Appendix I

Backward Wind Trajectories and Wind Roses at the Charlotte-Gastonia-Salisbury Area Monitors on High Ozone Days

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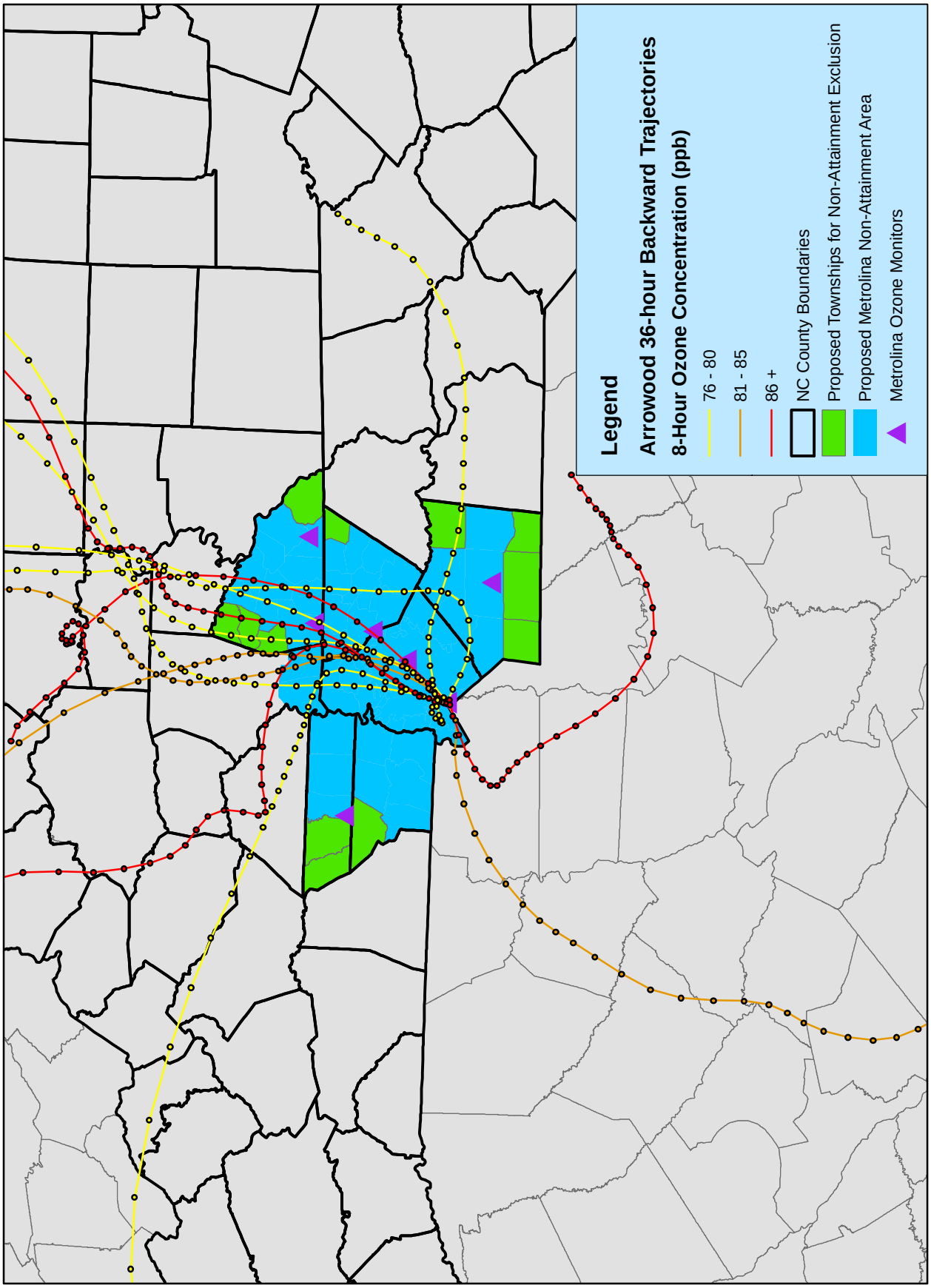
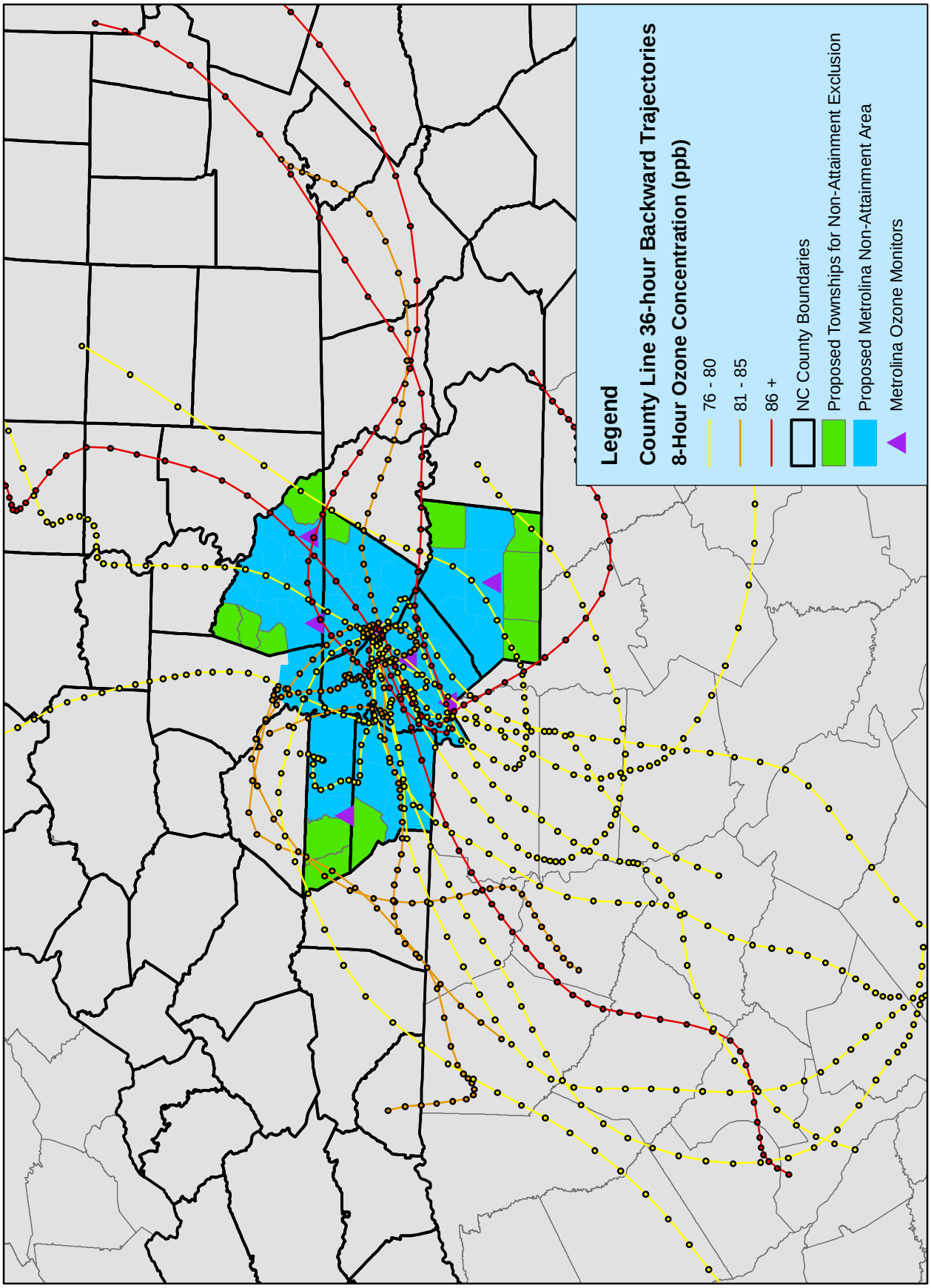
Backward Trajectories for Nonattainment Boundary Designations

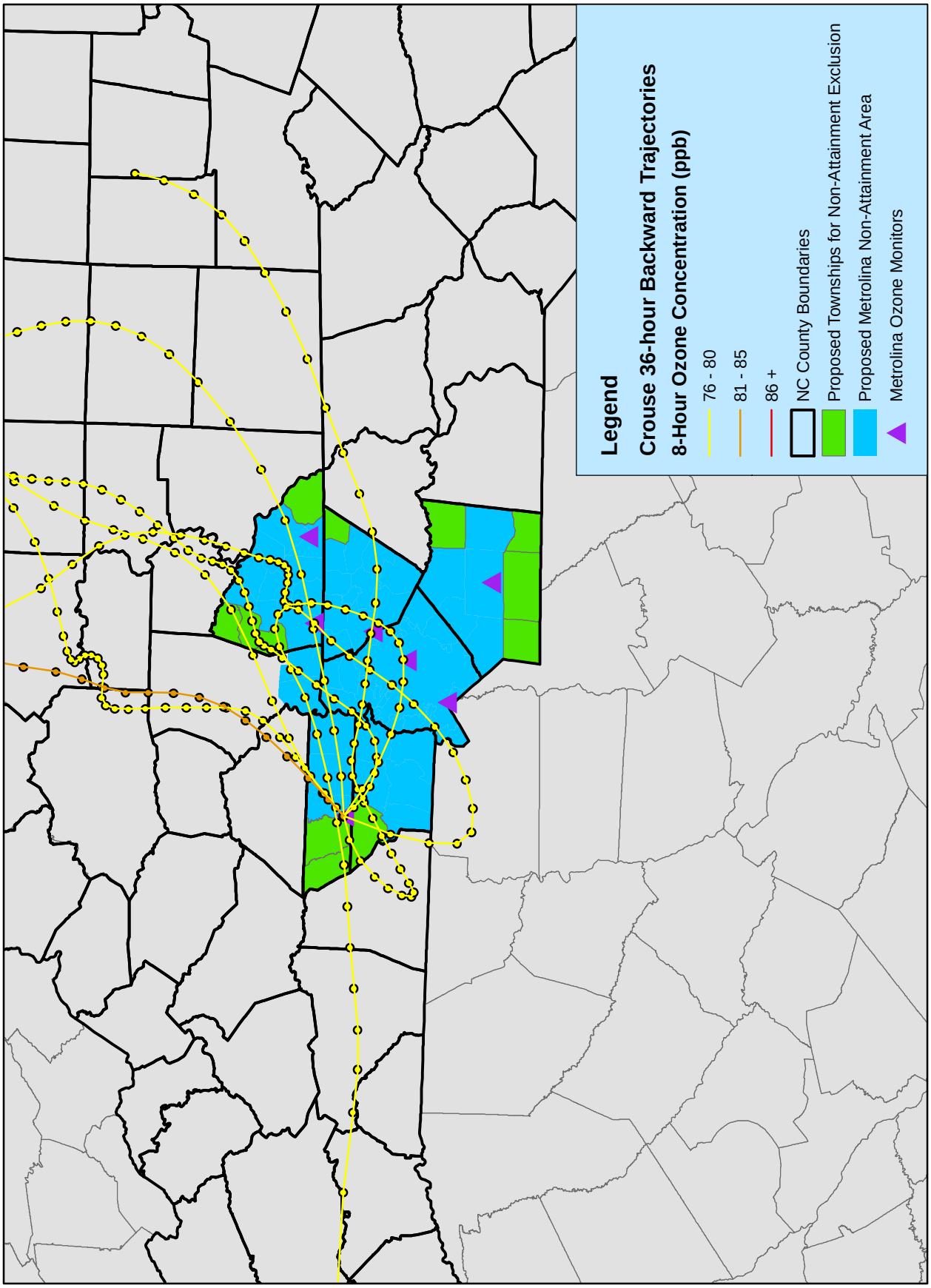
- Due to the 4-dimensional nature of the transport of an air parcel by the wind in the lower troposphere, a 2-dimensional (x,y) array displaying the wind field to determine the origin or source of an air parcel is insufficient. To more accurately assess the source region of an air parcel, both the spatial (x,y,z) and time components of an air parcel's transport must be considered. Trajectories incorporate both the spatial and temporal (time changing) characteristics of an air parcel's movement.
- Backward trajectories (or back trajectories) begin at a known end point (i.e. an air quality monitor location) and are run backwards in time to determine the origin of the air parcel that is at the desired end point. The time length of the backwards tracking can vary according to one's interest, and the initial source or origin of the parcel is linked to the length of time the air parcel is tracked backwards.
- For NCDAQ's ozone nonattainment boundary studies, trajectories were run backward to assess the path an air parcel took in arriving at the monitored end point for all monitors and all days at and above the .076 ppb standard. The NOAA Air Resources Laboratories (ARL) Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) Model was used to calculate the back trajectories.
- Trajectories are run with the ARL HYSPLIT model using the Eta archived data (EDAS), available in the native ARL format from the ARL HYSPLIT site. THE EDAS data has a grid resolution of 40 km, the greatest horizontal and vertical resolution of any data available for download on the HYSPLIT site. Over highly complex terrain (e.g. mountains) the data used in the model may not be sufficient to capture the actual elevation of the trajectory end point. Also, the longer the trajectory run, the greater the uncertainty the air parcel is being adequately represented in the model becomes. Atmospheric processes that take place in the 'real' atmosphere but are ignored or approximated in the model will increase uncertainty for long trajectory runs.
- Back trajectory heights originate at 10m, 500m, and 1000m. The duration of trajectories is 36 hours, which allows enough time to sufficiently determine the

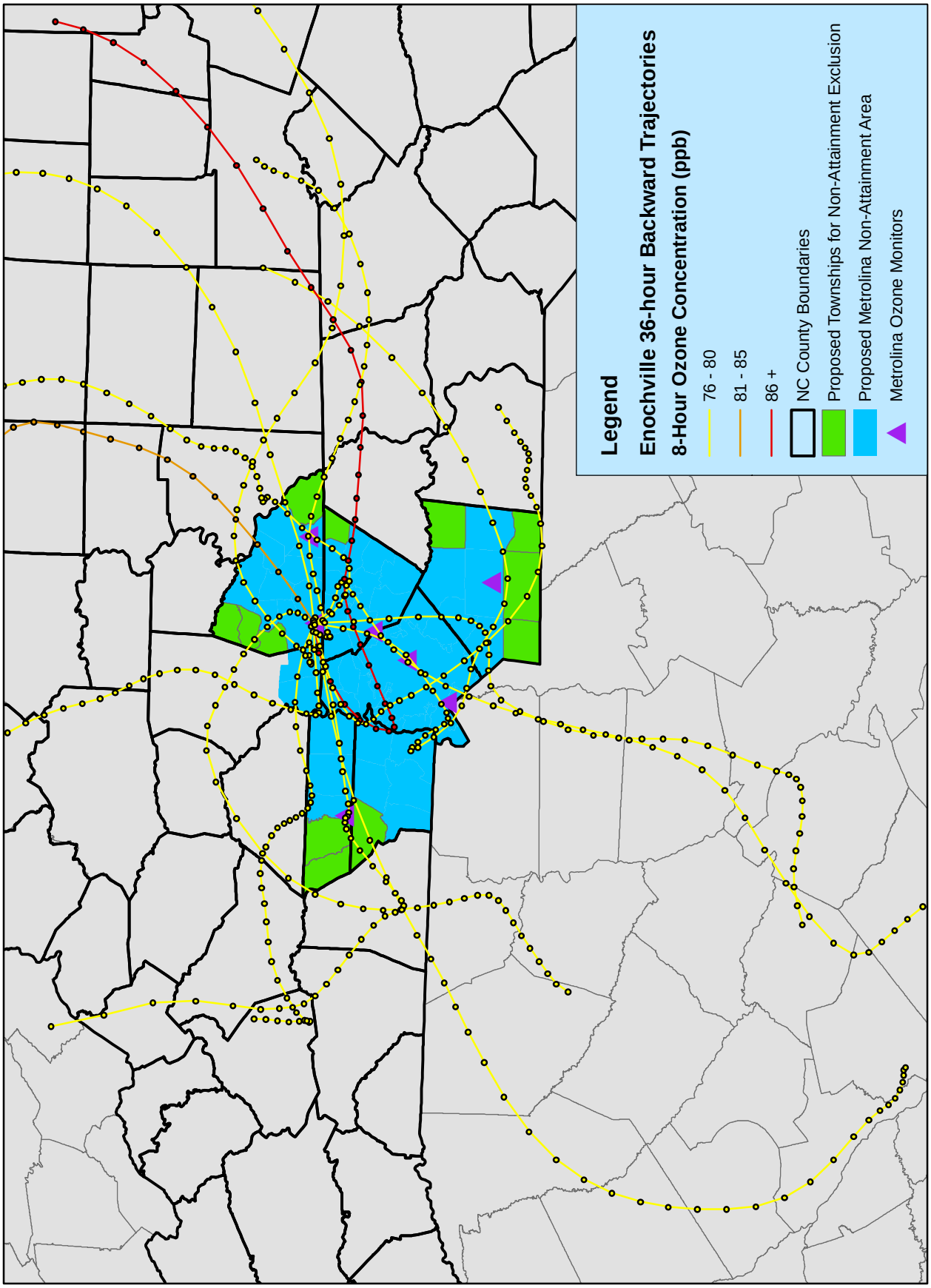
most significant source regions for the air parcel while limiting the amount of uncertainty that comes with longer duration trajectories. For simplicity, only the 10m back trajectories are shown. The 500m and 1000m backward trajectories did not differ significantly.

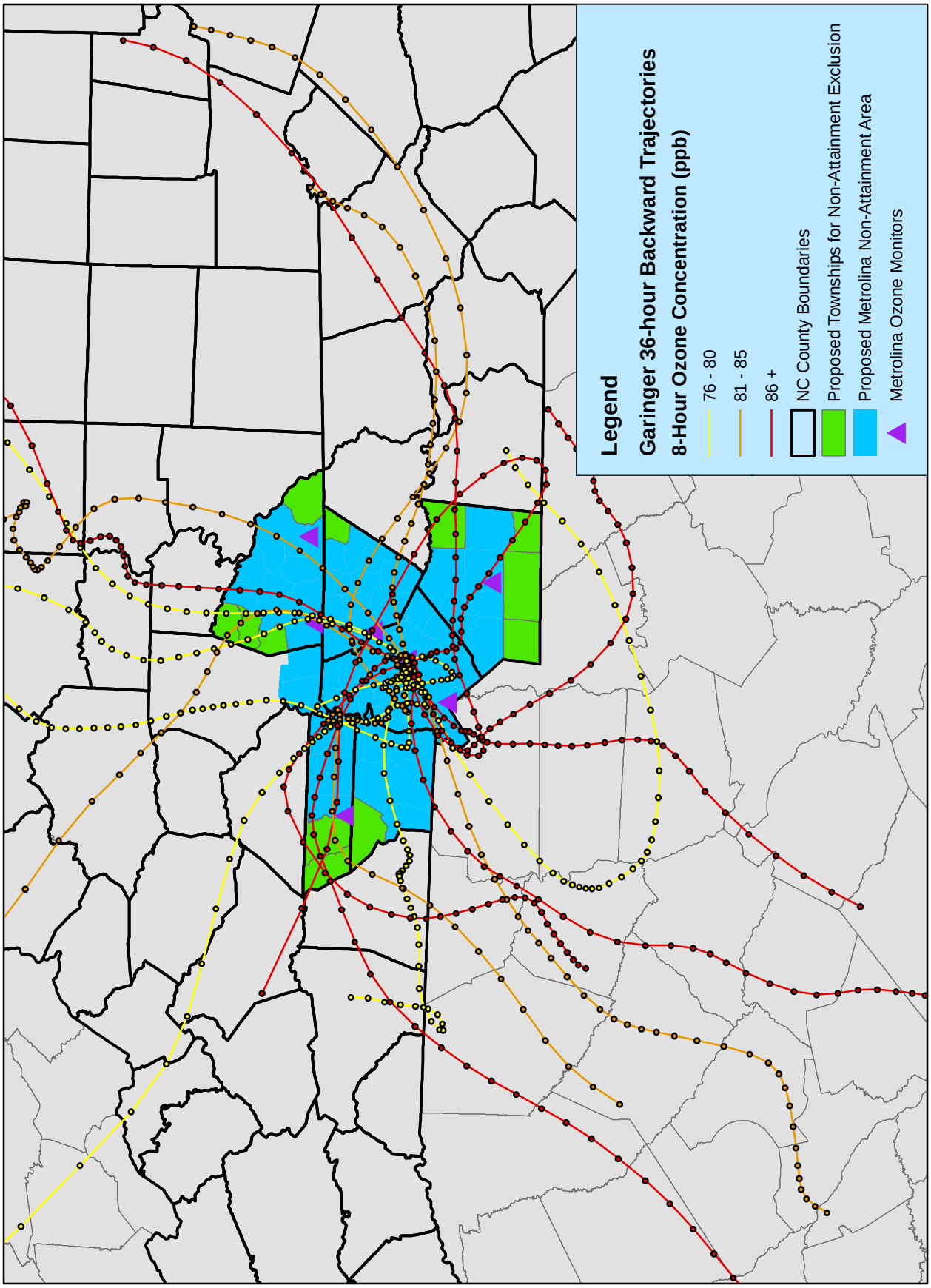
- The end time of the back trajectories for non-Ridge Top monitors is 2000 UTC (1600 EDT) on the day of the exceedance. Due to the highly variable nature of exceedance times at the Ridge Top locations, the end time of the trajectories is set to be the fourth hour following the start time of the 8-hour average making up the exceedance. For example, if an exceedance at a Ridge Top location was 1200UTC (0800EDT), the end time for the trajectory would be 1500UTC (1100EDT). Similarly, if the start time of the exceedance was 2200UTC (1800EDT), the end time of the trajectory would be 0100UTC (2200EDT) on the following day. The majority of exceedances at the Ridge Tops encompass the midnight hour and do in fact span 2 calendar days.

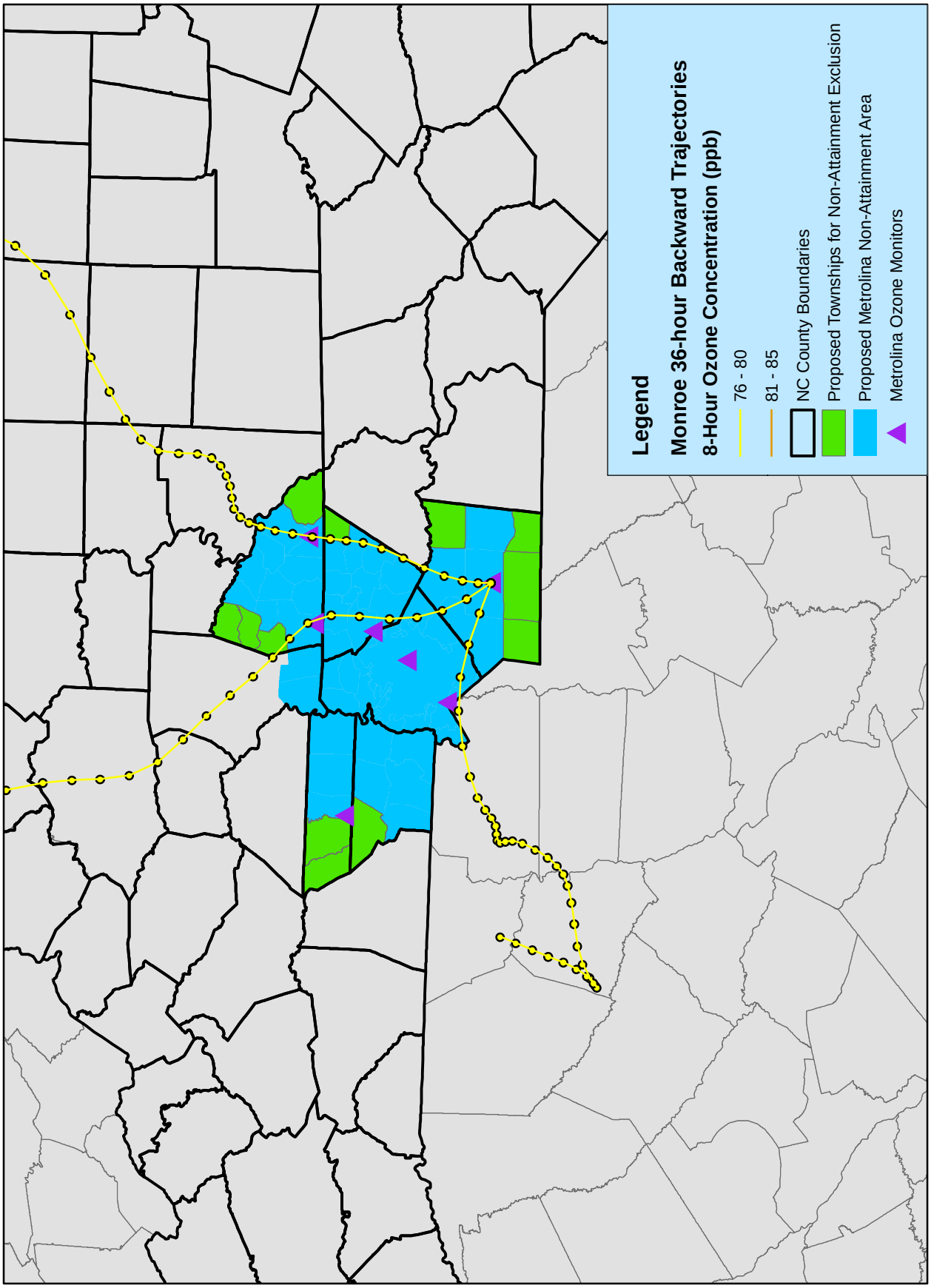

Legend
Arrowood 36-hour Backward Trajectories
8-Hour Ozone Concentration (ppb)
76 - 80
81 - 85
86 +
NC County Boundaries
Proposed Townships for Non-Attainment Exclusion
Proposed Metrolina Non-Attainment Area
Metrolina Ozone Monitors

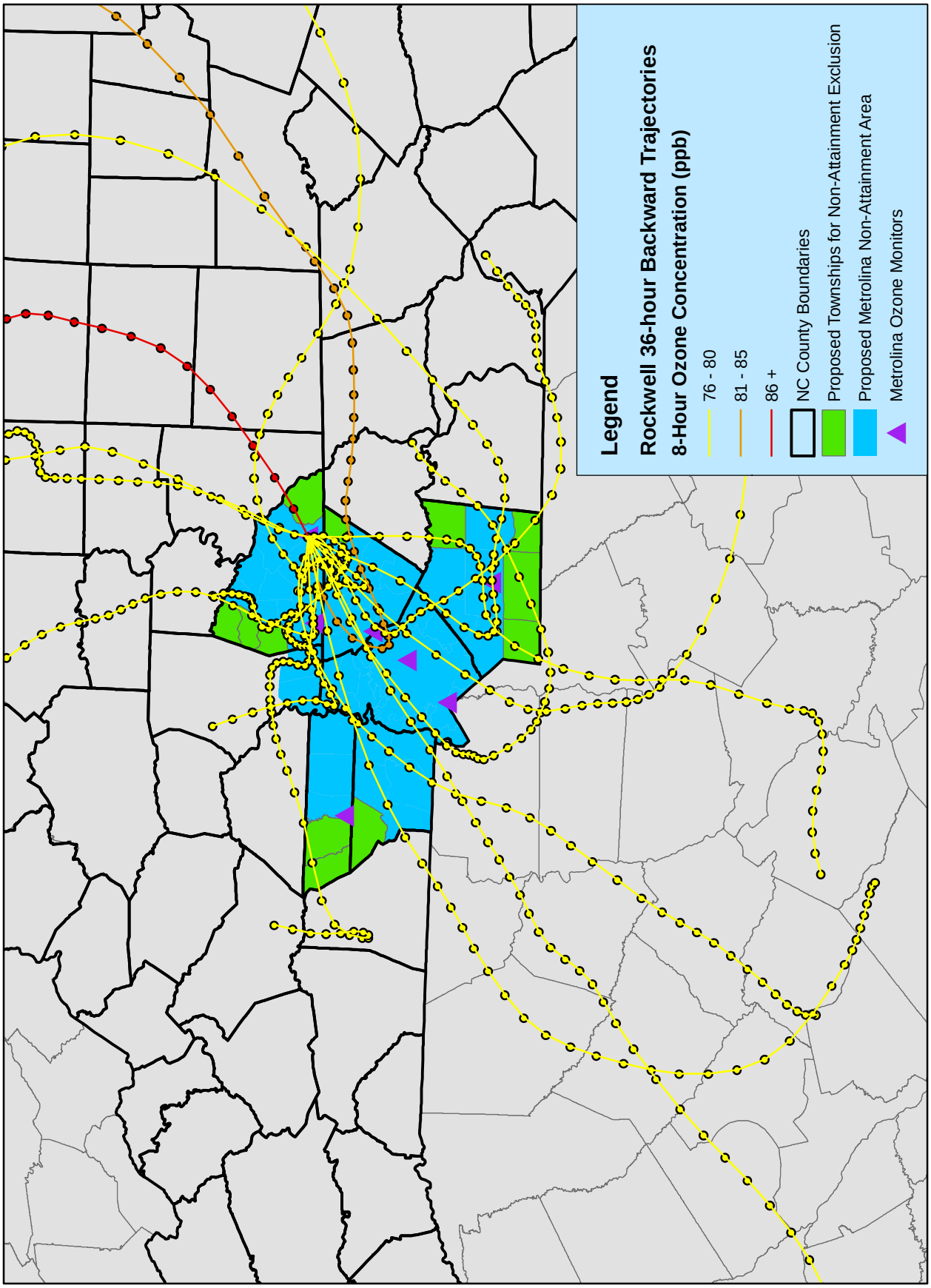

Legend
County Line 36-hour Backward Trajectories
8-Hour Ozone Concentration (ppb)
76 - 80
81 - 85
86 +
NC County Boundaries
Proposed Townships for Non-Attainment Exclusion
Proposed Metrolina Non-Attainment Area
Metrolina Ozone Monitors


Legend
Crouse 36-hour Backward Trajectories
8-Hour Ozone Concentration (ppb)
76 - 80
81 - 85
86 +
NC County Boundaries
Proposed Townships for Non-Attainment Exclusion
Proposed Metrolina Non-Attainment Area
Metrolina Ozone Monitors


Legend
Enochville 36-hour Backward Trajectories
8-Hour Ozone Concentration (ppb)
76 - 80
81 - 85
86 +
NC County Boundaries
Proposed Townships for Non-Attainment Exclusion
Proposed Metrolina Non-Attainment Area
Metrolina Ozone Monitors


Legend
Garinger 36-hour Backward Trajectories
8-Hour Ozone Concentration (ppb)
76 - 80
81 - 85
86 +
NC County Boundaries
Proposed Townships for Non-Attainment Exclusion
Proposed Metrolina Non-Attainment Area
Metrolina Ozone Monitors


Legend
Monroe 36-hour Backward Trajectories
8-Hour Ozone Concentration (ppb)
76 - 80
81 - 85
NC County Boundaries
Proposed Townships for Non-Attainment Exclusion
Proposed Metrolina Non-Attainment Area
Metrolina Ozone Monitors


Legend
Rockwell 36-hour Backward Trajectories
8-Hour Ozone Concentration (ppb)
76 - 80
81 - 85
86 +
NC County Boundaries
Proposed Townships for Non-Attainment Exclusion
Proposed Metrolina Non-Attainment Area
Metrolina Ozone Monitors

Wind Roses on Days with Ozone at or above 70 ppb

To get a more robust wind rose from 2009-2011, wind data for days with ozone down to 70 ppb was included in the dataset. Wind data is from 12z to 23z (7AM to 6PM) on days when ozone was at or above 70 ppb.

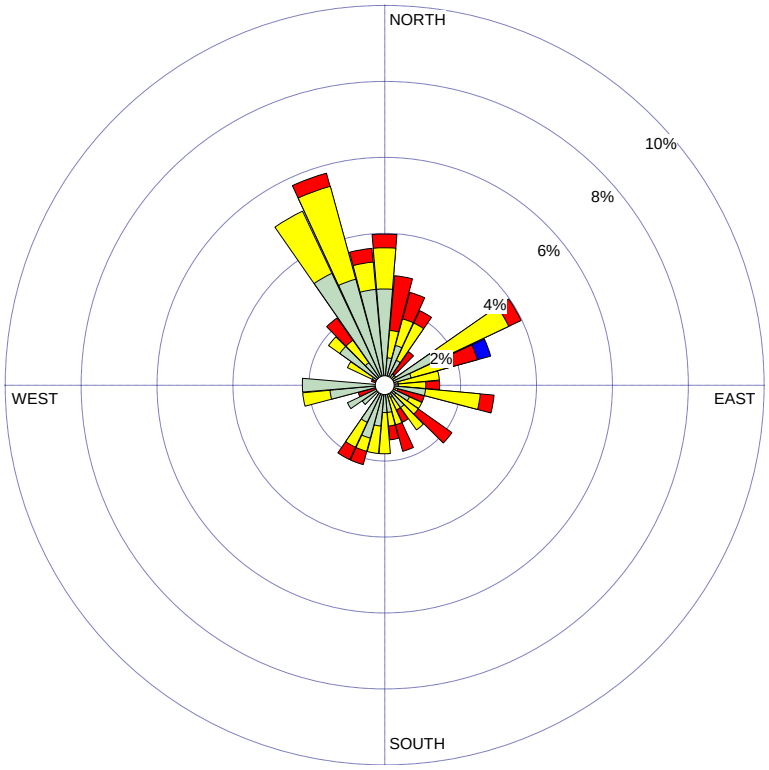
For reference, wind roses from 2006 to 2008 are also included.

WIND ROSE PLOT:

Arrowood wind rose for days >= 70ppb
2009-2011

DISPLAY:

Wind Speed
Direction (blowing from)



WIND SPEED
(Knots)

- >= 22
- 17 - 21
- 11 - 17
- 7 - 11
- 4 - 7
- 1 - 4

Calms: 29.60%

COMMENTS:	DATA PERIOD:	COMPANY NAME:	
12z to 23z winds No variable winds Station - KCLT	**Start Date: 7/14/2009 - 12:00** **End Date: 9/2/2011 - 23:00**	MODELER:	NCDENR
	CALM WINDS: **29.60%**	TOTAL COUNT: **277 hrs.**	
	AVG. WIND SPEED: **3.48 Knots**	DATE: **2/15/2012**	PROJECT NO.:

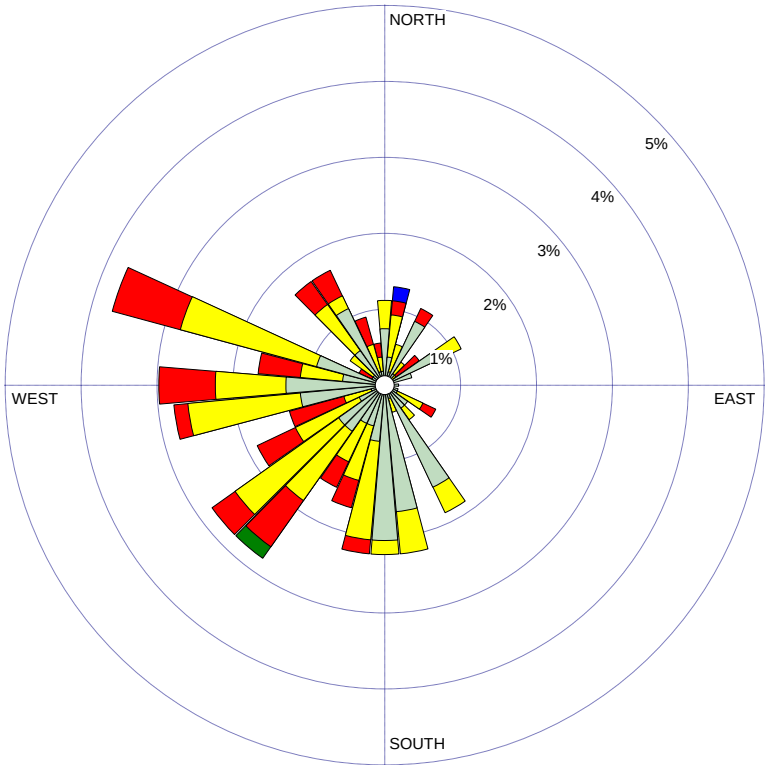
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

County Line wind rose for days >= 70ppb
2009-2011

DISPLAY:

Wind Speed
Direction (blowing from)



WIND SPEED
(Knots)

- >= 22
- 17 - 21
- 11 - 17
- 7 - 11
- 4 - 7
- 1 - 4

Calms: 53.70%

COMMENTS: 12z to 23z winds No variable winds Station - KJQF	DATA PERIOD: **Start Date: 6/2/2009 - 12:00** **End Date: 9/14/2011 - 23:00**	COMPANY NAME:	
		MODELER:	NCDENR
	CALM WINDS: **53.70%**	TOTAL COUNT: **539 hrs.**	
	AVG. WIND SPEED: **2.36 Knots**	DATE: **2/15/2012**	PROJECT NO.:

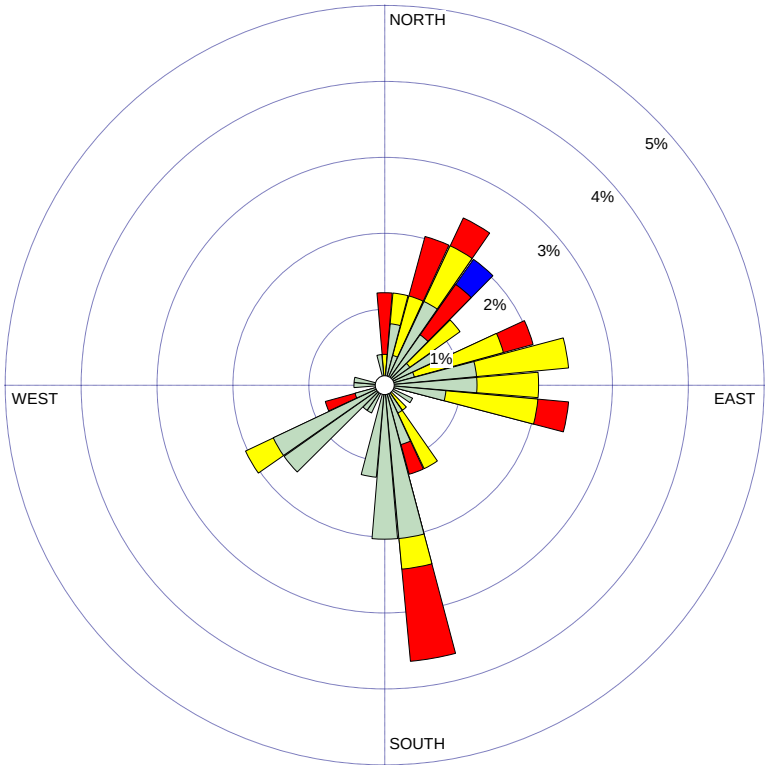
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Crouse wind rose for days >= 70ppb
2009-2011

DISPLAY:

Wind Speed
Direction (blowing from)



WIND SPEED
(Knots)

- >= 22
- 17 - 21
- 11 - 17
- 7 - 11
- 4 - 7
- 1 - 4

Calms: 63.56%

COMMENTS:	DATA PERIOD:	COMPANY NAME:	
12z to 23z winds No variable winds Station - KAKH	**Start Date: 4/2/2010 - 12:00** **End Date: 9/2/2011 - 23:00**	MODELER:	
	CALM WINDS: **63.56%**	TOTAL COUNT: **247 hrs.**	
	AVG. WIND SPEED: **1.77 Knots**	DATE: **2/15/2012**	PROJECT NO.:

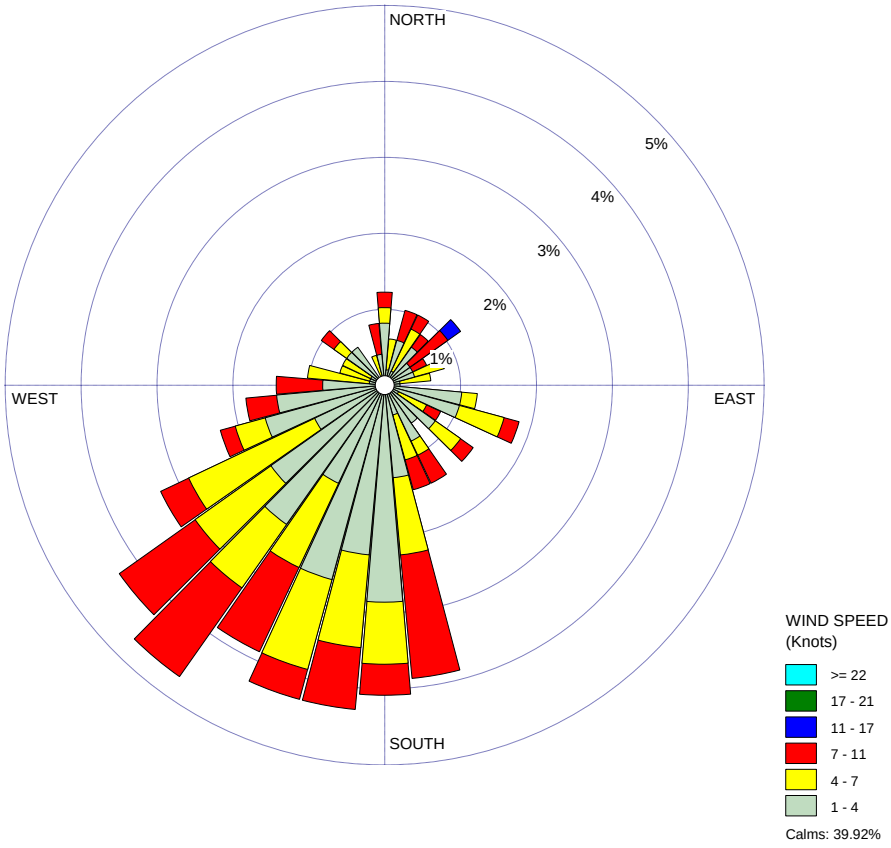
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Enochville wind rose for days >= 70ppb
2009-2011

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS: 12z to 23z winds No variable winds Station - KRUQ	DATA PERIOD: **Start Date: 4/18/2009 - 12:00** **End Date: 9/14/2011 - 23:00**	COMPANY NAME:	
		MODELER:	NCDENR
	CALM WINDS: **39.92%**	TOTAL COUNT: **491 hrs.**	
	AVG. WIND SPEED: **3.01 Knots**	DATE: **2/15/2012**	PROJECT NO.:

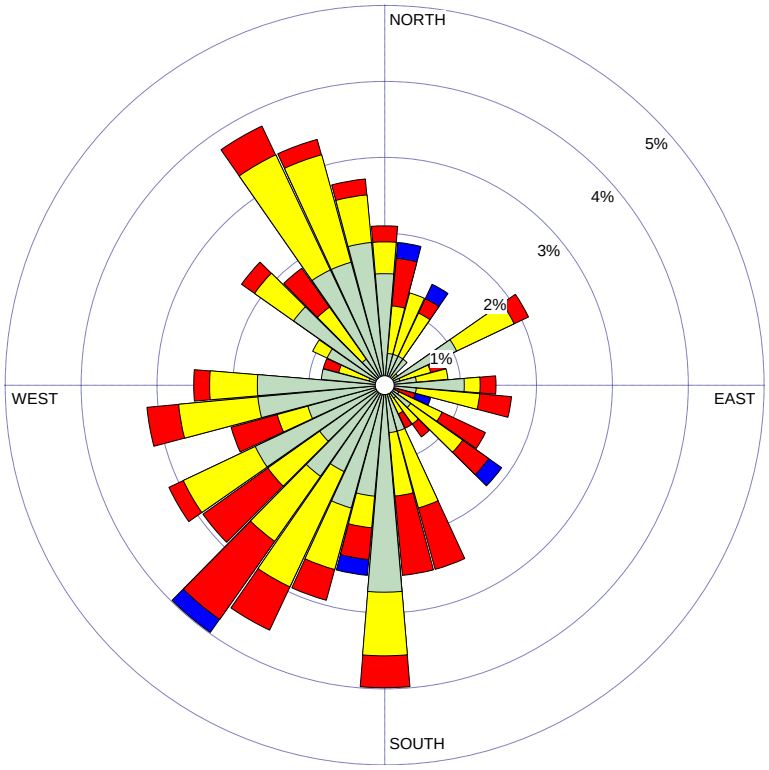
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Garinger wind rose for days >= 70ppb
2009-2011

DISPLAY:

Wind Speed
Direction (blowing from)



WIND SPEED
(Knots)

- >= 22
- 17 - 21
- 11 - 17
- 7 - 11
- 4 - 7
- 1 - 4

Calms: 27.82%

COMMENTS:	DATA PERIOD:	COMPANY NAME:	
12z to 23z winds No variable winds Station - KCLT	**Start Date: 6/25/2009 - 12:00** **End Date: 9/14/2011 - 23:00**	MODELER:	NCDENR
	CALM WINDS: **27.82%**	TOTAL COUNT: **478 hrs.**	
	AVG. WIND SPEED: **3.74 Knots**	DATE: **2/15/2012**	PROJECT NO.:

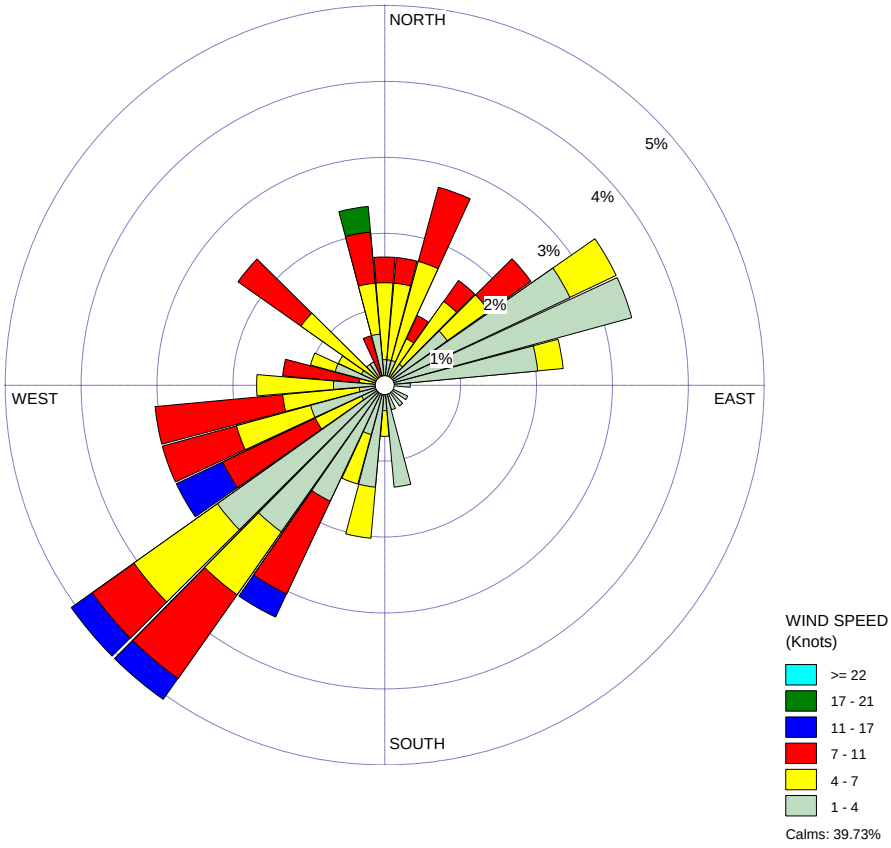
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Monroe wind rose for days >= 70ppb
2009-2011

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
12z to 23z winds No variable winds Station - KEKQ	**Start Date: 6/22/2009 - 12:00** **End Date: 9/13/2011 - 23:00**	MODELER:	NCDENR
	CALM WINDS: **39.73%**	TOTAL COUNT: **297 hrs.**	
	AVG. WIND SPEED: **3.30 Knots**	DATE: **2/15/2012**	PROJECT NO.:

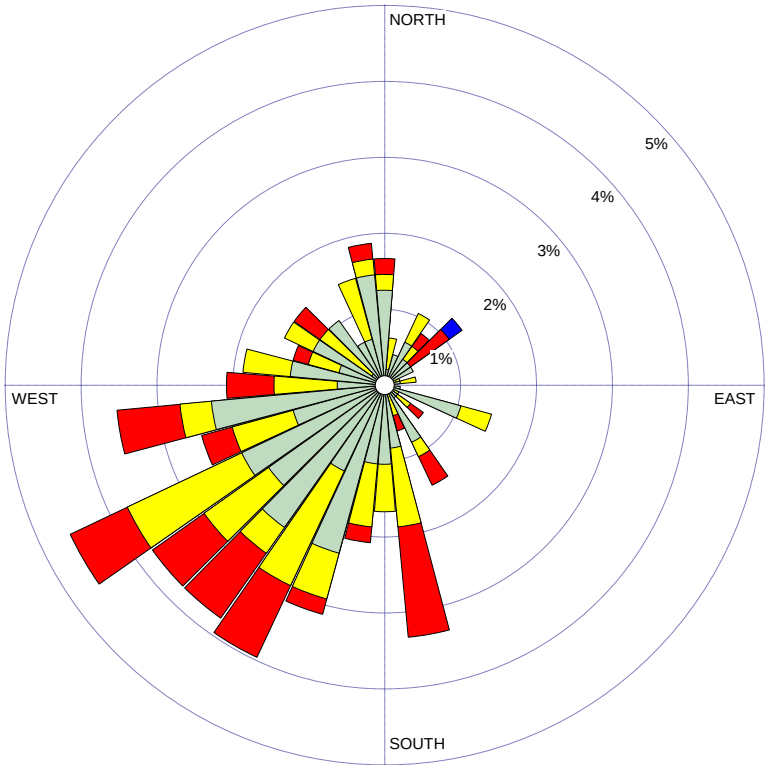
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Rockwell wind rose for days >= 70ppb
2009-2011

DISPLAY:

Wind Speed
Direction (blowing from)



WIND SPEED
(Knots)

- >= 22
- 17 - 21
- 11 - 17
- 7 - 11
- 4 - 7
- 1 - 4

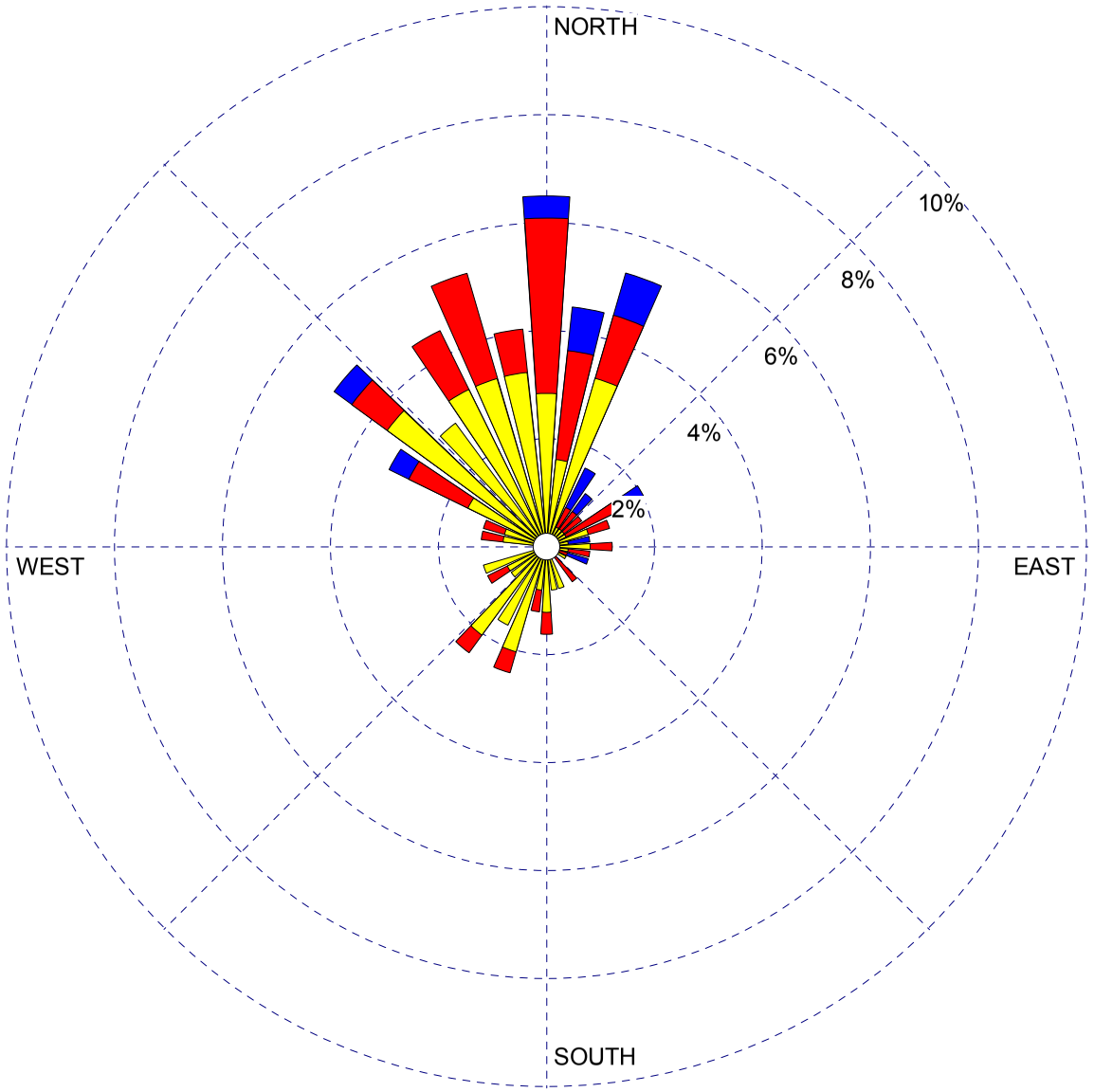
Calms: 42.07%

COMMENTS:	DATA PERIOD:	COMPANY NAME:	
12z to 23z winds No variable winds Station - KRUQ	**Start Date: 6/2/2009 - 12:00** **End Date: 9/14/2011 - 23:00**	MODELER:	NCDENR
	CALM WINDS: **42.07%**	TOTAL COUNT: **481 hrs.**	
	AVG. WIND SPEED: **2.79 Knots**	DATE: **2/15/2012**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:
Arrowood
Ozone >=76 ppb

DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS:
600-1900 EST
No Variable winds

DATA PERIOD:
2006-2008
Jan 1 - Dec 31
00:00 - 23:00

TOTAL COUNT:
247 hrs.

CALM WINDS:
30.77%

AVG. WIND SPEED:
3.68 Knots

COMPANY NAME:
NCDENR

MODELER:
NCW

DATE:
10/16/2008

PROJECT NO.:

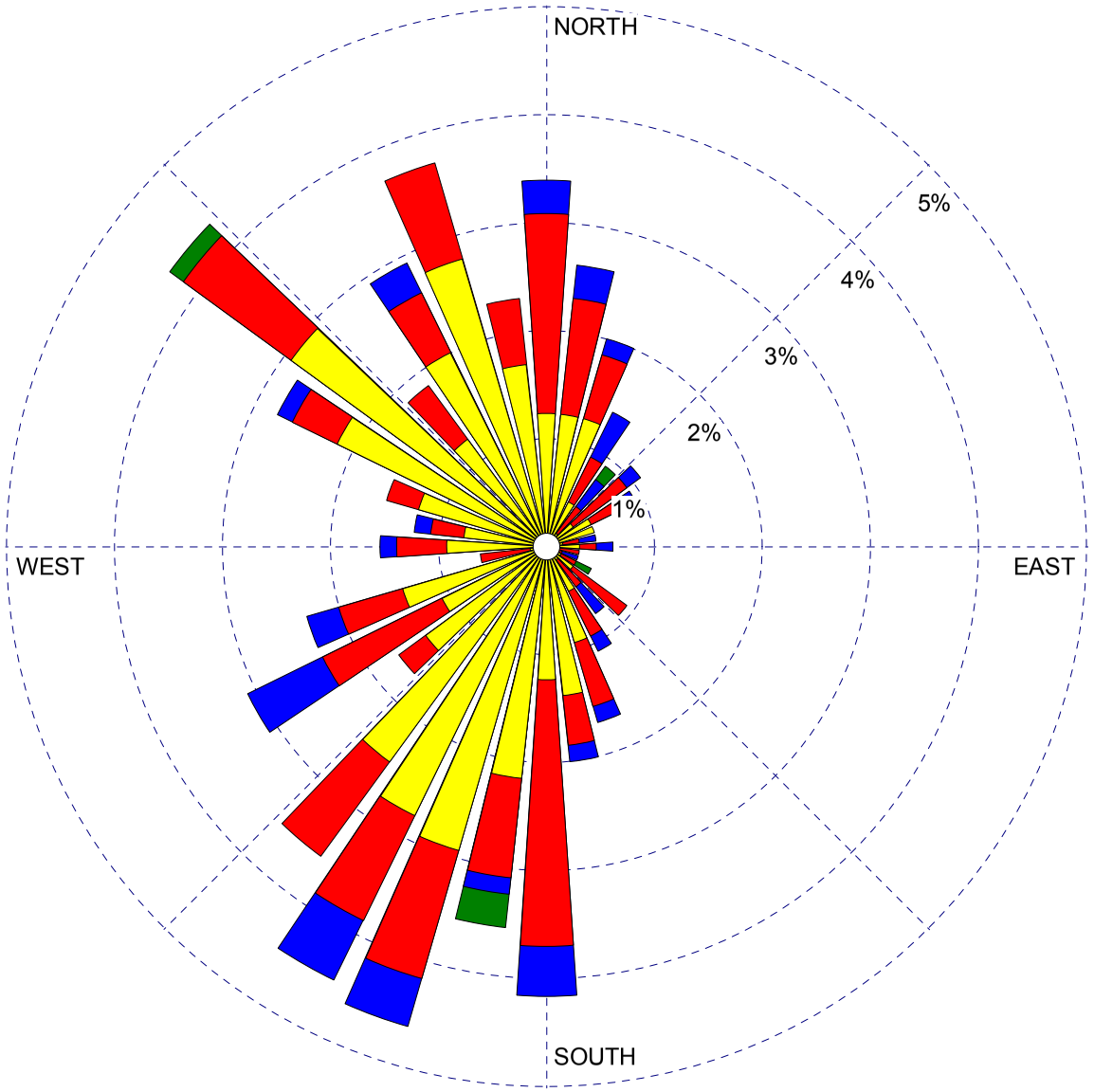
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

County Line
Ozone >=76 ppb

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:

Met Station:KCLT
600-1900 EST
No Variable winds

DATA PERIOD:

2006-2008
Jan 1 - Dec 31
00:00 - 23:00

TOTAL COUNT:	CALM WINDS:
650 hrs.	**28.46%**

AVG. WIND SPEED:

4.00 Knots

COMPANY NAME:

NCDENR

MODELER:

NCW

DATE:

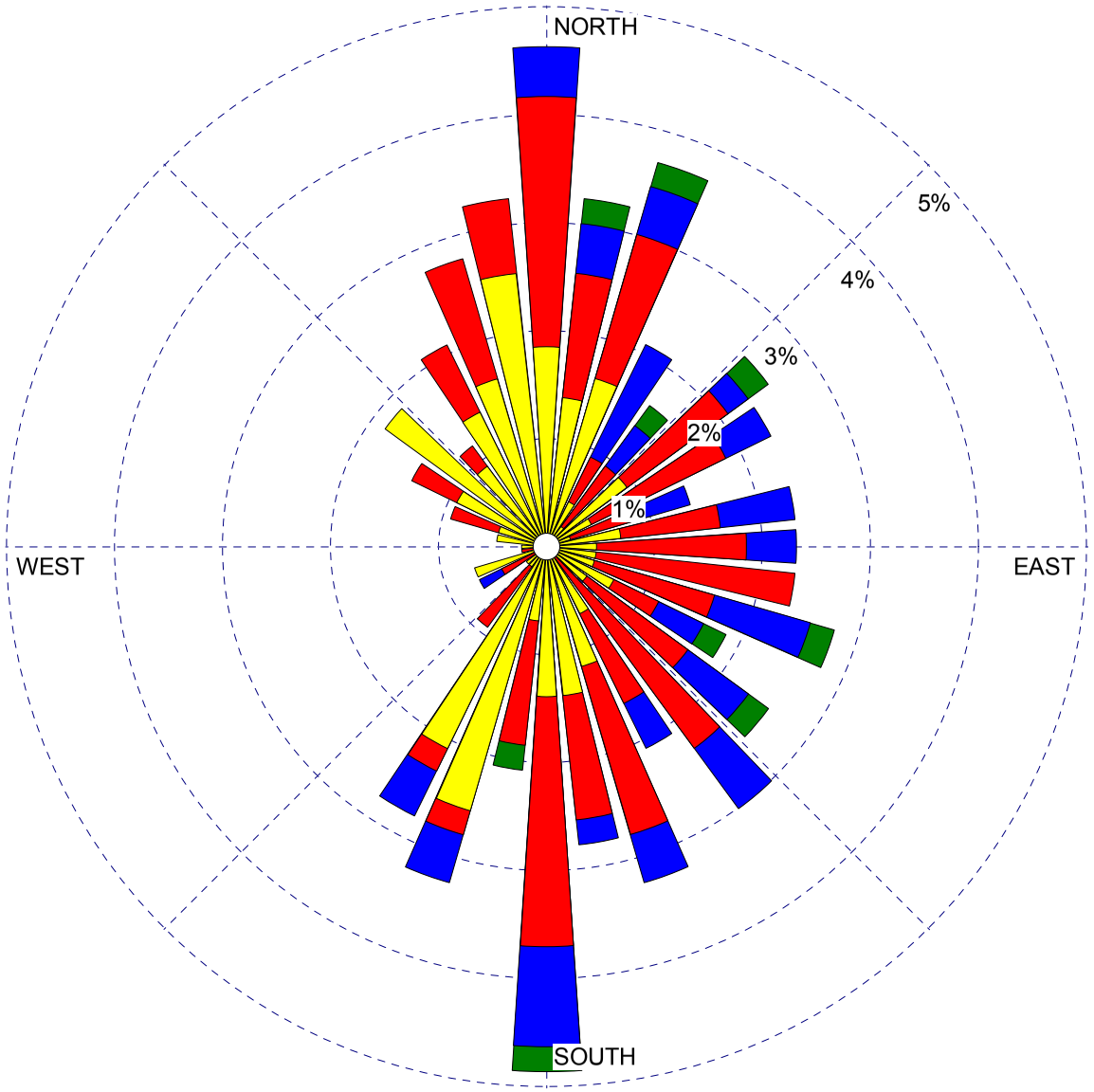
10/17/2008

PROJECT NO.:

WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:
Crouse
Ozone >=76 ppb

DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS:
Met Station:KCLT
600-1900 EST
No Variable winds

DATA PERIOD:
2006-2008
Jan 1 - Dec 31
00:00 - 23:00

TOTAL COUNT: **433 hrs.**

CALM WINDS: **23.56%**

AVG. WIND SPEED: **4.84 Knots**

COMPANY NAME: **NCDENR**

MODELER: **NCW**

DATE: **10/17/2008**

PROJECT NO.:

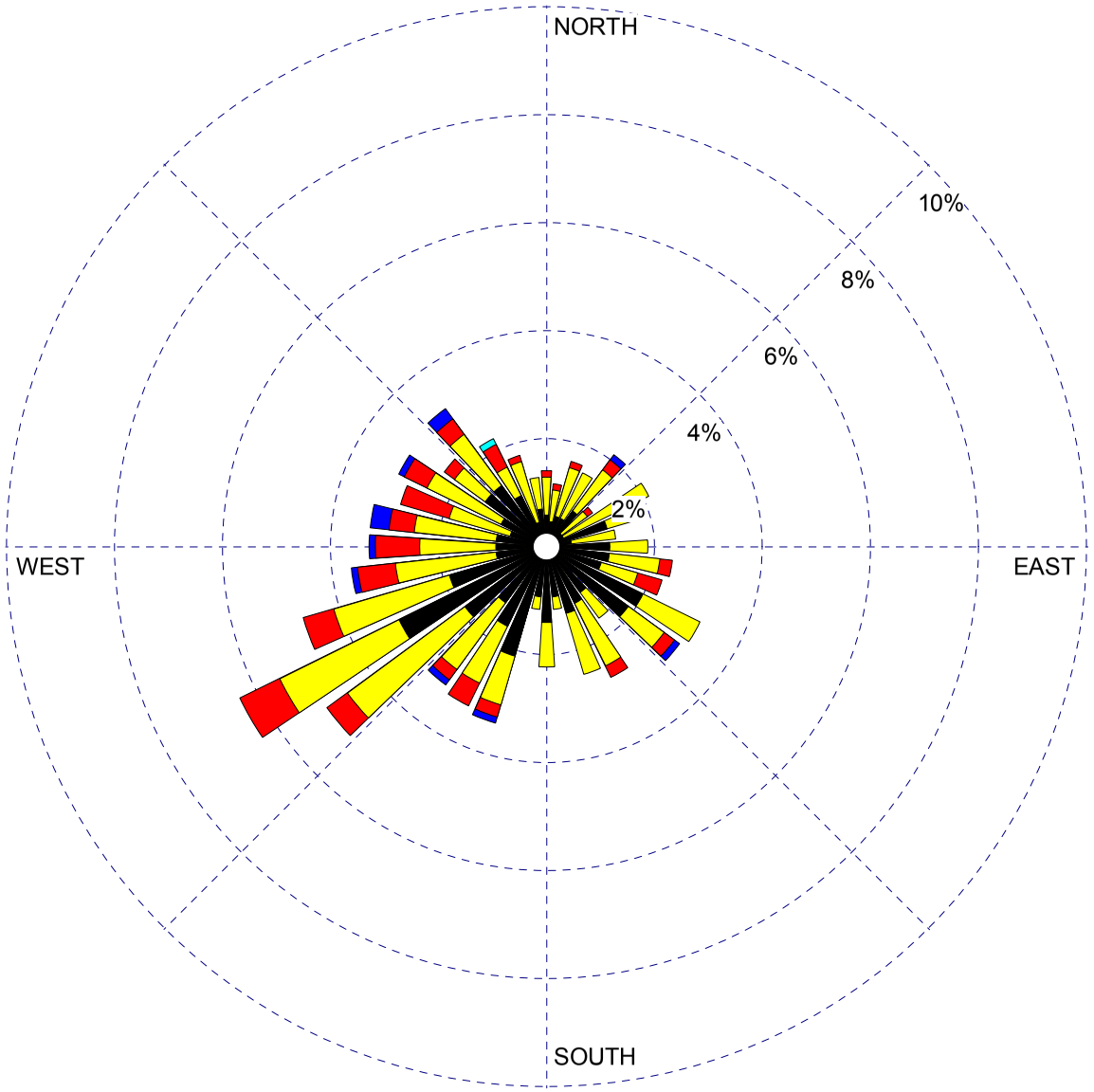
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Enochville
Ozone >=76 ppb

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:

Met Station:SALI
600-1900 EST
No Variable winds

DATA PERIOD:

2006-2008
Jan 1 - Dec 31
00:00 - 23:00

TOTAL COUNT:	CALM WINDS:
854 hrs.	**9.25%**

AVG. WIND SPEED:

2.89 Knots

COMPANY NAME:

NCDENR

MODELER:

NCW

DATE:

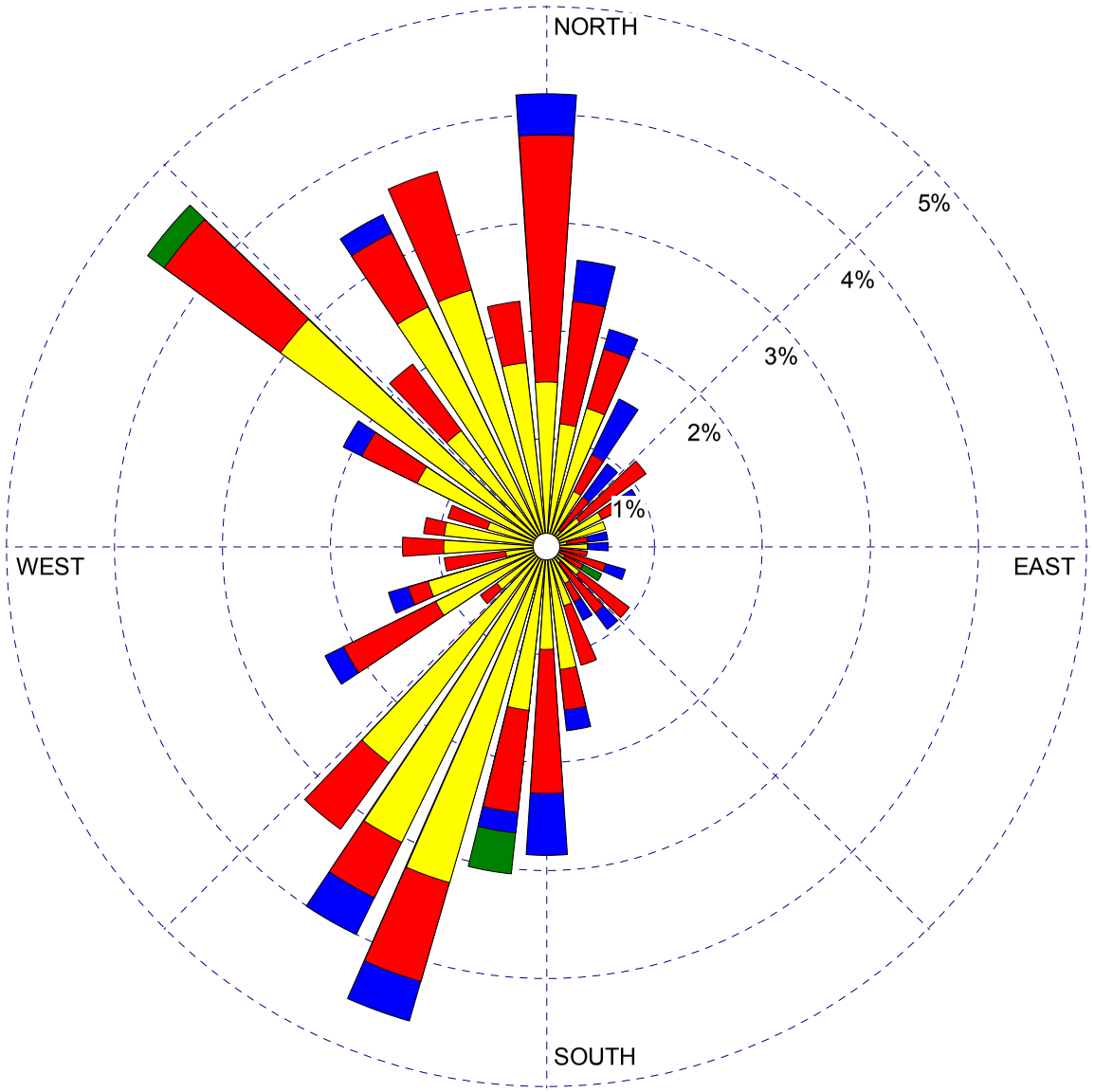
10/17/2008

PROJECT NO.:

WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:
Garinger
Ozone >=76 ppb

DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS:
Met Station:KCLT
600-1900 EST
No Variable winds

DATA PERIOD:
2006-2008
Jan 1 - Dec 31
00:00 - 23:00

TOTAL COUNT:
526 hrs.

CALM WINDS:
32.89%

AVG. WIND SPEED:
3.70 Knots

COMPANY NAME:
NCDENR

MODELER:
NCW

DATE:
10/17/2008

PROJECT NO.:

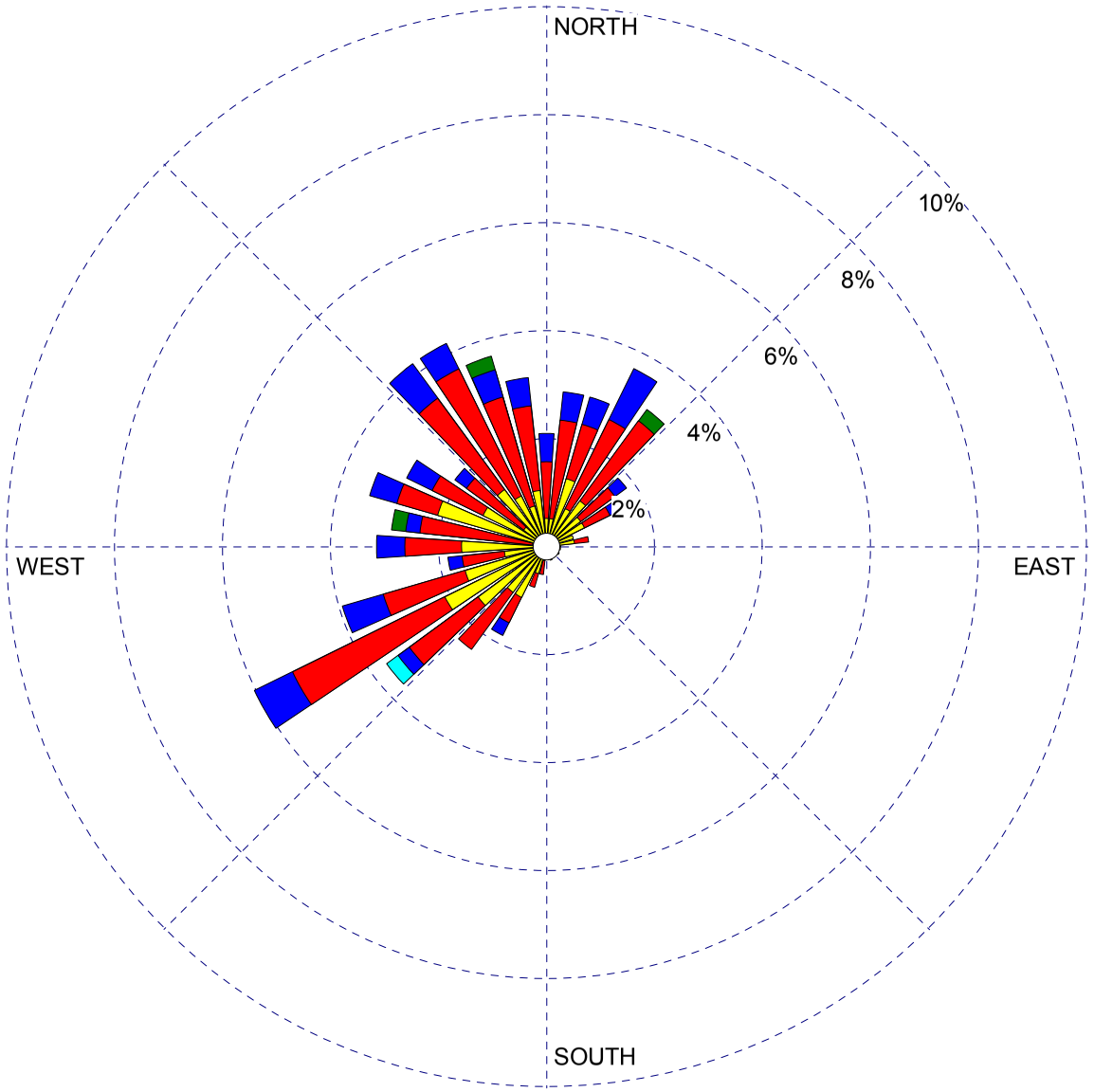
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Monroe
Ozone >=76 ppb

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:

Met Station:KEQY
600-1900 EST
No Variable winds

DATA PERIOD:

2006-2008
Jan 1 - Dec 31
00:00 - 23:00

TOTAL COUNT:	CALM WINDS:
382 hrs.	**29.06%**

AVG. WIND SPEED:

4.48 Knots

COMPANY NAME:

NCDENR

MODELER:

NCW

DATE:

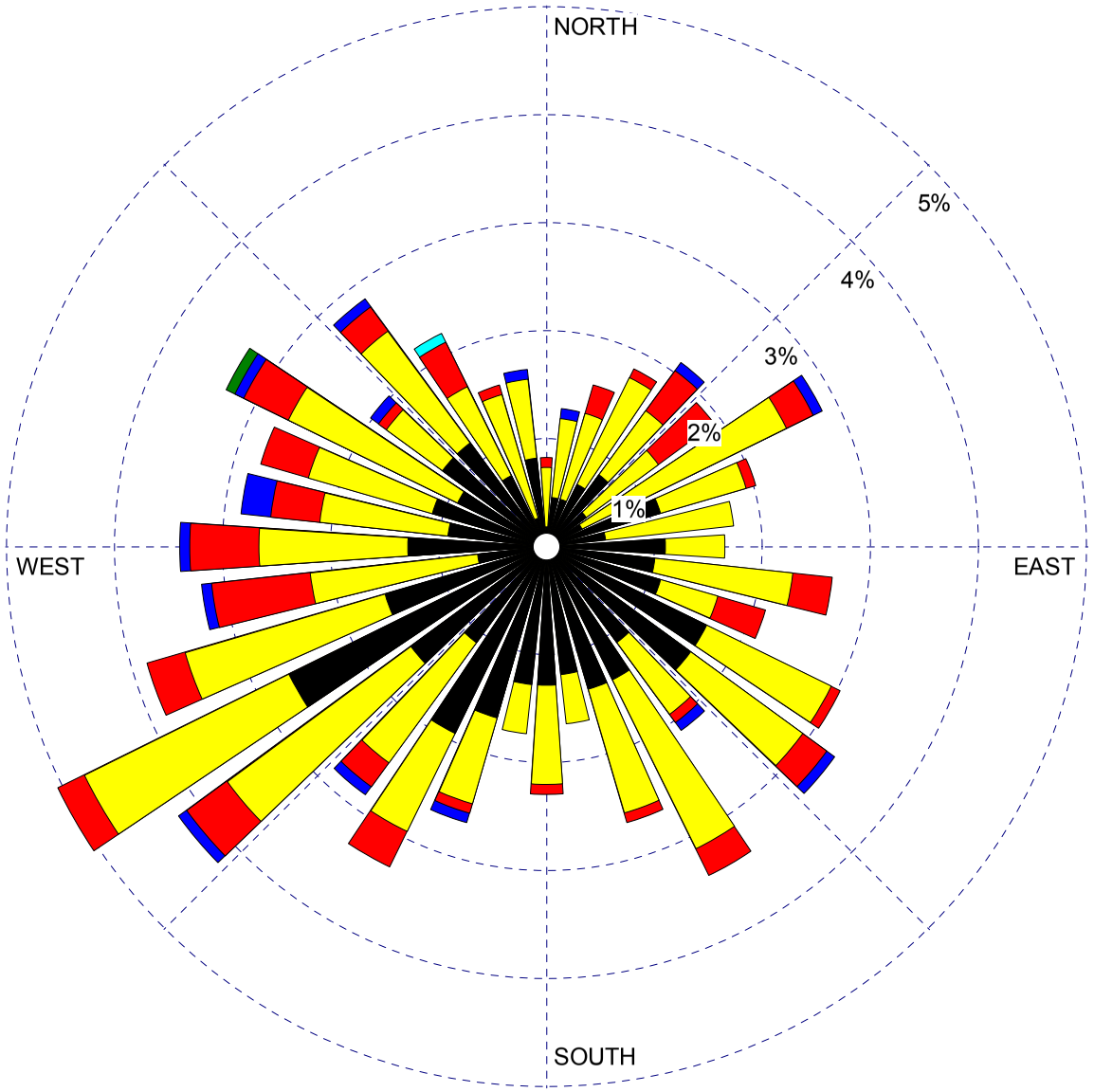
10/16/2008

PROJECT NO.:

WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:
Enochville
Ozone >=76 ppb

DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS:
Met Station:SALI
600-1900 EST
No Variable winds

DATA PERIOD:
2006-2008
Jan 1 - Dec 31
00:00 - 23:00

TOTAL COUNT:
1092 hrs.

CALM WINDS:
9.71%

AVG. WIND SPEED:
2.94 Knots

COMPANY NAME:
NCDENR

MODELER:
NCW

DATE:
10/17/2008

PROJECT NO.:

WRPLOT View - Lakes Environmental Software