BIG DRY CREEK

STATE OF THE WATERSHED

Annual Newsletter of the Big Dry Creek Watershed Association

December 2016 Volume 18

Big Dry Creek 2015 Water Quality and Biological Monitoring Review

A key focus of the Big Dry Creek Watershed Association (BDCWA) is annual assessment of water quality conditions in Big Dry Creek. In the spring of each year, BDCWA uploads the results of the instream water quality monitoring program into a long-term water quality database and compares the results to applicable water quality standards for Big Dry Creek. Findings are documented in an annual water quality report that is presented and discussed at the March BDCWA public meeting and then posted to the BDCWA website.

Biennially, biological monitoring is also conducted at a subset of the water quality monitoring sites. The most recent round of biological monitoring, which is conducted by Aquatics Associates, occurred during October 2016.

This brief article highlights some of the key findings of the 2015 water quality analysis and biological monitoring program, based on analysis of the data completed during 2016.

In 2015, water quality samples were collected and analyzed for a variety of constituents. Metals were monitored on a quarterly basis. All other constituents were monitored on a monthly basis. BDCWA communities also fund operation of the U.S. Geological Survey (USGS) gauging station at Westminster behind Front Range Community College.

Key findings and recommendations regarding Big Dry Creek water quality and aquatic life conditions based on analysis of the 2015 data set include:

1. Water quality in Big Dry Creek attained currently applicable stream standards, with the exception of *E. coli* and iron.

2. *E. coli* concentrations are elevated at multiple instream locations, with the highest concentrations present at bdc3.0 at I-25 below the Westminster wastewater treatment facility (WWTF) discharge and at bdc6.0 in the lower agricultural area. *E. coli* concentrations

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Big Dry Creek below Standley Lake on a winter day.

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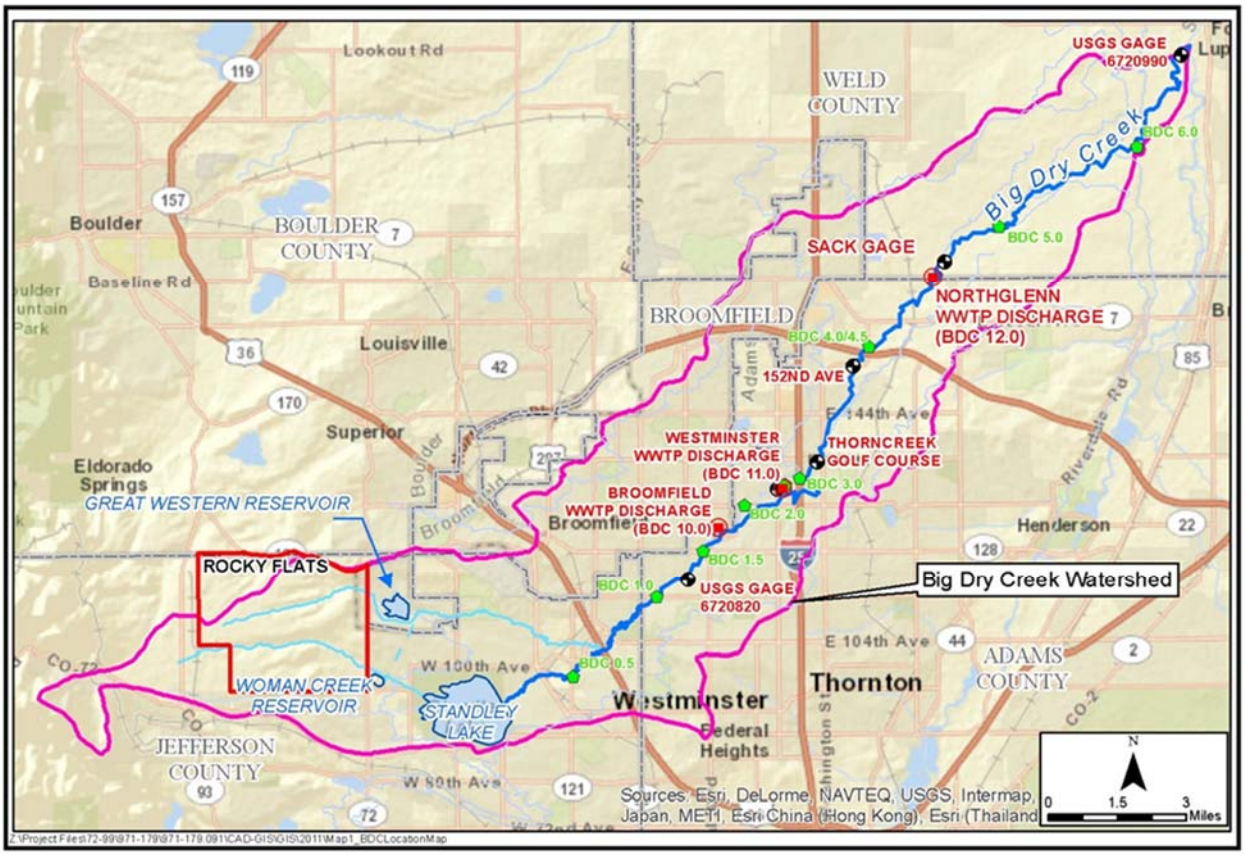
All Watershed Association general membership meetings are open to the public.

Meetings are generally held on a quarterly basis in March, June, September and December.

For More Information on the Next Watershed Meeting, contact Jane Clary: 303-480-1700 or visit our website: www.bigdrycreek.org

The Big Dry Creek Watershed Association is a 501(c)(3) corporation.



(Big Dry Creek 2015 Water Quality Review, Continued from page 1)

in the WWTF discharges are very low and do not exceed stream standards.

3. Although total recoverable iron samples collected and analyzed by BDCWA show attainment of the total recoverable iron standard at all monitoring locations, additional data collected by Metro Wastewater in the lower watershed show elevated iron concentrations. For this reason, Big Dry Creek below Weld County Road 8 is listed as impaired on the 2016 303(d) List. Elevated iron concentrations are expected to be due to stream bank and soil erosion in the lower watershed.

4. For the most recent five-year analysis period (2011-2015), Big Dry Creek attained its site-specific selenium standard. In 2016, the stream was removed from the 303(d) List of impaired waters for selenium.

5. Big Dry Creek does not attain the instream nitrogen and phosphorus "interim values" below WWTF discharges (from the Broomfield WWTF to the South Platte River). Although these values are not be expected to be adopted as stream standards on the main stem of Big Dry Creek prior to 2022, addressing nutrient sources on Big Dry Creek should be an increasing area of focus for BDCWA. More stringent CDPS permit limits are expected in the forthcoming permit renewal for the WWTFs.

6. Phosphorus concentrations and loads to Big Dry Creek have decreased over time as a result of treatment plant upgrades at the Broomfield and Westminster WWTFs, along with reuse programs that continue to be implemented at these WWTFs. Despite these improvements, the stream would not meet the interim total phosphorus criteria (potential future standard) from below the Broomfield WWTF to the confluence with the South Platte River.

7. Big Dry Creek currently attains aquatic life uses, based on calculation of MMI scores in accordance with Colorado's Aquatic Life Use Attainment Policy 10-1. Scores were calculated at six biological monitoring locations for fall monitoring conducted during 2008, 2010, 2012 and 2014. MMI scores vary substantially, both temporally and spatially. Biological monitoring was also conducted in the fall of 2016, with analysis of findings expected in 2017.

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8. Stream flows and WWTF discharges were relatively elevated during 2015. Stream flow is a significant factor influencing pollutant loads. For example, phosphorus loading was higher in 2015 due to these increased flows, despite phosphorus concentrations remaining relatively constant.

During 2017, BDCWA plans to continue its instream monitoring program. The City and County of Broomfield is also developing a monitoring program for *E. coli* using advanced molecular (DNA) methods on a targeted reach of stream in an effort to better identify sources of *E. coli* loading to Big Dry Creek.

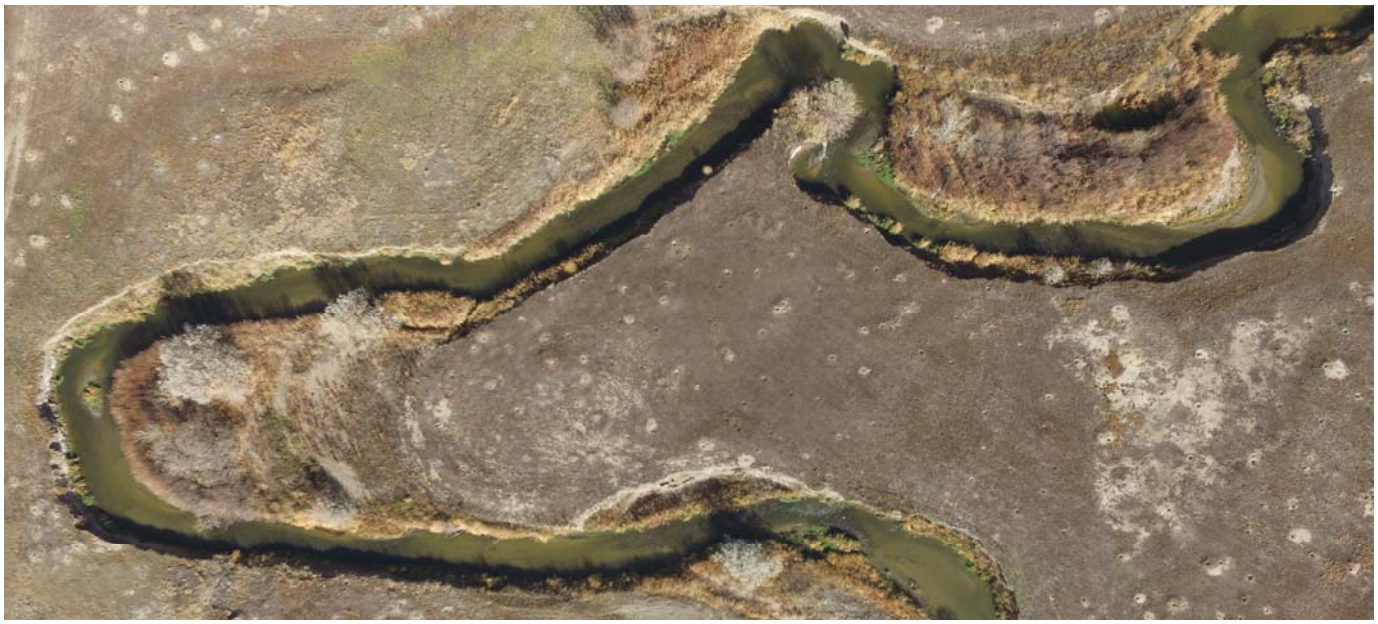
For a complete copy of the 2015 Annual Report, please visit http://www.bigdrycreek.org/.

Thornton and Adams County Come Together for Master Plan Development

The City of Thornton and Adams County are partnering to develop a master plan for publicly-owned open space in the Big Dry Creek corridor between Interstate 25 and 160th Avenue. The Big Dry Creek Recreation and Restoration Master Plan will include an assessment and evaluation of the biological, hydraulic, geomorphic, and open space resource values of Big Dry Creek to provide recreation and conservation opportunities, with a prioritized plan of action for restoration of the creek corridor through Thornton and unincorporated Adams County. Big Dry Creek provides outstanding opportunities for passive recreation and wildlife habitat and almost 300 acres of open land in the corridor have been preserved by Thornton and Adams County. Continuity of the open space corridor between Westminster's open space and Thornton/Adams County is a significant ecological and recreational benefit.

A floodplain restoration Pilot Project is being identified during the master planning process. This project will be designed and constructed following the completion of the Master Plan. For more information please contact Paula Schulte at Paula.Schulte@cityofthornton.net

New open space acquisition in Thornton and Adams County.



Aerial view of Big Dry Creek by drone in a candidate pilot project area where erosion and extreme meanders are present.

The CLEAN Center
Center for Comprehensive, OptimaL and Effective Abatement of Nutrients
Colorado State University

CLEAN Center Case Study: Big Dry Creek Watershed Integrated Nutrient Management Analysis

BDCWA is participating in a major research project with Colorado State University (CSU) researchers focused on watershed-scale nutrient reduction strategies. As part of this participation, BDCWA and Urban Drainage and Flood Control District have supported a special project related to characterization of nutrient loading from channel erosion. Dr. Brian Bledsoe and Ph.D. candidate Rod Lammers have led this effort. This article provides an interim update on study progress as of December 2016, with additional findings anticipated in 2017.

Fluvial Instability and Riparian Degradation

The purpose of this project is to evaluate the contribution of stream erosion to the overall nutrient budget of watersheds. Preliminary analysis was performed for the Big Dry Creek watershed, which has a history of channel instability and incision, likely increasing nutrient loading by contributing sediment bound phosphorus from channel erosion. Given that the South Platte watershed has significant nutrient issues, and the rollout of statewide in-stream nutrient criteria, examining this previously neglected source is an essential part of an overall nutrient reduction strategy. Additionally, mitigating excessive channel erosion via stream restoration may be a more cost-effective nutrient management strategy than, for example, upgrading wastewater treatment facilities after a certain level of treatment has been implemented at these facilities.

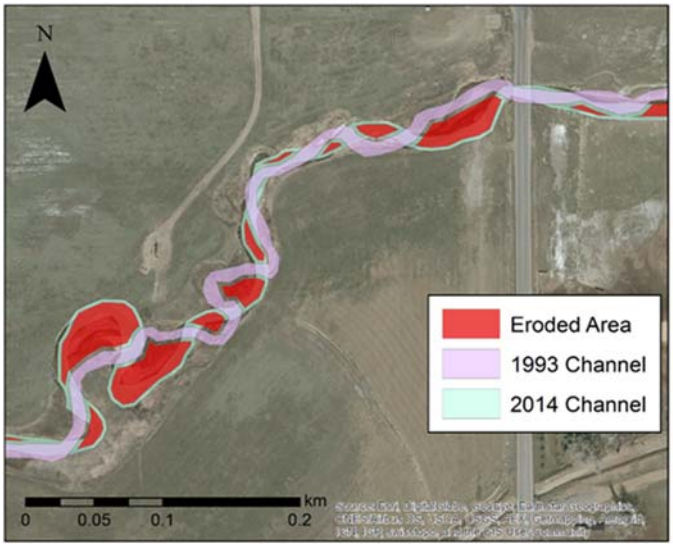


Figure 1. *An example of the satellite imagery analysis showing the channel location in 1993 and 2014 as well as the area of eroded channel over this time period.*

Methods of Analysis

CSU researchers are working to estimate current and historic phosphorus loading from bank erosion in Big Dry Creek. To quantify recent phosphorus loading rates from bank erosion, researchers performed an analysis of channel change using satellite imagery. Researchers digitized the stream channel from 1993 and 2014 images, allowing them to estimate eroded areas based on channel changes over this time period (Figure 1). These eroded areas were converted to volumes of eroded sediment by multiplying by the bank heights. Phosphorus loading was then estimated by multiplying these volumes by the phosphorus concentration of the bank soil. Bank heights and bank soil phosphorus data were collected in the field at representative points along the entire length of Big Dry Creek. Researchers then used these results to estimate potential phosphorus loading reductions if strategic bank stabilization was applied. To do this, researchers assumed significant areas of bank erosion would be stabilized, largely eliminating the sediment and phosphorus loading from these areas.

Preliminary Results

This bank erosion analysis suggests that this source accounts for an average of ~10% of the total annual phosphorus load in Big Dry Creek (~7,500 lb/yr from bank erosion compared to a total loading of ~750,000 lb/yr). However, the relative percentage attributed to bank erosion has increased in recent years due to a reduction in phosphorus loading from WWTFs. Although bank erosion is not a “huge” contribution, it is still a significant source of phosphorus in this watershed. The phosphorus loading from bank erosion can also be separated into components for the upper (urban land use) and lower (agricultural land use) portions of the watershed. This allows for more direct comparison with urban stormwater and agricultural non-point sources. The results were similar, but bank

Channel evolution in the agricultural area of Big Dry Creek.

erosion in the agricultural portion of the watershed contributed slightly more phosphorus than the urban area.

CSU researchers also calculated the impacts of bank stabilization targeted to the areas with maximum erosion. Restoring ~30% of the eroding bank length (~3.6 miles) reduced loading rates from bank erosion by ~60% (Figure 2). This high nutrient load reduction is predicted because researchers assumed stabilization would occur on the banks with the greatest erosion. If stabilization was applied more randomly, the associated nutrient reduction benefit would be less. There is a certain amount of uncertainty associated with these results. First, the satellite imagery analysis only takes into account lateral channel adjustment; channel incision, or erosion of the bed, is not accounted for which could underestimate nutrient loading. Conversely, there is also no accounting for deposition and storage of eroded bank sediment, which could reduce the total load that ends up influencing water quality. Furthermore, the restoration scenario assumes bank stabilization completely eliminates bank erosion which may not be realistic.

Next Steps

While this analysis provided an estimate of historic erosion rates (from 1993-2014), CSU researchers are also interested in how the channel will change in the future. To address this, researchers are working to develop a model that will predict how the stream channel will evolve in the future and what magnitude of phosphorus loading researchers may expect from the eroding channel. It is also important to note the linkages between channel erosion and stormwater management practices, such as those recommended by the Urban Drainage and Flood Control District in its *Urban Storm Drainage Criteria Manual*.

As urbanization continues in the Big Dry Creek watershed, the channel will continue to evolve as it adjusts to changes in flow and sediment inputs over time. Adequate stormwater infrastructure that minimizes hydrologic alteration may limit future channel changes. Additionally, bank stabilization effectiveness is also influenced by stormwater management practices that manage flow frequencies and durations in addition to flow magnitudes.

During 2017, CSU researchers will provide a final update to BDCWA on the results of their study. For additional information on the CSU CLEAN Center, see https://erams.com/clean/.

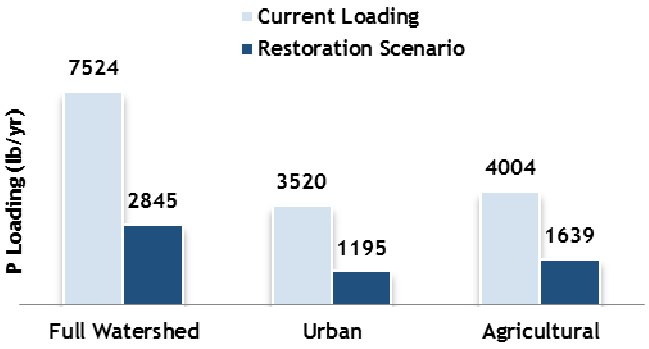


Figure 2. Phosphorus loading rates from bank erosion for the full watershed, urban portion, and agricultural portion under current conditions and a simulated restoration scenario.

Big Dry Creek *E. coli* Total Maximum Daily Load

In August 2016, the Colorado Water Quality Control Division (Division) finalized an *Escherichia coli* (*E. coli*) Total Maximum Daily Load (TMDL) for the main stem of Big Dry Creek. BDCWA participated in several meetings related to development of the TMDL and also provided comments on the TMDL during public notice during the summer of 2016. The purpose of the TMDL is to identify bacteria load reductions necessary for the creek to attain its "potential primary contact" recreational use standard of 205 cfu/100 mL for *E. coli*. *E. coli* is used as an easily-measured indicator for fecal contamination, but it is not necessarily disease-causing (unlike pathogenic *E. coli* O157:H7). Sources of *E. coli* may include humans, pets, livestock, wildlife, and other natural sources.

The *E. coli* load reduction objectives for Big Dry Creek vary by stream reach and flow conditions. The Division divided the segment into three distinct reaches to account for changes in land use, influences in river flow (diversions, reservoir releases, wastewater treatment facility [WWTF] contributions, etc.), and location of permitted point sources. TMDLs were developed for each reach: Upper Reach (from outlet of Standley Lake and Great Western Reservoir to sample location BDC 1.5); Middle Reach (from BDC 1.5 to 152nd Avenue); and Lower Reach (from 152nd Avenue to the confluence with the South Platte River). Allowable loads and waste-loads for *E. coli* were developed for varying flow conditions at a representative assessment location in each reach. For purposes of the TMDL, allowable *E. coli* loading to Big Dry Creek was allocated among municipal WWTFs, municipal stormwater runoff (MS4s), nonpoint sources (e.g., agriculture), a reserve capacity to allow for urban development, and a margin of safety (MOS). Table 3 from the TMDL provides an example of the loading and load reduction targeted for the middle reach of Big Dry Creek, which is located in the general vicinity of the open space behind Front Range Community College to 152nd Avenue. The existing *E. coli* conditions for various flow regimes are illustrated on a Load Duration Curve for the segment as shown in Figure 6.2-1 from the TMDL. Values above the blue line exceed the allowable loading for the stream.

Implementation of the TMDL will be an iterative process involving the CDPS permittees that discharge to Big Dry Creek and other nonpoint source pollution programs. The CDPS permitted domestic wastewater treatment facilities have already been addressed with effluent limits for *E. coli* equal to the water quality standard (205 cfu/100mL). These facilities already discharge well below these limits. Further reductions from these facilities are unnecessary at this time.

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Table 3. Middle Reach *E. coli* TMDL: allowable loading and pollutant reductions necessary to meet the recreation based *E. coli* standard in Big Dry Creek.

Loading Calculations (Giga-cfu/day)	High Flow	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flow
TMDL	423.34	198.56	129.18	73.58	27.94
MOS (10%)	42.33	19.86	12.92	7.36	2.79
Allowable Load	381.01	178.71	116.26	66.22	25.14
Existing Load	1119.13	425.48	244.05	114.49	94.98
Required Reductions	66%	58%	52%	42%	74%
WLA					
Westminster WWTF	58.24	54.32	51.49	31.97	16.99
Broomfield WWTF	74.20	64.00	57.63	31.58	4.92
MS4s	149.14	36.23	4.29	1.60	1.94
Reserve Capacity	7.46	1.81	0.21	0.08	0.10
LA					
Nonpoint Source	91.97	22.34	2.64	0.99	1.19

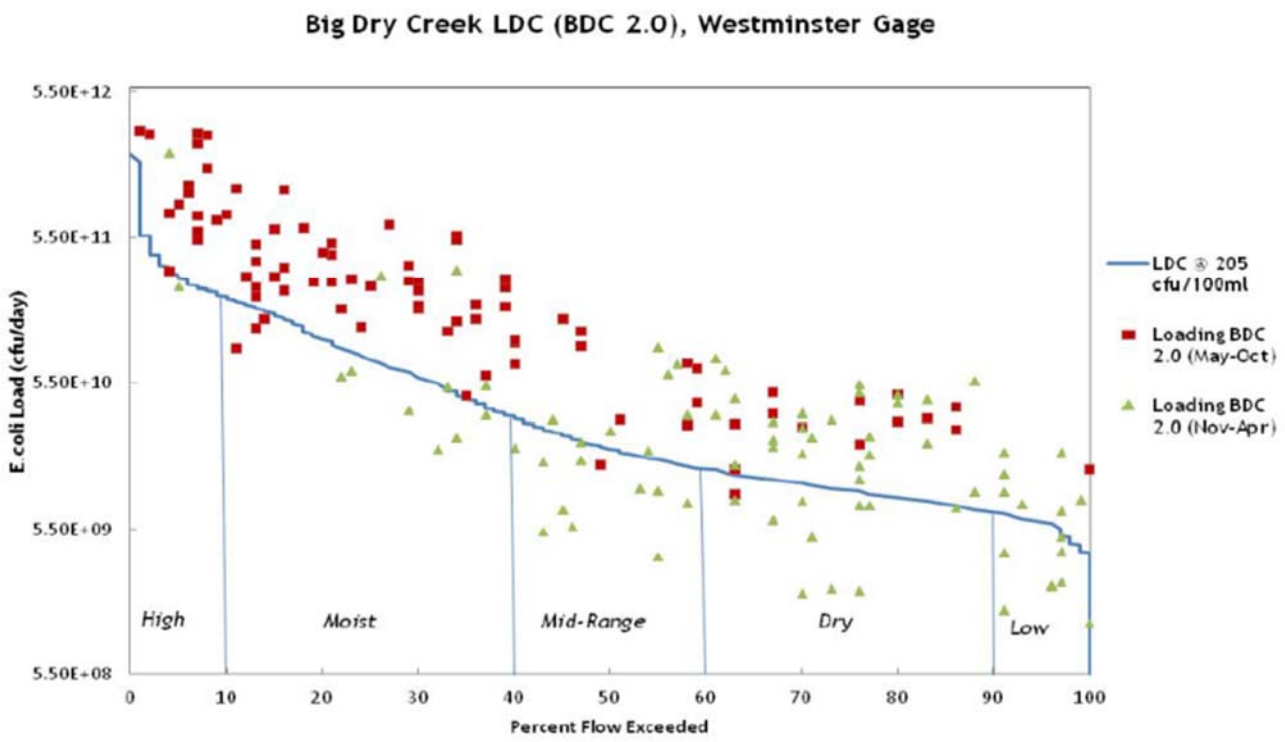

Figure 6.2-1 *E. coli* data (2003-2014) for bdc2.0 plotted on load duration curve based on Westminster flow gage.

The MS4 permitted discharges in the watershed require a stormwater management program to reduce discharge of pollutants to the maximum extent practicable (MEP) to protect water quality. There are minimum control measures already required in MS4 permits, which include: public education and outreach; public involvement/ participation; illicit discharge detection and elimination; construction site stormwater runoff control; post-construction stormwater management in new development and redevelopment; and pollution prevention/good housekeeping for municipal operations. Additional permit requirements, such as additional best management practices and monitoring, are also anticipated for the MS4 permits identified in this TMDL.

Implementation of the TMDL through the coordinated efforts of the Big Dry Creek Watershed Association is encouraged by the Division, given that the most effective strategies for pollutant load reductions require integration among entities with land draining to Big Dry Creek. However, each permit will have its own clear, specific and measurable requirements. Implementation actions may include, but are not limited to, the following: additional monitoring; infrastructure maintenance and upgrades; education and outreach; and stormwater BMPs. For more information about the TMDL see: https://www.colorado.gov/pacific/sites/default/files/WQ_TMDL_COSPBD01_Big_Dry_Creek_Ecoli_Final_Sept2016_w_EPA_Approval_letter.pdf.

Difference between Fecal Indicator Bacteria and Pathogens

Fecal matter often contains pathogens, which are disease-causing organisms. Because of the impracticality of testing for many pathogens associated with fecal waste, fecal indicator bacteria or "FIB" are used as indicators of fecal contamination. The FIB currently recommended by EPA include *E. coli* and/or enterococcus. FIB are not necessarily disease-causing and may be present due to non-fecal sources such as decaying plant matter and other environmental sources.

For more information on the use of fecal indicator bacteria in Recreational Water Quality Criteria, see the U.S. Environmental Protection Agency's website: https://www.epa.gov/wqc/2012-recreational-water-quality-criteria

For a new Colorado Toolbox for addressing *E. coli* sources, see: http://udfcd.org/wp-content/uploads/uploads/resources/guidance%20documents/Denver%20E%

What is the Big Dry Creek Watershed Association?

The Big Dry Creek Watershed Association (BDCWA) is a non-profit corporation consisting of individuals and entities who dedicate time and resources to developing a sound scientific understanding of water quality, flow, aquatic life and habitat conditions in the Big Dry Creek watershed and act to improve these conditions.

The Big Dry Creek Partnership, which included the City and County of Broomfield, the Cities of Northglenn and Westminster, and Rocky Flats Environmental Technology Site (RFETS), founded the BDCWA in 1997. These entities have been heavily involved in monitoring stream conditions for many years. Since 1997, the Association has expanded to include representatives from other cities, counties, farmers, ditch companies, citizens and regulatory and resource agencies. The BDCWA is open to those interested in cooperatively working towards understanding and prioritizing efforts to improve basin conditions.

In 2004, the BDCWA formed a non-profit corporation with a Board of Directors currently consisting of representatives of the Cities of Westminster and Northglenn, the City and County of Broomfield, Weld County and Adams County. Activities of the BDCWA during the last twenty years have been funded through the contributions from these entities, as well as the City of Thornton, U.S. Department of Energy, the Woman Creek Reservoir Authority, the Colorado Water Conservation Board, the U.S. Environmental Protection Agency's 319 program (as administered by the Colorado Department of Public Health and Environment) and the Regional Geographic Initiative grant program.

For more information on the Big Dry Creek Watershed Association, please visit the BDCWA's web page at www.bigdrycreek.org or contact Jane Clary, Watershed Coordinator, Wright Water Engineers, Inc., 303-480-1700 or clary@wrightwater.com.

BIG DRY CREEK

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