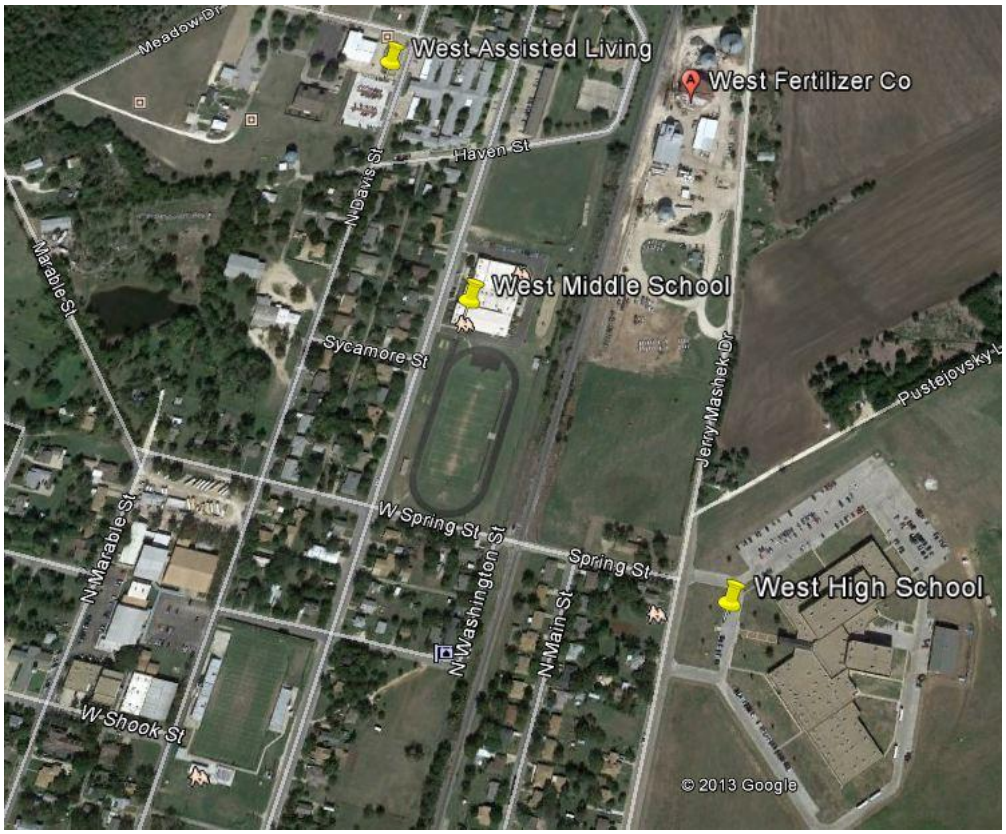
Updated Report (V2) for Airborne Data Collected
In Support of US EPA Region VI
West, Texas Fertilizer Fire

Background

On 17 April 2013 the US EPA Region 6 Emergency Operations Center (EOC) requested that ASPECT mobilize to support air monitoring activities at the West, Texas Fertilizer fire located near West, Texas. Available media information concerning the site indicated that a large explosion and subsequent fire started on 17 April 2013 at approximately 2110 and a second explosion at 2150. Reports indicate that multiple injuries and deaths have occurred. The ASPECT aircraft was notified at approximately 2300 on 17 April 2013 and was airborne at 2345 and was on station at 0000 18 April 2013. Due to the close proximity of the fire to the aircraft's home base, the aircraft landed at Midway regional and uploaded data. The approximate coordinates of the fertilizer facility is 31.8157N 97.0879W.

ASPECT response to this Mission/Incident was in support of:
US EPA Region 6. OSC: Mark Hayes

Figure 1. Site Map of the Magnablend Chemical Facility



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Due to a low cloud ceiling, the aircraft was flown at about 800 to 1000 feet above ground level (AGL) for the entire mission. The crew reported multiple fires and smoke in and around the facility, which included what appeared to be homes up to ¼ mile from the facility. During ASPECT over flights smoke/plume movement appeared to be to the Northwest.

Weather conditions at the time of data collection consisted of broken to overcast skies at 900 feet with winds from SE at 20 to 30 Kts. The surface temperature was 24°C with a relative humidity of 89%. The surface pressure was reported as 29.33 in Hg. Surface winds in Waco, Texas were reported to be from 160 Degrees at 20 Kts gusting to 30 Kts. The flight crew reported moderate to extreme turbulence and confirmed that winds were gusting from the south at the 800 foot flight level.

ASPECT System

The US EPA ASPECT system was used to collect airborne infrared (IR) images and data over the site. The ASPECT System is an emergency response aircraft permitting remote chemical detection in support of the first responder. The system consists of an airborne high speed Fourier transform infrared spectrometer (FTIR) couple with a wide-area IR line scanner. The ASPECT IR systems have the ability to detect compounds in both the 8 to 12 micron (800 to 1200 cm-1) and 3 to 5 micron (2000 to 3200 cm-1) regions. The 8 to 12 micron region is typically known as the atmospheric window region since the band is reasonably void of water and carbon dioxide influence. Spectrally, this region is used to detect carbon—non- carbon bonded compounds. The 3 to 5 micron region is also free of water and carbon dioxide but typically does not have sufficient energy for use. This band does show use in high-energy environments such as fires. The Carbon – Hydrogen stretch is very common in this region.

Collected data is examined while the aircraft is in flight status and preliminary data is sent using a satellite system to the ASPECT reach back team for analysis.

Flight Status

The order to launch the aircraft was given at 2300 local on 17 April 2013. The aircraft was airborne at 1145 and was on station at about 0000 on 18 April 2013. Flight information is summarized in Table 1 and Figure 2.

Table 1. Flight Status – 18 April 2013

Run (Log Run #)	Time (GMT)	Altitude (AGL Ft)	Heading (Deg)	L/S File (2013_04_18 …)	FTIR File	Comments
1	0447	---	---	---	---	System Test All OK

2	0505	800		05_05_21_R02	H1305.05	24 Photos, Up the plume
3	0506	800		05_06_04_R03		
4	0506	800		05_06_36_R04		False system trigger
5	0509	800		05_09_05_R05	H1305.09	27 Photos, Up Plume
6	0509	800		05_09_42_R06		
7	0512	800		05_12_43_R07	H1305.12	½ mile downwind, Ammonia Detected
8	0513	800		05_15_13_R08	H1305.15	1 mile downwind
9	0517	800		05_17_40_R09	H1305.17	14 photos, 2 mile downwind
10	0518	800		05_18_28_R10		2 mile downwind
11	0520	800		05_20_36_R11	H1305.20	14 photos, 3 mile downwind
12	0521	800		05_21_18_R12	H1305.21	4 mile downwind
13	0523	800		05_23_29_R13	H1305.23	Upwind of Fire
14	0526	800		05_26_26_R14	H1305.26	5 mile downwind
15	0527	800		05_27_04_R15	H1305.27	5 mile downwind
16	0528	800		05_28_39_R16	H1305.28	6 mile downwind
17	0529	800		05_29_18_R17	H1305.29	6 mile downwind
18	0530	800		05_30_47_R18	H1305.30	7 mile downwind
19	0531	800		05_31_27_R19	H1305.31	7 mile downwind
20	0534	800		05_34_04_R20	H1305.34	8 mile downwind
21	0535	800		05_35_48_R21	H1305.35	9 mile downwind

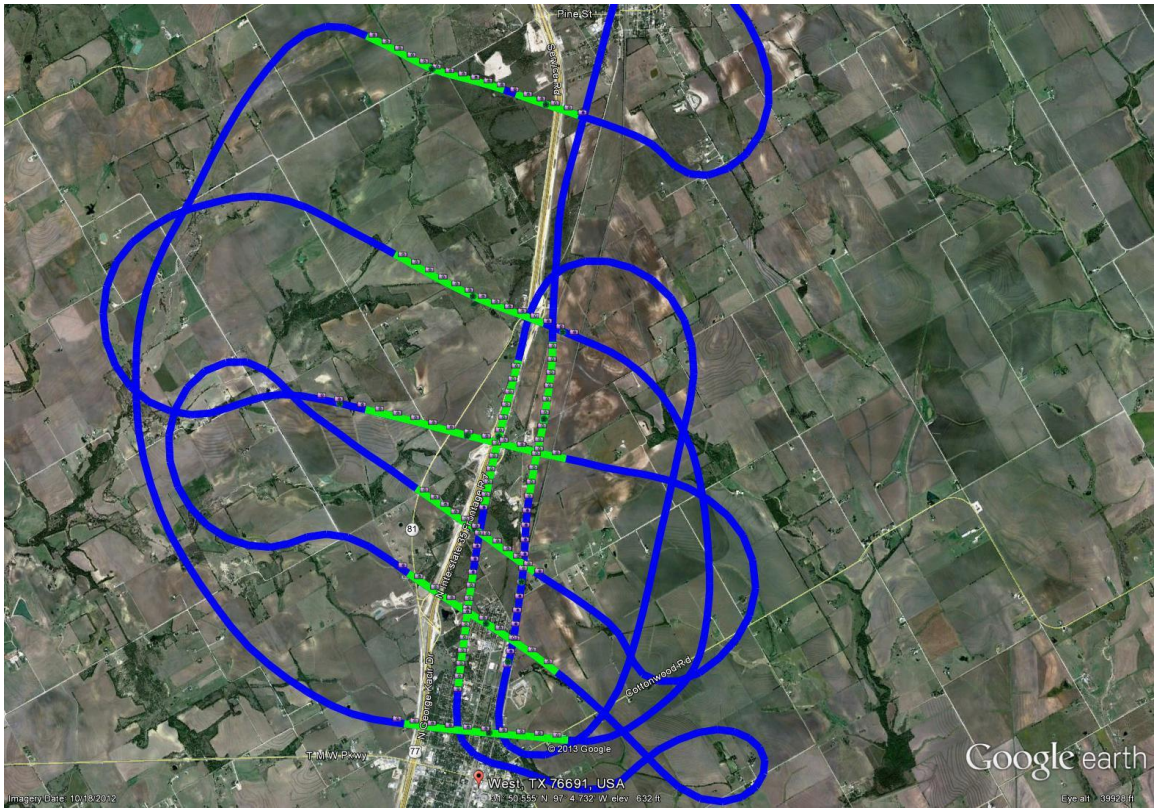

Figure 2 Flight Track, West, Texas Fertilizer Fire

Data Results

Line Scanner Data Results

A total of 20 data passes were made and an infrared line scanner image was generated for each pass. Figure 3 shows an IR image generated from Run 7 using three spectral band pass channels. The white area of the image shows the elevated temperature associated with the fire. Other than the elevated thermal signature of the fire, no plume was observed being generated or leaving the active fire. Normally, ASPECT flies at about 2800 feet and generates IR imagery that is about 3000 feet wide. Due to the low cloud ceiling, the IR images were only about 800 feet wide.

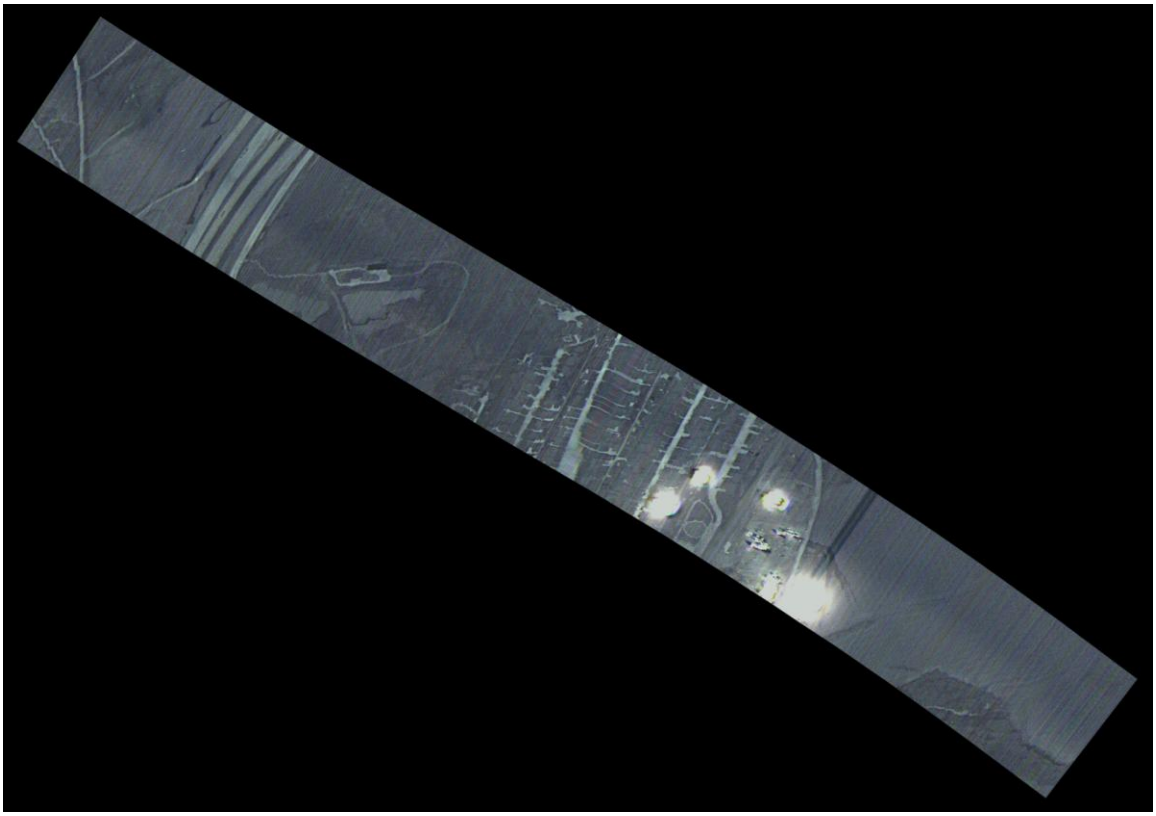

Figure 3, IR Image, West, Texas Fertilizer Fire, Run 7

FTIR Data Results

Spectral data was collected using the FTIR for each pass. A spectral resolution of 16 wavenumbers was used for all data passes. The following is a table summarizing the data sets generated during the flight.

ASPECT uses an automated detection algorithm to permit compounds to be analyzed while the aircraft is in flight. 71 compounds are included in this algorithm and the list and associated detection limits are given in Figure 4. In addition, collected data is also manually analyzed by comparing any detected spectral signatures to a collection of published library spectra.

Chemical Detection Algorithms

71 Automated

Detection limits (in ppm) referenced to a 10 meter path length

Acetic Acid (2.0)	Cumene (23.1)	Isoprene (6.5)	Propylene Oxide (6.8)
Acetone (5.6)	Diborane (5.0)	Isopropanol (8.5)	Silicon Tetrafluoride (0.2)
Acrolein (8.8)	1,1-Dichloroethene (3.7)	Isopropyl Acetate (0.7)	Sulfur Dioxide (15)
Acrylonitrile (12.5)	Dichloromethane (6.0)	MAPP (3.7)	Sulfur Hexafluoride (0.07)
Acrylic Acid (3.3)	Dichlorodifluoromethane (0.7)	Methyl Acetate (1.0)	Sulfur Mustard (6.0)
Allyl Alcohol (5.3)	1,1-Difluoroethane (0.8)	Methyl Ethyl Ketone (7.5)	Nitrogen Mustard (2.5)
Ammonia (2.0)	Difluoromethane (0.8)	Methanol (5.4)	Phosgene (0.5)
Arsine (18.7)	Ethanol (6.3)	Methylbromide (60)	Phosphine (8.3)
Bis-Chloroethyl Ether (1.7)	Ethyl Acetate (0.8)	Methyl Methacrylate (1.1)	Tetrachloroethylene (10)
Boron Tribromide (0.2)	Ethyl Formate (1.0)	MTEB (3.0)	1,1,1-Trichloroethane (1.9)
Boron Triflouride (5.6)	Ethylene (5.0)	Naphthalene (3.8)	Trichloroethylene (2.7)
1,3-Butadiene (5.0)	Formic Acid (5.0)	n-Butyl Acetate (3.8)	Trichloromethane (0.7)
1-Butene (12.0)	Freon 134a (0.8)	n-Butyl Alcohol (7.9)	Triethylamine (6.2)
2-Butene (18.8)	GA (Tabun) (0.7)	Nitric Acid (5.0)	Triethylphosphate (0.3)
Carbon Tetrachloride (0.2)	GB (Sarin) (0.5)	Nitrogen Trifluoride (0.7)	Trimethylamine (9.3)
Carbonyl Flouride (0.8)	Germane (1.5)	Phosphorus Oxychloride (2.0)	Trimethyl Phosphite (0.4)
Carbon Tetraflouride (0.1)	Hexafluoroacetone (0.4)	Propyl Acetate (0.7)	Vinyl Acetate (0.6)
Chlorodifluoromethane (0.6)	Isobutylene (15)	Propylene (3.7)	

Manual assessment of 500+ other chemical compounds

Figure 4. Automated ASPECT Detection Algorithm List and Detection Limits

Table 2. FTIR data set and detection notations

Run	Compound
1	System Test
2	No Detections
3	Not Collected
4	Not Collected
5	No Detection
6	Not Collected
7	Ammonia, 6.0 – 10.0 PPM
8	No Detections
9	No Detections
10	Not Collected
11	No Detections
12	No Detections
13	No Detections
14	No Detections
15	No Detections
16	No Detections
17	No Detections
18	No Detections
19	No Detections
20	No Detections
21	No Detections

Automated detection of ammonia was observed on data collection Run 7 and indicated moderate levels of ammonia 600 to 1000 feet downwind of the fire. Manual analysis of spectra for Run 7 showed characteristic absorption bands for ammonia at 960 and 920 wave numbers (figure 5). Initial estimates of ammonia concentration based on the signal to noise ration indicated that the highest levels of ammonia were approximately 6 to 10 ppm (volumetric) within the plume. Subsequent analysis of the data showed a slight reduction in concentration to a level of 6 ppm (volumetric). Figure 6 shows a plot of the ammonia detection as the aircraft flew over the plume for Run 7. Ammonia concentrations tended to remain fairly consistent across the plume and averaged about 5 ppm. No other compounds of significance were detected.

Subsequent data runs flown at increasing distances from the fire failed to detect ammonia or other compounds of significance. This implies that considerable dilution was acting on the plume due to both the distance and high turbulent winds.

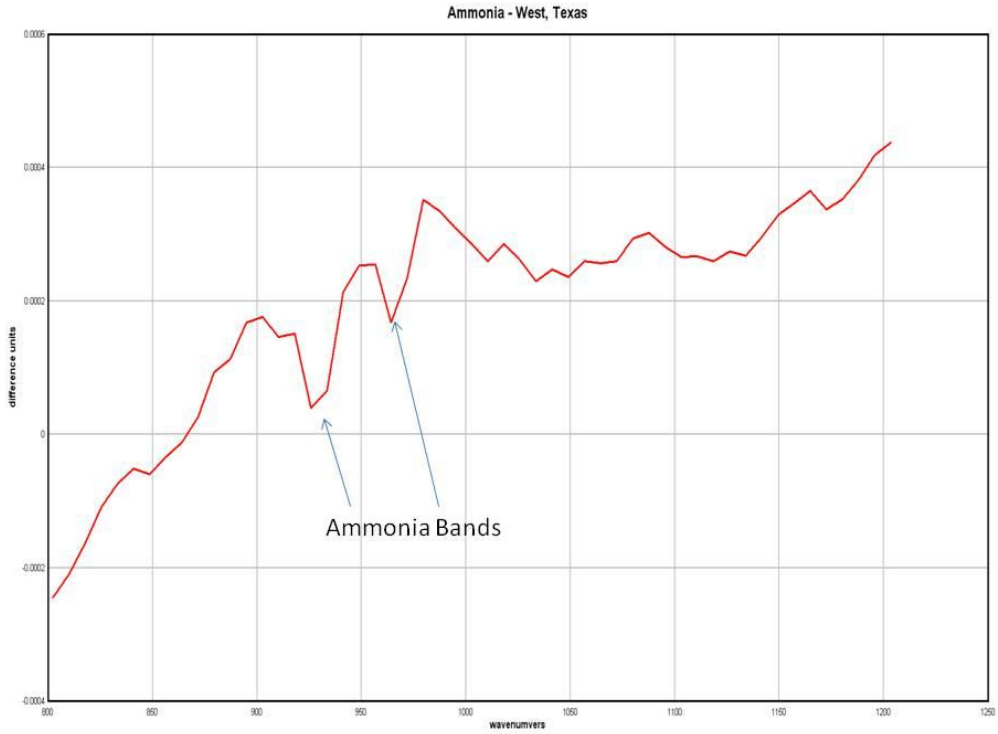

Figure 5. Ammonia Spectral Signature, West, Texas Fertilizer Fire

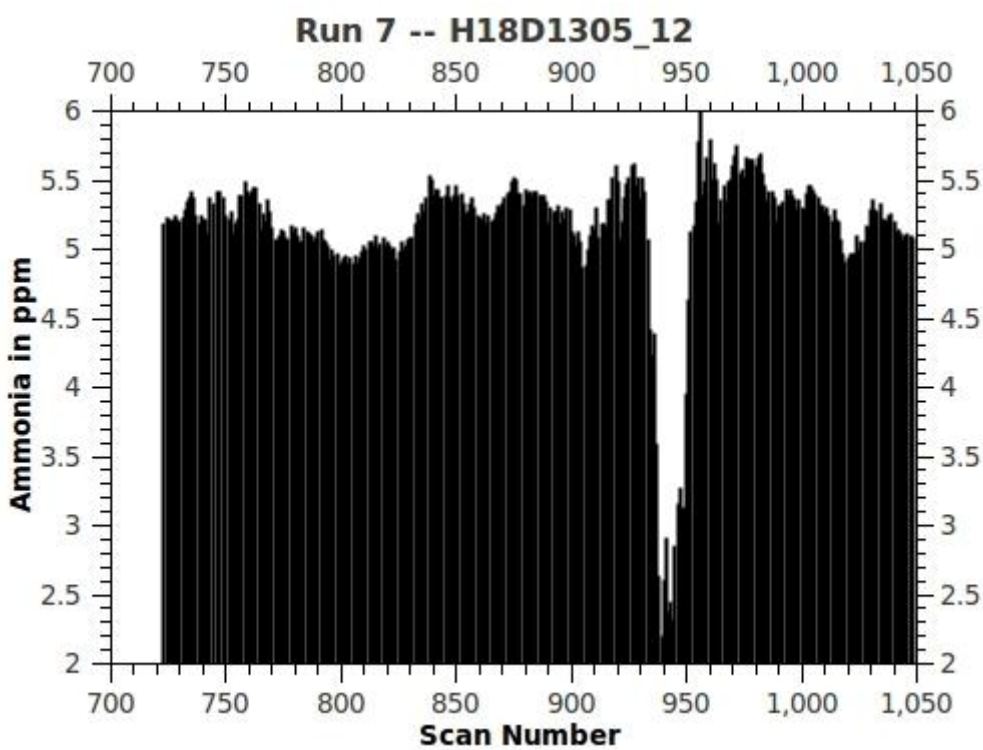

Figure 6. Concentration Profile for Ammonia, West, Texas Fertilizer Fire

Figure 7 shows the geographic location of the ammonia detections as observed with the ASPECT system. The wiggle in the line is a result of turbulence rolling the aiming point of the FTIR spectrometer.

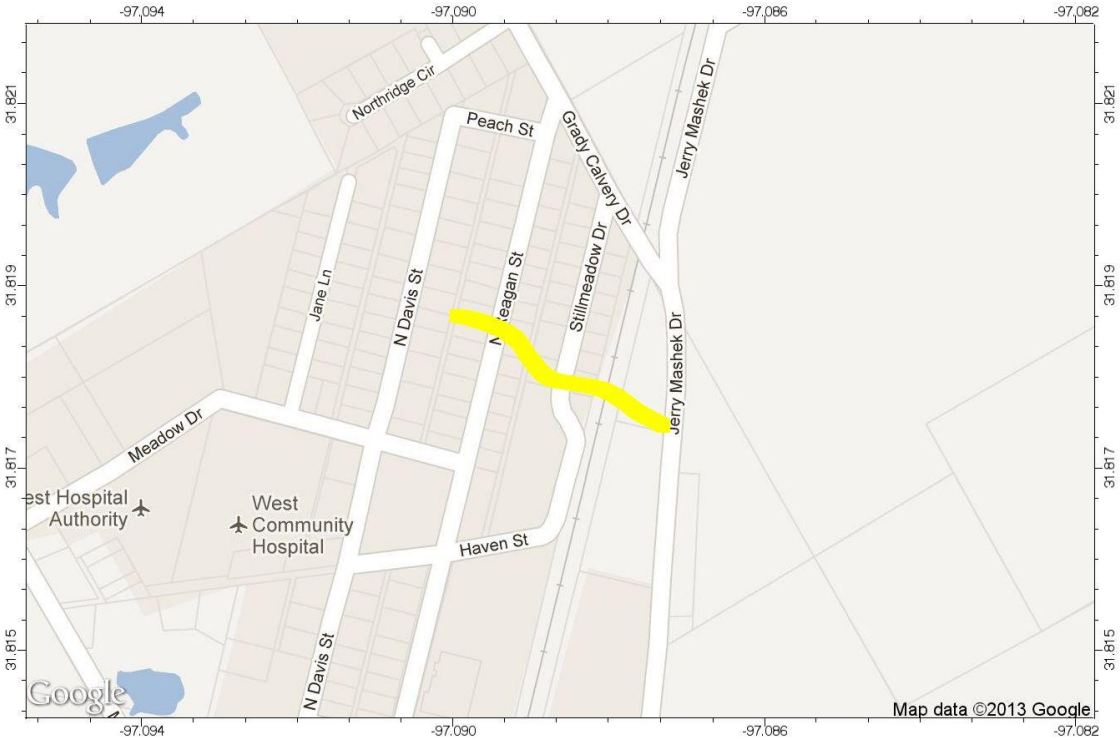

Figure 7. Ammonia Detection Locations, West, Texas Fertilizer Fire

Conclusions

The ASPECT aircraft was dispatched to the West, Texas Fertilizer Fire to support response activities due to an explosion and fire at the facility. Data collection over the site was initiated at 0000 on 18 April 2013 and included 20 data collection passes downwind of the primary fire. Reports from the crew and thermal features within the IR imagery, showed one large fire and several smaller fires, likely structure fires. Analysis of spectral data showed maximum levels of ammonia at about 6 ppm (volumetric) about 600 to 1000 feet downwind of the fire. Subsequent data collection at further downwind distances from the fire did not detect any hazardous compounds.