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PM10 Emission Inventory of Sources Surrounding Five Ambient Monitoring Sites in the Las Vegas Valley

Submitted to:
Clark County Department of Comprehensive Planning

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Final Report

PM_{10} Emission Inventory of Sources Surrounding Five Ambient Monitoring Sites in the Las Vegas Valley

Submitted to:

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1.0 INTRODUCTION

The Las Vegas Valley was designated as a moderate non-attainment area for particulate matter 10 microns or less in diameter (PM_{10}) in 1991. The Las Vegas Valley was subsequently designated as a serious PM_{10} non-attainment area in 1993. The PM_{10} non-attainment area in the Las Vegas Valley, which coincides with Hydrographic Basin 212, encompasses 15,000 square kilometers and includes the cities of Las Vegas, North Las Vegas, and Henderson, as well as unincorporated areas in Clark County (Figure 1-1).

The federal Clean Air Act requires states to develop and submit State Implementation Plans (SIPs) that specify the technologies, activities, and strategies which will be applied in each PM_{10} non-attainment area to achieve compliance with the PM_{10} standards. In October of 1997, the Board of Clark County Commissioners submitted an SIP for PM_{10} to the U.S. Environmental Protection Agency (EPA). The SIP was unable to demonstrate compliance with the 24-hour PM_{10} standard, and a five-year extension of the compliance date of 2001 was requested. The EPA has indicated that it may not approve the request for an extension of time and that Clark County will need to seek further reductions in emissions of PM_{10} to reach attainment.

The purpose of this study is to inventory PM_{10} sources surrounding five representative PM_{10} monitoring stations located within the non-attainment area. These inventories will provide additional information for the Las Vegas Valley PM_{10} SIP development. The sites were selected because they represent the monitoring stations with the highest readings of PM_{10} in the valley. A design day was designated for each site as the day the third highest 24-hour PM_{10} concentration was measured from 1997 through 1999. The representative sites and the corresponding design days are listed in Table 1-1.

Table 1-1
Representative Monitoring Stations and Design Days

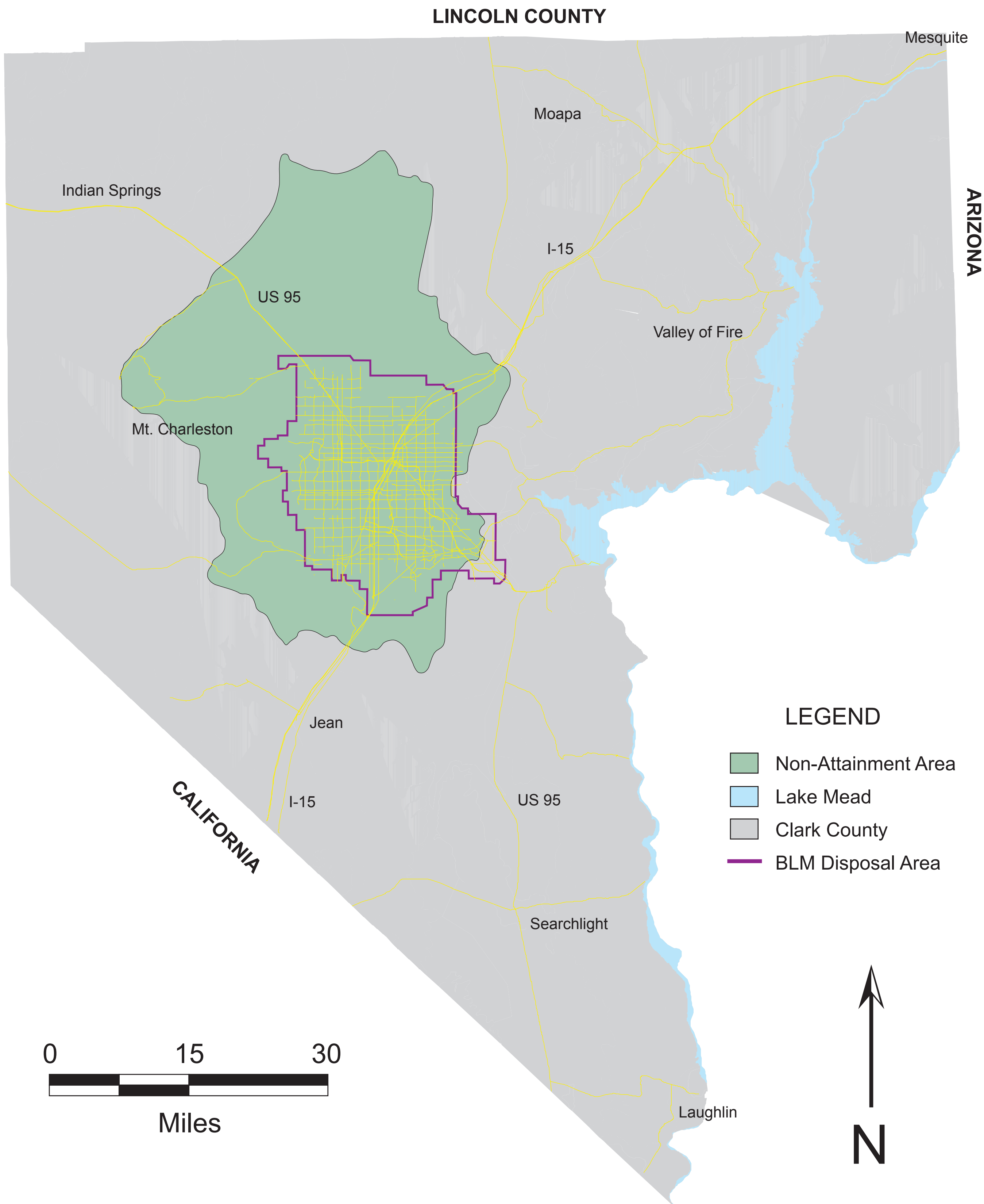
MONITORING STATION	DESIGN DAY	PM_{10} CONCENTRATION (mg/m^3)
Craig Road	January 20, 1999	254
East Flamingo	March 30, 1999	189
Green Valley	February 25, 1999	281
J. D. Smith	March 31, 1999	218
Pittman	March 30, 1999	239

The objectives of this study are:

- to identify PM_{10} sources within a two-kilometer radius of each monitoring station;
- to determine activity levels of these sources for a specified design day;
- to determine individual source emissions based on existing PM_{10} emissions information; and
- to establish an emission inventory for each monitoring station for the specified design day.

FIGURE 1-1

PM_{10} Non-attainment Area



C:\MacDougall_Jobs\MicroInventory\Road_Maps\Figure1-1.ai

A description of each monitoring station and its location are provided in Section 2. Section 3 summarizes the meteorological data measured at each site for the given design day. Potential PM_{10} sources within 2 kilometers of each station are described in Section 4. The activity level for each source for the design day is provided for each monitoring location in Section 5. Existing emission factors for the potential sources were listed in Section 6. In Section 7, the emission inventory for the 2 kilometers surrounding each site is presented as a total inventory and by inventory grid. Summary conclusions are contained in Section 8.

2.0 MONITORING STATIONS

A map of the Las Vegas Valley with the location of each of the five monitoring stations is presented in Figure 2-1. A description of each station is presented below.

2.1 CRAIG ROAD

The Craig Road monitoring station is located at 4701 Mitchell Street within the City of North Las Vegas. The site is in the northeast portion of the valley and the monitor is located in the paved parking lot of a light industrial facility. Continuous monitoring with a Graseby-Andersen beta attenuation monitor began in late 1992. The surrounding vacant land is rapidly developing with commercial, light industrial, and some residential land uses. The site is adjacent to heavy traffic volumes from I-15 and Craig Road. It is well representative of ambient air surrounding the Valley's development boundary due to urban growth and expansion.

Meteorological parameters measured at the site include temperature, wind speed, wind direction, and relative humidity. The Universal Trans Meridian (UTM) coordinates for the site are 671439 easting and 4012654 northing. The monitor inlet is 3.5 meters above ground level and 625 meters above mean sea level.

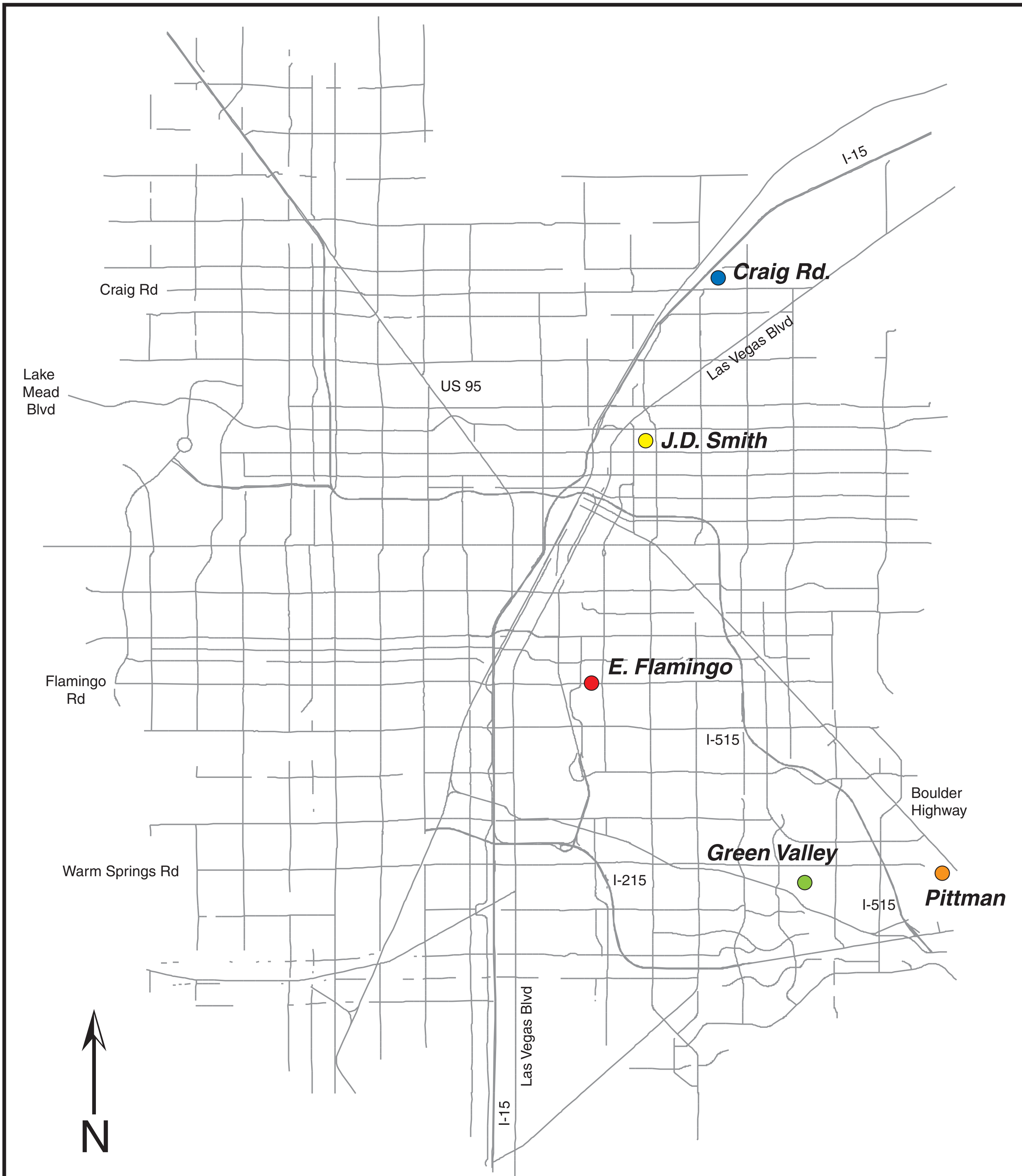
2.2 EAST FLAMINGO

The East Flamingo monitor is located three-fourths of a mile from the gaming corridor along Las Vegas Boulevard known as "The Strip". The strip is the heart of Las Vegas' tourist industry where a vast majority of the world's largest resorts are located, housing roughly 30 million visitors a year. The metropolitan area where the monitor is located is an unincorporated area of Clark County. The site represents a highly commercialized area. The monitor is located on a power line service easement.

Continuous monitoring with a Graseby-Andersen beta attenuation monitor began in late 1992. The monitor inlet is located 3.5 meters above ground level and 600 meters above mean sea level. Easting and northing UTM coordinates are 665976 and 3998058 respectively. Meteorological data for the following parameters are collected: temperature, wind speed, wind direction, and relative humidity.

2.3 GREEN VALLEY

The Green Valley monitoring station is located at 298 Arroyo Grande Boulevard in the southeast portion of the valley in the City of Henderson. The site lies on the border of a public park and is just north of an immense and highly active, 480 acre, sand and gravel operation. Continuous monitoring with a Graseby-Andersen beta attenuation monitor began in April of 1995. Concentrations from this site can reflect specific impacts from the sand and gravel source.



EXPLANATION

- Craig Rd. Monitoring Station
- E. Flamingo Monitoring Station
- Green Valley Monitoring Station
- J.D. Smith Monitoring Station
- Pittman Monitoring Station

Figure 2-1
Monitoring Station Map

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The UTM coordinates for the site are 675025 east and 3991294 north. The inlet height above ground is 3.5 meters and 613 meters above mean sea level. The meteorological parameters measured at the site are wind speed, wind direction, and temperature.

2.4 J. D. SMITH

The J. D. Smith monitoring station is located at 1301 B East Tonopah, on the corner of Bruce and Tonopah, in the north central portion of the valley. The site lies on the border of the J. D. Smith Middle School in McDaniels Park. Within the City of North Las Vegas, the area is primarily residential with retail outlets along major thoroughfares. Monitoring began at this location in October of 1998 when the McDaniel station required relocation. Particulate is monitored with a Grasby-Andersen beta attenuation monitor.

The UTM coordinates for the site are 668850 east 4006580 north. The inlet height above ground is 3.5 meters and 581 meters above mean sea level. The meteorological parameters measured at the site are wind speed, wind direction and temperature.

2.5 PITTMAN

The Pittman monitoring station is located in the City of Henderson, in the southeast portion of the Valley. Continuous monitoring using a Graseby-Andersen beta attenuation monitor began in mid 1994. The monitoring station address is 1137 N. Boulder Highway, a commercial storage area. The area is surrounded by light to moderate commercial and industrial uses with light traffic volumes.

Meteorological parameters measured at the site include temperature, wind speed, wind direction, and relative humidity. The UTM coordinates for the site are 680390 east and 3991640 north. The monitor inlet is 4.5 meters above ground level.

3.0 METEOROLOGICAL DATA

Wind roses of the wind speed and wind direction data collected by Clark County Air Quality Division (CCAQD) at four of the monitoring stations are presented in Figures 3-1 through 3-4 (CCAQD, 1999). Peak wind gusts were recorded at McCarran International Airport and reported by the National Oceanic and Atmospheric Administration (NOAA, 2000). None of the monitoring stations registered calm winds on their respective design days. The wind parameters were not measured at the Green Valley monitoring station on February 25, 1999, the design day for that location.

3.1 WIND MEASUREMENTS AT CRAIG ROAD MONITORING STATION

Winds were primarily out of the south-southwest on January 20, 1999 as measured at the Craig Road monitoring station. Sustained winds exceeded 17 knots (20 mph) for one hour and 11 (13 mph) knots for five hours. Maximum wind gusts reached 34 mph with two-minute sustained gusts of 31 mph.

3.2 WIND MEASUREMENTS AT EAST FLAMINGO MONITORING STATION

The design day for East Flamingo is March 30, 1999 and winds were from the south-southwest. Sustained winds exceeded 21 knots (24 mph) for one hour and 17 knots for six hours. Sustained winds exceeded 11 knots for a total of 16 hours. Peak winds as measured at McCarran Airport reached 51 mph with two-minute sustained peaks of 41 mph.. The McCarran weather station indicated smoke or haze on this day.

3.3 WIND MEASUREMENTS AT J. D. SMITH MONITORING STATION

Winds were primarily out of the west-southwest on March 31, 1999 the design day for the J. D. Smith monitoring station. Sustained winds exceeded 21knots for two hours, and exceeded 17 knots for a total of 6 hours. Wind speeds exceeded 11 knots for 13 hours during the 24-hour period. Peak wind speeds measured at McCarran Airport reached 54 mph with two-minute sustained peaks of 46 mph. The airport weather station indicated smoke or haze on this day.

3.4 WIND MEASUREMENTS AT PITTMAN MONITORING STATION

Winds were from the west as measured at the Pittman monitoring station on March 30, 1999. Sustained winds did not exceed 21 knots. Wind speeds did exceed 17 knots for five hours and sustained winds exceeded 11 knots for 9 hours. Peak winds as measured at McCarran Airport reached 51 mph with two-minute sustained peaks of 41 mph. The McCarran weather station report indicated smoke or haze on this day.

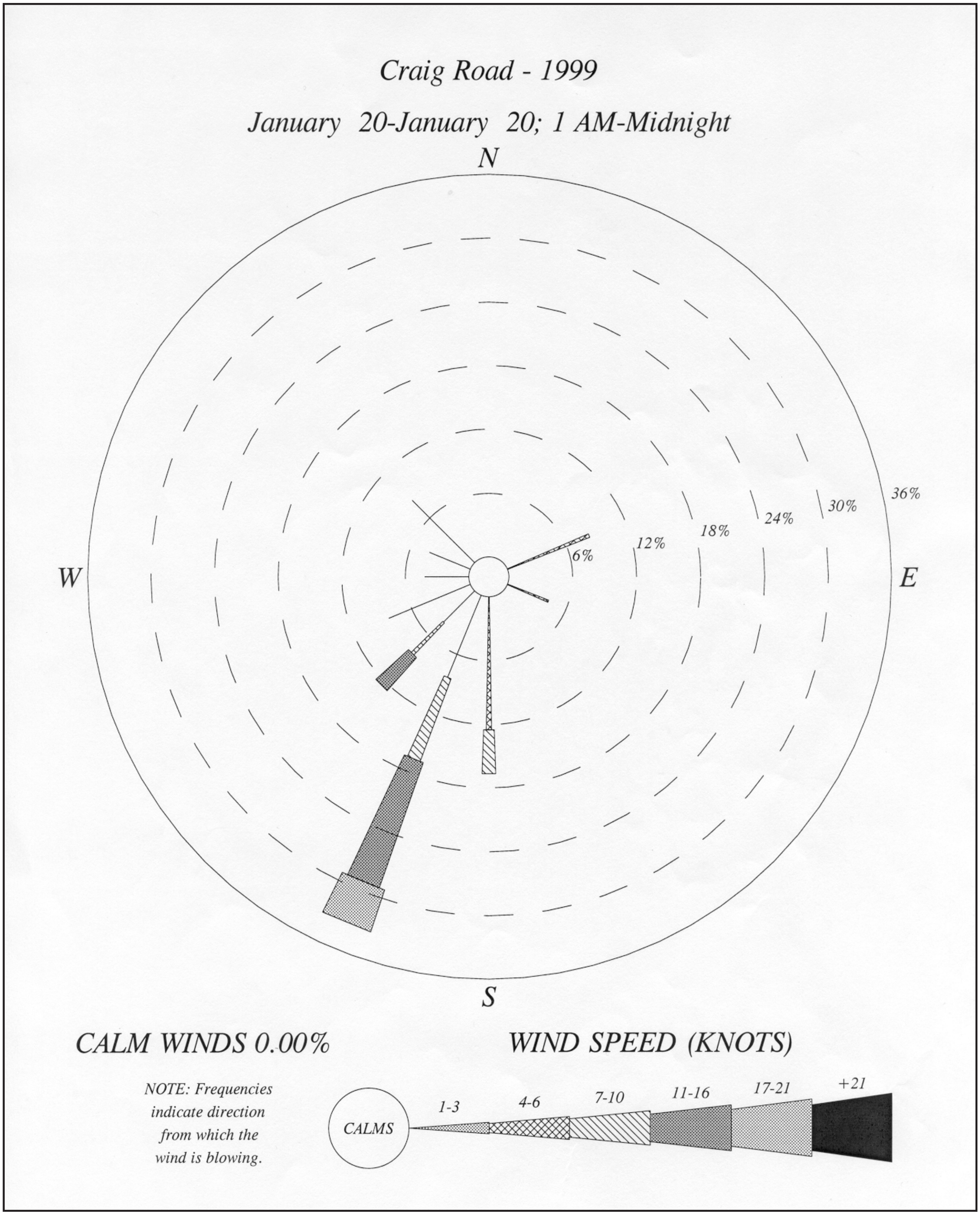

Figure 3-1 Craig Rd.

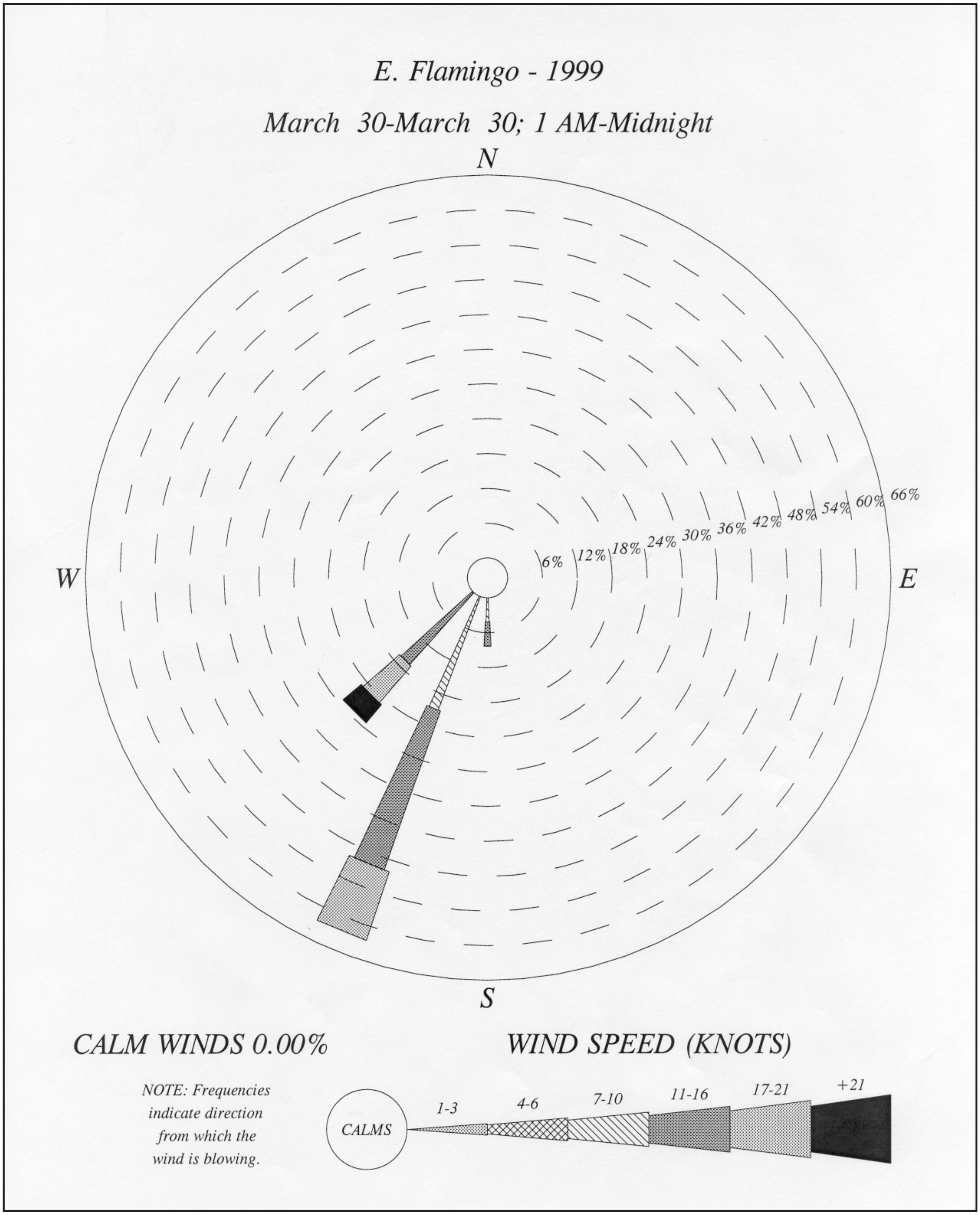

Figure 3-2 E. Flamingo Rd.

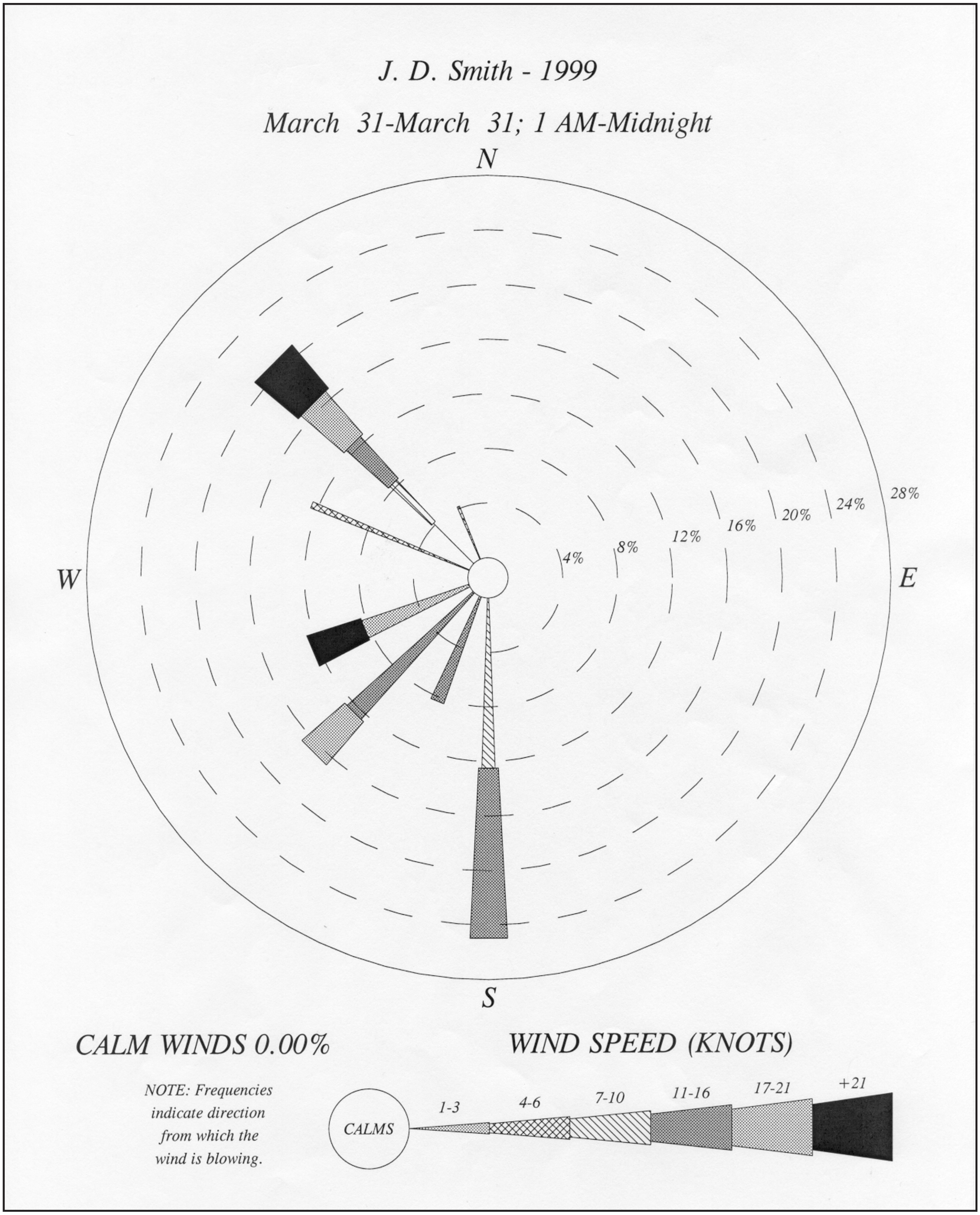

Figure 3-3 J.D. Smith

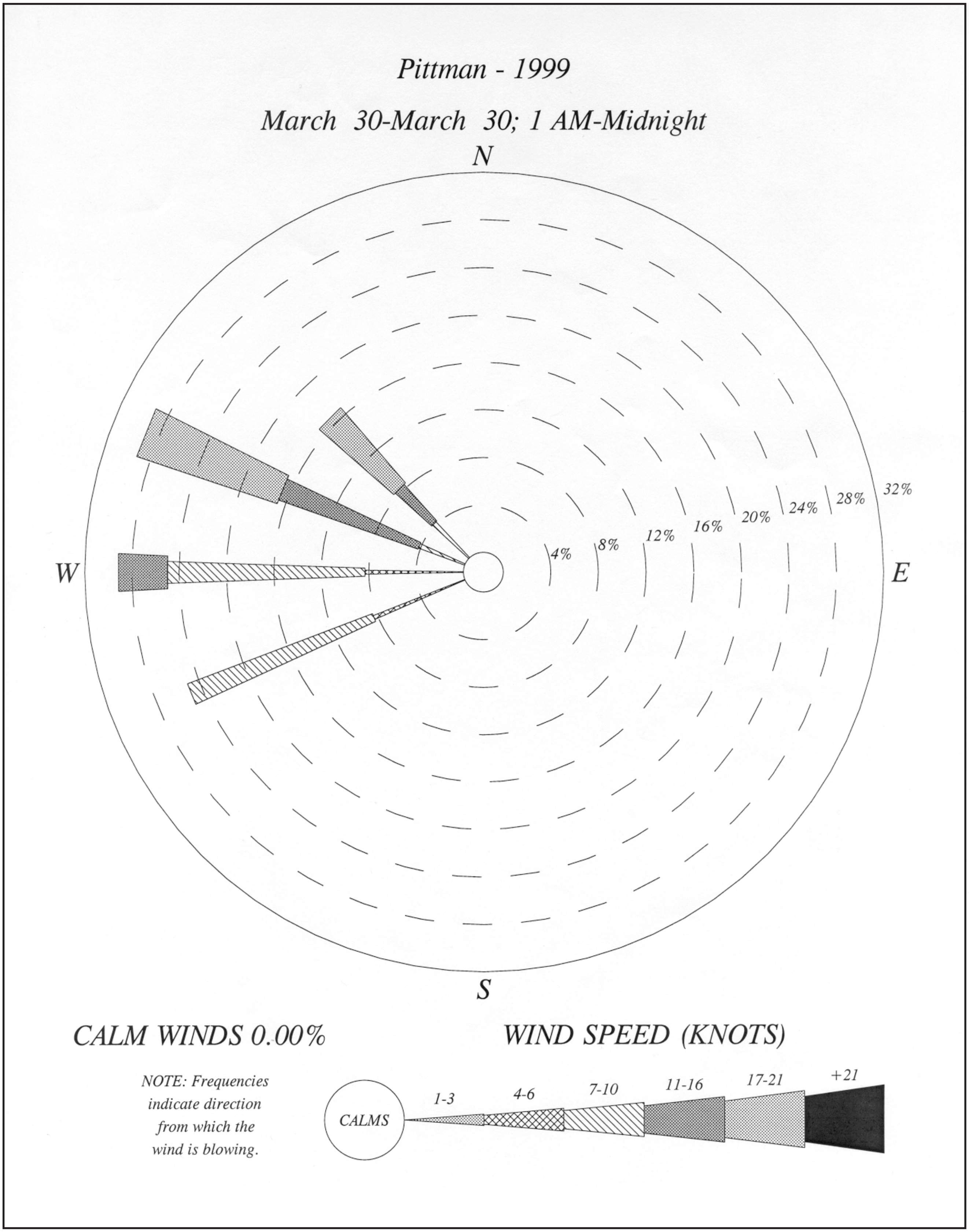

Figure 3-4 Pittman

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3.5 WIND MEASUREMENTS AT MCCARRAN AIRPORT ON FEBRUARY 25, 1999

Meteorological data was not captured at the Green Valley monitoring station on February 25, 1999, the design day for that site. The wind data from McCarran Airport indicate winds were from the southwest, averaging 19 mph with peak winds reaching 44 mph. The two-minute sustained peaks reached 39 mph. The weather station report also indicated smoke or haze on that day.

4.0 POTENTIAL PM_{10} SOURCES SURROUNDING THE AMBIENT MONITORING SITES

4.1 CRAIG ROAD

The potential PM_{10} sources surrounding the Craig Road monitoring station are presented in Figure 4-1. This same figure is provided on a larger scale in Appendix A of this report.

There are 1,637 acres of vacant land within the micro-inventory area: 828 acres native desert, 657 acres stabilized, and 152 acres unstable. An estimated 121 acres were under active construction at 17 sites on January 20, 1999. An off-road motorcycle race course covering 59 acres is located to the northwest of the monitoring station and three parcels totaling 18 acres were used for unpaved parking.

There are 2.9 miles of unpaved roads, 7.75 miles of freeway, 6 miles of minor arterials, and 66 miles of collector streets within a two-kilometer radius of the Craig Road monitoring station. Roadway classifications are shown in Figure 4-2.

The following stationary sources with PM_{10} are located within the micro-inventory area:

- All Star Transit Mix;
- Arc International;
- Basic Food Flavors;
- California Portland Cement Company;
- Cind-R-Lite;
- Pan-Osten;
- Pratte Development;
- Sweetheart Cup Corporation; and
- Worthington Armstrong Venture (WAVE).

4.2 EAST FLAMINGO

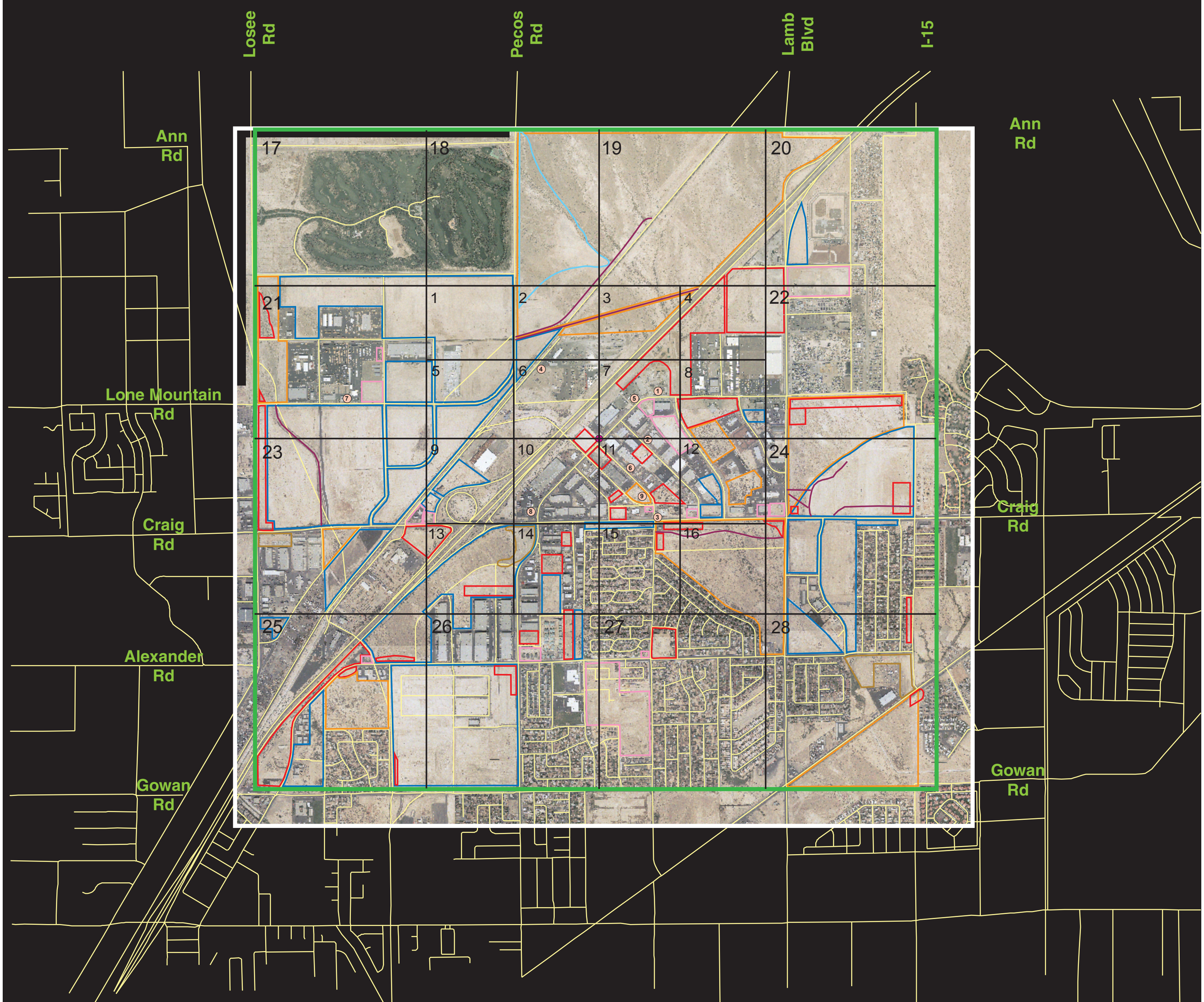
Potential PM_{10} sources within two kilometers of the East Flamingo monitoring station are mapped in Figure 4-3. This same figure is presented in Appendix A of this report on a larger scale.

There are 153 acres of vacant land within the East Flamingo micro-inventory area: 98 acres are stabilized, 12 acres are native desert, and 43 acres are unstable. On March 30, 1999 there were 16 active construction sites totaling 47 acres.

A single unpaved road, 0.2 miles in length, was located between two vacant parcels. There were 19 miles of major arterial, 10.5 miles of minor arterial and 54 miles of collector streets, as shown in Figure 4-4.

The following stationary sources have permits for boilers:

Figure 4-1
Craig Road
Land Use Map



1. All Star Transit Mix
2. Arc International
3. Basic Food Flavors
4. California Portland Cement Company
5. Cind-R-Lite
6. Pan-Osten
7. Pratte Development
8. Sweetheart Cup Corporation
9. Worthington Armstrong Venture (WAVE)

- Monitoring Station
- Stable - Man Made
- Stable - Native Environment
- Unstable
- Construction Lots
- Boundary Area
- Race Track
- Unpaved Road
- Parking

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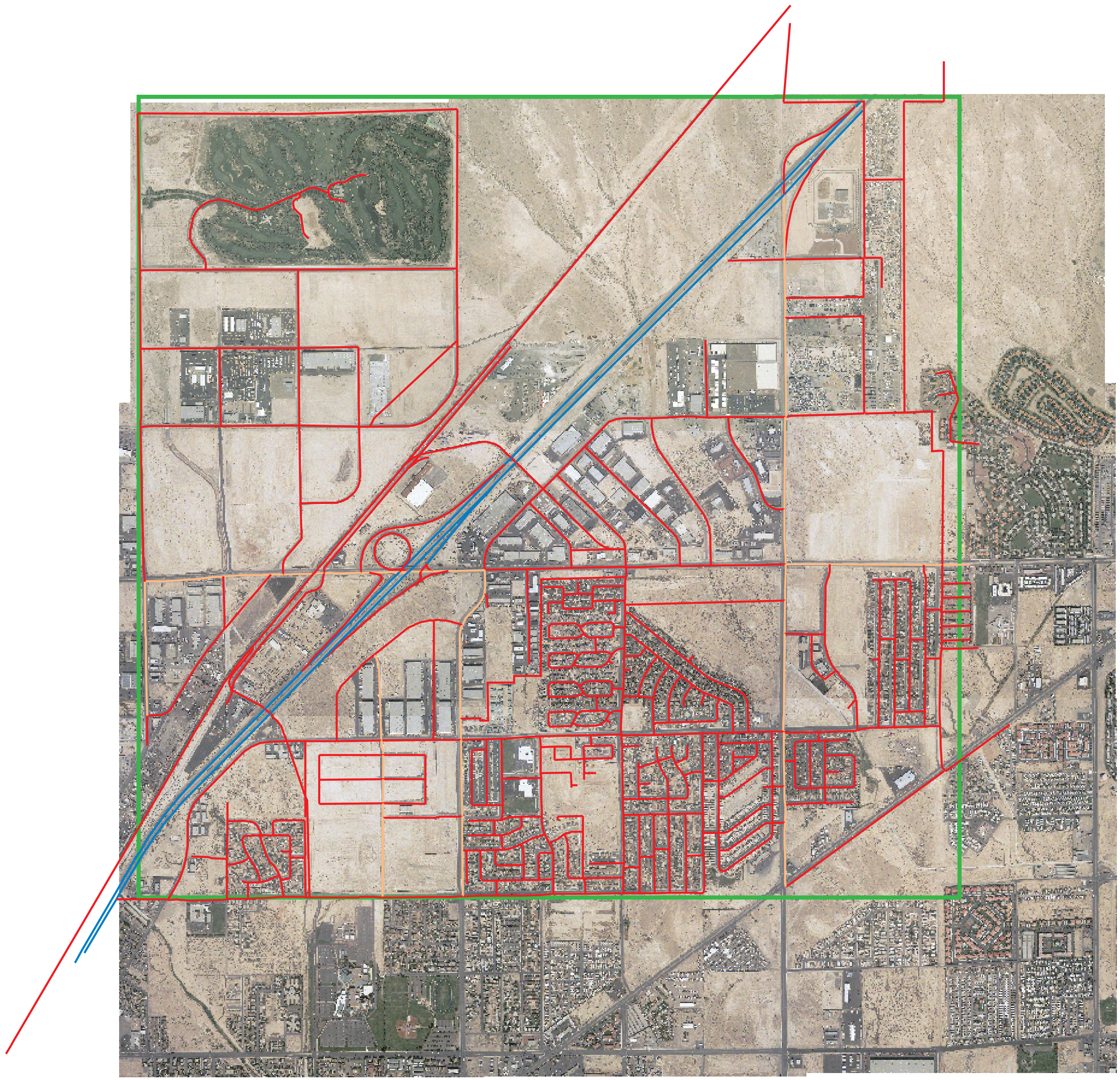
Figure 4-2
Craig Road Study Area
Roadway Classifications



Craig Roads

Collectors	(347,952 ft) (66 miles) (106 km)
Freeway	(40,954 ft) (7.75 miles) (12.5 km)
Minor Arterial	(32,615 ft) (6 miles) (10.7 km)
Boundary Area	

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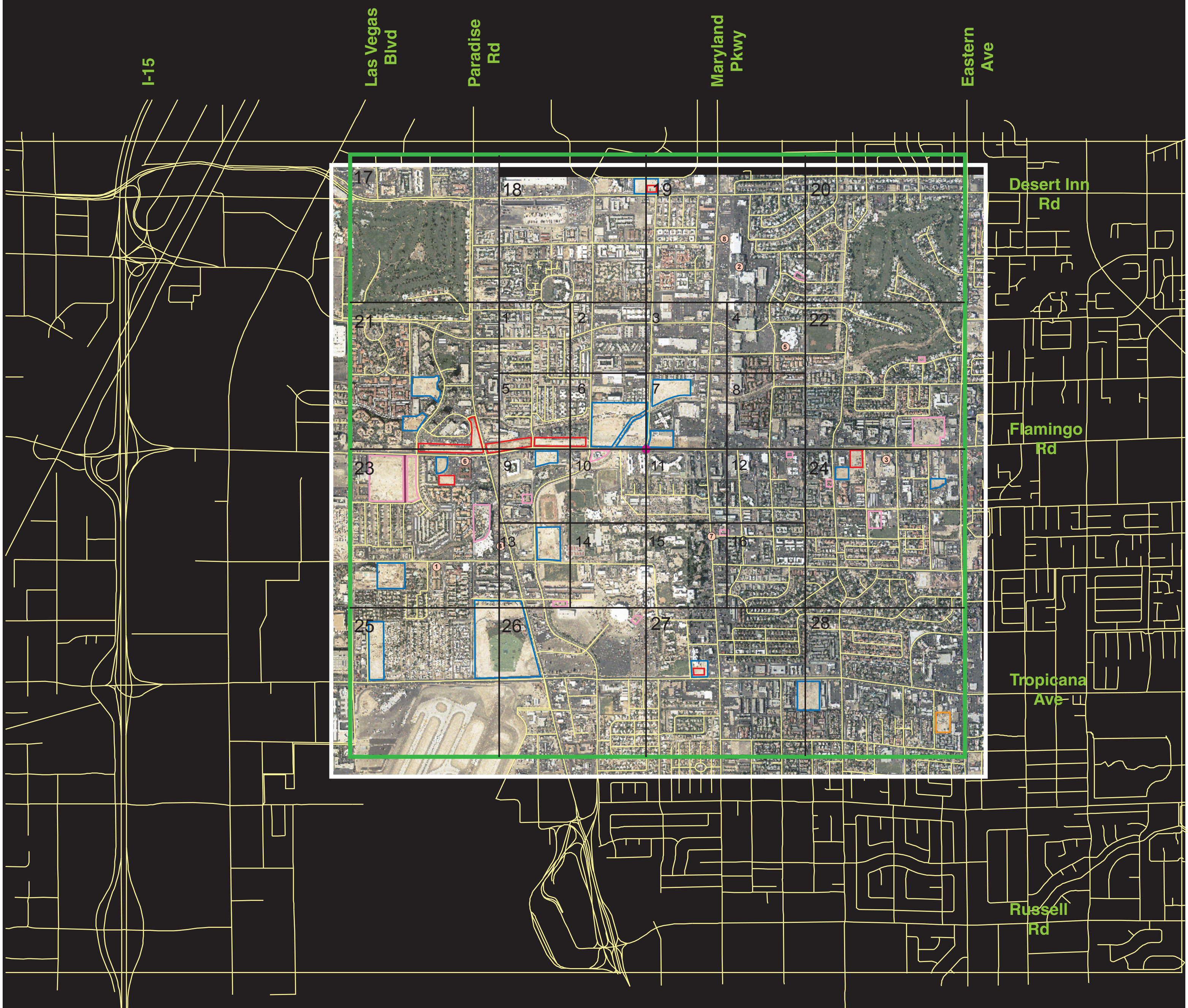
Figure 4-3
E. Flamingo
Land Use Map



1 Alexis Park Resort
2 Boulevard Mall
3 Desert Springs Hospital Inc
4 Hard Rock Hotel & Casino
5 Orr Junior High School
6 Quality Inn
7 University of Nevada Las Vegas
8 Sears, Roebuck & Company

Monitoring Station
Stable - Man Made
Stable - Native Environment
Unstable
Construction Lots
Boundary Area
Unpaved Road

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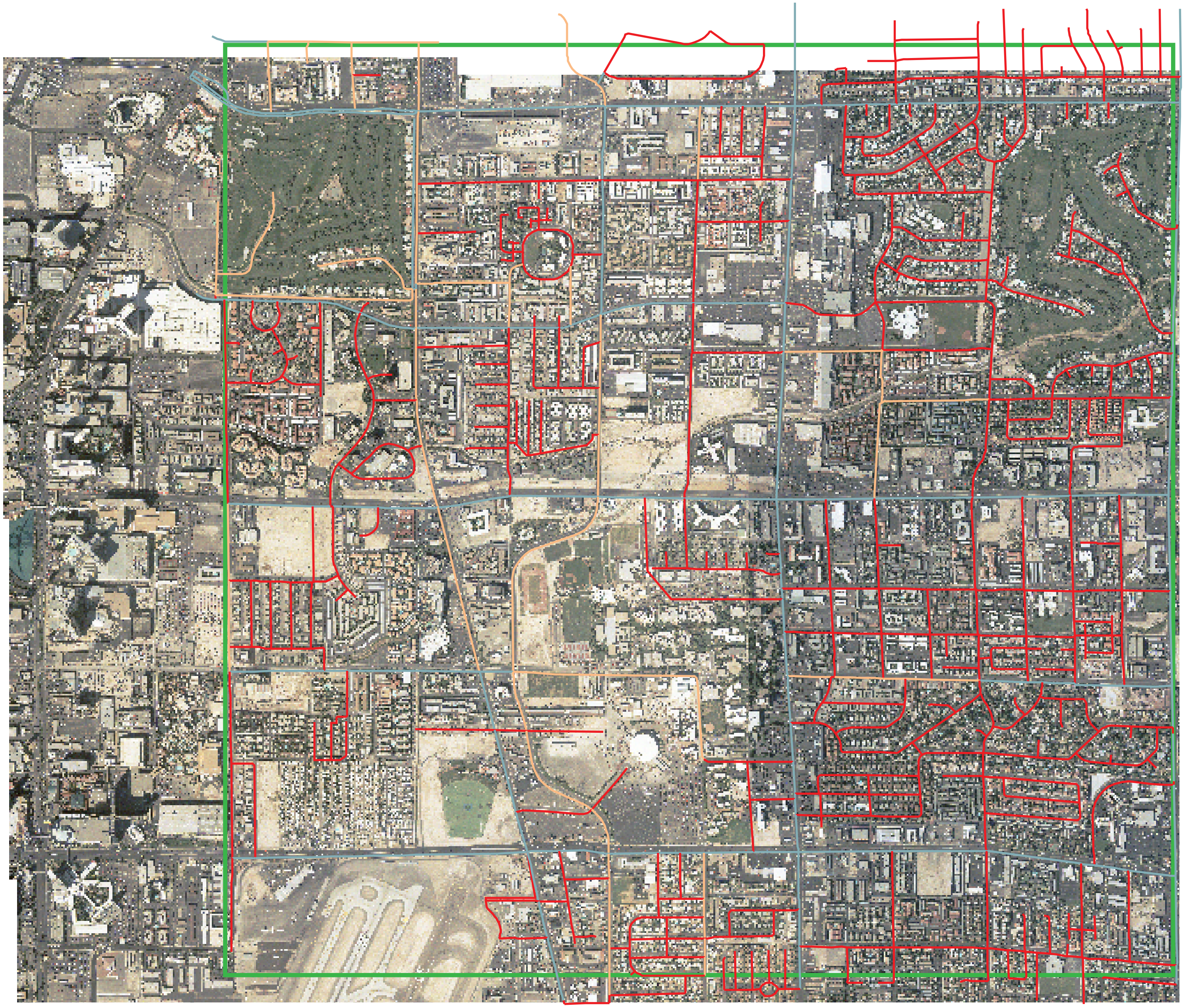
Figure 4-4
E. Flamingo Study Area
Roadway Classifications



Flamingo Roads

Red line	Collectors (268,468 ft) (51 miles) (82 km)
Blue-gray line	Major Arterial (98,460 ft) (19 miles) (30 km)
Orange line	Minor Arterial (55,777 ft) (10.5 miles) (17 km)
Green line	Boundary Area

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- Alexis Park Resort;
- Boulevard Mall;
- Desert Springs Hospital, Inc.;
- Hard Rock Hotel & Casino;
- Orr Junior High School;
- Quality Inn;
- University of Nevada Las Vegas; and
- Sears, Roebuck & Company.

4.3 GREEN VALLEY

The potential PM_{10} sources within the Green Valley micro-inventory area are predominately east and north of the monitoring station as shown in Figure 4-5. This same figure appears in Appendix A on a larger scale.

There are 313 acres of vacant land within two kilometers of the monitoring station, including two motorcycle courses covering 15 acres. There are 131 acres of native desert, 67 acres of stabilized land, and 115 acres designated as unstable. Twenty-two sites totaling 356 acres were under active construction on February 25, 1999.

The area has 3.5 miles of major arterial, 10 miles of minor arterial, 9.6 miles of collectors, and 91 miles of local streets. There are 0.34 miles of unpaved roads. Roadway classifications are shown in Figure 4-6.

Stationary sources with permits that included PM_{10} limits within the micro-inventory area are:

- Darling International, Inc.;
- Cranberry World West;
- Green Valley High School; and
- Hansen Aggregate.

4.4 J. D. SMITH

Several vacant parcels were identified within a two-kilometer area of the J. D. Smith monitoring station. As shown in Figure 4-7, the majority of parcels were not stable. A larger scale version of Figure 4-7 is provided in Appendix A.

Though most vacant parcels were not large, there were 202 acres of vacant land within the study area: 119 acres unstable, 29 acres of native desert, and 54 acres designated as stabilized. On March 31, 1999 there were 48.1 acres on 21 sites under active construction.

There are 4.5 miles of freeway and 12 miles of major arterial roadways in the study area (Figure 4-8). Collector streets cover 92 miles while minor arterial roadways in the area total 20 miles. There are 0.08 miles of unpaved roads in the southeastern portion of the micro-inventory area.

Figure 4-5
Green Valley
Land Use Map

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Figure 4-6
Green Valley Study Area
Roadway Classifications

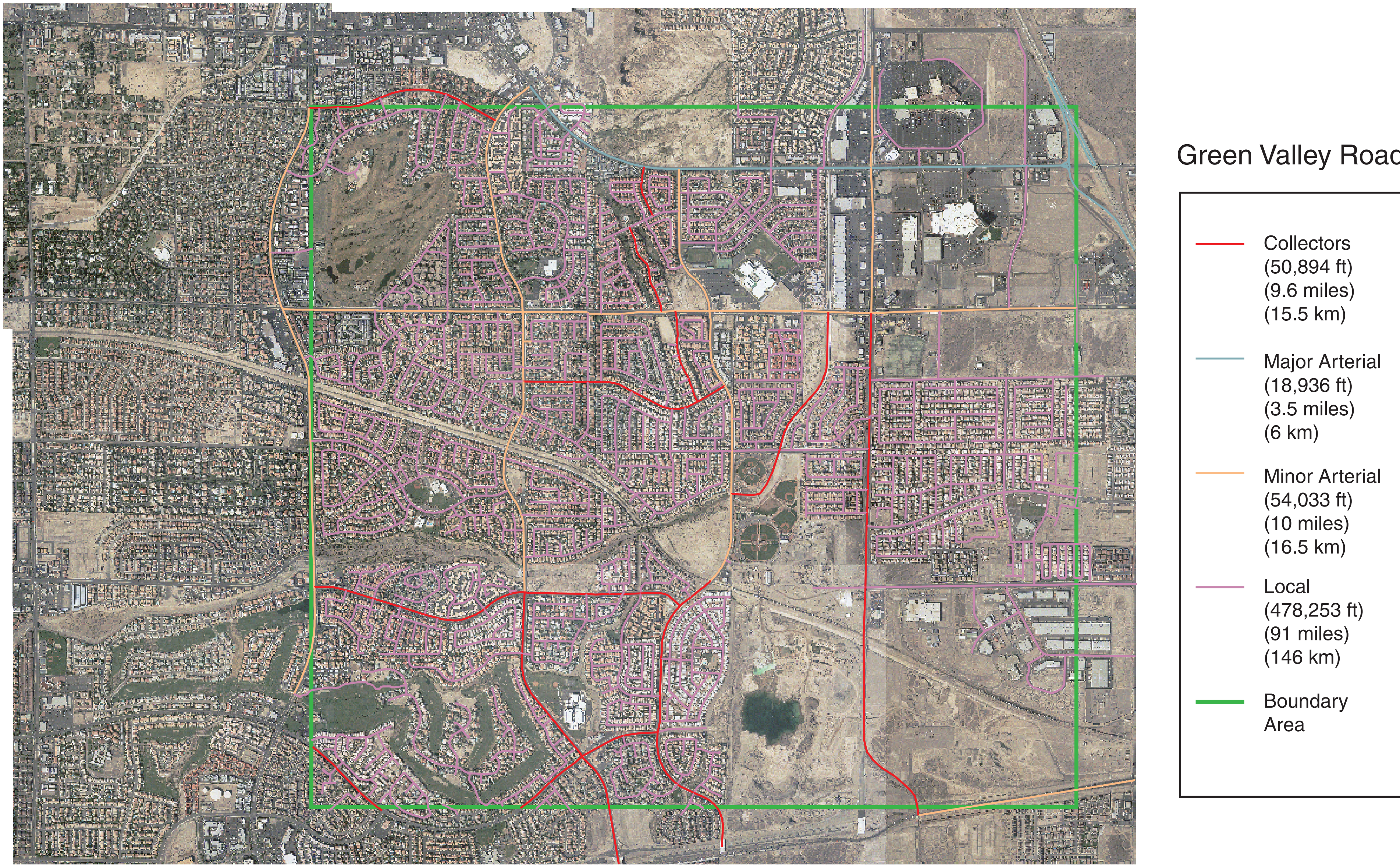

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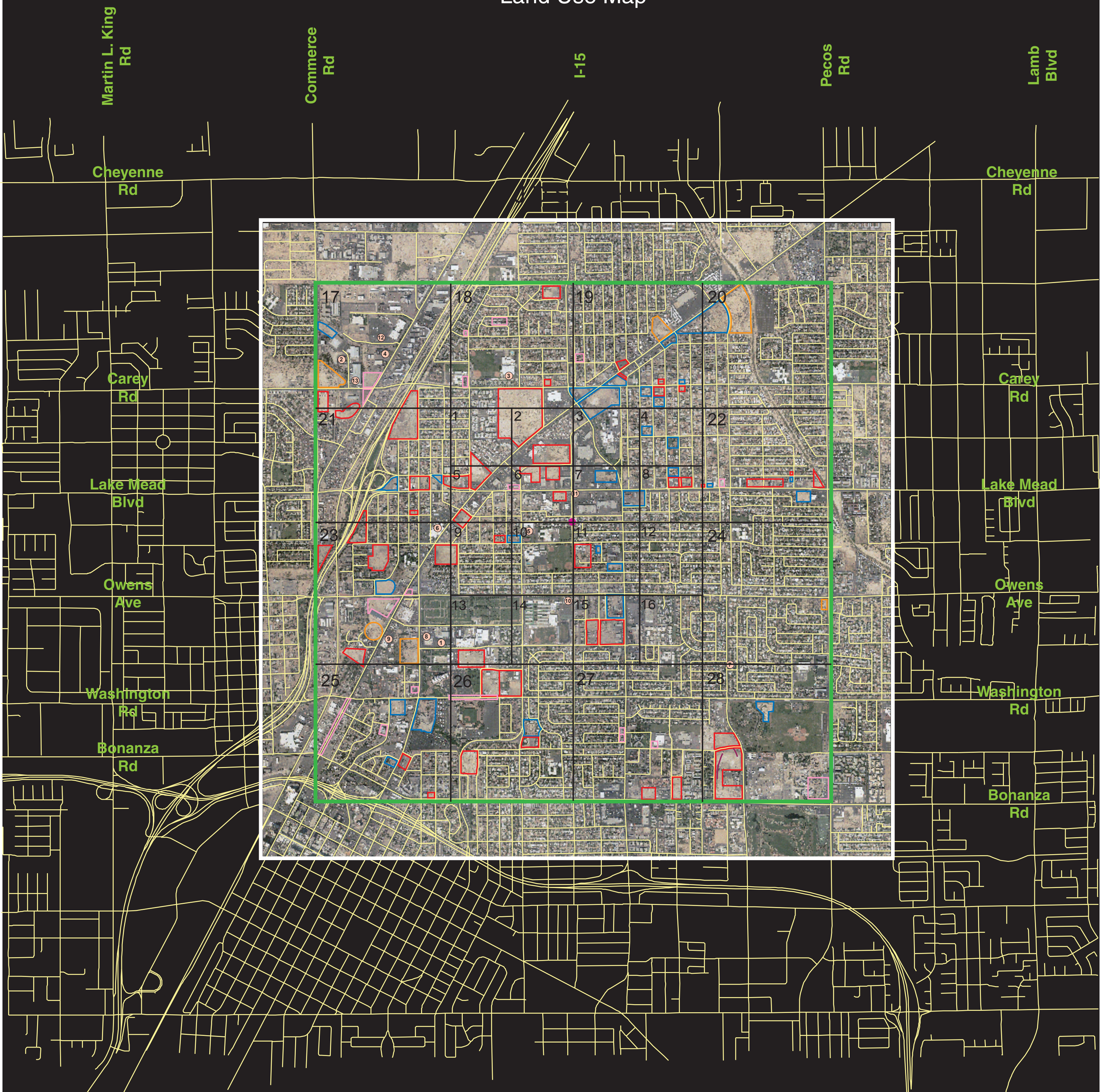
Figure 4-7
J.D. Smith
Land Use Map



1 Anderson Dairy Inc.
2 Allegis Pipe Co.
3 Bridger Junior High School
4 Hotel Linen Svc Inc.
5 J D Smith Middle School
6 Jerry's Nugget
7 Joe's Excavating
8 Mission Industries
9 Palm Mortuaries Cemeteries
10 Rancho High School
11 US Post Office
12 US Energy Dept.
13 Unitog Co.

Monitoring Station
Stable - Man Made
Stable - Native Environment
Unstable
Construction Lots
Boundary Area
Unpaved Road

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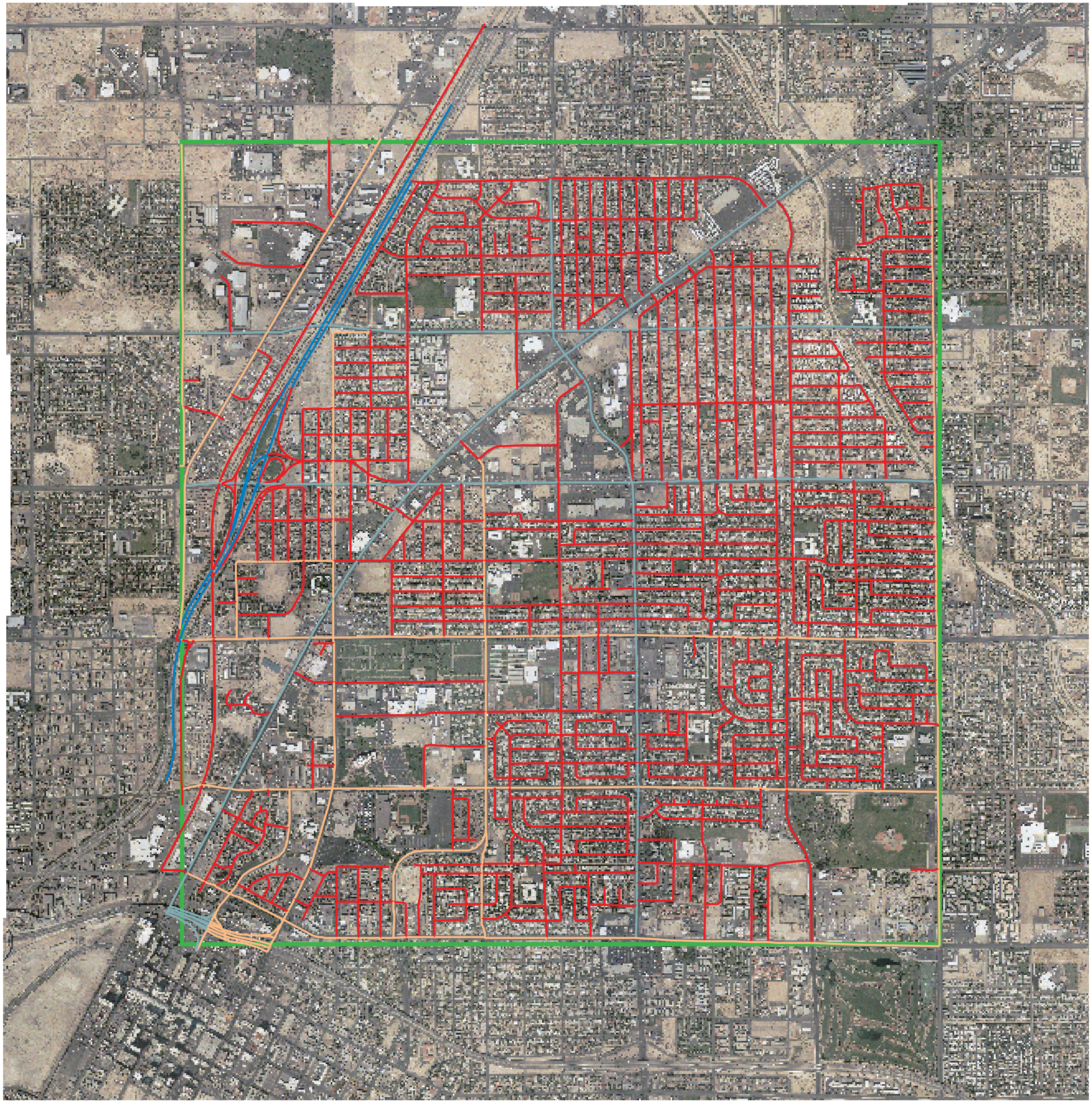
Figure 4-8
J.D. Smith Study Area
Roadway Classifications



J.D. Smith Roads

Collectors	(483,868 ft) (92 miles) (147 km)
Freeway	(23,861 ft) (4.5 miles) (7 km)
Major Arterial	(61,597 ft) (12 miles) (19 km)
Minor Arterial	(103,489 ft) (20 miles) (31.5 km)
Boundary Area	

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Twelve stationary sources were identified as having potential PM_{10} emissions. They are:

- Allegis Pipe Company;
- Bridger Junior High School;
- Hotel Linen Service Inc.;
- J. D. Smith Middle School;
- Jerry's Nugget;
- Joe's Excavating;
- Mission Industries;
- Palm Mortuaries Cemeteries;
- Rancho High School;
- U. S. Post Office
- U. S. Energy Department; and
- Unitog Company.

4.5 PITTMAN

As shown in Figure 4-9, the Pittman micro-inventory area has the greatest number of miles of unpaved roads of the five study areas. An enlarged copy of Figure 4-9 is presented in Appendix A.

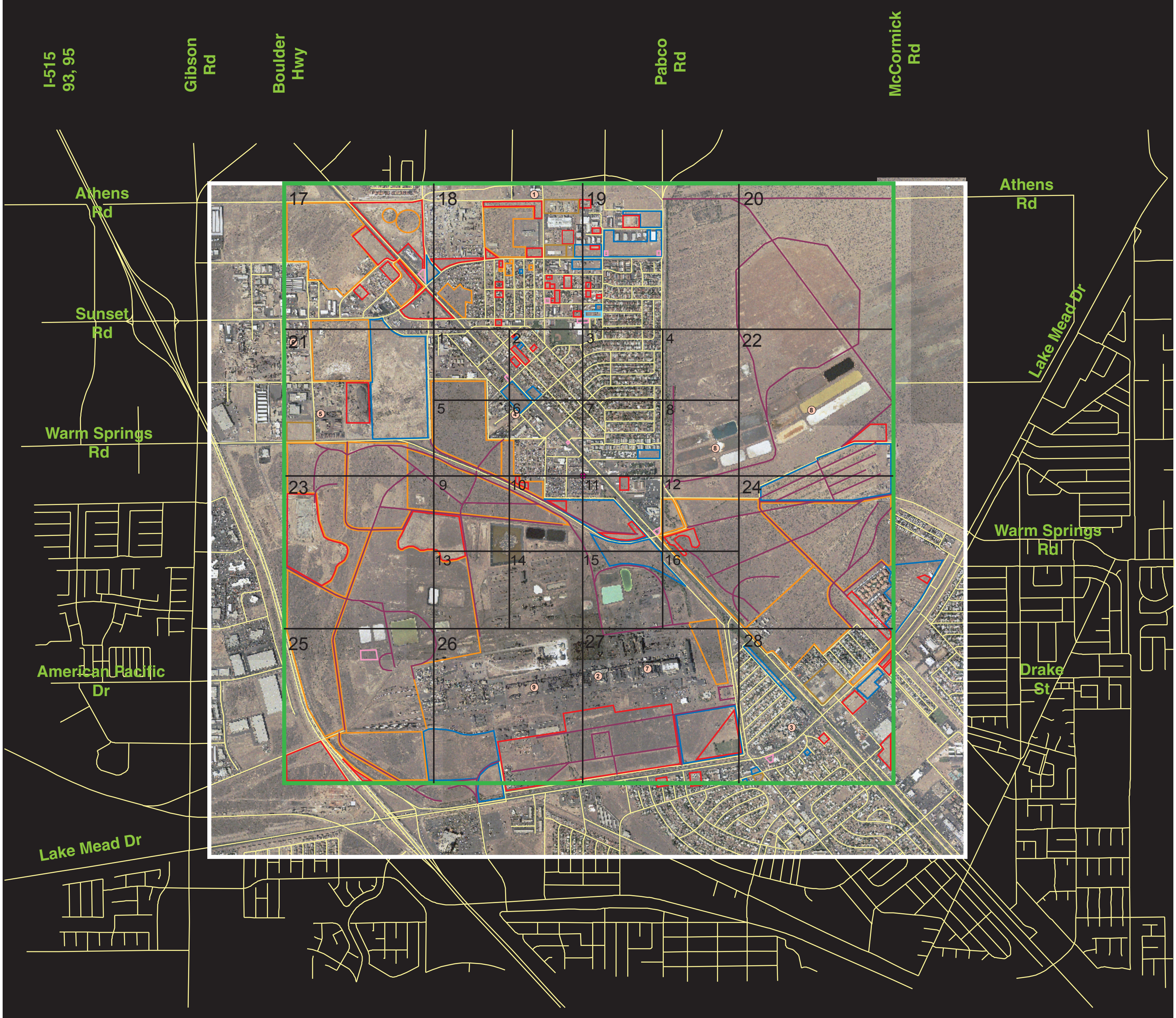
There are 13 miles of unpaved roads within the study area. Only 1.75 miles of freeway are located on the western edge of the micro-inventory area, as shown in Figure 4-10. Two minor arterial roadways total six miles, and there are 42.5 miles of collector streets.

There are 2,057 acres of vacant land: 346 acres are stabilized, 1,450 acres are native desert, and 261 acres are unstable. There are 11 identified parking areas covering 21 acres. Twelve sites totaling 29 acres were under active construction on March 30, 1999. There is one bike track in the area near an elementary school covering 0.61 acres.

Stationary sources with permits within a two-kilometer radius of the Pittman monitoring station are:

- Henderson City Animal Control;
- Chemical Lime Company;
- St. Rose Dominican Hospital;
- PMP (Pre-Mix Products) of Nevada;
- Monier LifeTile;
- Unifirst;
- Timet; and
- Timet Tailing Ponds.

Figure 4-9
Pittman
Land Use Map



1 Henderson City Animal Control
2 Chemical Lime Company
3 St. Rose Dominican Hospital
4 PMP (Pre-Mix Products) of Nevada
5 Monier LifeTile
6 Unifirst
7 Timet
8 Timet Tailing Ponds
9 Kerr McGee

- Monitoring Station
- Stable - Man Made
- Stable - Native Environment
- Unstable
- Construction Lots
- Boundary Area
- Bicycle Track
- Unpaved Road
- Parking

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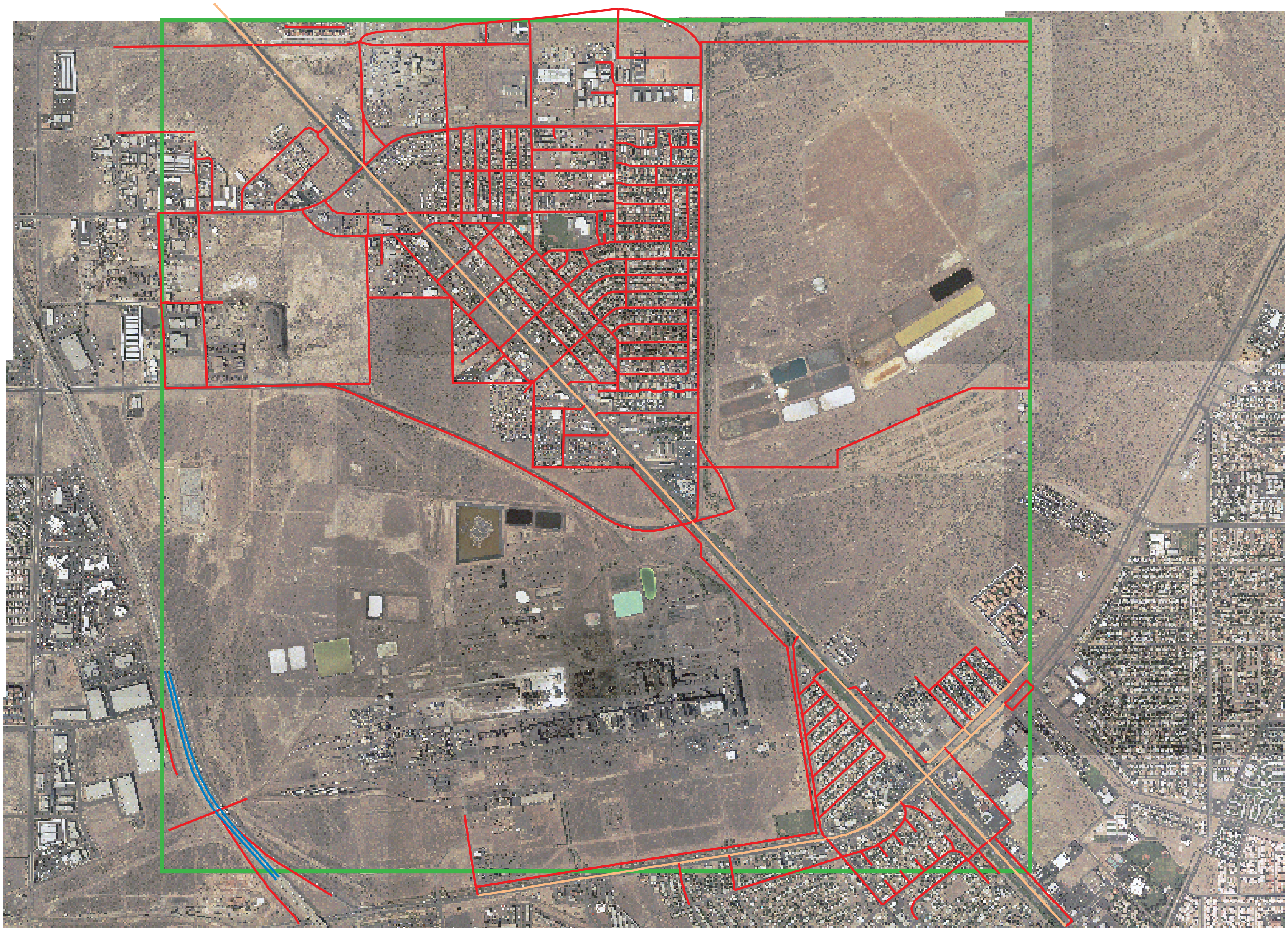
Figure 4-10
Pittman Study Area
Roadway Classifications



Pittman Roads

- Collectors (224,373 ft) (42.5 miles) (68 km)
- Freeway (9,318 ft) (1.75 miles) (3 km)
- Minor Arterial (30,992 ft) (6 miles) (9.5 km)
- Boundary Area

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5.0 EMISSION ACTIVITIES SURROUNDING THE AMBIENT MONITORING SITES

Potential sources were identified in Section 4.0 of this report. Some of the source activities vary from day to day, month to month, or year to year. Although located within the micro-inventory area, some sources may not have emissions on the design day. For most sources, the source contribution on the design day was considered average. The activity levels of the sources are described in detail below.

5.1 CRAIG ROAD

There were over 1,600 acres of vacant land within the Craig Road micro-inventory area. Wind speeds above 15 mph will entrain loose particles from vacant land. On the design day for this site, winds exceeded the threshold velocity for the re-entrainment of PM_{10} for six hours.

The average daily vehicle traffic counts within the study area were received from Clark County Comprehensive Planning (CCCP, 2000). The actual 1997 vehicle counts were extrapolated to 1999 using the growth rate calculated for the change from 1997 to 1998. The growth rate within the Craig Road study area was 11.5% per year. The vehicle miles traveled by roadway classification are presented in Table 5-1.

Table 5-1
Vehicle Miles Traveled in Craig Road Study Area

Roadway Classification	Vehicle Miles Traveled (VMT)
Collectors	454,208
Minor Arterial	215,445
Freeway	326,880

Two of the three unpaved parking sites in the Craig Road micro-inventory area are used for weekend swap meets. As the design day is a weekday, the number of vehicle miles traveled on these two lots was determined to be zero.

5.2 EAST FLAMINGO

Winds speeds above 15 mph will entrain PM_{10} into the air from vacant land. Wind speeds exceeded 15 mph for 16 hours on March 30, 1999, the design day for the East Flamingo monitoring station.

The average daily vehicle traffic counts within the study area were received from Clark County Comprehensive Planning (CCCP, 2000). The actual 1997 vehicle counts were extrapolated to 1999 using the growth rate calculated for the change from 1997 to 1998. The growth rate within the East Flamingo study area was 1.35 % per year, the lowest of any of the micro-inventory areas. The vehicle miles traveled by roadway classification are presented in Table 5-2.

Table 5-2
Vehicle Miles Traveled in East Flamingo Study Area

Roadway Classification	Vehicle Miles Traveled (VMT)
Collectors	220,013
Minor Arterial	225,788
Major Arterial	859,016

All of the stationary source emissions for the area were from permitted boilers. As the design day was a weekday, it was assumed the boilers operated under normal conditions.

5.3 GREEN VALLEY

The Green Valley micro-inventory area had the fewest number of stationary sources. All four reported normal operations on the design day.

There were over 350 acres under active construction on February 25, 1999 within two kilometers of the monitoring station. The number of acres under construction within the Green Valley study area were more than twice the number of acres under construction within any other study area.

Wind speeds averaged over 19 mph for the twenty-four hour period. As the actual number of hours winds exceeded 15 mph was not known, it was assumed winds exceeded the threshold wind velocity for a minimum of 12 hours. This would be a conservative estimate given the average wind speed for the day and the reported gusts over 40 mph.

The average daily vehicle traffic counts within the study area were received from Clark County Comprehensive Planning (CCCP, 2000). The actual 1997 vehicle counts were extrapolated to 1999 using the growth rate calculated for the change from 1997 to 1998. The growth rate within the Green Valley study area was 6.7% per year. The vehicle miles traveled by roadway classification are presented in Table 5-3.

Table 5-3
Vehicle Miles Traveled in Green Valley Study Area

Roadway Classification	Vehicle Miles Traveled (VMT)
Local	173,345
Collectors	76,766
Minor Arterial	263,052
Major Arterial	187,000

5.4 J. D. SMITH

Stationary sources within each study area were contacted to determine actual emissions for the design day. For March 31, 1999, Palm Mortuaries reported that they only used their crematorium for 4.5 hours. Therefore, the emissions for this source were calculated for 4.5 hours rather than for a full day of operation. All other stationary sources reported normal operations.

Wind speeds exceeded 15 mph for over 14 hours during the 24-hour period and peak wind gusts exceeded 50 mph. Unstable parcels in the area were relatively small, the largest measuring 22 acres.

Portions of the I-15 freeway as well as Las Vegas Boulevard are within the two-kilometer area surrounding the J. D. Smith monitoring station. The VMT data for the area was the highest of any of the micro-inventory areas, as presented in Table 5-4.

Table 5-4
Vehicle Miles Traveled in J. D. Smith Study Area

Roadway Classification	Vehicle Miles Traveled (VMT)
Collectors	536,555
Minor Arterial	1,223,017
Major Arterial	637,846
Freeway	351,900

The average daily vehicle traffic counts within the study area were received from Clark County Comprehensive Planning (CCCP, 2000). The actual 1997 vehicle counts were extrapolated to 1999 using the growth rate calculated for the change from 1997 to 1998. The growth rate within the J. D. Smith study area was 2.8 % per year.

5.5 PITTMAN

The Pittman study area has the largest number of acres of vacant land and the most miles of unpaved roads. More acres are used for unpaved parking as well. Winds exceeded the threshold wind velocity for PM_{10} for 9 hours during the 24-hour design day.

Several large stationary sources are in the Pittman study area. All the stationary sources were contacted regarding operations on March 30, 1999. Henderson Animal Control reported they did not operate their crematory furnace on the design day. All other stationary sources reported they operated as normal.

The average daily vehicle traffic counts within the study area were received from Clark County Comprehensive Planning (CCCP, 2000). The actual 1997 vehicle counts were extrapolated to 1999 using the growth rate calculated for the change from 1997 to 1998.

The growth rate within the Pittman study area was 25 % per year, the fastest growth rate of any of the study areas. The VMT for the area are presented in Table 5-5.

Table 5-5
Vehicle Miles Traveled in Pittman Study Area

Roadway Classification	Vehicle Miles Traveled (VMT)
Collectors	406,036
Minor Arterial	167,781
Freeway	79,743

6.1 VACANT LAND

Vacant land within a two-kilometer radius of each of the five monitoring stations was tested to determine if the soil was stable. As Clark County is considering a vacant land rule similar to a previously adopted rule in Maricopa County, Arizona, the stability test methods from the Maricopa County rule were used to access the stability of the parcels within each of the micro-inventory areas.

The Maricopa County test methods are presented in Appendix C of the county air quality regulations and referenced in Rule 310.01: Fugitive Dust from Open Areas, Vacant Lots, Unpaved Parking Lots, and Unpaved Roadways (Maricopa County, 1999). There are three tests used to evaluate a parcel: the ball drop, the threshold friction velocity, and the determination of vegetative cover.

For the ball drop test a steel ball with a diameter of 15.9 millimeters (0.625 inches) and a mass ranging from 16-17 grams is dropped from a height of 30 centimeters (1 foot) directly above the soil surface. If the falling ball neither creates a dent nor pulverizes the surface upon which the ball fell, the soil passes the ball drop test. Three tests were conducted within a one-foot square area on three randomly chosen survey areas of a parcel. The soil must pass two of the three individual ball drops and all three survey areas must pass for the parcel or portion of the parcel to be determined to be stabilized.

The micro-inventory study survey areas were chosen by facing away from a parcel and throwing a golf ball over one's shoulder. Where the golf ball landed was used as the center of the one-foot square area for the ball drop testing.

If a parcel or portion of a parcel failed the ball drop test, then the threshold friction velocity (TFV) was determined. The TFV was determined using the sieve analysis described in Appendix C of the Maricopa County regulations, which was based on W. S. Chepil's 1952 laboratory procedure. A set of sieves with 4 mm, 2 mm, 1 mm, 0.5 mm and 0.25 mm openings were stacked in order of the size opening with the largest size opening on top. A collector pan was placed under the bottom sieve.

A sample of loose material from a one-foot square area down to a depth of about 1 cm was collected using a brush and a dustpan. Rocks larger than 1 cm were removed from the sample. The sample was poured into the top sieve and the sieve unit covered with a lid. The covered sieve apparatus was then moved using a broad, circular motion in a horizontal plane. Twenty circular arm movements were completed: 10 in a clockwise direction and 10 in a counterclockwise direction. The sieve apparatus was moved just fast enough to achieve some relative horizontal motion between the sieves and the particles.

After the sieve apparatus was disassembled, each sieve and the collector pan were tilted slightly and gently tapped to align the material along one side. The sieves and the collector pan were lined up in a row and visibly inspected to determine the relative quantities of catch in each and the sieve or collector pan with the greatest volume of material. The correlation between sieve size and TFV is presented in Table 6-1 below.

Table 6-1
Determination of Threshold Friction Velocity

Sieve Opening (mm)	TFV (cm/s)
4	135
2	100
1	76
0.5	58
0.25	43
Collector Pan	30

Three random soil samples representing random portions of the overall conditions of a site were selected using the golf ball method described above. The results of the three samples were averaged together to determine the uncorrected TFV. The TFV was corrected for non-erodible elements if the uncorrected TFV average was below 100. Non-erodible elements are distinct elements, in the random portion of the overall conditions of a site, that are larger than 1 cm in diameter, remain firmly in place during a wind episode, and inhibit soil loss by consuming part of the shear stress of the wind. Non-erodible elements include stones and bulk surface material but do not include flat or standing vegetation.

For surfaces with non-erodible elements, three one-meter square areas representing a random portion of the overall conditions of the site were selected using the golf ball method. The non-erodible elements were divided into groups according to size. For each group, the overhead area for the non-erodible elements was calculated using the equations in Appendix C of the Maricopa County Air Quality Regulations. The results for the three samples were averaged. A correction factor was identified based upon the results of the non-erodible elements evaluation. Table 6-2 lists the correction factors. The TFV was multiplied by the corresponding correction factor to calculate the TFV corrected for non-erodible elements.

Table 6-2
Correction Factors for Threshold Friction Velocity

Percent Cover of Non-Erodible Elements	Correction Factor
Greater than or equal to 10%	5
Greater than or equal to 5% and less than 10%	3
Less than 5% and greater than or equal to 1%	2
Less than 1%	None

Sites with a TFV or corrected TFV greater than or equal to 100 were classified as stable. Sites with a lower TFV were evaluated for vegetation.

Two types of tests were conducted for vegetation counts. For flat vegetation a line transect method was performed. A 100-foot measuring tape was stretched across a random portion of the overall conditions of the site and firmly anchored. A 3/32-inch diameter wooden dowel was attached to the tape in one foot intervals. The number of times flat vegetation lay directly underneath the dowel was counted. The total number of times vegetation was counted represented the percentage of flat vegetation at the site. The line transect method was conducted three times at each site and the results averaged to determine the percentage of flat vegetation at the site. Sites with 50% or more of flat vegetation were considered stable.

For standing vegetative cover a survey area that represented a random portion of the overall conditions of the site in the shape of a square equal to at least 10 times the average height of the vegetation was marked off. For smaller standing vegetation, the survey area was three feet by three feet. The number of standing vegetative structures within the survey area were counted. If different types of vegetation and/or vegetation of different height and width existed in the survey area, the vegetative structures with similar dimensions were separated into groups. The number of vegetative structures in each group were counted. If the structure(s) was dense, the frontal silhouette area was calculated using the equations provided in Appendix C of the Maricopa County Air Quality Regulations. The average height and width of the vegetation in the survey area was also calculated. Then the percent cover of standing vegetation was calculated using the Maricopa County equations. Sites with greater than 30% standing vegetative cover were classified as stable.

6.1.1 Native Desert

To estimate wind erosion emissions from unpaved surfaces the University of Nevada Las Vegas (UNLV) was contracted by Clark County Comprehensive Planning (CCCP) to calculate geometric mean hourly emission rates from native desert and unstable soils within the Valley (UNLV, 2000a).

The result of the study provided PM_{10} emission factors dependent on varying wind speeds measured by UNLV's portable wind tunnel during the summer of 1995 for native desert and unstable land areas. The extrapolated emission factors accounted for vegetation cover. An initial "spike" was measured when wind speeds reach a level where particles were first measured. The mean hourly emission rates and spike values for native desert are presented in Table 6-3.

Table 6-3
Mean Hourly Emission Rates for Native Desert

Wind Speed (mph)	All Soils		Soil Group 2		Soil Group 3		Soil Group 5		Soil Group 6		Soil Group 7		Soil Group 8		Soil Group 9	
	Geometric Mean Flux (ton/acre/hr)	Geometric Mean Spike (ton/acre)	Geometric Mean Flux (ton/acre/hr)	Geometric Mean Spike (ton/acre)	Geometric Mean Flux (ton/acre/hr)	Geometric Mean Spike (ton/acre)	Geometric Mean Flux (ton/acre/hr)	Geometric Mean Spike (ton/acre)	Geometric Mean Flux (ton/acre/hr)	Geometric Mean Spike (ton/acre)	Geometric Mean Flux (ton/acre/hr)	Geometric Mean Spike (ton/acre)	Geometric Mean Flux (ton/acre/hr)	Geometric Mean Spike (ton/acre)	Geometric Mean Flux (ton/acre/hr)	Geometric Mean Spike (ton/acre)
10-14.9			N/A	N/A												
15-19.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.95E-03	4.00E-04	N/A	N/A
20-24.9	N/A	N/A	4.65E-04	5.53E-05	N/A	N/A	N/A	N/A	1.61E-03	6.56E-05	N/A	N/A	1.06E-02	2.64E-03	N/A	N/A
25-29.9	1.61E-03	3.61E-04	1.52E-03	1.34E-04	5.16E-04	N/A	2.52E-03	6.32E-04	7.25E-03	1.42E-03	N/A	N/A	N/A	N/A	1.61E-03	3.61E-04
30-34.9	3.01E-03	4.68E-04	2.48E-03	5.46E-04	N/A	N/A	2.15E-03	5.66E-04	1.69E-02	2.11E-03	1.43E-03	1.88E-04	6.33E-03	6.40E-04	3.01E-03	4.68E-04
35-39.9	3.18E-03	8.15E-04	2.45E-03	1.04E-03	N/A	N/A	2.66E-03	7.48E-04	4.78E-03	2.15E-03	2.41E-03	3.79E-04	3.44E-03	1.21E-03	3.18E-03	8.15E-04
40-44.9	8.47E-03	1.64E-03	6.48E-03	1.87E-03	1.91E-03	5.13E-04	7.18E-03	3.49E-03	3.63E-03	9.28E-04	5.90E-03	1.25E-03	4.81E-03	1.41E-03	8.47E-03	1.64E-03
45-49.9	8.78E-03	2.48E-03	7.18E-03	2.25E-03	5.68E-03	1.45E-03	8.69E-03	2.38E-03	9.08E-03	4.20E-03	1.03E-02	2.19E-03	3.26E-03	4.15E-03	8.78E-03	2.48E-03
50-54.9	1.03E-02	1.79E-03	1.24E-02	3.19E-03	7.46E-03	3.52E-03	1.32E-02	3.52E-03	7.78E-03	1.48E-03	1.43E-02	1.50E-03	N/A	N/A	1.03E-02	1.79E-03

The emission rates vary by soil type (U.S. Department of Agriculture, 1985). The native desert was classified by soil type before the emission factors were applied. If an emission factor was not available for a given soil type, the factor for all soils was used. Because the native desert parcels have a limited PM_{10} reservoir, it was assumed the reservoir would be depleted within one hour of sustained winds above the "spike" wind speed. Therefore, only one hour of emissions was calculated during each 24-hour design day for native desert parcels. The "spike" mass was added to the mass calculated using the mean hourly emission factors. The "spike" mass was also added for recorded wind gusts.

6.1.2 Unstable Vacant Land

The emission factors for unstable land were determined using the same methods as for native desert. The emission factors developed by UNLV for unstable land are presented in Table 6-4.

Again the unstable land was classified by soil type and the appropriate emission factor applied. The all soils emission factor was used when specific soil type factors were not available. Unlike the native desert, a limited reservoir was not assumed for unstable land parcels. For every hour the sustained wind speeds were within a given wind speed category above the "spike" wind speed, the emissions were calculated. A single "spike" mass was added for each acre assuming the design day represented a single wind event and reservoir recharging would not have occurred during the 24-hour period. A single "spike" mass was also added for recorded wind gusts. Wind speeds less than the "spike" speed do not contribute to PM_{10} emissions from natural wind erosion and are eliminated from emission calculations.

6.1.3 Stabilized Vacant Land

The third category of vacant land was stabilized. This designation was given to parcels which were no longer native desert and had been determined to be stable using the methodology previously described. The emission factors for this category were also developed by UNLV using data from a 1998-1999 wind tunnel study (UNLV, 2000b).

The same wind tunnel methodology used to measure emissions from native desert and unstable parcels was used to estimate emissions from nine dust suppressants including water. The average emission factor at a given wind speed was used to calculate the emissions from the stabilized parcels. Spikes were generally not observed from the stabilized parcels and were not included in the emission calculations. The factors used for stabilized parcels are presented in Table 6-5.

Table 6-4
Mean Hourly Emission Rates for Unstable Land

Wind Speed (mph)	All Soils		Soil Group 2		Soil Group 3		Soil Group 5		Soil Group 6		Soil Group 7		Soil Group 8		Soil Group 9	
	Geometric Mean Flux (ton/acre/hr)	Geometric Mean Spike (ton/acre)	Geometric Mean Flux (ton/acre/hr)	Geometric Mean Spike (ton/acre)	Geometric Mean Flux (ton/acre/hr)	Geometric Mean Spike (ton/acre)	Geometric Mean Flux (ton/acre/hr)	Geometric Mean Spike (ton/acre)	Geometric Mean Flux (ton/acre/hr)	Geometric Mean Spike (ton/acre)	Geometric Mean Flux (ton/acre/hr)	Geometric Mean Spike (ton/acre)	Geometric Mean Flux (ton/acre/hr)	Geometric Mean Spike (ton/acre)	Geometric Mean Flux (ton/acre/hr)	Geometric Mean Spike (ton/acre)
10-14.9	N/A	N/A	N/A	N/A									N/A	N/A		
15-19.9	4.95E-03	9.65E-04	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
20-24.9	5.21E-03	8.16E-04	N/A	N/A	N/A	N/A	4.26E-03	2.67E-03	N/A	N/A	N/A	N/A	1.62E-03	1.10E-04	1.75E-02	3.06E-03
25-29.9	6.40E-03	1.94E-03	N/A	N/A	N/A	N/A	2.72E-02	1.19E-02	N/A	N/A	N/A	N/A	3.00E-03	3.34E-04	N/A	N/A
30-34.9	4.62E-03	1.41E-03	4.12E-03	8.28E-04	1.36E-03	6.59E-04	7.23E-02	2.67E-02	N/A	N/A	N/A	N/A	3.75E-03	N/A	4.57E-02	1.30E-02
35-39.9	7.05E-03	3.80E-03	2.81E-03	8.63E-04	5.42E-03	1.49E-03	1.95E-02	5.93E-03	N/A	N/A	N/A	N/A	1.21E-02	2.36E-03	N/A	N/A
40-44.9	1.13E-02	3.45E-03	2.80E-03	1.37E-03	N/A	N/A	7.99E-03	3.37E-03	N/A	N/A	N/A	N/A	3.96E-03	1.58E-03	3.40E-01	3.87E-02
45-49.9	7.12E-03	4.50E-03	7.27E-03	2.33E-03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.44E-02	4.79E-03	5.08E-02	6.25E-03
50-54.9	3.69E-03	1.30E-03	2.13E-03	1.82E-03	N/A	N/A	2.33E-02	6.95E-03	N/A	N/A	N/A	N/A	8.26E-02	1.15E-02	N/A	N/A

Table 6-5
Mean Hourly Emission Rates for Stabilized Land

Wind Speed (mph)	Geometric Mean Flux (ton/acre/hour)
15 – 19.9	4.2 E-4
20 – 24.9	3.4 E-4
25 – 29.9	1.9 E-4

As with native desert, it was assumed that the stabilized parcels have a limited PM_{10} reservoir that would be depleted within one hour of sustained winds above the threshold wind velocity. Therefore only one hour of emissions was calculated during each 24-hour design day for stabilized parcels.

6.2 CONSTRUCTION SITES

Three specific activities potentially produce PM_{10} from construction operations. They are:

- the construction activities themselves (i.e. grading, trenching, crushing, screening);
- increased on-road paved road dust emissions due to track-out from the construction site onto the adjacent paved street network; and
- wind erosion over construction areas.

Wind erosion was calculated using the emission factors and methodology for unstable land described in section 6.1.2 of this document. Emission factors for each of the other two activities are described below.

6.2.1 Construction Activities

A Best Available Control Measure (BACM) report on construction activities completed by Midwest Research Institute (MRI) recommends up to five different levels of uncontrolled PM_{10} emission estimates methods for construction activities (MRI, 1996). Each level of emission estimate varied based on the amount of valid data known about each construction project. The emission estimates derived by MRI were from on-site evaluation of construction operations within four of the serious PM_{10} non-attainment areas: Las Vegas, NV; Coachella Valley, CA; South Coast, CA; and San Joaquin Valley, CA.

For the construction sites in the micro-inventory areas on the design days, the available information from the CCAQD construction activities permits data base included the type of construction project and the number of acres. For construction sites where only the amount of land involved and the type of construction project is known, two emission factors were provided. For general construction sites which do not include any cut and fill areas, large-scale earthmoving operations, or heavy traffic volumes, an emission factor of 0.011 tons/acre/month would apply. For general construction sites which do include cut and fill areas, large-scale earthmoving operations, or heavy traffic volumes, an emission factor of 0.42 tons/acre/month would apply.

CCHD enforcement officers provided information as to which types of construction operations within the Las Vegas Valley usually include cut and fill areas, large-scale earthmoving activities, and/or heavy traffic volumes. In general, all airport, flood detention, highway, public works, and underground utility operations include either cut and fill areas, large-scale earthmoving activities, and/or heavy traffic volumes. Therefore an emission factor of 0.42 tons/acre/month was assigned to those types of construction projects.

The remaining types of construction projects, including commercial, public parks, public buildings, and residential homes sometimes include cut and fill areas, large-scale earthmoving activities, and/or heavy traffic volumes and other times do not. Therefore, an average emission factor of 0.265 tons/acre/month (0.11 plus 0.42 divided by two) was used to account for this variation.

To convert from the monthly emission factors developed by MRI, the number of days in the month in which the design day occurred was used. For example, if the design day occurred in March, the emission factor was divided by 31 because March has 31 days.

The emission factors developed by MRI are uncontrolled values, meaning no soil stabilization was assumed to occur. The CCHD regulations require the control of PM_{10} emissions at construction sites. Dust control at construction sites is usually implemented using water. The U.S. EPA assigns a 50% control efficiency to watering for control of particulate emissions from construction sites (EPA, 1988). The CCHD enforcement officers also provided compliance rates for each type of construction activity as shown in Table 6-6.

Table 6-6
Dust Mitigation Compliance Rate by Construction Type

Type of Construction	Percentage of Sites Implementing Controls (50% Reduction)
Airport	80%
Commercial	50%
Flood Detention	70%
Highway	80%
Public Parks	80%
Public Bridges	70%
Public Works	70%
Residential Homes	50%
Underground Utilities	20%
Miscellaneous	80%

6.2.2 Track-out

To estimate the emissions from track-out, each construction site access point PM_{10} emission increase is estimated as:

$$\Delta E = [0.016\ (3.29sL/2)^{0.65}(W/3)^{1.5}\ VMT$$

where:

ΔE = increase in PM_{10} emissions (pounds per day);
0.016 = base emission factor for PM_{10};
3.29 = the silt loading increase on adjacent road from construction site track-out (g/VMT);
sL = road surface silt loading (grams per square meter);
W = average weight (tons) of the vehicles traveling the adjacent road; and
VMT = number of vehicle miles traveled on adjacent road through track-out area.

The location of active construction sites on the design day for each area was determined by reviewing the construction activities permits that had been issued by Clark County Health District (CCHD) Air Quality Division (CCAQD). The CCAQD staff estimated the average number of access points per site based upon the type of construction being completed. These estimates are presented in Table 6-7.

Table 6-7
Average Number of Access Points by Construction Type

Type of Construction	Average Number of Access Points
Airport	1 per 30 acres
Commercial	1 per 10 acres
Flood Detention	1 per 30 acres
Highway	1 per 10 acres
Public Parks	1 per 10 acres
Public Buildings	1 per 10 acres
Public Works	1 per 30 acres
Residential Homes	1 per 10 acres
Underground Utilities	0 access
Miscellaneous	1 per 10 acres

As the 3.29 factor was determined by measuring the silt loading increase from sites with track-out control measures in place, additional control efficiency factors were not applied. The 3.29 factor was developed by direct silt loading measurements taken before and after construction traffic egress points (Dames & Moore, 1999).

The daily traffic counts on adjacent streets were provided by Clark County Comprehensive Planning. The track-out distance used was 150 feet, as this is the distance the over which the track-out silt loading increase was measured. The mean vehicle weight value of three tons was used as developed in the Particulate Matter (PM_{10}) Attainment Demonstration Plan (Clark County,1997).

6.3 UNPAVED ROAD DUST

The AP-42 equation for calculating PM_{10} emissions from unpaved roads is:

$$E = \frac{2.6(s/12)^{0.8}(W/3)^{0.4}}{(M/0.2)^{0.3}}$$

where:

E = site-specific emission factor (lb/VMT);
s = surface material silt content (%);
W = mean vehicle weight (tons); and
M = surface material moisture content (%).

Grab samples from unpaved roads within the Las Vegas Valley were analyzed for silt content by Desert Research Institute in 1996 (DRI, 1996). The average silt content measured for unpaved roads was about 16 percent. The mean vehicle weight used in Clark County is three tons (Clark County, 1997).

The surface material moisture content was not directly measured for any of the design days. Total reported rain for January through March of 1999 was 0.08 inches. With average daily temperatures above 60°F, it is reasonable to assume that uncontrolled unpaved roads would have low moisture contents. The range for moisture contents from AP-42 is 0.03- 20 percent with 0.2 percent presented as a dry, worst-case condition. For the micro-inventory design day calculations, the dry, worst-case condition default of 0.2 percent was used.

Incorporating the values for s, W and M in the equation for unpaved roads, the emission factor becomes E = 3.27 lb/VMT. The average number of vehicles per day on unpaved roads during the year 1999 was estimated at 30 in the Particulate Attainment Plan (Clark County, 1997).

6.4 PAVED ROAD DUST

The AP-42 equation for calculating PM_{10} emissions from re-entrained paved road dust is:

$$E = 0.016(sL/2)^{0.65}(W/3)^{1.5}$$

where:

E = particulate emission factor (lb/VMT);
sL = road surface silt loading (g/m^2); and
W = Average weight (tons) of the vehicles traveling the road.

The average weight of the vehicles traveling the road was established by Clark County in the 1997 Particulate Matter (PM_{10}) Attainment Demonstration Plan as three tons. The road surface silt loading factor varies depending on the type of roadway.

In the fall of 1999, road surface silt loading measurements were conducted by Dames & Moore (Dames & Moore, 1999). Dames & Moore used the method prescribed in AP-42, Appendix C.1 (EPA, 1993). The silt loading measurements are presented in Table 6-8.

Table 6-8
Paved Road Silt Loading Measurements by Road Type (g/m^2)

Roadway Category	Category Definitions	AP-42 Methodology Silt Loadings
Local	Two lanes with 500 cars or fewer in a day	1.7 +/- 0.6
Collector	Two lanes with 501 to 10,000 cars per day	0.86 +/- 0.03
Minor Arterial	Four or more lanes with a car count of 10,001 to 30,000 cars per day	1.0 +/- 0.7
Major Arterial	Four or more lanes with a car count of 30,001 to 150,000 cars per day	0.5 +/- 0.2
Freeway	Four of more lanes with a car count of at least 150,000 cars per day	

Incorporating the value of three tons for W into the re-entrained paved road dust emission equation, the equation becomes:

$$E = 0.016(sL/2)^{0.65}$$

6.5 UNPAVED PARKING

There are several areas near roadways where vendors park to sell wares or where vehicles pull over for a short period of time. These areas have been indicated on the land use maps as parking areas.

Emissions of PM_{10} from these parcels occur either from wind erosion or from vehicles travelling across them. Wind erosion was calculated using the emission factors and methodology for unstable land described in section 6.1.2 of this document. The PM_{10} emissions from vehicle travel over the soil was calculated as from an unpaved road.

The AP-42 equation for calculating PM_{10} emissions from unpaved roads is:

$$E = \frac{2.6(s/12)^{0.8}(W/3)^{0.4}}{(M/0.2)^{0.3}}$$

where:

E = site-specific emission factor (lb/VMT);
s = surface material silt content (%);
W = mean vehicle weight (tons); and
M = surface material moisture content (%).

The average surface material silt content for the Las Vegas Valley is 12 percent (Ad Hoc Committee on PM_{10} Offset Funding). The mean vehicle weight used in Clark County is three tons (Clark County, 1997).

The surface material moisture content was not directly measured for any of the design days. Total reported rain for January through March of 1999 was 0.08 inches. With average daily temperatures above 60°F, it is reasonable to assume uncontrolled unpaved roads would have low moisture contents. The range for moisture contents from AP-42 is 0.03- 20 percent with 0.2 percent presented as a dry, worst-case condition. For the micro-inventory design day calculations, the dry, worst-case condition default of 0.2 percent was used.

Incorporating the values for s, W and M in the equation for unpaved roads, the emission factor becomes E = 2.6 lb/VMT for the parking areas. The average number of vehicles per day on unpaved roads during the year 1999 was estimated at 30 in the Particulate Attainment Plan (Clark County, 1997). Assuming 30 vehicles travel the longest linear dimension of a parking parcel (i.e. the length) the vehicle miles traveled was calculated for each parking area.

6.6 RACE TRACKS

There are some areas where tires have been placed and regular off-road motorcycle racing takes place. Emissions of PM_{10} from these parcels occur either from wind erosion or from the motorcycles travelling across them. Wind erosion was calculated using the emission factors and methodology for unstable land described in section 6.1.2 of this document. Again the EPA emission equation for unpaved roadways was used to estimate emissions from this land use.

The AP-42 equation for calculating PM_{10} emissions from unpaved roads is:

$$E = \frac{2.6(s/12)^{0.8}(W/3)^{0.4}}{(M/0.2)^{0.3}}$$

where:

E = site-specific emission factor (lb/VMT);
s = surface material silt content (%);
W = mean vehicle weight (tons); and
M = surface material moisture content (%).

The average surface material silt content for the Las Vegas Valley is 12 percent (Ad Hoc Committee on PM_{10} Offset Funding). The mean vehicle weight for motorcycles is 0.075 tons.

The surface material moisture content was not directly measured for any of the design days. Total reported rain for January through March of 1999 was 0.08 inches. With average daily temperatures above 60°F, it is reasonable to assume uncontrolled unpaved roads would have low moisture contents. The range for moisture contents from AP-42 is 0.03- 20 percent with 0.2 percent presented as a dry, worst-case condition. For the micro-inventory design day calculations, the dry, worst-case condition default of 0.2 percent was used.

Incorporating the values for s, W and M in the equation for unpaved roads, the emission factor becomes E = 0.594 lb/VMT for motorcycle racing. The average number of vehicles per day on unpaved roads during the year 1999 was estimated at 30 in the Particulate Attainment Plan (Clark County, 1997).

Assuming 30 motorcycles per day cover the race "course" in each area, the VMT was calculated for these sites. The square area of the site was divided by two, as not all of the area was covered by tracks. The average width of a motorcycle track was assumed to be three feet. By dividing half the site area by three feet, the linear miles traveled was calculated.

6.7 VEHICLE EXHAUST, BRAKE AND TIRE WEAR

To calculate PM_{10} emissions from vehicles, either from direct vehicle exhaust from fuel combustion or from brake and tire wear, the following information for the micro-inventory areas was required:

- the length of each individual roadway segment;
- the average daily traffic (ADT) for each roadway segment;
- the functional classification of each roadway segment; and
- the PM_{10} emission rates for brake wear, tire wear, and vehicle exhaust by roadway functional classification.

The length of each individual roadway segment and the functional classification of each roadway segment for each micro-inventory area was presented in Section 4.0 of this report. The ADT for each roadway segment was presented in Section 5.0 of this report by micro-inventory area.

The PM_{10} emission factors as well as the SO_4 and NO_x emission factors from motor vehicles were developed by Clark County Comprehensive Planning by roadway functional classification. The factors are in grams/mile and summarized in Table 6-9.

Table 6-9
Mobile Source Emission Factors for 1999 (g/mile)

Emission Category	Local	Collectors	Minor Arterial	Major Arterial and Freeway
Exhaust PM (includes direct SO_4)	0.064	0.064	0.065	0.065
Brake Wear	0.013	0.013	0.013	0.013
Tire Wear	0.009	0.009	0.009	0.009
Direct SO_4	0.010	0.011	0.011	0.011
Indirect SO_4	0.033	0.033	0.032	0.032
NO_x (winter)	2.016	2.058	2.110	2.294

The total VMT for each roadway category was calculated by multiplying the roadway length by the ADT. The VMT was then multiplied by the appropriate emission factor provided in Table 6-8 to calculate the PM, SO_4, and NO_x emissions. As all design days occur in winter months, the winter NO_x emissions were included. Although SO_4, and NO_x are not emitted directly as PM_{10}, these compounds can form secondary PM_{10} and have been included in the inventory.

6.8 STATIONARY SOURCES

To estimate the emissions from stationary sources, the following information for each micro-inventory areas was required:

- the location of each stationary source;
- the operating schedule of the source on the designated design day; and
- the hourly or daily emission rate for the source.

The location of stationary sources within each micro-inventory area is presented in Section 4.0 of this report. The operating schedule of any source that was determined to not be operating on a normal schedule for that source on the designated design day is presented in Section 5.0 of this report.

The U.S. EPA requires that stationary source emission inventories must include all point sources that emit or have the potential to emit at least 70 tons per year of PM_{10} (EPA, 1994). The CCAQD requires all stationary sources with the potential to emit one ton per year of PM_{10} or SO_2; or two tons per year of NO_x, to obtain a permit (CCAQD, 1998). Within the CCAQD permits for stationary sources, either an hourly or daily emission limit for each compound is specified. Emissions from stationary sources within the micro-inventory area were assumed to be equal to the established permit limits.

7.0 PM_{10} EMISSION INVENTORY RESULTS

7.1 BACKGROUND CONCENTRATIONS

To determine the background concentration on each of the design days, the PM_{10} concentration measured at each of the monitoring stations was reviewed to determine the lowest measured concentration in the area. Table 7-1 presents the measured concentrations at each of the ambient monitoring stations in the CCAQD network for the design days.

Table 7-1
Measured PM_{10} Concentrations on Design Days

Monitoring Station	Measured PM_{10} Concentration ($\mu g/m^3$)			
	1/20/99	2/25/99	3/30/99	3/31/99
Apex	69	85	351	105
Boulder City	41	50	40	76
City Center	73	69	110	183
Craig Road	254	202	261	442
East Sahara	66	74	64	108
Flamingo	163	-	189	150
Green Valley	-	281	358	200
J. D. Smith	79	78	123	218
Jean	24	16	35	56
Lone Mountain	97	53	49	57
Pittman	138	260	239	217
Palo Verde	-	48	89	109
Microscale	66	73	81	127
S. E. Valley	64	73	73	115
Spring Valley	-	75	50	60
Walter Johnson	66	43	44	42

When the lowest concentration had been determined, the wind roses for the design day were reviewed to ensure the minimum measurement had occurred at a station upwind of the representative stations. Based upon the results of the evaluation the following background concentrations were used.

Figure 7-1
Emission Inventory Grid Structure

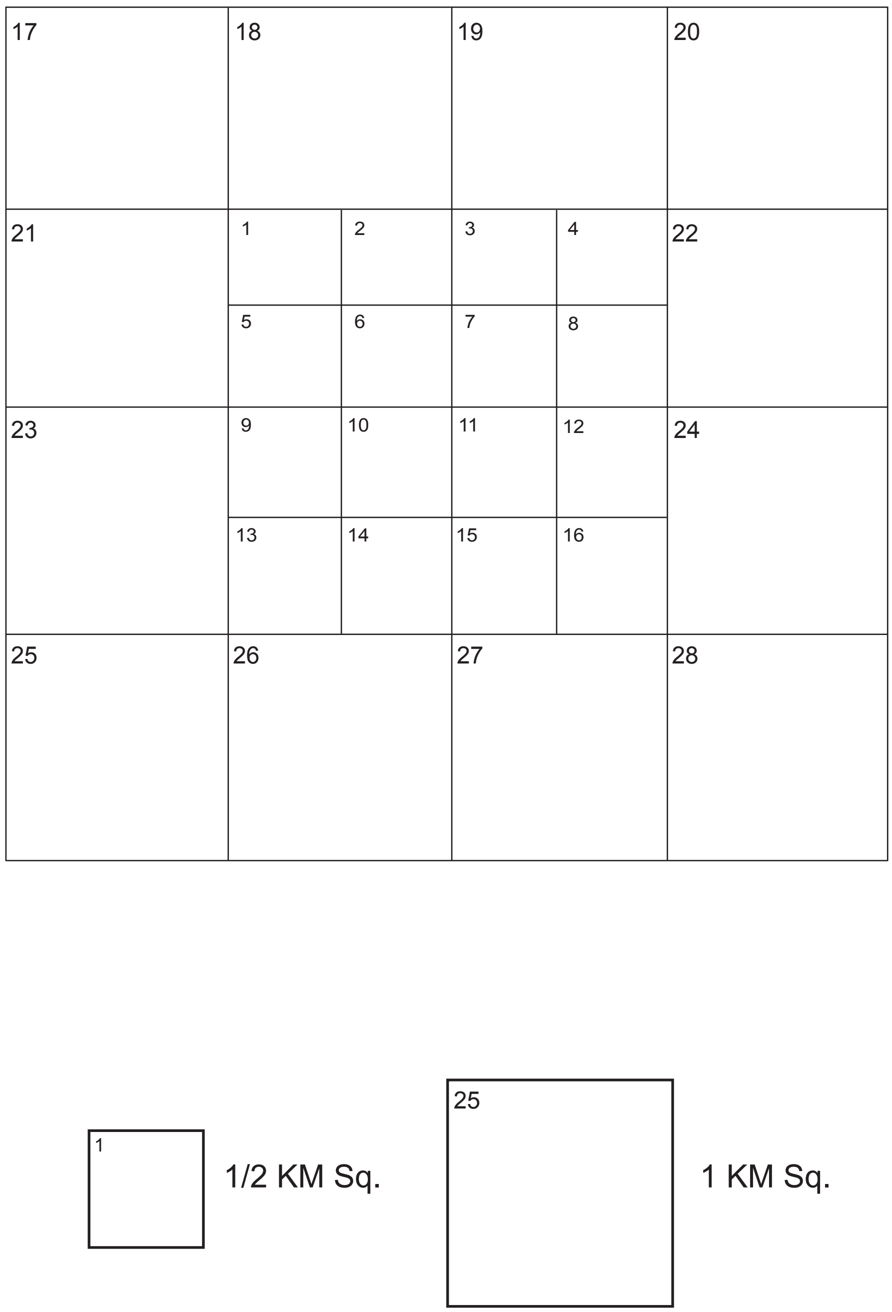

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Table 7-2
Background Concentrations

Monitoring Station	Design Day	Background Concentration (mg/m^3)
Craig Road	January 20, 1999	24
East Flamingo	March 30,1999	35
Green Valley	February 25, 1999	16
J. D. Smith	March 31, 1999	42
Pittman	March 30, 1999	35

The lowest concentration measured on each of the design days was at the Jean monitoring station, with the exception of March 31, 1999. On March 31, 1999 the lowest concentration was measured at the Walter Johnson monitoring site. Available meteorological data show winds generally out of the south or west on the design days. The Jean station is south, southwest of the Las Vegas Valley and the Walter Johnson monitor is on the west side of Las Vegas. Each of these stations was located upwind of the five representative stations on the respective design days.

7.2 GRID STRUCTURE

The 4-square kilometer area centered on the monitoring station for each of the micro-inventories was divided into smaller grids. Within a one-kilometer radius surrounding each station the grid was divided into ½ kilometer squares. Between one kilometer and two kilometers from the monitoring station the area was divided into squares measuring one kilometer on each side. Figure 7-1 shows the grid structure.

For referencing, the grid squares were numbered. The numbering system is shown in Figure 7-1. The smaller grid squares were numbered west to east and north to south. The larger grid squares were numbered in the same order consecutively after the smaller squares. A grid overlay has been provided for each of the land use maps in Section 4.0. By placing the center point of the grid on the monitoring station of the land use map, the sources within each grid square can be identified.

The spatial distribution of the sources is important to demonstrate that each of the monitoring stations are representative of the Las Vegas Valley and impacts measured at a monitor are not dominated by a nearby large source of PM_{10}. If the emissions of PM_{10} are not evenly distributed throughout the micro-inventory area, the influence of a source or source category can be evaluated.

7.3 CRAIG ROAD

The PM_{10} emission inventory for sources within a two-kilometer radius of the Craig Road monitoring station is presented in Table 7-3.

Table 7-3
Craig Road Monitoring Station PM_{10} Emission Inventory

Source Category	Emissions (tons)	Percent Contribution
Vacant Land	10.39	48.96
Native Desert	5.57	26.24
Unstable	4.32	20.36
Stabilized	0.5	2.36
Construction	3.43	16.16
Wind Erosion	2.72	12.82
Construction Activities	0.68	3.20
Track Out	0.03	0.14
Unpaved Road Dust	0.14	0.66
Paved Road Dust	3.98	18.75
Unpaved Parking	0.514	2.42
Wind Erosion	0.51	2.40
Vehicles	0.004	0.02
Race Tracks	2.43	11.45
Wind Erosion	1.71	8.06
Vehicles	0.72	3.39
Vehicles		
PM_{10}	0.1	0.47
SOx	0.05	
NOx	2.36	
Stationary Sources		
PM_{10}	0.24	1.13
SOx	0.0004	
NOx	0.0583	
Total		
PM_{10}	21.22	
SOx	0.0504	
NOx	2.418	

Almost 50 percent of the emissions were from wind erosion of vacant land. Re-entrained dust from paved roads was a distant second. Construction emissions were dominated by wind erosion as were emissions from race tracks and unpaved parking. Wind erosion emissions from all sources contributed over 70 percent of the total inventory.

The emissions by grid square are presented in Table 7-4. Emissions appear to be relatively evenly distributed except for the area northwest of the monitor. The most northwest grid cell (17) is dominated by a golf course. This area contributes a relatively small amount to the overall inventory. The next grid cell to the east (18) has a large area used for motorcycle racing. The greatest amount of emissions by grid area is attributed to this grid square.

Table 7-4
Craig Road Emission Inventory by Grid Squares

Grid Square Number	Emissions (tons)
1	0.19
2	0.40
3	0.87
4	0.25
5	0.11
6	0.21
7	0.71
8	0.45
9	0.36
10	0.56
11	0.34
12	0.28
13	0.16
14	0.35
15	0.44
16	0.41
17	0.10
18	2.64
19	2.00
20	0.93
21	0.97
22	1.31
23	0.77
24	0.92
25	1.24
26	1.12
27	1.68
28	1.45

7.4 EAST FLAMINGO

The PM_{10} emission inventory for sources within a two-kilometer radius of the East Flamingo monitoring station is presented in Table 7-5.

Table 7-5
East Flamingo Monitoring Station PM_{10} Emission Inventory

Source Category	Emissions (tons)	Percent Contribution
Vacant Land	2.91	24.37
Native Desert	0.141	1.17
Unstable	2.68	22.44
Stabilized	0.091	0.75
Construction	3.92	32.84
Wind Erosion	3.56	29.82
Construction Activities	0.32	2.68
Track Out	0.04	0.34
Unpaved Road Dust	0.01	0.08
Paved Road Dust	4.96	41.54
Vehicles		
PM_{10}	0.13	1.09
SOx	0.06	
NOx	3.22	
Stationary Sources		
PM_{10}	0.01	0.08
SOx	0.001	
NOx	0.14	
Total		
PM_{10}	11.94	
SOx	0.061	
NOx	3.36	

The three categories with the greatest contribution were wind erosion from vacant land, construction and re-entrained paved road dust. The re-entrained paved road dust contribution was the largest of any source category. Contributions from all other categories were less than five percent.

The emissions by grid square are presented in Table 7-6.

Table 7-6
East Flamingo Emission Inventory by Grid Squares

Grid Square Number	Emissions (tons)
1	0.07
2	0.08
3	0.08
4	0.02
5	0.57
6	0.17
7	0.07
8	0.01
9	0.52
10	0.46
11	0.12
12	0.34
13	0.18
14	0.02
15	0.07
16	0.10
17	0.34
18	0.16
19	1.49
20	0.14
21	0.79
22	0.88
23	2.94
24	1.03
25	0.16
26	0.43
27	0.50
28	0.20

Emission estimates from the areas closest to the monitor do not exceed a ton and most are less than one-quarter of a ton. The area with the greatest emissions is located to the west of the monitor. This area has three construction sites and is upwind of the monitor for the design day. Emissions from this area exceed 20 percent of the entire design day inventory.

7.5 GREEN VALLEY

The PM_{10} emission inventory for sources within a two-kilometer radius of the Green Valley monitoring station is presented in Table 7-7.

Table 7-7
Green Valley Monitoring Station PM_{10} Emission Inventory

Source Category	Emissions (tons)	Percent Contribution
Vacant Land	8.03	23.42
Native Desert	0.70	2.04
Unstable	7.29	21.27
Stabilized	0.04	0.12
Construction	21.19	61.81
Wind Erosion	18.3	53.4
Construction Activities	2.85	8.32
Track Out	0.04	0.09
Unpaved Road Dust	0.017	0.05
Paved Road Dust	3.54	10.33
Race Tracks	1.26	3.68
Wind Erosion	1.08	3.15
Vehicles	0.18	0.53
Vehicles		
PM_{10}	0.07	0.20
SOx	0.03	
NOx	1.64	
Stationary Sources		
PM_{10}	0.17	0.50
SOx	0.19	
NOx	0.02	
Total		
PM_{10}	34.28	
SOx	0.22	
NOx	1.66	

The emission inventory for the Green Valley monitoring station area is dominated by construction emissions. Over 350 acres of land were under active construction in February of 1999. Wind erosion from construction sites was the single largest contributor to PM_{10} in the inventory. The next two highest categories were re-entrained paved road dust and wind erosion from vacant land. All other categories contributed less than 10 percent to the inventory.

The emissions by grid square are presented in Table 7-8.

Table 7-8
Green Valley Emission Inventory by Grid Squares

Grid Square Number	Emissions (tons)
1	0.59
2	0.42
3	1.20
4	3.11
5	0.11
6	0.24
7	0.42
8	0.13
9	0.12
10	0.41
11	0.72
12	0.75
13	0.26
14	0.54
15	0.07
16	0.07
17	0.28
18	4.17
19	0.97
20	4.09
21	0.31
22	0.57
23	1.03
24	4.97
25	0.13
26	0.15
27	2.54
28	5.91

The distribution of emissions throughout the micro-inventory area is skewed toward the regions of the study area where there were construction sites or disturbed vacant land. Most of the sources were to the east of the monitoring station and not upwind. However a large area with a race track is located within one kilometer, southwest of the site.

7.6 J. D. SMITH

The PM_{10} emission inventory for sources within a two-kilometer radius of the J. D. Smith monitoring station is presented in Table 7-9.

Table 7-9
J. D. Smith Monitoring Station PM_{10} Emission Inventory

Source Category	Emissions (tons)	Percent Contribution
Vacant Land	10.08	36.56
Native Desert	0.63	2.28
Unstable	9.4	34.10
Stabilized	0.05	0.18
Construction	5.52	20.02
Wind Erosion	5.1	18.50
Construction Activities	0.35	1.27
Track Out	0.07	0.25
Unpaved Road Dust	0.004	0.01
Paved Road Dust	11.63	42.18
Vehicles		
PM_{10}	0.26	0.94
SOx	0.13	
NOx	6.6	
Stationary Sources		
PM_{10}	0.08	0.29
SOx	0.002	
NOx	0.12	
Total		
PM_{10}	27.57	
SOx	0.132	
NOx	6.72	

The largest contributor to PM_{10} emissions in the area surrounding the J. D. Smith monitoring station is re-entrained paved road dust. Wind erosion from vacant land is the next highest category. Construction emissions contributed less than 20 percent. All other sources contributed less than 10 percent to the emission inventory.

The emissions by grid square are presented in Table 7-10.

Table 7-10
J. D. Smith Emission Inventory by Grid Squares

Grid Square Number	Emissions (tons)
1	0.30
2	0.80
3	0.27
4	0.08
5	1.02
6	0.55
7	0.17
8	0.12
9	0.19
10	0.23
11	0.23
12	0.04
13	0.49
14	0.36
15	0.39
16	0.23
17	1.76
18	1.66
19	0.82
20	0.90
21	2.21
22	0.94
23	2.32
24	0.66
25	1.96
26	2.45
27	2.09
28	4.33

Reviewing the emissions by grid cell, the variation appears to be dominated by construction and vacant land. The emissions from vehicles and stationary sources do not influence the spatial distribution. Generally the larger sources are to the west and south of the monitoring station. This is in keeping with the design day when winds were out of the west, southwest.

7.7 PITTMAN

The PM_{10} emission inventory for sources within a two-kilometer radius of the Pittman monitoring station is presented in Table 7-11.

Table 7-11
Pittman Monitoring Station PM_{10} Emission Inventory

Source Category	Emissions (tons)	Percent Contribution
Vacant Land	27.32	80.88
Native Desert	14.16	41.92
Unstable	12.9	38.19
Stabilized	0.26	0.77
Construction	1.32	3.91
Wind Erosion	1.12	3.32
Construction Activities	0.19	0.56
Track Out	0.01	0.03
Unpaved Road Dust	0.66	1.95
Paved Road Dust	2.92	8.64
Unpaved Parking	1.14	3.37
Wind Erosion	1.11	3.28
Vehicles	0.03	0.09
Vehicles		
PM_{10}	0.06	0.18
SOx	0.03	
NOx	1.51	
Stationary Sources		
PM_{10}	0.36	1.07
SOx	0.02	
NOx	0.19	
Total		
PM_{10}	33.78	
SOx	0.05	
NOx	1.7	

Approximately 80 percent of the emissions in the area on the design day were from wind erosion of vacant land. There are over 2000 acres of vacant land within two kilometers of the monitoring station. About 70 percent of the vacant land is native desert. Re-entrained paved road dust accounted for about 8 percent while construction accounted for only around 4 percent.

The emissions by grid square are presented in Table 7-12.

Table 7-12
Pittman Emission Inventory by Grid Squares

Grid Square Number	Emissions (tons)
1	0.39
2	0.48
3	0.12
4	0.39
5	0.54
6	0.32
7	0.14
8	0.01
9	1.11
10	0.41
11	0.36
12	0.56
13	0.42
14	-
15	0.01
16	0.60
17	2.94
18	2.14
19	2.22
20	2.40
21	1.17
22	1.25
23	2.40
24	2.96
25	2.82
26	1.97
27	3.79
28	1.86

Sources surrounding the Pittman monitoring station are fairly evenly distributed with most emissions occurring between one and two kilometers from the monitor. Grid cell number 14 was not apportioned any emissions because the area is controlled by a stationary source covering several acres. The emissions from the entire stationary source were attributed to another area. Generally the emissions vary in accordance with the number of acres of vacant land in each grid area.

8.0 CONCLUSIONS

The largest contributors to the PM_{10} emission inventory surrounding the five representative monitoring stations are wind erosion from vacant land, construction, and re-entrained paved road dust. The relative contribution of each of these sources varies from site to site depending on land use. All other sources combined contribute less than 10 percent to the overall inventory.

For use in attainment demonstration, the percent contribution from each of the sources was applied to the design day measured concentration. The background concentration was also included. By reviewing the emission inventory results in this way, the emission reduction by source category can be addressed.

8.1 CRAIG ROAD DESIGN DAY MASS CONTRIBUTION

The measured PM_{10} concentration on January 20, 1999 at the Craig Road monitoring station was 254 $\mu g/m^3$. The background concentration as measured at the Jean monitoring station was 24 $\mu g/m^3$. By apportioning the sources to this design concentration based upon their percent contribution, the mass contribution shown in Table 8-1 was calculated.

Table 8-1
Craig Road Inventory Mass Contributions

Source Category	**Relative Mass Contribution (mg/m^3)**
Vacant Land	112.59
Native Desert	60.35
Unstable	46.81
Stabilized	5.42
Construction	37.17
Wind Erosion	29.48
Construction	7.37
Track Out	0.33
Unpaved Road	1.52
Paved Road Dust	43.13
Unpaved Parking	5.57
Wind Erosion	5.53
Vehicles	0.04
Race Tracks	26.33
Wind Erosion	18.53
Vehicles	7.80
Vehicles	1.08
Stationary Sources	2.60
Background	24
Total	254

Paved road dust, construction and wind erosion from unstable vacant parcels each contribute roughly the same amount to the mass contribution. The race track is the next highest contributor. Attainment demonstration should focus on those source categories with total mass contributions over 150 µg/m^3.

8.2 EAST FLAMINGO DESIGN DAY MASS CONTRIBUTION

The measured PM_{10} concentration on March 30, 1999 at the East Flamingo monitoring station was 189 µg/m^3. The background concentration as measured at the Jean monitoring station was 35 µg/m^3. By apportioning the sources to this design concentration based upon their percent contribution, the mass contribution shown in Table 8-2 was calculated.

Table 8-2
East Flamingo Inventory Mass Contributions

Source Category	Relative Mass Contribution (mg/m^3)
Vacant Land	37.54
Native Desert	1.82
Unstable	34.55
Stabilized	1.17
Construction	50.54
Wind Erosion	45.91
Construction Activities	4.11
Track Out	0.52
Unpaved Road Dust	0.13
Paved Road Dust	63.97
Vehicles	1.68
Stationary Sources	0.14
Background	35
Total	189

Applying only the enhanced control of paved road dust may not be enough to demonstrate attainment on the design day at this site. Construction and unstable vacant land controls may also be required.

8.3 GREEN VALLEY DESIGN DAY MASS CONTRIBUTION

The measured PM_{10} concentration on February 25, 1999 at the Green Valley monitoring station was 281 µg/m^3. The background concentration as measured at the Jean monitoring station was 16 µg/m^3. By apportioning the sources to this design concentration based upon their percent contribution, the mass contribution shown in Table 8-3 was calculated.

Table 8-3
Green Valley Inventory Mass Contributions

Source Category	Relative Mass Contribution (mg/m^3)
Vacant Land	62.08
Native Desert	5.41
Unstable	56.36
Stabilized	0.31
Construction	163.82
Wind Erosion	141.48
Construction Activities	22.03
Track Out	0.31
Unpaved Road Dust	0.13
Paved Road Dust	27.37
Race Tracks	9.74
Wind Erosion	8.35
Vehicles	1.39
Vehicles	0.54
Stationary Sources	1.31
Background	16
Total	281

Wind erosion from unstable vacant land, either from construction sites, race tracks, or vacant sites accounts for over 200 $\mu g/m^3$ of the mass contribution. Re-entrained paved road dust is the next largest contributor. Control strategies for these sources would be necessary to demonstrate attainment at this site.

8.4 J. D. SMITH DESIGN DAY CONTRIBUTION

The measured PM_{10} concentration on March 31, 1999 at the J. D. Smith monitoring station was 218 $\mu g/m^3$. The background concentration as measured at the Walter Johnson monitoring station was 42 $\mu g/m^3$. By apportioning the sources to this design concentration based upon their percent contribution, the mass contribution shown in Table 8-4 was calculated.

Table 8-4
J. D. Smith Inventory Mass Contributions

Source Category	Relative Mass Contribution (mg/m^3)
Vacant Land	64.34
Native Desert	4.02
Unstable	60.00
Stabilized	0.32
Construction	35.23
Wind Erosion	32.55
Construction Activities	2.23
Track Out	0.45
Unpaved Road Dust	0.03
Paved Road Dust	74.23
Vehicles	1.66
Stationary Sources	0.51
Background	42
Total	218

Paved road dust is the largest contributor to PM_{10} at this site. Wind erosion from vacant land and construction are also large contributors. Control strategies for these three sources will provide for attainment demonstration for the J. D. Smith design day.

8.5 PITTMAN DESIGN DAY CONTRIBUTION

The measured PM_{10} concentration on March 30, 1999 at the Pittman monitoring station was 239 $\mu g/m^3$. The background concentration as measured at the Jean monitoring station was 35 $\mu g/m^3$. By apportioning the sources to this design concentration based upon their percent contribution, the mass contribution shown in Table 8-5 was calculated.

Table 8-5
Pittman Inventory Mass Contributions

Source Category	**Relative Mass Contribution (mg/m^3)**
Vacant Land	164.99
Native Desert	85.51
Unstable	77.90
Stable	1.57
Construction	7.97
Wind Erosion	6.76
Construction Activities	1.15
Track Out	0.06
Unpaved Road Dust	3.99
Paved Road Dust	17.63
Unpaved Parking	6.88
Wind Erosion	6.70
Vehicles	0.18
Vehicles	0.36
Stationary Sources	2.17
Background	35
Total	239

With over 85 $\mu g/m^3$ of mass attributed to wind erosion from native desert parcels, adequate reduction from other sources to demonstrate attainment may be difficult. Control of wind erosion from construction sites, unstable vacant land and unpaved parking areas will not demonstrate attainment without significant control strategies for re-entrained paved road dust as well. All other sources combined are estimated to contribute less than 10 $\mu g/m^3$ on the design day for the Pittman monitoring station.

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