

Monitoring Indicator Bacteria as Part of the IOWATER Program

IOWATER Program
109 Trowbridge Hall
Iowa City, IA 52242-1319
www.iowater.net

December 2009

IOWATER, Iowa's volunteer water quality monitoring program, aims to protect and improve Iowa's water quality by raising citizen awareness about Iowa's watersheds, supporting and encouraging the growth and networking of Iowa's volunteer water monitoring communities, and promoting water monitoring activities as a means of assessing and understanding Iowa's aquatic resources. Since 2001, IOWATER has conducted bacteria workshops to train volunteers to analyze water samples for indicator bacteria using Micrology Laboratories' Coliscan Easygel kit. This report summarizes indicator bacteria data collected as part of the IOWATER Program from April 2001 through September 2009.

History of IOWATER Monitoring for Indicator Bacteria

In 2001, the IOWATER Program began to offer training in bacteria monitoring methods using the Coliscan Easygel kit as part of its Level 2 IOWATER workshops. The Level 2 workshop was an 8-hour training that included an introduction to Quality Assurance Project Plans (QAPPs), data interpretation, and test procedures for chloride and bacteria. Completion of an IOWATER Level 1 workshop was a prerequisite for attending a Level 2 workshop. IOWATER also offered advanced workshops for benthic macroinvertebrate indexing and standing waters in 2001.

Three Level 2 workshops were offered in 2001 and another 4 in 2002. At the conclusion of the 2002 training season, and at the suggestion of IOWATER volunteers, IOWATER staff revised the Level 2 and advanced workshops. For the 2003 workshop season, the Standing Waters Module and chloride test procedures were combined into the Level 1 workshop. No Level 2 workshops were held in 2003; instead during this time the Level 2 workshop was redesigned. Benthic macroinvertebrate indexing workshops continued to be offered in 2003, while no bacteria training was conducted in 2003.

In 2004, IOWATER decided to eliminate Level 2 workshops in their current form. Volunteers were, however, very interested in bacteria monitoring. In 2004, IOWATER began to offer bacteria monitoring workshops as a 4-hour advanced workshop.

Materials and Methods

Upon completion of an IOWATER bacteria workshop, all volunteers are given a complete set of equipment necessary to do the bacteria monitoring. This includes an IOWATER bacteria manual, thermometer, Coliscan Easygel media and plates, permanent marker, night light and extension chord, Styrofoam cooler, sterile pipettes, an interpreting the plates chart, and a laminated grid for counting bacteria.

Volunteers register a specific monitoring site by providing the Universal Transverse Mercator (UTM) coordinates for the site. Volunteers are encouraged to choose a site location that is representative of the water body, be it a stream or a lake.

The frequency of assessments is determined by the volunteer, however IOWATER provides recommended frequencies for each assessment. When completing a bacteria assessment, volunteers are encouraged to conduct a chemical/physical assessment at the same time. IOWATER recommends that a chemical/physical assessment be completed monthly.

Bacteria samples are collected in triplicate, with the same volume of water being collected for each replicate. It is recommended that a volunteer start by using 1 ml of water for each of the triplicate samples. For subsequent sampling events, the IOWATER volunteer can adjust the volume depending on previous bacteria results, as well as climate conditions and time of year considerations. Bacteria samples are to be incubated between 85-99 °F for 48 hours and then counted. On the IOWATER Bacteria field sheet (Appendix 1), the IOWATER volunteer records sample volume, incubation time, incubation temperature, and number of *E. coli* and general coliform bacteria per replicate. Bacteria plates are disposed of according to instructions provided during the IOWATER training (<http://www.iowater.net/Publications/BacteriaManual.pdf>).

Bacteria Monitoring Statistics

As of August 2009, a total of 472 volunteers have completed training in the IOWATER bacteria monitoring methods (Table 1). This represents 15% of all volunteers who have attended an IOWATER Level 1 workshop. Of the 472 volunteers who have been certified to do bacteria monitoring, 129 (27%) of them have submitted bacteria data. Of those who have submitted data, they generally have begun to do so within a year of attending the bacteria monitoring workshop.

A total of 1,794 bacteria records for 344 sites were submitted to the IOWATER database from April 2001 through September 2009 (Figure 1). All but 2 of the 344 sites are stream sites; the other 2 are lake sites. These data were submitted by 129 volunteers. The vast majority of data submitted included data for both *E. coli* and general coliform bacteria.

Table 1. Number of IOWATER volunteers trained for bacteria monitoring.

Year	Number of IOWATER Volunteers Certified for Bacteria Monitoring	Number of Newly Certified Volunteers who have Submitted Bacteria Data Count (%)
2001	167	47 (28%)
2002	53	16 (30%)
2003*	0	0 (0%)
2004	50	12 (20%)
2005	60	20 (33%)
2006	65	21 (32%)
2007	30	3 (10%)
2008	28	6 (21%)
2009	10	3 (30%)

* Note: No bacteria workshops were conducted in 2003.

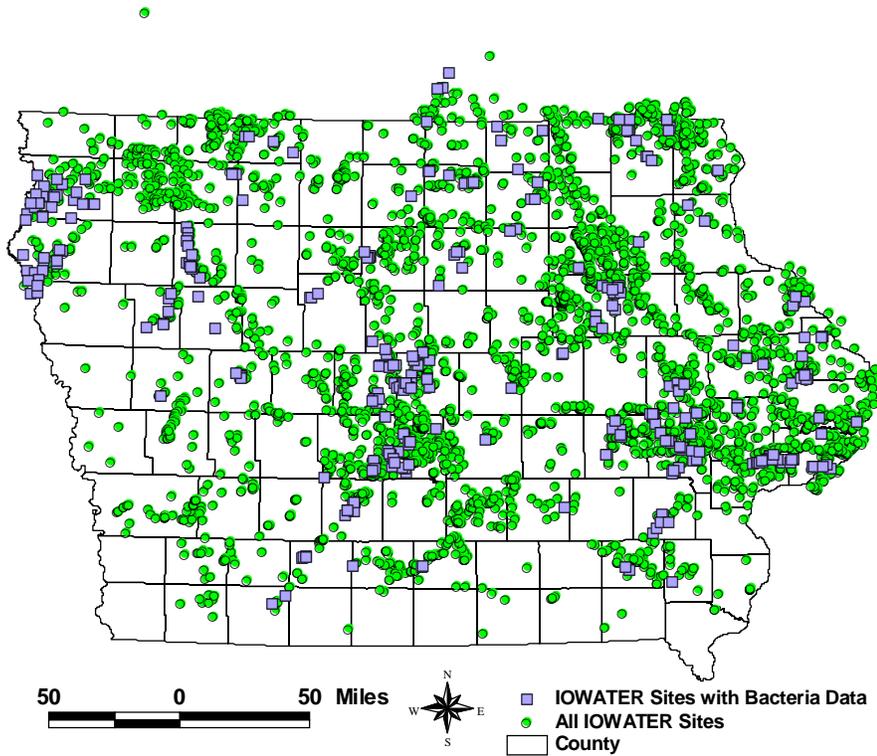


Figure 1. Location of IOWATER sites with bacteria data collected from April 2001 through September 2009. The map also includes sites monitored in Minnesota and Illinois.

For 70% of the sites, fewer than 5 bacteria data records have been submitted to the IOWATER database (Figure 2). Approximately 19% of the sites have more than 10 bacteria data records.

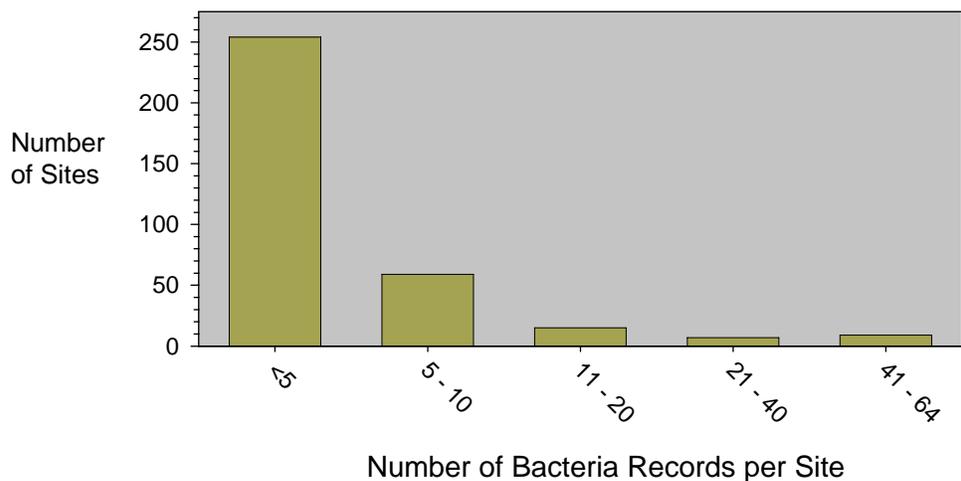


Figure 2. Number of bacteria records submitted per site. A total of 344 sites had bacteria data.

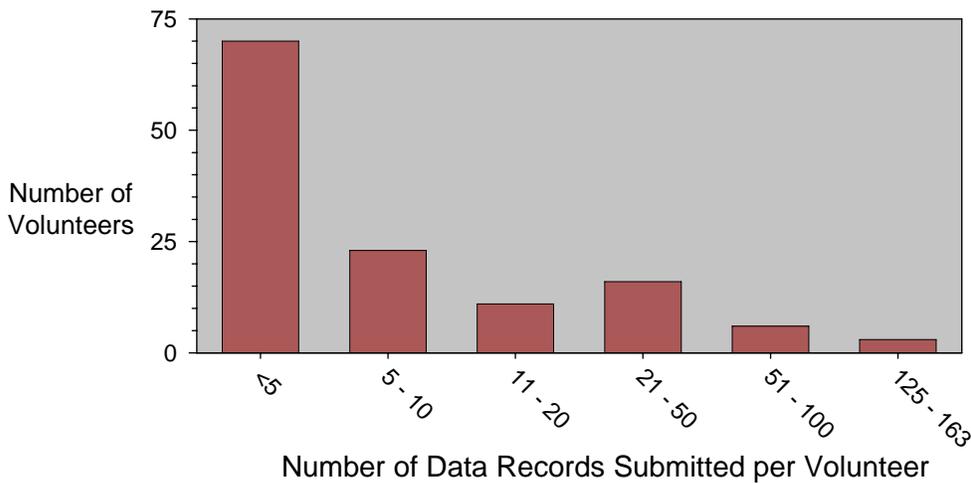


Figure 3. Number of bacteria data records submitted per volunteer. A total of 26 volunteers, each submitting 20+ data records, account for 76% of the bacteria data records available.

A small percentage of the 129 volunteers who have submitted data account for the majority of available bacteria data in the IOWATER database (Figure 3). Thirty-seven volunteers, each collecting 10+ records, generated 1,503 data sets which represent 84% of the submitted bacteria data. Twenty-six of the volunteers each submitted 20+ records, or 76% of the available data; fourteen volunteers each submitted 30+ records, which accounted for 59% of available data. For these volunteers, bacteria monitoring has generally occurred on a monthly basis.

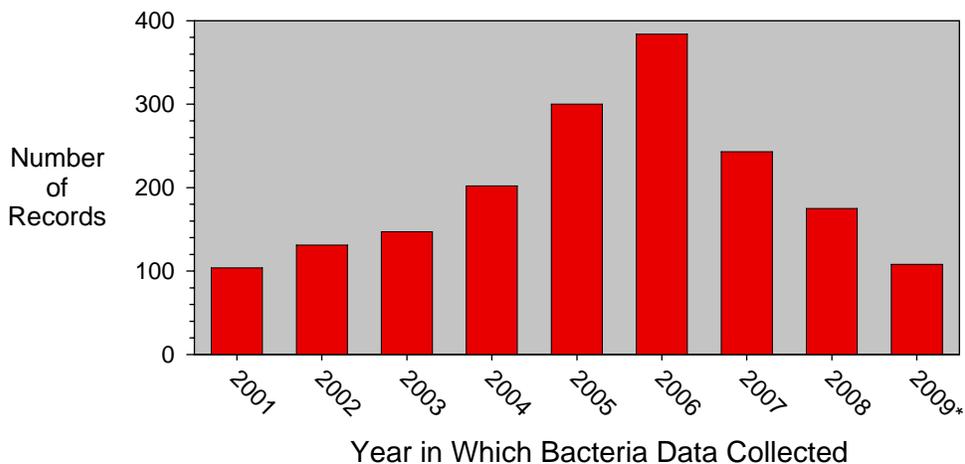


Figure 4. Number of bacteria records submitted by year. (* Year 2009 represents a partial year of data through August 2009.)

The greatest number of bacteria records were submitted in 2006 (Figure 4). For all but approximately 70 data records, other chemical or physical parameters were also measured when bacteria samples were collected.

Long-Term Data Sets

A total of 22 IOWATER sites have 15 or more bacteria data sets that have been submitted for each of these sites. These sites have been monitored by 10 IOWATER volunteers or teams. For the sites with the longer term data sets, 14 have been monitored for bacteria on a monthly basis whereas the remaining 8 sites were monitored 3 to 6 times a year. Only 12 of the 22 sites are still being monitored. For 7 of the 22 sites, monitoring was discontinued in 2008 after being monitored monthly for 6 to 7 years. These 7 sites were monitored by 3 IOWATER volunteers, and all of the sites were located in the Squaw Creek watershed near Ames.

Appendix 2 includes time series graphs for the 22 IOWATER sites that have 15 or more bacteria data sets. In addition to *E. coli* bacteria, chloride, flow, transparency, and rainfall, where available, were also plotted.

Bacteria Results Relative to Water Quality Standards

Bacteria results were variable, with both the *E. coli* and general coliform bacteria ranging from 0 to >20,000 CFU/100 ml. For 60% of the data records, *E. coli* bacteria exceeded 235 CFU/100 ml while 13% exceeded 2,880 CFU/100 ml. The values of 235 and 2,880 represent Iowa's single sample maximum water quality standards for primary contact recreational use (Class A1), secondary contact recreational use (Class A2), and children's recreational use (A3). The standard of 235 CFU/100 ml applies to Class A1 and A3 waters from March 15 through November 15, and the standard of 2,880 applies to Class A2 waters during the same time period. Iowa has also established geometric mean values for Class A water bodies. The geometric mean is calculated using at least five consecutive samples collected during a 30-day period. The geometric mean for Class A1 and A3 waters is 126 CFU/100 ml, while 630 CFU/100 ml is the standard for Class A2 waters. The geometric mean is also applicable during the recreational season from March 15 through November 15.

***E. coli* Bacteria and Chloride Relationship**

The presence of *E. coli* bacteria in water suggests contamination by a relatively fresh source of fecal matter from a warm-blooded organism, as well as the potential for an increased risk from waterborne disease. Elevated levels of chloride in water can also indicate inputs of human or animal waste. Figure 5 is a scatter plot for data sets that had both *E. coli* and chloride results. The data show no relationship between *E. coli* bacteria and chloride. All non-detections for chloride were plotted at the detection limit of 25.

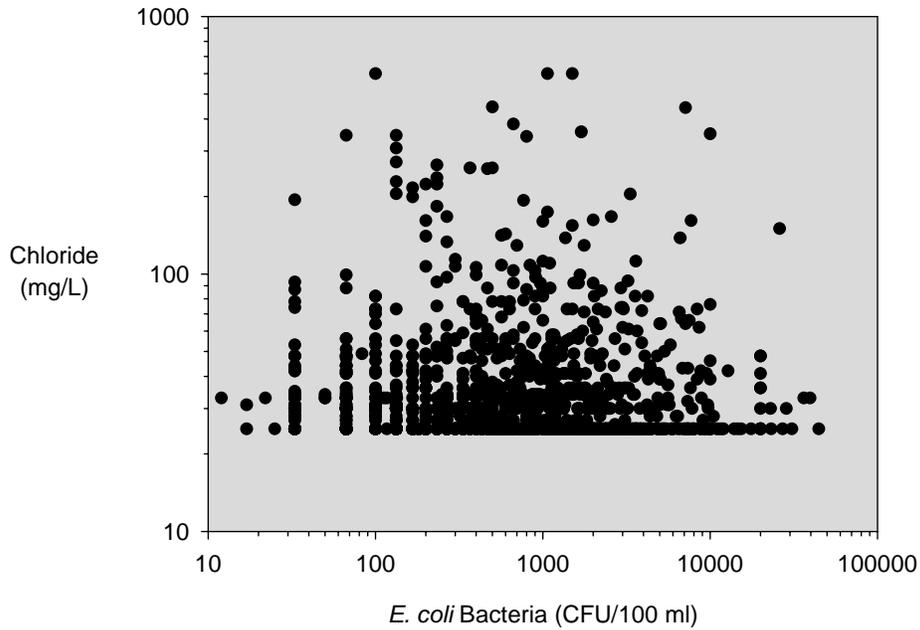


Figure 5. Scatterplot of *E. coli* bacteria and chloride data available from the IOWATER database.

Summary

- A total of 15% of Level 1 IOWATER volunteers have completed a bacteria workshop.
- Twenty-seven percent of bacteria certified volunteers have submitted bacteria data.
- A small percentage of bacteria certified volunteers have submitted the majority of available bacteria data to the IOWATER database. These volunteers generally sampled for bacteria on a monthly basis.
- The number of bacteria records submitted to the IOWATER database increased from 2001 to 2006, with the greatest number of records submitted in 2006, followed by a decline in data records submitted from 2007 through 2009.
- IOWATER data show no relationship between *E. coli* bacteria and chloride.
- Sixty percent of the *E. coli* bacteria results exceeded Iowa's single sample maximum *E. coli* standard for Class A1 and A3 streams of 235 CFU/100 ml, while 13% exceeded the Class A2 standard of 2,880 CFU/100 ml.

Appendix 1.

IOWATER Bacteria Assessment Data Sheet



IOWATER Bacteria Monitoring

Date _____ Time _____

IOWATER Monitor _____ Site Number _____

Other Volunteers Involved

of Adults (incl. yourself) _____ # of Children _____

Note: It is recommended that a Level 1 Chemical/Physical Stream Assessment form also be completed.

Other Stream Assessment Observations and Notes

Bacteria Numbers	<i>E. Coli</i> Bacteria (count) (dark blue-purple)	General Coliform Bacteria (count) (pink)
Replicate 1		
Replicate 2		
Replicate 3		

Volume of Water Sampled for each replicate (ml) _____

Incubation Start Time _____ Incubation End Time _____

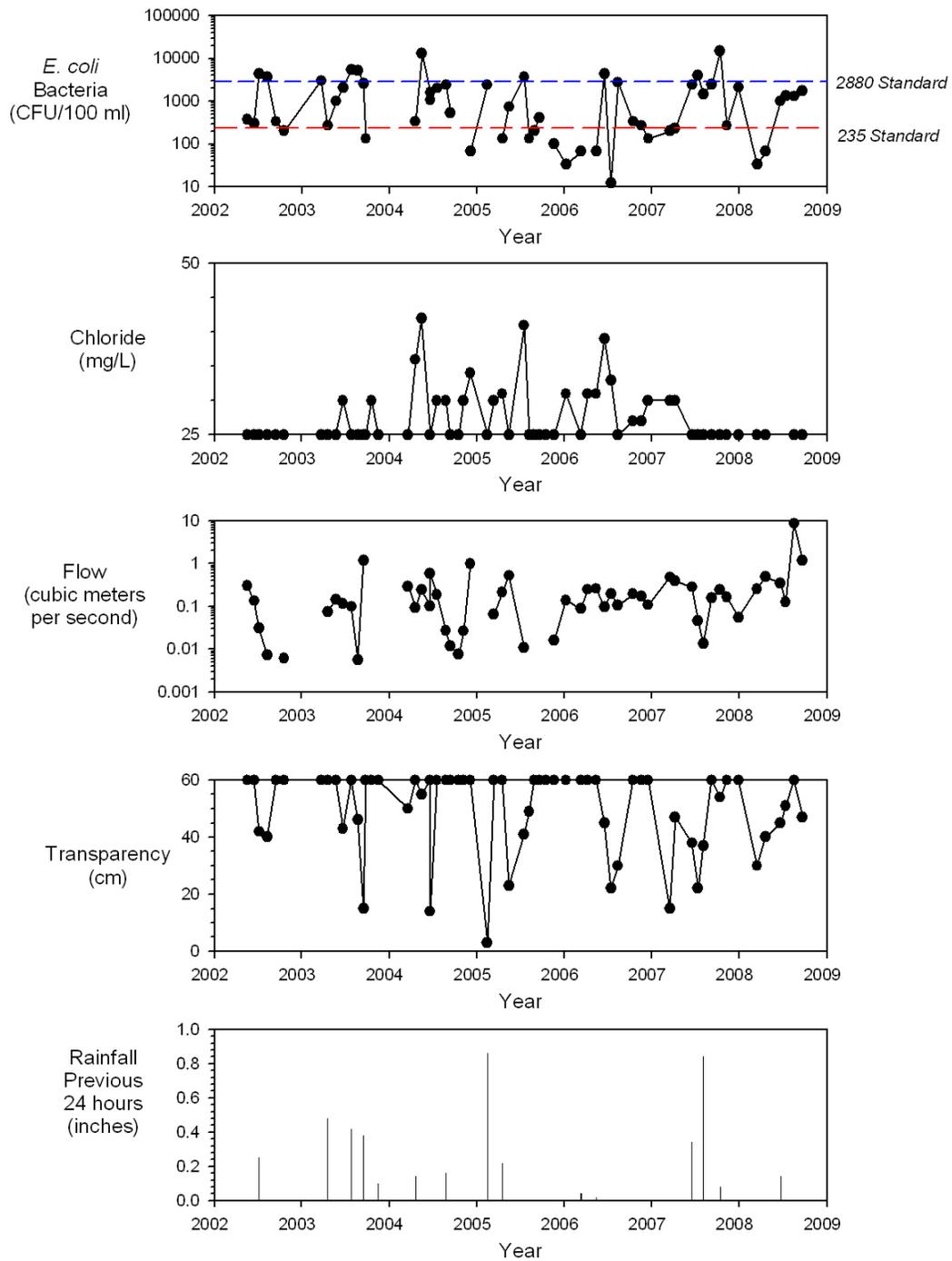
Bacteria Incubation Period (hours) _____

Bacteria Incubation Temperature _____ °Fahrenheit

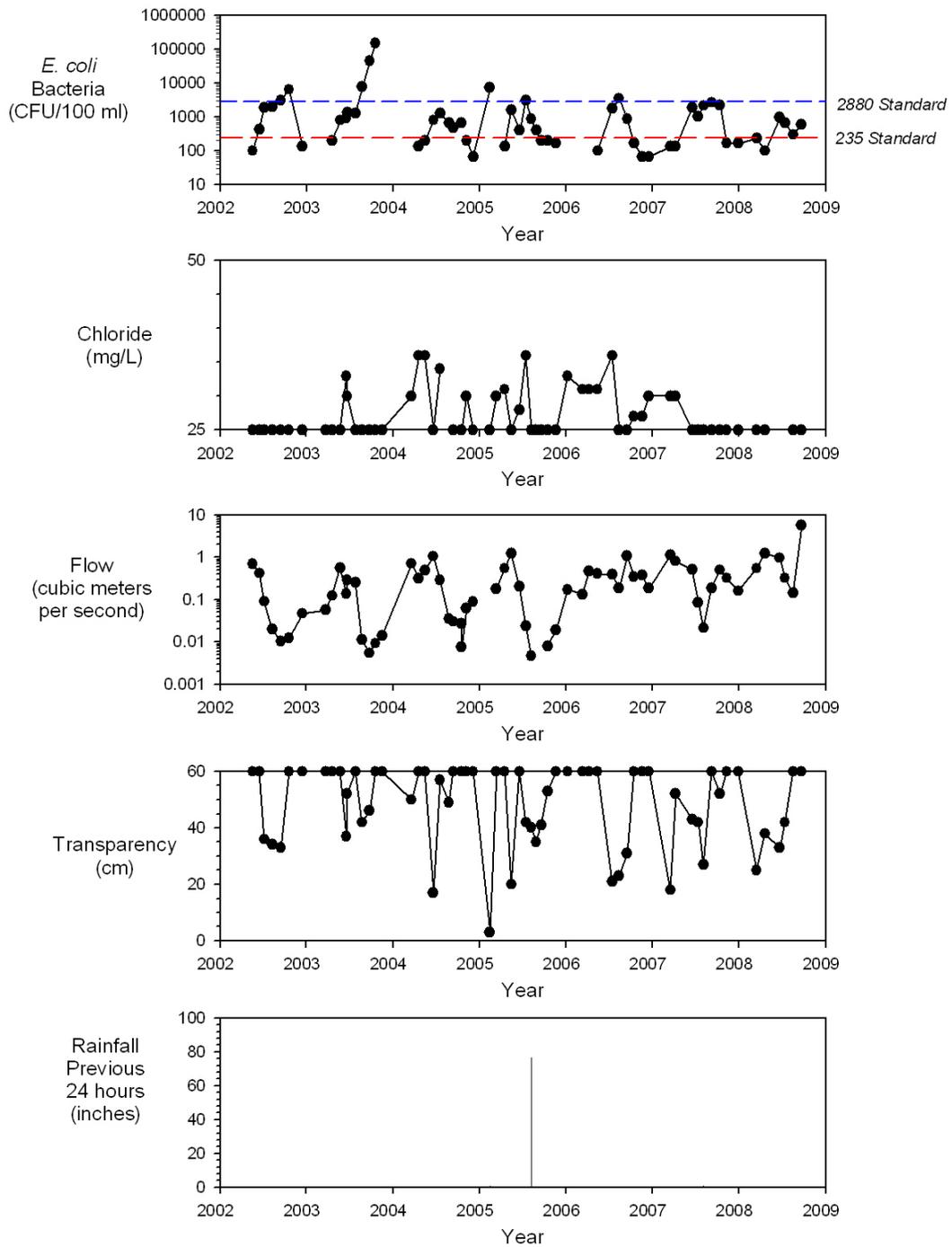
Appendix 2.

**Time Series Graphs for Sites with 15 or More Bacteria Records.
(Sites are listed numerically by site number.)**

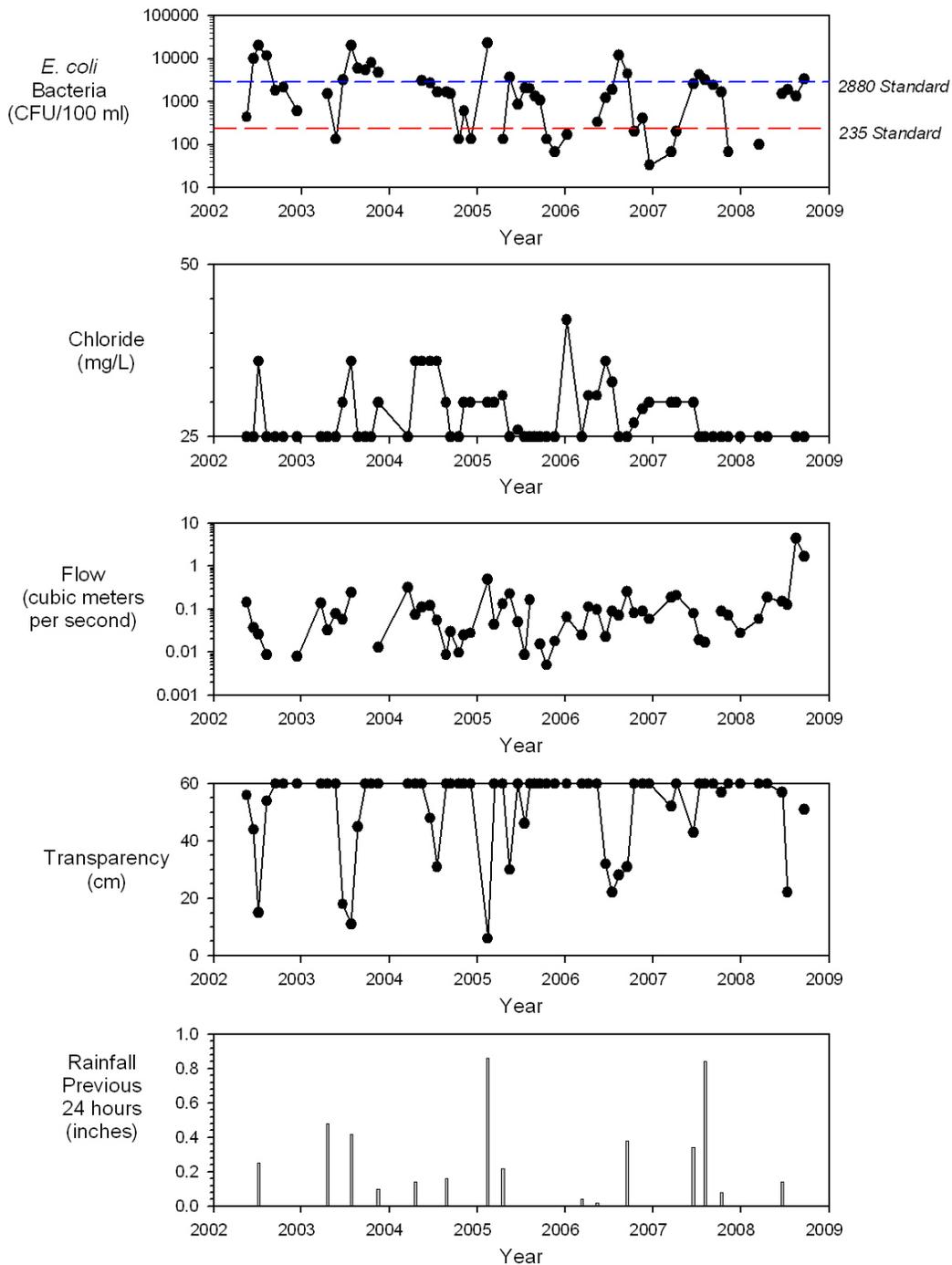
908019 - Montgomery Creek 1 (Boone Co.)



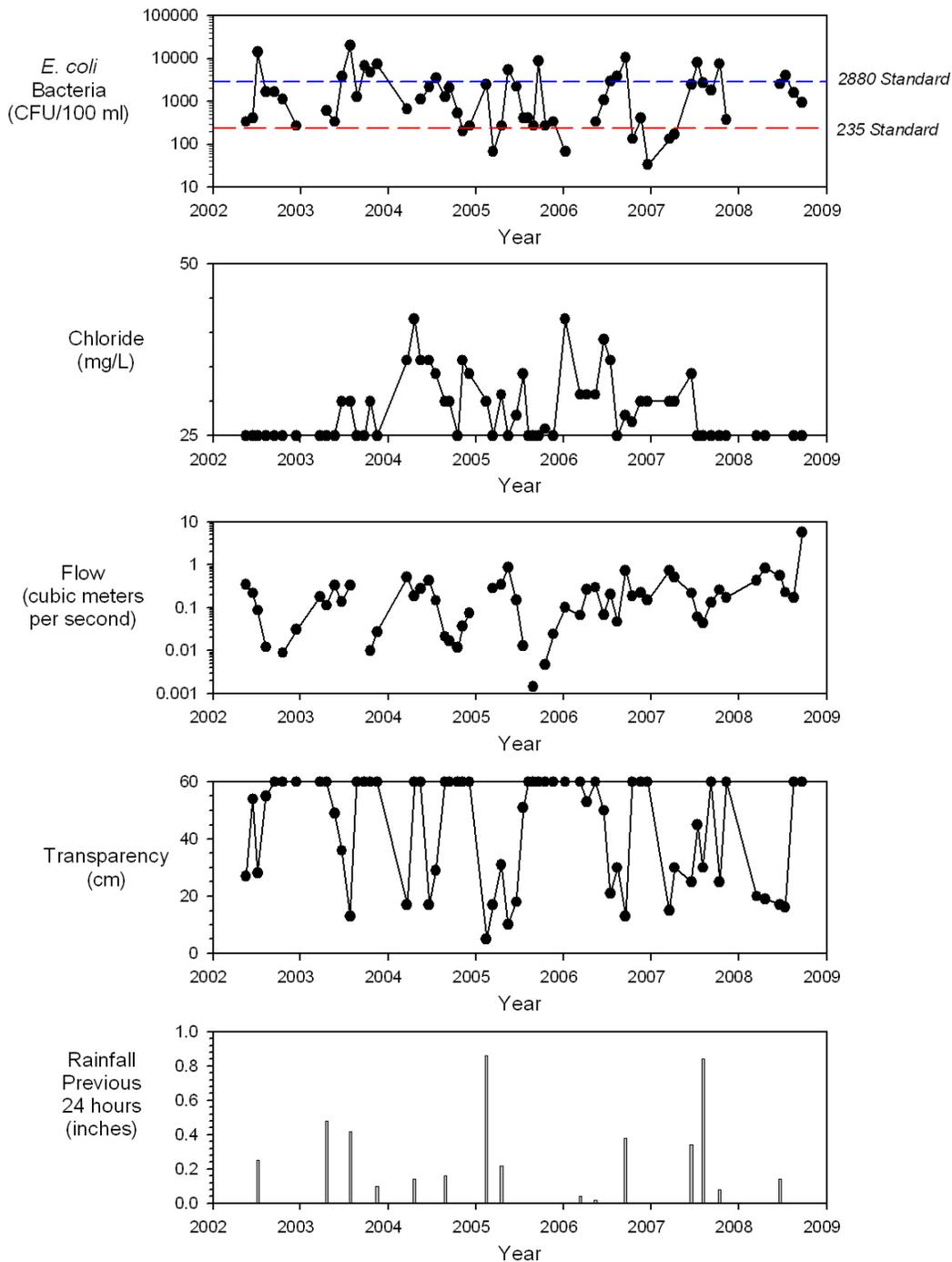
908020 - Montgomery Creek 2 (Boone Co.)



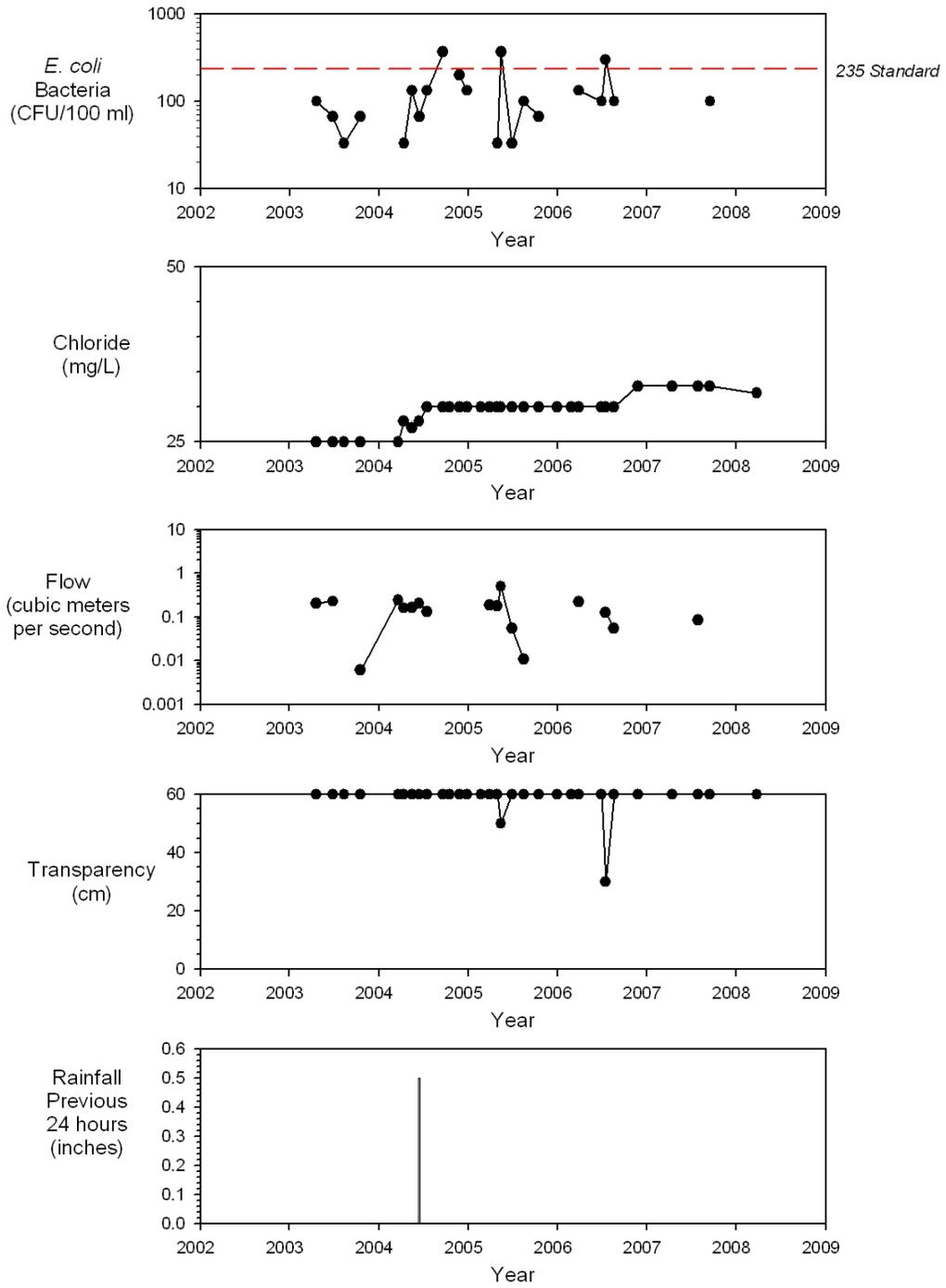
908021 - Prairie Creek 1 (Boone Co.)



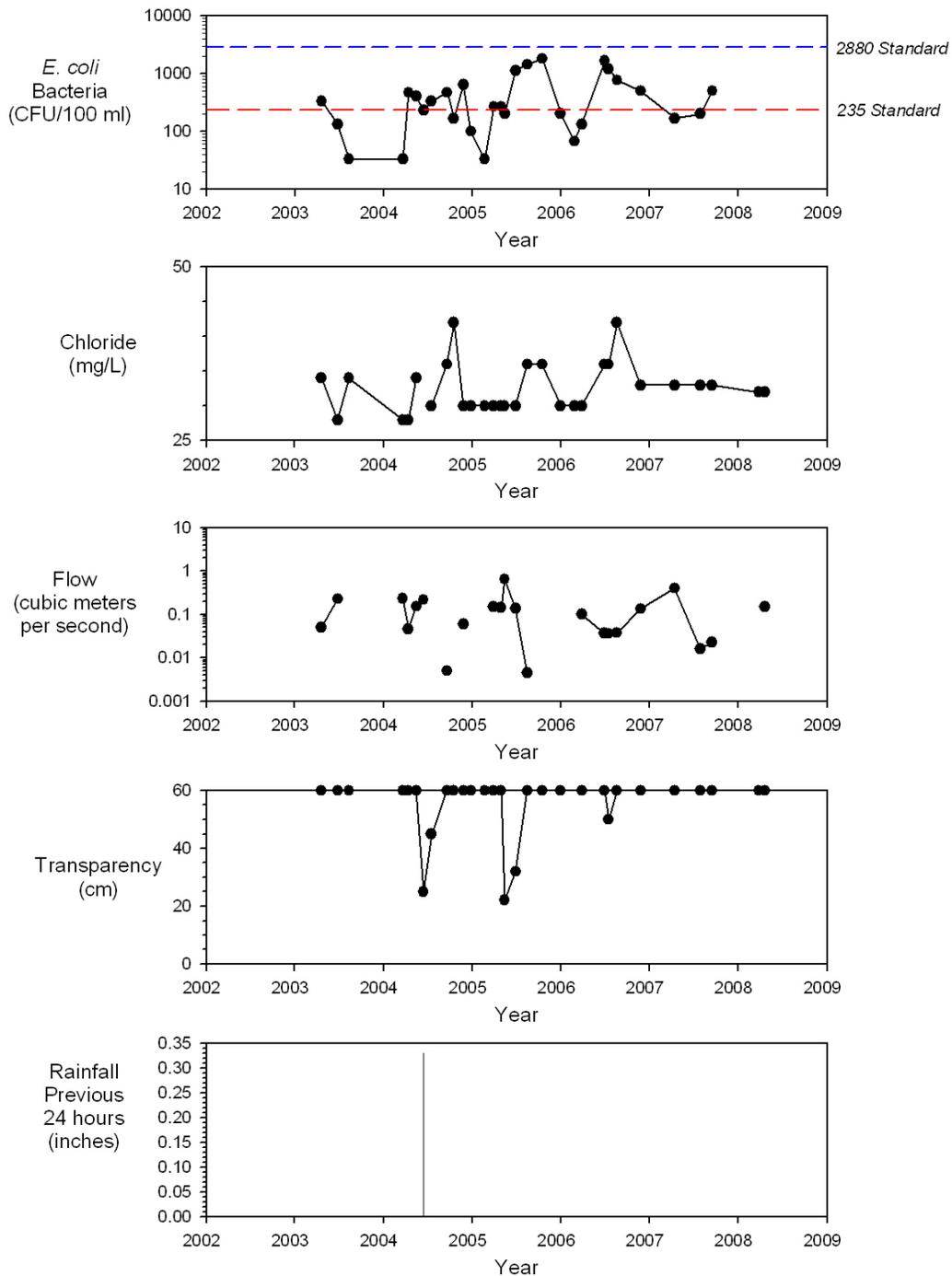
908022 - Prairie Creek 2 (Boone Co.)



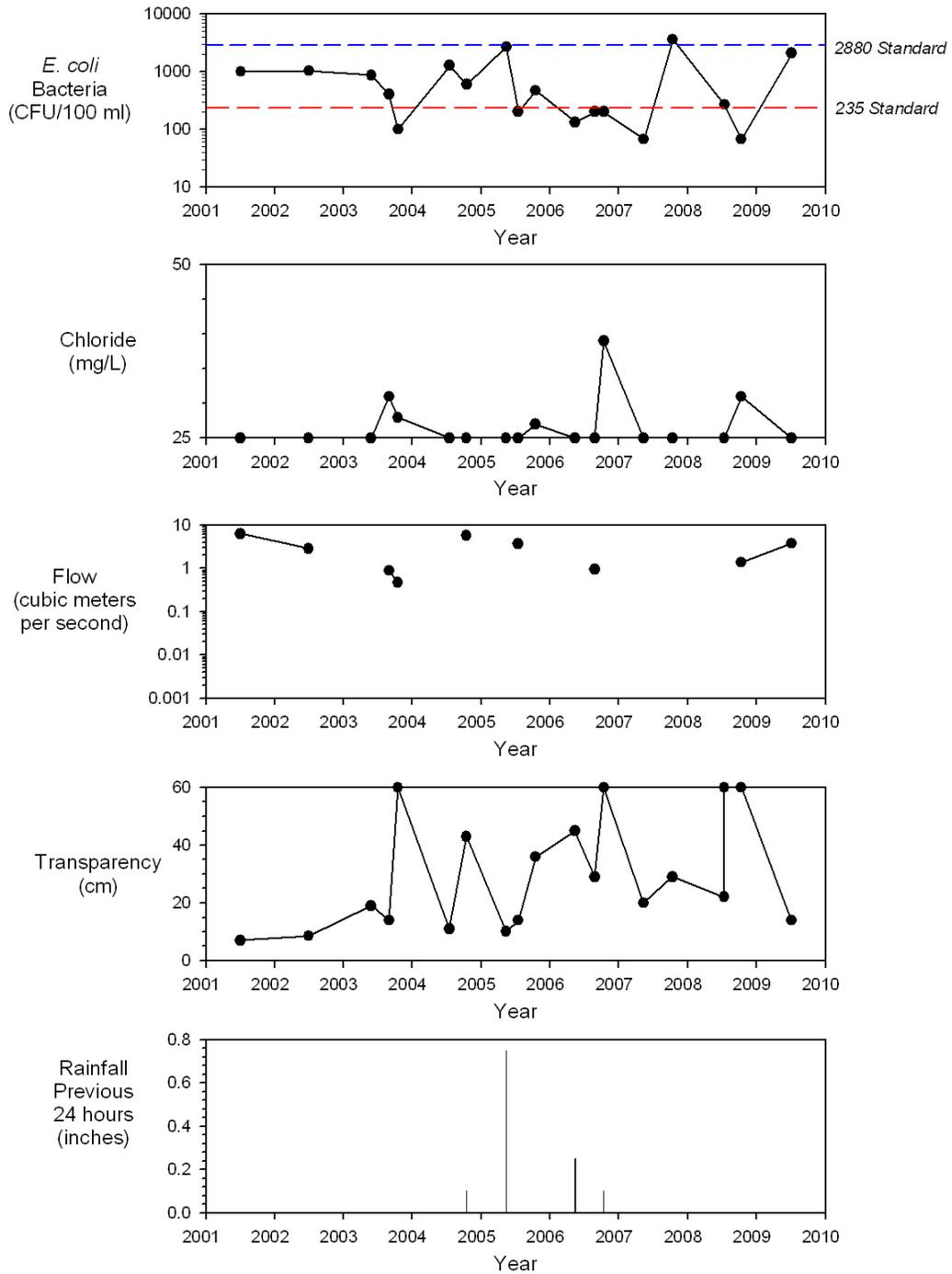
908028 - Glacial Creek (Squaw Creek Trib - Boone Co.)



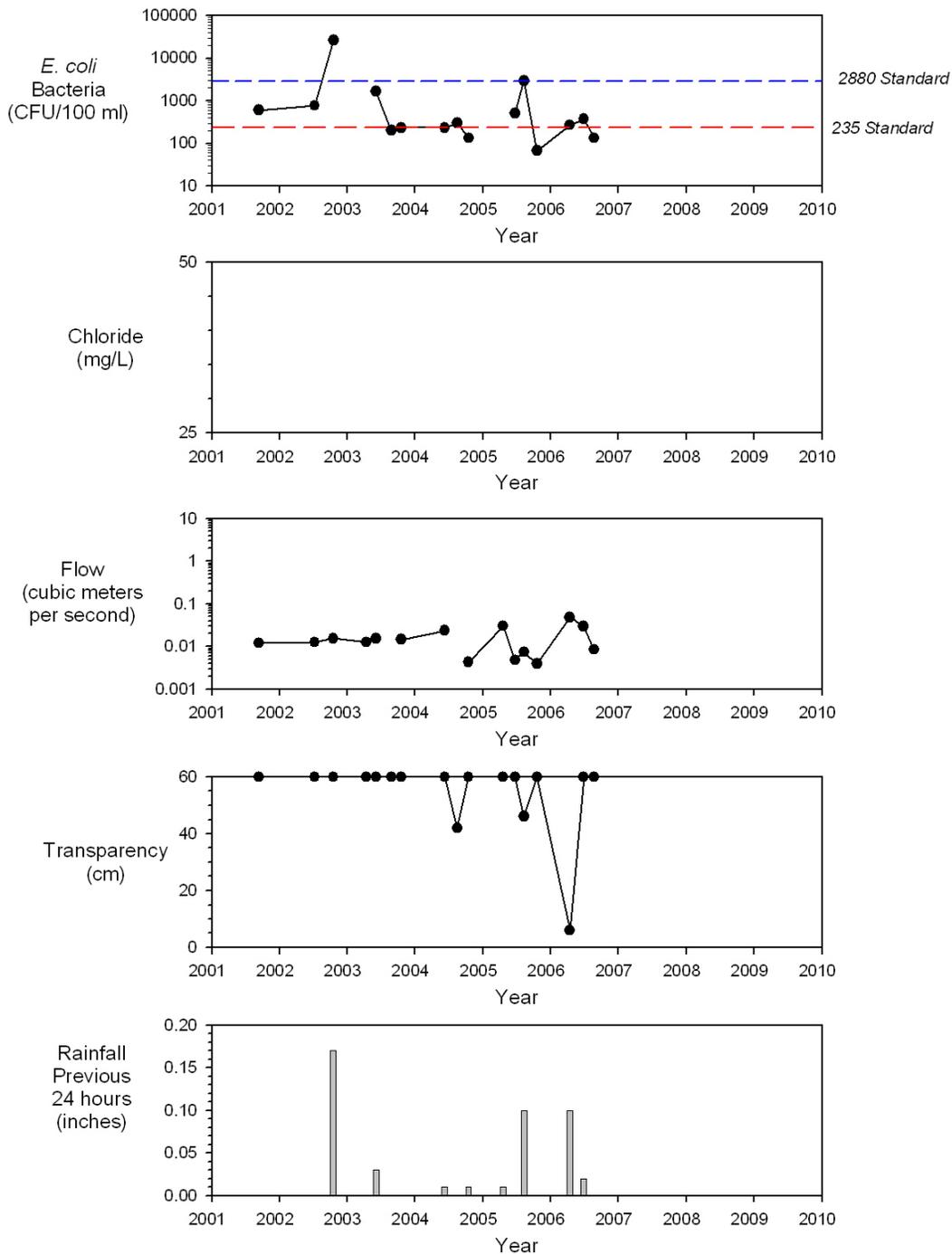
908029 - Bluestem Creek (Squaw Creek Trib - Boone Co.)



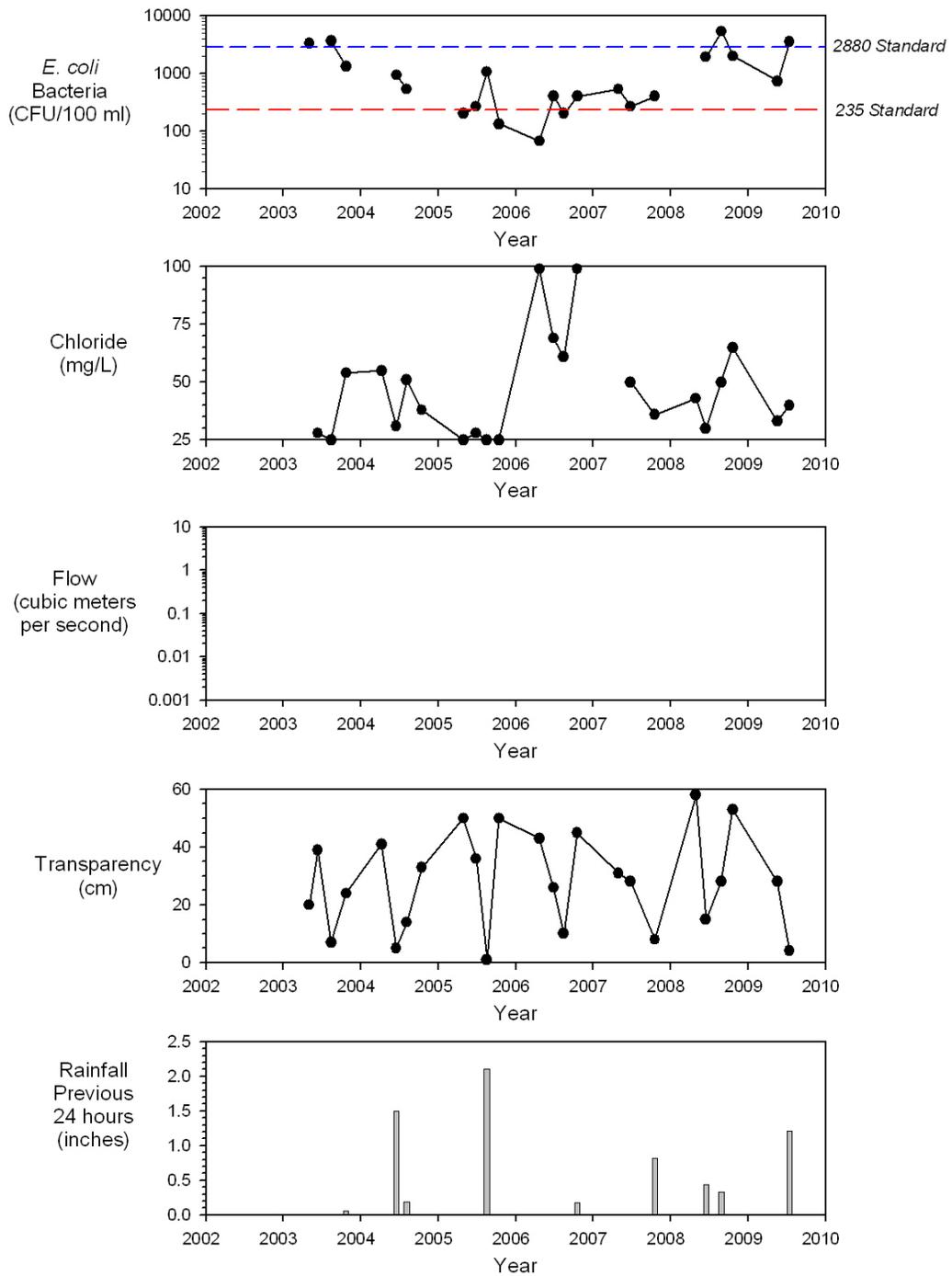
917013 - Winnebago River (tile outlet - Cerro Gordo Co.)



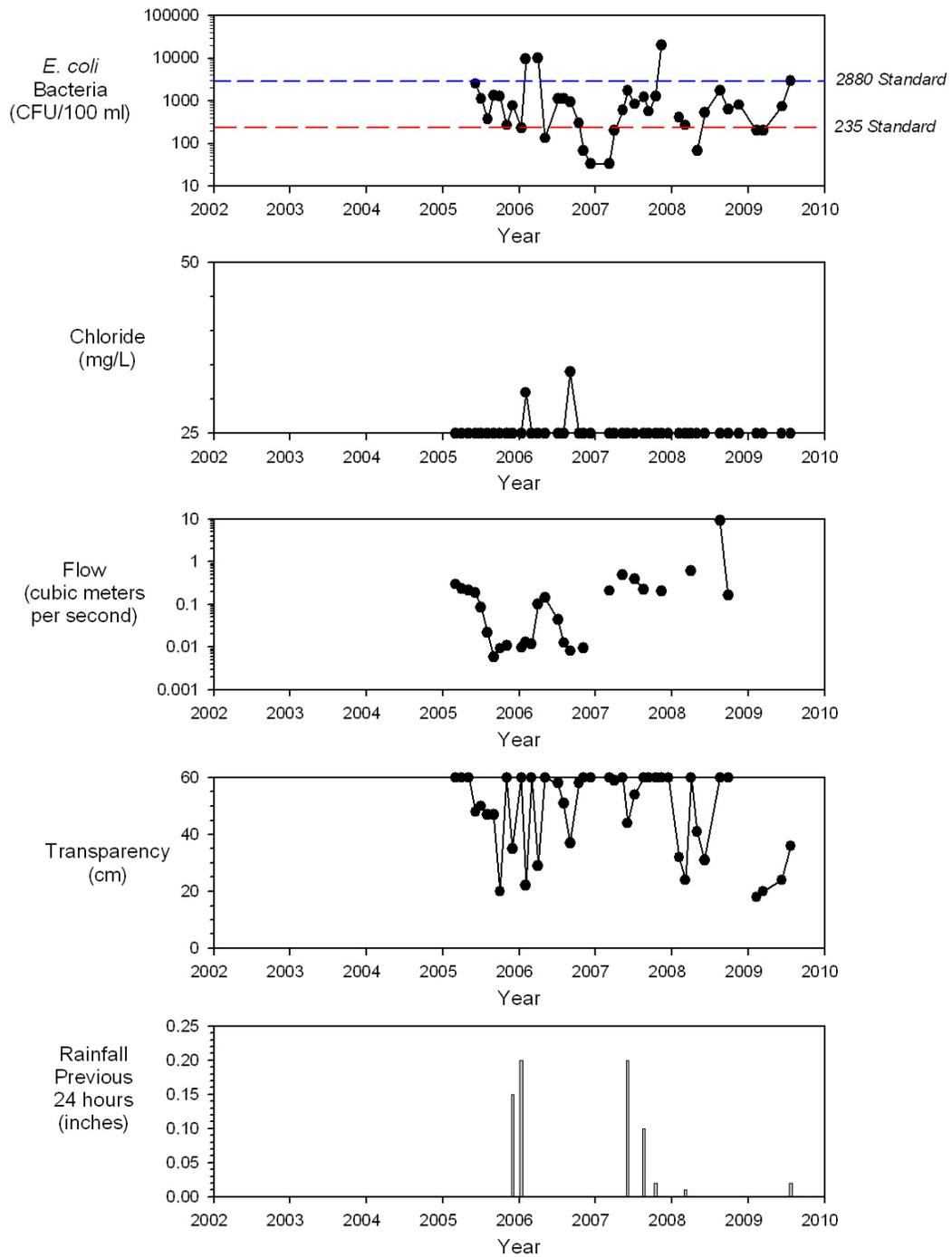
931007 - Catfish Creek North Fork (Dubuque Co.)



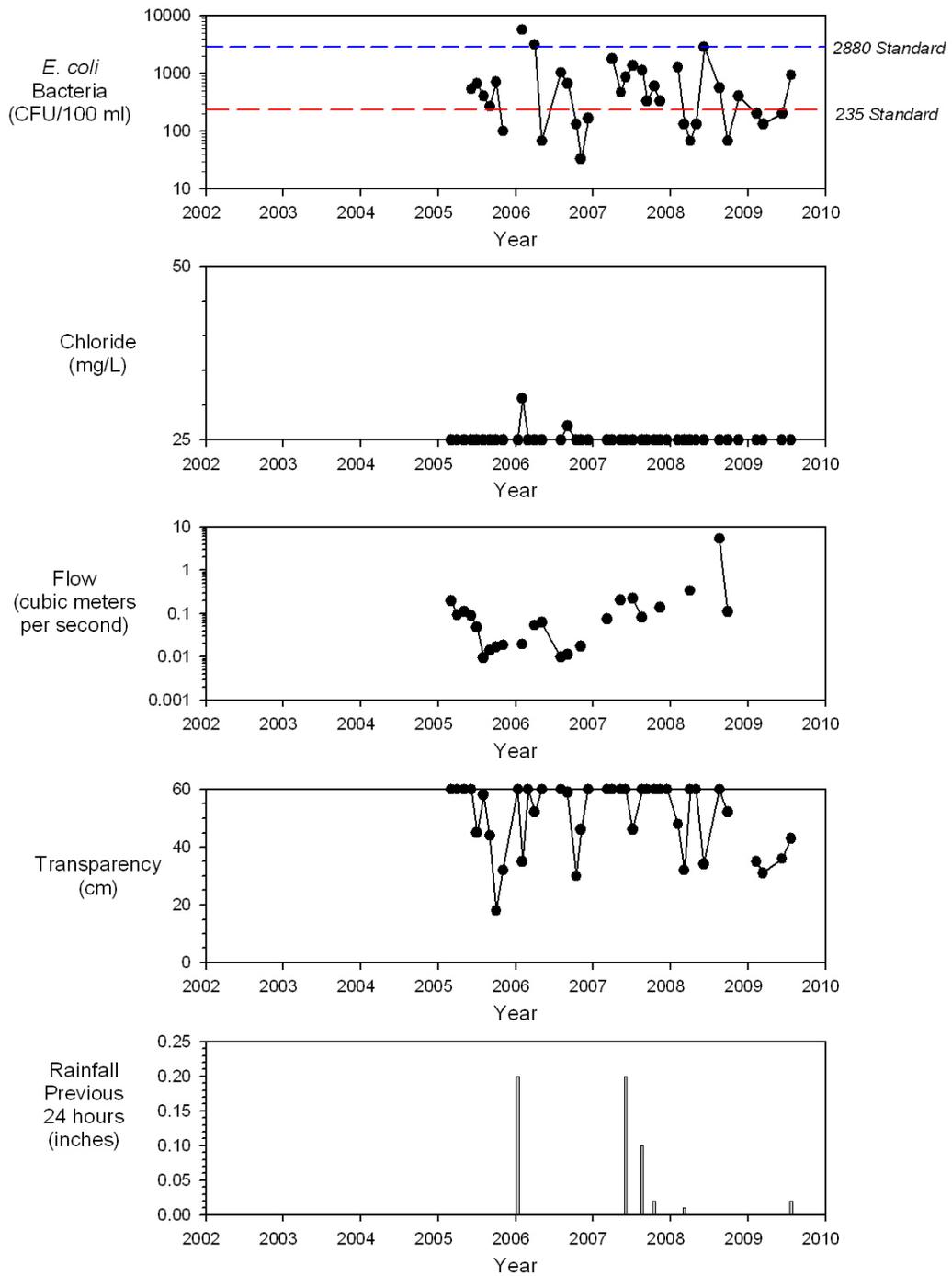
931021 - Main Fork Catfish Creek (Dubuque Co.)



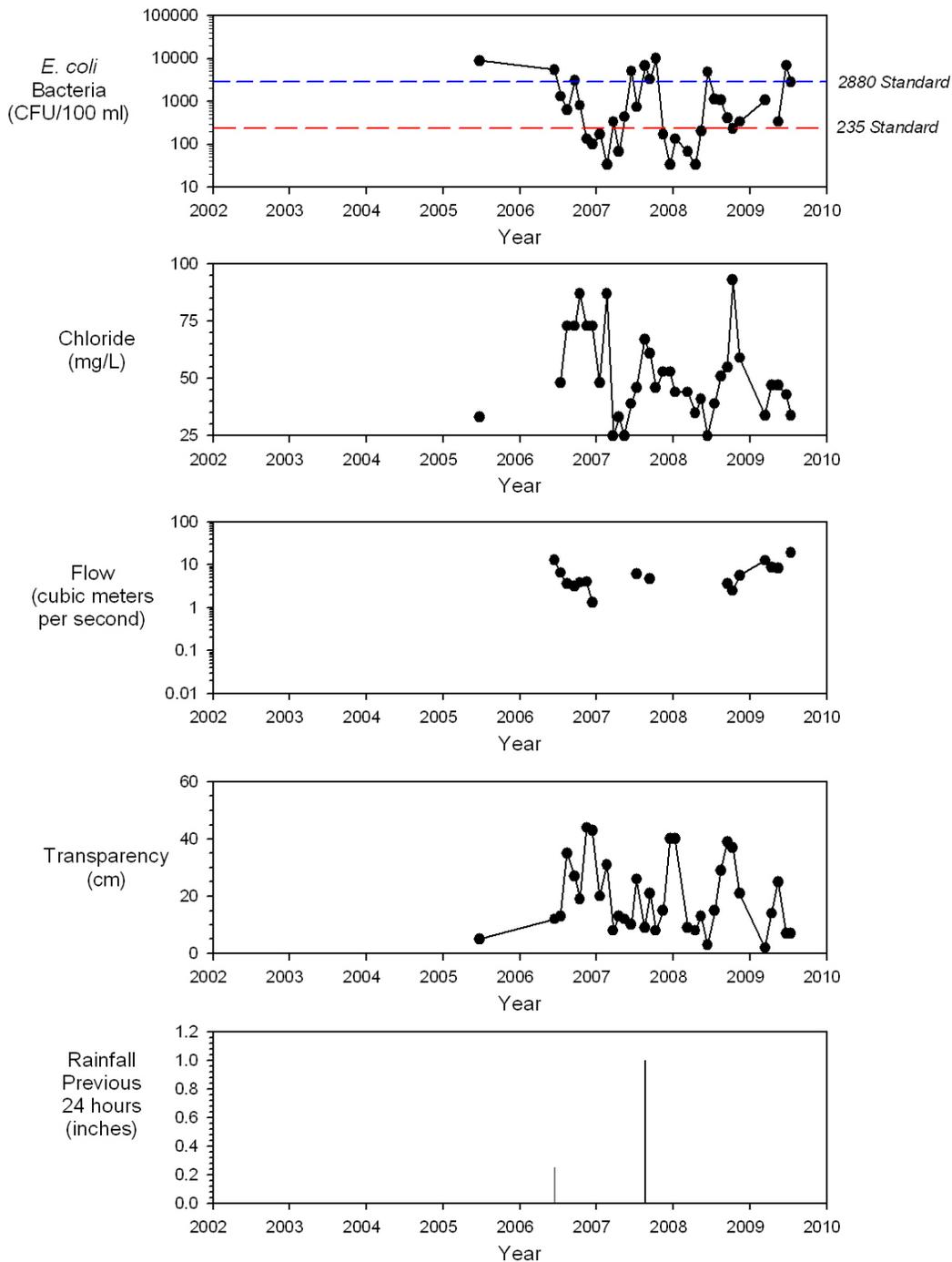
970014 - Mud Creek (Vine Ave - Muscatine Co.)



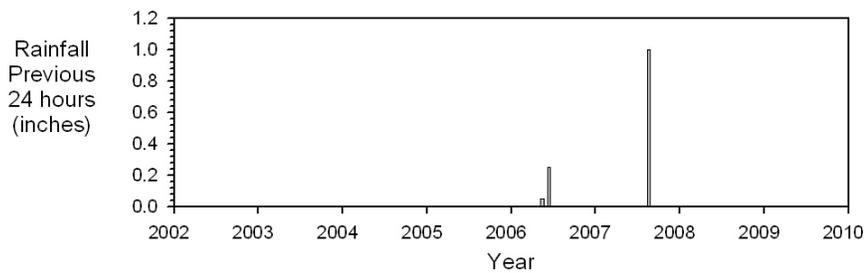
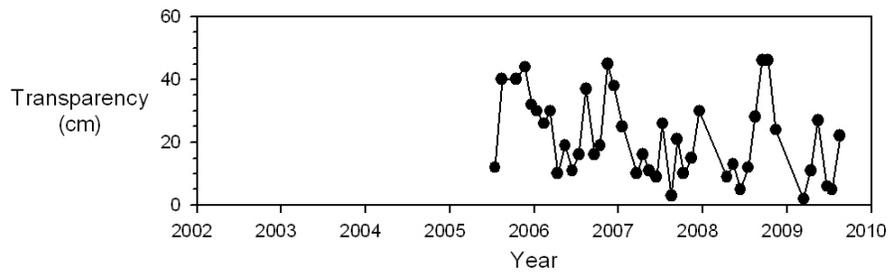
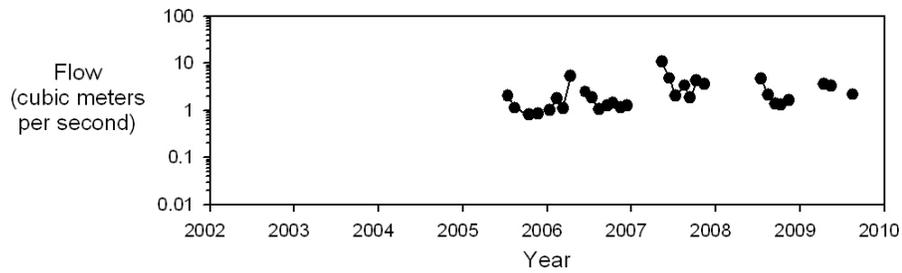
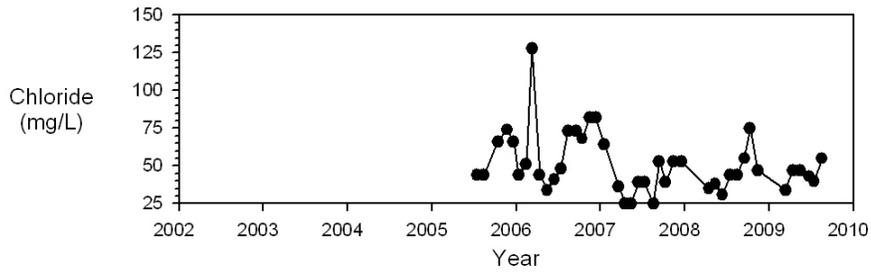
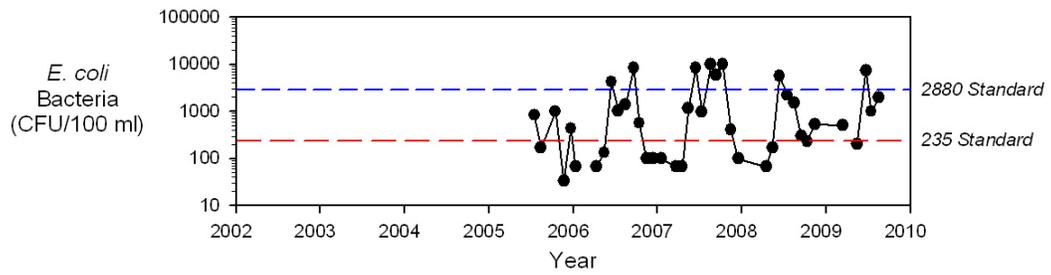
970015 - Mud Creek (Western Ave - Muscatine Co.)



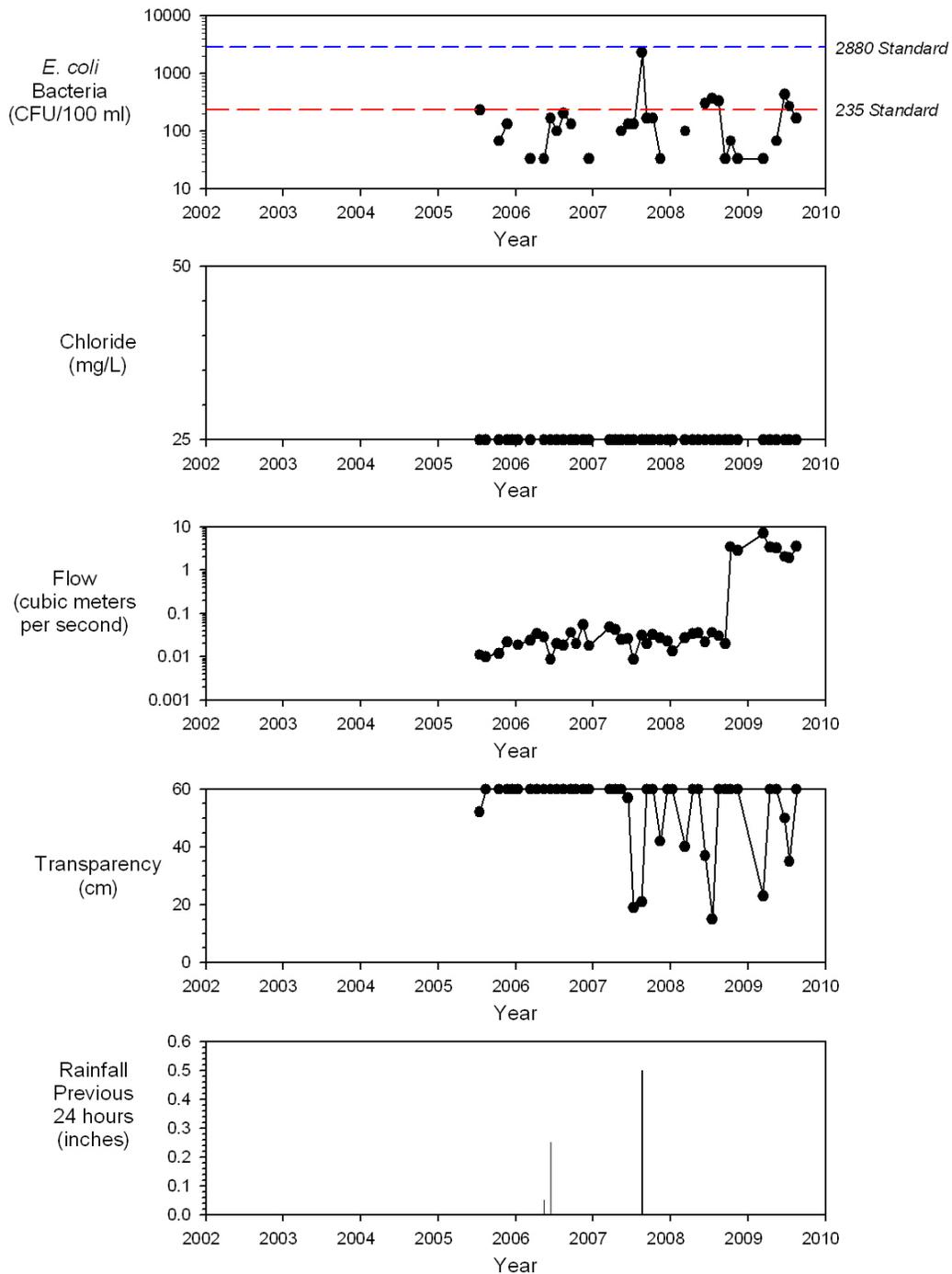
975013 - Floyd River (Plymouth Co.)



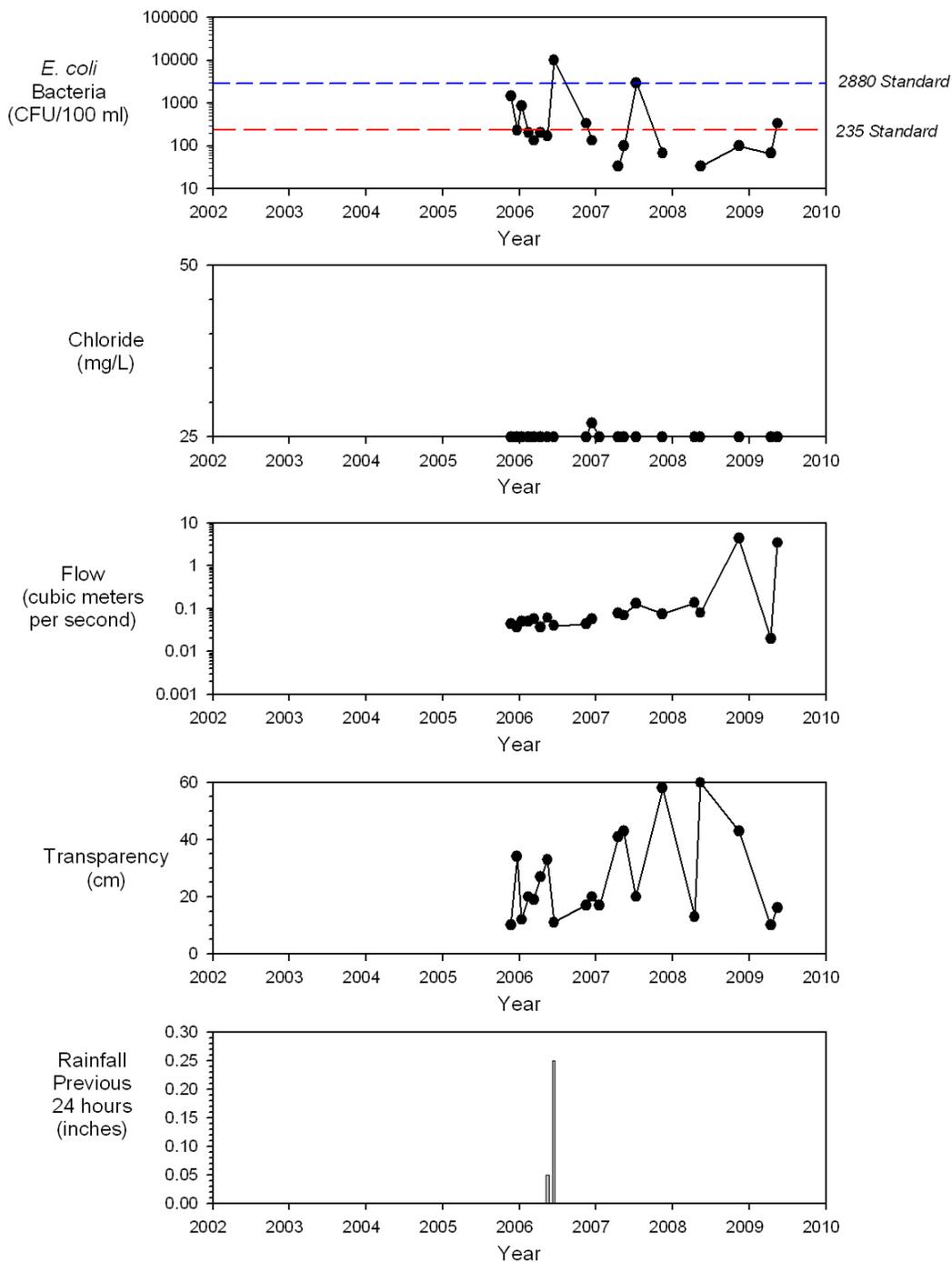
975019 - West Branch Floyd River (Plymouth Co.)



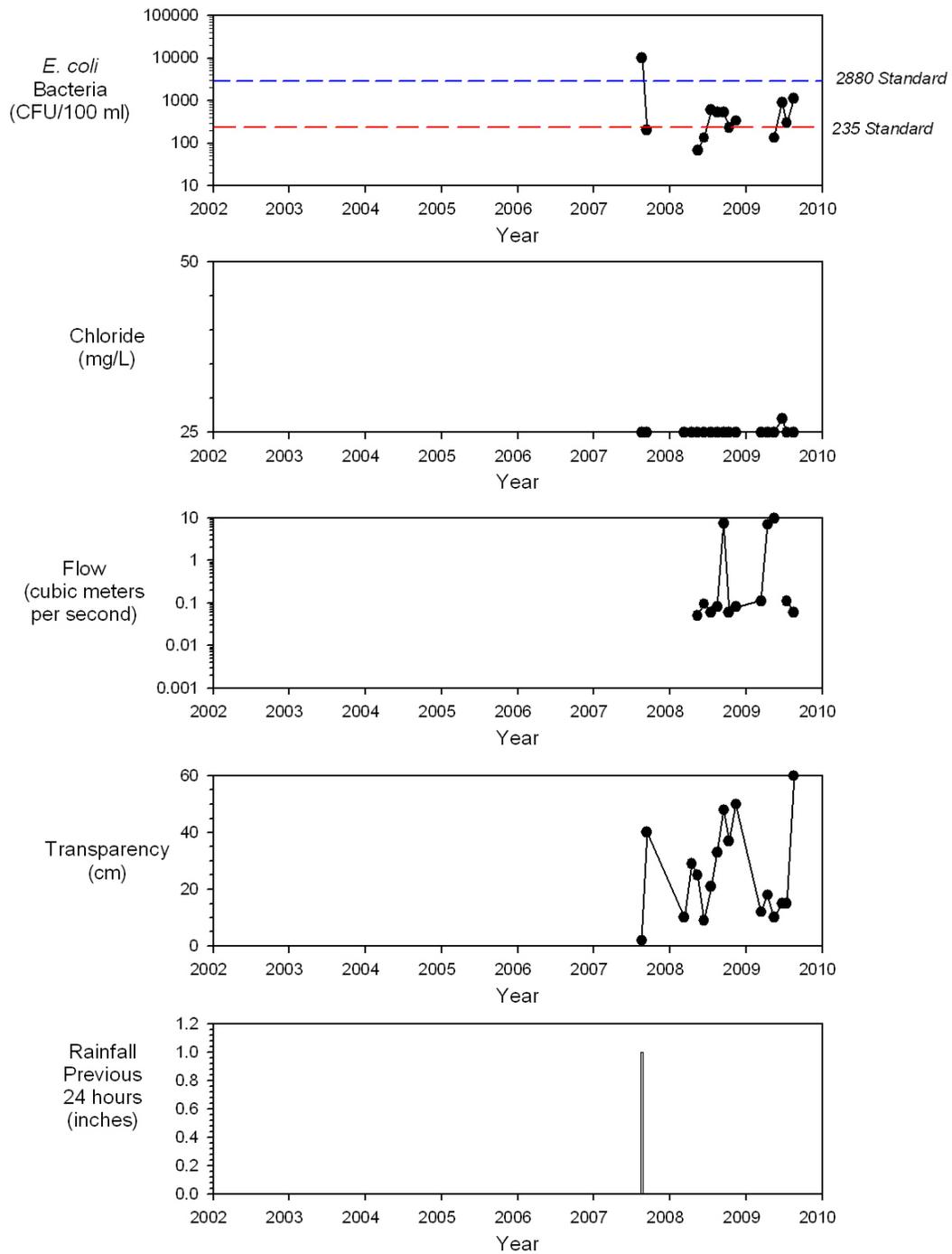
975020 - Rock Creek (Plymouth Co.)



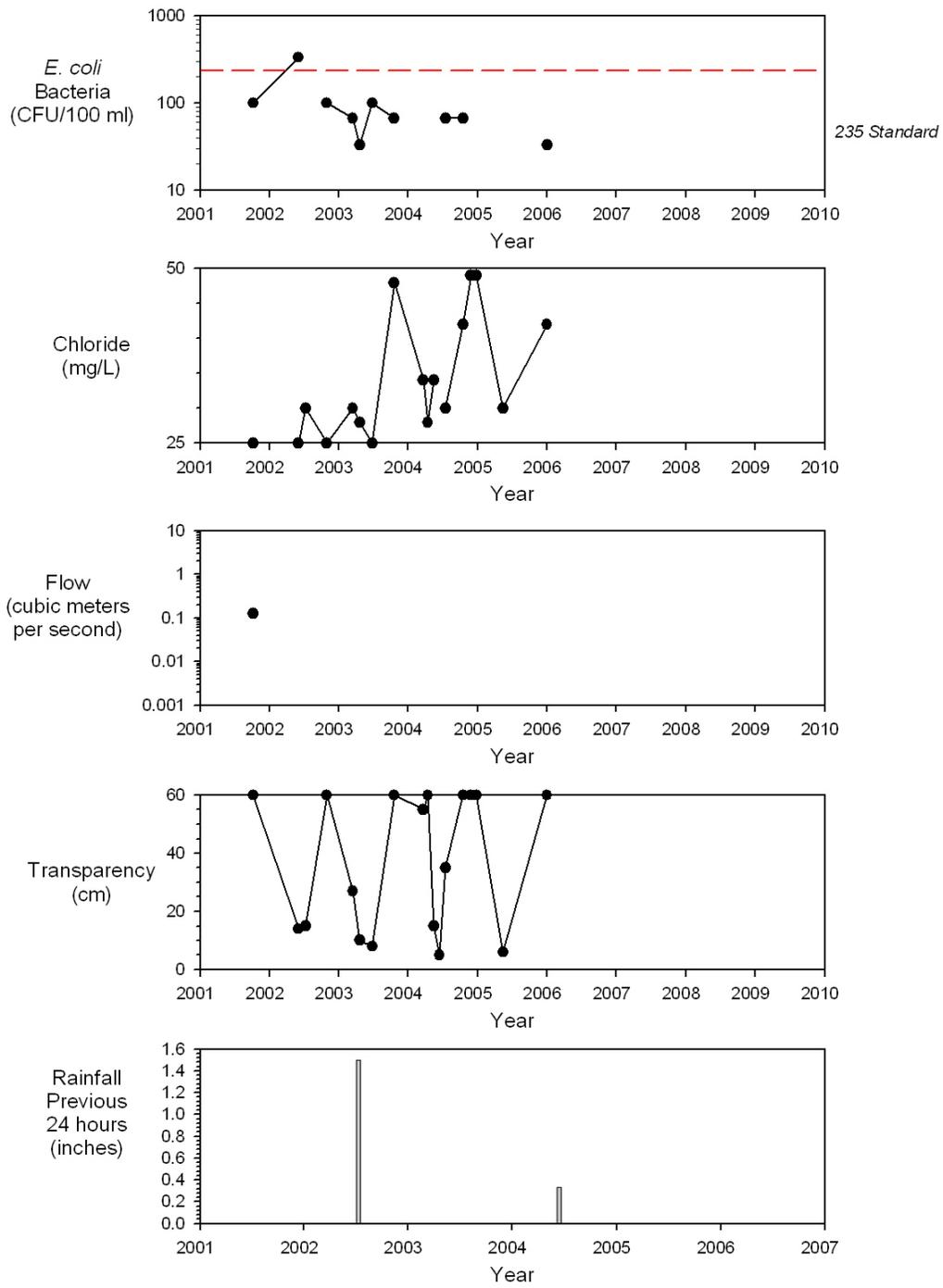
975022 - Merrill Ditch (Plymouth County)



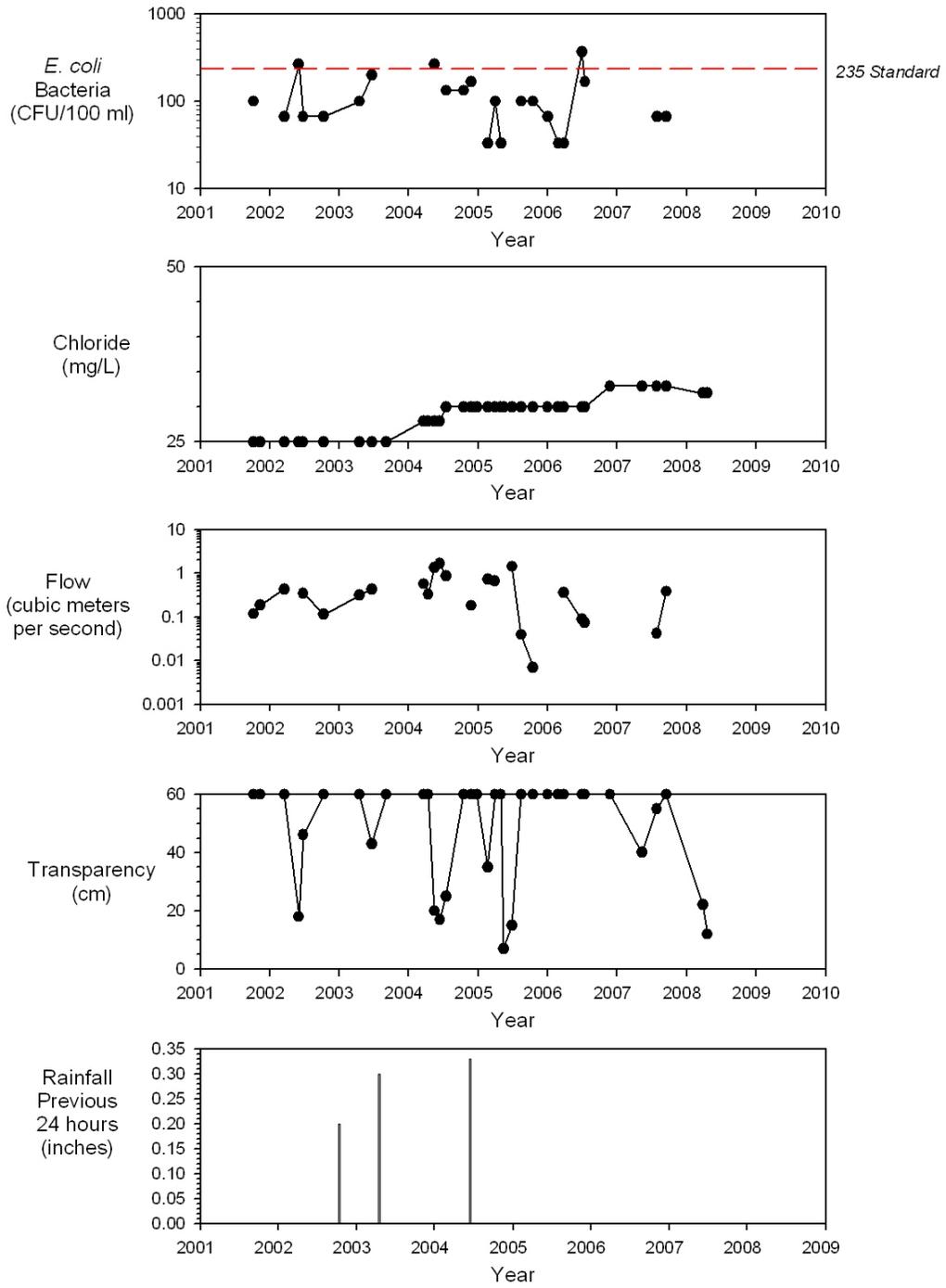
975024 - Merrill Ditch (C42 Bridge - Plymouth Co.)



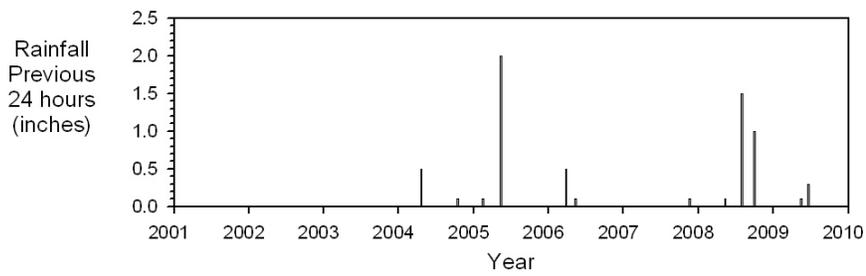
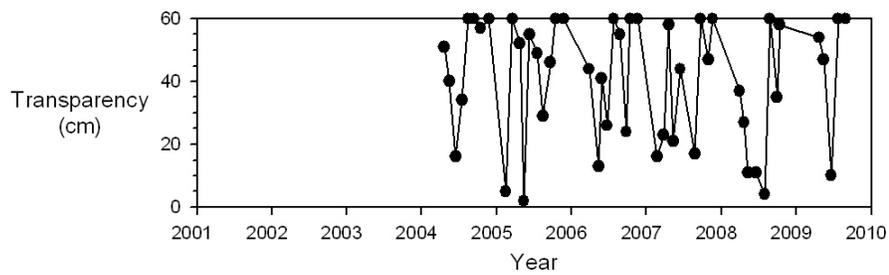
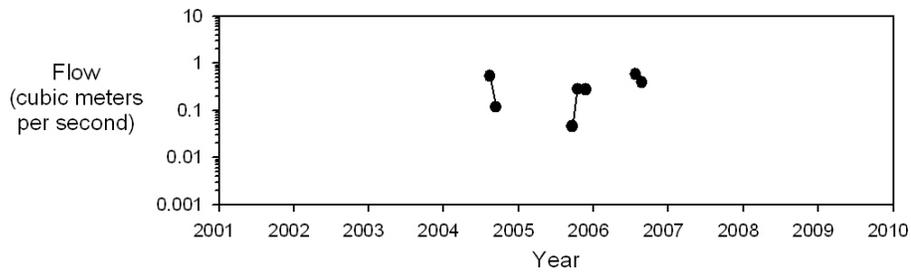
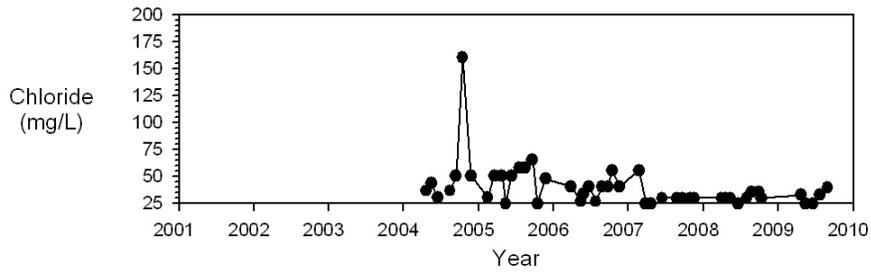
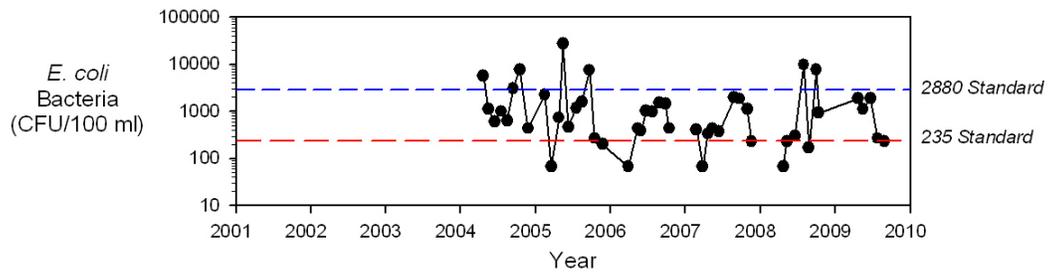
985003 - South Skunk River (near 190th - Story Co.)



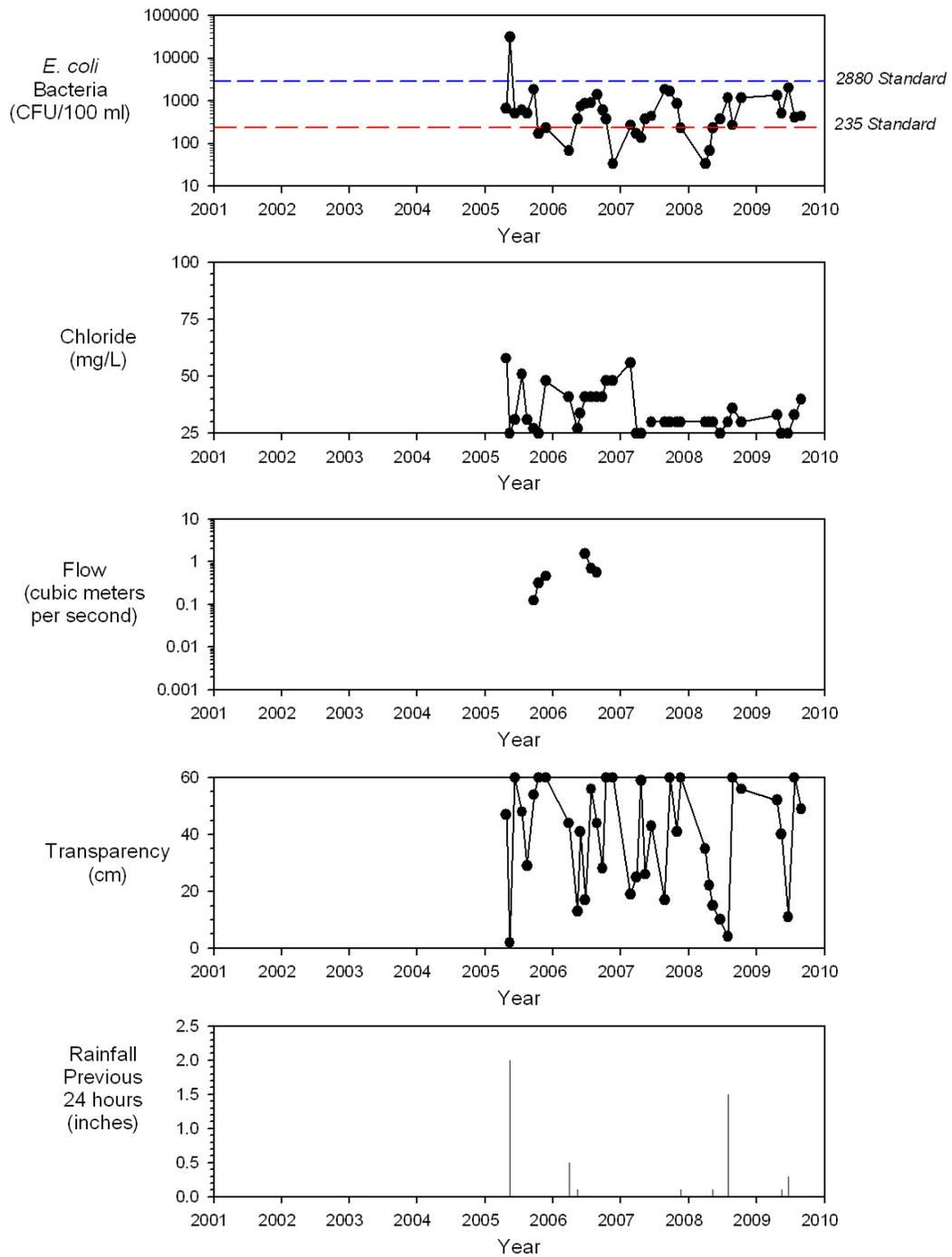
985024 - Long Dick Creek at 567th Ave (Story Co.)



985039 - Squaw Creek at Duff Ave. (Story Co.)



985040 - Squaw Creek at Fourth St. (Story Co.)



999022 - Buttermilk Creek (Wright Co.)

