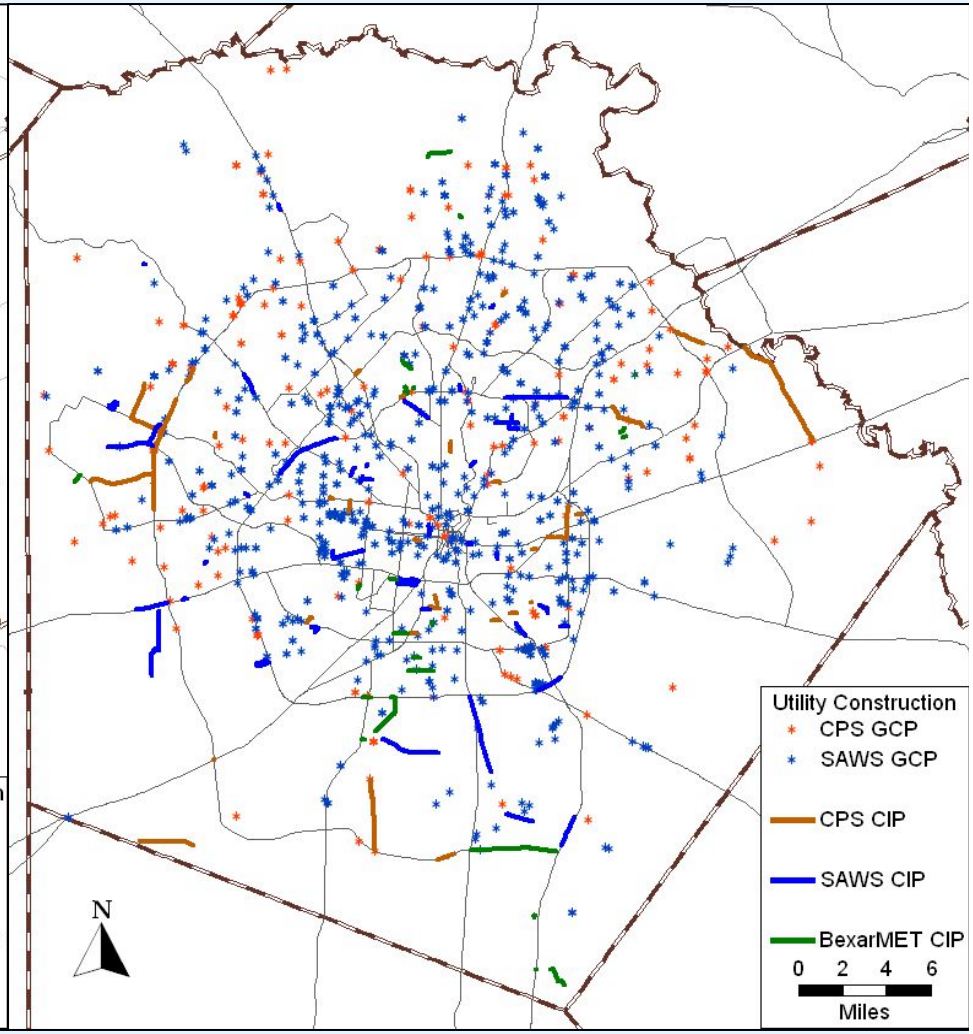
Sector	Spatial Allocation Methodology
➢ Heavy Highway	TxDOT and MPO Construction Dollar Value
➢ Utility	CPS, BexarMet, and SAWS Construction Dollar Value
➢ Commercial Construction	COSA and Bexar Com. Building and Demolition Permits
➢ Residential	COSA and Bexar Residential Building Permits
➢ City/County Roads	COSA and Bexar Road Dollar Value
➢ TxDOT	TxDOT and MPO Construction Dollar Value
➢ Scrap Recycling	Scrap and waste Materials Employment
➢ Landscaping	EPA Default
➢ Brick and Stone	Related construction materials Employment
➢ Concrete	Block, brick, other, and ready-mix Employment
➢ Special Trade	COSA and Bexar Commercial Building Permits
➢ Municipal/County-Op. Eq.	COSA and Bexar Road Dollar Value
➢ Manufacturing	Manufacturing Employees (only companies > 4 employees)
➢ Agriculture	Crop Location
➢ Toyota	Location of Toyota
➢ Landfills	Location of Landfills
➢ Quarries	Location of Quarries
➢ Other Sectors	Total Construction Cost

AACOG
Alamo Area Council Of Governments

Heavy Highway Construction Projects, 2005



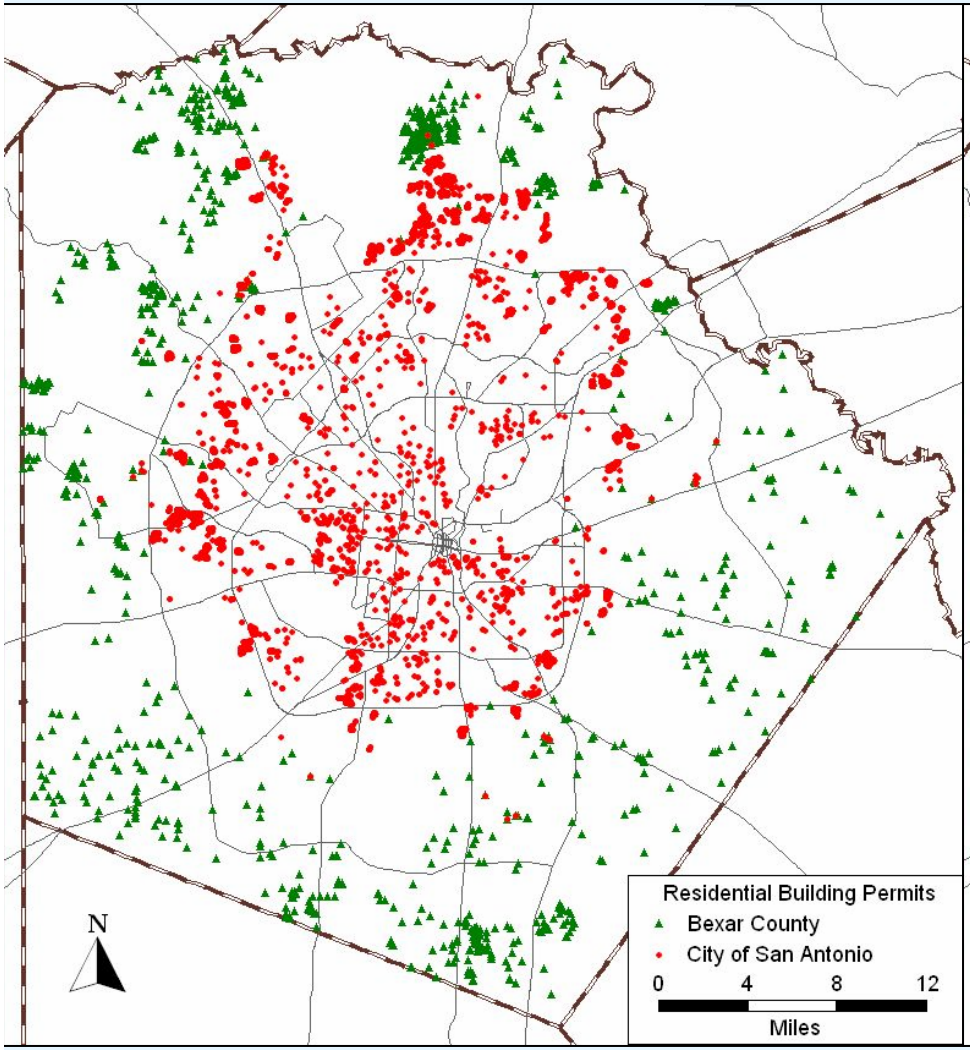
Utility Construction Projects, 2005



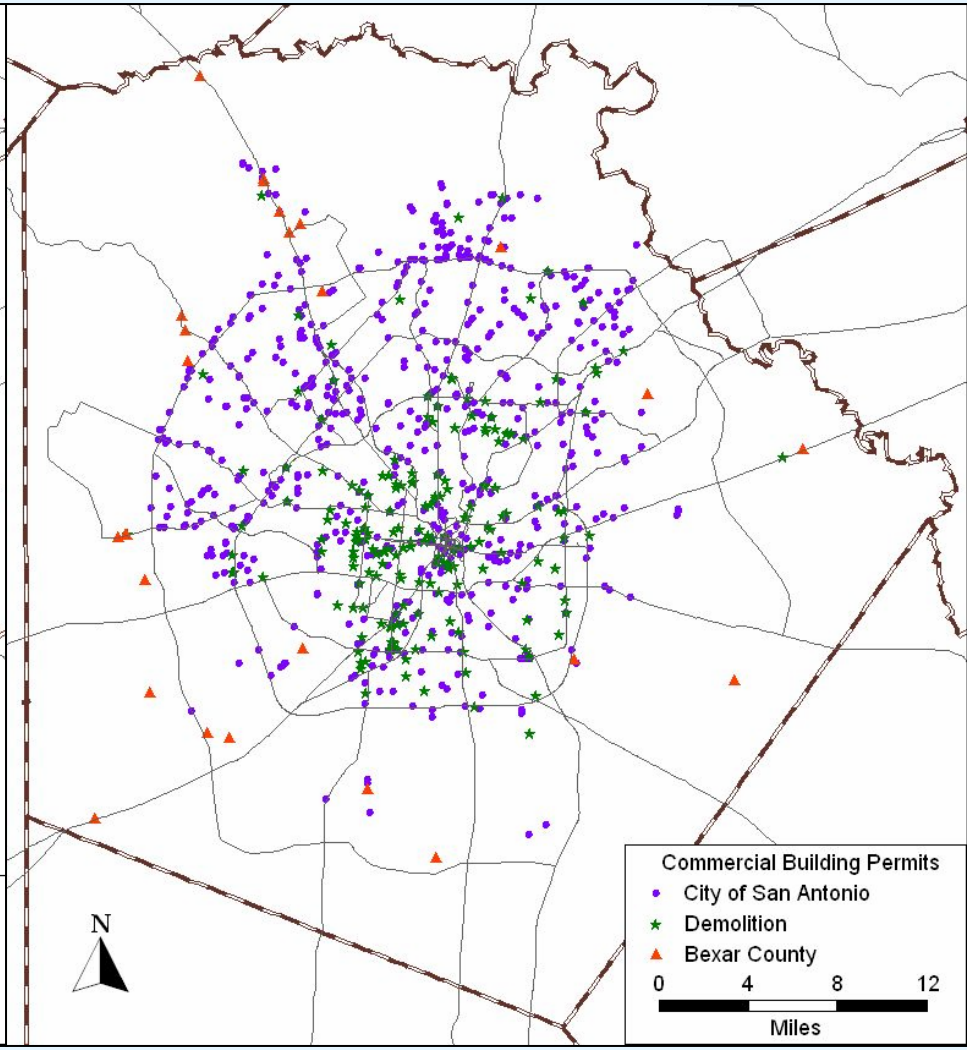
Plot Date: Feb. 21, 2007
Map Compilation: Feb. 8, 2007
Source: SA-Bexar MPO, TxDOT, SAWS, CPS, and BexarMET

AACOG
Alamo Area Council Of Governments

Residential Building Permits, 2005



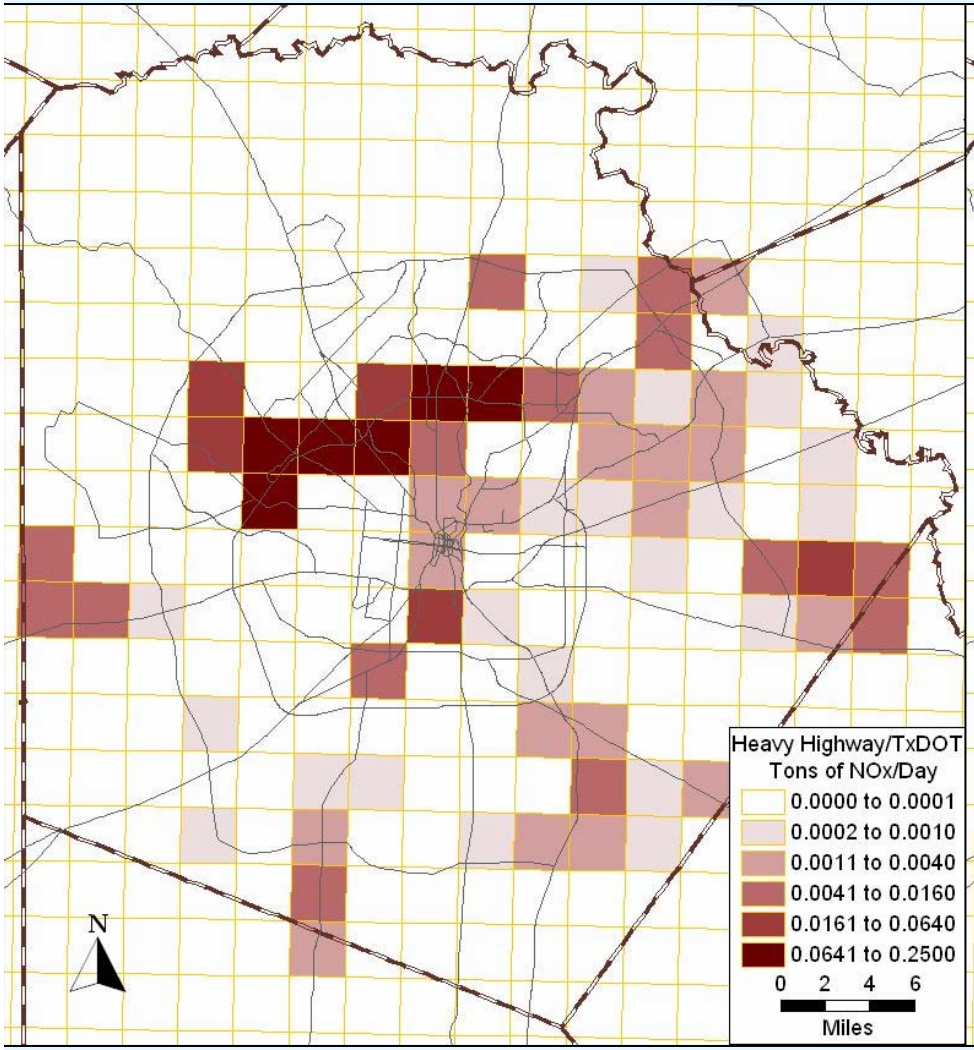
Commercial Building and Demolition Permits, 2005



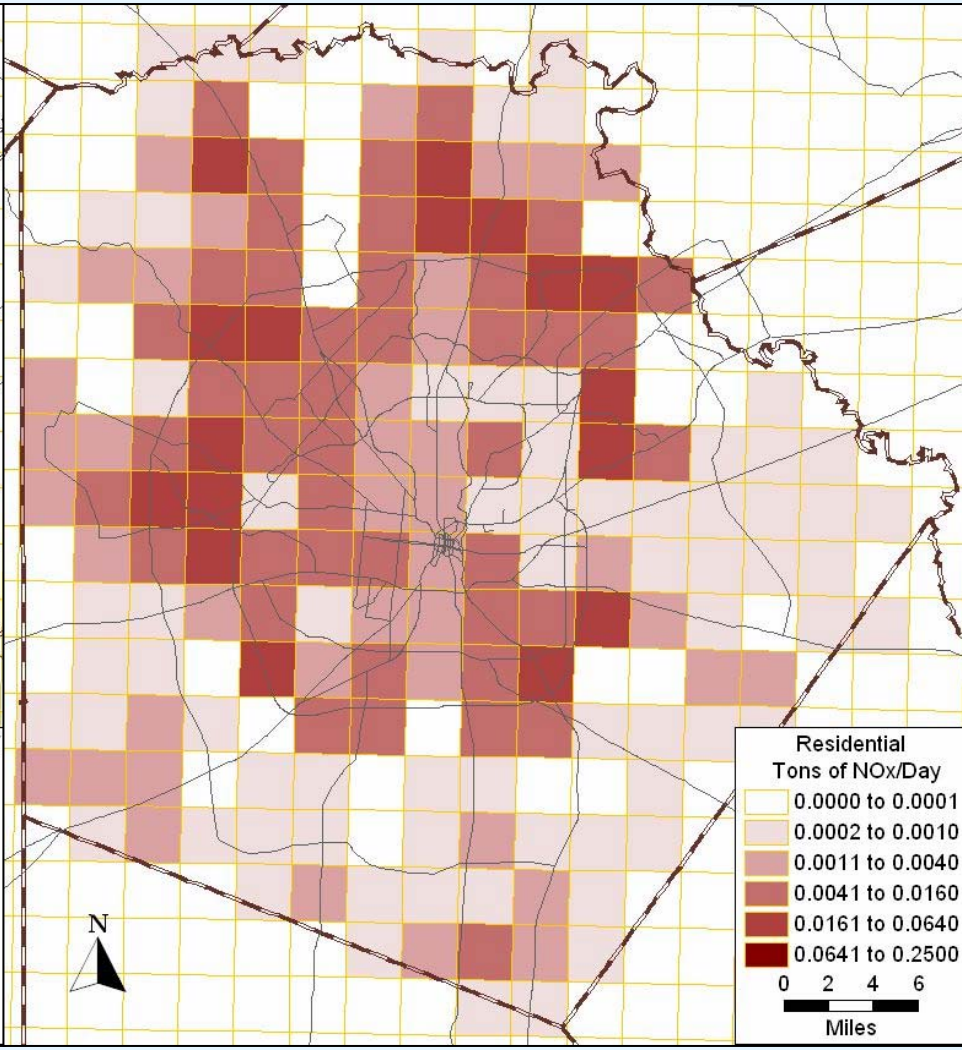
Plot Date: Feb. 22, 2007
Map Compilation: Feb. 21, 2007
Source: City of San Antonio and Bexar County

AACOG
Alamo Area Council Of Governments

Heavy Highway Construction Eq. Emissions (tons of NOx/day), 2005.



Residential Construction Eq. Emissions (tons of NOx/day), 2005

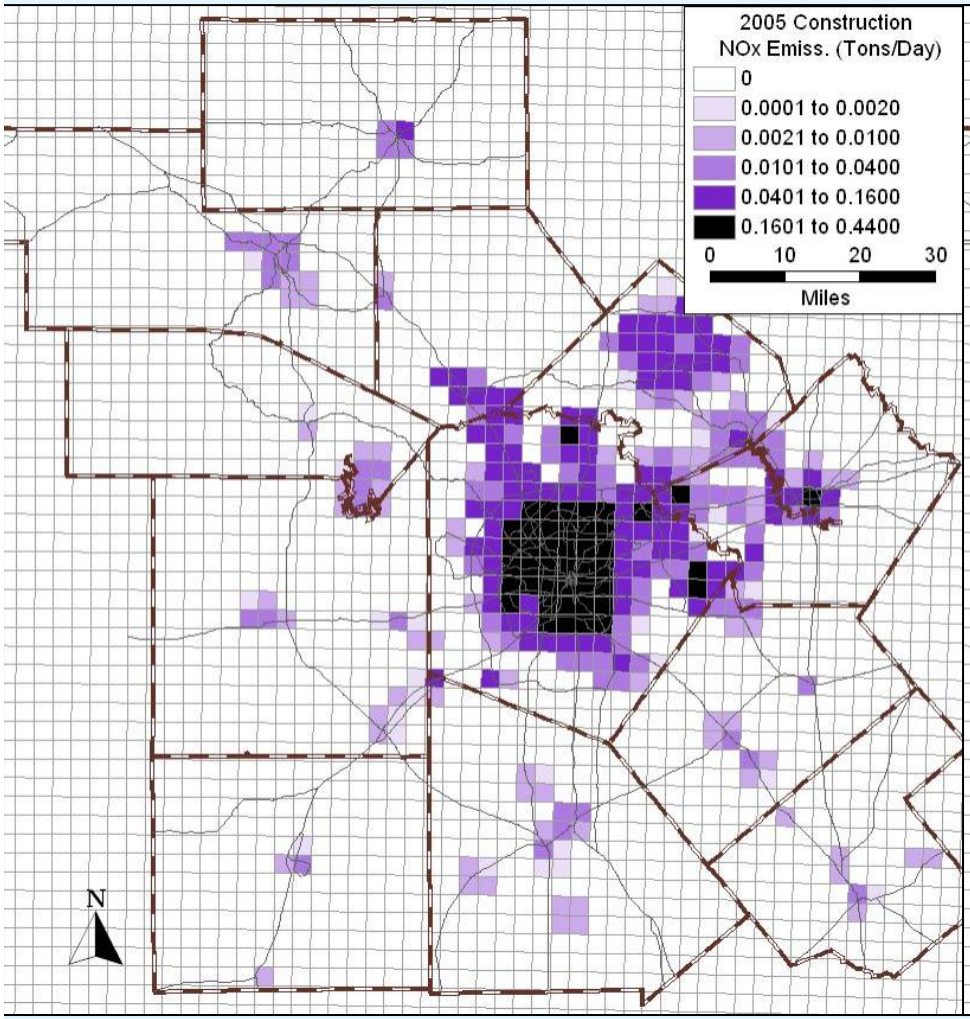


Plot Date: Feb. 22, 2007
Map Compilation: Feb. 21, 2007
Source: SA-Bexar MPO, TxDOT, SAWS, CPS, and BexarMET, City of San Antonio, and Bexar County

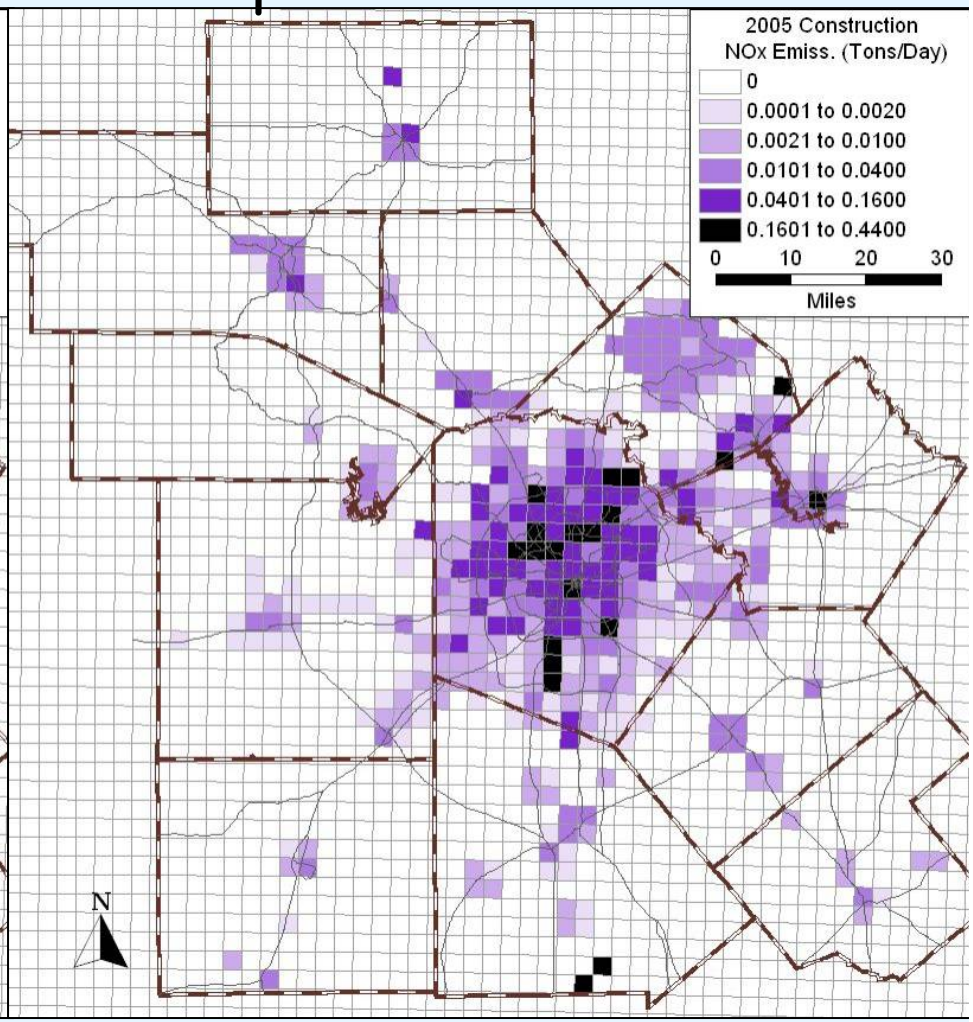
AACOG
Alamo Area Council Of Governments

Construction Equipment Spatial Allocation, (tons of NOx/day), 2005

Default Allocation

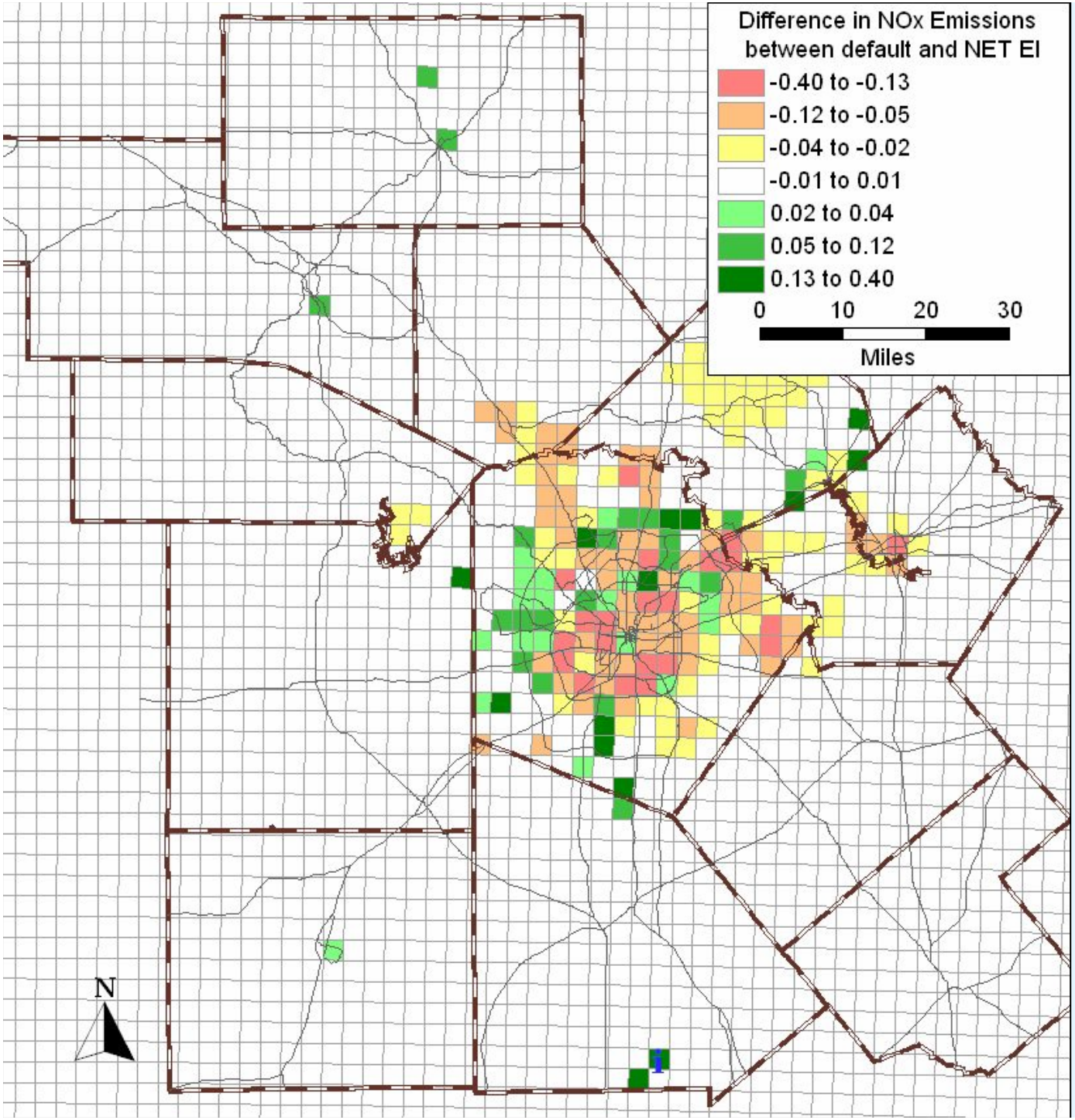


Updated Allocation



Plot Date: March 5, 2007
Map Compilation: Feb. 27, 2007

AACOG
Alamo Area Council Of Governments



Difference between Construction Default and Updated Spatial Allocation, (tons of NOx/day), 2005

Plot Date: March 5, 2007
Map Compilation: Feb. 27, 2007

AACOG
Alamo Area Council Of Governments

Photochemical Model

- AACOG developed a Comprehensive Air Quality Model with Extensions (CAMx) photochemical model simulating the high-ozone episode that occurred between September 13th and 20th, 1999.
- The model was updated with the latest emission inventory for 2005
- Two model runs performed for construction equipment:
    1. Default spatial allocation
    2. Updated spatial allocation
- Construction equipment emissions and activity were constant between the two runs.
- When the updated spatial allocated construction equipment emissions were put into the photochemical model, there was a significant impact on ozone formation.

AACOG
Alamo Area Council Of Governments

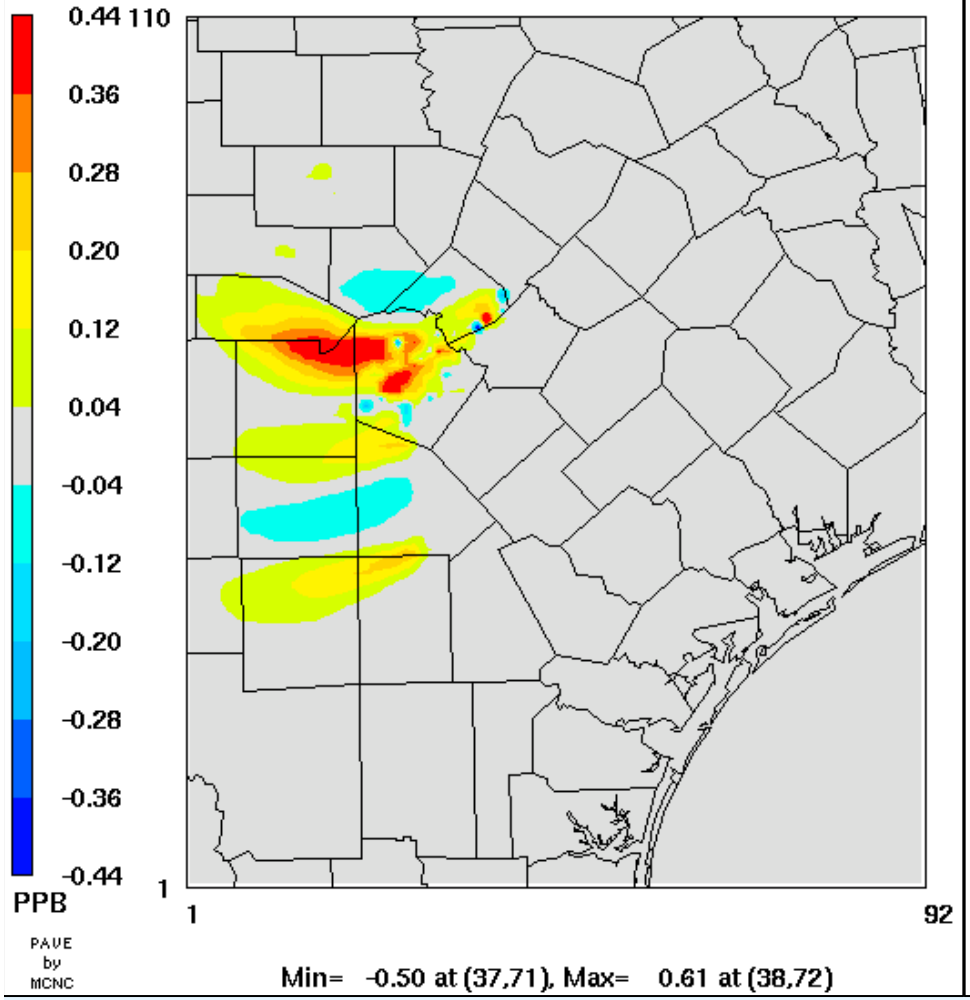
Impact of the Updated Spatial Allocated Construction Equipment on Peak Ozone Formation at Selected CAMS station.

CAMS Station	Change in 8-hour ozone average, 2005 (ppb.)					
	Wednesday Sept. 15	Thursday Sept. 16	Friday Sept. 17	Saturday Sept. 18	Sunday Sept. 19	Monday Sept. 20
CAMS 58	0.09	-0.11	-0.03	-0.01	-0.01	0.36
CAMS 23	0.18	**-0.16**	-0.05	-0.01	-0.01	0.35
CAMS 59	0.06	-0.01	0.01	0.00	0.01	0.30
CAMS 678	**0.44**	-0.01	0.39	0.02	0.01	0.40

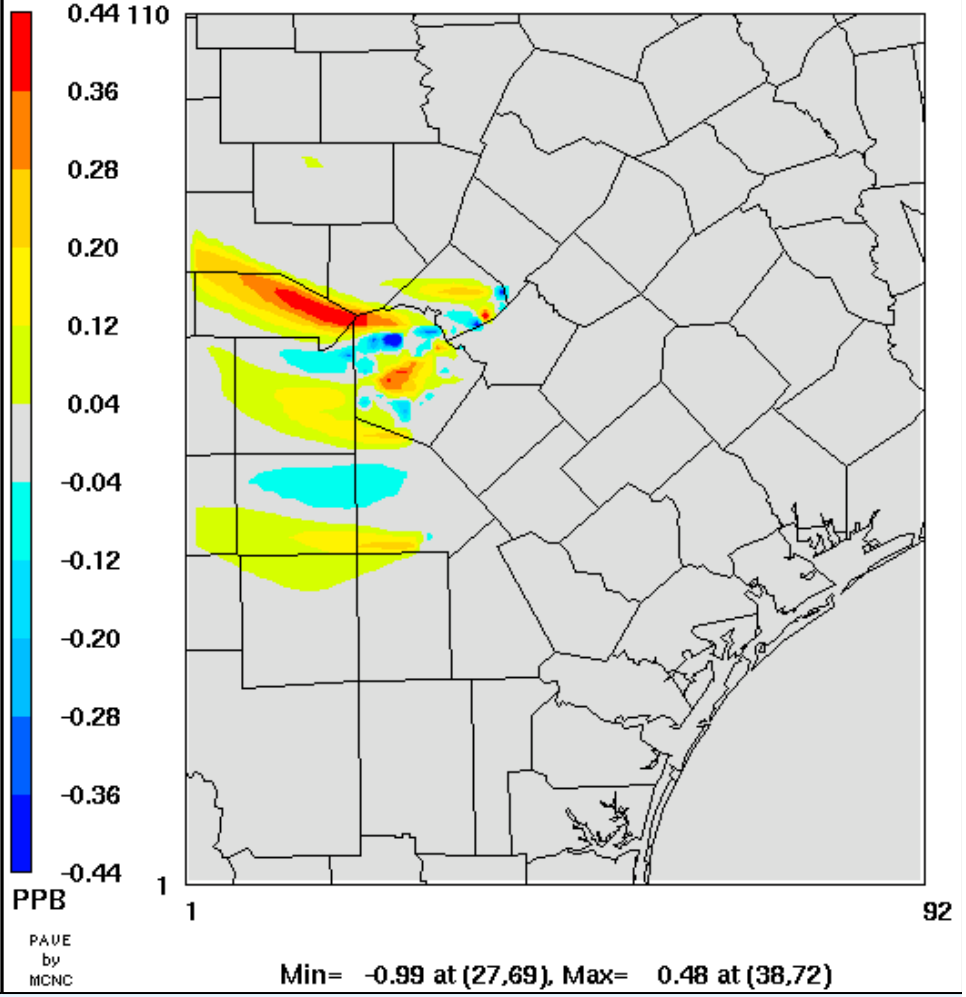
AACOG
Alamo Area Council Of Governments

Difference of Layer One Ozone, 8-hour Average, (Construction – Default)

Sept. 15, 2005



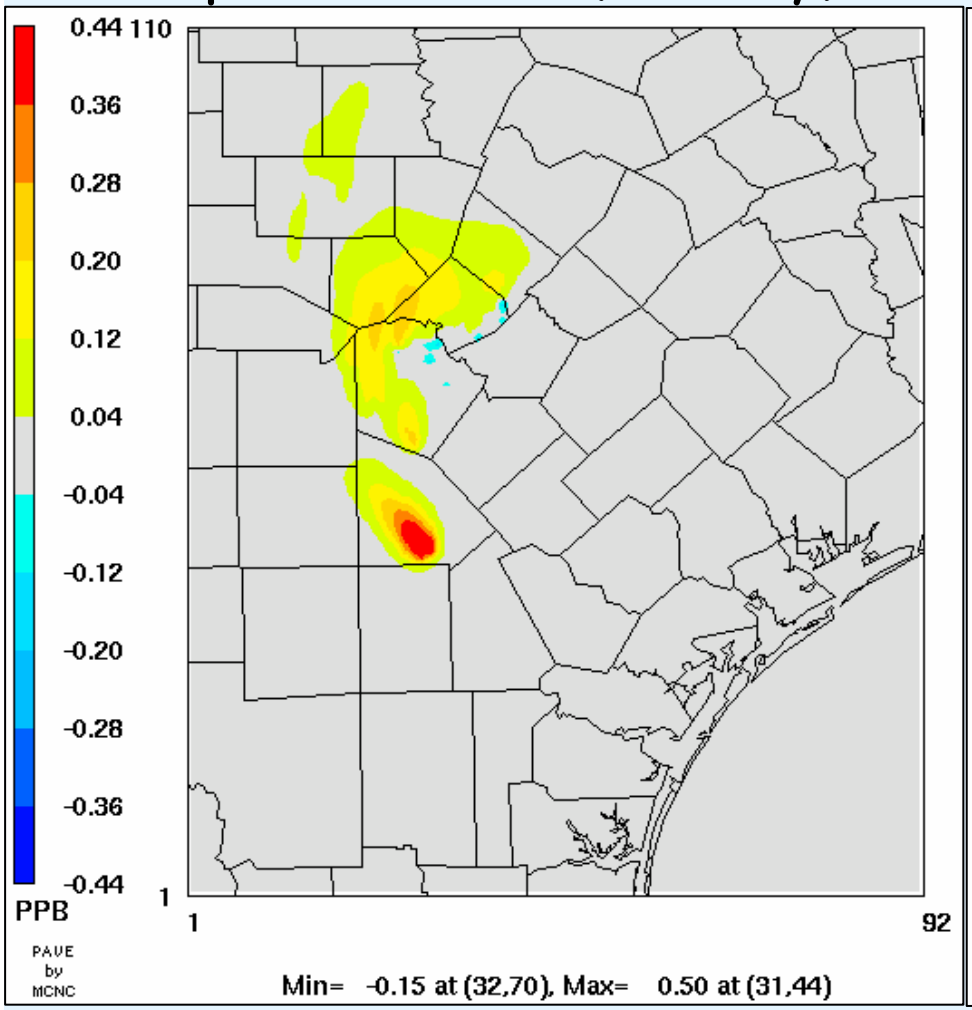
Sept. 16, 2005



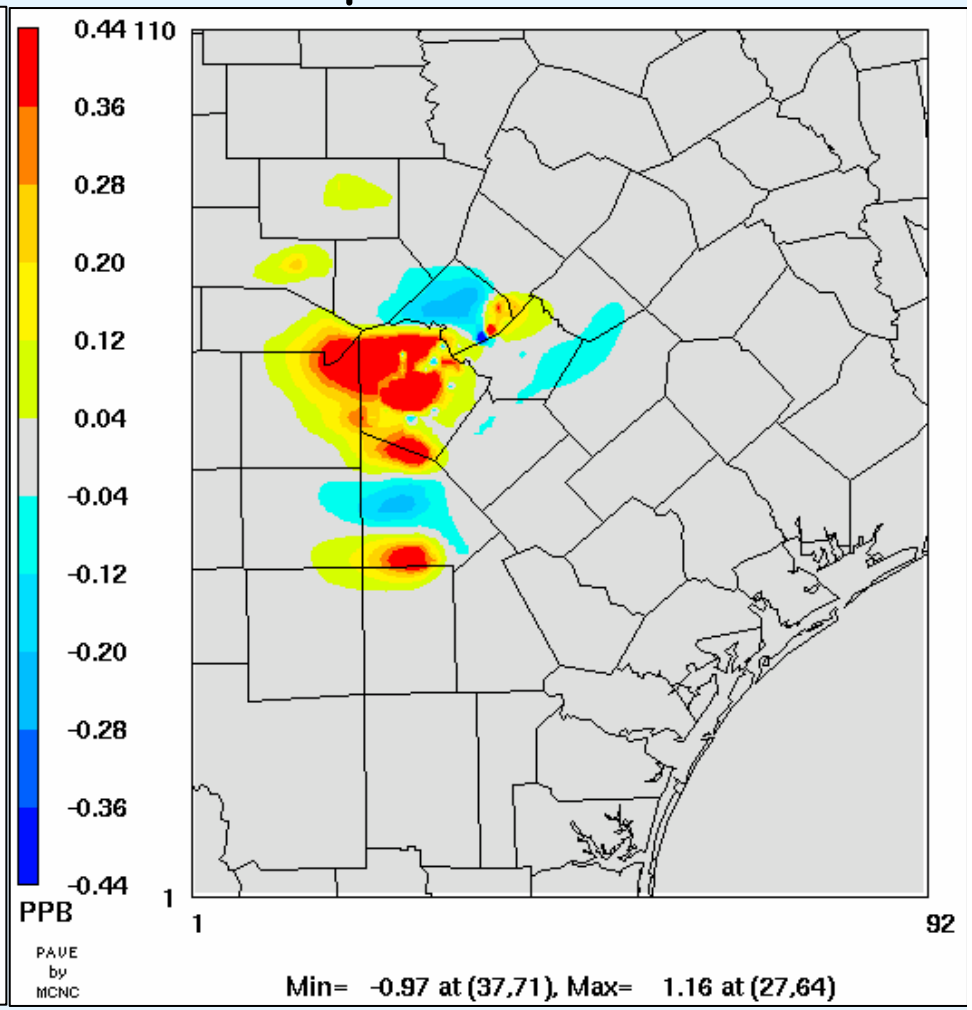
AACOG
Alamo Area Council Of Governments

Difference of Layer One Ozone, 8-hour Average, (Construction – Default)

Sept. 19, 2005 (Sunday)



Sept. 20, 2005

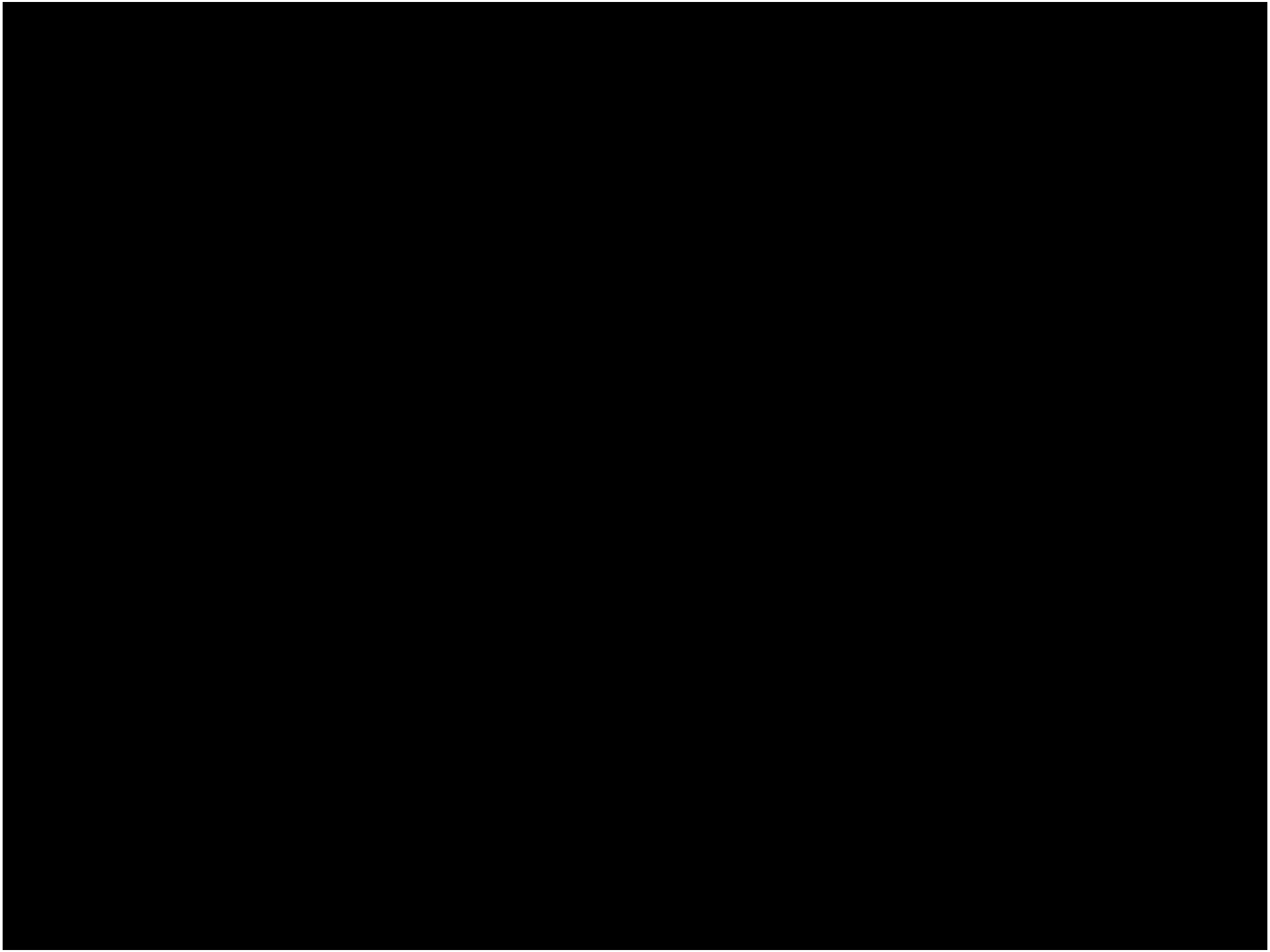


AACOG
Alamo Area Council Of Governments

Summary

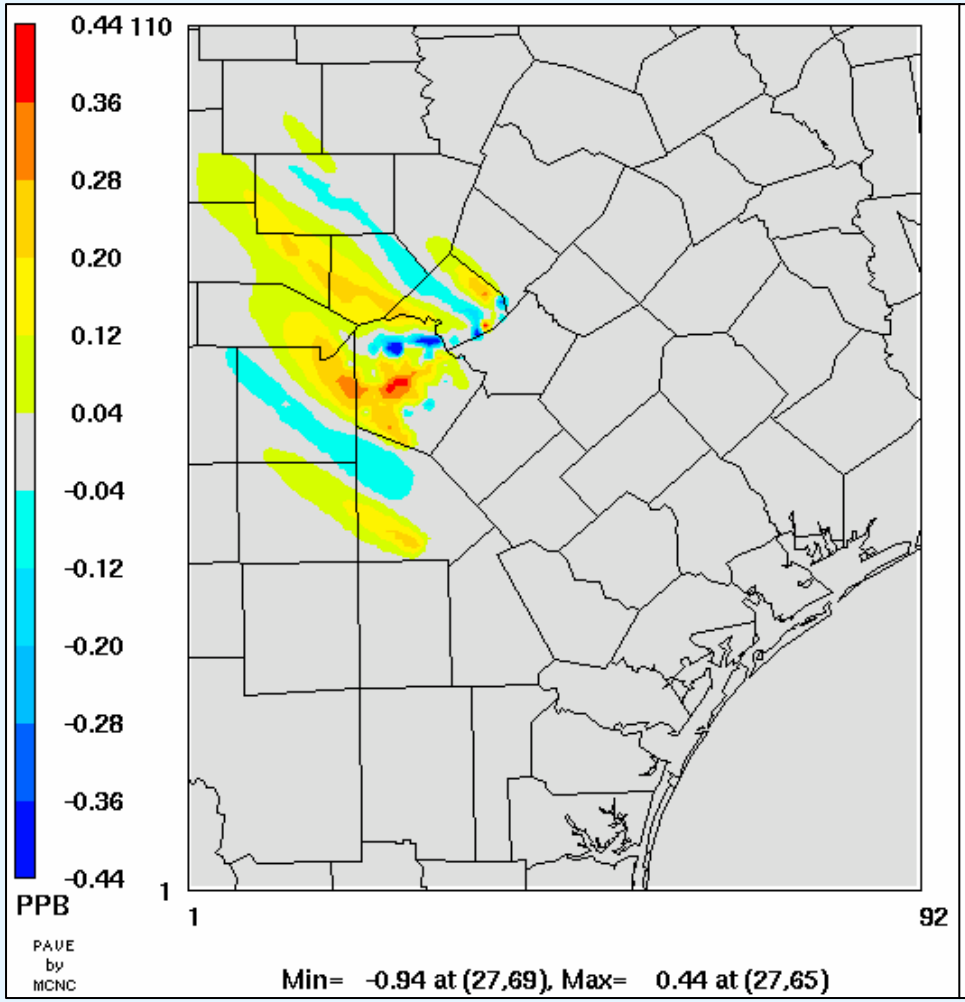
- By separating construction equipment into 25 categories and updating the spatial allocation, the emission inventory was improved.
- The greatest increase in peak hour 8-hour ozone average was 0.44 ppb. and the greatest decrease was –0.16 ppb.
- Updating the spatial allocation of other emission inventory categories could impact the prediction of ozone concentrations in photochemical models.

AACOG
Alamo Area Council Of Governments

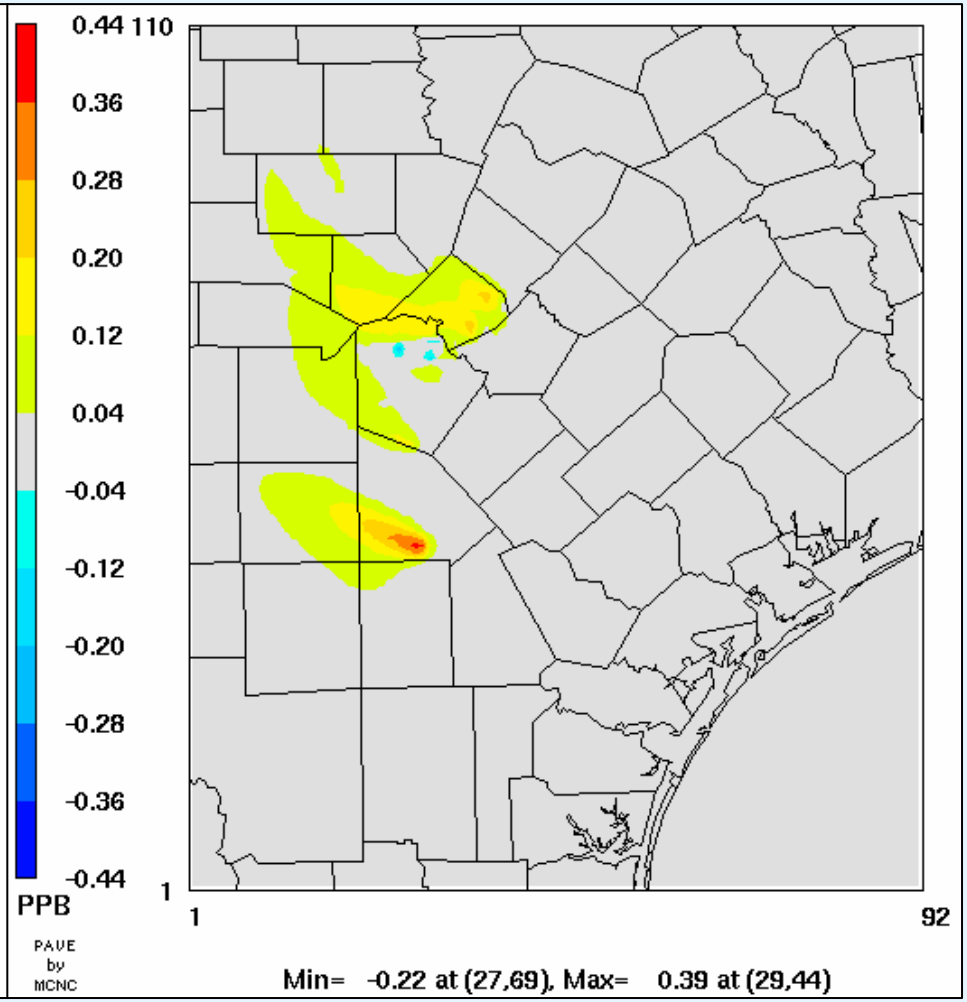


Difference of Layer One Ozone, 8-hour Average, (Construction – Default)

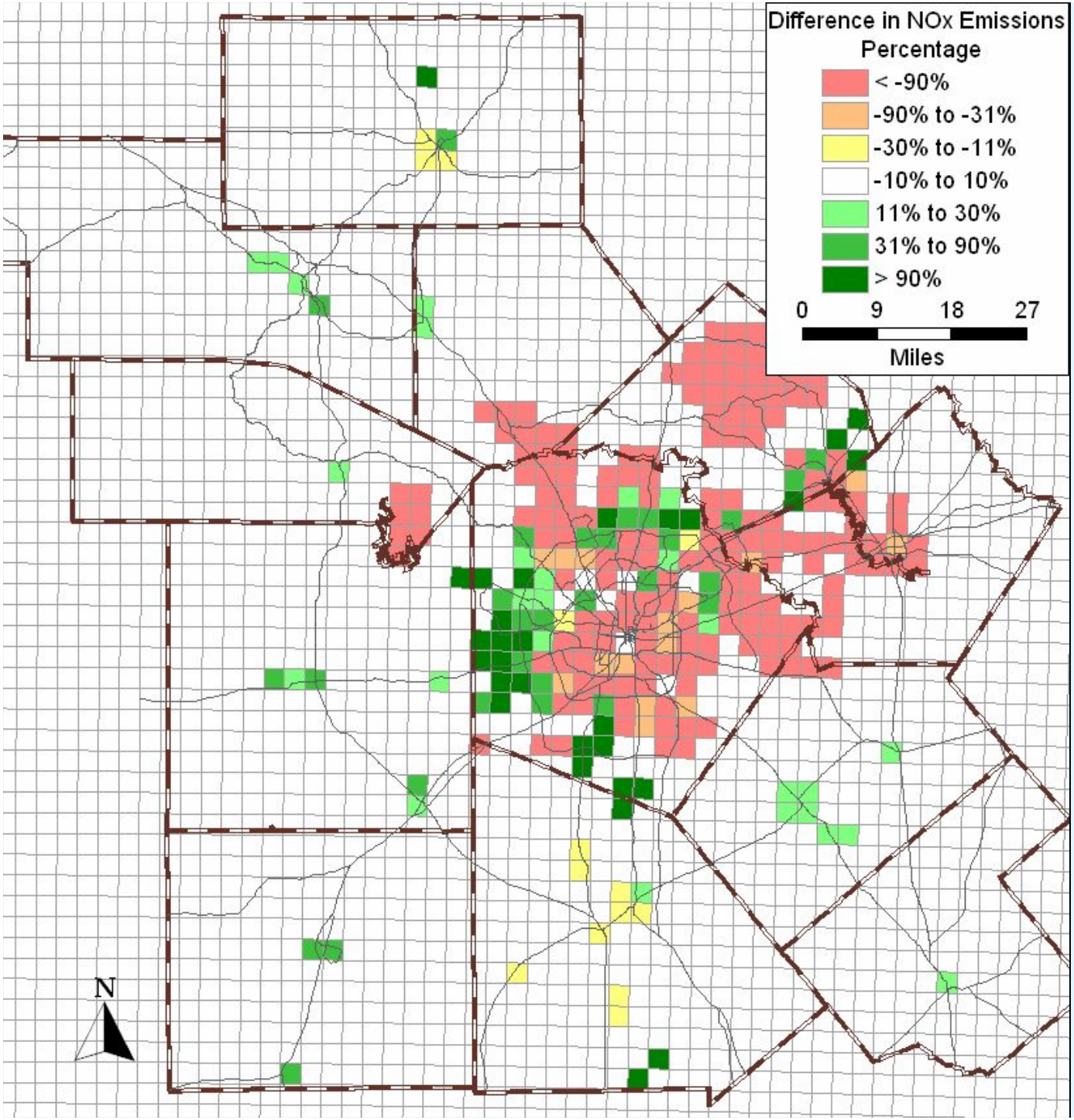
Sept. 17, 2005



Sept. 18, 2005



AACOG
Alamo Area Council Of Governments



Percent Difference between Construction Default and Updated Spatial Allocation, (tons of NOx/day), 2005

Plot Date: March 5, 2007
Map Compilation: Feb. 27, 2007

AACOG
Alamo Area Council Of Governments