

Chapter WQ

COAL QUALITY AND GEOCHEMISTRY, WILLISTON
BASIN, NORTH DAKOTA

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Contents

Coal Quality and Geochemistry, Williston Basin, North Dakota.....	WQ-1
References Cited	WQ-5

Figures

- WQ-1. Index map showing the Williston Basin, North Dakota.
- WQ-2. Index map showing coal quality data distribution in the Hagel coal zone, Center-Falkirk.
- WQ-3. Index map showing coal quality data distribution in the Beulah-Zap coal zone, Beulah coalfield.
- WQ-4. Index map showing coal quality data distribution in the Harmon coal zone, Bowman-Dickinson coalfield.
- WQ-5. Index map showing coal quality data distribution in the the Hansen coal zone, Bowman-Dickinson coalfield.
- WQ-6. Ash yield in the Hagel coal zone, Center-Falkirk coalfield.
- WQ-7. Ash yield in the Beulah-Zap coal zone, Beulah coalfield.
- WQ-8. Ash yield in the Harmon coal zone, Bowman-Dickinson coalfield.
- WQ-9. Ash yield in the Hansen coal zone, Bowman-Dickinson coalfield.
- WQ-10. Sulfur content in the Hagel coal zone, Center-Falkirk coalfield.
- WQ-11. Sulfur content in the Beulah-Zap coal zone, Beulah coalfield.
- WQ-12. Sulfur content in the Harmon coal zone, Bowman-Dickinson coalfield.
- WQ-13. Sulfur content in the Hansen coal zone, Bowman-Dickinson coalfield.
- WQ-14. Moist, mineral-matter-free Btu/lb in the Hagel coal zone, Center-Falkirk coalfield.

Figures—continued

- WQ-15.** Moist, mineral-matter-free Btu/lb in the Beulah-Zap coal zone, Beulah coalfield.
- WQ-16.** Moist, mineral-matter-free Btu/lb in the Harmon coal zone, Bowman-Dickinson coalfield.
- WQ-17.** Moist, mineral-matter-free Btu/lb in the Hansen coal zone, Bowman-Dickinson coalfield.
- WQ-18.** Pounds of sulfur dioxide per million Btu in the Hagel coal zone, Center-Falkirk coalfield.
- WQ-19.** Pounds of sulfur dioxide per million Btu in the Beulah-Zap coal zone, Beulah coalfield.
- WQ-20.** Pounds of sulfur dioxide per million Btu in the Harmon coal zone, Bowman-Dickinson coalfield.
- WQ-21.** Pounds of sulfur dioxide per million Btu in the Hansen coal zone, Bowman-Dickinson coalfield.
- WQ-22.** Antimony concentration in the Hagel coal zone, Center-Falkirk coalfield.
- WQ-23.** Arsenic concentration in the Hagel coal zone, Center-Falkirk coalfield.
- WQ-24.** Beryllium concentration in the Hagel coal zone, Center-Falkirk coalfield.
- WQ-25.** Cadmium concentration in the Hagel coal zone, Center-Falkirk coalfield.
- WQ-26.** Chromium concentration in the Hagel coal zone, Center-Falkirk coalfield.
- WQ-27.** Cobalt concentration in the Hagel coal zone, Center-Falkirk coalfield.
- WQ-28.** Lead concentration in the Hagel coal zone, Center-Falkirk coalfield.
- WQ-29.** Manganese concentration in the Hagel coal zone, Center-Falkirk coalfield.
- WQ-30.** Mercury concentration in the Hagel coal zone, Center-Falkirk coalfield.

Figures—continued

- WQ-31. Nickel concentration in the Hagel coal zone, Center-Falkirk coalfield.
- WQ-32. Selenium concentration in the Hagel coal zone, Center-Falkirk coalfield.
- WQ-33. Uranium concentration in the Hagel coal zone, Center-Falkirk coalfield.
- WQ-34. Antimony concentration in the Beulah-Zap coal zone, Beulah coalfield.
- WQ-35. Arsenic concentration in the Beulah-Zap coal zone, Beulah coalfield.
- WQ-36. Beryllium concentration in the Beulah-Zap coal zone, Beulah coalfield.
- WQ-37. Cadmium concentration in the Beulah-Zap coal zone, Beulah coalfield.
- WQ-38. Chromium concentration in the Beulah-Zap coal zone, Beulah coalfield.
- WQ-39. Cobalt concentration in the Beulah-Zap coal zone, Beulah coalfield.
- WQ-40. Lead concentration in the Beulah-Zap coal zone, Beulah coalfield.
- WQ-41. Manganese concentration in the Beulah-Zap coal zone, Beulah coalfield.
- WQ-42. Mercury concentration in the Beulah-Zap coal zone, Beulah coalfield.
- WQ-43. Nickel concentration in the Beulah-Zap coal zone, Beulah coalfield.
- WQ-44. Selenium concentration in the Beulah-Zap coal zone, Beulah coalfield.
- WQ-45. Uranium concentration in the Beulah-Zap coal zone, Beulah coalfield.
- WQ-46. Antimony concentration in the Harmon coal zone, Bowman-Dickinson coalfield.
- WQ-47. Arsenic concentration in the Harmon coal zone, Bowman-Dickinson coalfield.
- WQ-48. Beryllium concentration in the Harmon coal zone, Bowman-Dickinson coalfield.
- WQ-49. Cadmium concentration in the Harmon coal zone, Bowman-Dickinson coalfield.

Figures—continued

- WQ-50.** Chromium concentration in the Harmon coal zone, Bowman-Dickinson coalfield.
- WQ-51.** Cobalt concentration in the Harmon coal zone, Bowman-Dickinson coalfield.
- WQ-52.** Lead concentration in the Harmon coal zone, Bowman-Dickinson coalfield.
- WQ-53.** Manganese concentration in the Harmon coal zone, Bowman-Dickinson coalfield.
- WQ-54.** Mercury concentration in the Harmon coal zone, Bowman-Dickinson coalfield.
- WQ-55.** Nickel concentration in the Harmon coal zone, Bowman-Dickinson coalfield.
- WQ-56.** Selenium concentration in the Harmon coal zone, Bowman-Dickinson coalfield.
- WQ-57.** Uranium concentration in the Harmon coal zone, Bowman-Dickinson coalfield.
- WQ-58.** Arsenic concentration in the Hansen coal zone, Bowman-Dickinson coalfield.
- WQ-59.** Cadmium concentration in the Hansen coal zone, Bowman-Dickinson coalfield.
- WQ-60.** Chromium concentration in the Hansen coal zone, Bowman-Dickinson coalfield.
- WQ-61.** Lead concentration in the Hansen coal zone, Bowman-Dickinson coalfield.

Figures—continued

- WQ-62.** Mercury concentration in the Hansen coal zone, Bowman-Dickinson coalfield.
- WQ-63.** Selenium concentration in the Hansen coal zone, Bowman-Dickinson coalfield.
- WQ-64.** Uranium concentration in the Hansen coal zone, Bowman-Dickinson coalfield.

Tables

- WQ-1.** Summary data for the Hagel, Beulah-Zap, Harmon, and Hansen coal zones
- WQ-2.** Summary data for the Hagel coal zone, Center-Falkirk coalfield
- WQ-3.** Summary data for the Beulah-Zap coal zone, Beulah coalfield
- WQ-4.** Summary data for the Harmon coal zone, Bowman-Dickinson coalfield
- WQ-5.** Summary data for the Hansen coal zone, Bowman-Dickinson coalfield

COAL QUALITY AND GEOCHEMISTRY, WILLISTON BASIN, NORTH DAKOTA

Coal in the Williston Basin, North Dakota is considered to be a low-contaminant lignite resource. The coal assessment in the Williston Basin includes has three coalfields ([fig. WQ-1](#)) that contain four coal zones: (1) Center-Falkirk coalfield with the Hagel coal zone, (2) Beulah coalfield with the Beulah-Zap coal zone, and (3) Bowman-Dickinson coalfield with the Harmon and Hansen coal zones. For the location and description of coalfields and coal zones, see [chapter WF-Framework Geology of Fort Union coal in the Williston Basin](#). Coal analyses from the Hagel, Beulah-Zap, Harmon, and Hansen, coal zones have the following arithmetic mean values (on an as-received basis): **moisture**–37.88 percent, **ash yield**–7.96 percent, **total sulfur**–0.84 percent, **calorific value**–6,510 Btu/lb, **pounds of SO₂ per million Btu**–2.54, and **moist, mineral-matter-free Btu/lb**–7,110. Arithmetic mean concentration (in parts per million and on whole-coal and remnant-moisture basis) of elements of environmental concern for coal in these coal beds are: **antimony**–0.60, **arsenic**–9.1, **beryllium**–0.73, **cadmium**–0.086, **chromium**–7.4, **cobalt**–2.9, **lead**–3.5, **manganese**–75, **mercury**–0.14, **nickel**–4.3, **selenium**–0.74, and **uranium**–1.5. Coal from the Williston Basin is developed from 4 mines and utilized for mine mouth electric power generation. [Table WQ-1](#) is a summary of analytical values from the four coal zones (Hagel, Beulah-Zap, Harmon, and Hansen). [Tables WQ-2 through WQ-5](#) summarize the analytical values for coal in the four coal zones separately.

Both proprietary and public data are used in the summary data tables, but only public data is shown on location maps and on other graphic displays. A common problem in statistical summaries of trace-element data arises when element values

are below the limits of detection. This results in a censored distribution. To compute unbiased estimates of censored data for the elements in this table, we adopted the protocol of reducing all “less than” values by 50 percent to generate a real value for these data. Summary statistics of range (minimum, with an “L” indicating “less than”, and maximum values) and arithmetic means were generated using the modified data. Moisture values are reported on an as-received basis (American Society for Testing and Materials, 1994b, designation D3180-89). Because no equilibrium moisture values are available for this report, apparent ranks can not reliably be determined.

Between 1974 and 1994, the U.S. Geological Survey analyzed samples of coal for major-, minor-, and trace-element contents. Prior to performing the analyses, most of the coal samples were dried at room temperature and humidity for as much as 80 hours. Some samples, however, may have only been dried enough to allow grinding (to less than 100 mesh). Moisture content in the samples is unknown, although moisture contents were probably similar to that which would remain after air-dry loss determination (American Society for Testing and Materials ASTM Standards, 1994c, designation D3302-91). Since the actual moisture content of the samples analyzed between 1974 and 1994 is unknown and can not be determined, the major-, minor-, and trace-element contents are reported on a remnant moisture basis. Also, the elemental analysis of the samples cannot be converted to any other moisture basis. In addition, these analyses can only provide an approximation of load factors (such as, pounds of mercury per trillion Btu).

For the following graphical displays, figures WQ-2 through WQ-62, show public data locations and values of the variables listed in **tables WQ-2 through WQ-5**, except for calorific value and moisture, for the coal in the Hagel, Beulah-Zap,

Harmon, and Hansen coal zones. The locations of public data points used in this summary are shown on [figures WQ-2 through WQ-5](#). When more than one analysis was available per location, the analytical values were weight averaged on coal sample thickness. For ash ([figs. WQ-6 through WQ-9](#)) and total sulfur ([figs. WQ-10 through WQ-13](#)), the values are color coded low, medium, and high, following guidelines established in U.S. Geological Survey Circular 891 (Wood and others, 1983). For moist, mineral-matter-free Btu, which is used in conjunction with other factors to determine apparent rank ([figs. WQ-14 through WQ-17](#)), we utilized the apparent rank designations established by American Society for Testing and Materials, (1994a), designation D388-92a. For pounds of SO₂ per million Btu ([figs. WQ-18 through WQ-21](#)), values are color coded according to the U.S. Environmental Protection Agency’s Phase I, Phase II, and non-compliant limits for sulfur emission from coal-fired power plants (U.S. Environmental Protection Agency, 1996).

No guidelines have been established for the elements of environmental concern (also referred to as “hazardous air pollutants” or “HAPs”). Analytical values for these elements are color coded based on the following parameters: (1) each element of environmental concern was ranked from the lowest to highest value for all data in the Northern Rockies and Great Plains region, and (2) quartiles were established for each element. Low represents those values that are less than the .25 quartile (also known as the lower quartile or the 25th percentile). Medium represents those values that are within the .25 to .75 quartiles (two quartiles representing 50 percent of the values or between the 25th to 75th percentile). High represents those values that are in the upper .25 quartile (or greater than the 75th percentile). [Figures WQ-22 through WQ-64](#) show the elements of environmental concern. [Figures WQ-22 through WQ-33](#) are for the Hagel coal zone, [figures WQ-](#)

34 through WQ-45 are for the Beulah-Zap coal zone, figures WQ-46 through WQ-57 are for the Harmon coal zone, and figures WQ-58 through WQ-64 are for the Hansen coal zone.

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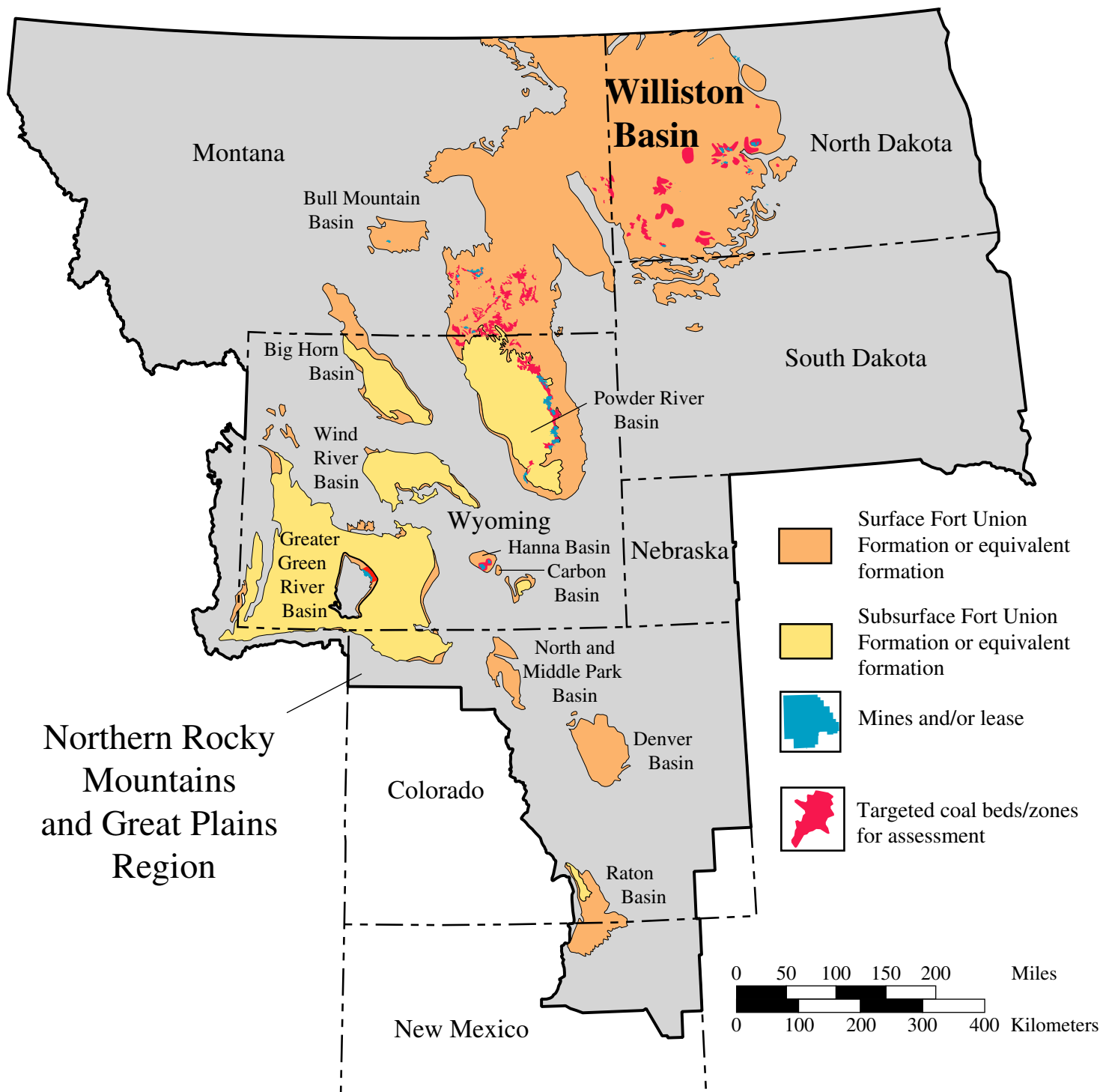


Figure WQ-1. Index map showing the Williston Basin, North Dakota.

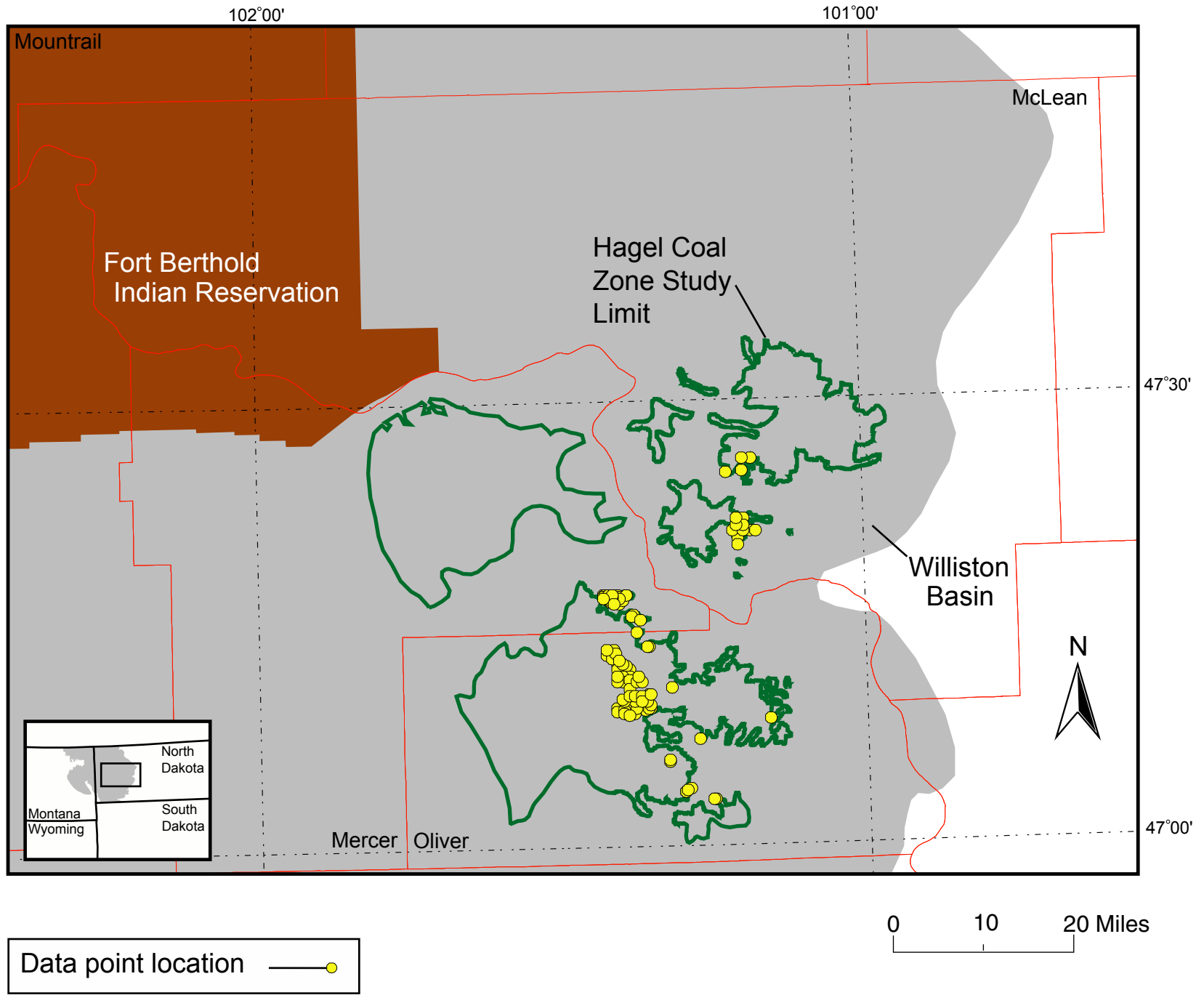


Figure WQ-2. Index map showing coal quality data distribution in the Hagel coal zone, Center-Falkirk coalfield, Williston Basin, North Dakota.

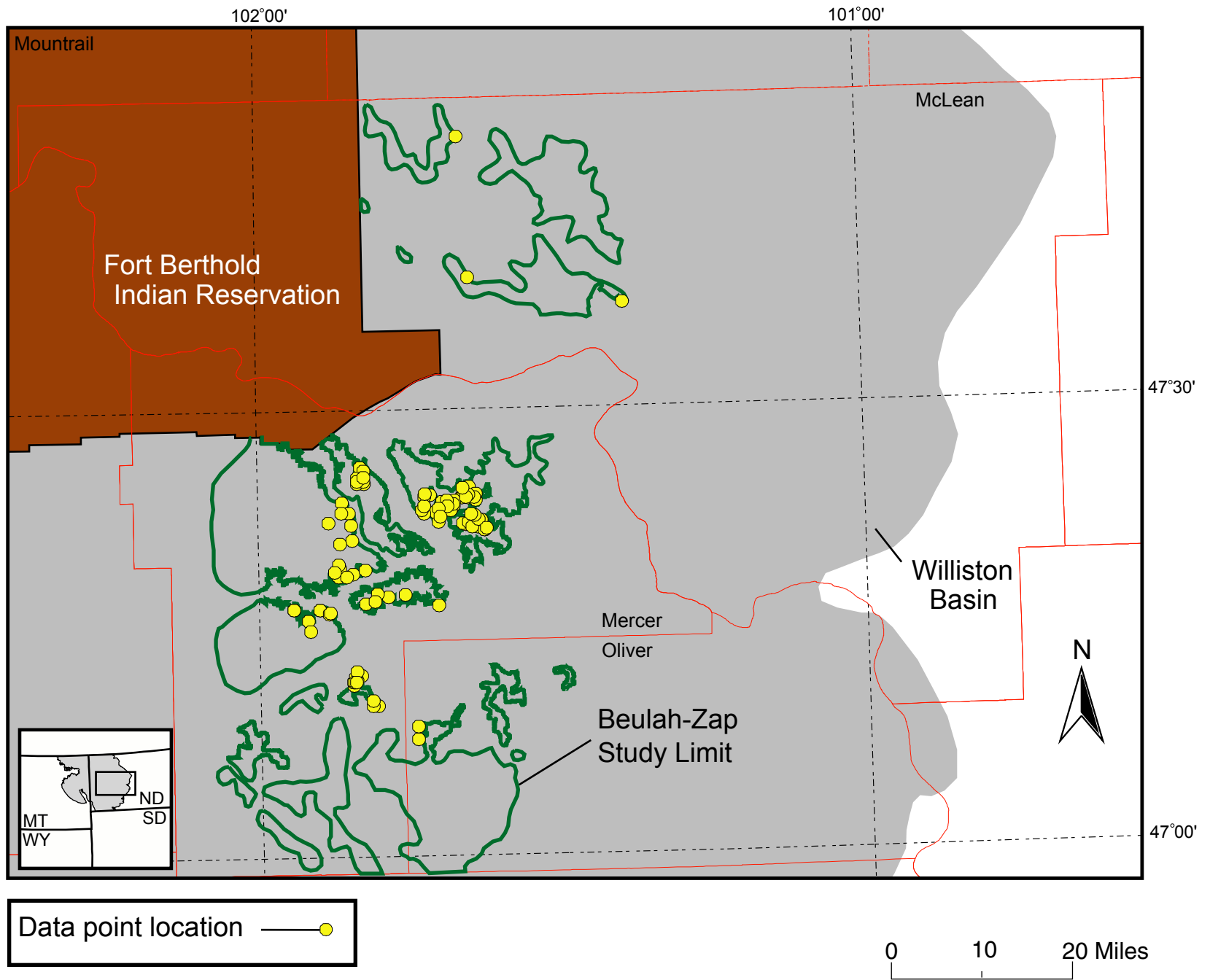


Figure WQ-3. Index map showing coal quality data distribution in the Beulah-Zap coal zone, Beulah coalfield, Williston Basin, North Dakota.

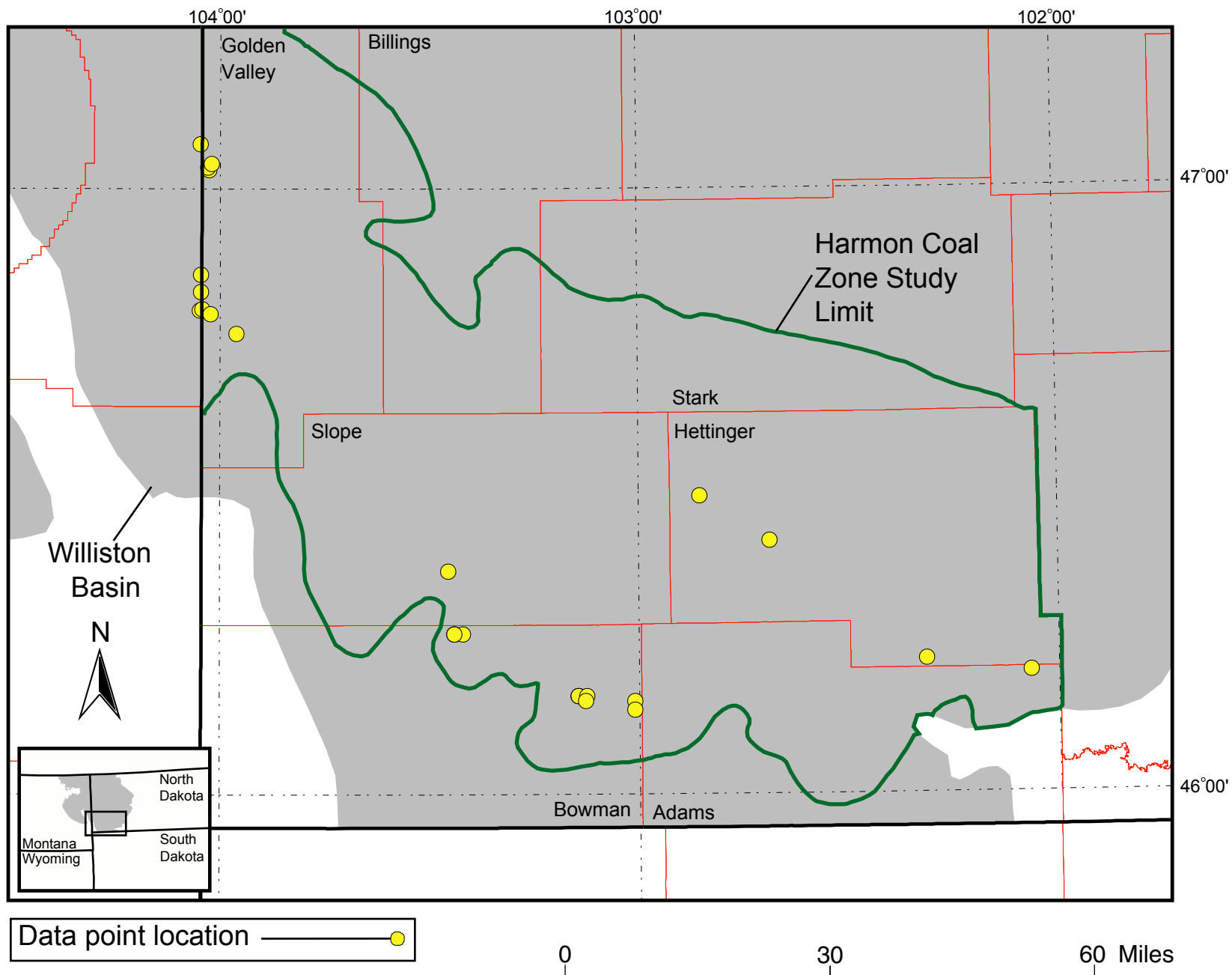


Figure WQ-4. Index map showing coal quality data distribution in the Harmon coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

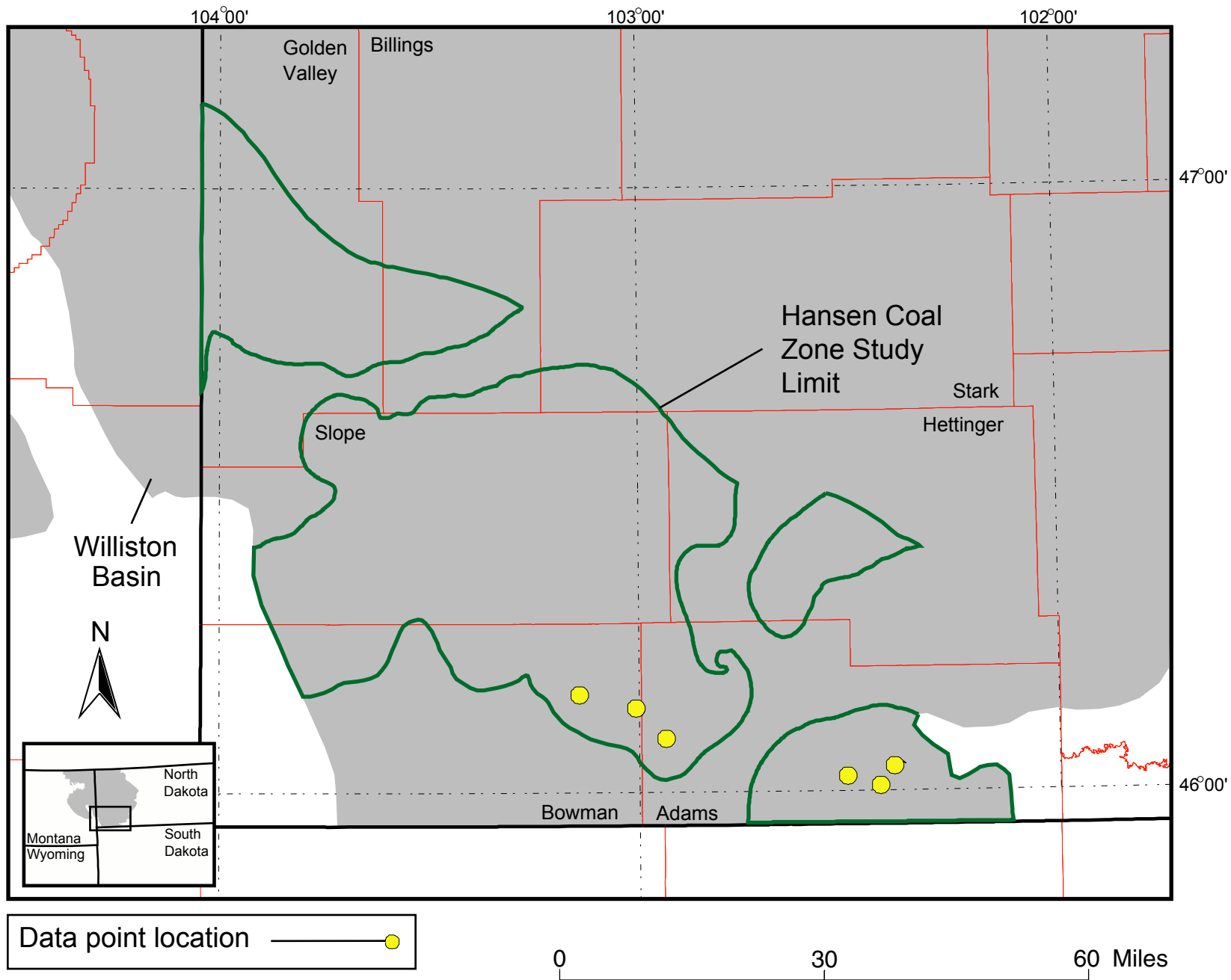


Figure WQ-5. Index map showing coal quality data distribution in the Hansen coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

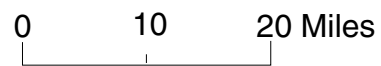
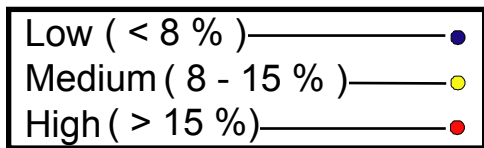
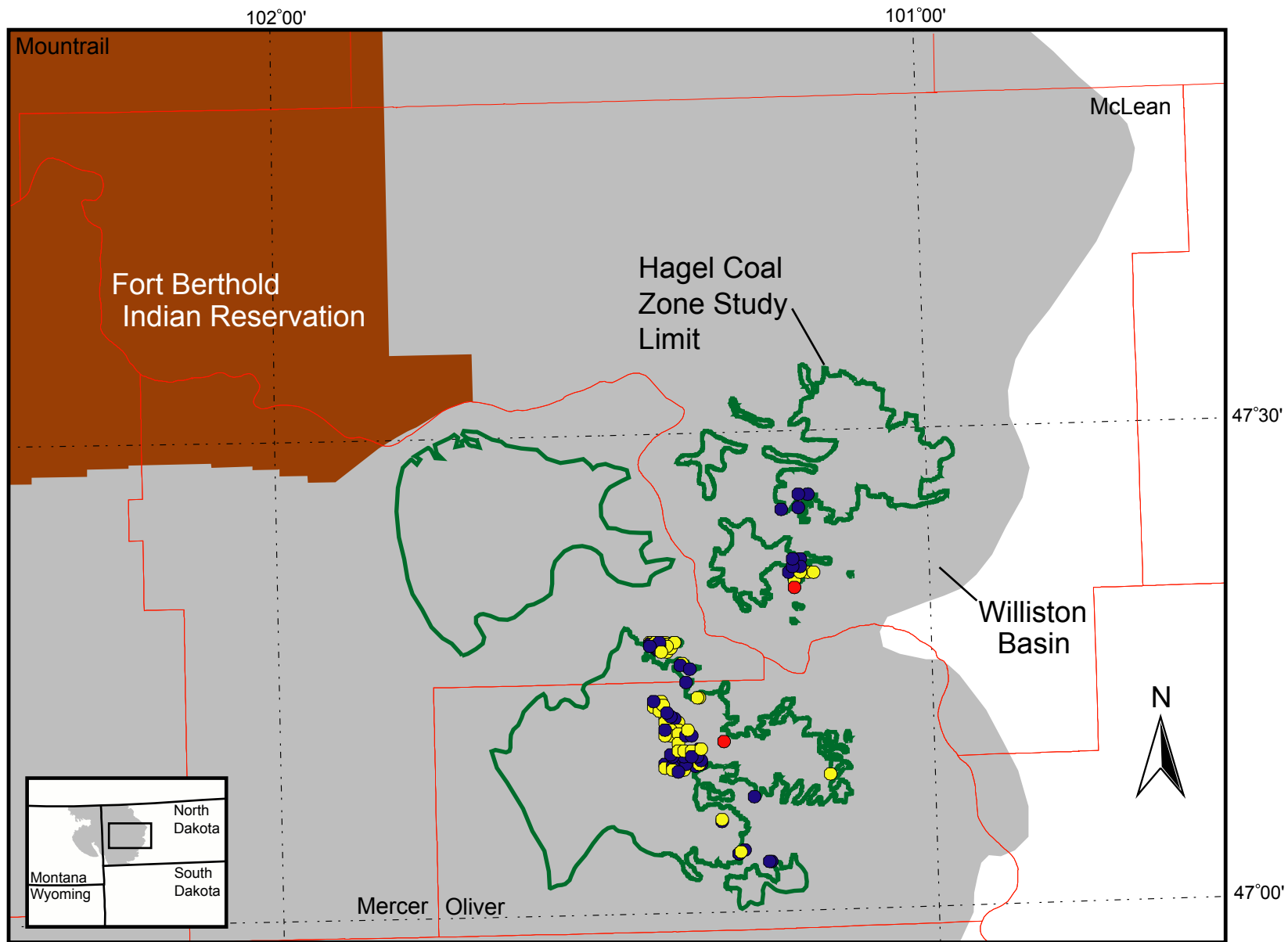


Figure WQ-6. Ash yield in the Hagel coal zone, Center-Falkirk coalfield, Williston Basin, North Dakota.

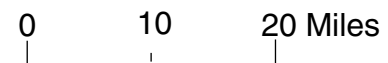
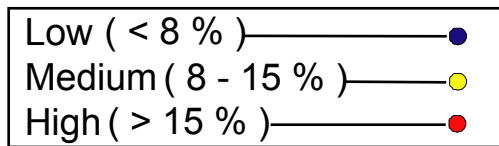
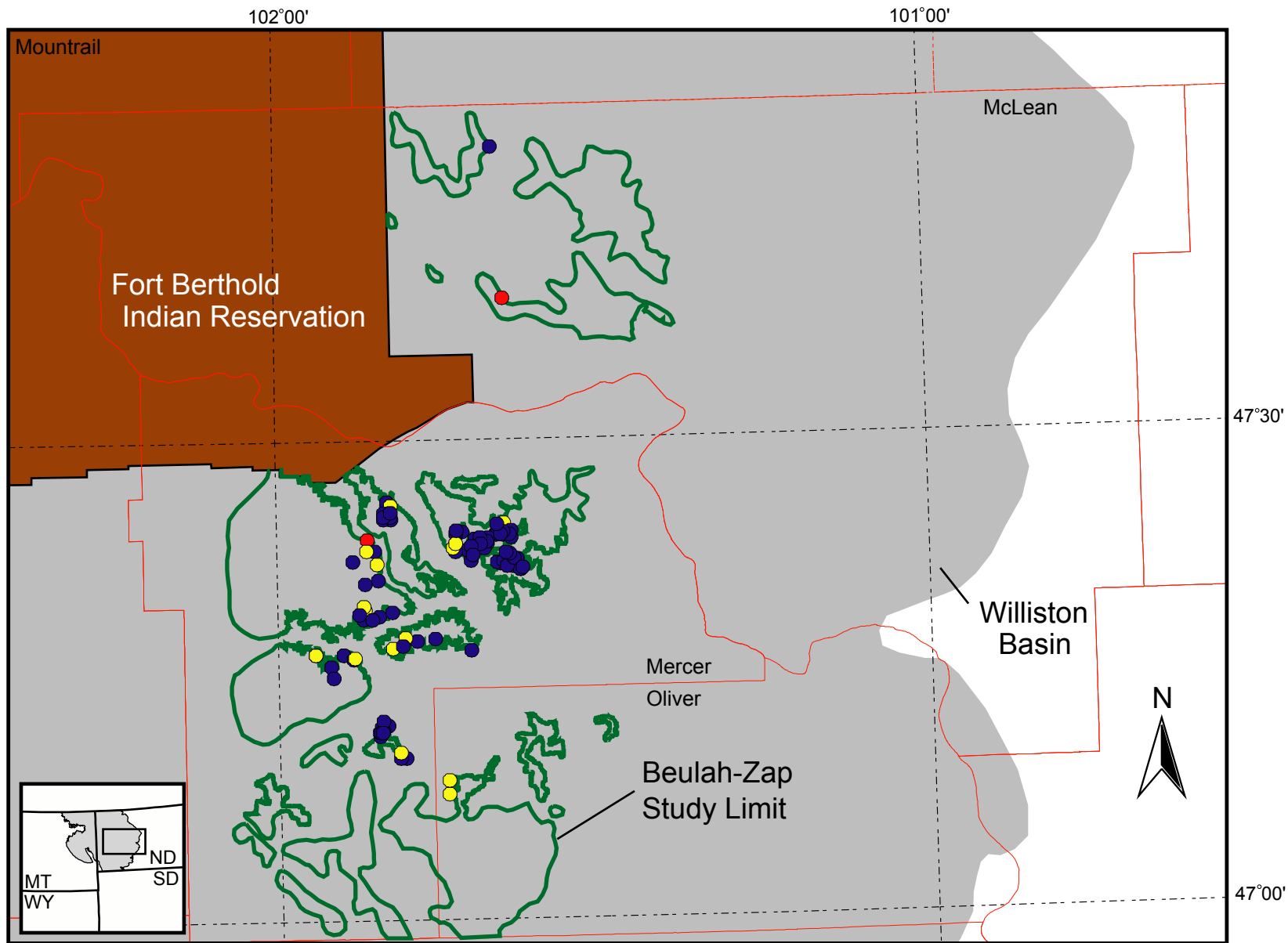


Figure WQ-7. Ash yield in the Beulah-Zap coal zone, Beulah coalfield, Williston Basin, North Dakota.

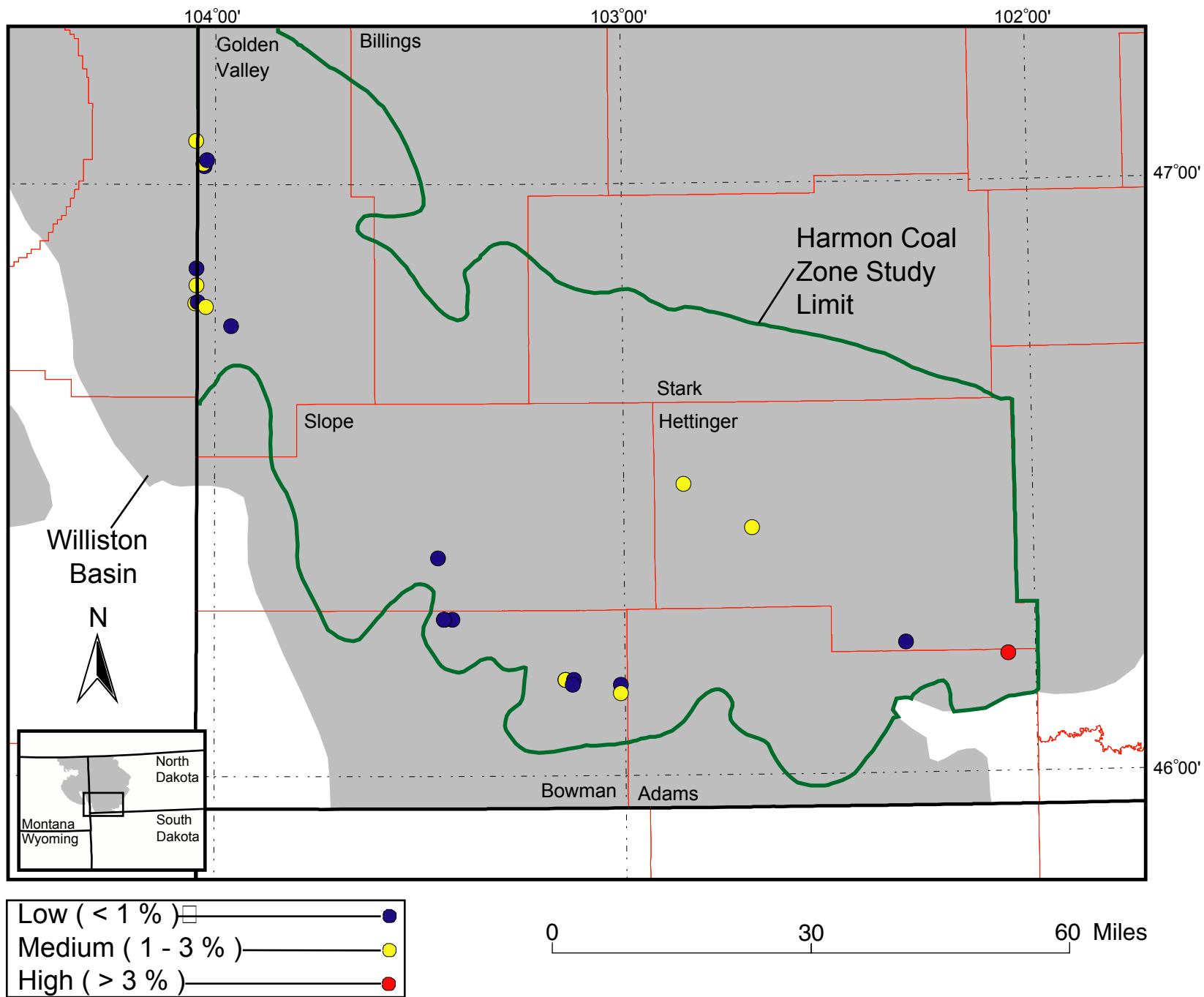


Figure WQ-8. Ash yield in the Harmon coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

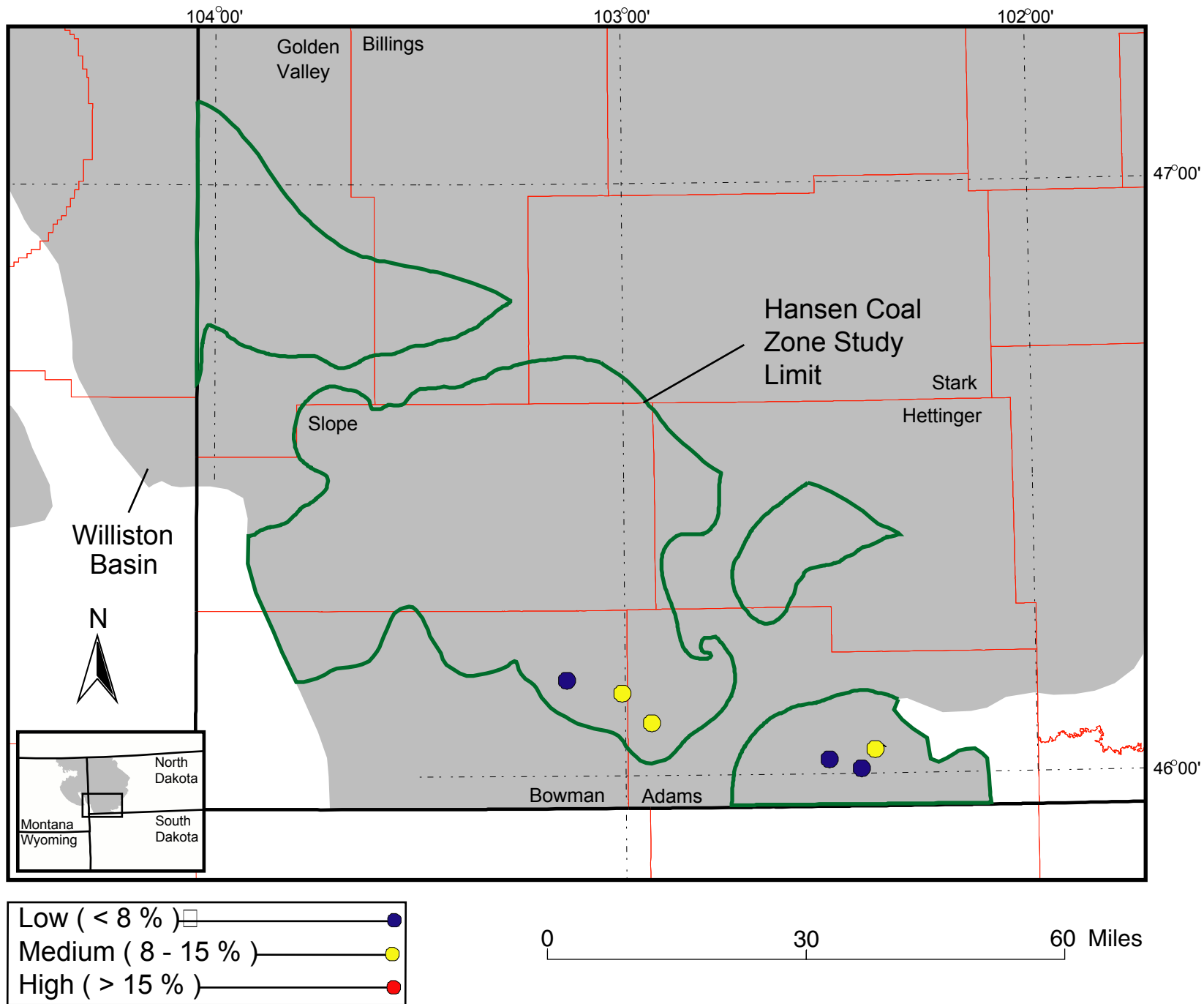


Figure WQ-9. Ash yield in the Hansen coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

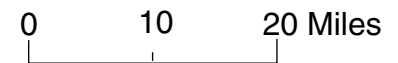
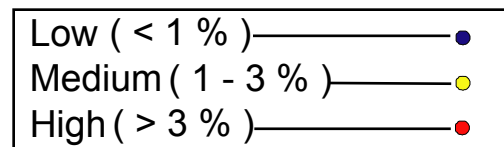
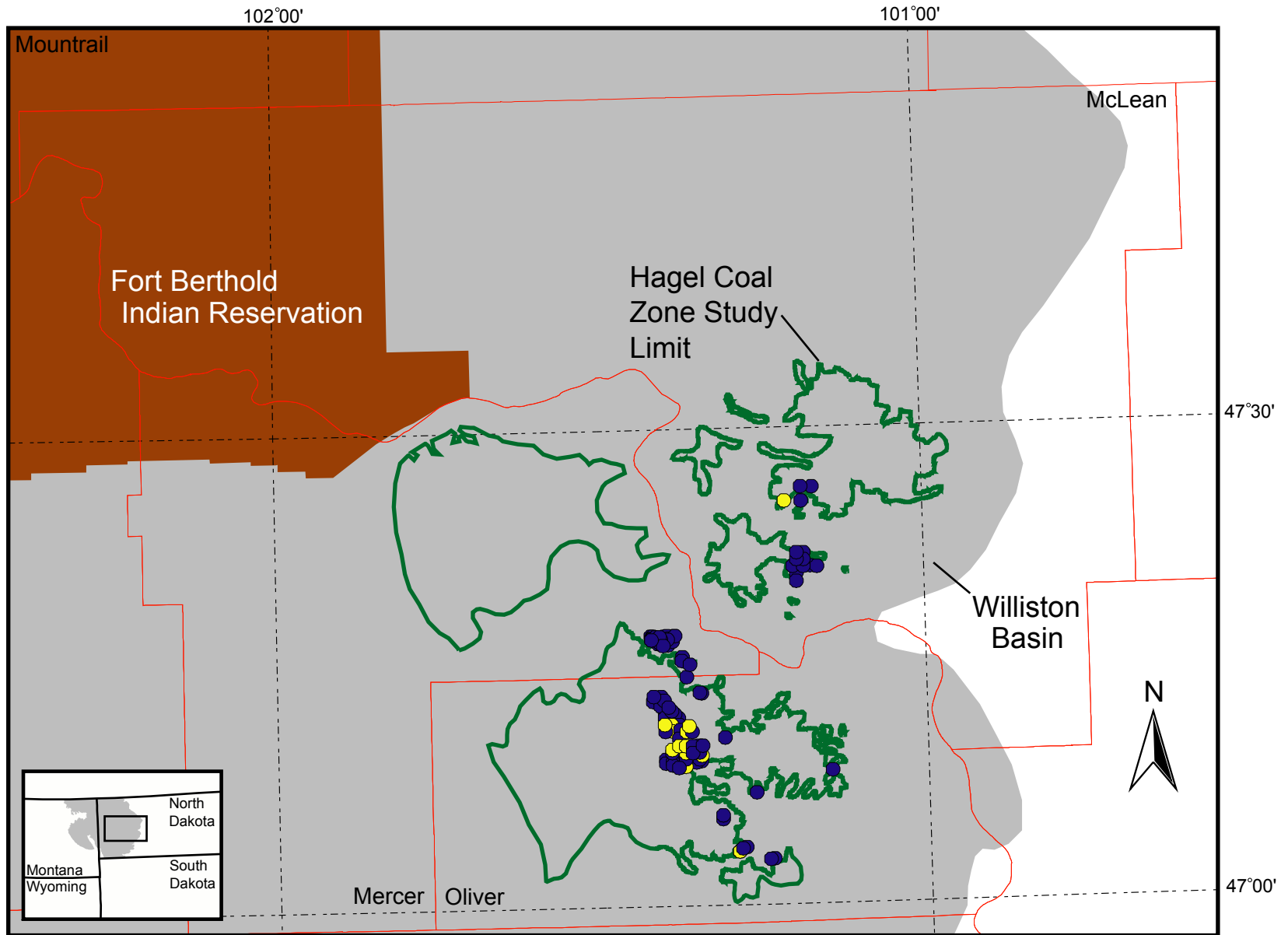


Figure WQ-10. Sulfur content in the Hagel coal zone, Center-Falkirk coalfield, Williston Basin, North Dakota.

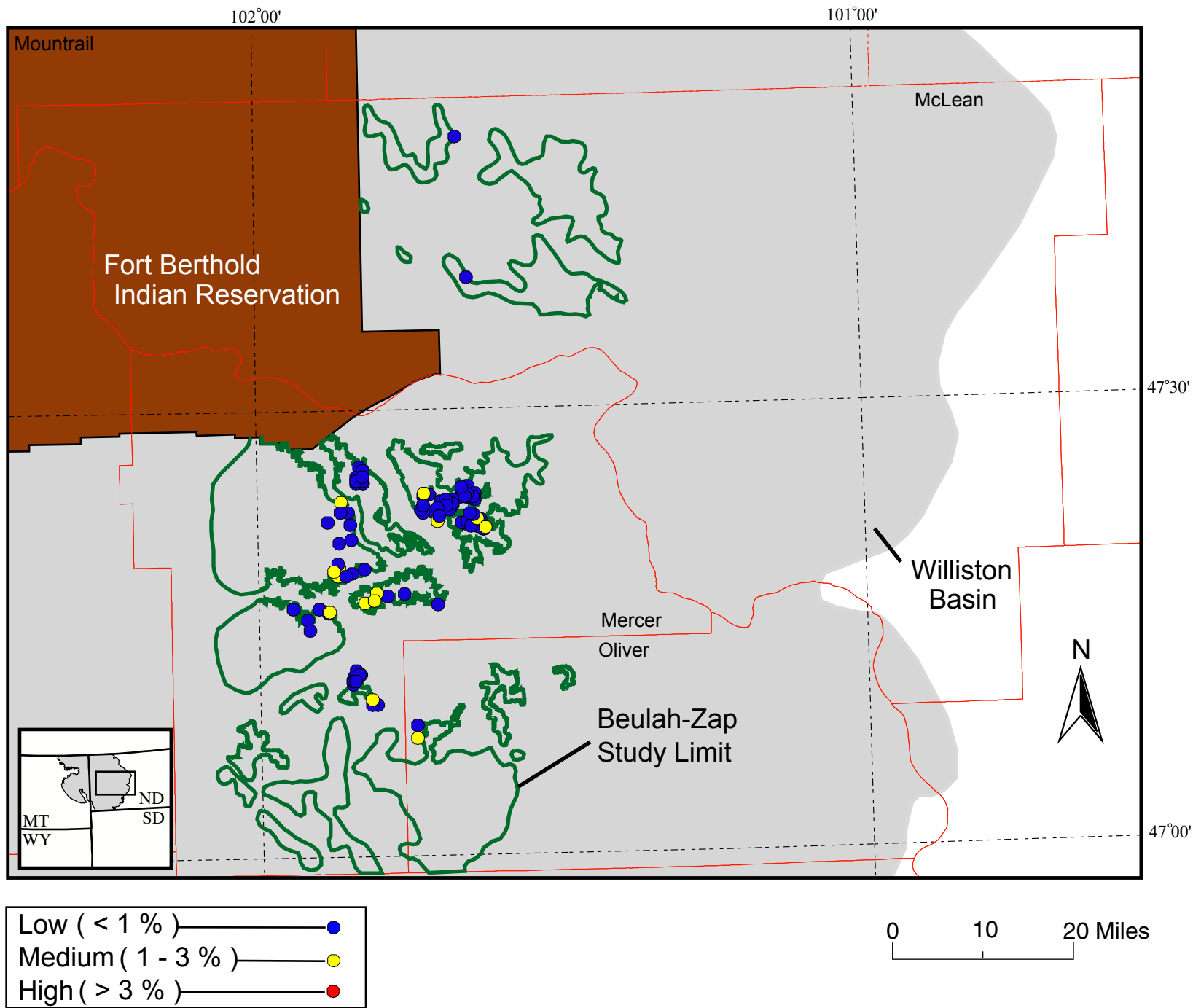


Figure WQ-11. Sulfur content in the Beulah-Zap coal zone, Beulah coalfield, Williston Basin, North Dakota.

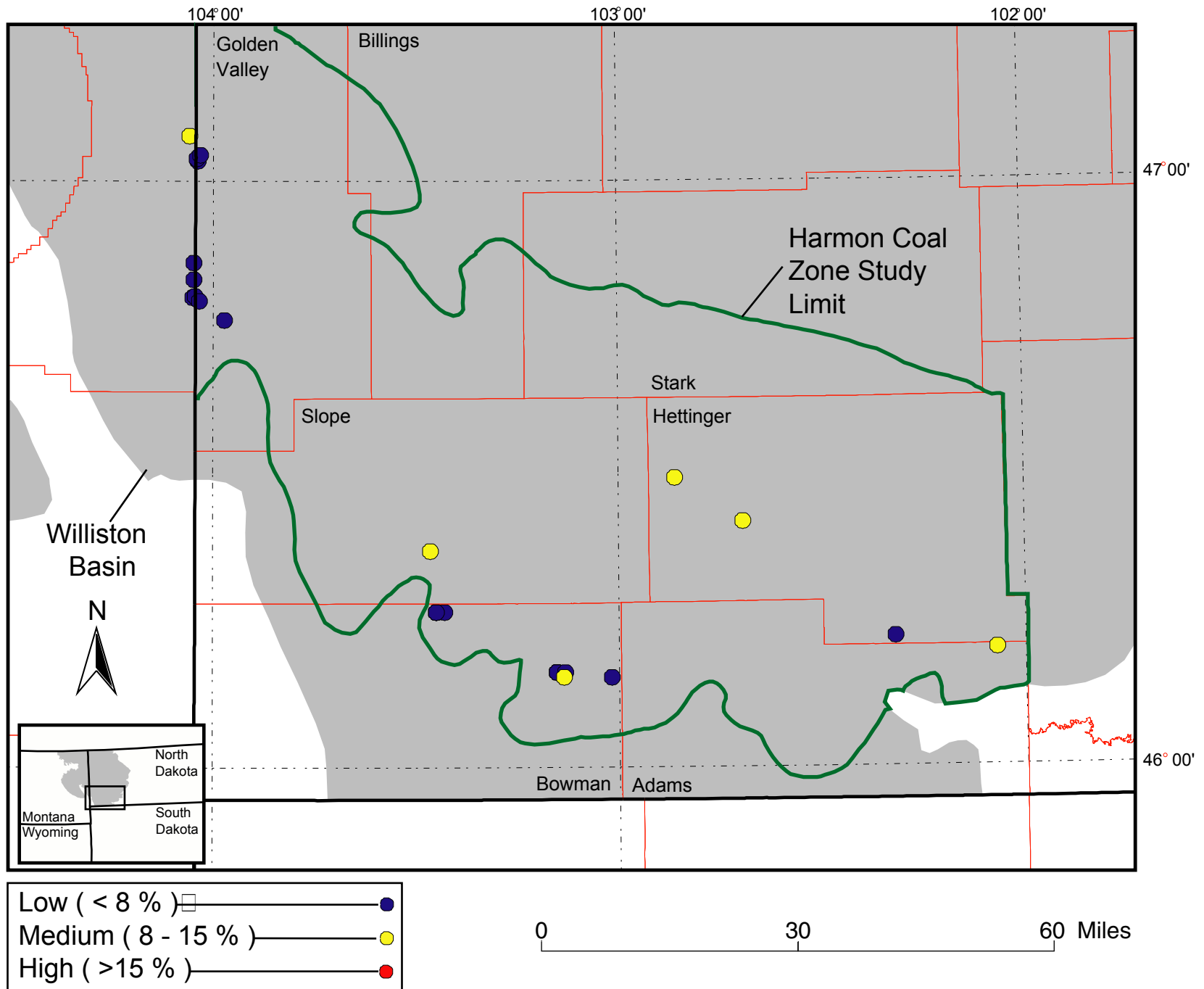


Figure WQ-12. Sulfur content in the Harmon coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

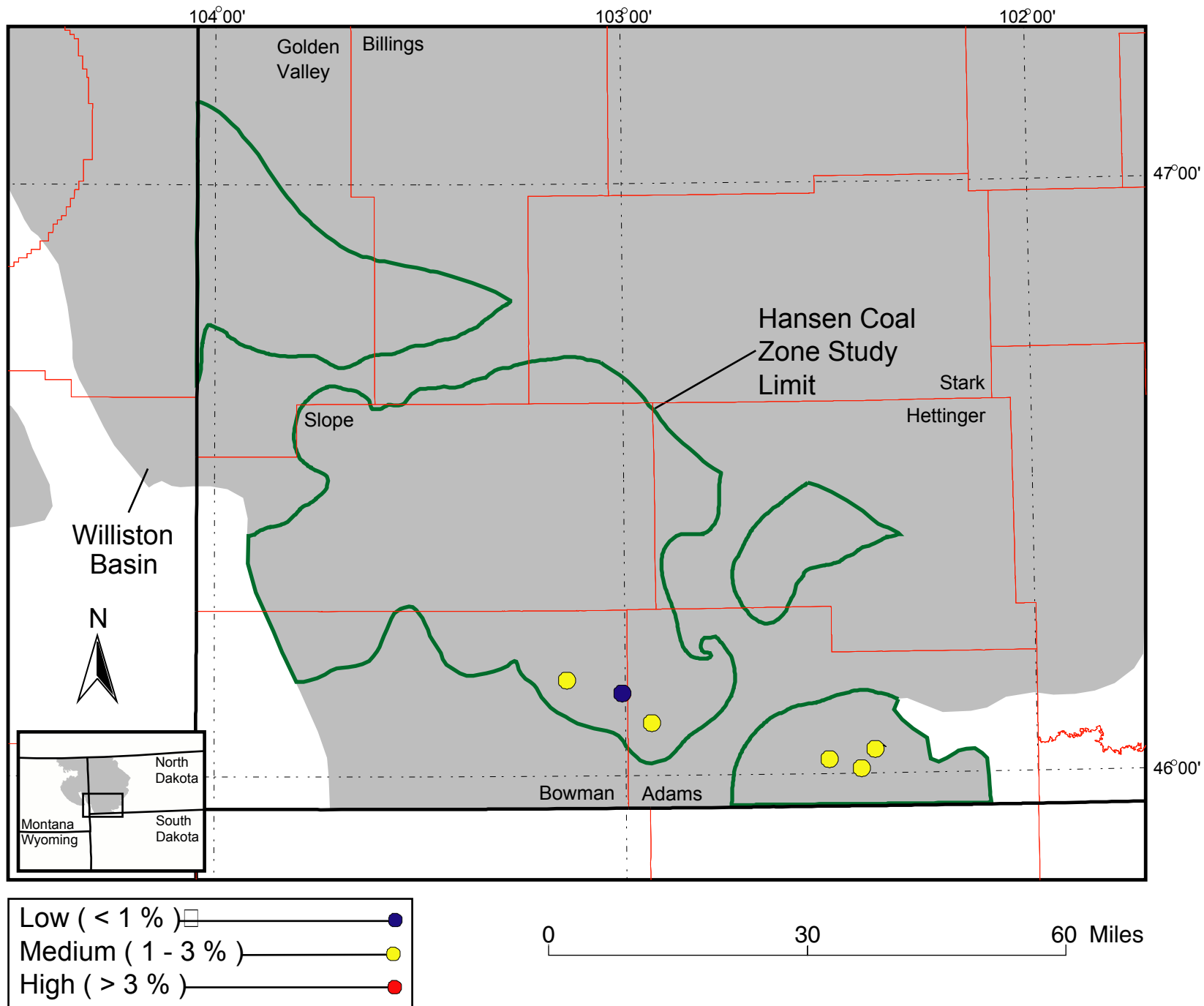


Figure WQ-13. Sulfur content in the Hansen coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

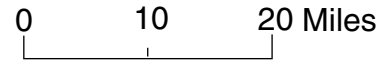
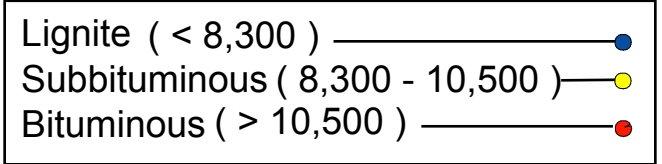
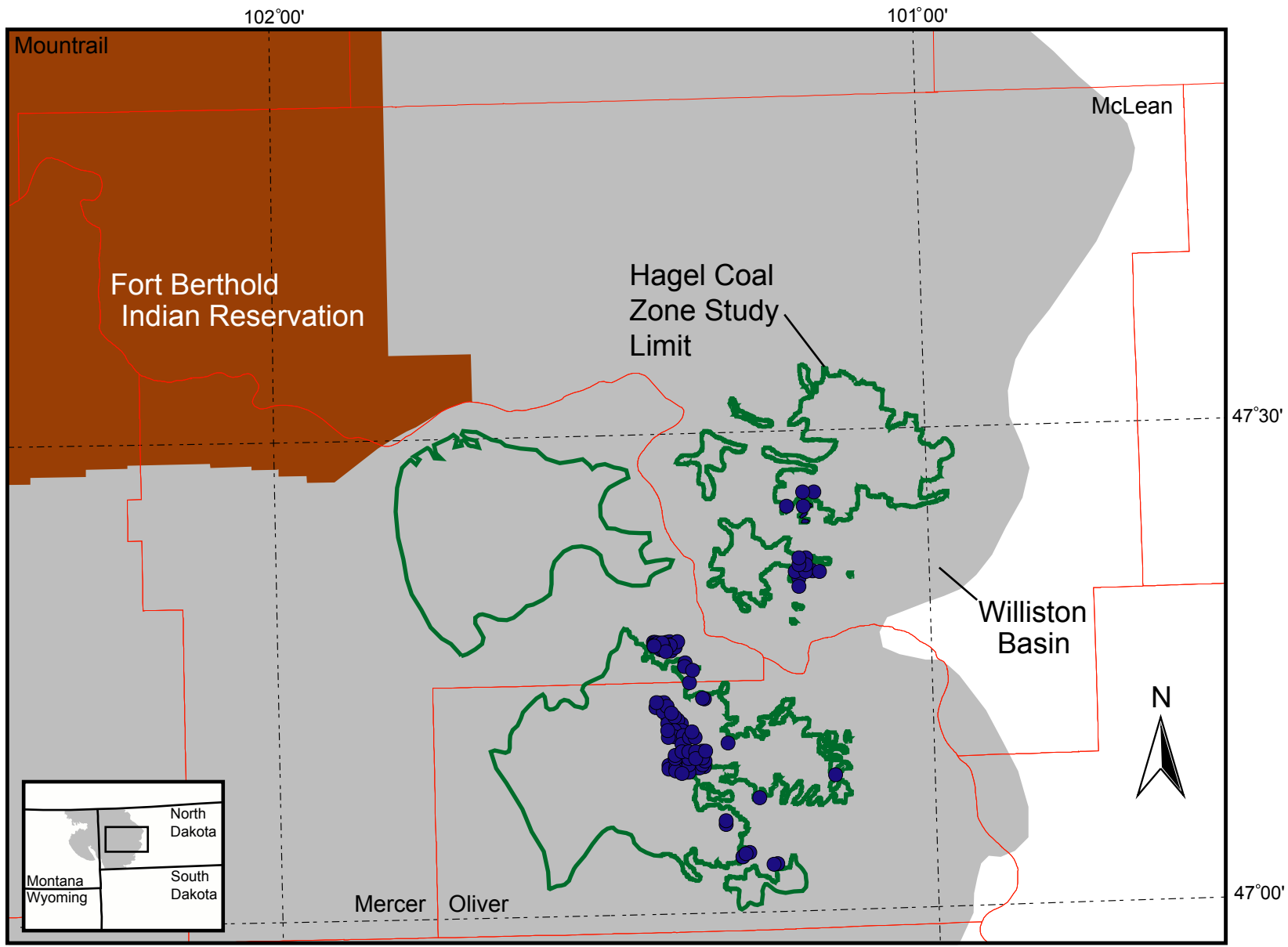


Figure WQ-14. Moist, mineral-matter-free Btu/lb in the Hagel coal zone, Center-Falkirk coalfield, Williston Basin, North Dakota.

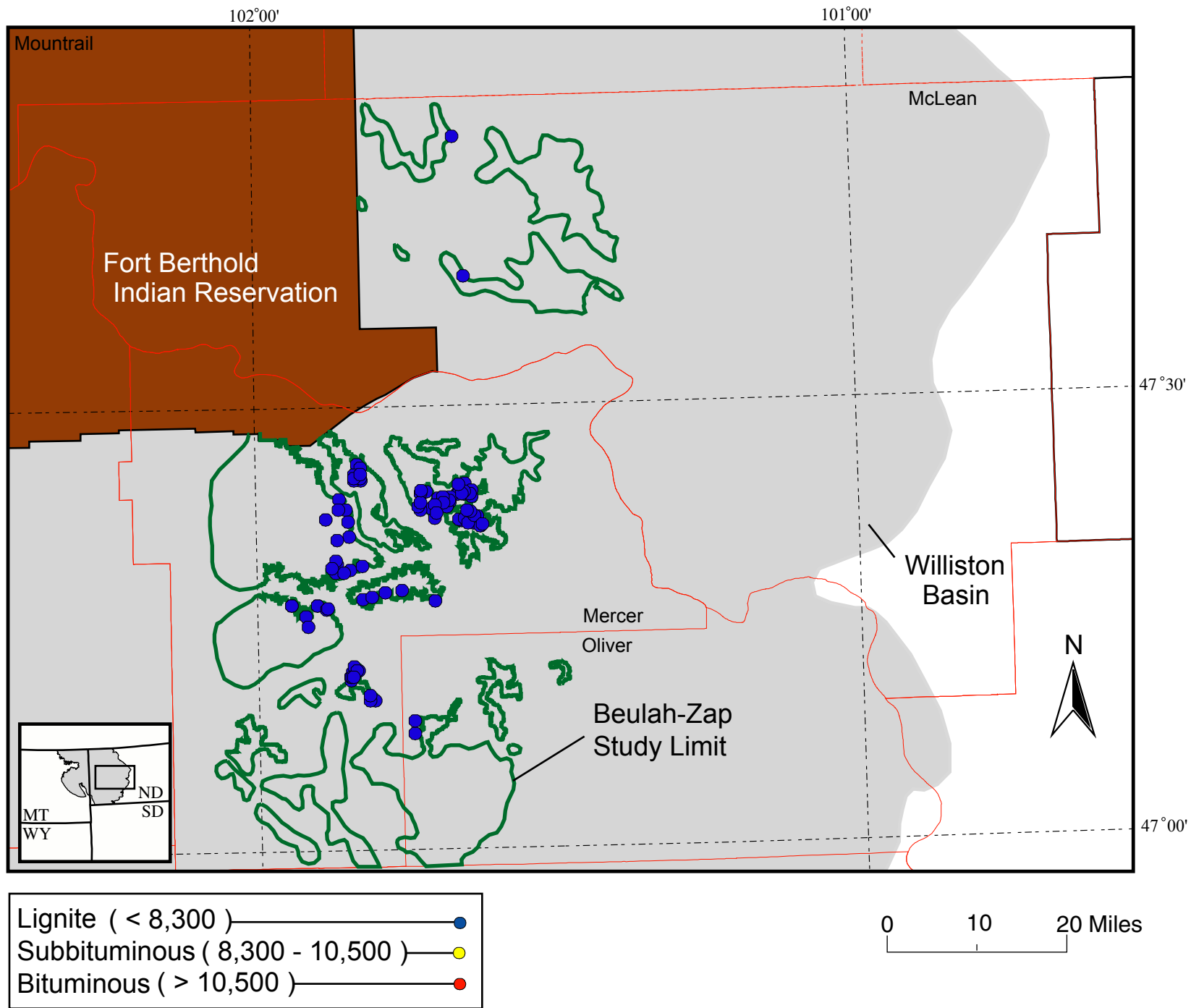


Figure WQ-15. Moist, mineral-matter-free Btu/lb in the Beulah-Zap coal zone, Beulah coalfield, Williston Basin, North Dakota.

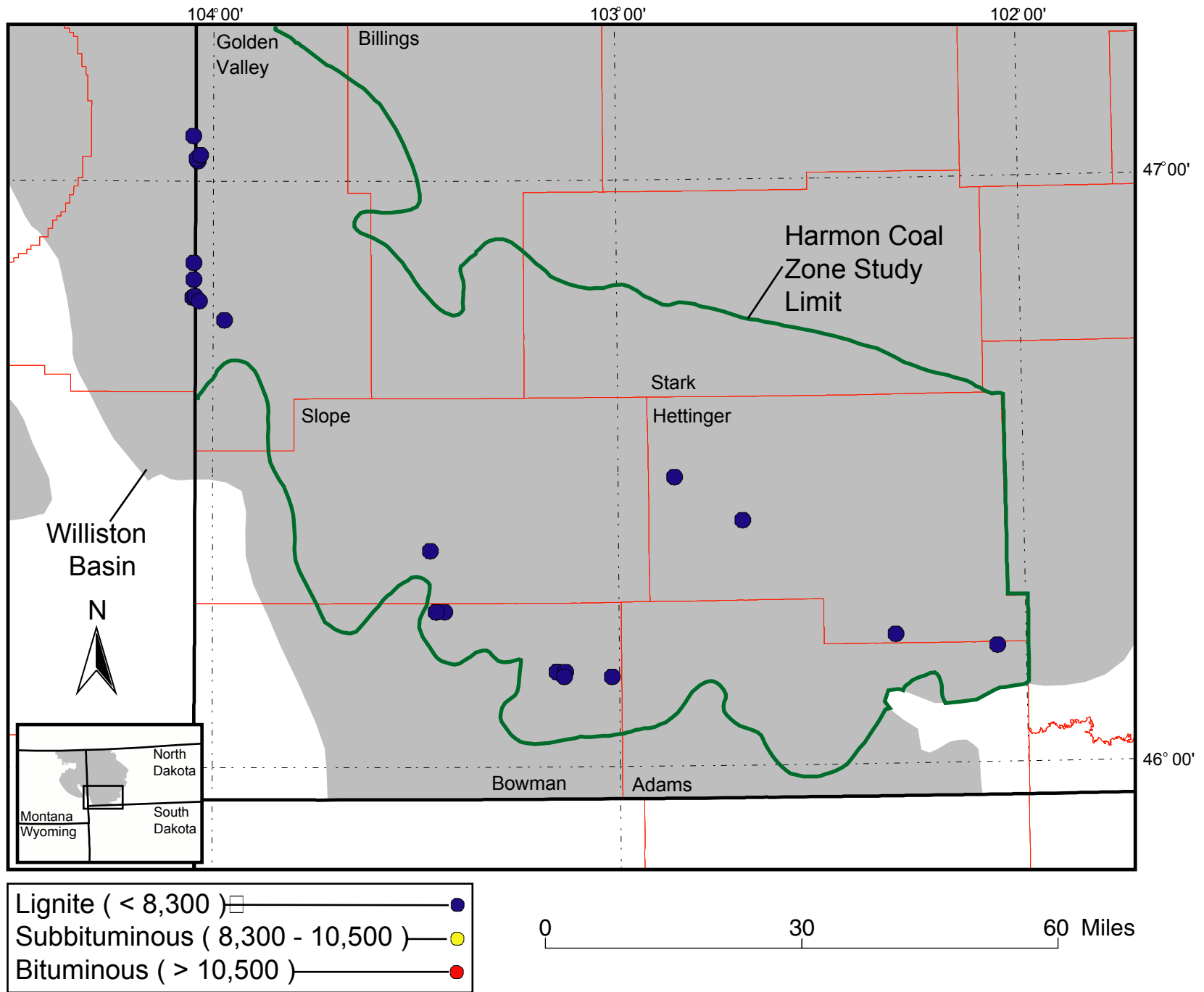


Figure WQ-16. Moist, mineral-matter-free Btu/lb in the Harmon coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

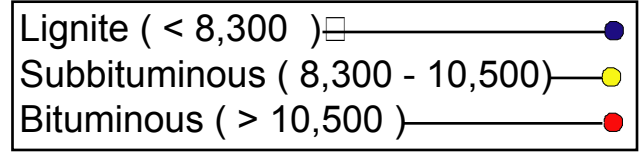
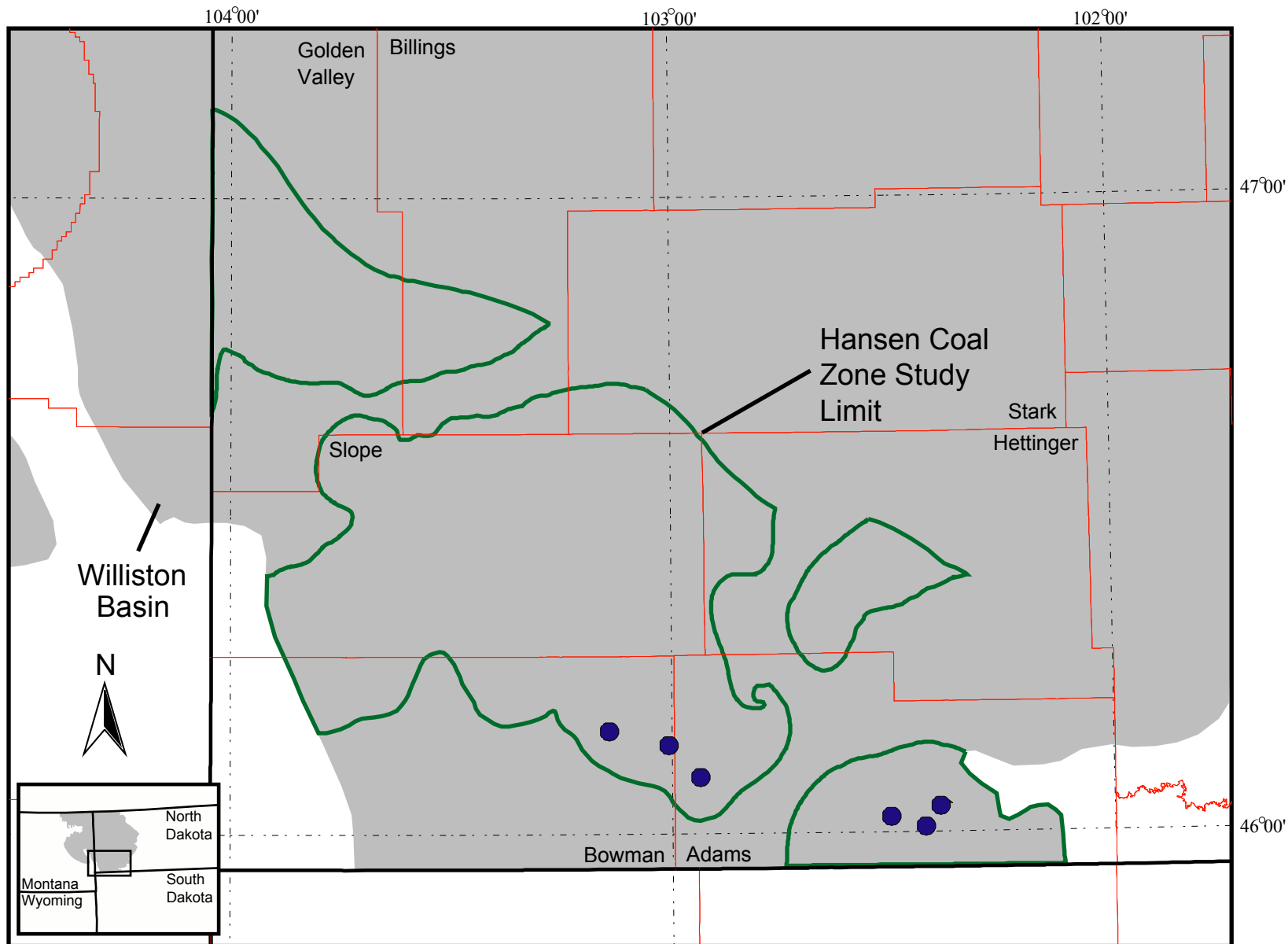


Figure WQ-17. Moist, mineral-matter-free Btu/lb in the Hansen coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

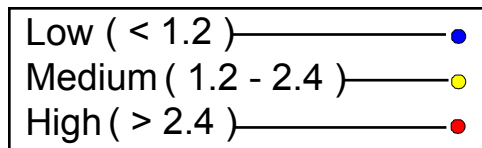
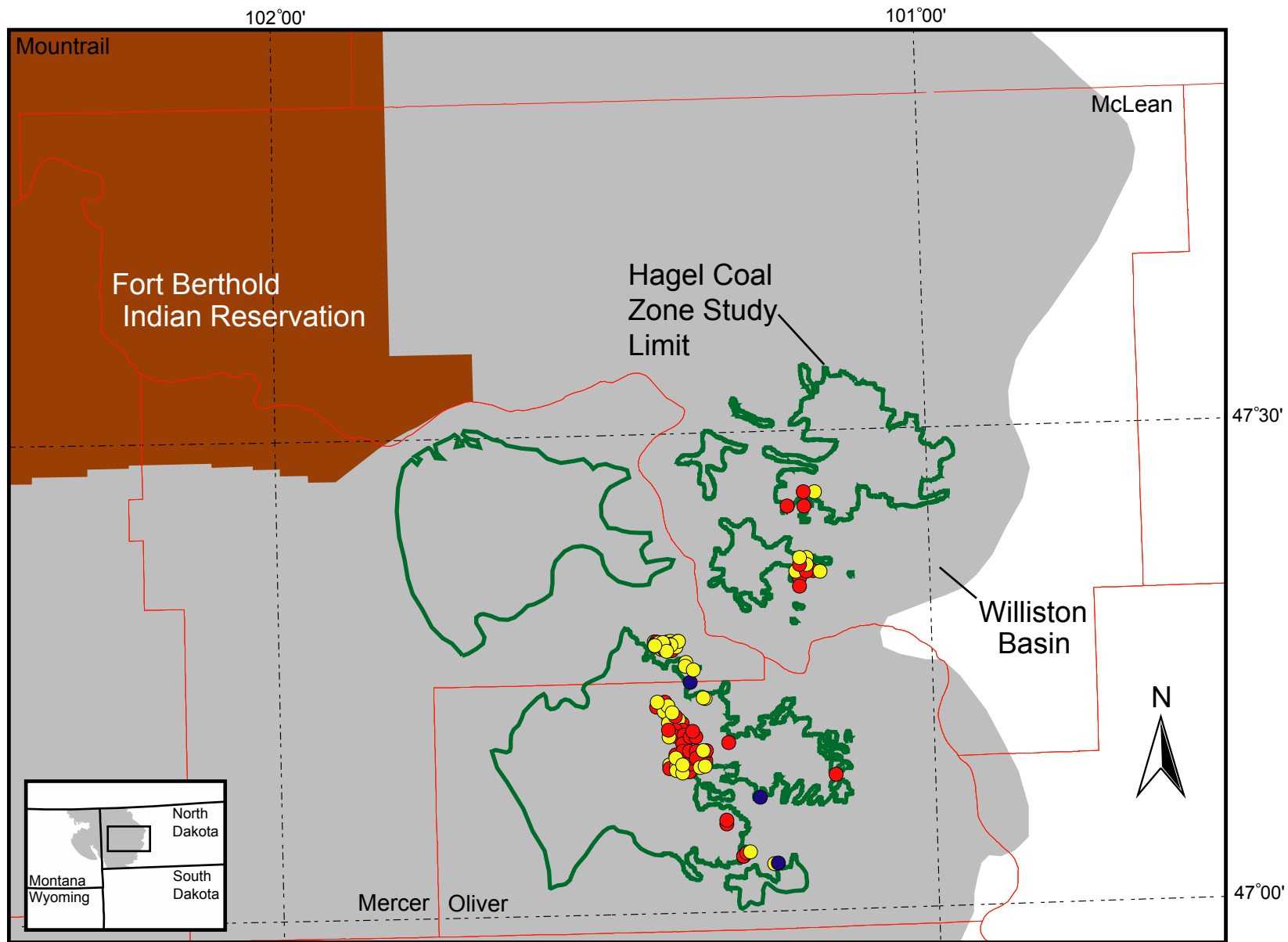


Figure WQ-18. Pounds of sulfur dioxide per million Btu in the Hagel coal zone, Center-Falkirk coalfield, Williston Basin, North Dakota.

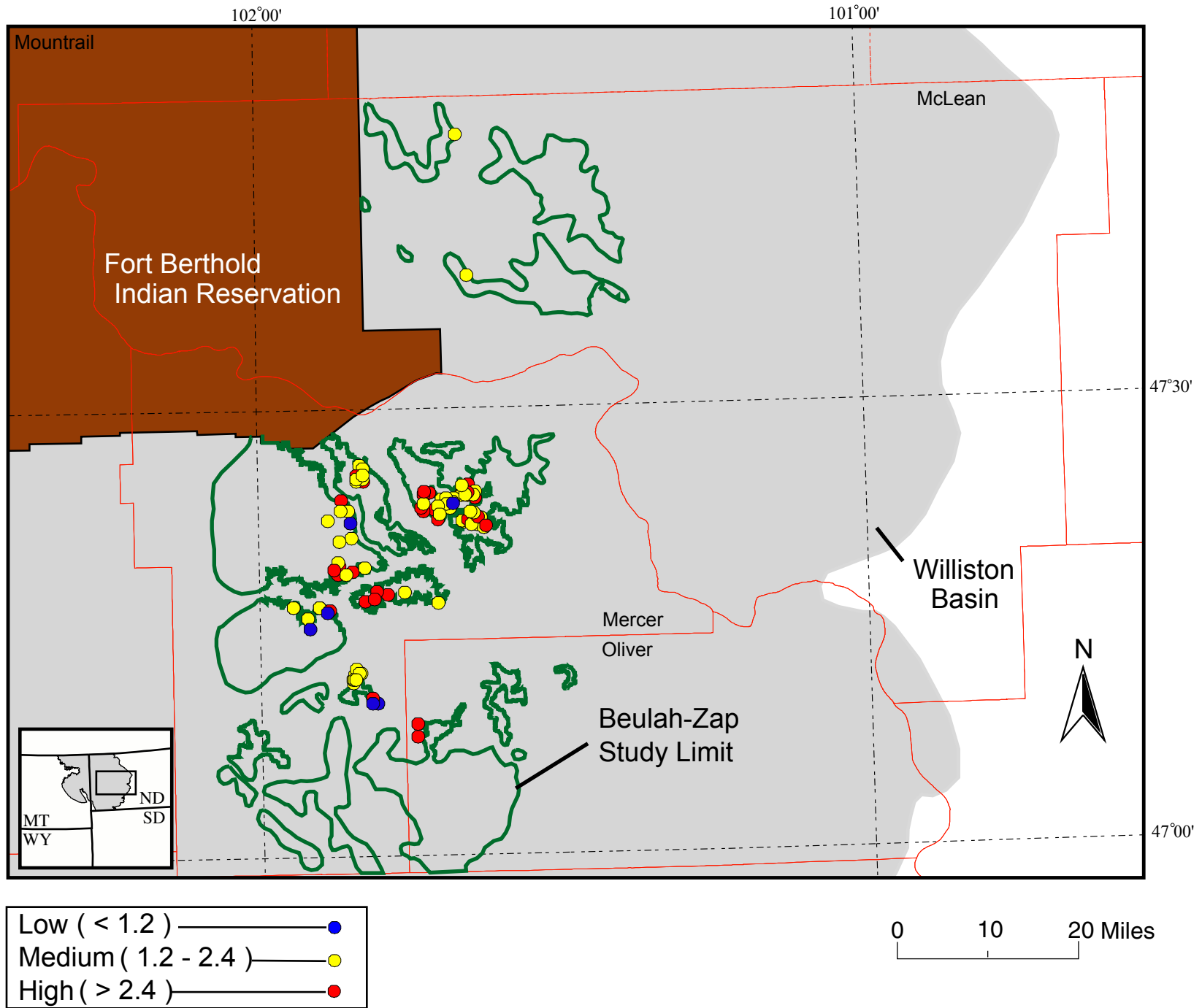


Figure WQ-19. Pounds of sulfur dioxide per million Btu in the Beulah-Zap coal zone, Beulah coalfield, Williston Basin, North Dakota.

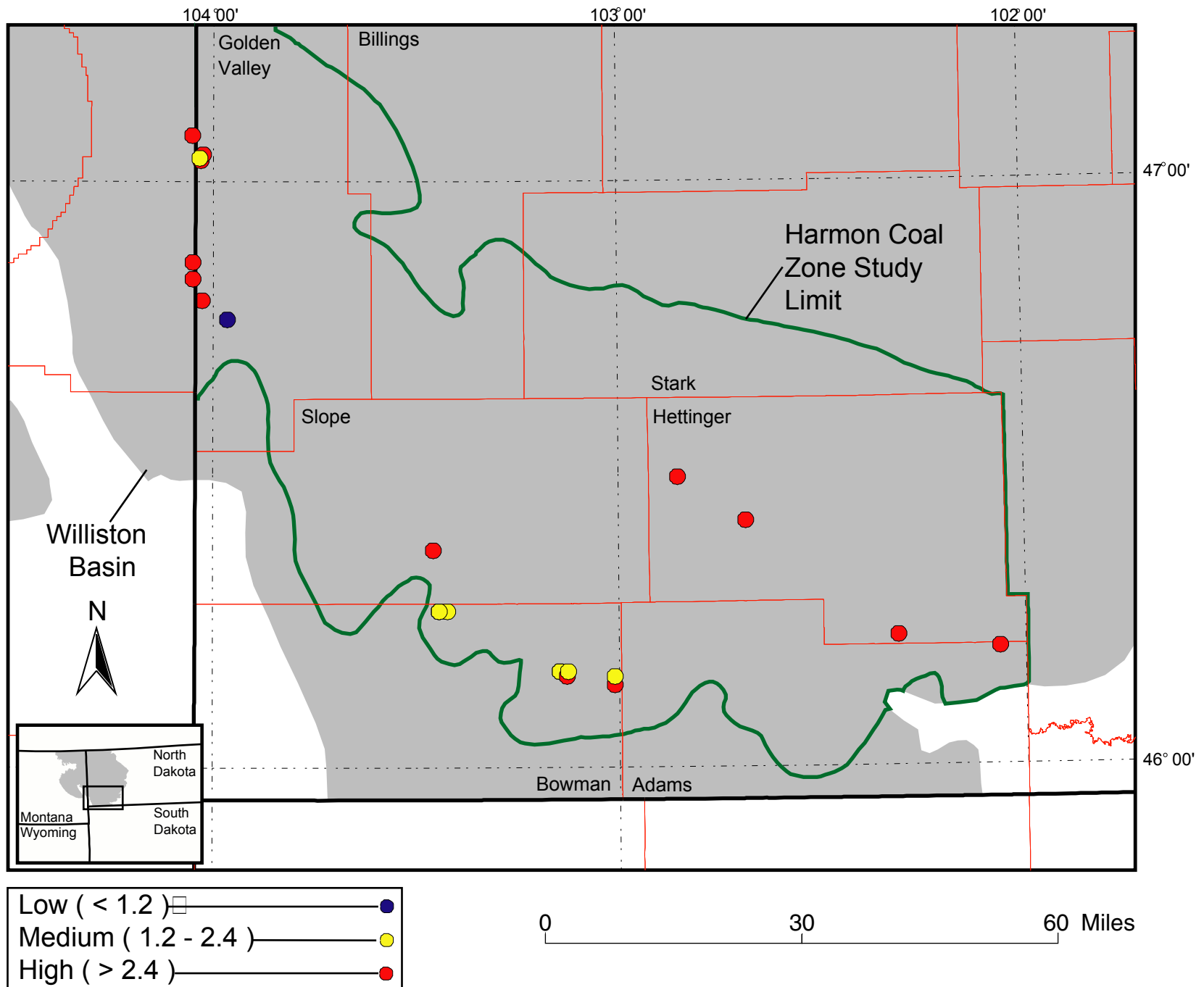


Figure WQ-20. Pounds of sulfur dioxide per million Btu in the Harmon coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

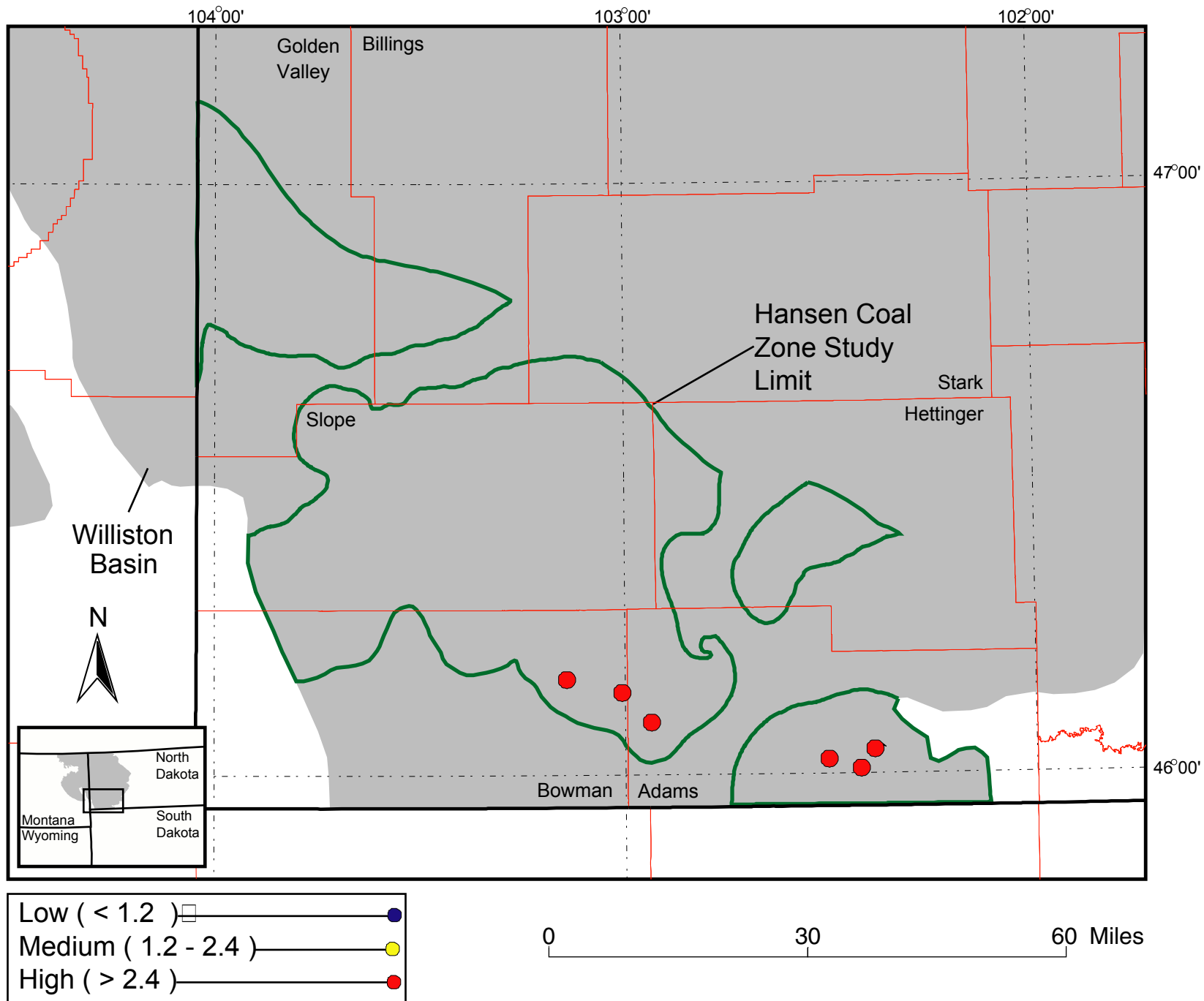


Figure WQ-21. Pounds of sulfur dioxide per million Btu in the Hansen coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

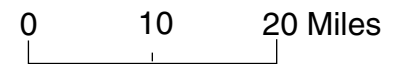
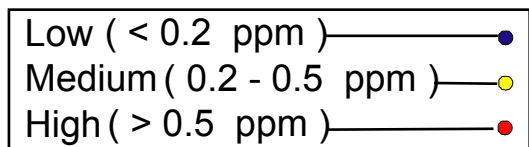
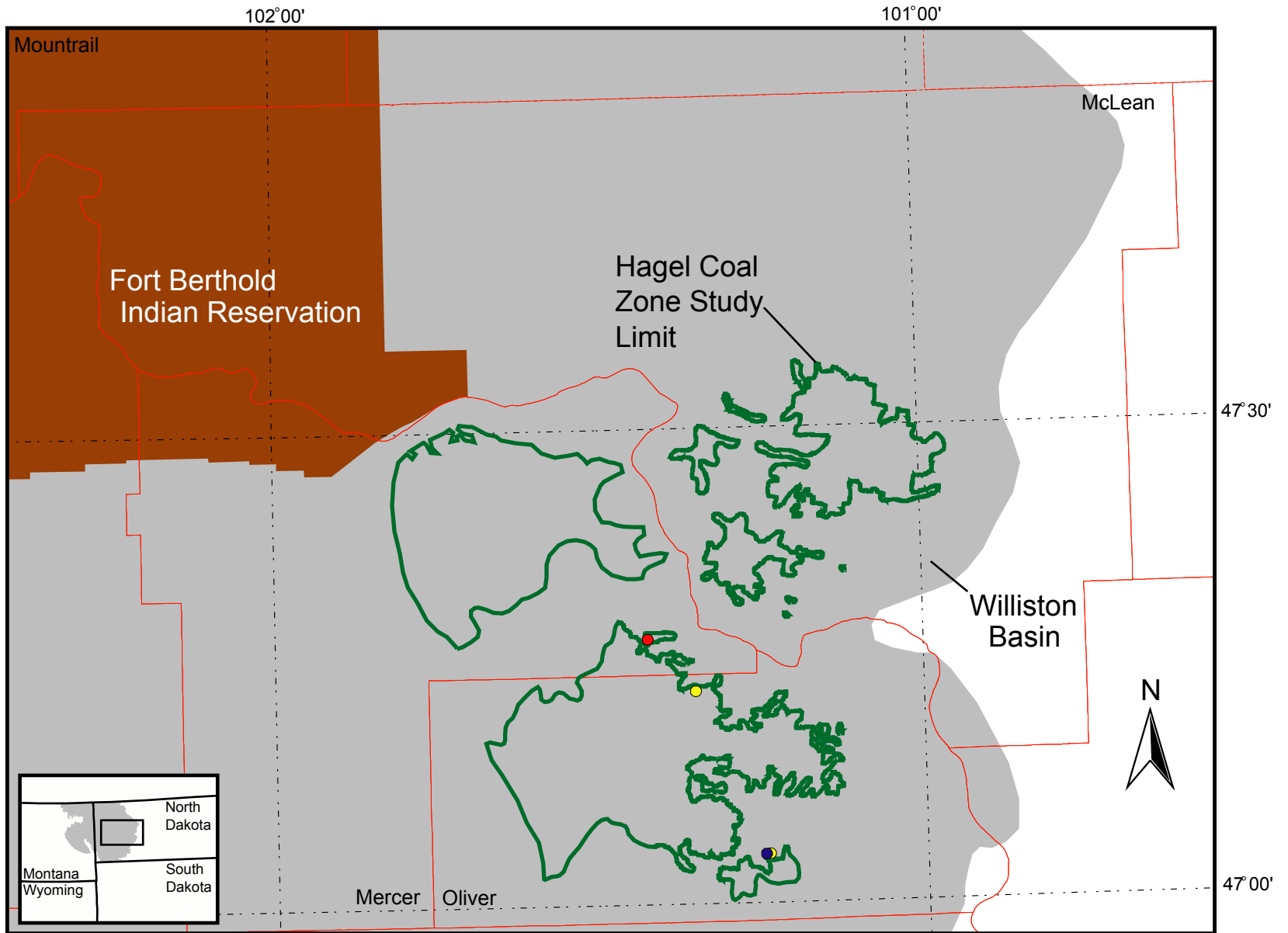


Figure WQ-22. Antimony concentration in the Hagel coal zone, Center-Falkirk coalfield, Williston Basin, North Dakota.

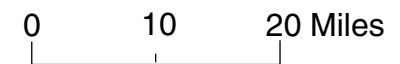
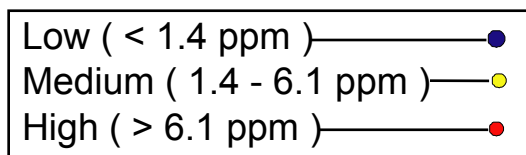
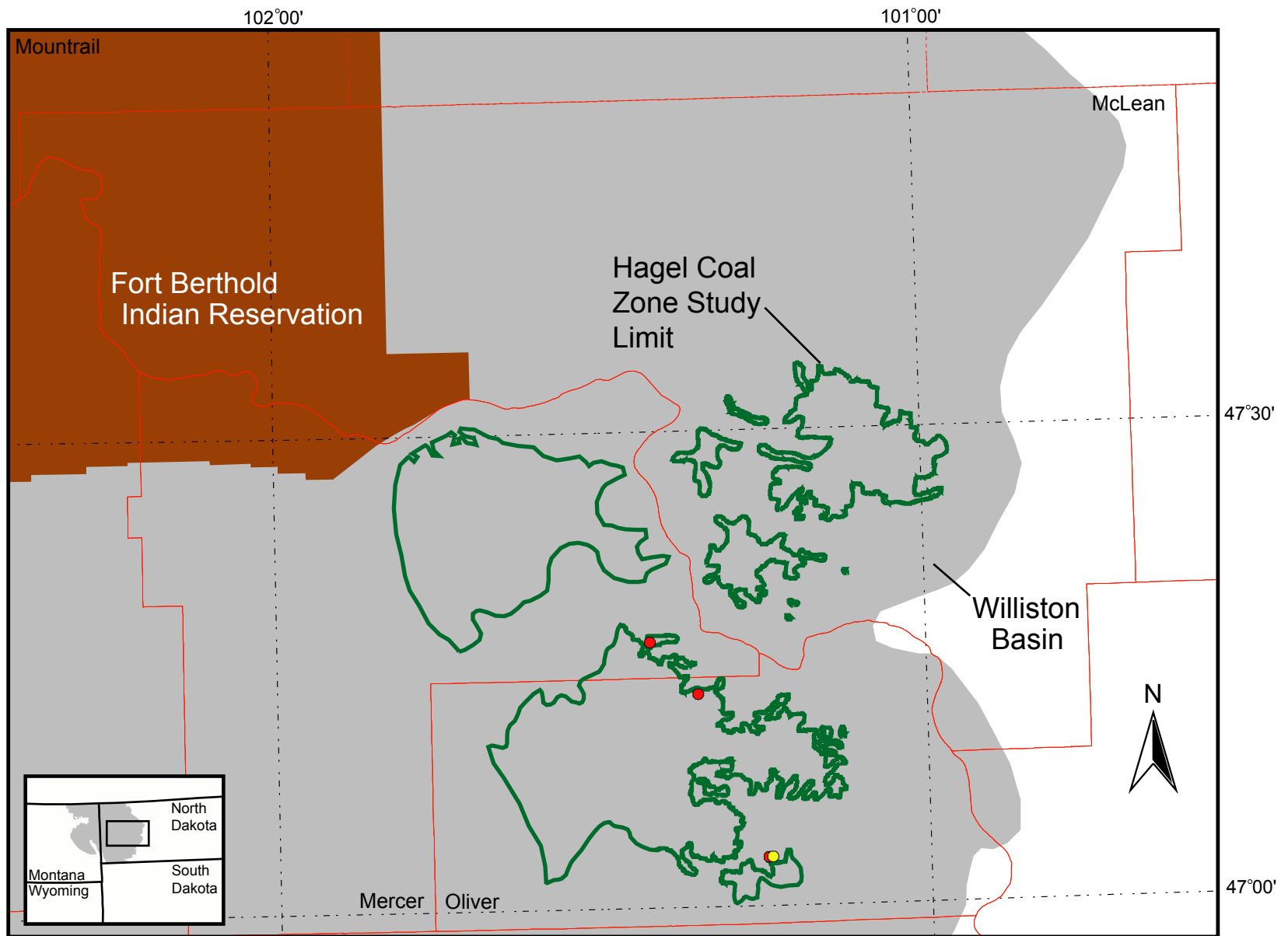


Figure WQ-23. Arsenic concentration in the Hagel coal zone, Center-Falkirk coalfield, Williston Basin, North Dakota.

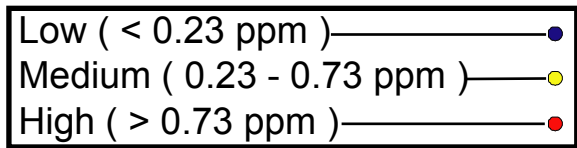
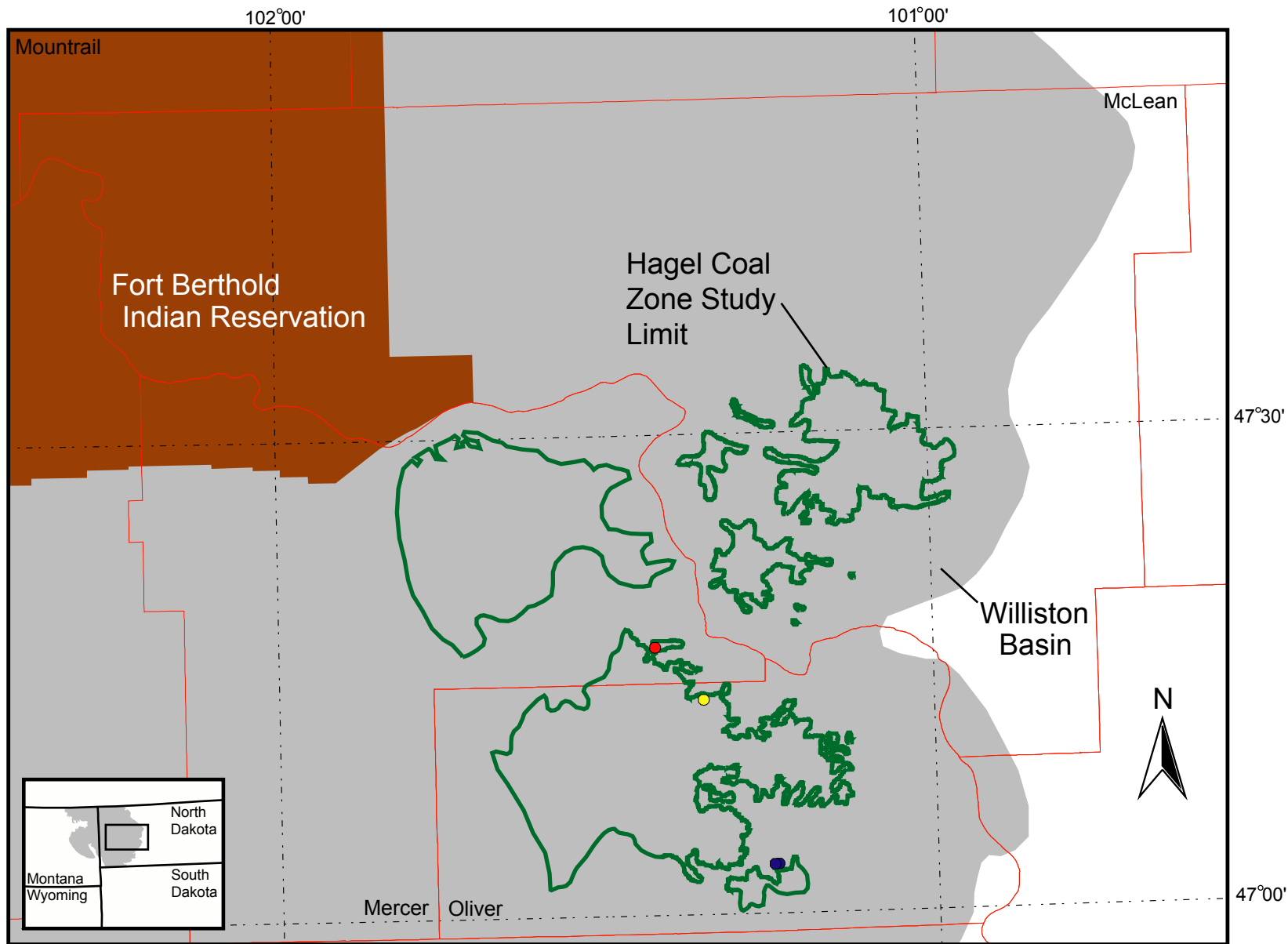


Figure WQ-24. Beryllium concentration in the Hagel coal zone, Center-Falkirk coalfield, Williston Basin, North Dakota.

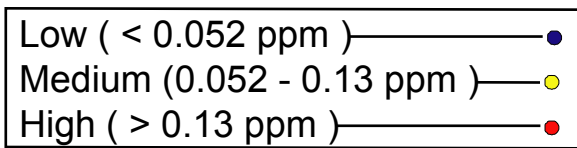
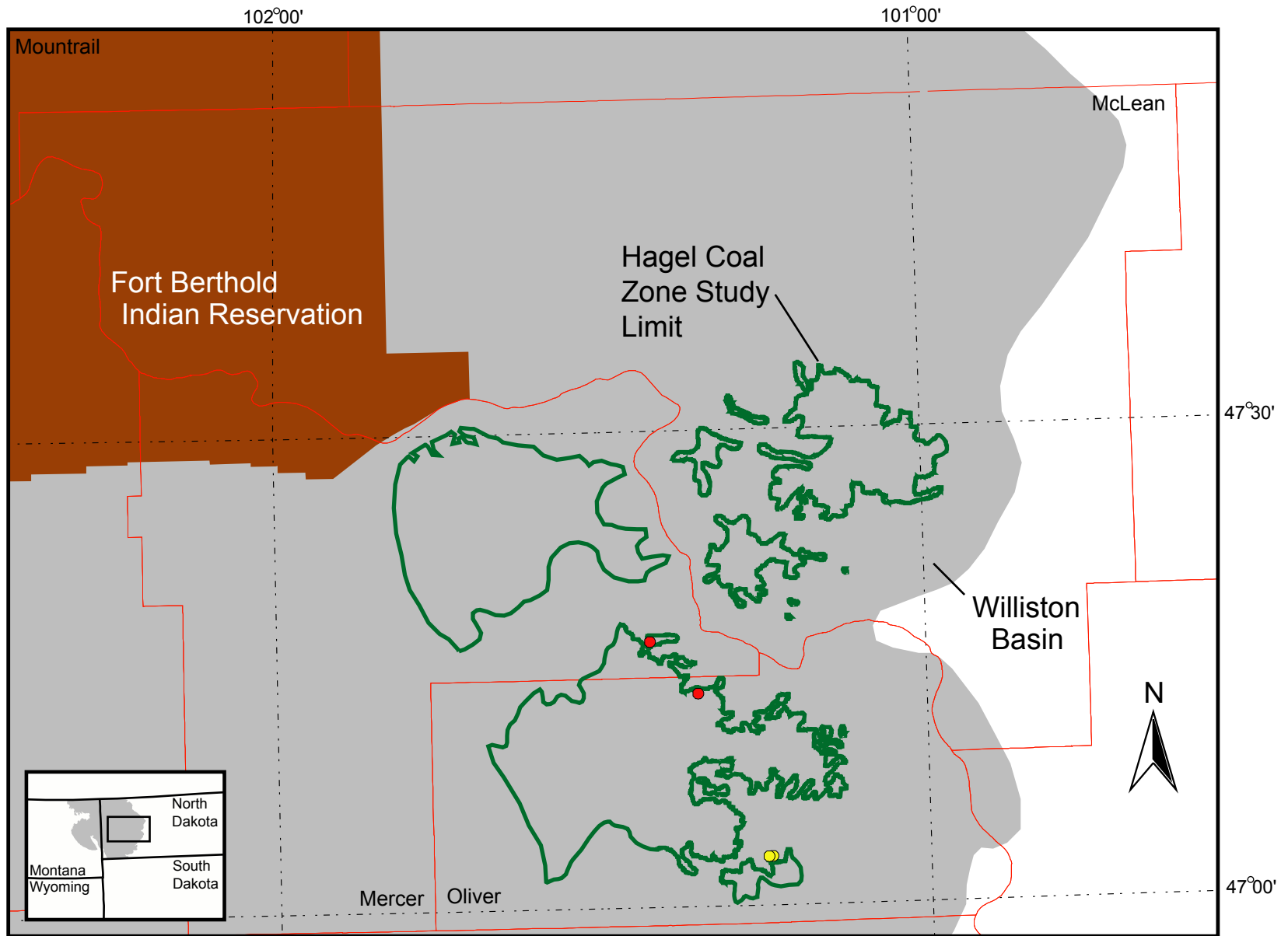


Figure WQ-25. Cadmium concentration in the Hagel coal zone, Center-Falkirk coalfield, Williston Basin, North Dakota.

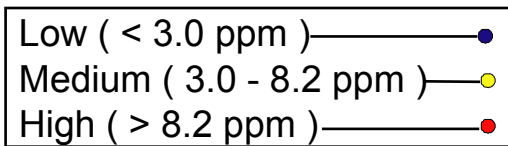
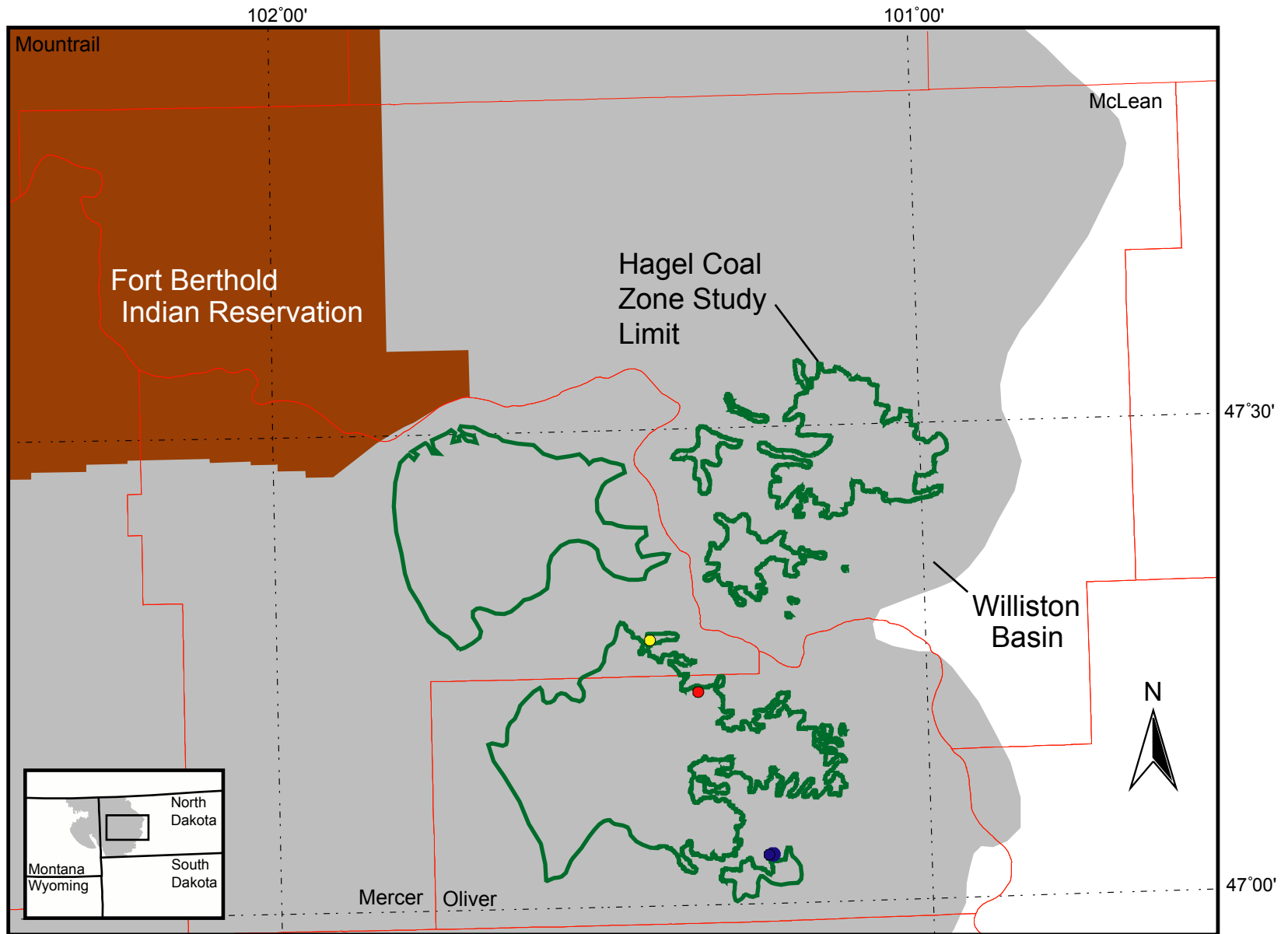


Figure WQ-26. Chromium concentration in the Hagel coal zone, Center-Falkirk coalfield, Williston Basin, North Dakota.

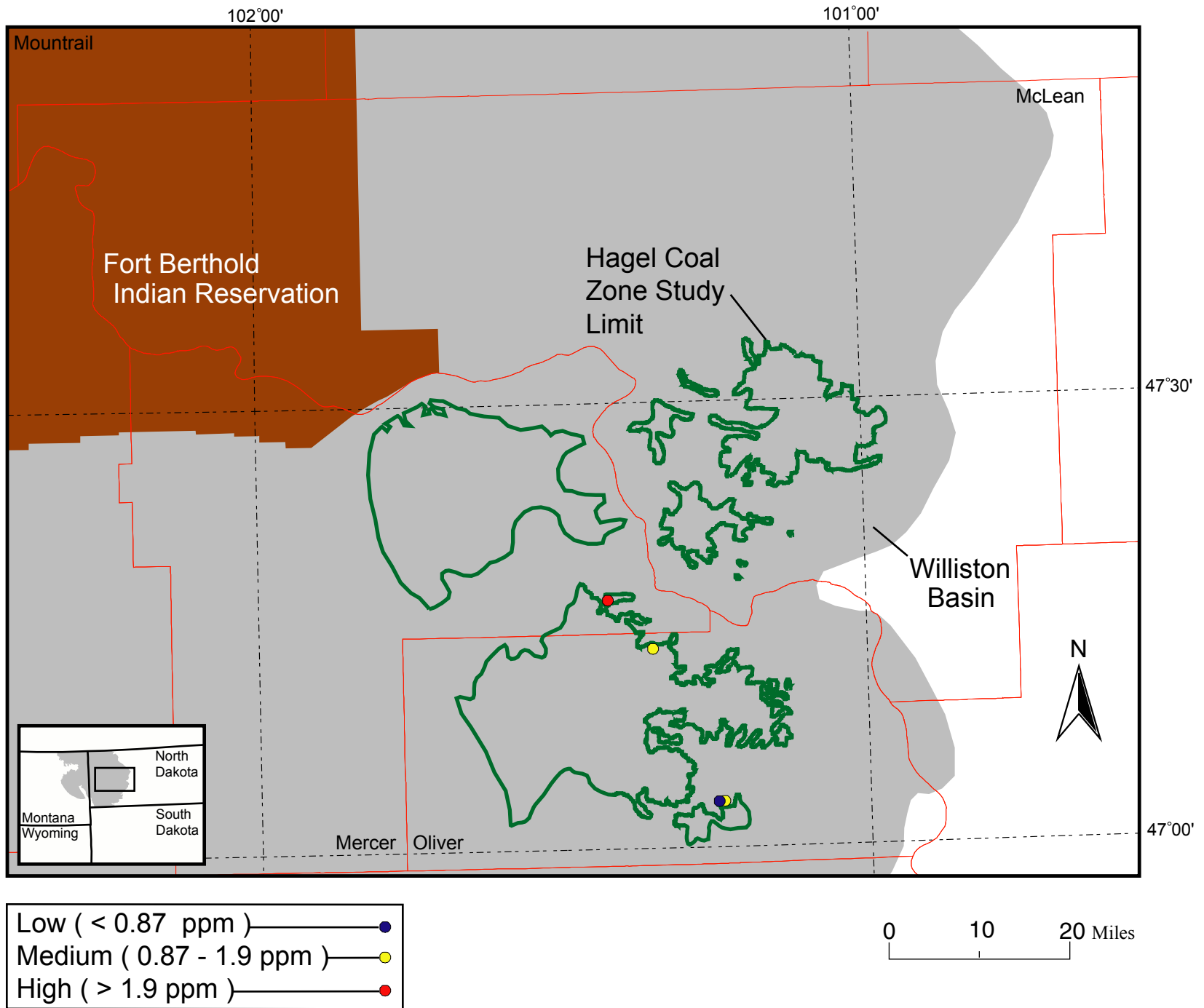


Figure WQ-27. Cobalt concentration in the Hagel coal zone, Center-Falkirk coalfield, Williston Basin, North Dakota.

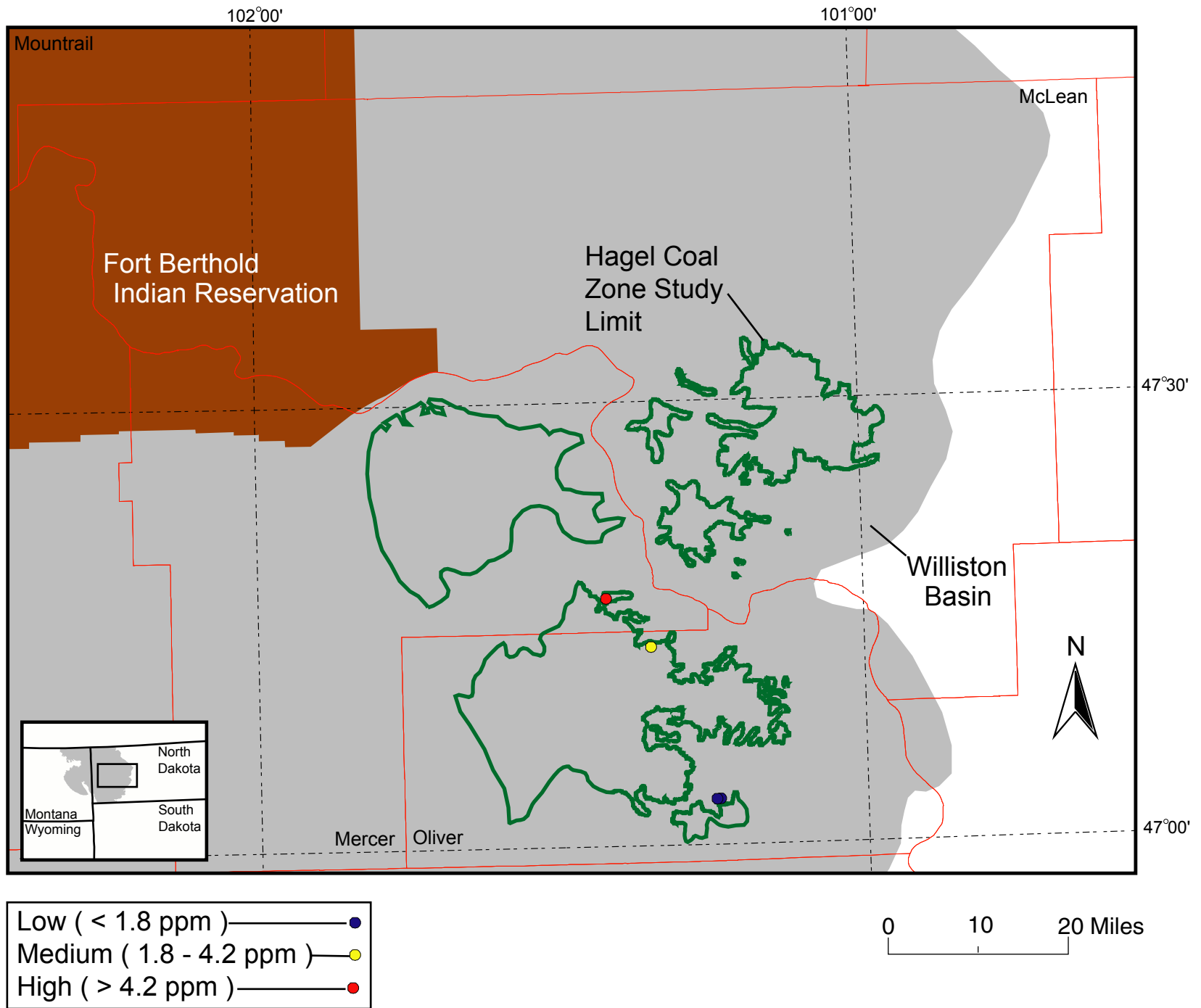


Figure WQ-28. Lead concentration in the Hagel coal zone, Center-Falkirk coalfield, Williston Basin, North Dakota.

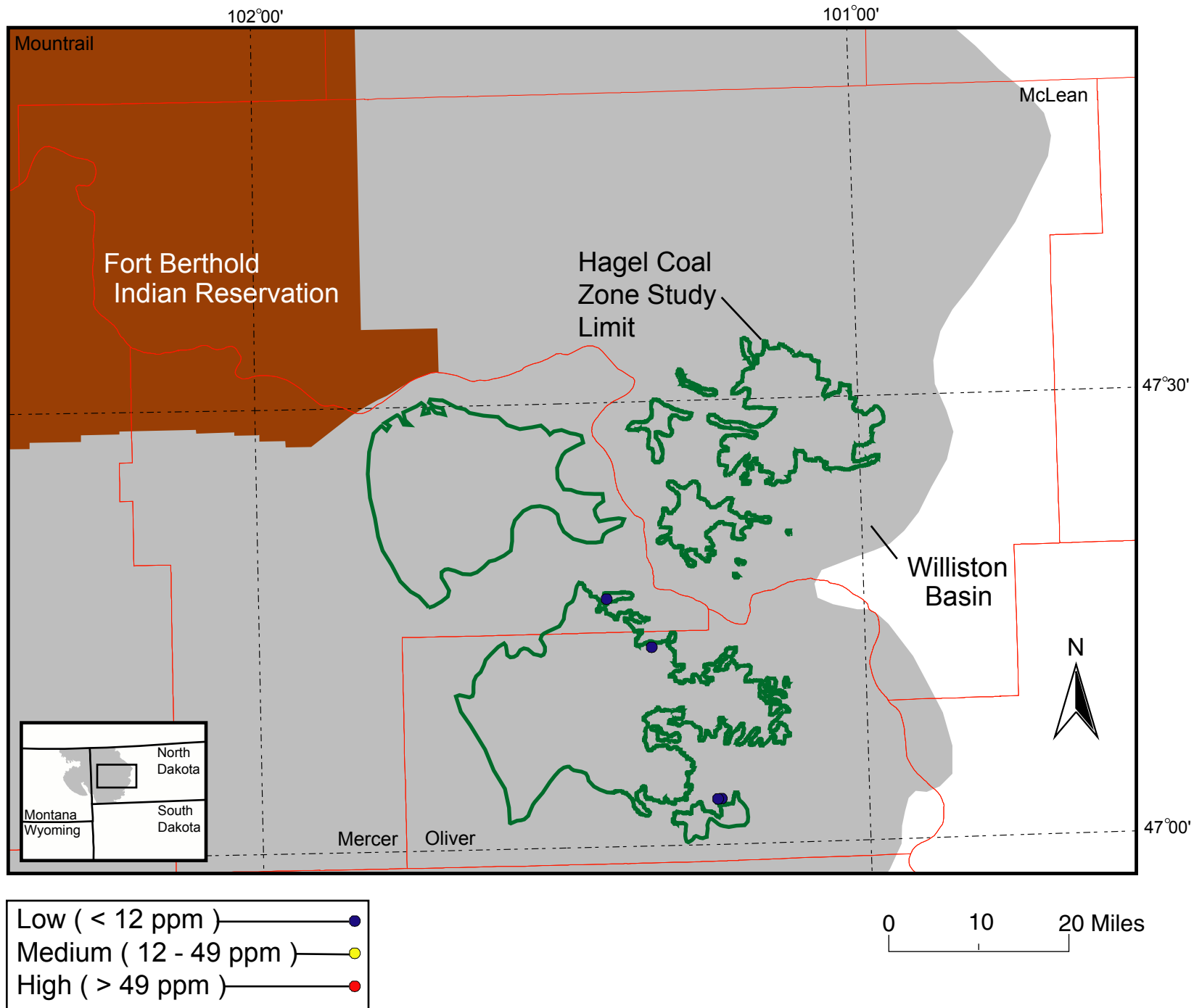


Figure WQ-29. Manganese concentration in the Hagel coal zone, Center-Falkirk coalfield, Williston Basin, North Dakota.

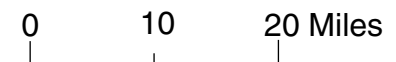
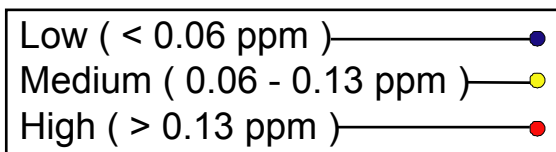
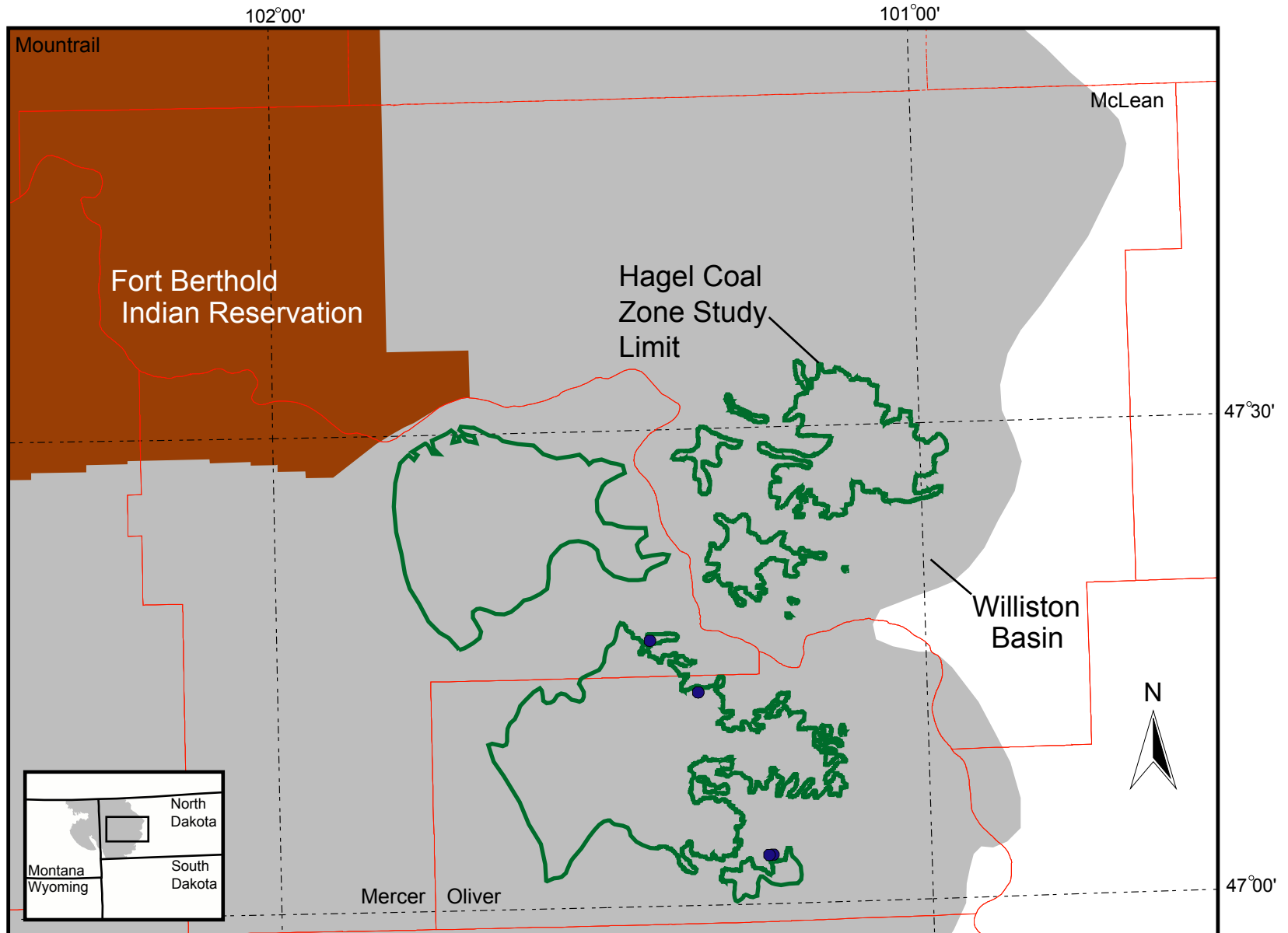


Figure WQ-30. Mercury concentration in the Hagel coal zone, Center-Falkirk coalfield, Williston Basin, North Dakota.

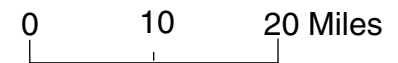
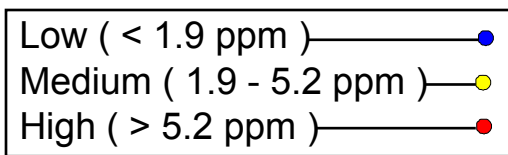
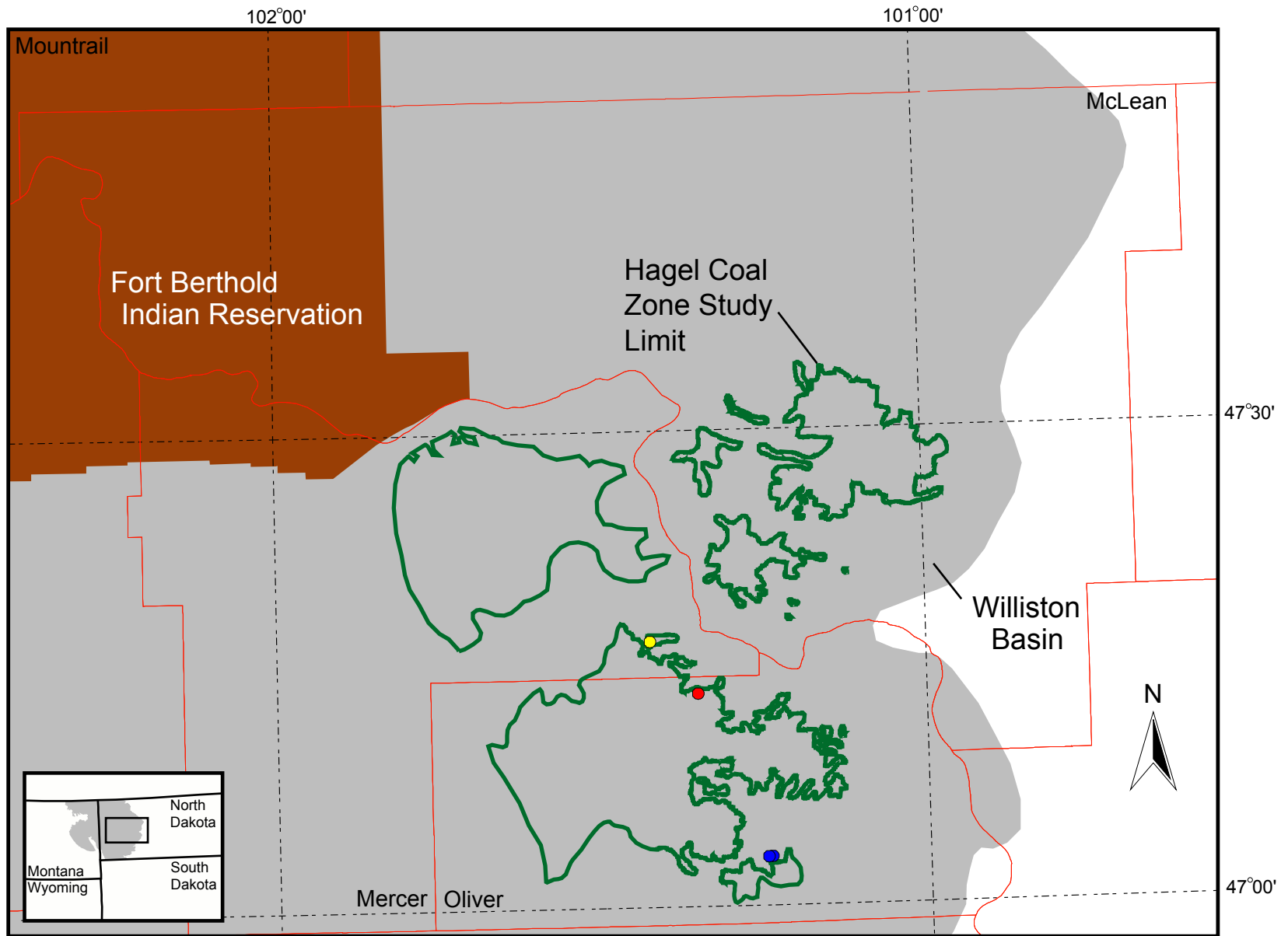


Figure WQ-31. Nickel concentration in the Hagel coal zone, Center-Falkirk coalfield, Williston Basin, North Dakota.

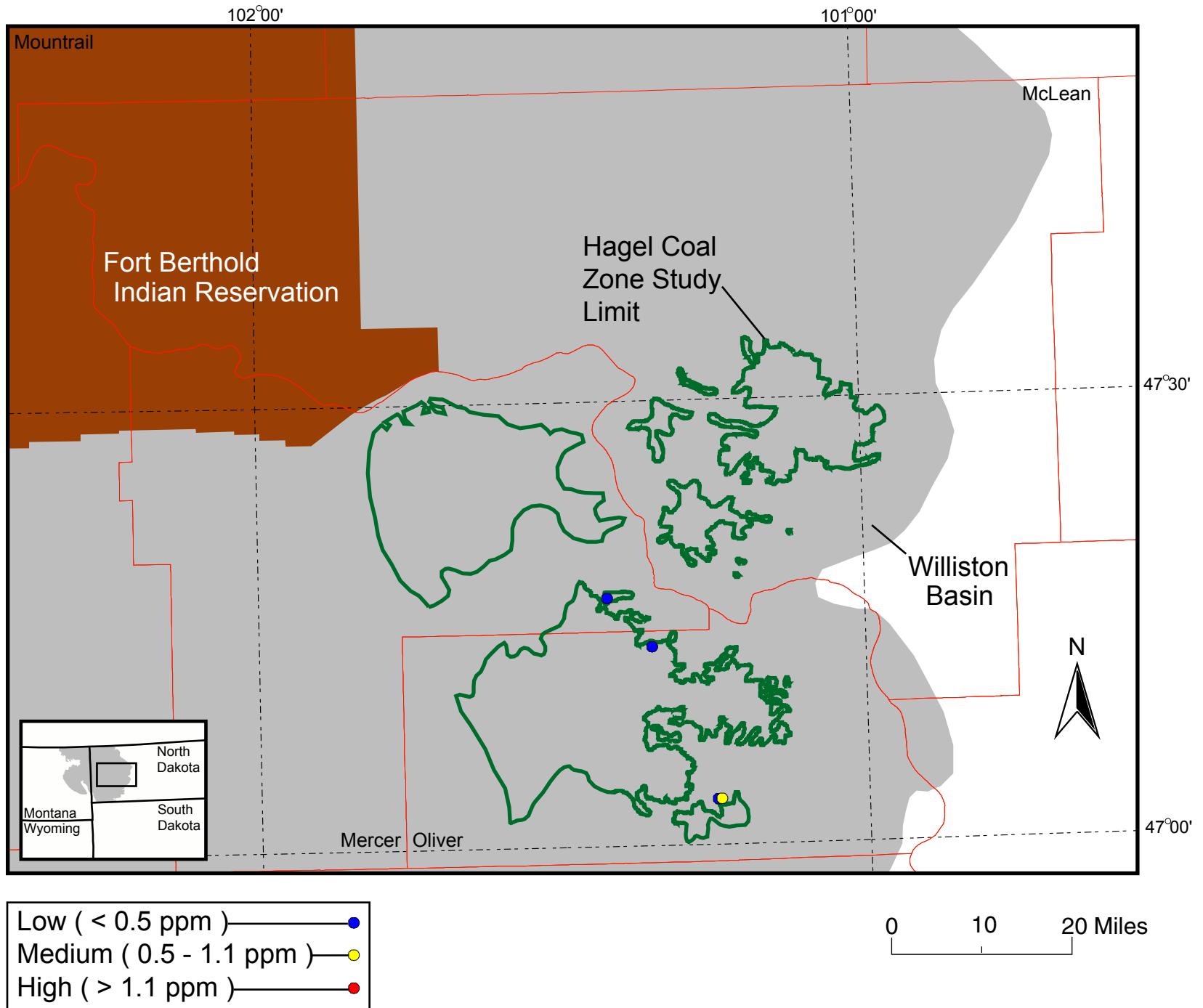


Figure WQ-32. Selenium concentration in the Hagel coal zone, Center-Falkirk coalfield, Williston Basin, North Dakota.

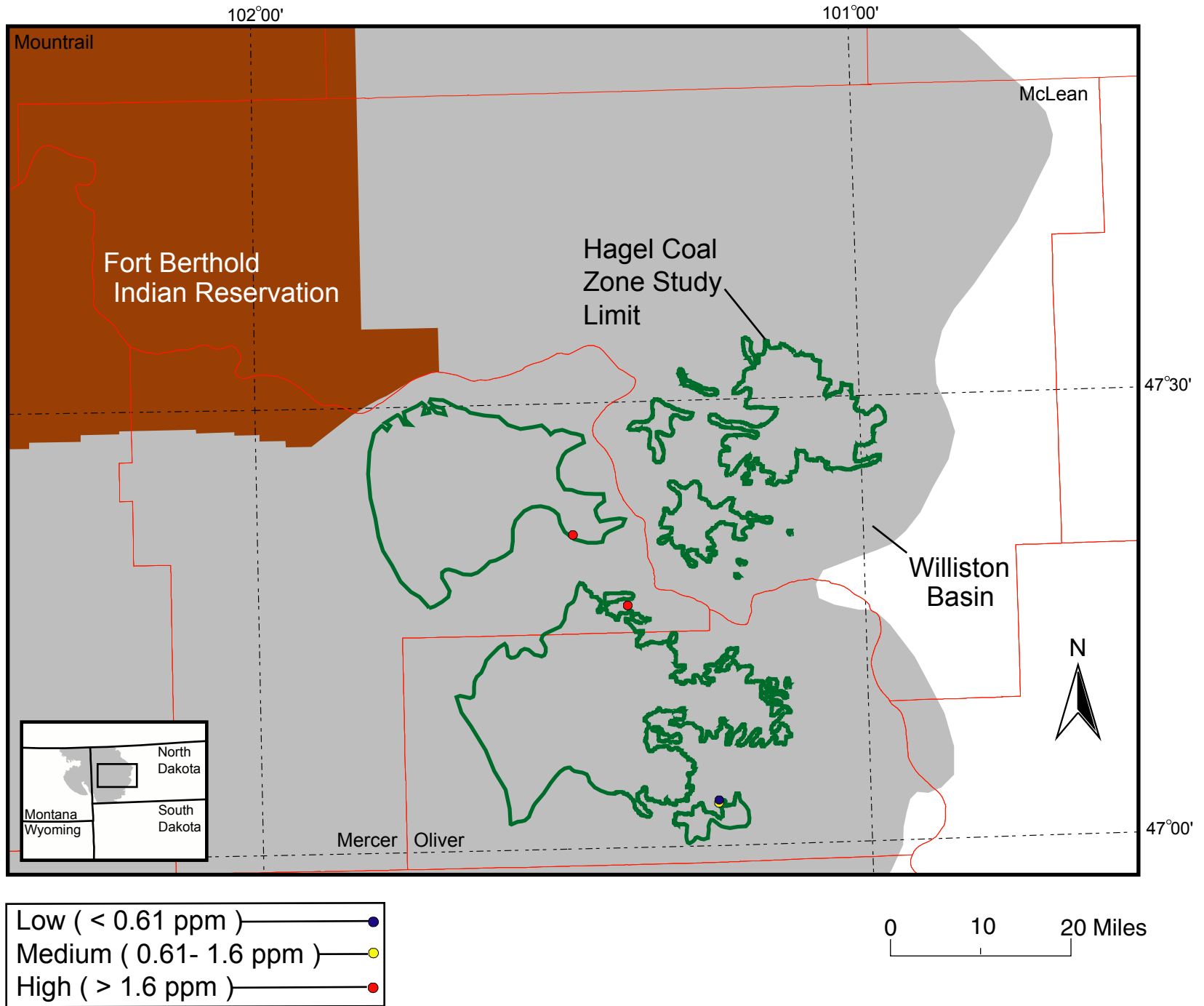


Figure WQ-33. Uranium concentration in the Hagel coal zone, Center-Falkirk coalfield, Williston Basin, North Dakota.

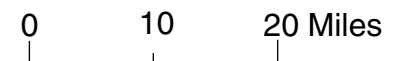
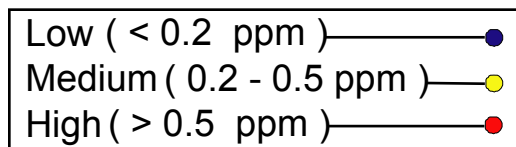
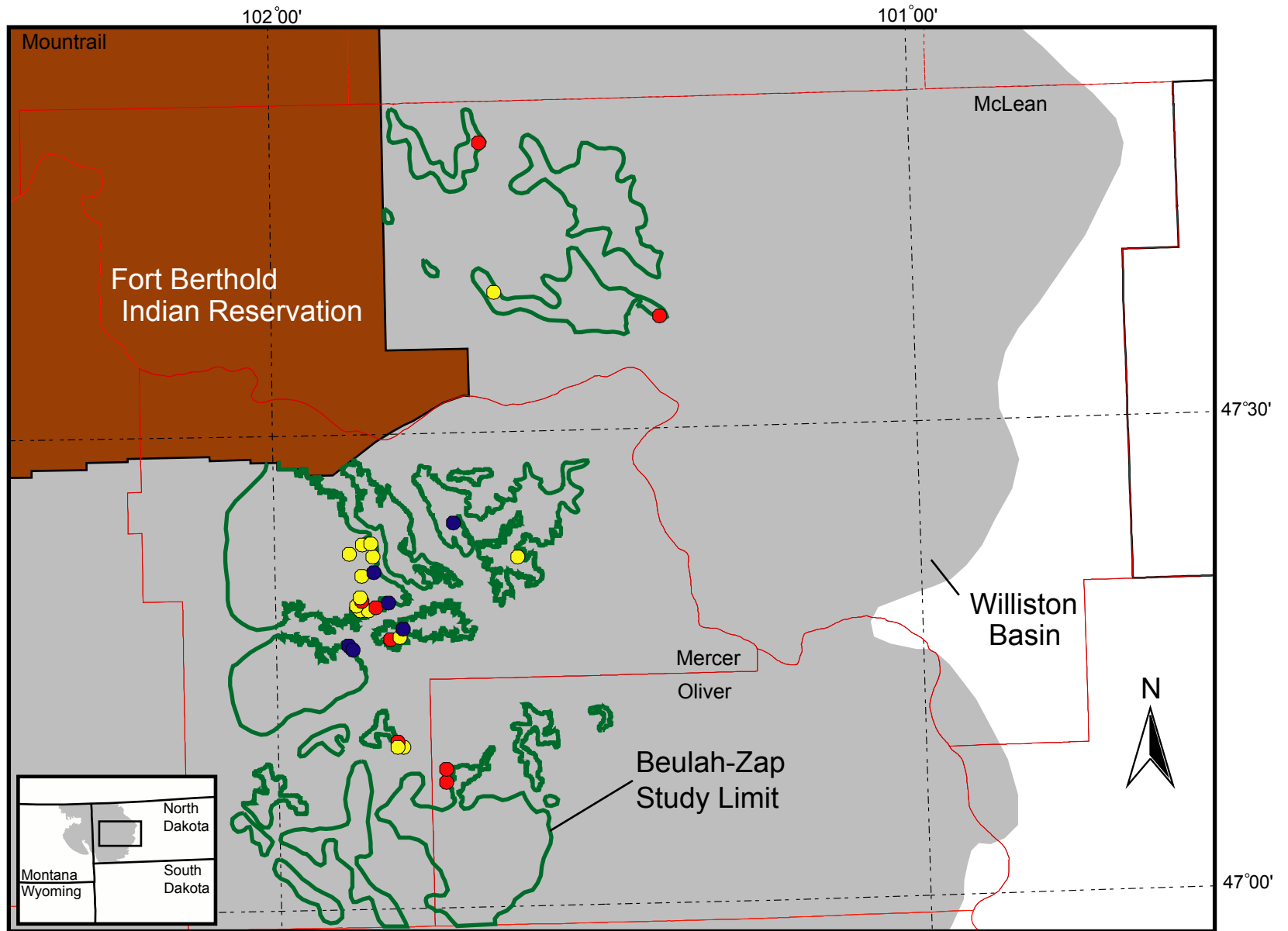


Figure WQ-34. Antimony concentration in the Beulah-Zap coal zone, Beulah coalfield, Williston Basin, North Dakota.

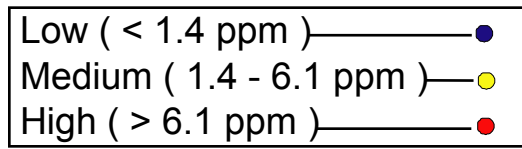
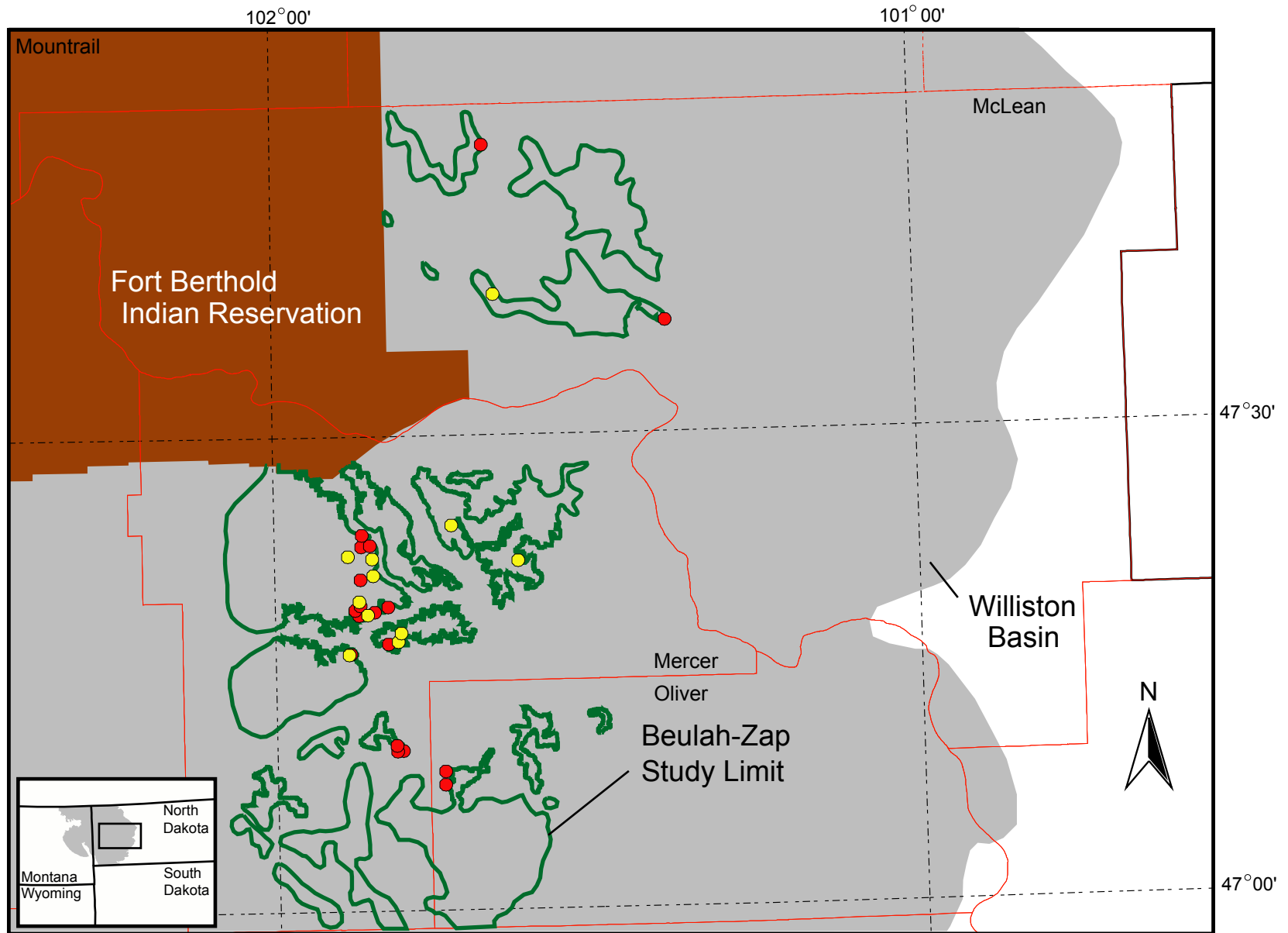


Figure WQ-35. Arsenic concentration in the Beulah-Zap coal zone, Beulah coalfield, Williston Basin, North Dakota.

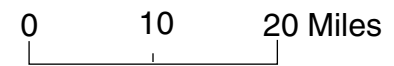
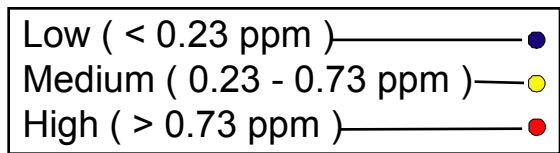
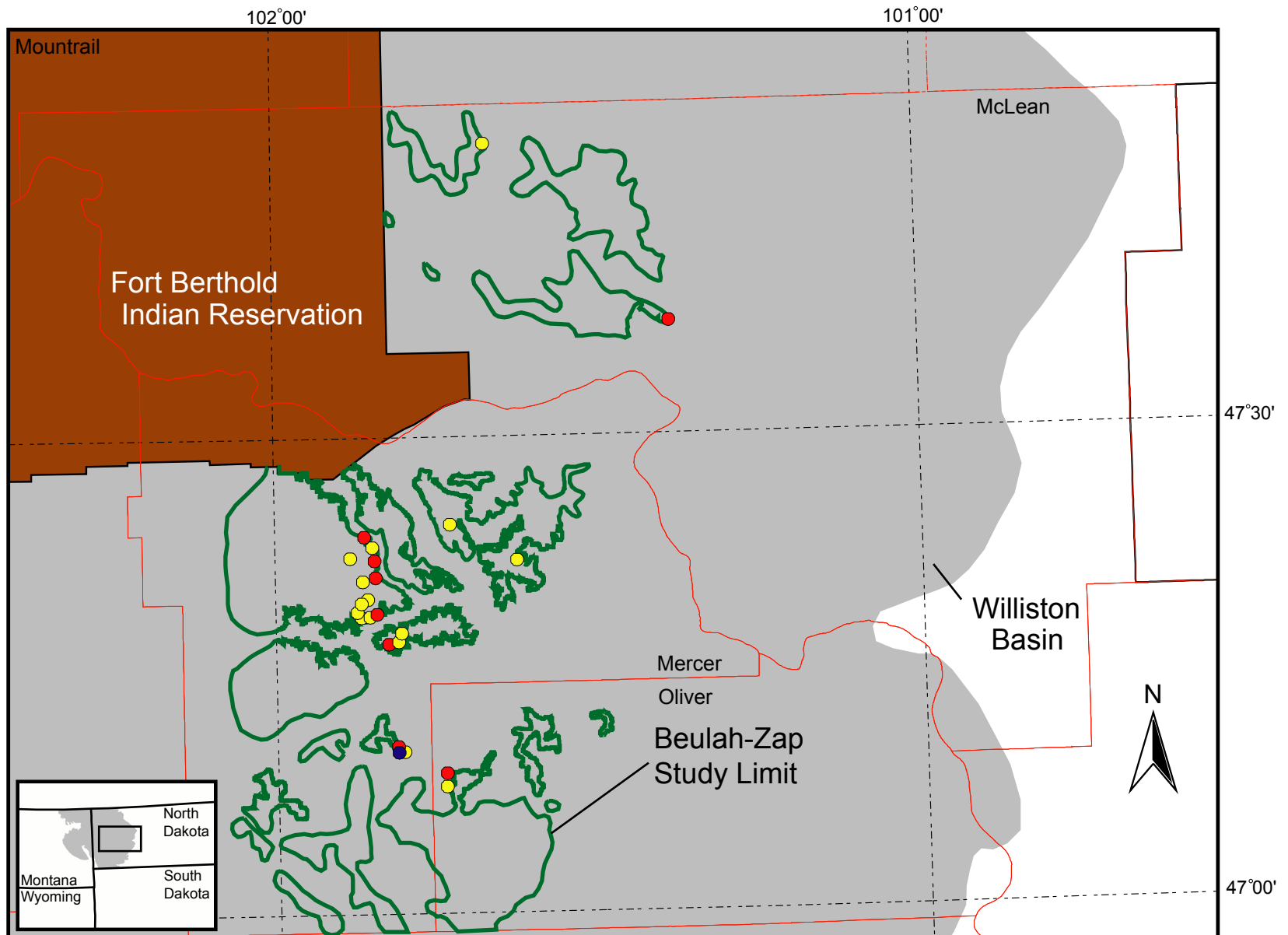


Figure WQ-36. Beryllium concentration in the Beulah-Zap coal zone, Beulah coalfield, Williston Basin, North Dakota.

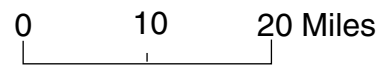
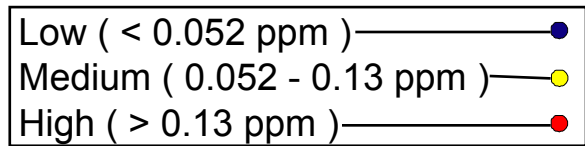
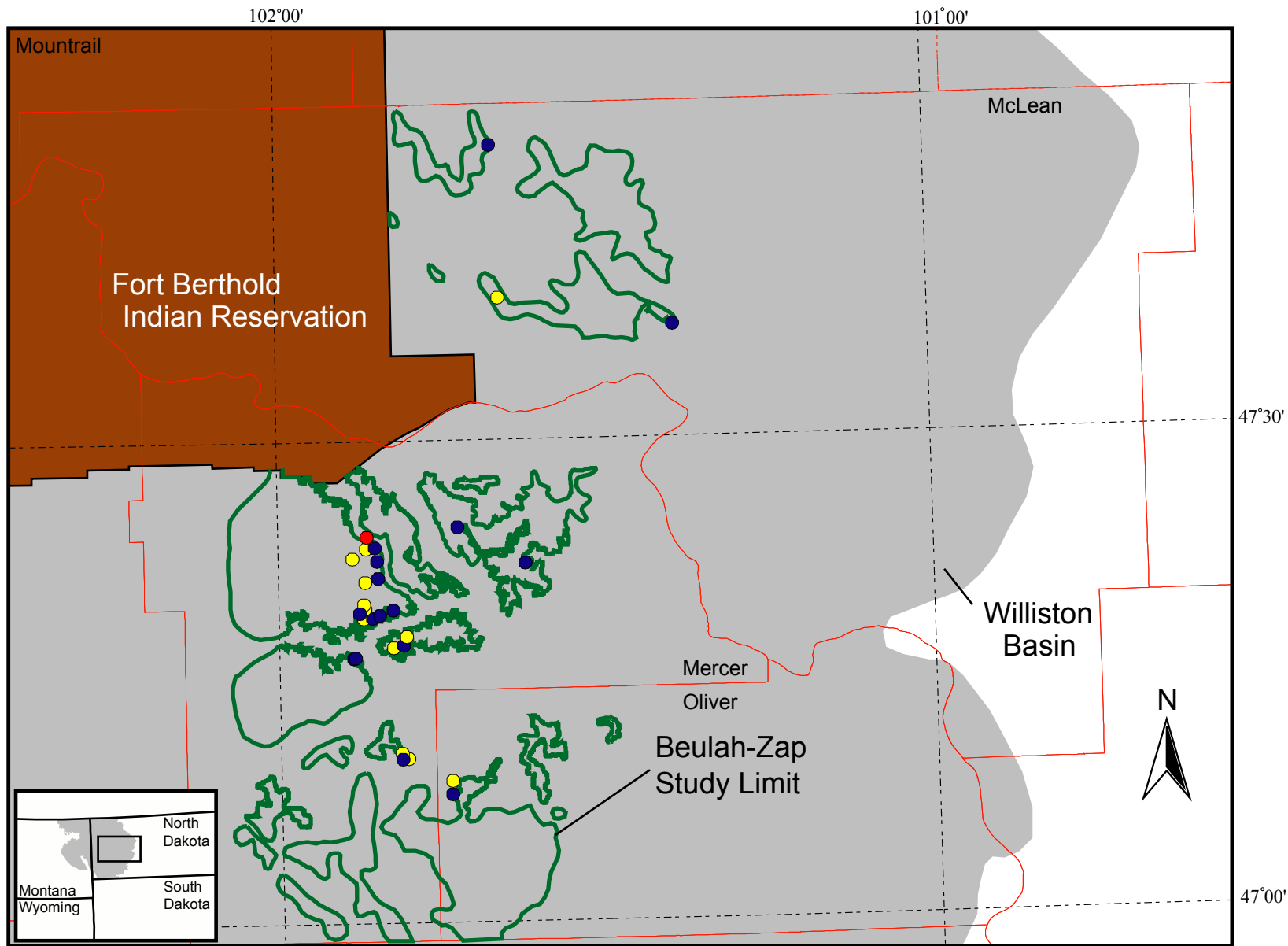


Figure WQ-37. Cadmium concentration in the Beulah-Zap coal zone, Beulah coalfield, Williston Basin, North Dakota.

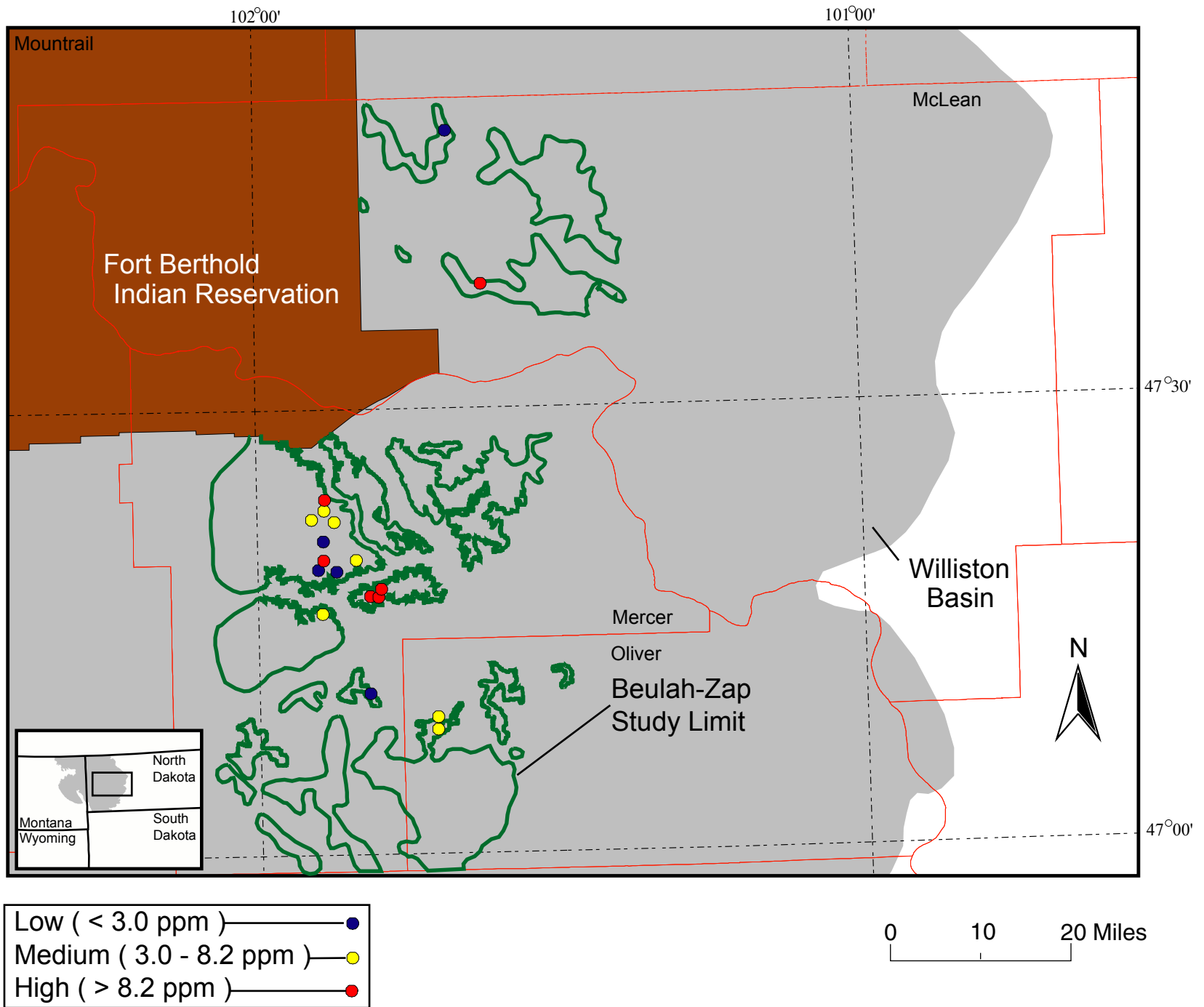


Figure WQ-38. Chromium concentration in the Beulah-Zap coal zone, Beulah coalfield, Williston Basin, North Dakota.

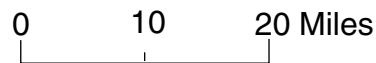
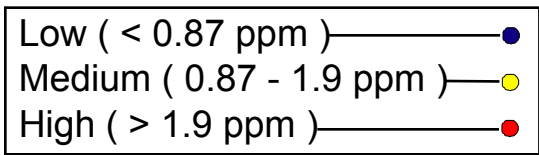
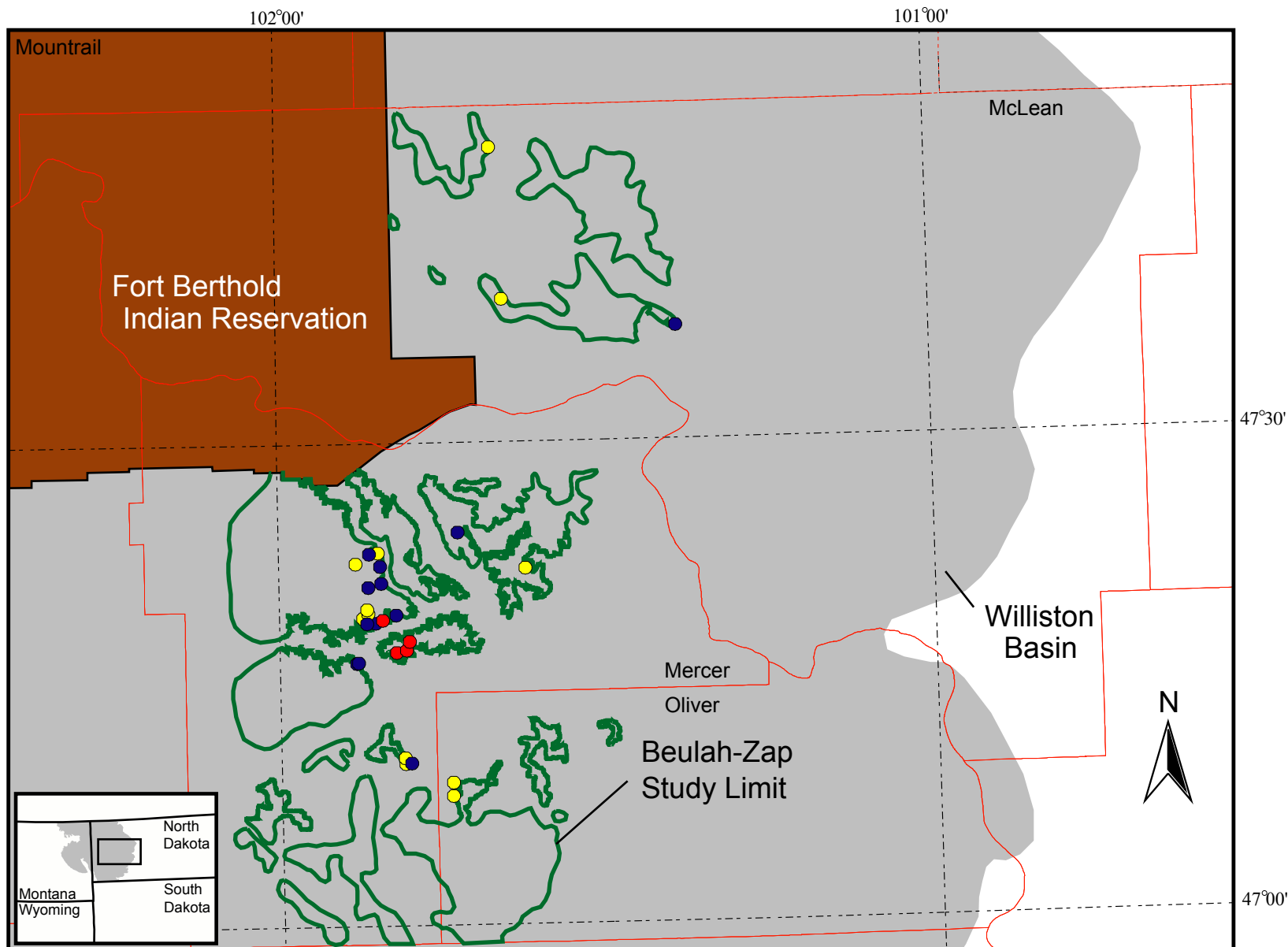


Figure WQ-39. Cobalt concentration in the Beulah-Zap coal zone, Beulah coalfield, Williston Basin, North Dakota.

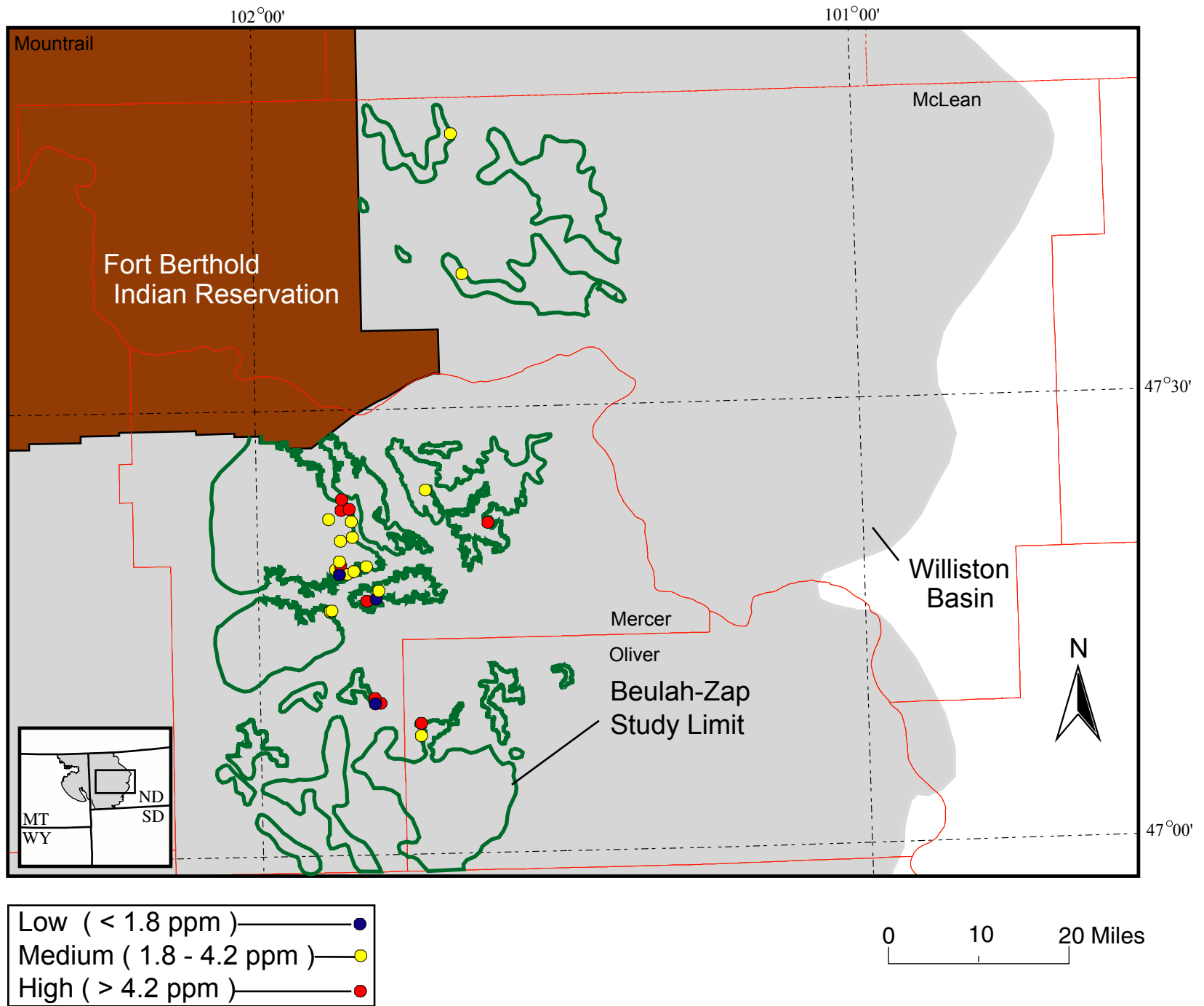


Figure WQ-40. Lead concentration in the Beulah-Zap coal zone, Beulah coalfield, Williston Basin, North Dakota.

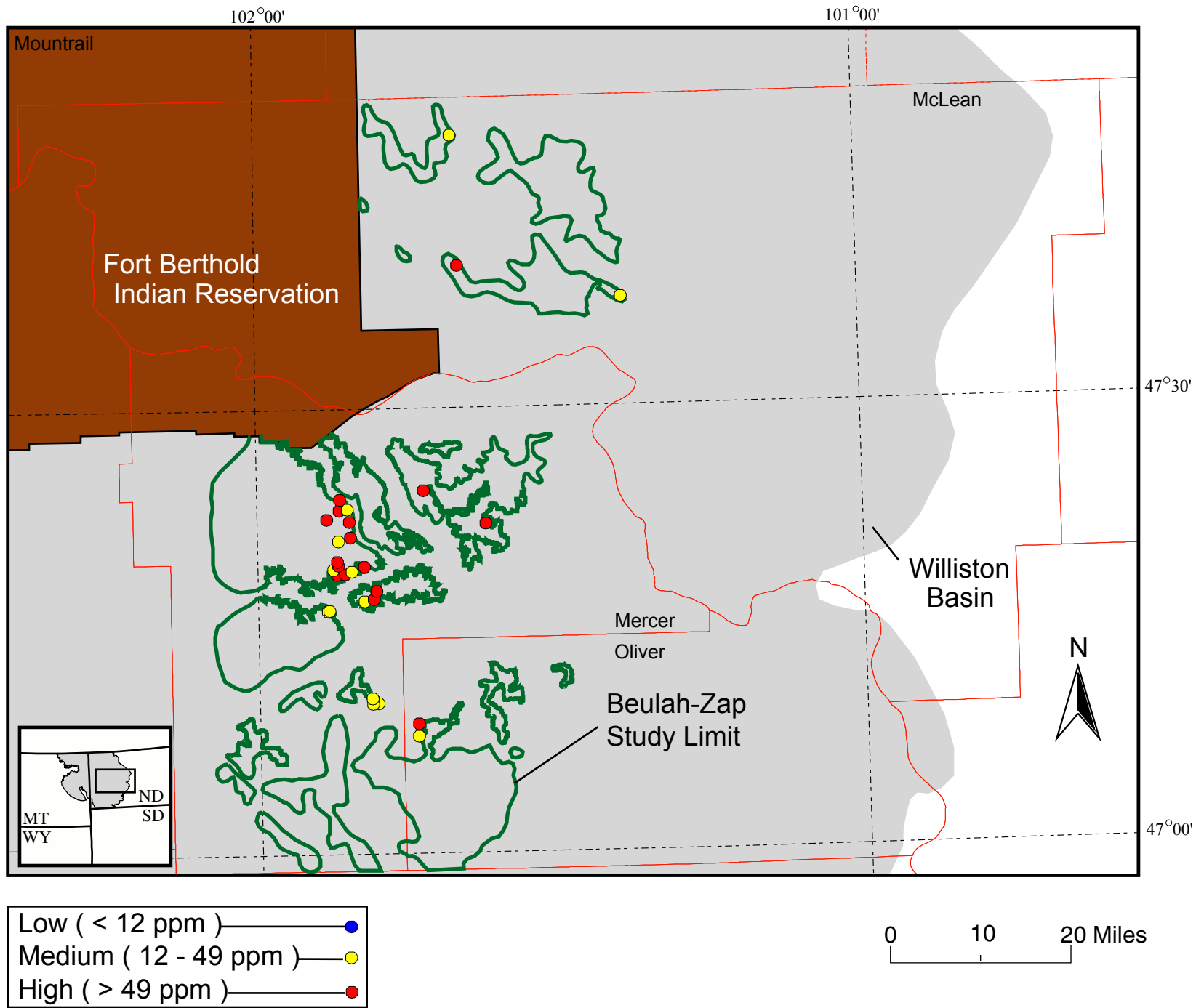


Figure WQ-41. Manganese concentration in the Beulah-Zap coal zone, Beulah coalfield, Williston Basin, North Dakota.

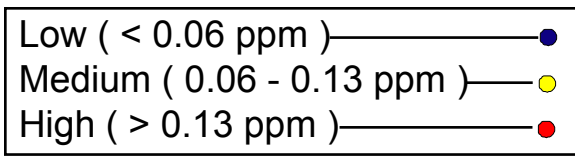
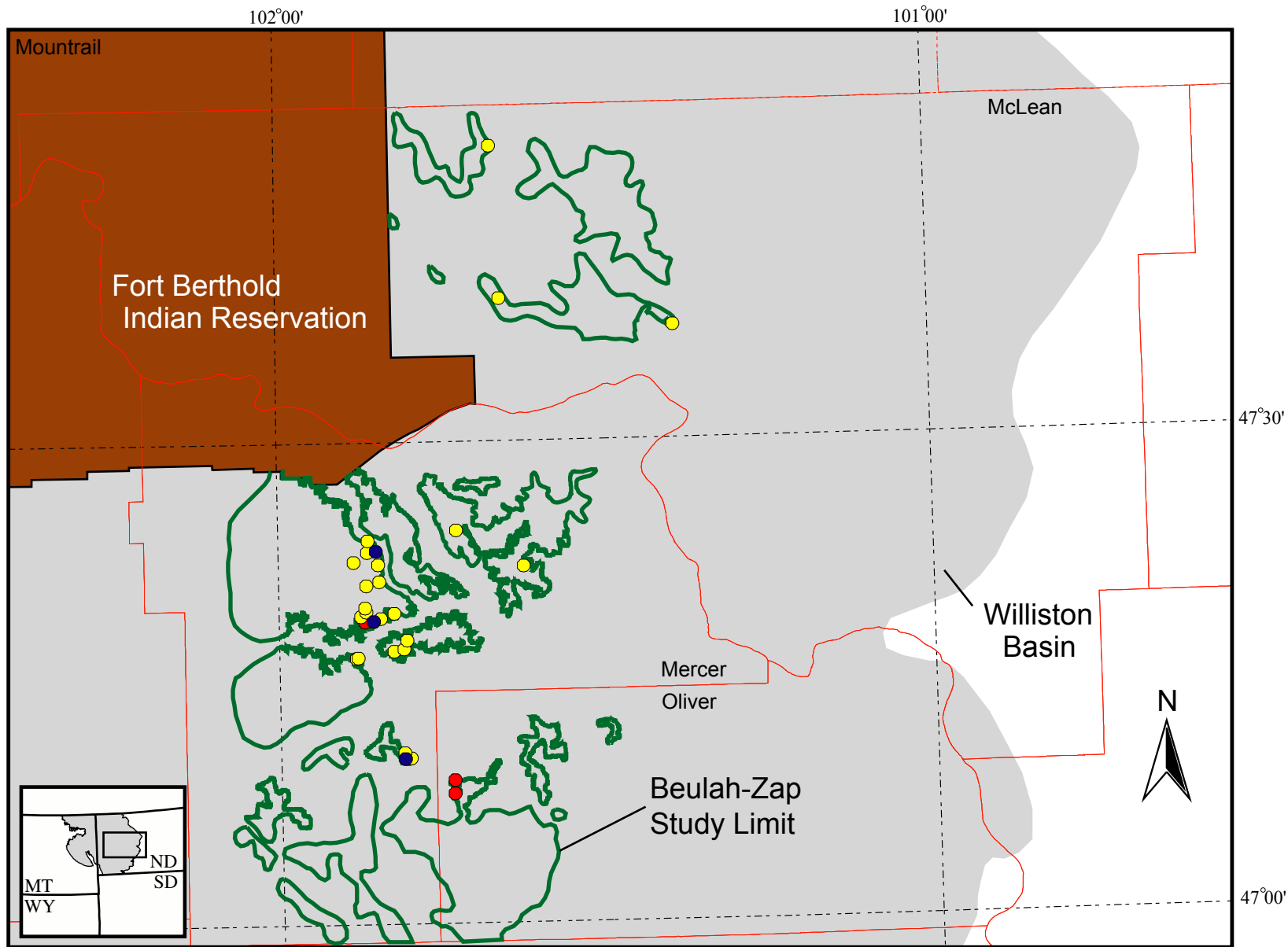


Figure WQ-42. Mercury concentration in the Beulah-Zap coal zone, Beulah coalfield, Williston Basin, North Dakota.

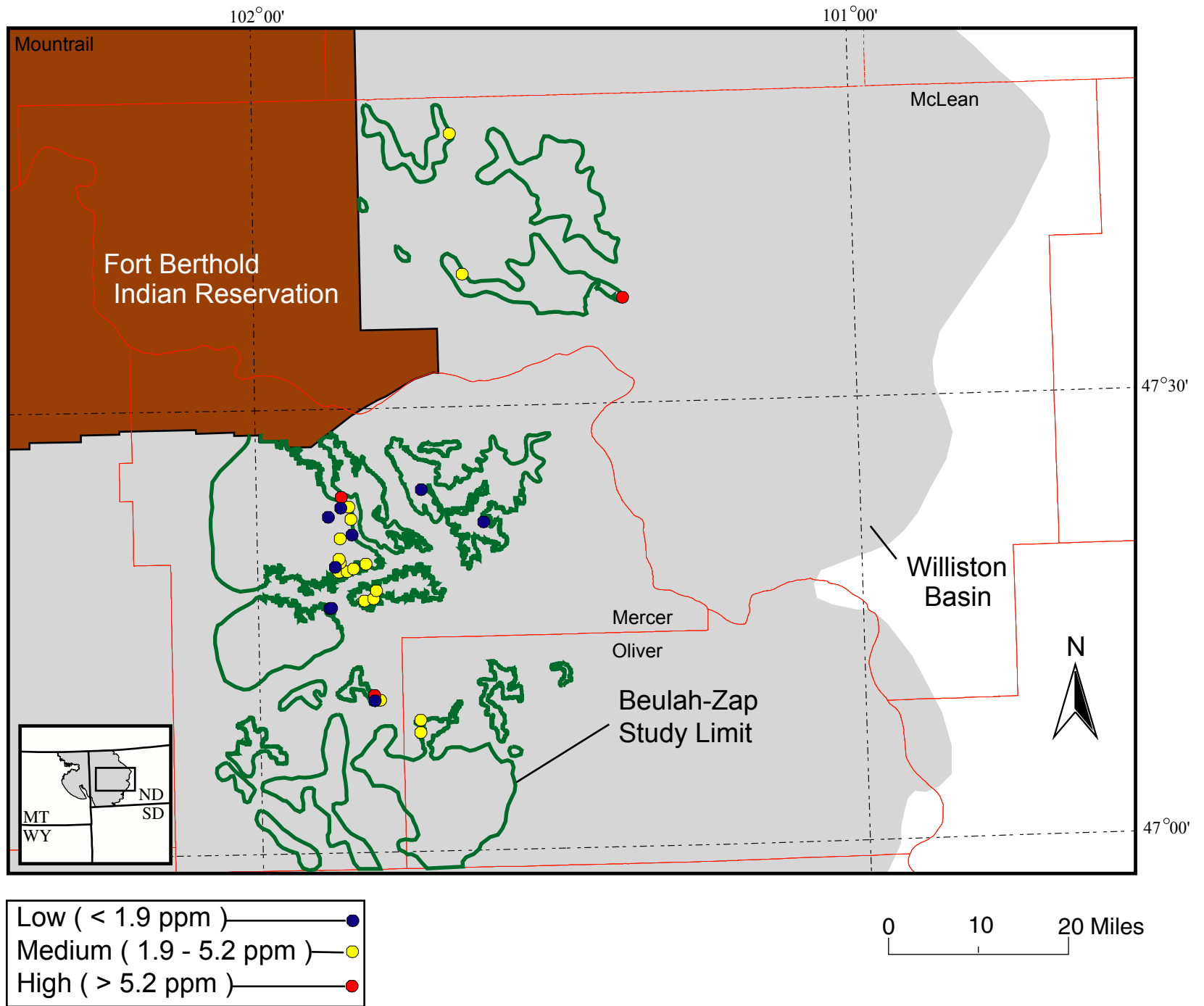


Figure WQ-43. Nickel concentration in the Beulah-Zap coal zone, Beulah coalfield, Williston Basin, North Dakota.

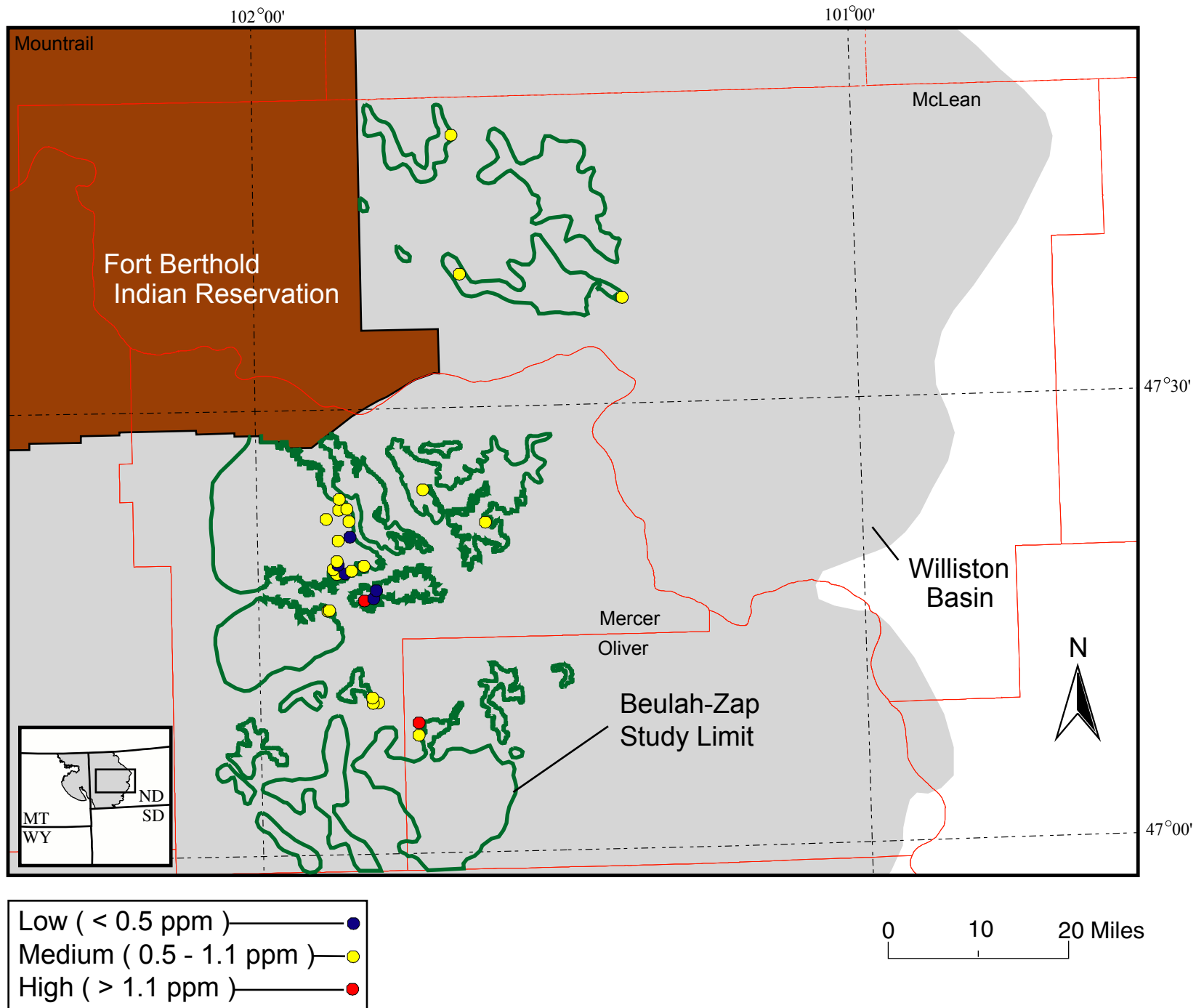


Figure WQ-44. Selenium concentration in the Beulah-Zap coal zone, Beulah coalfield, Williston Basin, North Dakota.

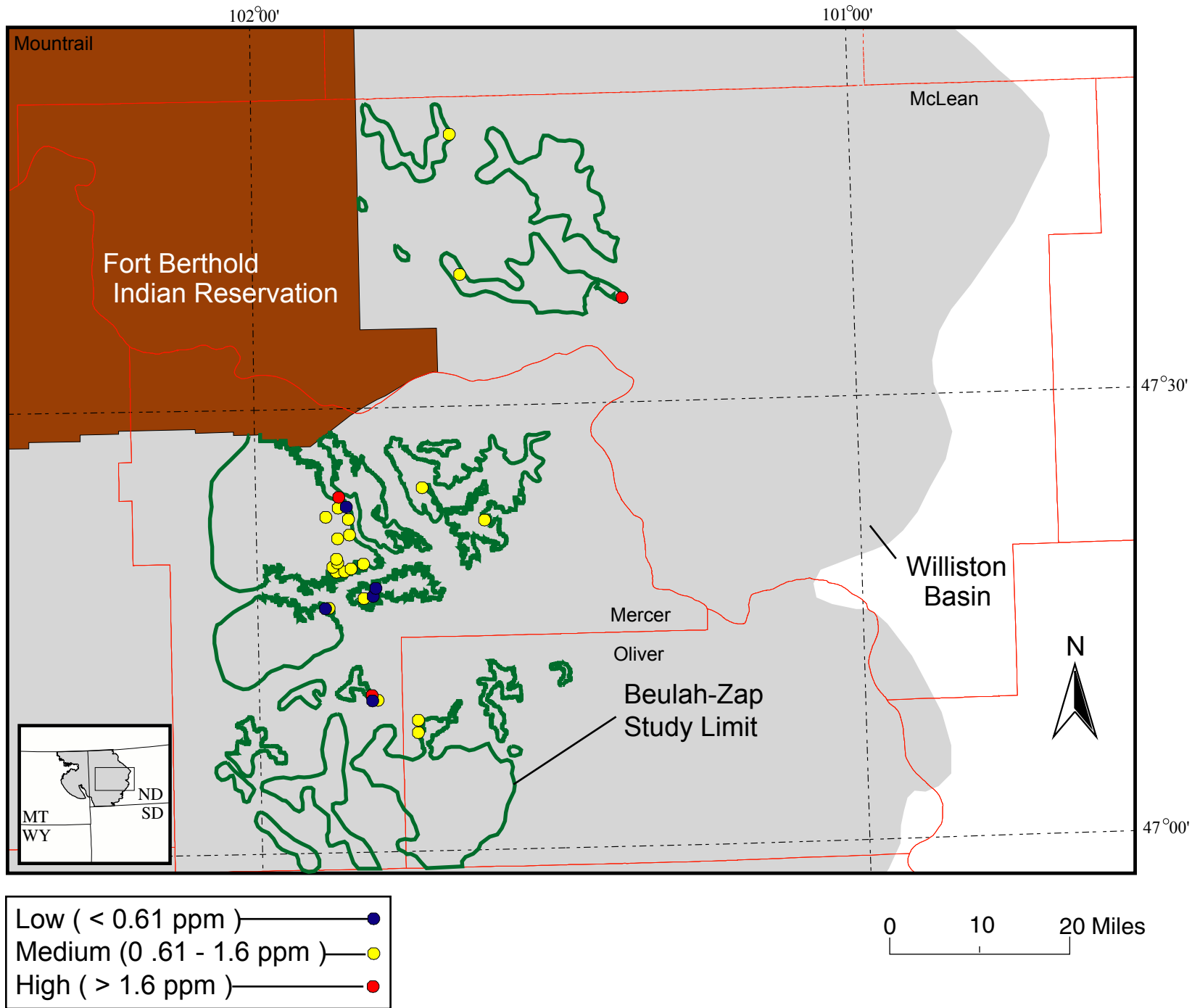


Figure WQ-45. Uranium concentration in the Beulah-Zap coal zone, Beulah coalfield, Williston Basin, North Dakota.

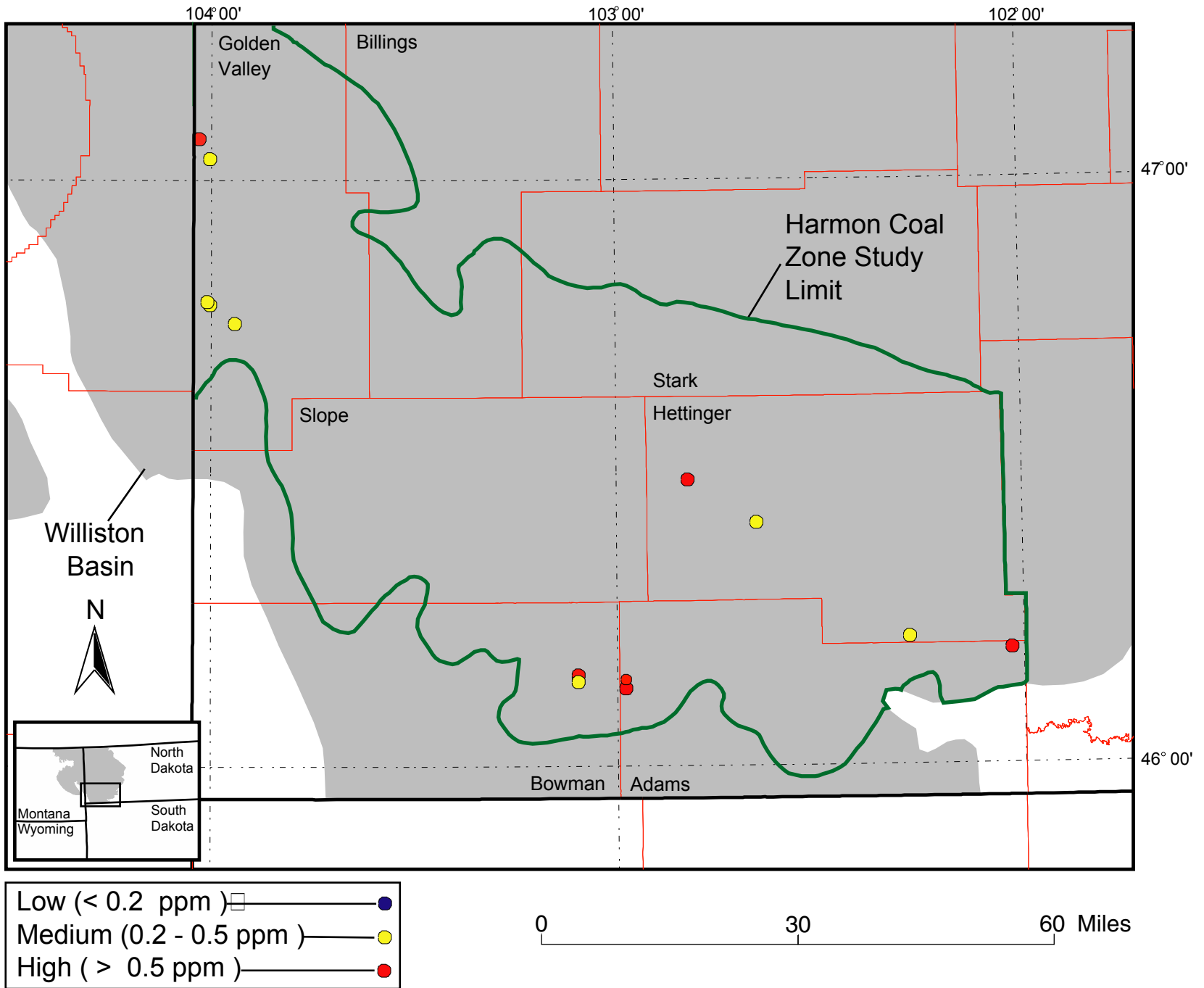


Figure WQ-46. Antimony concentration in the Harmon coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

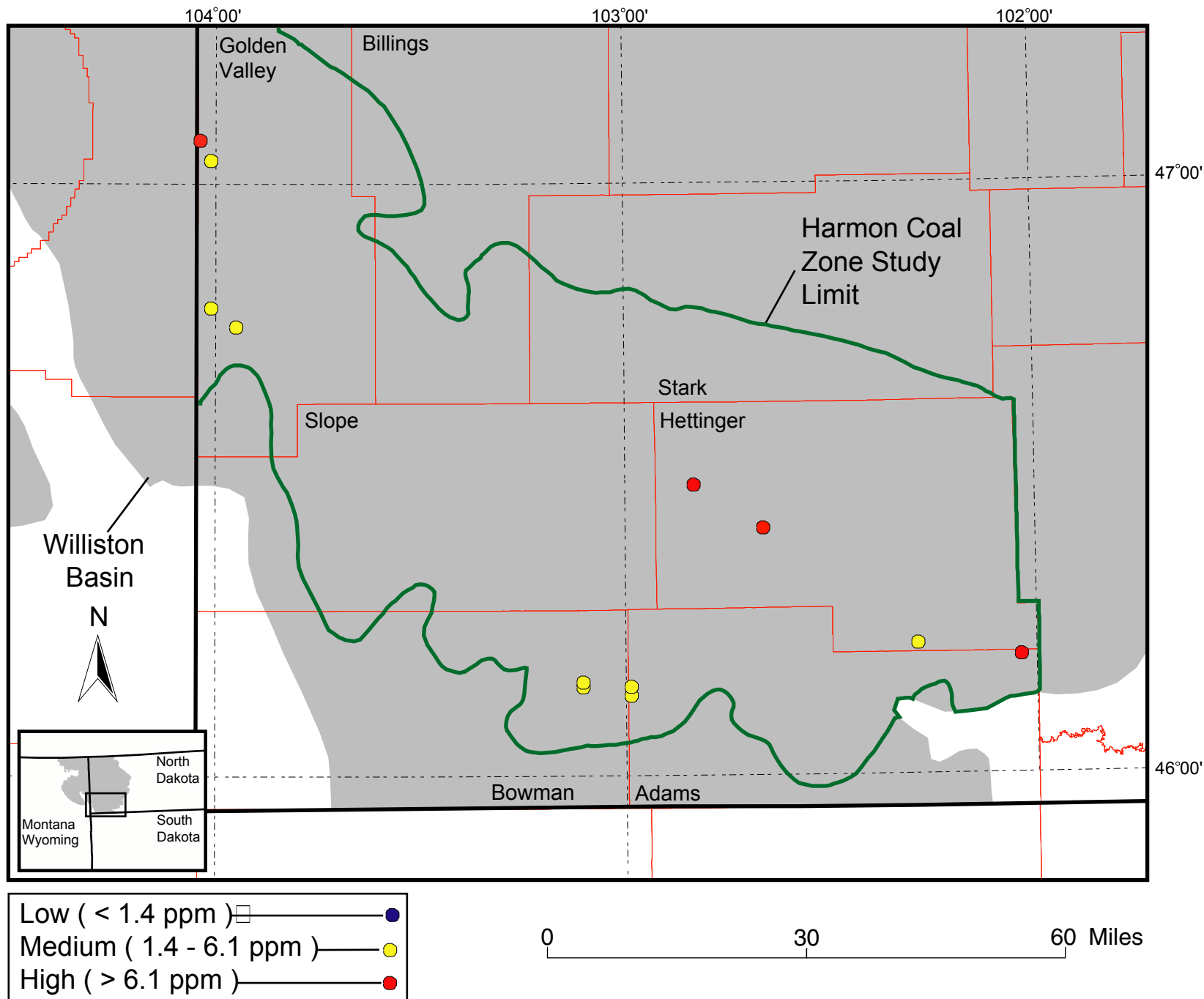


Figure WQ-47. Arsenic concentration in the Harmon coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

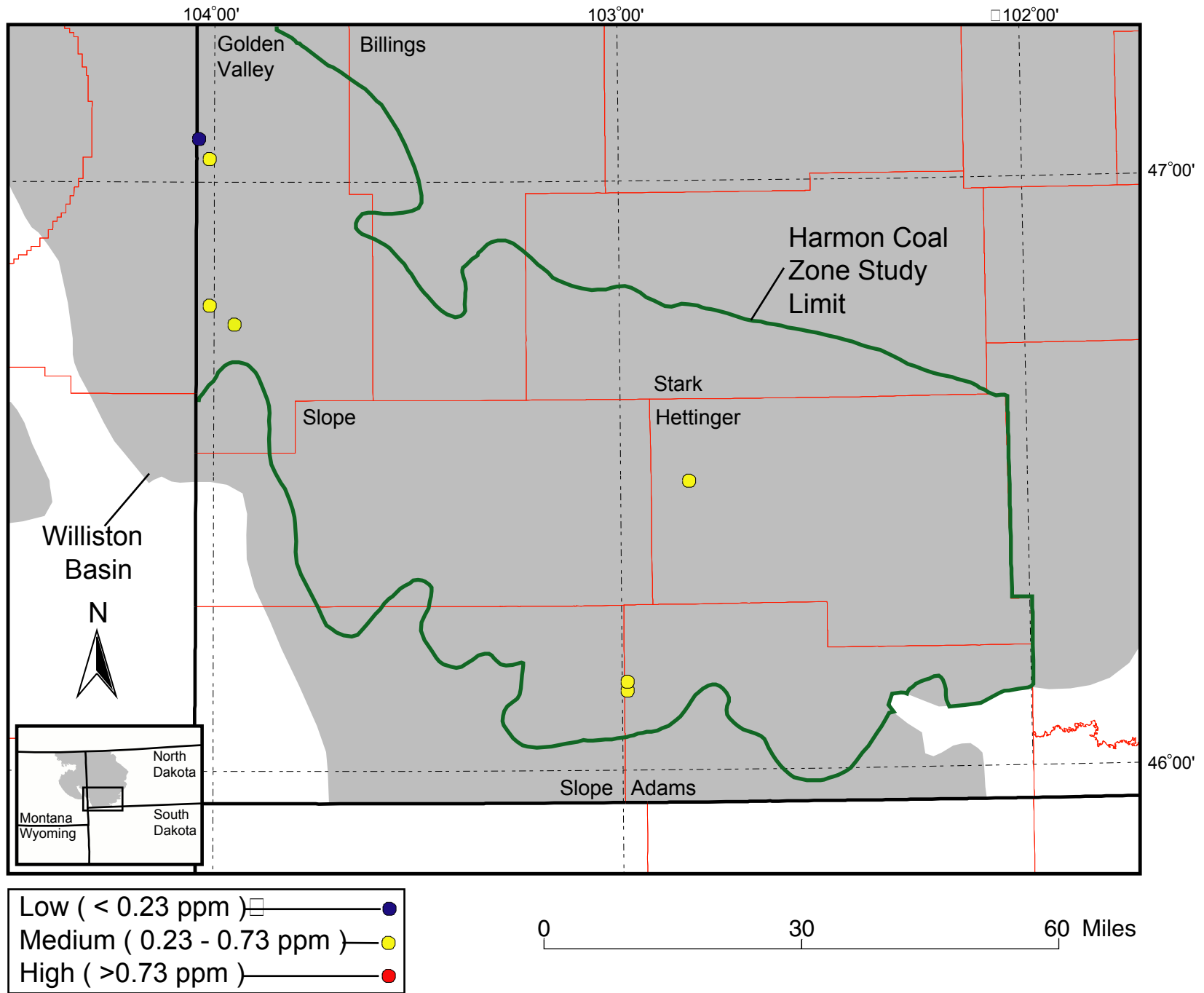


Figure WQ-48. Beryllium concentration in the Harmon coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

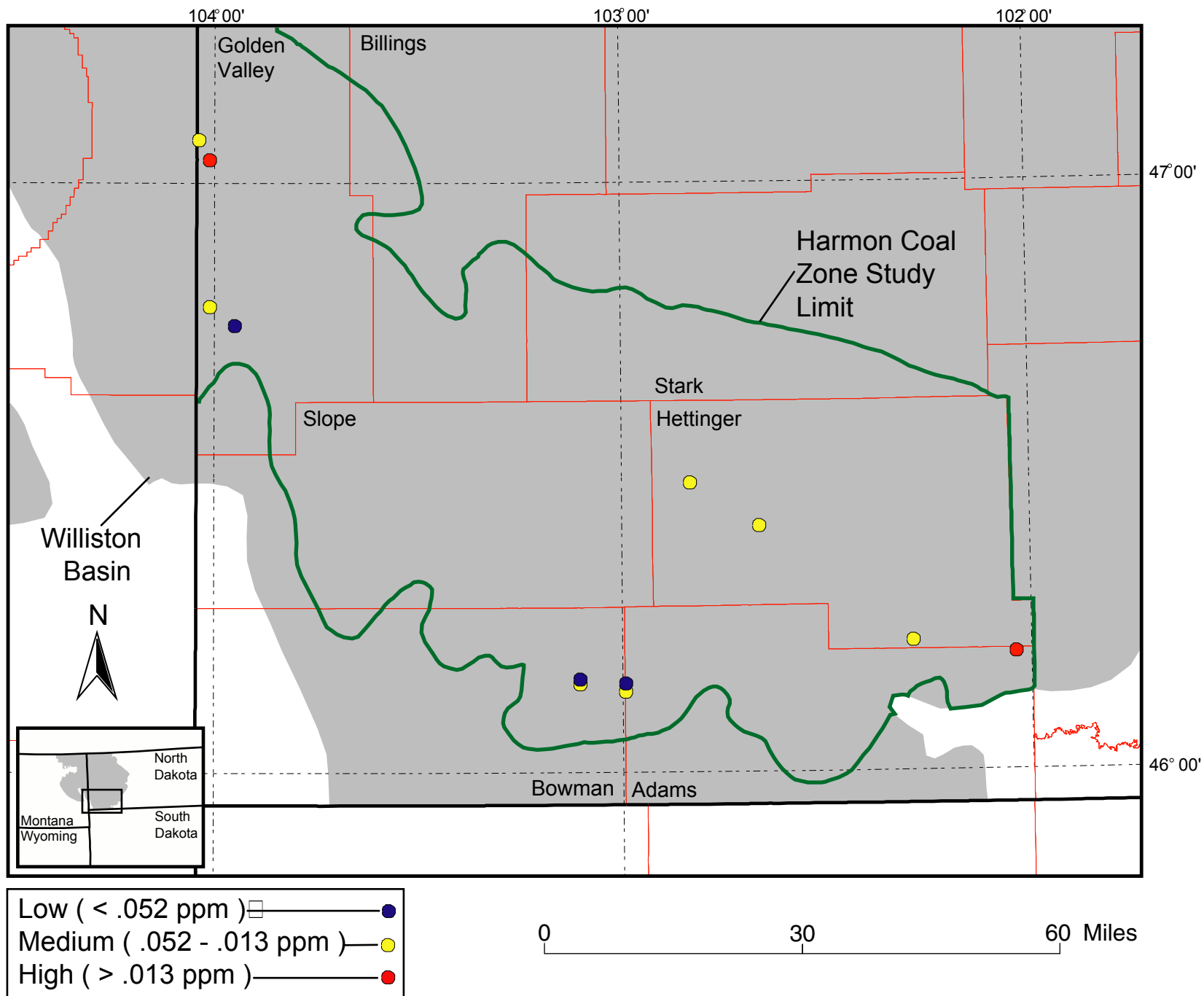


Figure WQ-49. Cadmium concentration in the Harmon coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

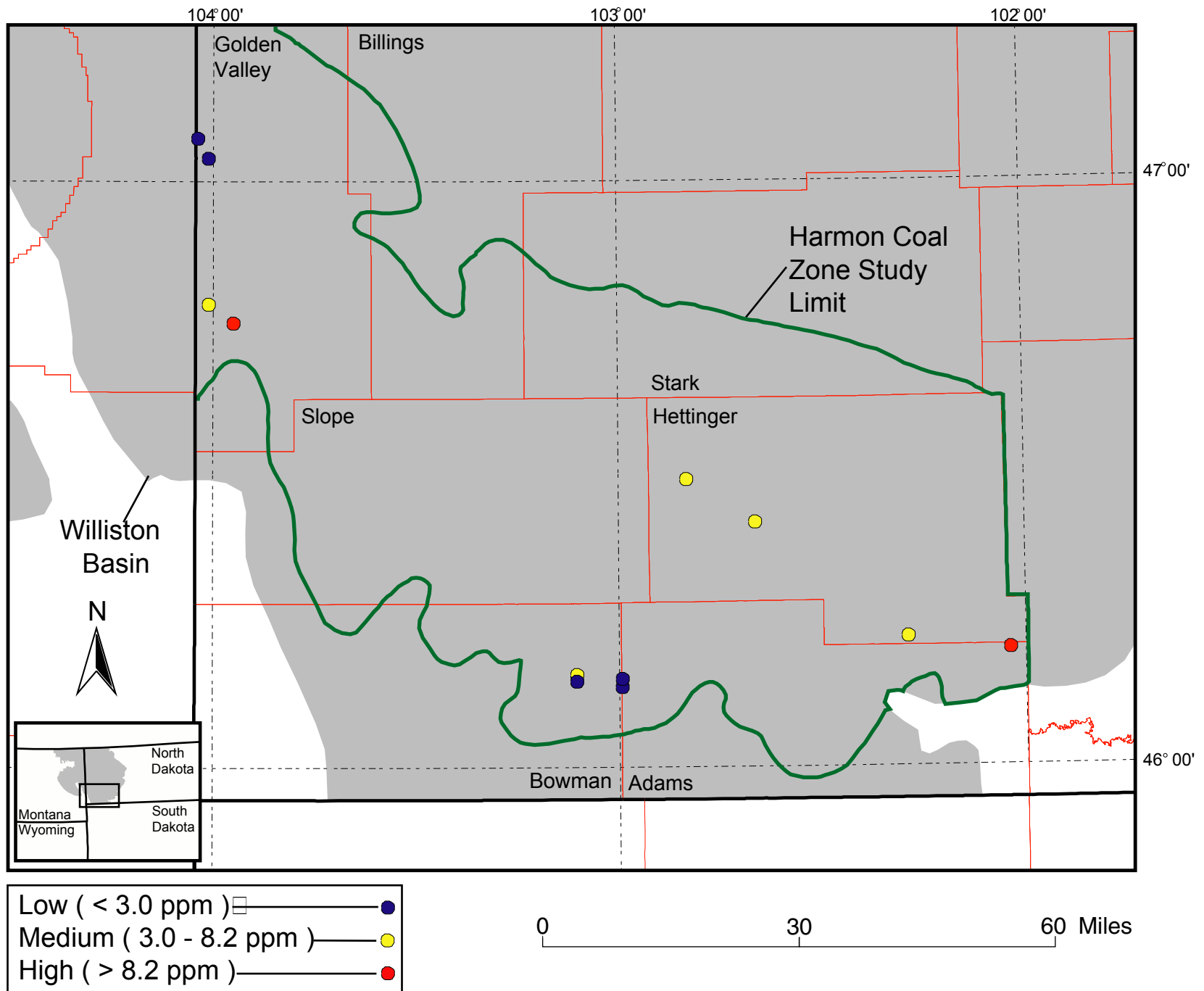


Figure WQ-50. Chromium concentration in the Harmon coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

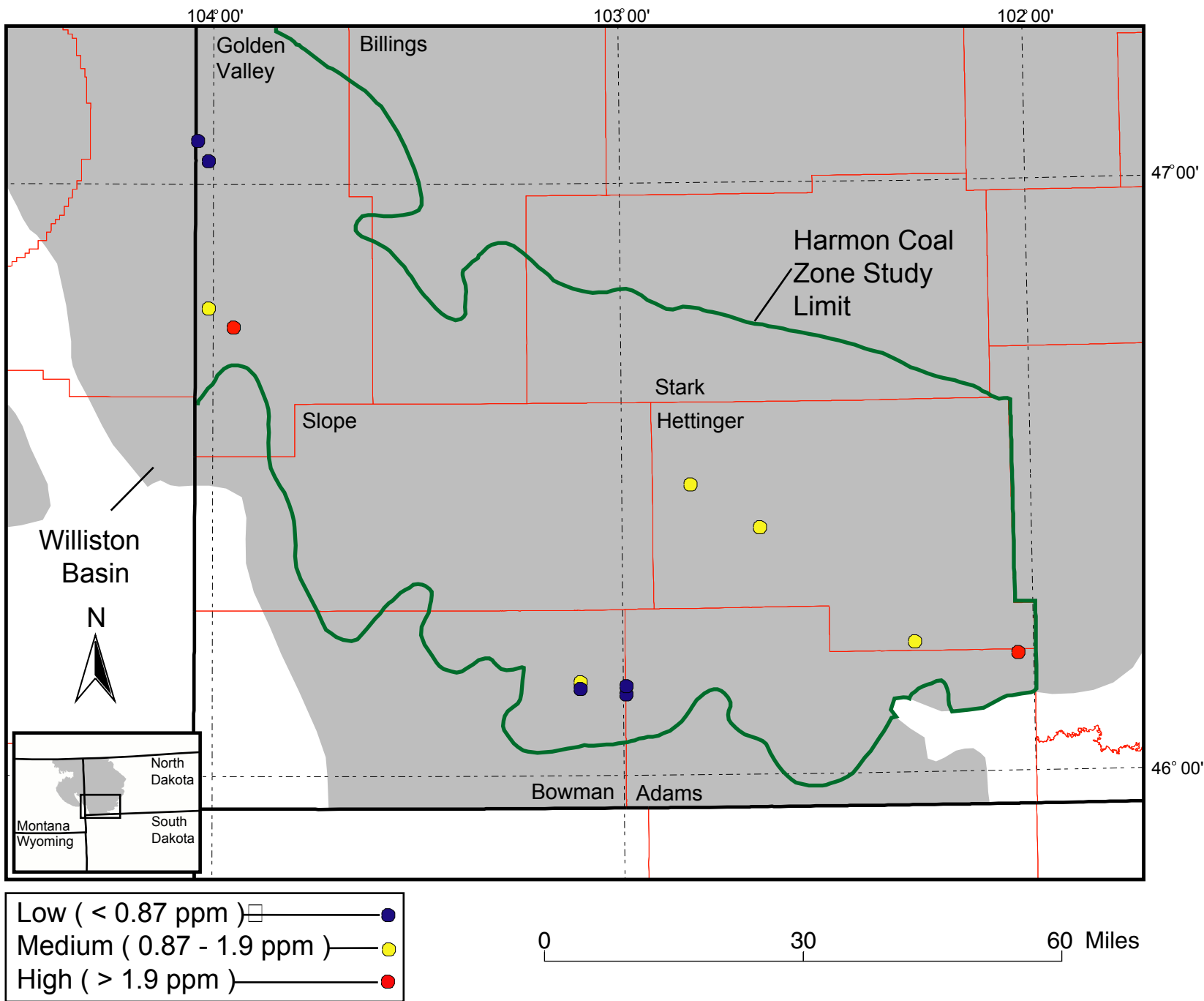


Figure WQ-51. Cobalt concentration in the Harmon coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

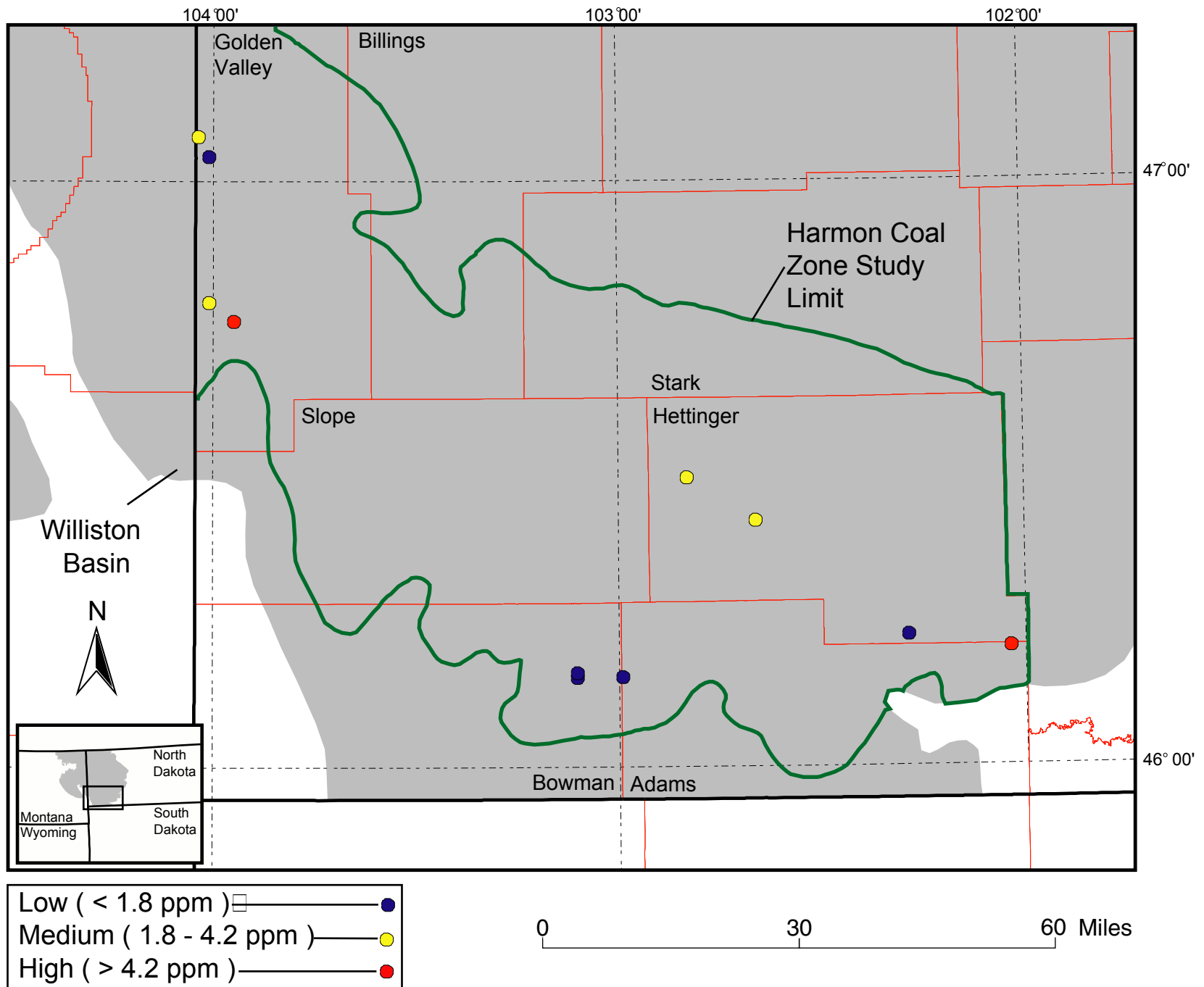


Figure WQ-52. Lead concentration in the Harmon coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

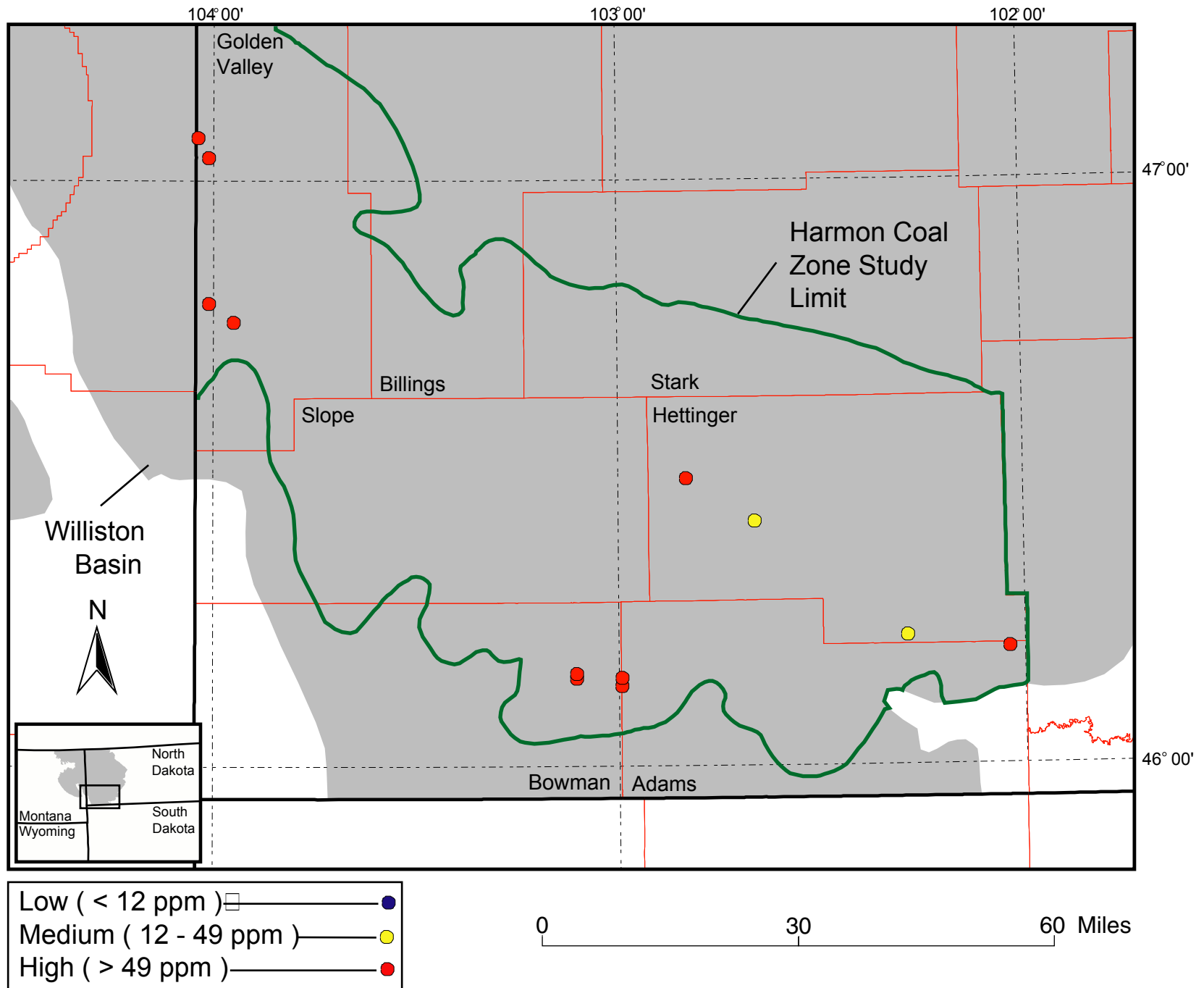


Figure WQ-53. Manganese concentration in the Harmon coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

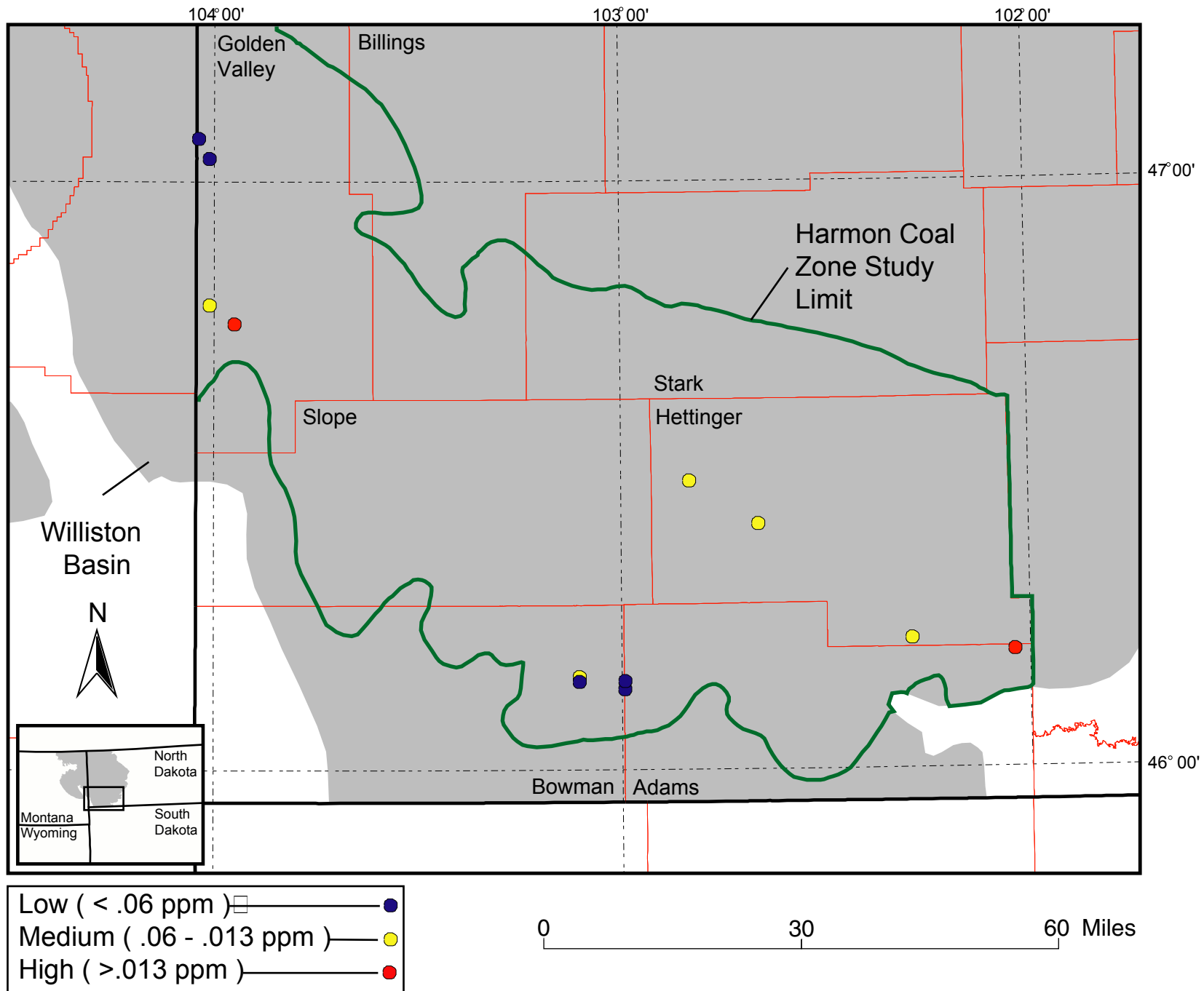


Figure WQ-54. Mercury concentration in the Harmon coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

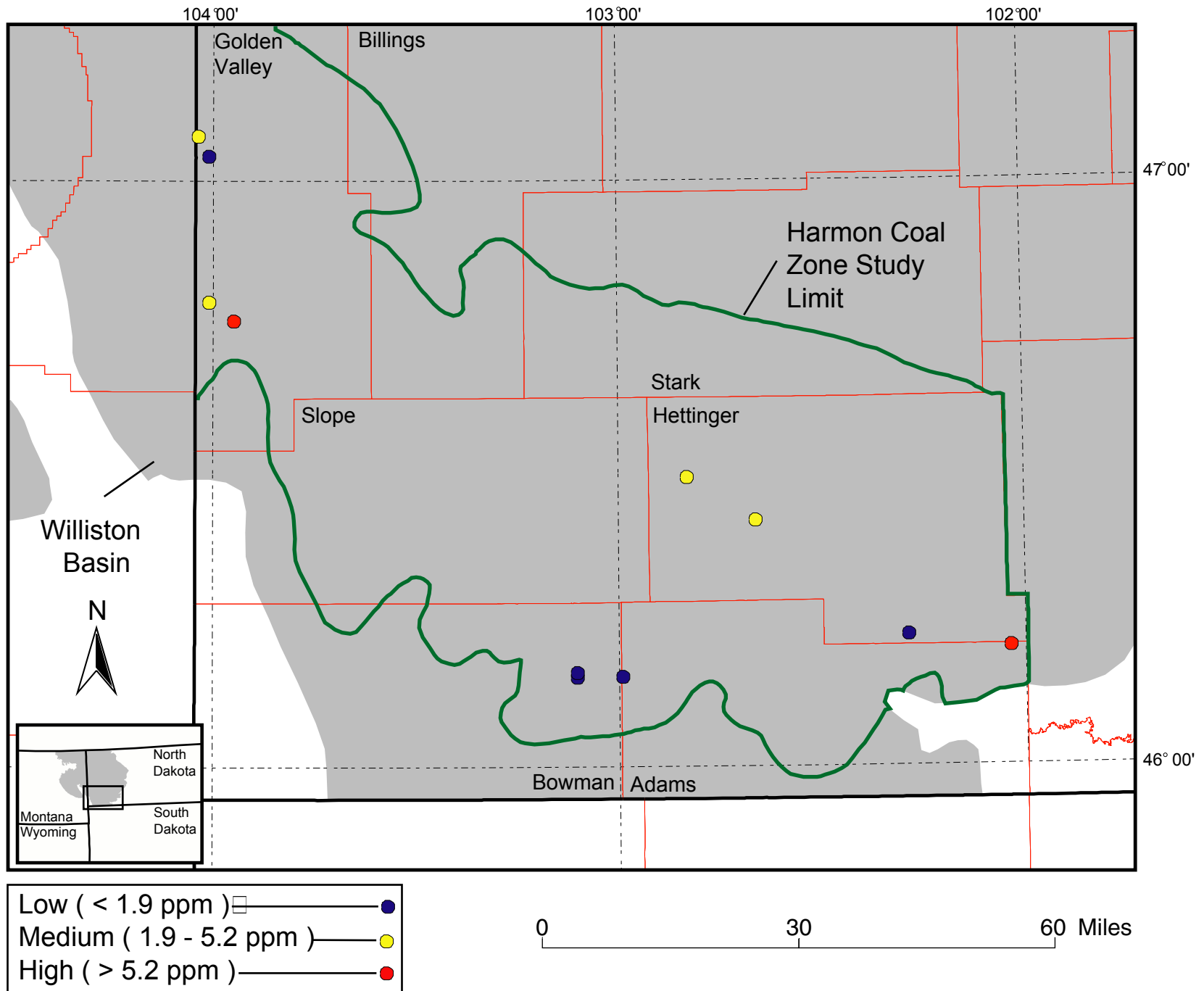


Figure WQ-55. Nickel concentration in the Harmon coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

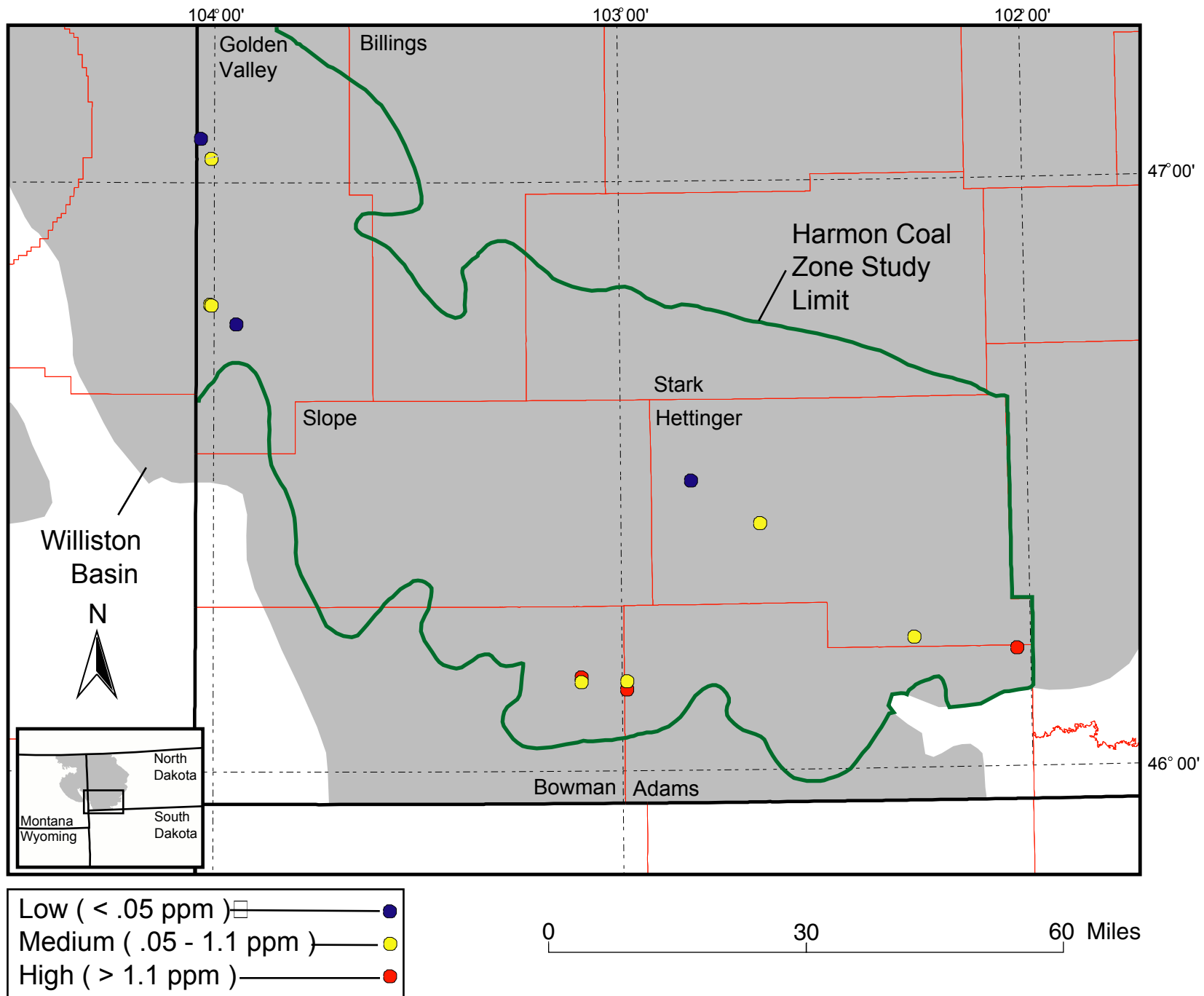


Figure WQ-56. Selenium concentration in the Harmon coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

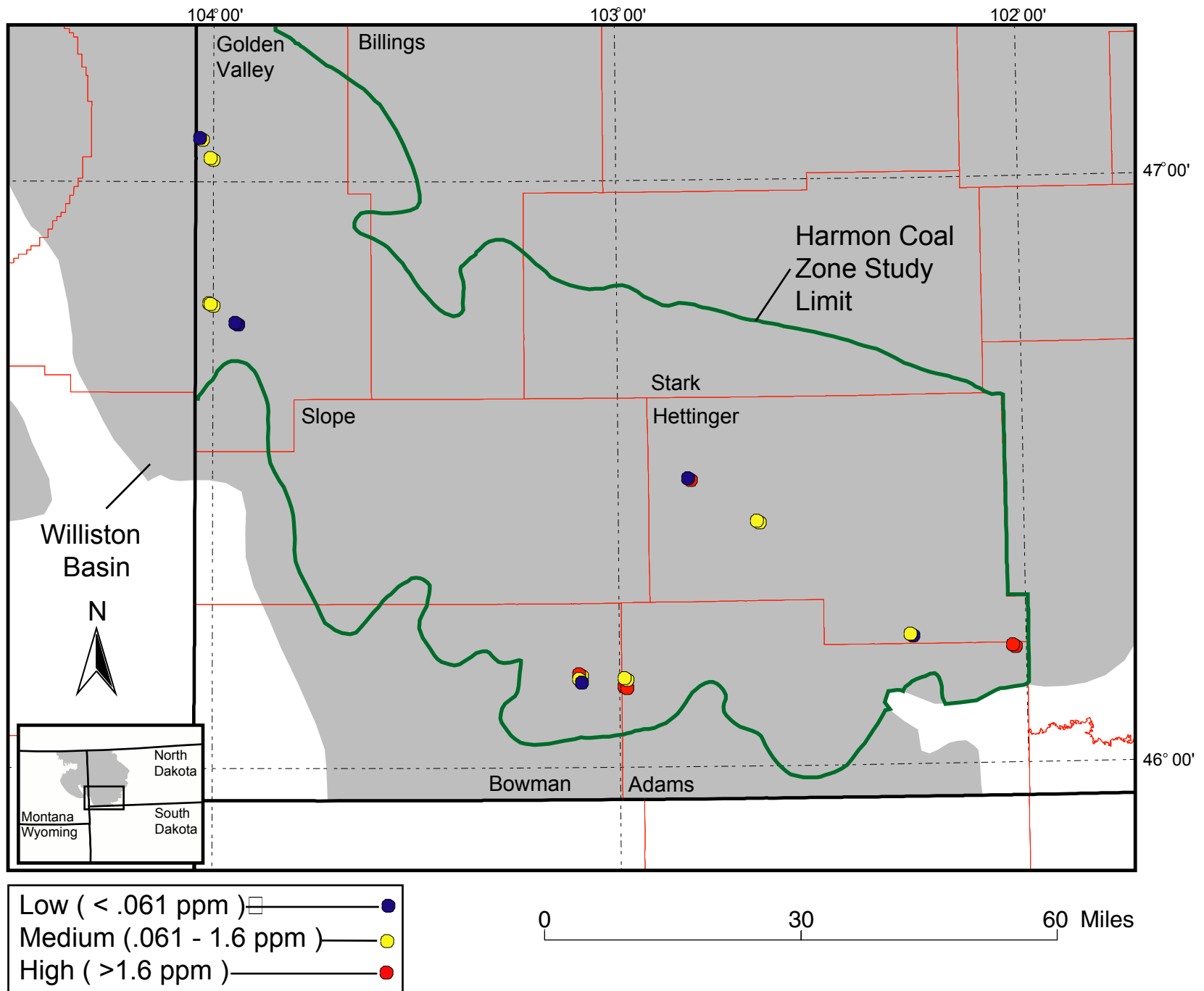


Figure WQ-57. Uranium concentration in the Harmon coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

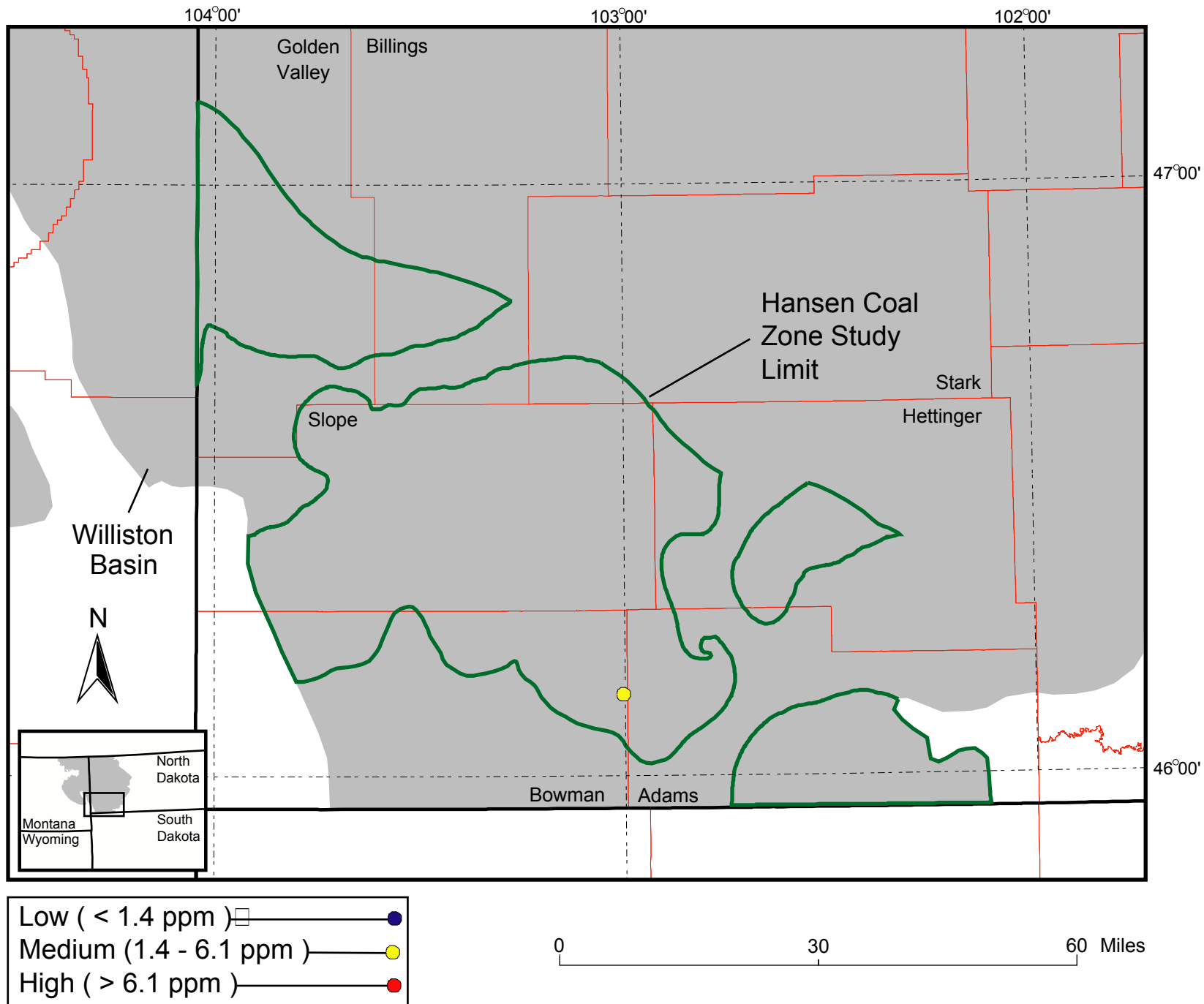


Figure WQ-58. Arsenic concentration in the Hansen coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

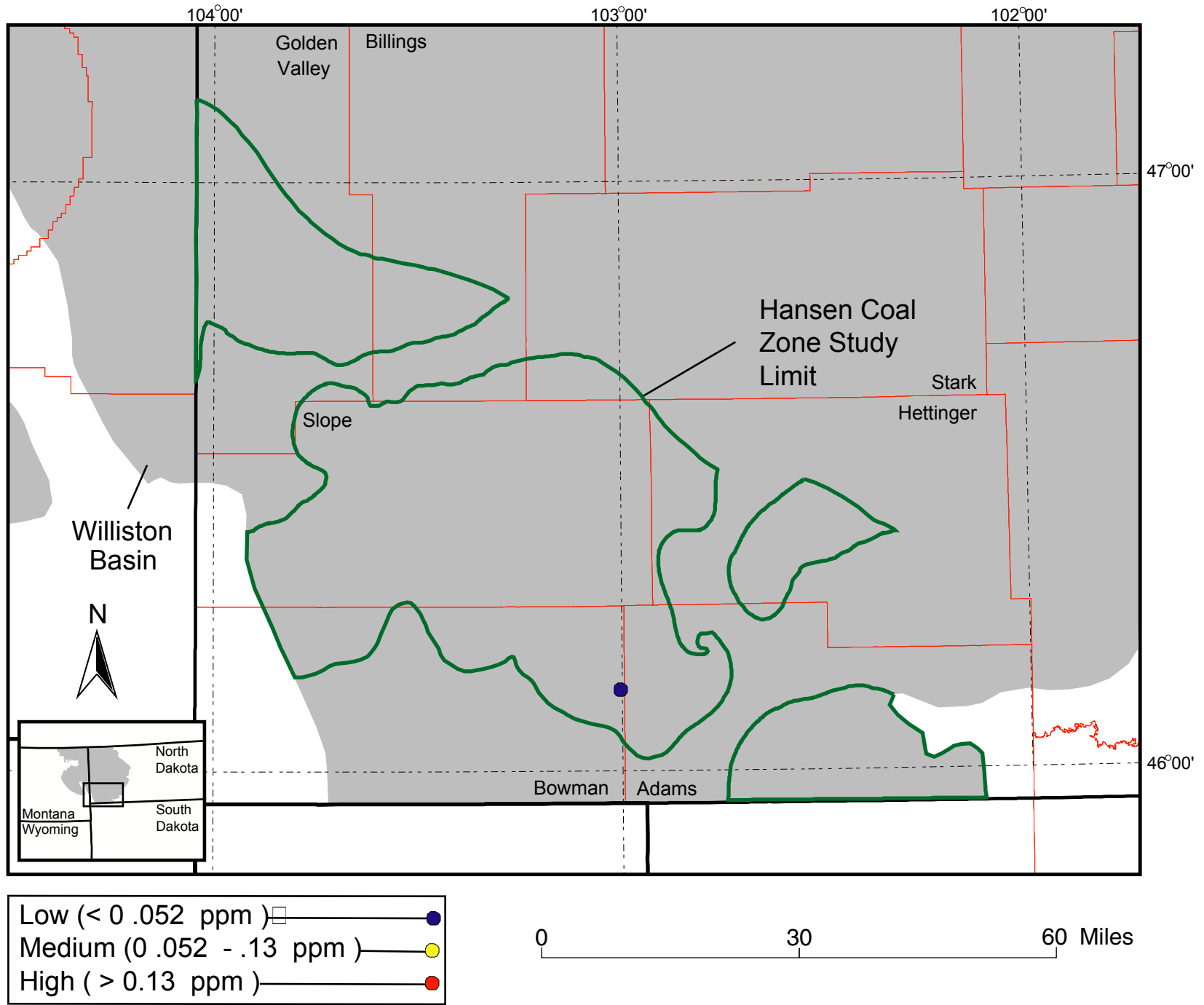


Figure WQ-59. Cadmium concentration in the Hansen coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

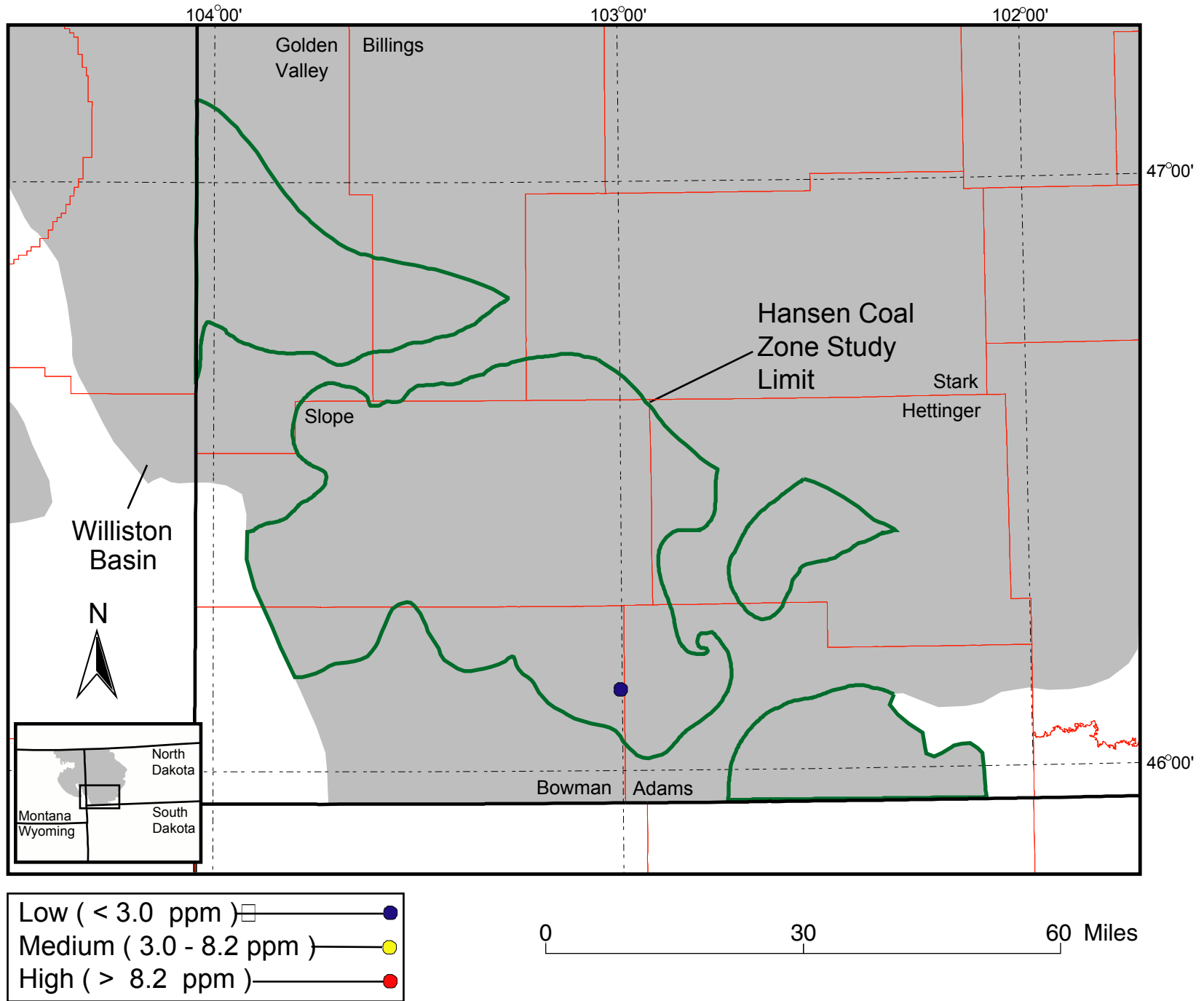


Figure WQ-60. Chromium concentration in the Hansen coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

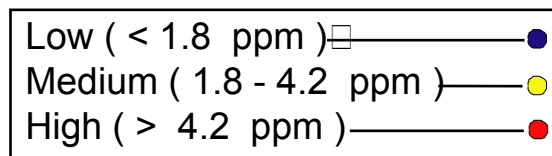
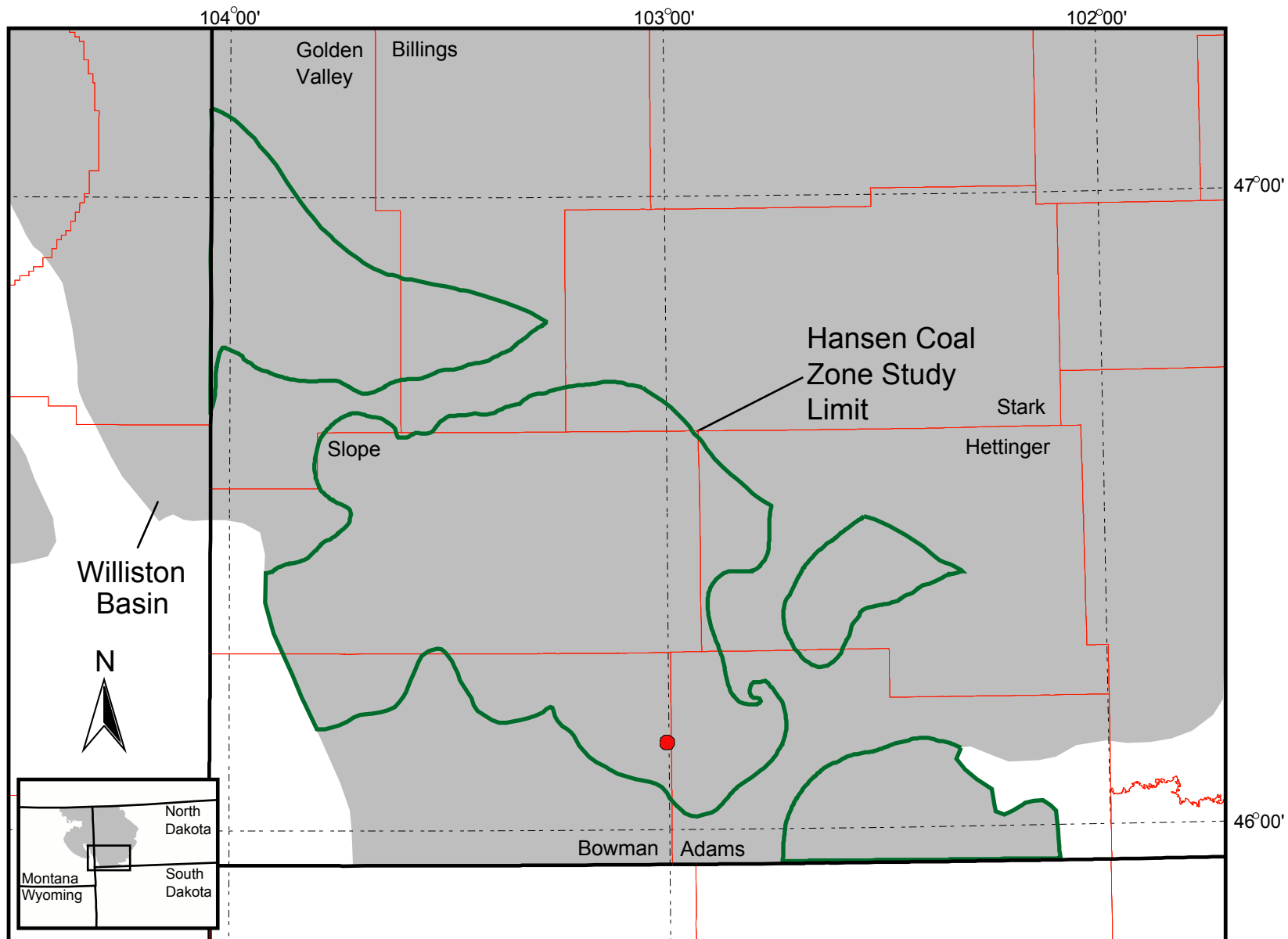


Figure WQ-61. Lead concentration in the Hansen coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

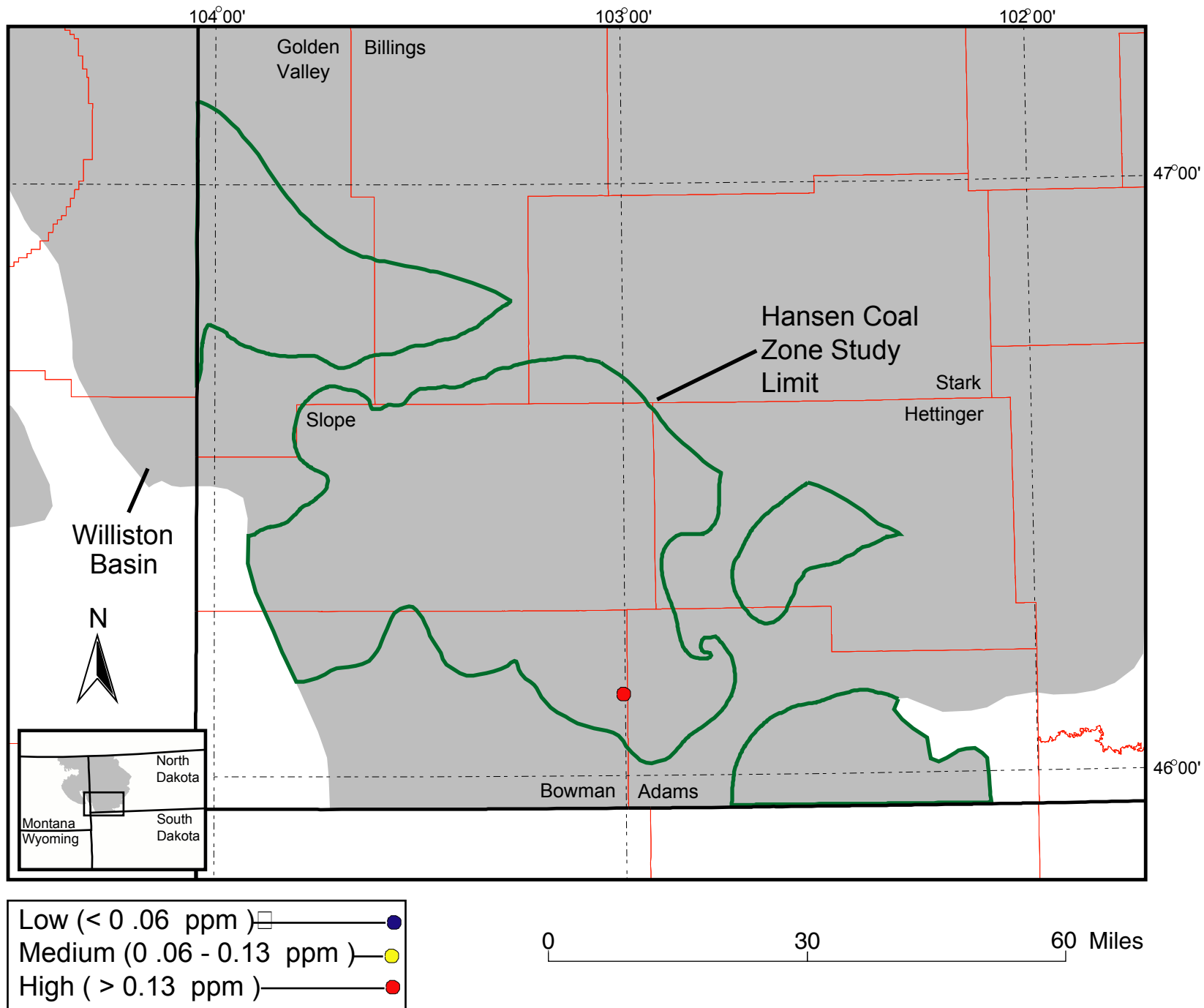


Figure WQ-62. Mercury concentration in the Hansen coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

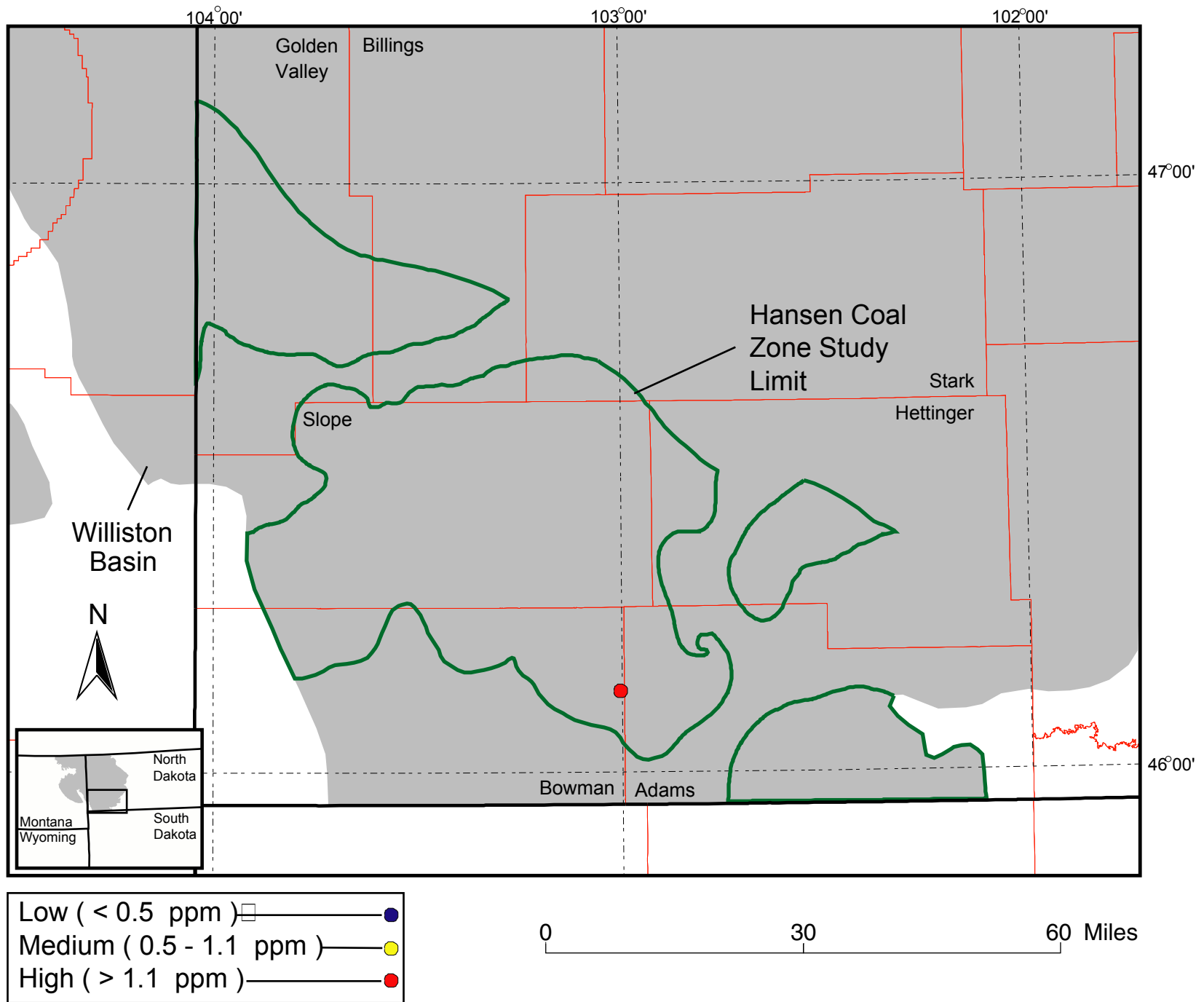


Figure WQ-63. Selenium concentration in the Hansen coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

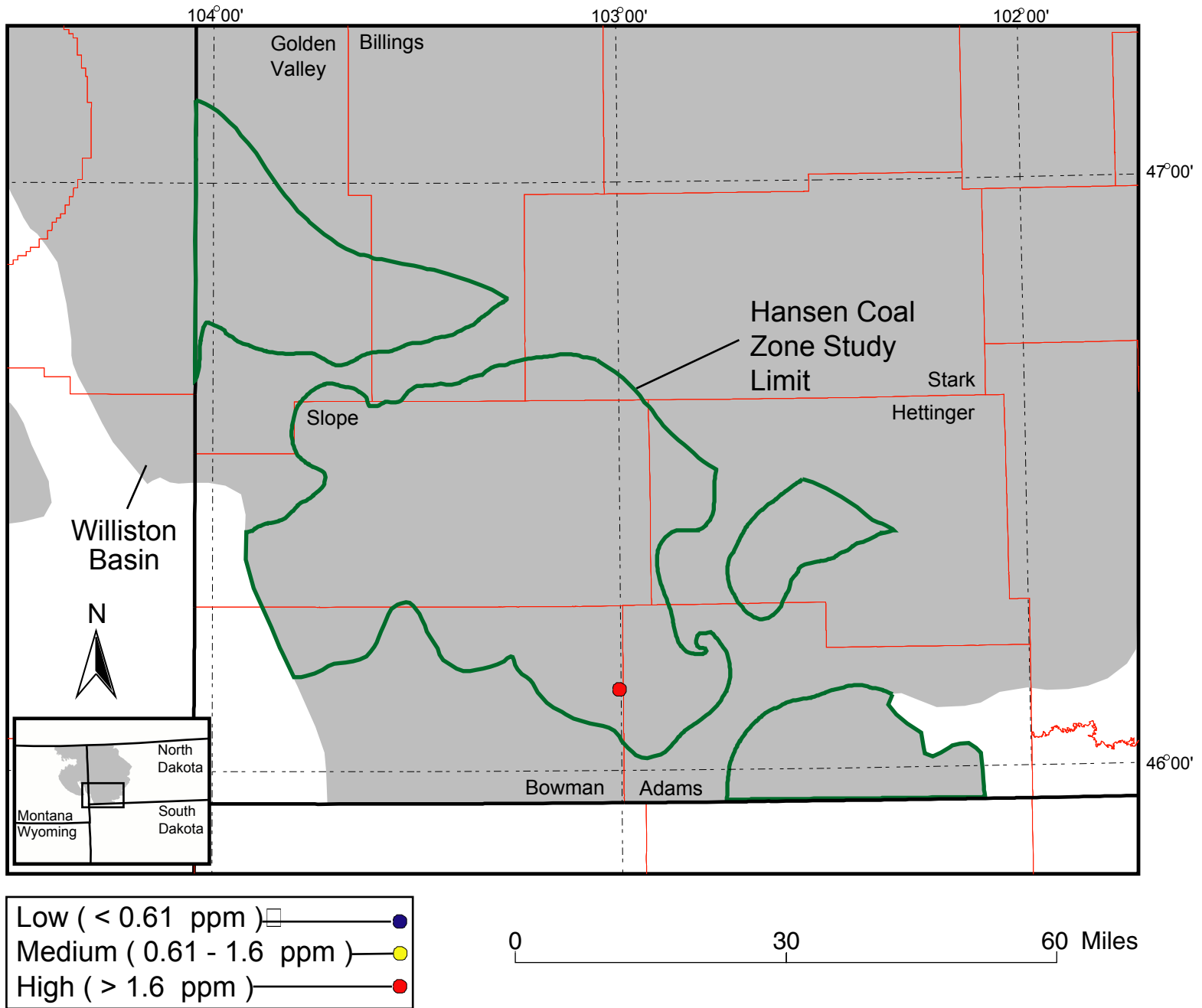


Figure WQ-64. Uranium concentration in the Hansen coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota.

Table WQ-1. Summary data for the hagel, Beulah-Zap, Harmon, and Hansen coal zones assessed in the Williston Basin, North Dakota. Calculated from the unpublished U.S. Geological Survey coal quality database (USCHEM), February, 1992; Bragg and others (1994); and proprietary source(s)

Variable	Number of samples	Range		Mean
		Minimum	Maximum	
Moisture ¹	281	27.70	51.24	37.88
Ash ¹	281	4.00	31.00	7.96
Total sulfur ¹	281	0.30	3.50	0.84
Calorific value ²	281	3,260	7,860	6,510
lb SO ₂ ³	281	0.79	12.14	2.54
MMMFbtu ⁴	281	5,110	8,560	7,110
Antimony ⁵	52	0.075L	3.0	0.60
Arsenic ⁵	53	1.8	32	9.1
Beryllium ⁵	38	0.21L	2.2	0.73
Cadmium ⁵	53	0.011L	0.95	0.086
Chromium ⁵	53	0.76	54	7.4
Cobalt ⁵	49	0.31L	43	2.9
Lead ⁵	53	0.70L	12	3.5
Manganese ⁵	53	8.7	580	75
Mercury ⁵	53	0.02	0.5	0.14
Nickel ⁵	51	0.80L	57	4.3
Selenium ⁵	52	0.050L	1.6	0.74
Uranium ⁵	53	0.31	4.3	1.5

¹ Values are in percent and on an as-received basis.

² Value is in British thermal units per pound of coal (Btu).

³ Value is in pounds per million Btu and on an as-received basis.

⁴ Value is in British thermal units on a moist, mineral-matter-free basis.

⁵ Values are in parts per million (ppm) on a whole-coal and remnant-moisture basis; "L" denotes less than value shown.

Table WQ-2. Summary data for the Hagel coal zone, Center-Falkirk coalfield, Williston Basin, North Dakota. Calculated from the unpublished U.S. Geological Survey coal quality database (USCHEM), February, 1992; Bragg and others (1994); and proprietary source(s)

Variable	Number of samples	Range		Mean
		Minimum	Maximum	
Moisture ¹	128	30.80	51.24	38.82
Ash ¹	128	4.00	17.47	8.09
Total sulfur ¹	128	0.30	1.78	0.77
Calorific value ²	128	4,890	7,530	6,420
lb SO ₂ ³	128	0.83	5.44	2.43
MMMFbtu ⁴	128	5,360	7,900	7,020
Antimony ⁵	6	0.10	1.10	0.54
Arsenic ⁵	6	5.0	28	13
Beryllium ⁵	4	0.36	1.1	0.73
Cadmium ⁵	6	0.036L	0.16	0.083
Chromium ⁵	6	0.76	8.5	4.9
Cobalt ⁵	5	0.31L	2.1	0.90
Lead ⁵	6	0.90	8.2	3.3
Manganese ⁵	6	11	46	20
Mercury ⁵	6	0.050L	0.5	0.18
Nickel ⁵	6	0.97	6.2	2.8
Selenium ⁵	5	0.80	1.6	1.1
Uranium ⁵	6	0.47	3.2	1.5

¹ Values are in percent and on an as-received basis.

² Value is in British thermal units per pound of coal (Btu).

³ Value is in pounds per million Btu and on an as-received basis.

⁴ Value is in British thermal units on a moist, mineral-matter-free basis.

⁵ Values are in parts per million (ppm) on a whole-coal and remnant-moisture basis; "L" denotes less than value shown.

Table WQ-3. Summary data for the Beulah-Zap coal zone, Beulah coalfield, Williston Basin, North Dakota. Calculated from the unpublished U.S. Geological Survey coal quality database (USCHEM), February, 1992; Bragg and others (1994); and proprietary source(s)

Variable	Number of samples	Range		Mean
		Minimum	Maximum	
Moisture ¹	112	27.7	47.53	36.97
Ash ¹	112	4.34	30.70	7.33
Total sulfur ¹	112	0.30	2.80	0.78
Calorific value ²	112	4,490	7,860	6,710
lb SO ₂ ³	112	0.79	8.15	2.33
MMMFbtu ⁴	112	5,110	8,560	7,280
Antimony ⁵	31	0.075L	1.9	0.45
Arsenic ⁵	32	1.8	30	8.3
Beryllium ⁵	25	0.22	2.24	0.66
Cadmium ⁵	32	0.011L	0.19	0.064
Chromium ⁵	32	1.2	54	8.5
Cobalt ⁵	31	0.45	43	3.5
Lead ⁵	32	1.2	11	3.6
Manganese ⁵	32	14	580	74
Mercury ⁵	32	0.03	0.21	0.096
Nickel ⁵	32	0.80L	57	4.4
Selenium ⁵	32	0.39	1.3	0.69
Uranium ⁵	32	0.38	4.0	1.1

¹ Values are in percent and on an as-received basis.

² Value is in British thermal units per pound of coal (Btu).

³ Value is in pounds per million Btu and on an as-received basis.

⁴ Value is in British thermal units on a moist, mineral-matter-free basis.

⁵ Values are in parts per million (ppm) on a whole-coal and remnant-moisture basis; "L" denotes less than value shown.

Table WQ-4. Summary data for the Harmon coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota. Calculated from the unpublished U.S. Geological Survey coal quality database (USCHEM), February, 1992; Bragg and others (1994); and proprietary source(s)

Variable	Number of samples	Range		Mean
		Minimum	Maximum	
Moisture ¹	32	29.50	46.20	39.02
Ash ¹	32	4.40	19.10	8.16
Total sulfur ¹	32	0.30	2.40	1.00
Calorific value ²	32	5,060	7,620	6,200
lb SO ₂ ³	32	0.96	8.21	3.29
MMMFbtu ⁴	32	5,670	8,020	6,790
Antimony ⁵	14	0.20	3.0	0.70
Arsenic ⁵	14	2.0	32	8.27
Beryllium ⁵	9	0.21L	0.87	0.41
Cadmium ⁵	14	0.029	0.21	0.072
Chromium ⁵	14	0.83	13	3.70
Cobalt ⁵	13	0.40	2.6	1.1
Lead ⁵	14	0.70L	12	3.5
Manganese ⁵	14	8.7	200	90
Mercury ⁵	14	0.02	0.48	0.19
Nickel ⁵	13	1.1	7.7	2.5
Selenium ⁵	14	0.050L	1.6	0.73
Uranium ⁵	14	0.31	4.3	1.2

¹ Values are in percent and on an as-received basis.

² Value is in British thermal units per pound of coal (Btu).

³ Value is in pounds per million Btu and on an as-received basis.

⁴ Value is in British thermal units on a moist, mineral-matter-free basis.

⁵ Values are in parts per million (ppm) on a whole-coal and remnant-moisture basis; "L" denotes less than value shown.

Table WQ-5. Summary data for the Hansen coal zone, Bowman-Dickinson coalfield, Williston Basin, North Dakota. Calculated from the unpublished U.S. Geological Survey coal quality database (USCHEM), February, 1992; Bragg and others (1994); and proprietary source(s)

Variable	Number of samples	Range		Mean
		Minimum	Maximum	
Moisture ¹	9	31.80	41.20	35.99
Ash ¹	9	7.10	31.00	11.45
Total sulfur ¹	9	0.60	3.50	1.45
Calorific value ²	9	3,260	7,710	6,440
lb SO ₂ ³	9	1.94	12.14	4.80
MMMFbtu ⁴	9	5,860	8,400	7,360
Antimony ⁵	1	0.50	0.50	0.50
Arsenic ⁵	1	5.0	5.0	5.0
Beryllium ⁵	0	—	—	—
Cadmium ⁵	1	0.055	0.055	0.055
Chromium ⁵	1	1.7	1.7	1.7
Cobalt ⁵	0	—	—	—
Lead ⁵	1	5.1	5.1	5.1
Manganese ⁵	1	57	57	57
Mercury ⁵	1	0.48	0.48	0.48
Nickel ⁵	0	—	—	—
Selenium ⁵	1	1.2	1.2	1.2
Uranium ⁵	1	1.6	1.6	1.6

¹ Values are in percent and on an as-received basis.

² Value is in British thermal units per pound of coal (Btu).

³ Value is in pounds per million Btu and on an as-received basis.

⁴ Value is in British thermal units on a moist, mineral-matter-free basis.

⁵ Values are in parts per million (ppm) on a whole-coal and remnant-moisture basis; “L” denotes less than value shown.