4.03 2008 – 2009 BCWP Data Collection

Initially, data was collected from 20 sample sites, commencing July 2008. In January 2009, two additional sites were added to accommodate the Rogers Ditch subwatershed included in the Busseron Creek watershed after re-delineation, fall 2008. (See *Figure IV-42 – BCWP Sample Sites and Drainage Areas*) Monthly parameters included: turbidity, water temperature, pH, Total Dissolved Solids (TDS), Dissolved Oxygen, E. coli, Total Suspended Solids (TSS), Ammonia (NH3), Nitrite – Nitrate (NO2-NO3), and Total Phosphorus (P). Quarterly parameters included: dissolved and total Aluminum (Al), dissolved and total iron (Fe), dissolved and total Copper (Cu), and dissolved and total Manganese (Mn).

It should be noted that this data was affected by June 2008 flood events, September 2008 storm events, and spring 2009 weather conditions that prohibited typical farming activities.

Modeling data has been incorporated into subsequent analysis to simulate more typical loading of N, P, and sediments associated with agricultural activities.

Macroinvertebrates were collected and identified in September 2008 and July 2009. Habitat assessments were collected at sampling sites in August 2008. Analysis of geo-referenced land use and land cover data provided additional habitat quality information. (See Section 4.02)

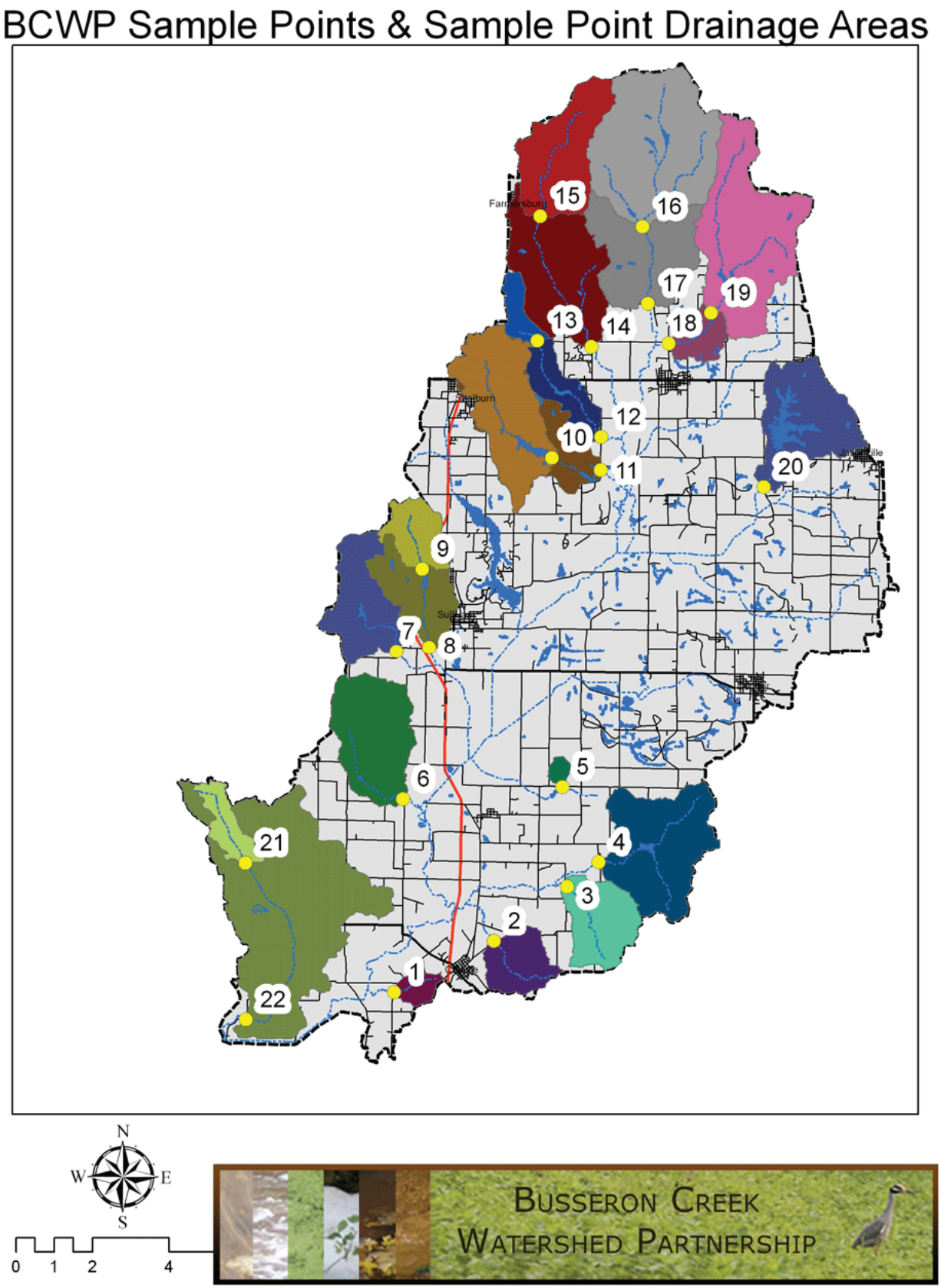

Figure IV-42 – BCWP Sample Sites and Drainage Areas

(a) 2008-2009 BCWP Summary by Sample Site

Data for all parameters except DO and sediment was compared to standards set forth in Title 327, Article 2 of the Indiana Administrative Code – Water Quality Standards (327 IAC 2). Dissolved Oxygen results were compared to 317 IAC 2 standards then were further compared to Indiana averages.

(i) Site #1

Figure IV-43 - BCWP Sample Site 1 Drainage Basin
Acreage: 476.8
Land Use: 58% Cultivated Crops, 30.7% Forested, 5.7% Low Density Residential, 5% Grass/Pasture
Soil Drainage Class: 75% Moderately Low Runoff Potential, 19% Low Runoff Potential, 6% Low Runoff Potential

# of Samples: 14 and 4 for metals
Problems/Exceed Standards: Turbidity (1 Fall), DO (6, Late Summer-Fall), E.Coli (4, Spring/Summer), Total Phosphorous (1, Fall), Total Aluminum (2/4, Aug&Feb), Dissolved Al (1/4, Feb)
Possible Sources: Agricultural runoff, failing septic or livestock. Aluminum and phosphorous from erosion of soils, low DO associated with harvesting and decaying plants, E. coli from livestock/failing septic/manure application.

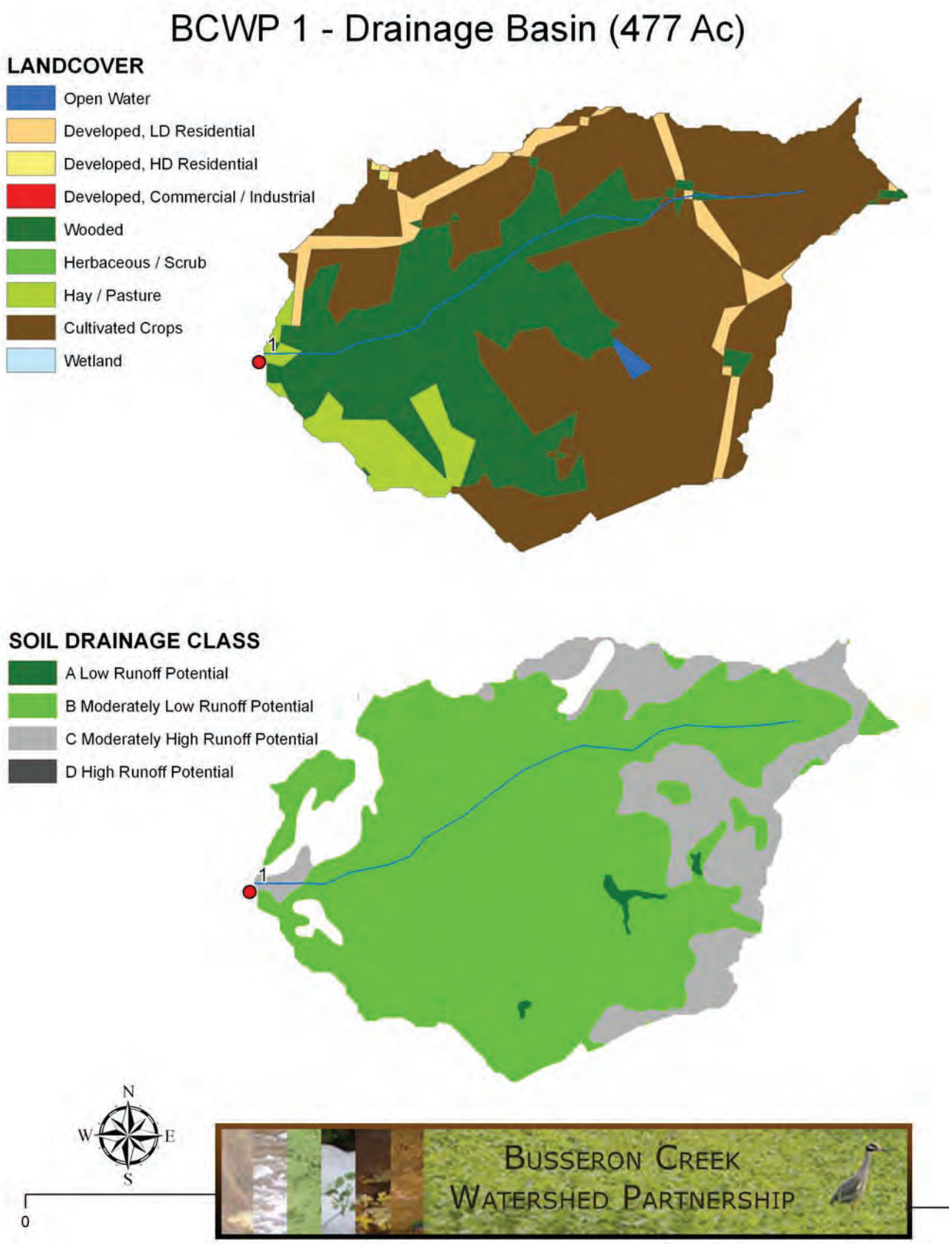

Figure IV-43 - BCWP Sample Site 1 Drainage Basin

(ii) Site #2

Figure IV-44 - BCWP Sample Site 2 Drainage Basin
Acreage: 1606.1
Land Use: 92% Cultivated Crops, 6% LD-Residential, 3.5% Forested
Soil Drainage Class: 56% Moderately Low Runoff Potential, 44% Moderately High Runoff Potential

# of Samples: 14 and 4 for metals
Problems/Exceed Standards: Turbidity (6, Summer / Spring), DO (3,Early Fall, no flow), E. Coli (9, Summer/Winter), TSS (1, Oct), Total Phosphorous (7 Summer / Fall), Total Aluminum (3/4, Aug, Nov, May), Dissolved Al (2/3, Nov, May)
Possible Sources Agricultural runoff, failing septic. Agricultural soil erosion. Aluminum and phosphorous from erosion of soils, low DO associated with harvesting and decaying plants, E. coli from failing septic.

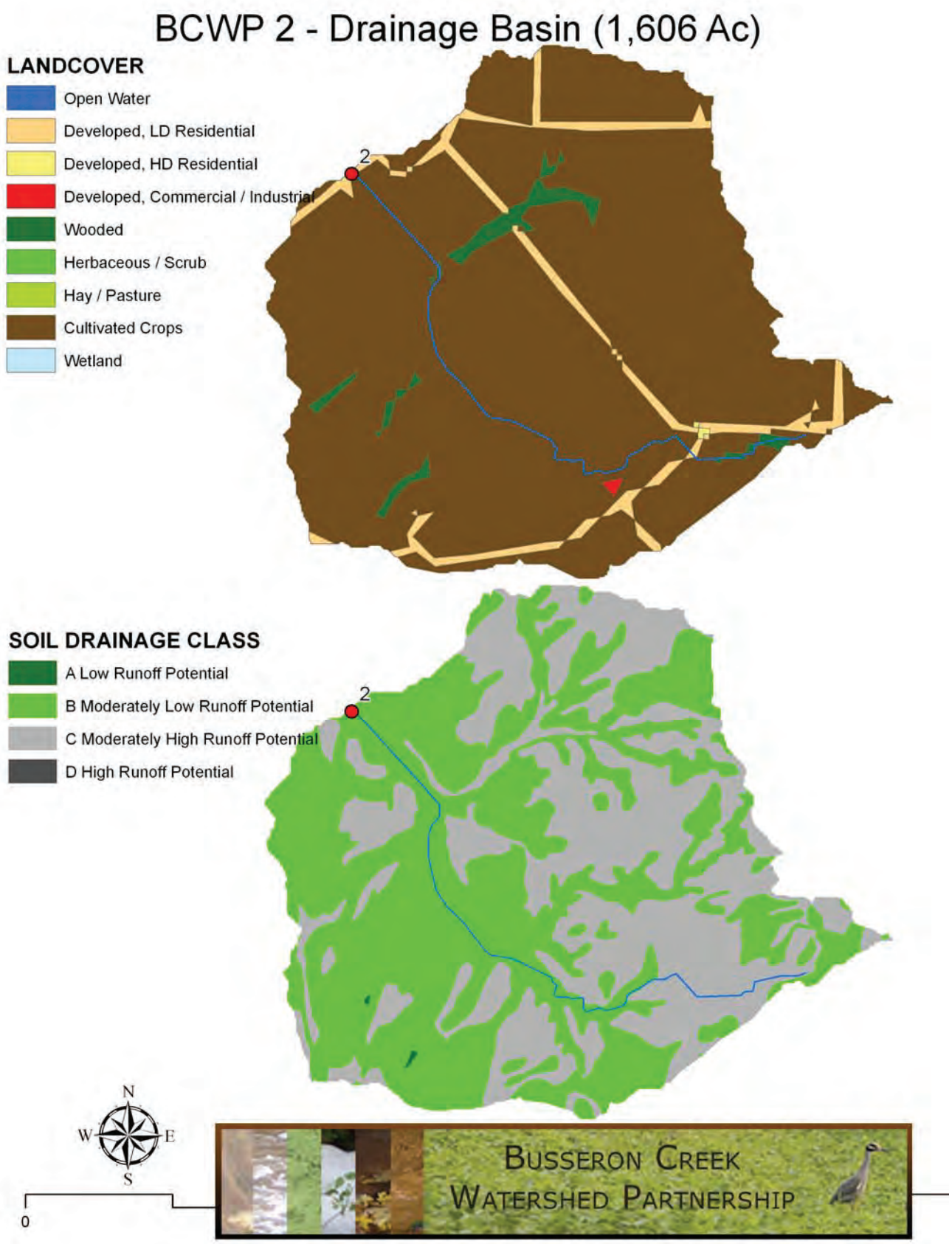

Figure IV-44 - BCWP Sample Site 2 Drainage Basin

(iii) Site #3

Figure IV-45 - BCWP Sample Site 3 Drainage Basin
Acreage: 2336.0
Land Use: 77% Cultivated Crops, 16% Forest, 5% LD-Residential
Soil Drainage Class: 77% Moderately High Runoff Potential, 21% Moderately Low Runoff Potential, 1% Water

# of Samples: 14 total, 4 for metals, 3 dissolved metals
Problems/Exceed Standards: Turbidity (4,June, Dec, May, Aug), DO (4,Late Summer,2 w/ no flow), E. Coli (8, Summer/Fall/Winter), Total Phosphorus (4 Fall 08, Spring 09),Total Aluminum (2/4, Aug, Nov), Dissolved Al (1/3, Nov)
Possible Sources: Agricultural runoff, failing septic. Residential in close proximity to streams points to potential influence from failing septics.
Turbidity is associated with crop land soil erosion. Aluminum and phosphorous from erosion of soils, low DO associated with harvesting and decaying plants, E. coli from failing septic/ manure application.

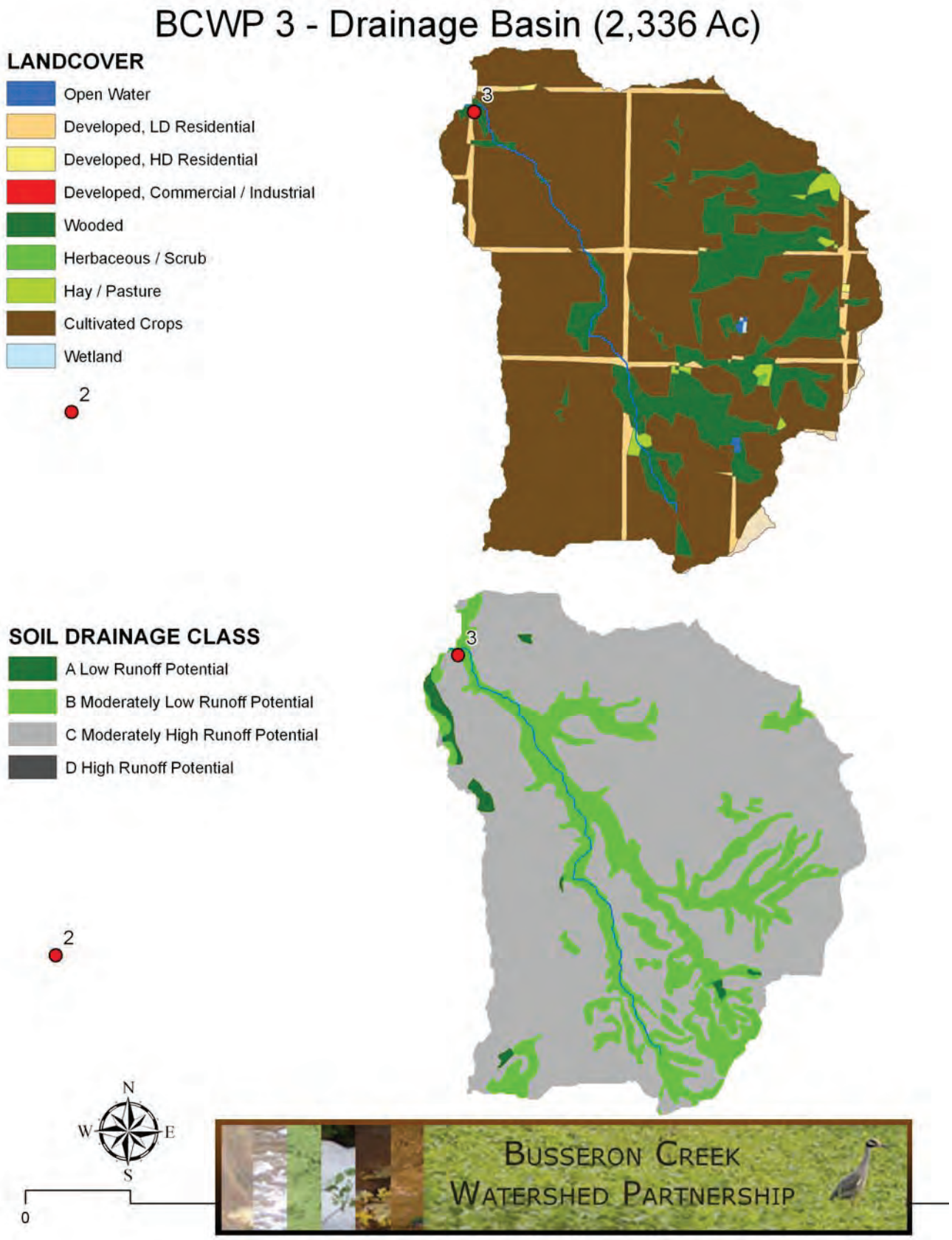

Figure IV-45 - BCWP Sample Site 3 Drainage Basin

(iv) Site #4

Figure IV-46 - BCWP Sample Site 4 Drainage Basin
Acreage: 4668.6
Land Use: 48.7% Cultivated Crops, 40.8% Forested, 5.3% Grass Pasture (abandoned Surface Mining), and 3.2% LD-Residential, Surface mining, temporary cessation of operation
Soil Drainage Class: 57% Moderately High Runoff Potential, 34% Moderately Low Runoff Potential, 8% High Runoff Potential, 1% Water

# of Samples: 14 total, 4 for metals, 3 dissolved metals
Problems/Exceed Standards: Turbidity (11,All Year), DO (2, Oct, Aug), E. Coli (5, Sept/Aug 08, June / Aug / Nov 09), TDS (2, Oct & Nov) TSS (5, Spring/Summer), Total Aluminum (3/4, Aug, Feb, Nov), Dissolved Al (2/3, Feb, May), Total Iron (2/4, Feb, May)
Possible Sources Presence of past mining activities indicated by the sediment (Turbidity, TSS, TDS) and metals (Al, Fe) in the water. Agricultural runoff may be source of sediments, and potential septic failures also may be present in the watershed evidence from E. coli and Phosphorous.

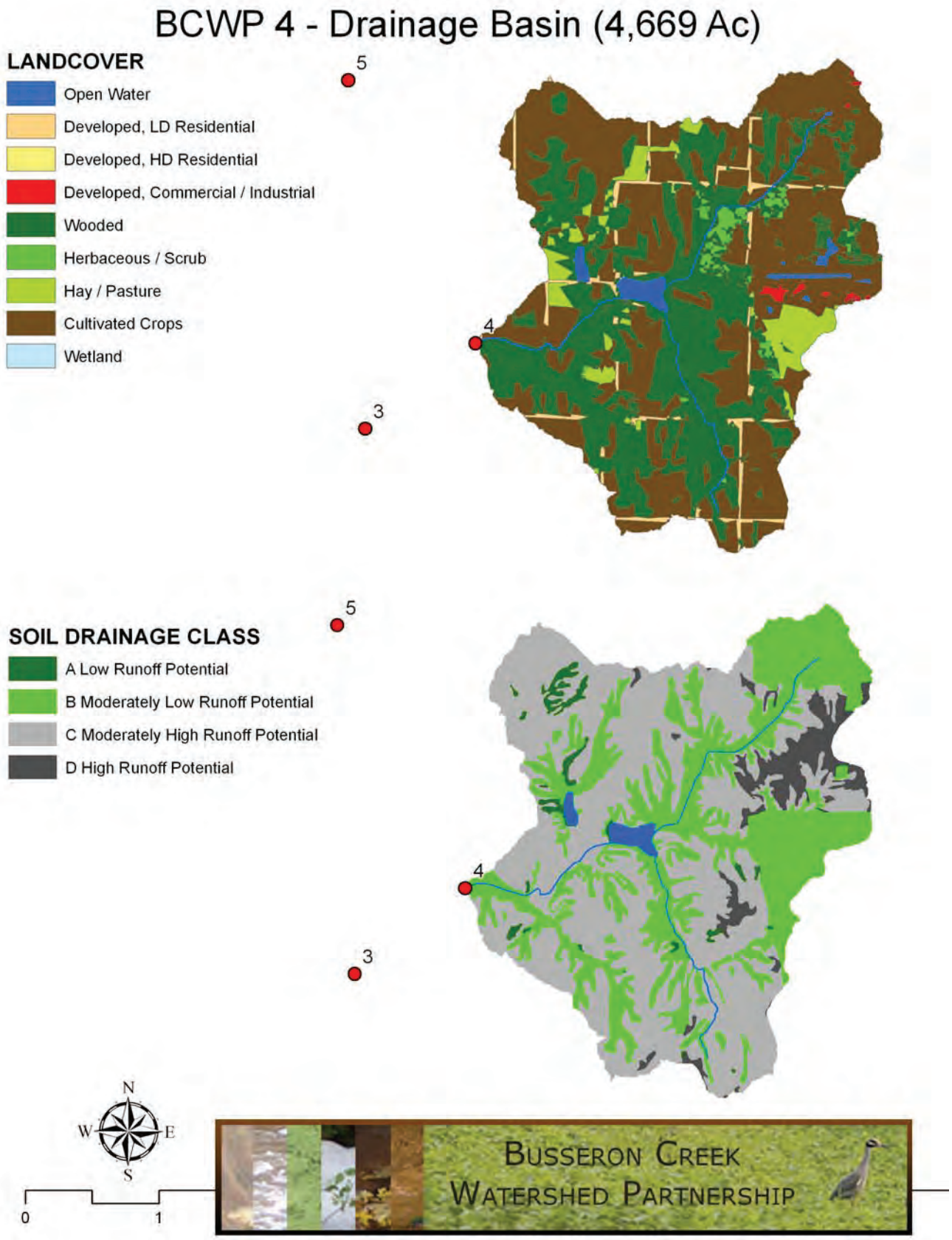

Figure IV-46 - BCWP Sample Site 4 Drainage Basin

(v) Site #5

Figure IV-47 - BCWP Sample Site 5 Drainage Basin
Acreage: 210.6
Land Use: 43.9% Forested, 28.7% Cultivated Crops, 25.6% Grass Pasture, 1.9% LD-Residential
Soil Drainage Class: 83% Moderately High Runoff Potential, 17% Moderately Low Runoff Potential

# of Samples: 13 total, 3 for metals, 2 dissolved metals
Problems/Exceed Standards: Turbidity (6, July-Oct 08, Aug Nov 09), DO (8, year-round), Specific Conductivity (4, July-Oct), E. Coli (7, June, July, Sept, Dec, March, Aug, Nov), TSS (4, Aug-Oct), Ammonia (3), Total Phosphorous (7, Jun -Nov), Total Aluminum (3/3, Aug, Feb,March), Total Iron (1/2, Aug), Total Copper (1/2, Aug), Total manganese (1, Aug)
Possible Sources: Conductivity is an indirect measure of the presence of dissolved solids such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, and iron, and can be used as an indicator of water pollution. However specific conductivity does not match TDS. High amounts of metals of all sorts may be from soils since no mining activity. Often with very low amounts of DO. May need to investigate illegal dumping in the area.

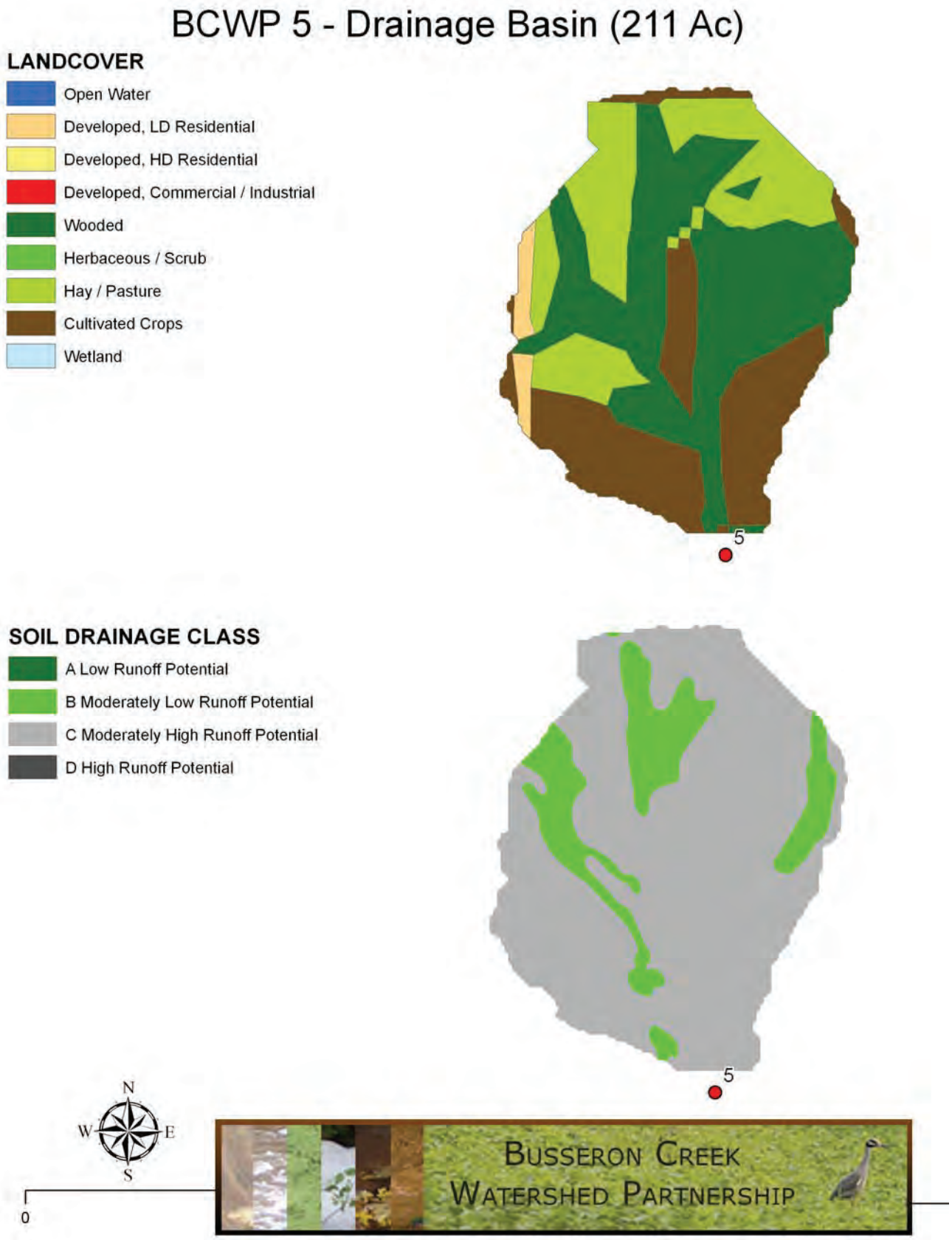

Figure IV-47 - BCWP Sample Site 5 Drainage Basin

(vi) Site #6

Figure IV-48 - BCWP Sample Site 6 Drainage Basin
Acreage: 3757.9
Land Use: 86.8% Cultivated Crops, 7.4% LD-Residential, 3.7% Forest, and 1.9% Grass/Pasture
Soil Drainage Class: 35% Moderately High Runoff Potential, 65% Moderately Low Runoff Potential

# of Samples: 14 total, 4 for metals, 3 dissolved metals
Problems/Exceed Standards: Turbidity (8, Spring-Summer-Fall), DO (3, Aug & Oct, no flow), E. Coli (9, Year-round), TSS (3, Summer - Fall),Ammonia (1, Aug), Total Phosphorous (8, Spring-Summer-Fall), Total Aluminum (3/4, Aug, Nov, March), Dissolved Al (2/3, Aug & Feb), Total Manganeese (2/4, Aug & Nov), Dissolved Manganeese (1, Nov)
Possible Sources: Agricultural soil erosion, livestock proximity to streams, and potential septic failure.

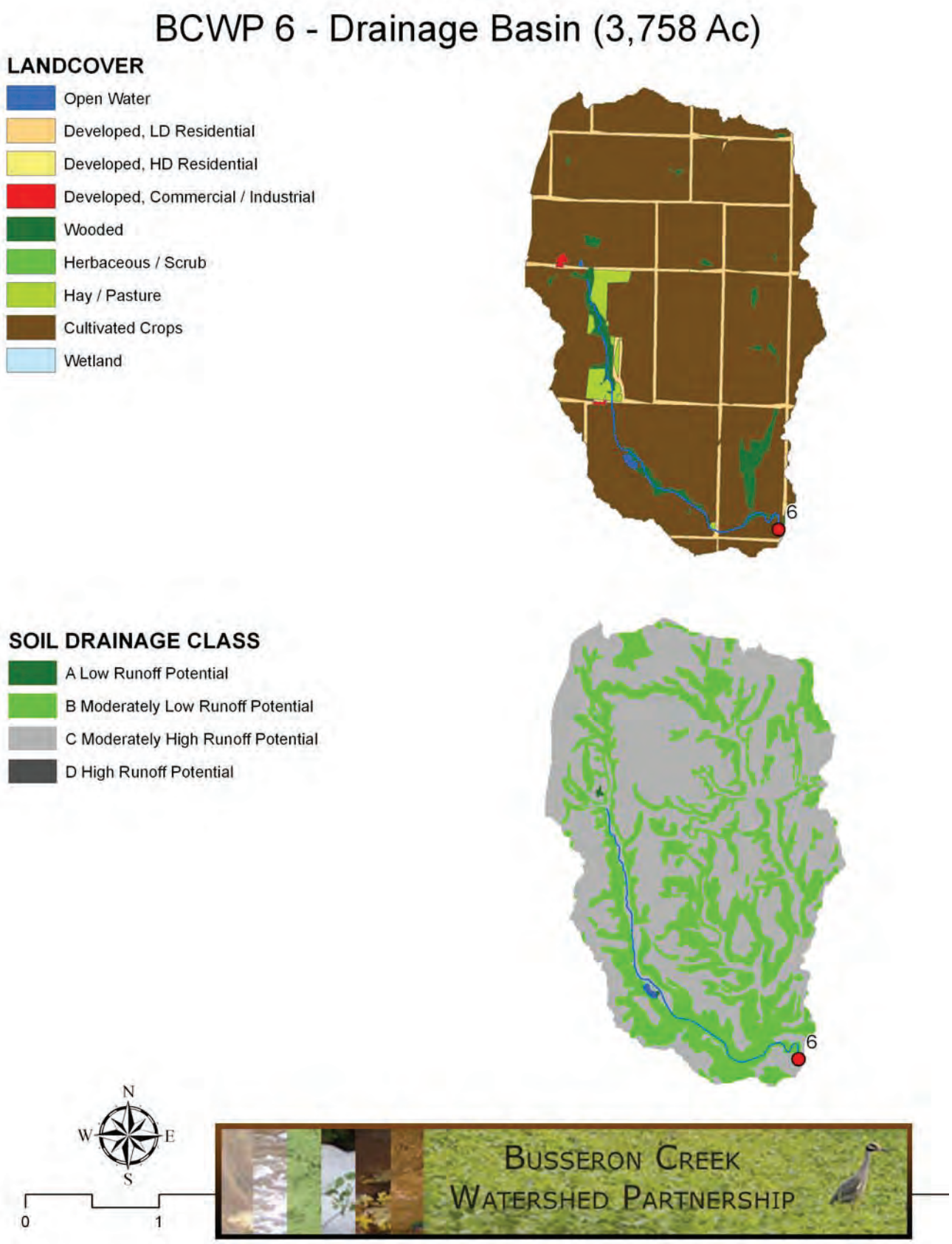

Figure IV-48 - BCWP Sample Site 6 Drainage Basin

(vii) Site #7

Figure IV-49 - BCWP Sample Point 7 Drainage Basin
Acreage: 2797.8
Land Use: 80.5% Cultivated Crops, 10.9% Forest, 5.1% LD-Residential, 1.7% Grass/Pasture, 0.8% HD-Residential
Soil Drainage Class: 67% Moderately High Runoff Potential, 32% Moderately Low Runoff Potential, 1% Water

# of Samples: 14 total, 4 for metals, 3 dissolved metals
Problems/Exceed Standards: Turbidity (8,June-Sept & Feb-March), DO (4, Aug, Oct-Nov), E. Coli (5, Year-round), TSS (2 Sept & April),Ammonia (2 Summer) Total Phosphorous (13, Year-round), Total Aluminum (3/4, Aug, Feb, May), Dissolved Al (1/3, May)
Possible Sources: Agricultural soil erosion, livestock proximity to streams, and potential septic failure.

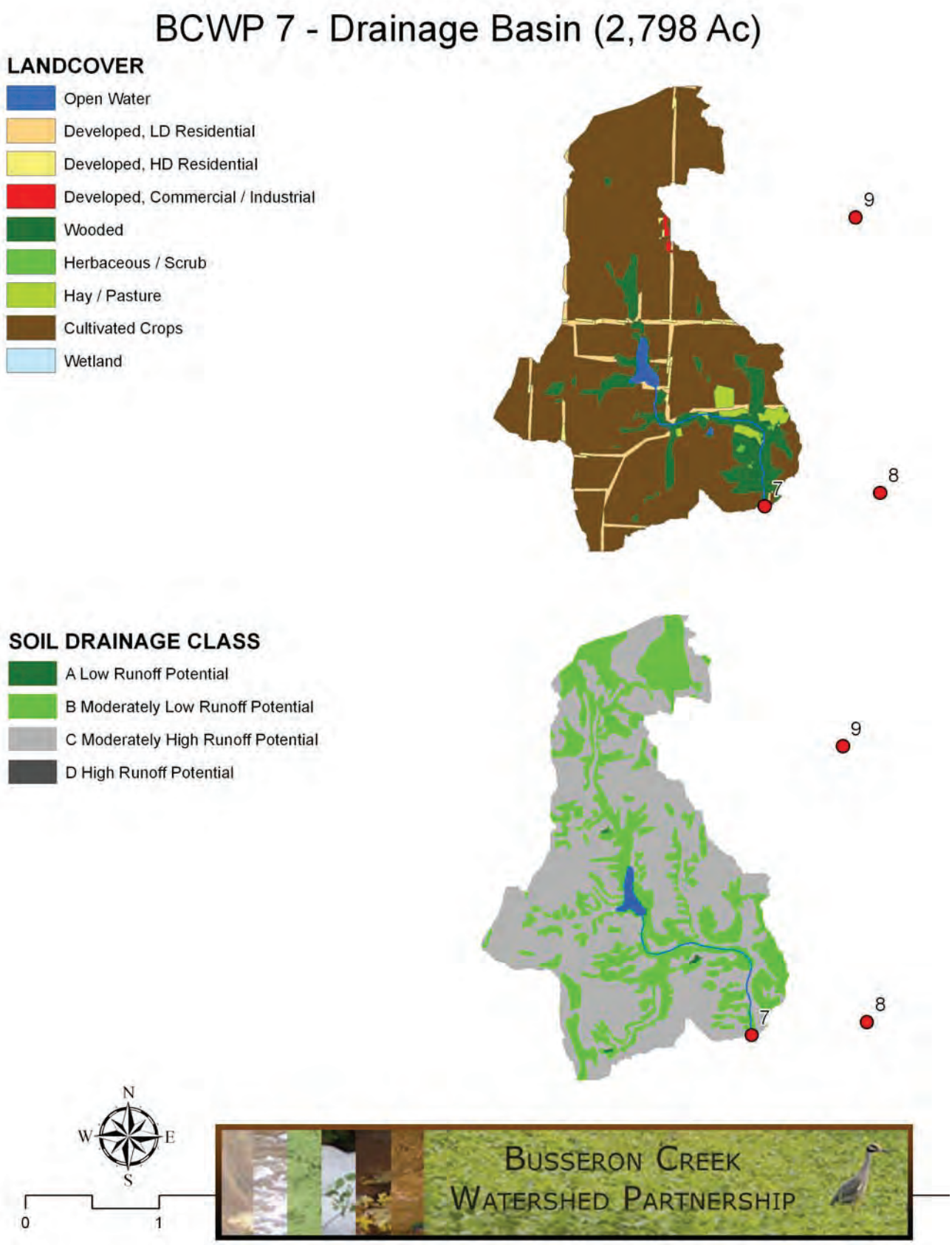

Figure IV-49 - BCWP Sample Point 7 Drainage Basin

(viii) Site #8

Figure IV-50 - BCWP Sample Site 8 Drainage Basin
Acreage: 3714.9
Land Use: 57.9% Cultivated Crops, 11% Forest, 14.1% LD-Residential, 8.5% HD-Residential, 2.5% Commercial, 0.8% Industrial, 3.5% Grass/Pasture, Sullivan Proper
Soil Drainage Class: 56% Moderately High Runoff Potential, 42% Moderately Low Runoff Potential, 2% Water

# of Samples: 13 total, 3 for metals, 2 dissolved metals
Problems/Exceed Standards: Turbidity (9, Spring-Summer-Fall), DO (2, Aug(no flow), Oct), E. Coli (9,Year-round), TSS (2, Fall),Ammonia (2, July-Aug) Total Phosphorous (8 , Year-round), Total Aluminum (3/3, Aug, Nov, May), Dissolved Al (2/2, Nov, May)
Possible Sources: Runoff from residential, commercial, and industrial. Failing storm and sewer systems, CSOs, failing septic systems, golf course runoff, CSO's.

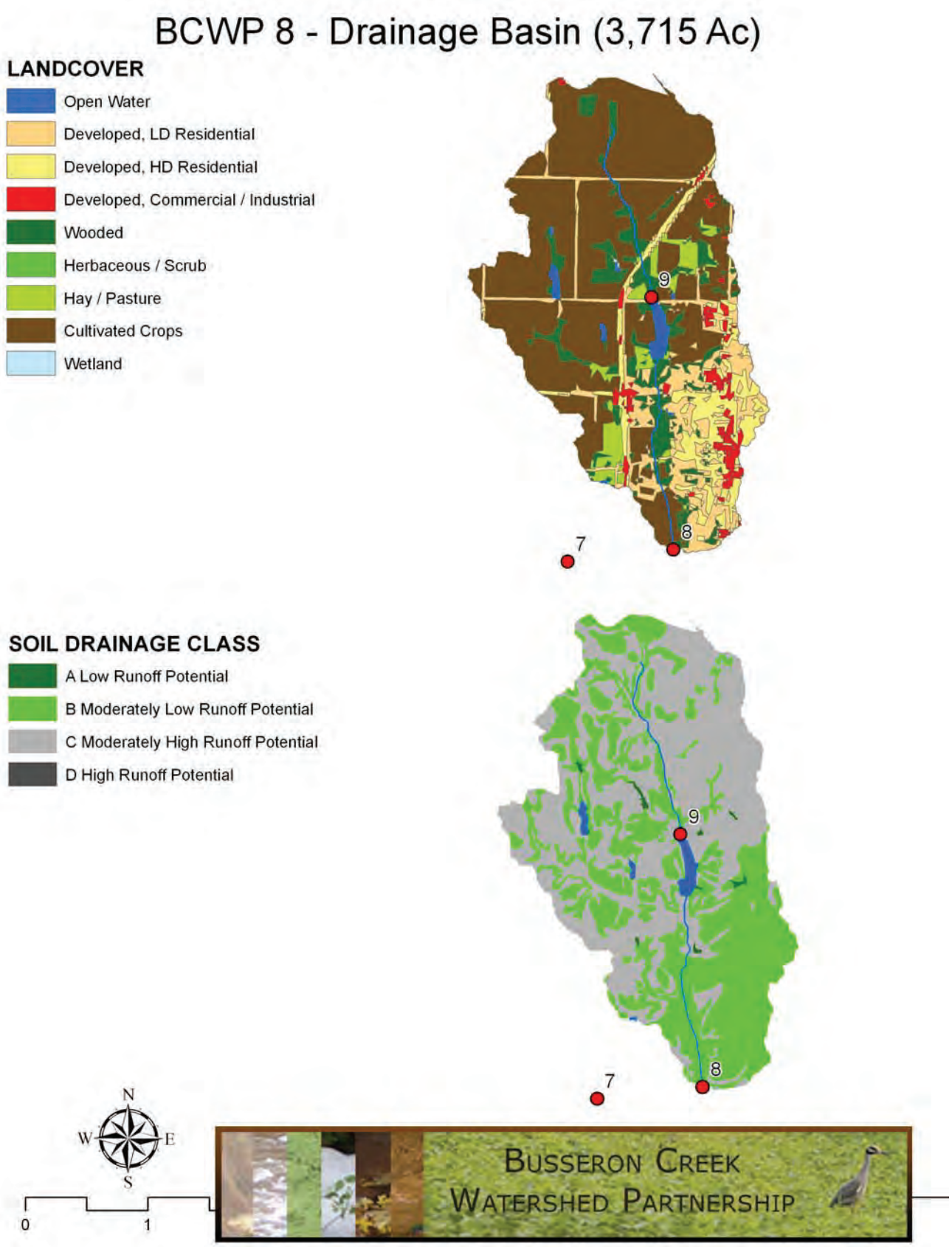

Figure IV-50 - BCWP Sample Site 8 Drainage Basin

(ix) Site #9

Figure IV-51 - BCWP Sample Site 9 Drainage Basin
Acreage: 1479.7
Land Use: 77.2% Cultivated Crops, 11.4% Forest, 4.3% LD-Residential, 2.2% HD-Residential,0.6% Commercial, 3.7% Grass/Pasture, Sullivan outliers(northside)
Soil Drainage Class: 73% Moderately High Runoff Potential, 26% Moderately Low Runoff Potential, 1% Water

# of Samples: 14 total, 4 for metals, 3 dissolved metals
Problems/Exceed Standards: Turbidity (8,Spring-Summer-Fall), DO (6, Spring-Summer), E. Coli (3,Oct-Nov & April), TSS (5, Spring-Summer-Fall), Total Phosphorous (10, Year-round), Total Aluminum (3/4, Nov, Feb, May), Dissolved Al (3/3, Nov,Feb, May), Fe Total (1/4, May), Dissolved Fe(1/3, May)
Possible Sources: E.coli indicates some failing sewage/septic systems due to timing of exceedance , Low DO is associated with no flow indicating high amount of production in stream. Agricultural runoff may be a source of nutrients and sediment, Runoff from Highway 41 and urban land may be source of metals. Urban runoff or agricultural soil erosion may be source of turbidity.

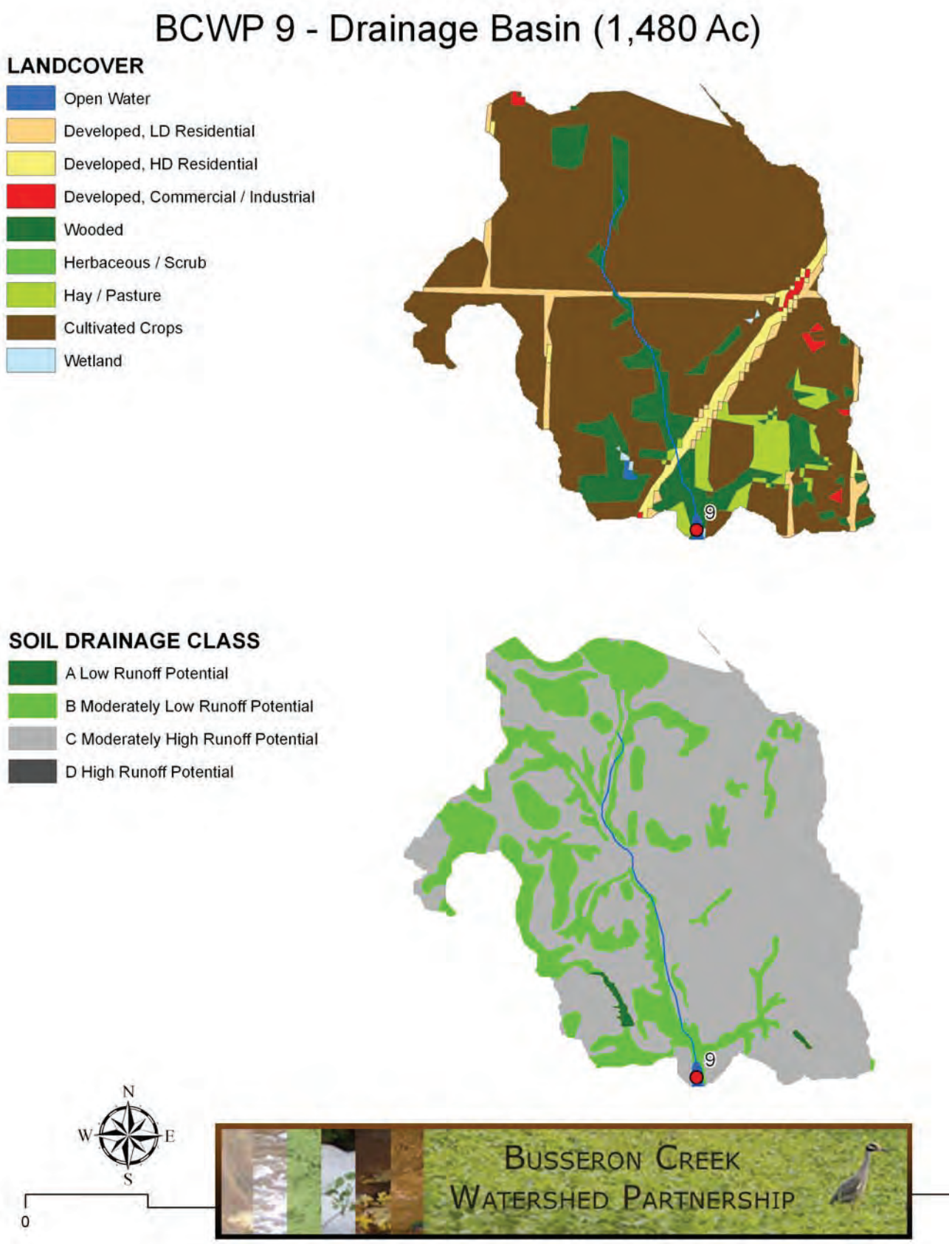

Figure IV-51 - BCWP Sample Site 9 Drainage Basin

(x) Site #10

Figure IV-52 - BCWP Sample Site 10 Drainage Basin
Acreage: 4427.6
Land Use: 65% Cultivated Crops, 18.7% Forest, 8.4% LD-Residential, 2.6% HD-Residential, 0.9% Commercial, 2.1% Grass/Pasture, Abandoned mine land, Shelburn
Soil Drainage Class: 90% Moderately High Runoff Potential, 6% Moderately Low Runoff Potential, 4% Water

# of Samples: 14 total, 4 for metals, 3 dissolved metals
Problems/Exceed Standards: Turbidity (7, Year-round), DO (3, Summer-Fall), TSS (1, Sept), Total Phosphorus(9 Year-round),Total Aluminum (2/4, Aug, May), Dissolved Al (1/3, May), Mn Total (1/4,Nov)
Possible Sources: Some escaped sediments from abandoned mine land mostly under regulation levels. Agricultural practices resulting in high amounts of phosphorus and turbidity.

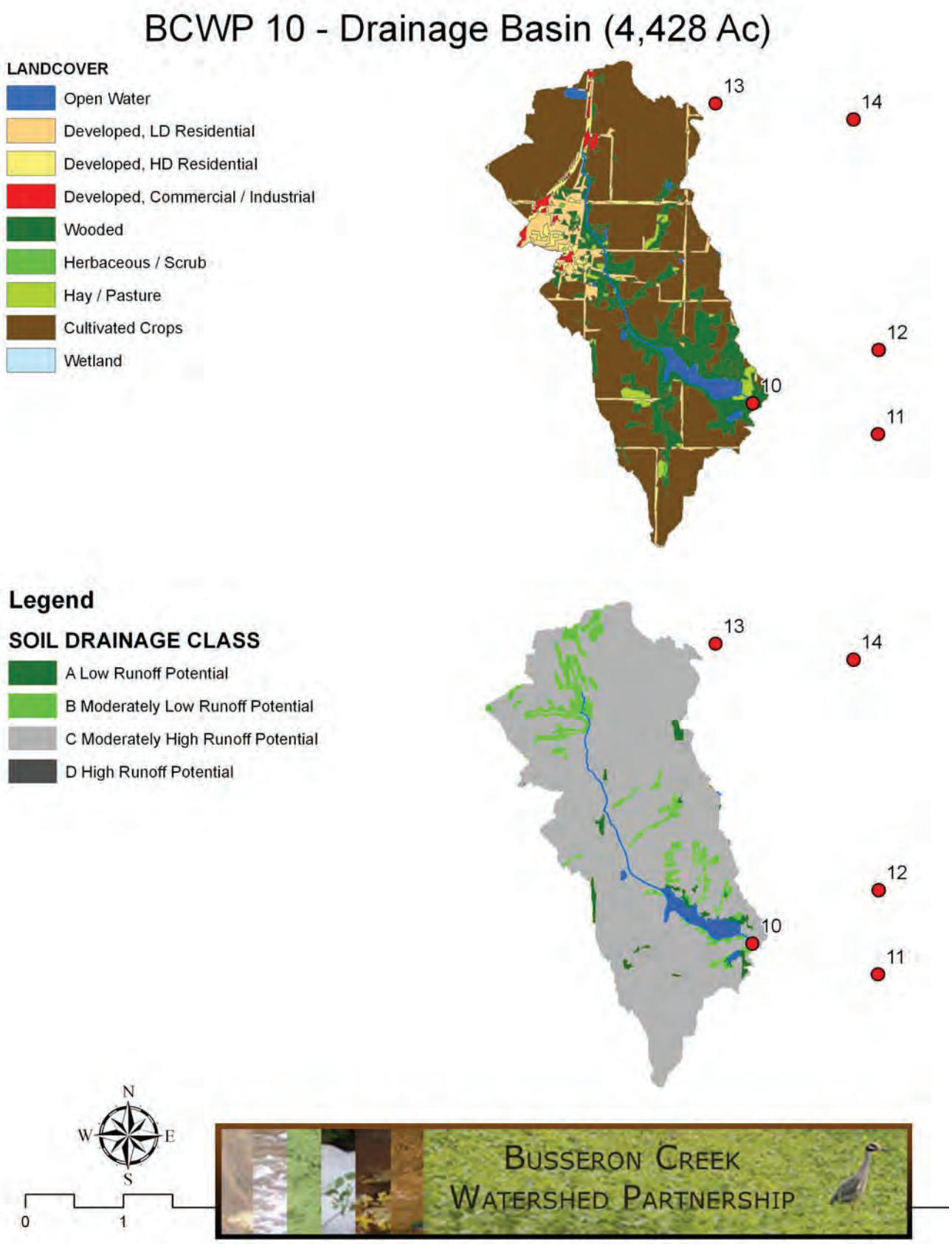

Figure IV-52 - BCWP Sample Site 10 Drainage Basin

(xi) Site #11

Figure IV-53 - BCWP Sample Site 11 Drainage Basin
Acreage: 5577.9
Land Use: 59.8% Cultivated Crops, 23.3% Forest, 7.6% LD-Residential, 2.1% HD-Residential,0.7% Commercial, 3.8% Grass/Pasture, Shelburn, abandoned mine land
Soil Drainage Class: 82% Moderately High Runoff Potential, 13% Moderately Low Runoff Potential, 5% Water

# of Samples: 10 total, 2 for metals, 1 dissolved metals
Problems/Exceed Standards: Turbidity (2,July & Nov), E. Coli (1 Nov), TSS (2, July & Sept), Total Phosphorous (2, Fall-Winter Jan very high may be error), Total Aluminum (2/2, Aug & Nov), Dissolved Al (1/1 , Nov)
Possible Sources: Collapse of culvert June 2008. Previous coal mining activity. Agricultural practices.

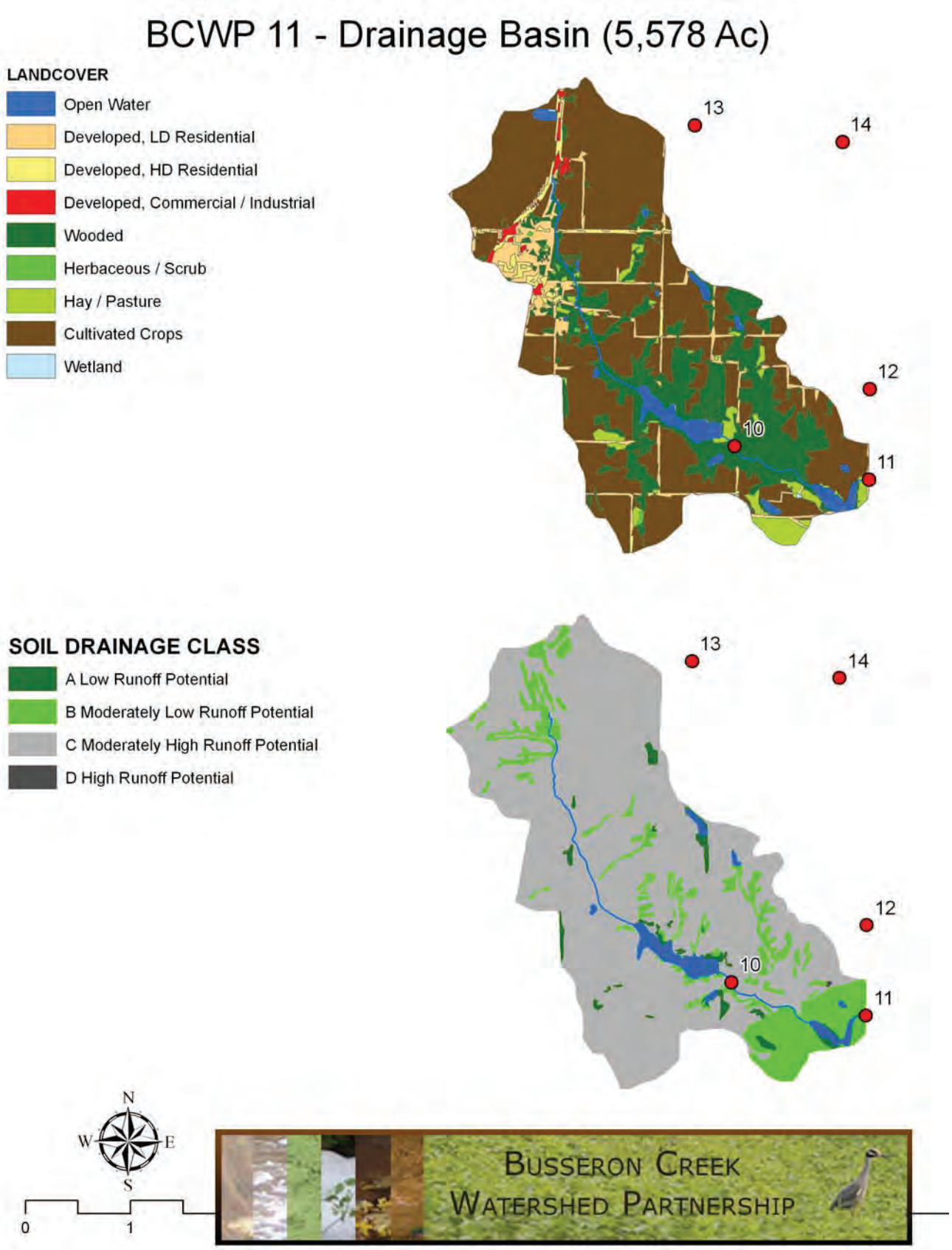

Figure IV-53 - BCWP Sample Site 11 Drainage Basin

(xii) Site #12

Figure IV-54 - BCWP Sample Site 12 Drainage Basin
Acreage: 2250.4
Land Use: 64.5% Cultivated Crops, 26% Forest, 4.8% LD-Residential, 0.4% HD-Residential, 3.1% Grass/Pasture, Abandoned mining activities
Soil Drainage Class: 92% Moderately High Runoff Potential, 4% Moderately Low Runoff Potential, 3% Water, 1% Water

# of Samples: 14 total, 4 for metals, 3 dissolved metals
Problems/Exceed Standards: Turbidity (1, May), DO (3 Spring-Summer-Fall), E.Coli (3, Fall), TSS (1, Sept), Total Aluminum (2/4, Feb, May), Dissolved Al (1/3, May), Fe Total (1/4, May), Fe Dissolved (1/3, May), Mn Total (1/4,Nov), Mn Dissolved (1/4, Nov)
Possible Sources: Agricultural soil erosion. Potential for AML source of metals.

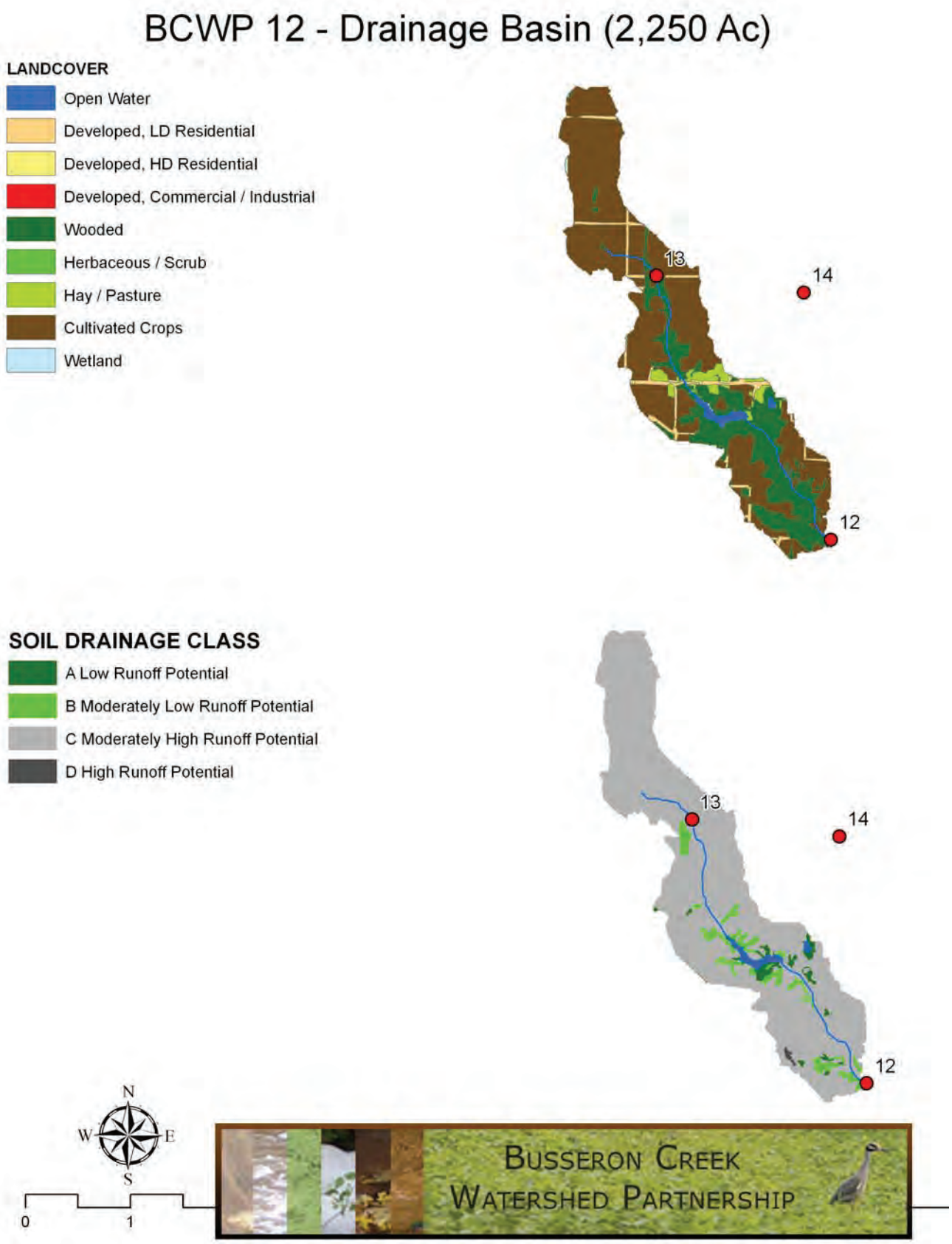

Figure IV-54 - BCWP Sample Site 12 Drainage Basin

(xiii) Site #13

Figure IV-55 - BCWP Sample Site 13 Drainage Basin
Acreage: 711.9
Land Use: 92.4% Cultivated Crops, 2.9% Forest, 4.5% LD-Residential,
Soil Drainage Class: 99% Moderately High Runoff Potential

# of Samples: 14 total, 4 for metals, 3 dissolved metals
Problems/Exceed Standards: Turbidity (3, Spring-Fall), DO (8, Year-round *very little if any* flow), E.Coli (5, Spring-Summer), TSS (2, Sept & Nov), Ammonia (1 Nov)Total Phosphorous (7, Year-round), Total Aluminum (3/4, Aug, Nov, May), Dissolved Al (2/3,Nov& May), Fe Total (1/4, Nov), Fe Dissolved (1/3, Nov)
Possible Sources: Agricultural practices, ditching, soil and channel erosion.

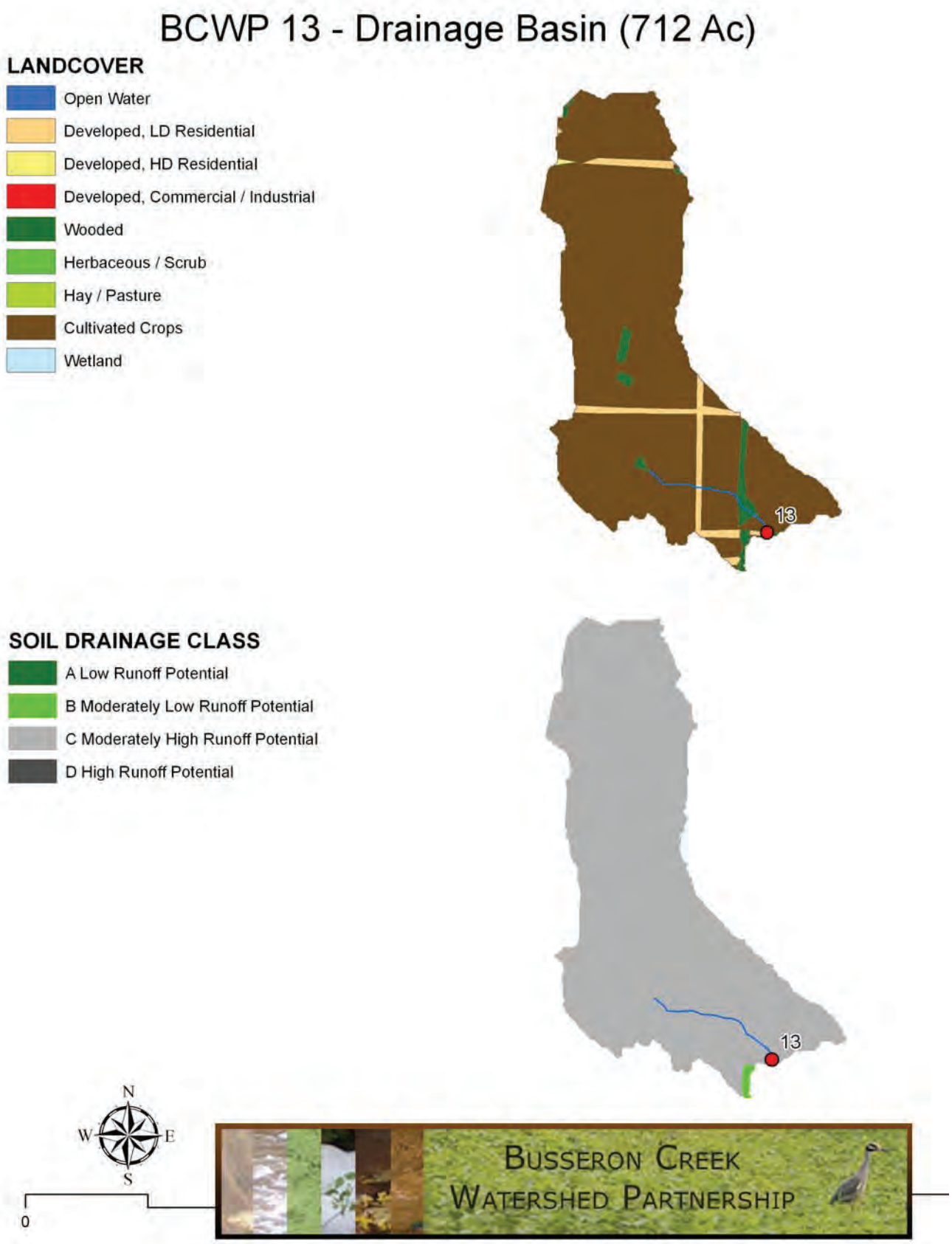

Figure IV-55 - BCWP Sample Site 13 Drainage Basin

(xiv) Site #14

Figure IV-56 - BCWP Sample Site 14 Drainage Basin
Acreage: 8102.2
Land Use: 63.9% Cultivated Crops, 26.5% Forest, 4.2% LD-Residential, 0.3% Commercial, 0.9% Industrial, 1.1% Grass/Pasture, Farmersburg, Active Mining
Soil Drainage Class: 55% Moderately High Runoff Potential, 41% Moderately Low Runoff Potential, 2% Water, 1% High Runoff Potential

# of Samples: 14 total, 4 for metals, 3 dissolved metals
Problems/Exceed Standards: Turbidity (2, April-May), E.Coli (3 Spring-Summer-Fall), Total Phosphorus (1 April), Total Aluminum (4/4, Aug, Nov,Feb, May), Dissolved Al (1/3,Nov)
Possible Sources: Soil and channel erosion. Septic systems / sewage treatment facilities.

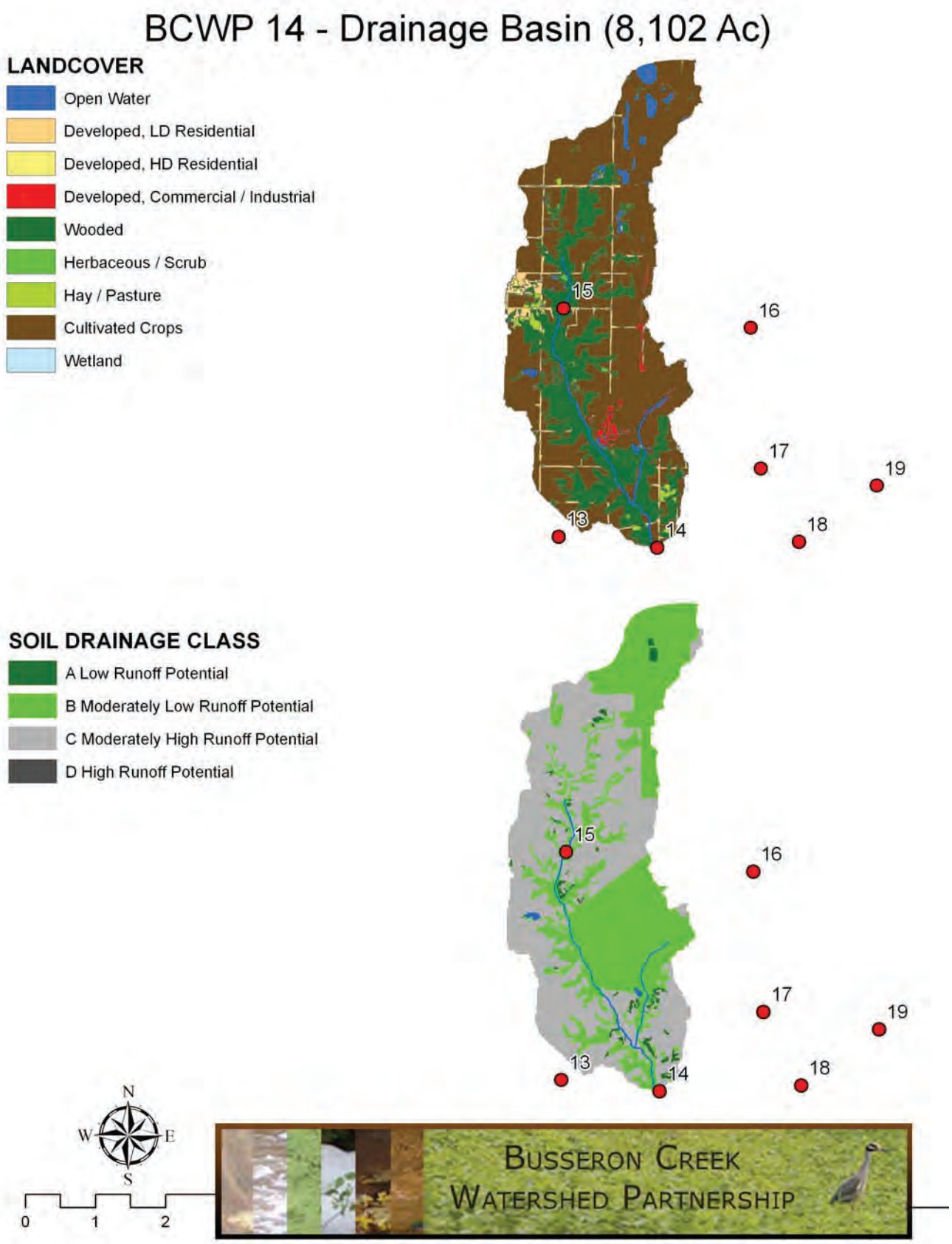

Figure IV-56 - BCWP Sample Site 14 Drainage Basin

(xv) Site #15

Figure IV-57 - BCWP Sample Site 15 Drainage Basin
Acreage: 3549.8
Land Use: 73.2% Cultivated Crops, 16.8% Forest, 3.6% LD-Residential, 0.7% HD-Residential, 0.1% Commercial, 0.3% Industrial, 0.6% Grass/Pasture, Farmersburg, Active Mining
Soil Drainage Class: 57% Moderately High Runoff Potential, 38% Moderately Low Runoff Potential, 5% Water

# of Samples: 14 total, 4 for metals, 3 dissolved metals
Problems/Exceed Standards: Turbidity (1, April), Ammonia (1, Jan),Total Aluminum (3/4, Aug, Nov , May), Dissolved Al (2/3,Nov & May)
Possible Sources: Ammonia in stream indicates straight piping of raw sewage or presence of livestock/animal feces in stream.

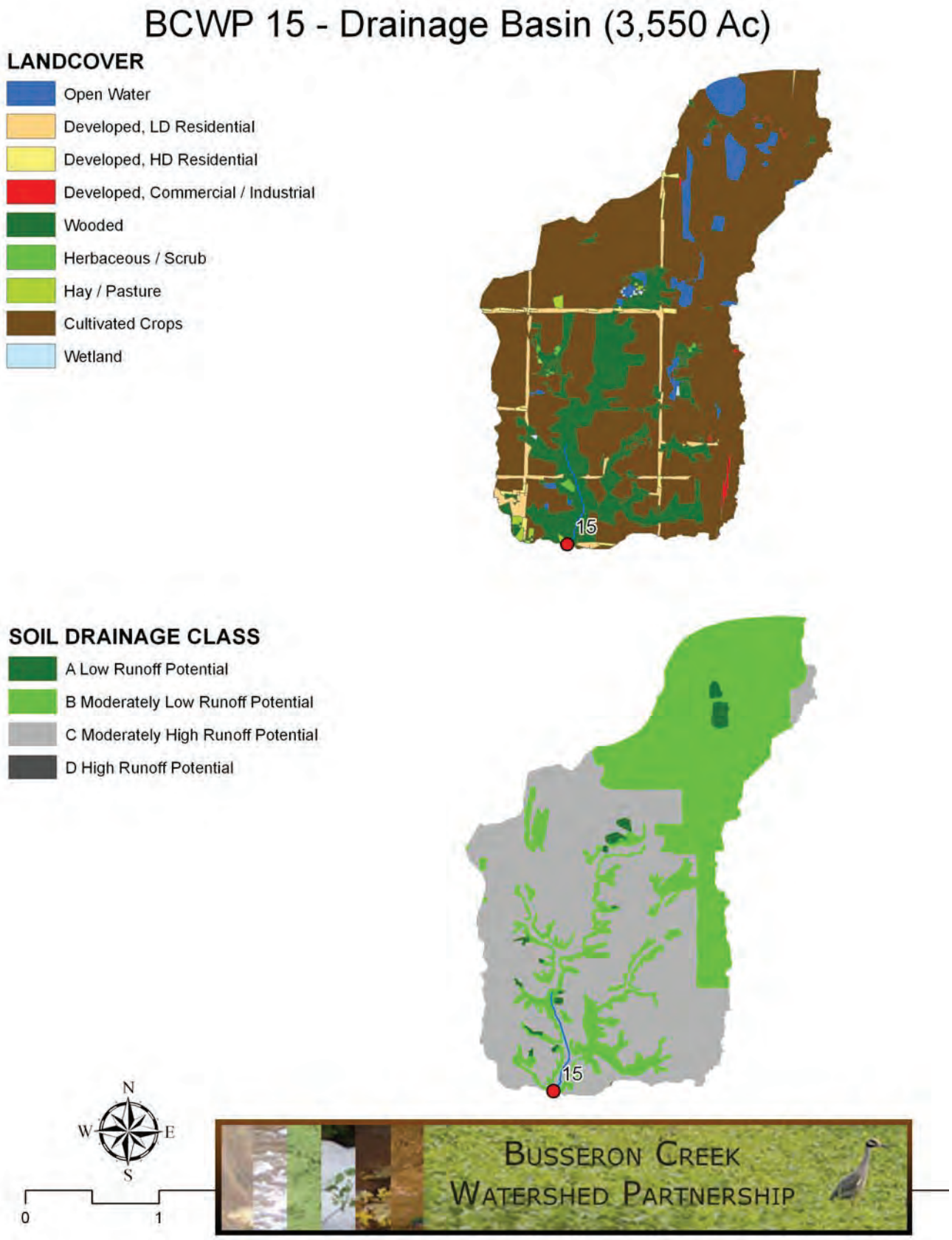

Figure IV-57 - BCWP Sample Site 15 Drainage Basin

(xvi) Site #16

Figure IV-58 - BCWP Sample Site 16 Drainage Basin
Acreage: 6920.0
Land Use: 59% Cultivated Crops, 25.2% Forest, 4.4% LD-Residential, 0.7% HD-Residential, 0.2% Commercial, 0.1% Industrial, 8.3% Grass/Pasture, Active Mining
Soil Drainage Class: 67% Moderately High Runoff Potential, 30% Moderately Low Runoff Potential, 2% Water, 1% High Runoff Potential

# of Samples: 14 total, 4 for metals, 3 dissolved metals
Problems/Exceed Standards: Turbidity (5,July, Feb, April-June),Total Phosphorus (5 Year-round) Total Aluminum (2/4, Feb , May), Dissolved Al (1/3, Feb , May)
Possible Sources: Soil and/or channel erosion.

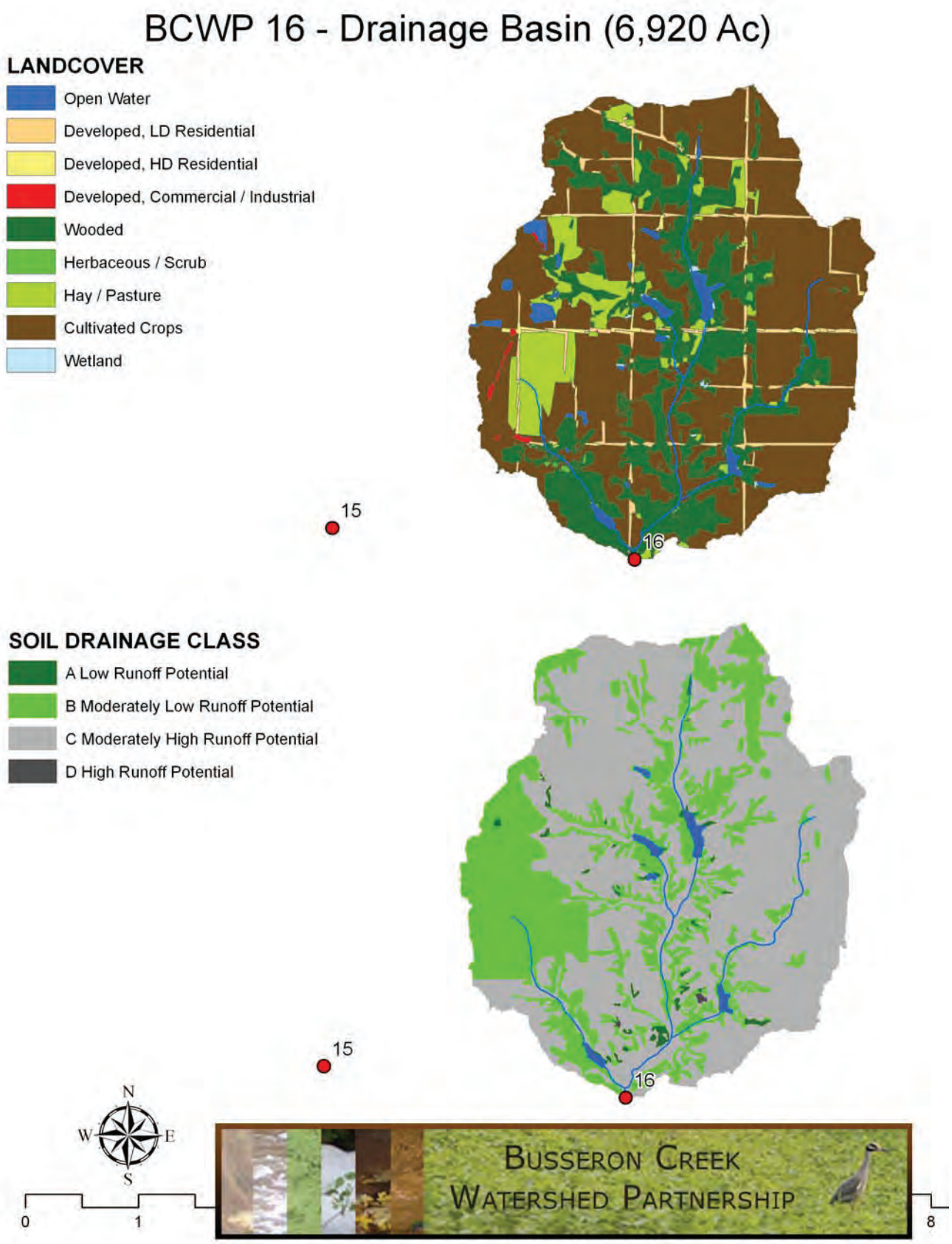

Figure IV-58 - BCWP Sample Site 16 Drainage Basin

(xvii) Site #17

Figure IV-59 - BCWP Sample Site 17 Drainage Basin
Acreage: 10,665.7
Land Use: 57.6% Cultivated Crops, 27.8% Forest, 7.5% Grass/Pasture, 4.7% LD-Residential, 0.6% HD-Residential, 0.1% Commercial, 0.1% Industrial, Active Mining
Soil Drainage Class: 70% Moderately High Runoff Potential, 27% Moderately Low Runoff Potential, 2% Water, 1% High Runoff Potential

# of Samples: 7 total, 2 for metals, 1 dissolved metals
Problems/Exceed Standards: Turbidity (1, Oct),E.Coli (3, Sept-Nov), Total Phosphorus (2 July, Sept), Total Aluminum (1/2,Nov), Dissolved Al (1/1,Nov), Mn Total (1/2, Aug)
Possible Sources: Soil and/or channel erosion. Mining activities could be source of manganese.

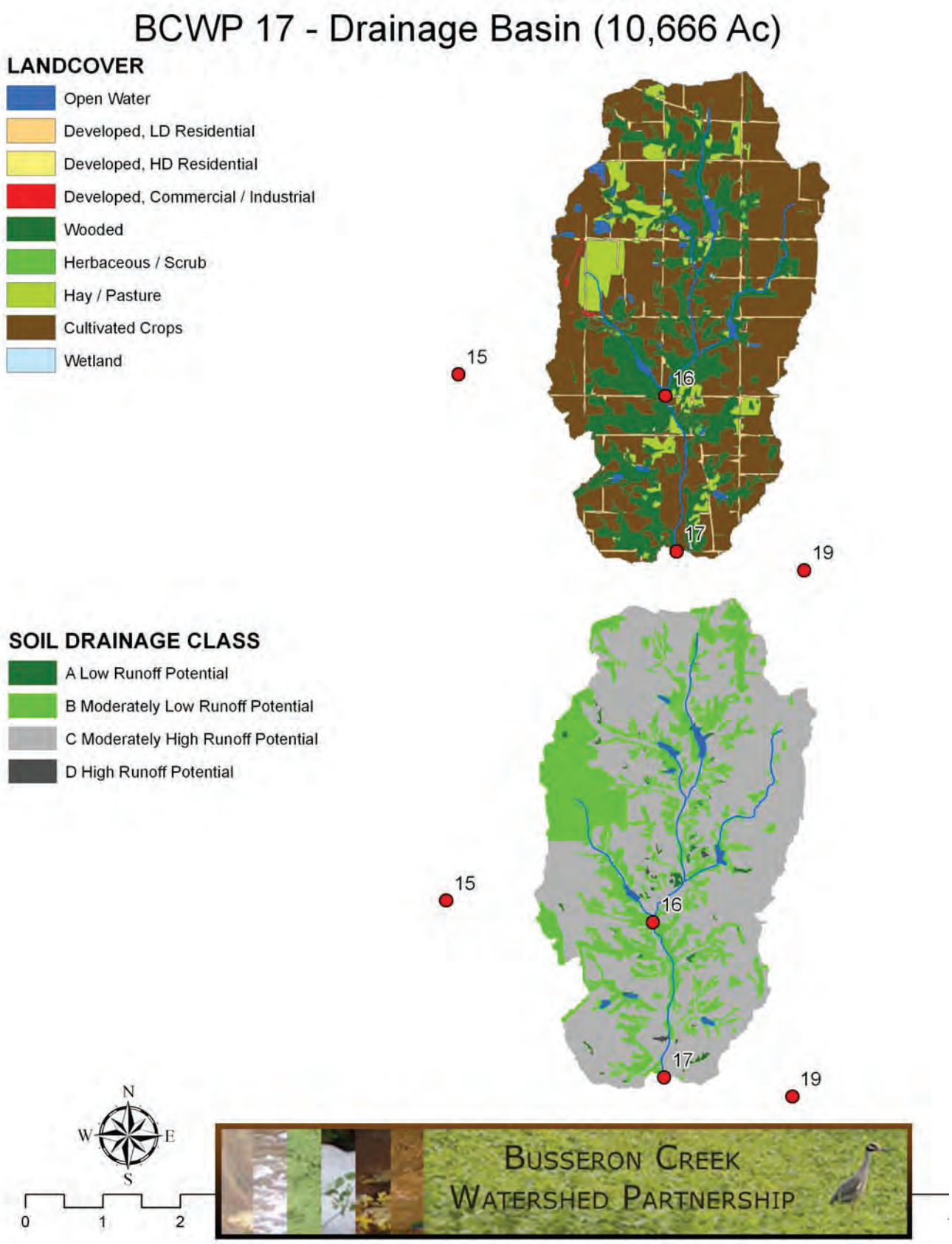

Figure IV-59 - BCWP Sample Site 17 Drainage Basin

(xviii) Site #18

Figure IV-60 - BCWP Sample Site 18 Drainage Basin
Acreage: 7304.4
Land Use: 53% Cultivated Crops, 35% Forest, 5.1% LD-Residential, 0.1% HD-Residential, 5.1% Grass/Pasture, minor abandoned mine land
Soil Drainage Class: 56% Moderately High Runoff Potential, 23% Moderately Low Runoff Potential, 19% High Runoff Potential, 2% Water

# of Samples: 14 total, 4 for metals, 3 dissolved metals
Problems/Exceed Standards: Turbidity (7, Year-round), DO (3 Summer-Fall), E.Coli (5 Spring-Summer-Fall), TSS (1 Aug), Total Phosphorus (7 Year-round), Total Aluminum (2/4, Feb, May), Dissolved Al (2/3,Feb, May), Mn Total (1/4,Nov), Mn Dissolved (1/3, Nov)
Possible Sources: Soil and/or channel erosion problems. Potential septic failure. Abandoned mine lands.

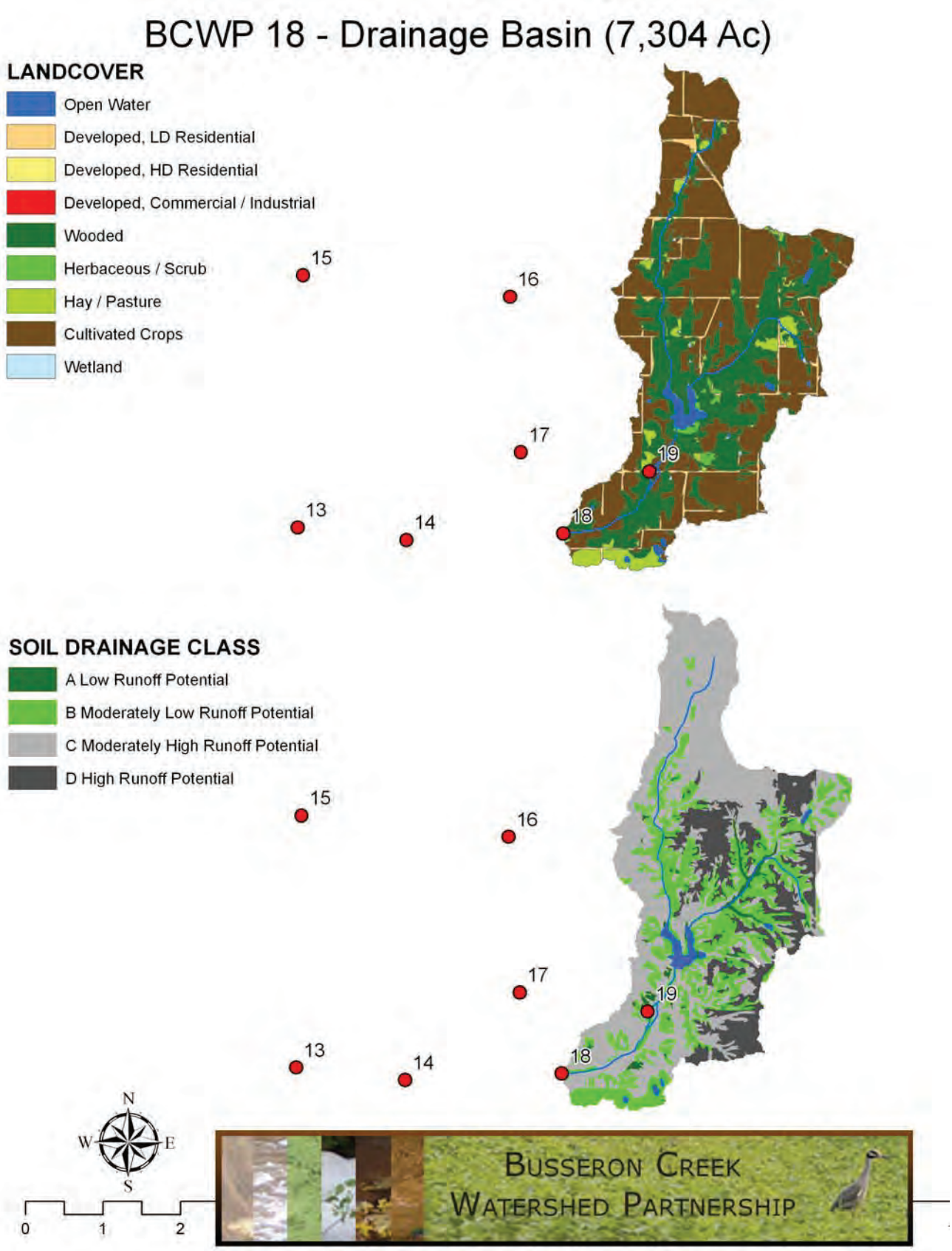

Figure IV-60 - BCWP Sample Site 18 Drainage Basin

(xix) Site #19

Figure IV-61 - BCWP Sample Site 19 Drainage Basin
Acreage: 6301.8
Land Use: 55% Cultivated Crops, 34.3% Forest, 5.2% LD-Residential, 0.2% HD-Residential, 3.7% Grass/Pasture, abandoned mine land
Soil Drainage Class: 56% Moderately High Runoff Potential, 21% Moderately Low Runoff Potential, 21% High Runoff Potential, 2% Water

# of Samples: 14 total, 4 for metals, 3 dissolved metals
Problems/Exceed Standards: Turbidity (8, Year-round), DO (3, Summer-Fall), E.Coli (3, July-Sept), TSS (3, Spring-Summer-Fall), Total Phosphorus (7 Year-round), Total Aluminum (3/4,Aug, Feb, May), Dissolved Al (1/3, May)
Possible Sources: Soil and/or channel erosion problems. Potential septic failure. Abandoned mine lands

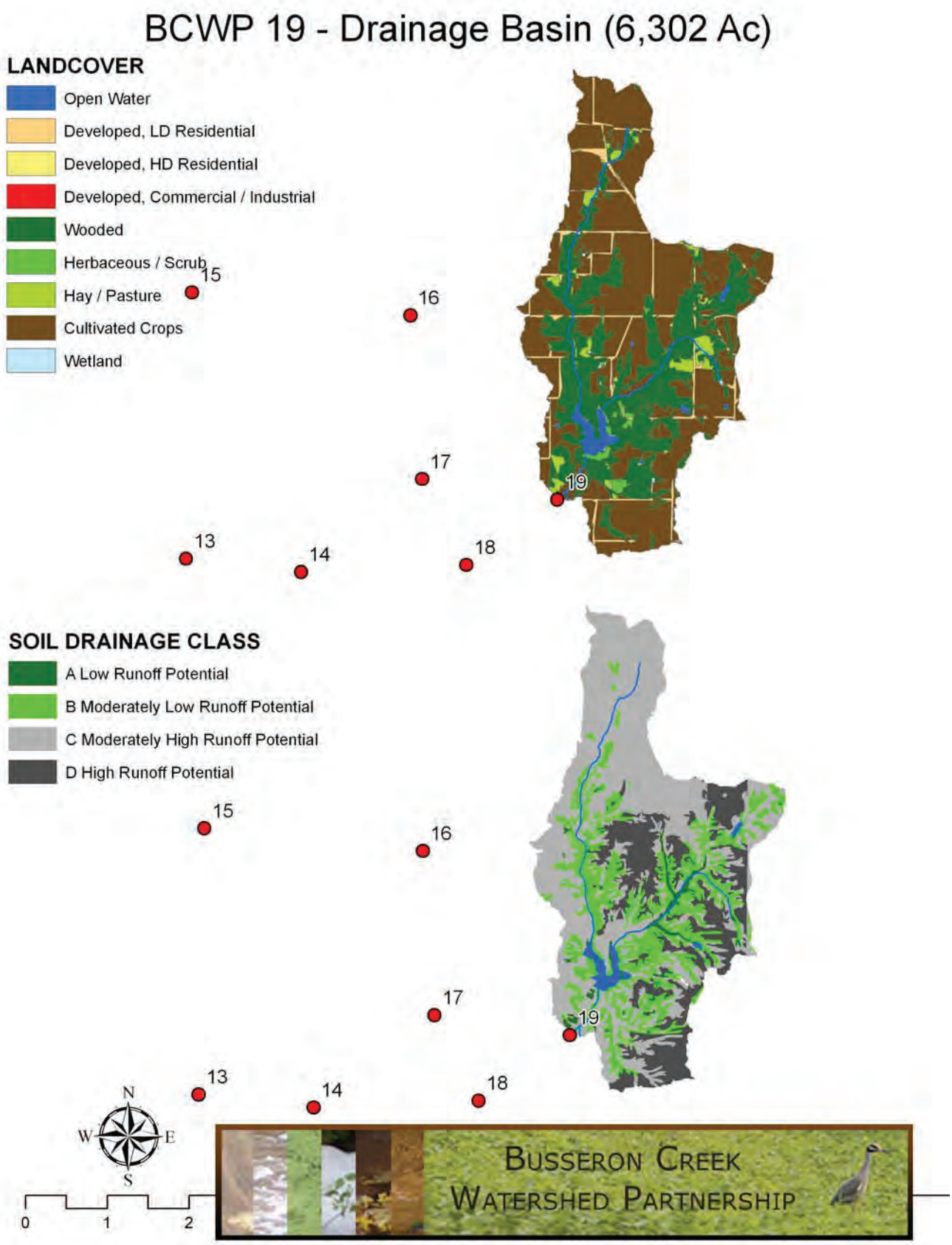

Figure IV-61 - BCWP Sample Site 19 Drainage Basin

(xx) Site #20

Figure IV-62 - BCWP Sample Site 20 Drainage Basin
Acreage: 3845.6
Land Use: 23.6% Cultivated Crops, 56.4% Forest, 5.6% LD-Residential, 1.0% HD-Residential, 4.8% Grass/Pasture, Shakamak State Park, Portion of Jasonville
Soil Drainage Class: 40% Moderately High Runoff Potential, 30% High Runoff Potential, 21% Moderately Low Runoff Potential, 8% Water

# of Samples: 14 total, 4 for metals, 3 dissolved metals
Problems/Exceed Standards: D.O. (1 Oct), E.Coli (3, Aug-Sept), Ammonia (1 July), Total Phosphorous (1, Oct), Total Aluminum (1/4, Feb), Dissolved Al (1/3, May)
Possible Sources: Comparatively healthy site / stream. Possible septic (comparatively minor).

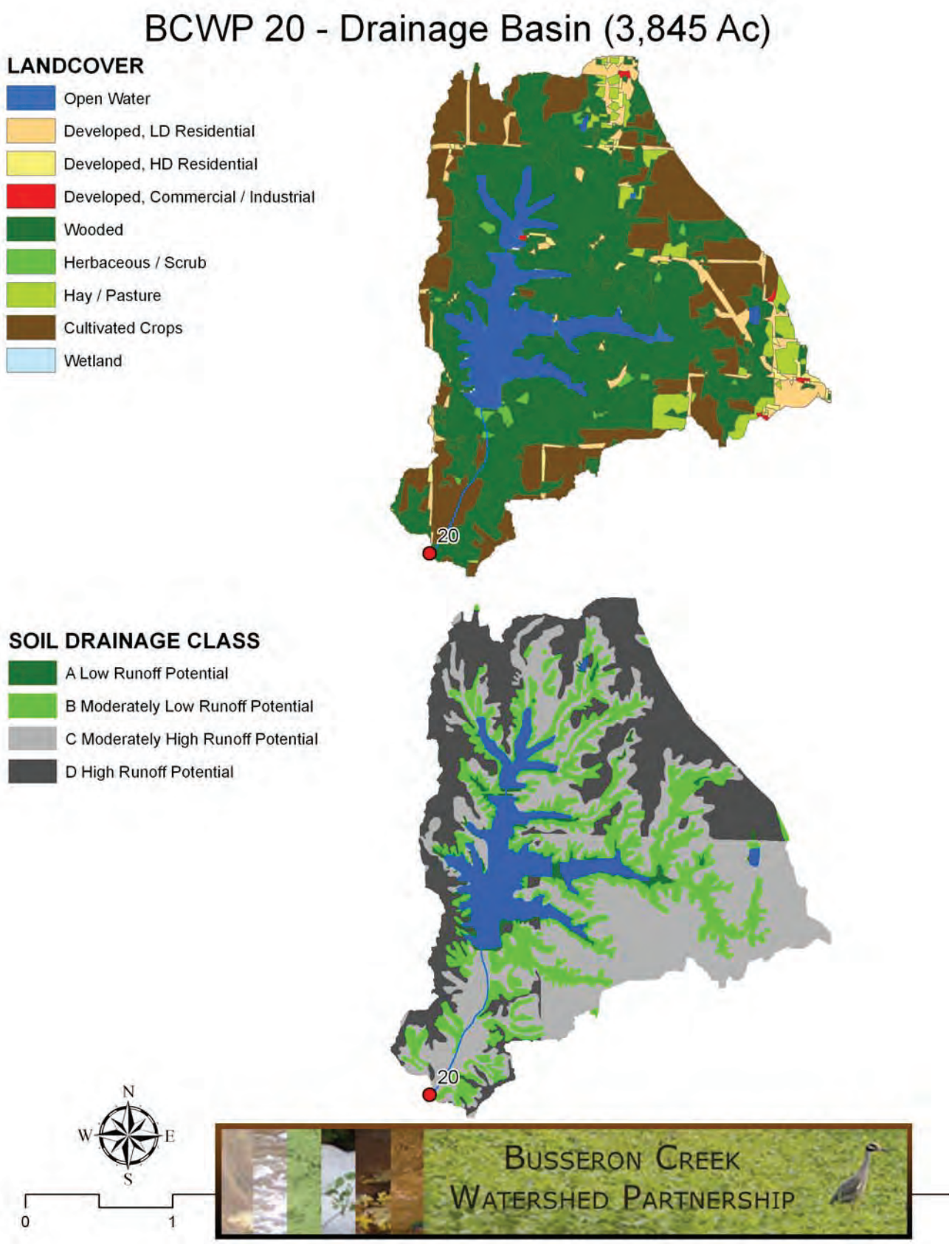

Figure IV-62 - BCWP Sample Site 20 Drainage Basin

(xxi) Sample Site: 21

Figure IV-63 - BCWP Sample Site 21 Drainage Basin
Acreage: 1064.7
Land Use: 91.8% Cultivated Crops, 2.8% Forest, 5.1% LD-Residential, 0.1% HD-Residential, 0.1% Grass/Pasture
Soil Drainage Class: 75% Moderately Low Runoff Potential, 25% Low Runoff Potential

# of Samples: 8 total, 2 for metals, 2 dissolved metals
Problems/Exceed Standards: D.O. (1 June), E.Coli (3, Spring-Summer-Fall), Total Phosphorous (2, April Nov),Nitrate/Nitrite (2, Jan &May) Total Aluminum (1/2, May)
Possible Sources: Nitrogen present due to the conductivity of the soils(i.e. water flows easily through soils). Agricultural land contributes to all values. Use of manure as fertilizer source. Nearby private septic.

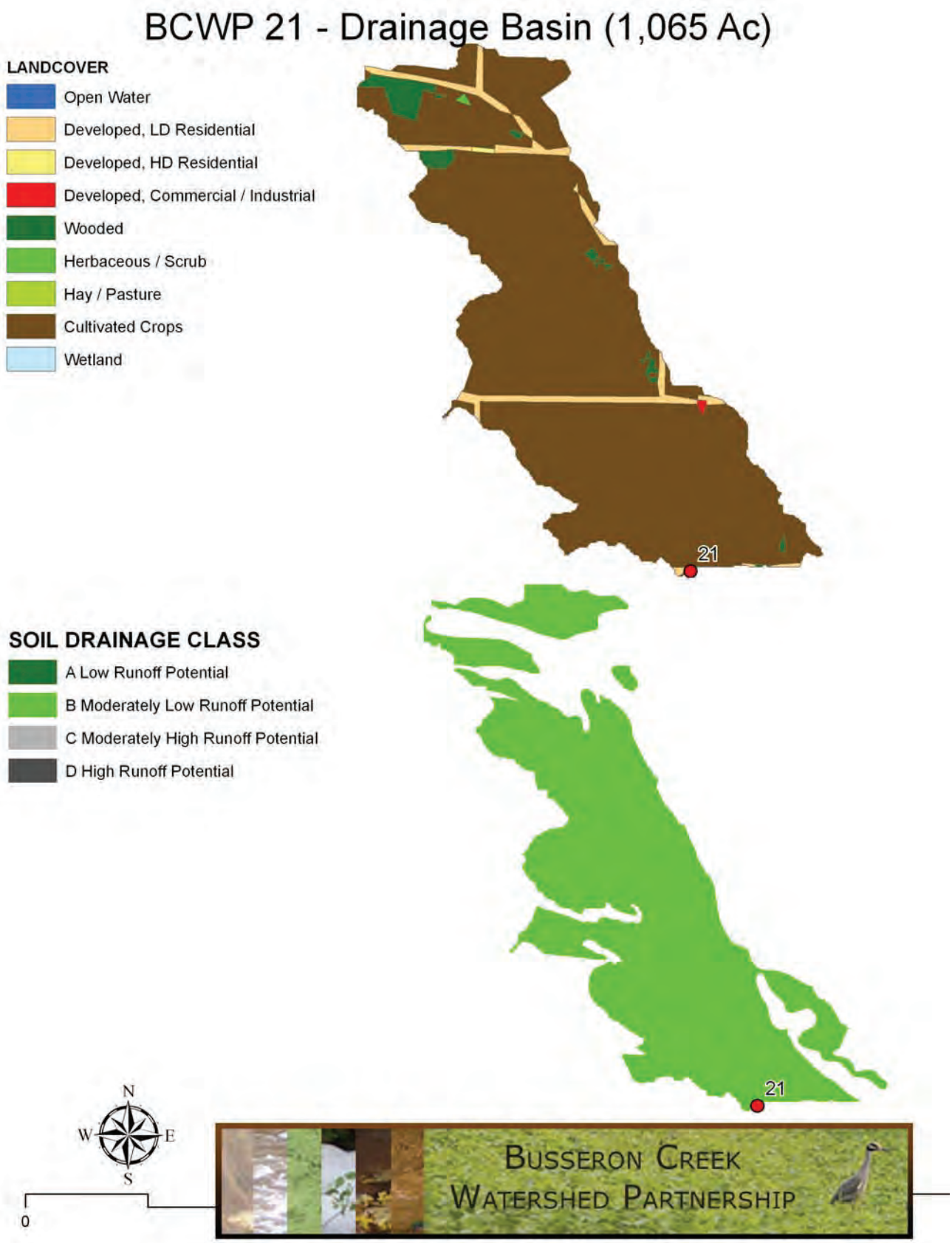

Figure IV-63 - BCWP Sample Site 21 Drainage Basin

(xxii) Site #22

Figure IV-64 - BCWP Sample Site 22 Drainage Basin
Acreage: 11647.3
Land Use: 90.7% Cultivated Crops, 1.6% Forest, 5.1% LD-Residential, 0.1% HD-Residential, 2.1% Grass/Pasture
Soil Drainage Class: 62% Moderately Low Runoff Potential, 21% Low Runoff Potential, 13% Moderately High Runoff Potential, 3% High Runoff Potential

# of Samples: 8 total, 2 for metals, 2 dissolved metals
Problems/Exceed Standards: Turbidity (1 Nov), D. O. (1 June) E.Coli (1, March), Total Phosphorus (2 May-June), Total Aluminum (1/2, May), Dissolved Al (1/2, May)
Possible sources: Agricultural land contributes to all values. Potential loading from Wabash River (back pressure).

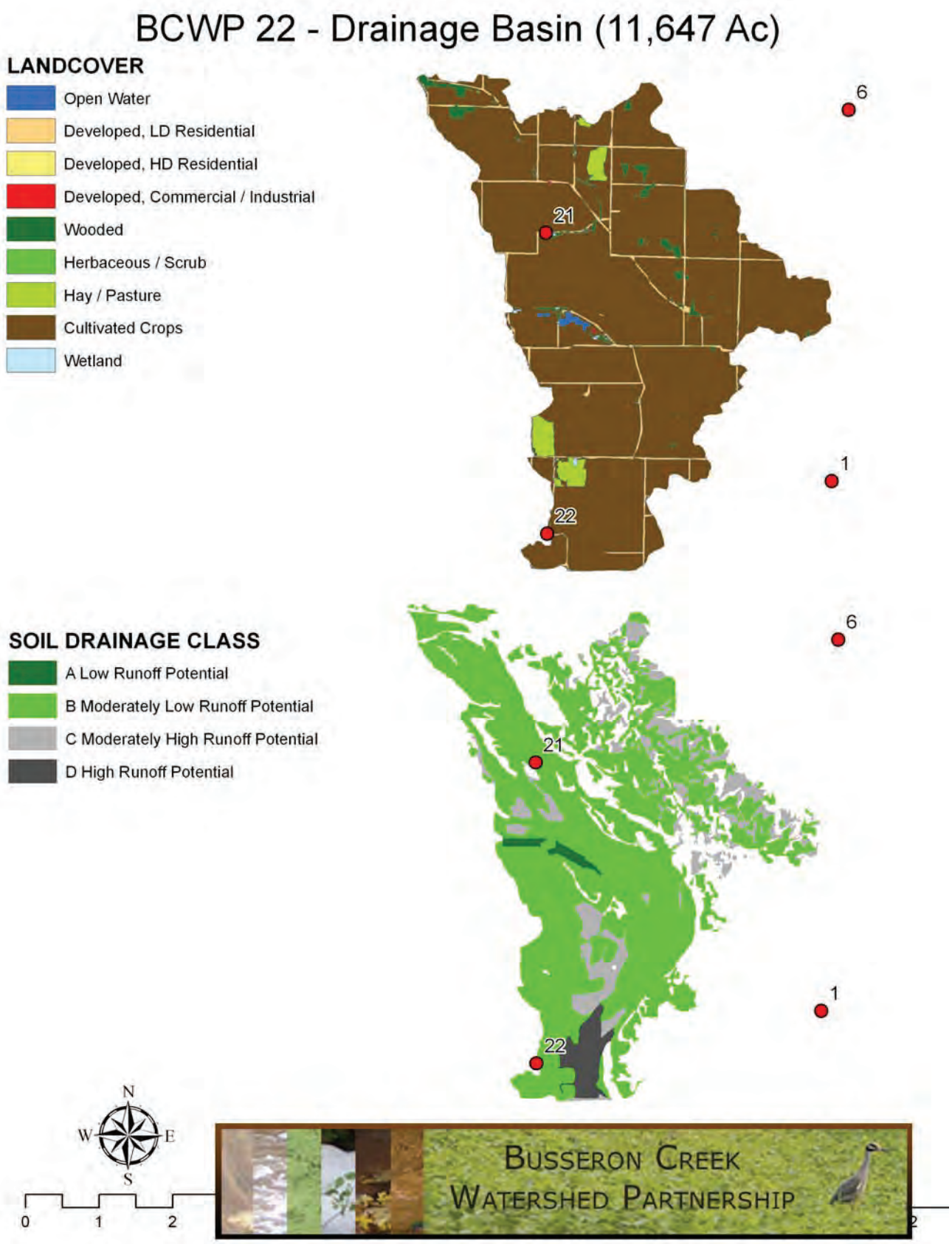

Figure IV-64 - BCWP Sample Site 22 Drainage Basin

(b) BCWP Impairment Summary

Data for all parameters except DO and sediment was compared to standards set forth in Title 327, Article 2 of the Indiana Administrative Code – Water Quality Standards (327 IAC 2). Those standards are further identified in Appendix B, Table XI-A. Most sites exceeded standards for turbidity, phosphorus and aluminum, indicating problems associated with soil erosion and channel stability. Nearly all sites exceeded Indiana water quality standards for E. coli at recreation levels. Sites with high levels of E. coli should be investigated further to determine if source is manure fertilizer or failing septic / straight piping.

Dissolved Oxygen results were compared to 327 IAC 2 standards then were further compared to Indiana averages. Most sites exceeded standards. Nearly all fell below Indiana averages. Results further indicate problems associated with nutrient / E. coli loads combined with low flow.

Parameter Ranking

In order to assist in identification of priority areas and to quickly identify areas that may require additional investigation, each parameter was ranked "Good", "Fair", "Poor", or "Very Poor". (See *Table IV-3 – BCWP Impairments*) Those classifications are discussed further by parameter in the following Sections 4.03 (b) i – xvii.

(i) Tree Canopy

There is no current standard for canopy density. Natural breaks were utilized to develop classification levels.

Classification is based upon average percentage of canopy cover in a 200ft buffer from sample point location.

Good = >25%
Fair = 16% - 24%
Poor = 5% - 15%
Very Poor = <5%

(ii) Citizens Qualitative Habitat Evaluation Index (CQHEI)

Available through Hoosier Riverwatch, the index was developed by the Ohio Environmental Protection Agency as a "Citizens" companion to the Qualitative Habitat Evaluation Index used by the state's professional staff. Data sheets were modified from information provided by the Ohio EPA. The purpose of the index is to provide a measure of the stream habitat and riparian health that generally corresponds to physical factors affecting fish and other aquatic life (i.e. macroinvertebrates). The CQHEI produces a total score that can be used to compare changes at one site over time or compare two different sites.

Classification is based upon CQHEI totals.

Good = >50.0
Fair = 40 - 49
Poor = 20 - 39
Very Poor = <20

(iii) Temperature

From 327-IAC 2-1-6(b):

The following are conditions for temperature:

A. There shall be no abnormal temperature changes that may adversely affect aquatic life unless caused by natural conditions.

B. The normal daily and seasonal temperature fluctuations that existed before the addition of heat due to other than natural causes shall be maintained.

C. The maximum temperature rise at any time or place above natural temperatures shall not exceed:

i. five (5) degrees Fahrenheit (two and eight-tenths (2.8) degrees Celsius) in streams; and

ii. three (3) degrees Fahrenheit (one and seven-tenths (1.7) degrees Celsius) in lakes and reservoirs.

D. Water temperatures shall not exceed the maximum limits in the following table during more than one percent (1%)of the hours in the twelve (12) month period ending with any month. At no time shall the water temperature at such locations exceed the maximum limits in the following table by more than three (3) degrees Fahrenheit (one and seven-tenths (1.7) degrees Celsius):

Month	*Ohio River Main Stem °F(°C)*	*Other Indiana Streams °F(°C)*
January	*50 (10.0)*	*50 (10.0)*
February	*50 (10.0)*	*50 (10.0)*
March	*60 (15.6)*	*60 (15.6)*
April	*70 (21.1)*	*70 (21.1)*
May	*80 (26.7)*	*80 (26.7)*
June	*87 (30.6)*	*90 (32.2)*
July	*89 (31.7)*	*90 (32.2)*
August	*89 (31.7)*	*90 (32.2)*
September	*87 (30.7)*	*90 (32.2)*
October	*78 (25.6)*	*78 (25.5)*
November	*70 (21.1)*	*70 (21.1)*
December	*57 (14.0)*	*57 (14.0)*

No surface water temperature were found to exceed Indiana Water Quality Standards Classification is based upon average June – Sept temperature.

Good = <68°F
Fair = 68°F – 73°F
Poor = <73°F

(iv) Dissolved Oxygen

From 327-IAC 2-1-6(b):

Concentrations of dissolved oxygen shall:

A. average at least five (5.0) milligrams per liter per calendar day; and
B. not be less than four (4.0) milligrams per liter at any time.

Although some site were found to exceed standards, classification is based upon percent changed required to reach Indiana average annual Dissolved Oxygen levels (9.8 mg / L per Hoosier Riverwatch Volunteer Stream Monitoring Training Manual).

Good = <8%
Fair = 8% - 19%
Poor = 16% - 20%
Very Poor = >20%

(v) pH

From 327-IAC 2-1-6(b):

No pH values below (6.0) or above (9.0), except for daily fluctuations that:

A. exceed pH nine (9.0); and
B. are correlated with photosynthetic activity

No BCWP sampling sites exceeded 327-IAC-2-1-6(b). Classification is based upon average pH

Good = <7.0 – 7.6
Fair = >7.6

(vi) Turbidity

Classification is based upon average of April – October sampling events, using the Indiana average as a "Good" rating. (Indiana average = 36 NTU per Hoosier Riverwatch Volunteer Stream Monitoring Training Manual)

Good = <36 NTU
Fair = 37 – 40 NTU
Poor = 41 – 50 NTU
Very Poor = >50 NTU

(vii) Total Suspended Solids

Loads of TSS were developed from BCWP sampling events. Classification is based upon percent reduction required to achieve draft Indiana TMDL target loads of TSS. Allowed annual concentration of TSS is a calculated figure

$$\frac{\text{Flow (L/Year)} * \text{Max. Target (30mg/L)}}{1{,}000{,}000} = \text{Allowed kg / Year}$$

Good = <5%
Fair = 5% – 14%
Poor = 15% – 25%
Very Poor = >25%

(viii) Total Dissolved Solids

From 327-IAC 2-1-6(e):

The concentration of dissolved solids shall not exceed seven hundred fifty (750) milligrams per liter unless due to naturally occurring sources. A specific conductance of one thousand two hundred (1,200) micromhos per centimeter (at twenty-five (25) degrees Celsius) may be considered equivalent to a dissolved solids concentration of seven hundred fifty (750) milligrams per liter.

It should be noted that these standards relate to surface water quality for public water supply. Classification is based upon averages exceeding 500 mg/L TDS.

Good = <500 mg/L TDS
Fair = >500 mg/L TDS

(ix) E. Coli

From 327-IAC 2-1-6(d):

For full body contact recreational uses, E. coli bacteria shall not exceed the following:

A. One hundred twenty-five (125) per one hundred (100) milliliters as a geometric mean based on not less than five (5) samples equally spaced over a thirty (30) day period.

B. Two hundred thirty five (235) cfu or MPN per one hundred (100) milliliters where the:

i. E. coli exceedances are incidental and attributable solely to E. coli resulting from discharge of treated wastewater from a wastewater treatment plant as defined in IC 13-11-2-258; and

ii. Criterion in clause (A) is met.

Classification is based upon a combination of percent reduction required to achieve allowed annual loads of E. coli and percentage of samples exceeding Indiana standards.

Allowed most probable number (MPN) of E. coli colonies is a calculated figure.

$$\text{Flow (L/Year)} * \text{Indiana Standard (235 MPN/L)} = \text{Allowed MPN / Year}$$

Good = No annual load reductions required. <20% of samples exceed standards
Fair = No annual load reductions required. >20% of samples exceed standards.
Poor = <90% annual load reductions required to meet state standards
Very Poor = >90% annual load reductions required to meet state standards

(x) Nitrogen, as NH3

According to 327 IAC 2-1-6 (b), maximum total Ammonia (NH3) is a range between 0.0 and .21 mg/L depending on temperature and pH. Classification is based upon the percentage reduction required to achieve allowed loads of NH3 when samples exceeded Indiana standards.

Allowed concentration of NH3 is a calculated figure.

$$\frac{\text{Flow (L/Day) * Indiana Standard (from table - mg/L based upon pH)}}{1{,}000{,}000} = \text{Allowed kg / Day}$$

Good = < 25%
Fair = 25% - 50%
Poor = 51% - 90%
Very Poor = >90%

(xi) Total Nitrogen

Loading is based upon annual loads from channel erosion, septic sources, and from agricultural practices (including livestock sources) as computed by the Center for Watershed Protection Watershed Treatment Model and STEP-L modeling. Although calculated loads are well within EPA recommended max load of 0.591mg/L Total Kjeldahl Nitrogen, classification rankings were assigned for use in critical area identification.

Allowed annual concentration of TKN is a calculated figure

$$\frac{\text{Flow (L/Year) * EPA standard (0.591 mg/L)}}{1{,}000{,}000} = \text{Allowed kg / Year}$$

N from Ag. Sources (kg / Drainage Area Acre)

> 30.0	Very Poor
25.0 – 30.0	Poor
20.0 – 24.9	Fair
10.0 – 19.9	Good
< 10.0	Very Good

N from Channel Erosion (Tonne Sediment / Mi)

> 100.0	Very Poor
80.0 – 99.0	Poor
65.0 – 79.0	Fair
50.0 – 64.0	Good
< 50.0	Very Good

N from Septic Sources (kg/Drainage Area Acre)

> 10.0	Very Poor
2.5 – 10.0	Poor
1.5 – 2.4	Fair
0.5 – 1.4	Good
< 0.5	Very Good

Classification rankings were then given the following values: 1 = Very Good; 2 = Good; 3 = Fair; 4 = Poor; 5 = Very Poor. The classification rankings were averaged for each sample site and the following classifications assigned:

Good = < 3.0
Fair = 3.0 – 3.9
Poor = 4.0 – 4.5
Very Poor = > 4.5

(xii) Total Phosphorus

According to the Indiana Department of Environmental Website, the US EPA recommendation for maximum Phosphorus loading is 0.076 mg/L. Classification is based upon percent reduction required to achieve those recommendations for annual loads of Phosphorus

Allowed annual concentration of P is a calculated figure.

$$\frac{\text{Flow (L/Year) * EPA Recommendation (0.076 mg/L)}}{1{,}000{,}000} = \text{Allowed kg / Year}$$

Required reductions were then weighted by percentage of samples exceeding EPA recommendations.

% Exceedence * % Required Reduction = Ranked Reduction

Good = < 10%
Fair = 10% - 100%
Poor = 101% - 200%
Very Poor = > 200%

(xiii) Aluminum

Target values of 0.174 mg/L is a numeric criterion developed by IDEM following the process explained in 327 IAC 2-1-8. Details may be found in the Busseron Creek Watershed Draft TMDL report developed by IDEM and dated September 2008.

Classification is based upon percent reduction required to achieve targeted annual loads of Aluminum.

Allowed annual concentration of Al is a calculated figure.

$$\frac{\text{Flow (L/Year) * Draft Indiana TMDL target (0.174 mg/L)}}{1{,}000{,}000} = \text{Allowed kg / Year}$$

Good = < 10%
Fair = 10% - 100%
Poor = 101% - 200%
Very Poor = > 200%

(xiv) Iron

Target values of 2.5 mg/L is a numeric criterion developed by IDEM following the process explained in 327 IAC 2-1-8. Details may be found in the Busseron Creek Watershed Draft TMDL report developed by IDEM and dated September 2008.

Classification is based upon percent reduction required to achieve targeted annual loads of Iron.

Allowed annual concentration of Fe is a calculated figure.

$$\frac{\text{Flow (L/Year) * Draft Indiana TMDL target (2.5 mg/L)}}{1{,}000{,}000} = \text{Allowed kg / Year}$$

Good = No reductions required
Fair = No reductions required, some samples exceeded standards
Poor = <10% reduction required
Very Poor = > 10% reduction required (one site classified VP, 41% reduction required)

(xv) Copper

According to 327 IAC 2-1-6 (a), Table 6-2, the allowed concentration of Cu (Chronic Acute Criteria) is a calculated figure:

Chronic Acute Criteria for Cu (µg/L) = e[0.8545 * {LN (hardness)} - 1.465] * .96

No samples exceeded Indiana standards

(xvi) Manganese

According to 327 IAC 2-1-6 (a), Table 6-2, the allowed concentration of Mn (Chronic Acute Criteria) is a calculated figure:

Chronic Acute Criteria for Mn (µg/L) = e[0.8784 * {LN (hardness)} + 2.226]

Five sites exceeded standards, but, based upon average loads for those sites, no reductions are required.

Table IV-3 – BCWP Impairments

Site No.	Stream	Subwatershed	12-Digit HUC	Parameter															
				Tree Cover	CQHEI	Temperature	Dissolved Oxygen	pH	Turbidity	Total Suspended Solids	Total Dissolved Solids	E. Coli	Nitrogen, as NH3	Total N, from CWP Model	Total P	Aluminum	Iron	Copper	Manganese
1	Tanyard Branch	Tanyard Branch - Busseron Creek	051201111512	○			○					●			○				
2	Bear Run	Middle Fork Creek	051201111510	●	○		○		●			■		●	○	■			
3	Unnamed Tributary to Middle Fork Creek	Middle Fork Creek	051201111510	●		○	○					●				●			
4	Middle Fork Creek	Middle Fork Creek	051201111510	○	○		○		■	■	○	●			○	●	●		○
5	Robbins Branch	Buck Creek - Busseron Creek	051201111509	●	●		■		■			■	■		■	■	■		○
6	Unnamed Tributary to Busseron Creek	Tanyard Branch - Busseron Creek	051201111512	●	●							■	●	○	■				
7	Unnamed Tributary to Buck Creek	Buck Creek - Busseron Creek	051201111509	○		○	●		●	●		○	■	●	●	●			
8	Buck Creek	Buck Creek - Busseron Creek	051201111509	■	●	●	●		■			■	●	○	●	■	○		
9	Buck Creek	Buck Creek - Busseron Creek	051201111509	○		○	■		■			●		○	■	●	○		
10	Kettle Creek	Kettle Creek - Busseron Creek	051201111506			○	●		○				■	○	●				
11	Kettle Creek	Kettle Creek - Busseron Creek	051201111506	■		○								○	■	○			
12	Unnamed Tributary to Busseron Creek	Sulphur Creek - Busseron Creek	051201111505			○	●					○		●	○	■	●		○
13	Unnamed Tributary to Busseron Creek	Sulphur Creek - Busseron Creek	051201111505	●	●	○	■				○	■	■	■	●	●	○		
14	West Fork Busseron Creek	West Fork Busseron Creek	051201111502	●		●		○			○	●				●			
15	West Fork Busseron Creek	West Fork Busseron Creek	051201111502			●		○					■	○		○			
16	Busseron Creek	Chowning Creek-Busseron Creek	051201111501	○		●		○						○					
17	Busseron Creek	Chowning Creek-Busseron Creek	051201111501	●	■	○	●					■							○
18	East For Busseron Creek	Chowning Creek-Busseron Creek	051201111501	●	●	○	■		●			○		○	○	○			
19	East For Busseron Creek	Chowning Creek-Busseron Creek	051201111501	○		○	○		●			○		○	○	■			○
20	Big Branch Creek	Headwaters Big Branch	051201111503			○						○	■			●			
21	Rogers Ditch	Rogers Ditch	051201111511	■	■	○						○		●	○	●			
22	Rogers Ditch	Rogers Ditch	051201111511	■	●			○						■	○				

Good	
Fair	○
Poor	●
Very Poor	■
Not sampled	*

4.04 Benchmark Water Quality Summary

As a cholesterol test is used by physicians in the identification and monitoring of heart disease, a water quality benchmark can be used to identify concerns. It can also be used as a measuring stick for water quality improvements.

Information from 2000 Source Identification Study (IDEM); 2008 TMDL (IDEM); NPDES violation data; BCWP sampling events, modeling of nutrient loads, habitat assessments, windshield surveys, and analysis of geo-referenced landuse and tree cover data (See Sections 4.01-4.04) were compiled as a benchmark for water quality. The benchmark summary is presented in Sections 4.05(a) through 4.05(l) on a subwatershed basis. These impairments are further discussed in Section V as they relate to source concerns. This assessment was also utilized as part of the critical area identification process (Section VI). See *Table VI-2 – Parameter-based Critical Watersheds*, page 197 for matrix impairment classifications.

As best management practices are implemented, comparison of post-BMP sampling and surveys will provide a means of quantifying water quality improvements in these Subwatersheds. (See Section IX, Monitoring)

(a) Chowning Creek – Busseron Creek (HUC 051201111501)

Chowning Creek is highly impaired for, E. coli and impaired for sediment, dissolved oxygen, nitrogen, phosphorus and aluminum. Habitat quality is fair as is temperature, and turbidity. Total suspended solids, pH, dissolved solids and iron are good.

(b) West Fork Busseron Creek (HUC 051201111502)

West Fork Busseron Creek is highly impaired for E. coli and dissolved oxygen. It is impaired for nitrogen, phosphorus and aluminum. Habitat quality is fair as are temperature, pH, total suspended solids, and sediment. Turbidity, total dissolved solids, and iron are good.

(c) Headwaters Big Branch (HUC 051201111503)

The Headwaters of the Big Branch is impaired for dissolved oxygen, turbidity, and total suspended solids. Temperature is fair as is E. coli. Total dissolved solids, nitrogen, phosphorus, metals, sediment, and pH are good as is habitat quality.

(d) Mud Creek - Big Branch (HUC 051201111504)

The Mud Creek area is highly impaired for pH, turbidity, total suspended solids, and aluminum. It is impaired for dissolved oxygen, total dissolved solids, and iron. Sediment is fair. Temperature, levels of nitrogen, phosphorus, and habitat quality are good.

(e) Sulfur Creek – Busseron Creek (HUC 051201111505)

The Sulfur Creek area is highly impaired for dissolved oxygen, pH and aluminum. It is impaired for turbidity, total suspended solids E. coli, and iron. Total dissolved solids, sediment, nitrogen, and phosphorus levels are fair. Temperature and wildlife habitat are good.

(f) Kettle Creek – Busseron Creek (HUC 051201111506)

The Kettle Creek area is highly impaired for iron and impaired for dissolved oxygen, E. coli, and nutrients (both N and P). Habitat quality, total suspended solids, total dissolved solids, sediment, and aluminum are fair. Temperature, pH, and turbidity are good.

(g) Buttermilk Creek (HUC 051201111507)

Habitat quality, dissolved oxygen, turbidity, total dissolved solids, sediment, phosphorus, and nitrogen levels are fair. Temperature, pH, total suspended solids, and metals are good.

(h) Morrison Creek – Busseron Creek (HUC 051201111508)

The Morrison Creek area is highly impaired for iron and it is impaired for habitat quality, dissolved oxygen, E. coli, and nitrogen levels. Total suspended solids, pH, phosphorus, and sediment levels are fair. Temperature, turbidity, total dissolved solids, and aluminum levels are good.

(i) Buck Creek – Busseron Creek (HUC 051201111509)

The Buck Creek area is highly impaired for E. coli, dissolved oxygen, and aluminum. It is impaired for phosphorus, nitrogen, total suspended solids, and habitat quality. Temperature, turbidity, sediment, and iron are fair. Total dissolved solids and pH are good.

(j) Middle Fork Creek (HUC 051201111510)

Middle Fork Creek area is highly impaired for E. coli and impaired for habitat quality, sediment, nitrogen, phosphorus, and levels of aluminum. Dissolved oxygen, turbidity, and iron levels are fair. Temperature, pH, total suspended solids and total dissolved solids are good.

(k) Rogers Ditch (HUC 051201111511)

Rogers Ditch is impaired for nitrogen, phosphorus, aluminum, sediment and habitat quality. E. coli and dissolved oxygen levels are fair. Temperature, pH, turbidity, total suspended solids, total dissolved solids, and iron levels are good.

(l) Tanyard Branch – Busseron Creek (HUC 051201111512)

The Tanyard Branch area is highly impaired for turbidity and sediment. It is impaired for habitat quality, E. coli, phosphorus and nitrogen. Dissolved oxygen and total dissolved solids levels are fair. Temperature, pH, total suspended solids, iron, and aluminum levels are good.