2017 Dry Run Creek Geomorphological Watershed Assessment

2016/2017 Academic Year
By: University of Northern Iowa
Dept. of Earth and Environmental Science
Geomorphology Class Project

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Acknowledgements –
Many thanks to the University of Northern Iowa Conservation Corps (Eric Giddens and Kamyar Enshayan) funded by the Roy J. Carver Charitable Trust; Josh Balk and the Dry Run Creek Advisory Board; and the Departments of Geography, Earth and Environmental Science.

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2. INTRODUCTION

Dry Run Creek (DRC) watershed is a primary drainage basin located in northwestern Black Hawk County (Figure 1). It is fed predominantly by agricultural runoff in its upper reaches, and becomes heavily urbanized as it travels through the city of Cedar Falls, before draining into the Cedar River. The stream is perennial, however some are tiled and new segments have developed both naturally and artificially. Re-evaluation of the creek is underway and indicates some changes in urban and rural areas. Data was collected during the fall of 2016 by University of Northern Iowa geomorphology students, using handheld GPS devices and standardized data sheets.

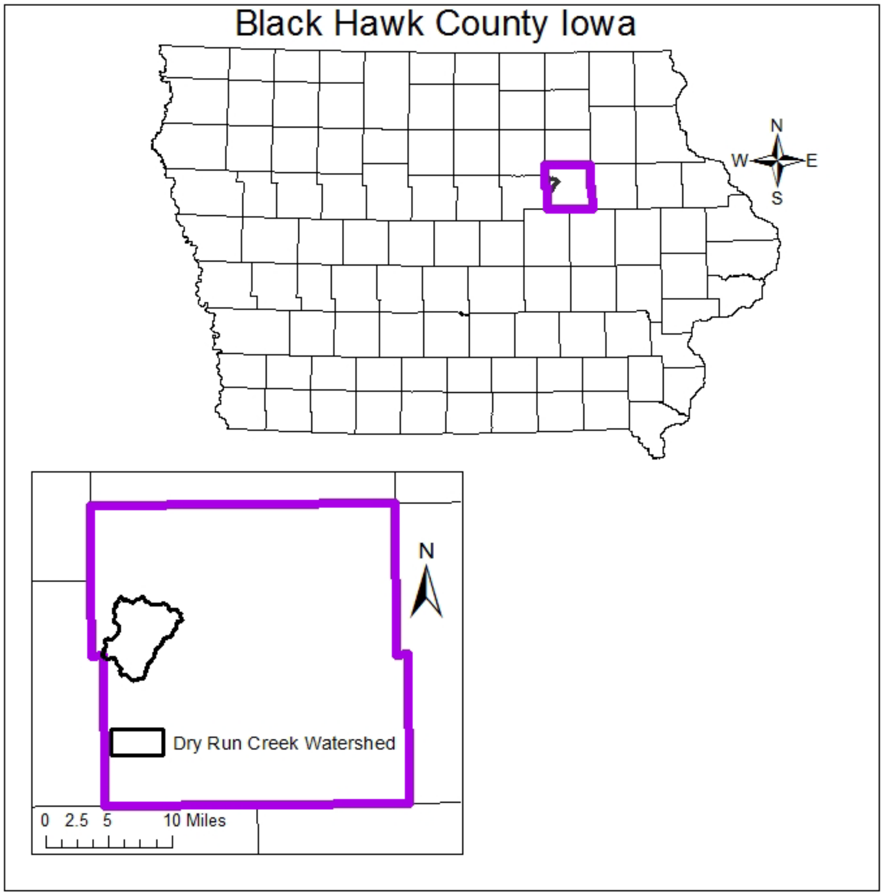

Figure 1. Location of Black Hawk County within Iowa. Inset map, show placement of the Dry Run Creek Watershed, within Black Hawk County.

2.1. HYDROLOGY

DRC drains an area of 15220 acres, with a topographic highpoint of 1025 and a low point where it discharges into the Cedar River of 845 feet. For one inch of precipitation, a percentage of 663 million gallons of water is added to the stream load of DRC for a certain duration of time. Exact percentage of precipitation that reaches DRC is not possible to calculate, but the effect a precipitation event has on the stream depth can help illustrate the increase in stream load (Figure 2 and 3).

Stream levels increase as rains come in April and throughout the summer months and taper off during the drier months of September through November. Though December, January, and February are the driest months (averaging an inch each), the stream is shallow enough that most if not the entire stream is frozen. Therefore, precipitation that does fall (in the form of snow) does not noticeably affect discharge, or erosion until spring thaw occurs.

As urbanization increases and infiltration rates decrease, DRC's length and discharge continue to increase as the stability of the system continues to decrease. Simply stated, the DRC water resource has deteriorated as the urban area has grown. In addition, in-stream habitat and riparian zones that once helped filter the watershed have slowly been reduced over the last decades. With less filtration, larger precipitation events carry increasing amounts of sediment, nutrients, and synthetics (such as pesticides) into DRC. The following graphs illustrate the increases in nitrates and E-coli to DRC associated with precipitation values from April-November of 2016.

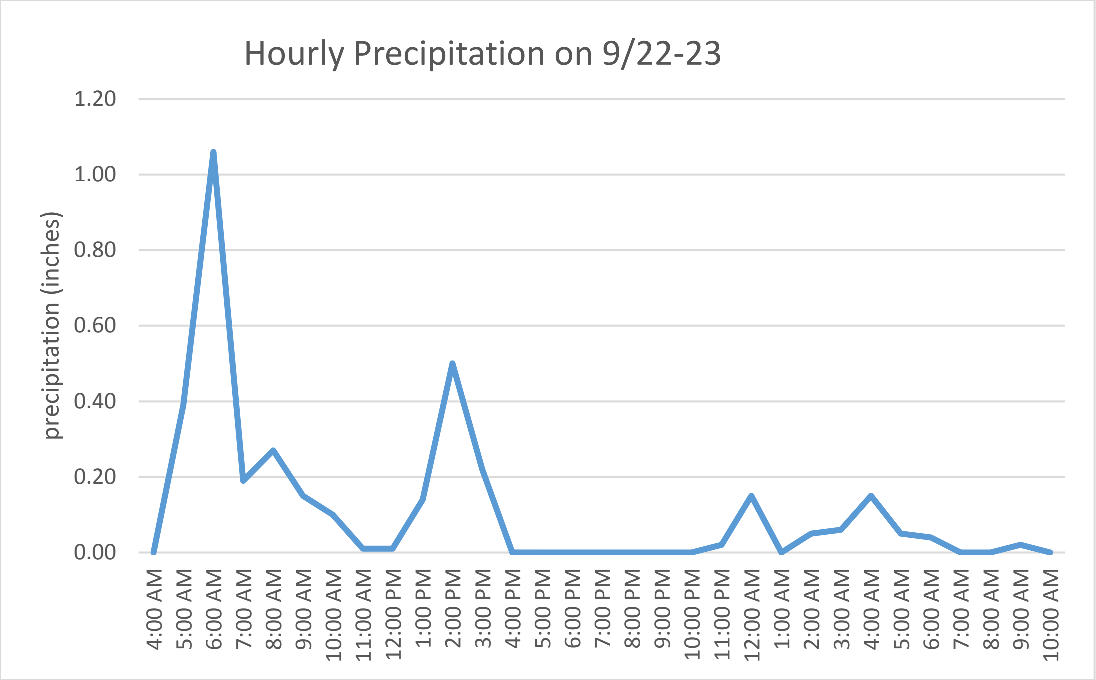

Figure 2. Hourly precipitation on Dry Run Creek, UNI's Campus, Sept. 22-23, 2016. Site 7, Dr. Mohammad Iqbal (UNI) well site (http://www.uni.edu/hydrology/)

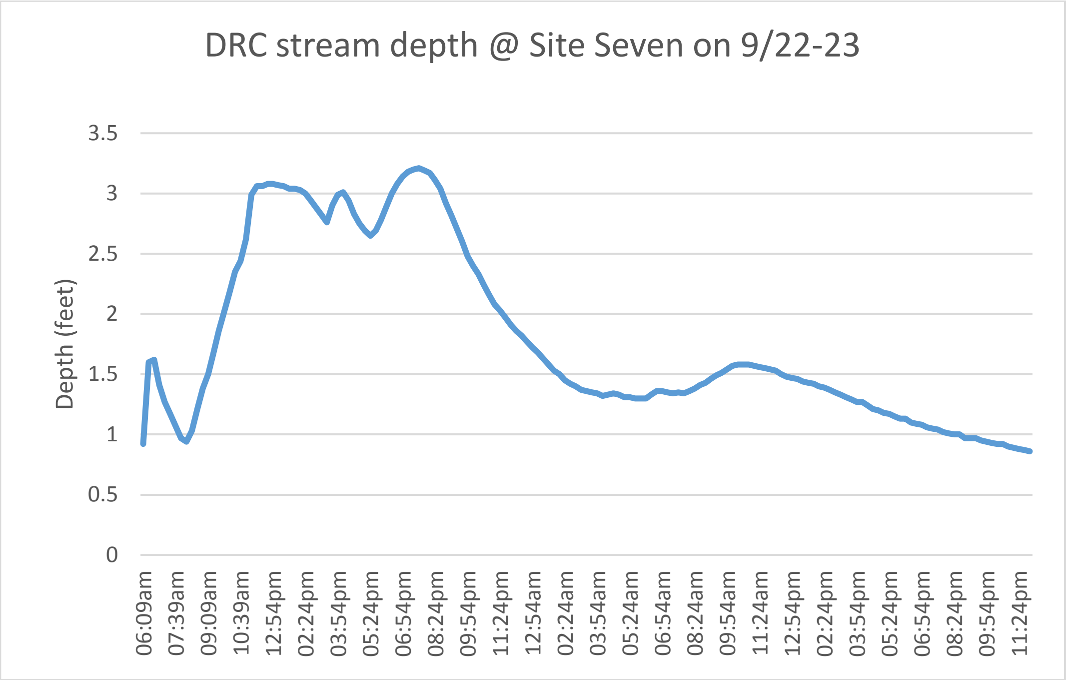

Figure 3. Hourly precipitation on Dry Run Creek, Site 7, illustrates the change in depth of DRC at site.

Stream levels increase as rains come in April and throughout the summer months and taper off during the drier months of September through November. Though December, January, and February are the driest months (averaging an inch each), the stream is shallow enough that most if not the entire stream is frozen. Therefore, precipitation that does fall (in the form of snow) does not noticeably affect discharge, or erosion until spring thaw occurs. As urbanization increases and infiltration rates decrease, DRC's length and discharge continue to increase as the stability of the system continues to decrease. Simply stated, the DRC water resource has deteriorated as the urban area has grown. In addition, in-stream habitat and riparian zones that once helped filter the watershed have slowly been reduced over the last decades. With less filtration, larger precipitation events carry increasing amounts of sediment, nutrients, and synthetics (such as pesticides) into DRC (Figure 4).

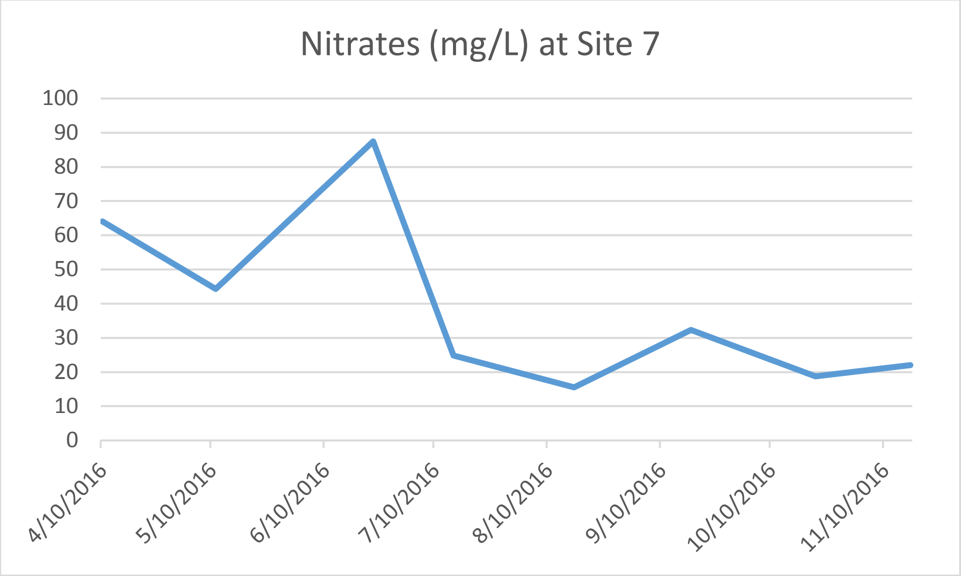

Figure 4. Site 7 Nitrate levels, Dr. Iqbal's well site also records data for other contaminants (e.g. E.coli)

2.2. GEOLOGY

2.2.1 BEDROCK GEOLOGY

The bedrock surface within the DRC watershed is composed of two major units that were deposited during the Middle Devonian (385-390 Ma). The youngest and most prevalent unit is the Coralville Formation (0-52 ft.) (Figure 5). The area is characterized by a lower fossiliferous carbonate - dolomite, dolomitic limestone - dominated member with abundant marine fauna (Gizzard Creek Member), and an upper carbonate dominated member with laminated, brecciated, or evaporitic textures and some restricted marine fauna (Iowa City Member). Below the Coralville Formation is the Little Cedar Formation (0-121 ft) characterized by a lower fossiliferous carbonate - dolomite, dolomitic limestone - dominated member and an upper sparsely fossiliferous to non-fossiliferous carbonate - dolomite, shale, and limestone - dominated member (Hinkle Member) (Rowden et al., 2012).

2.2.2 SURFICIAL GEOLOGY

The DRC watershed lies within the Iowan Erosion Surface (IES) (Figure 6). Complex sediment assemblages of glacial, periglacial, eolian/wind, fluvial /river and pedisediment/gravity deposits characterize the IES. Geologic interpretations of this landscape date back 100 years and continue to change as new scientific techniques and data inform our understanding of the area’s development. A foundation of Pre-Illinoian glacial sediments (1.2 Ma to 550,000 y.b.p) set the stage for subsequent periods of intense weathering and erosion (Ruhe, 1969; Hallberg et al., 1978).

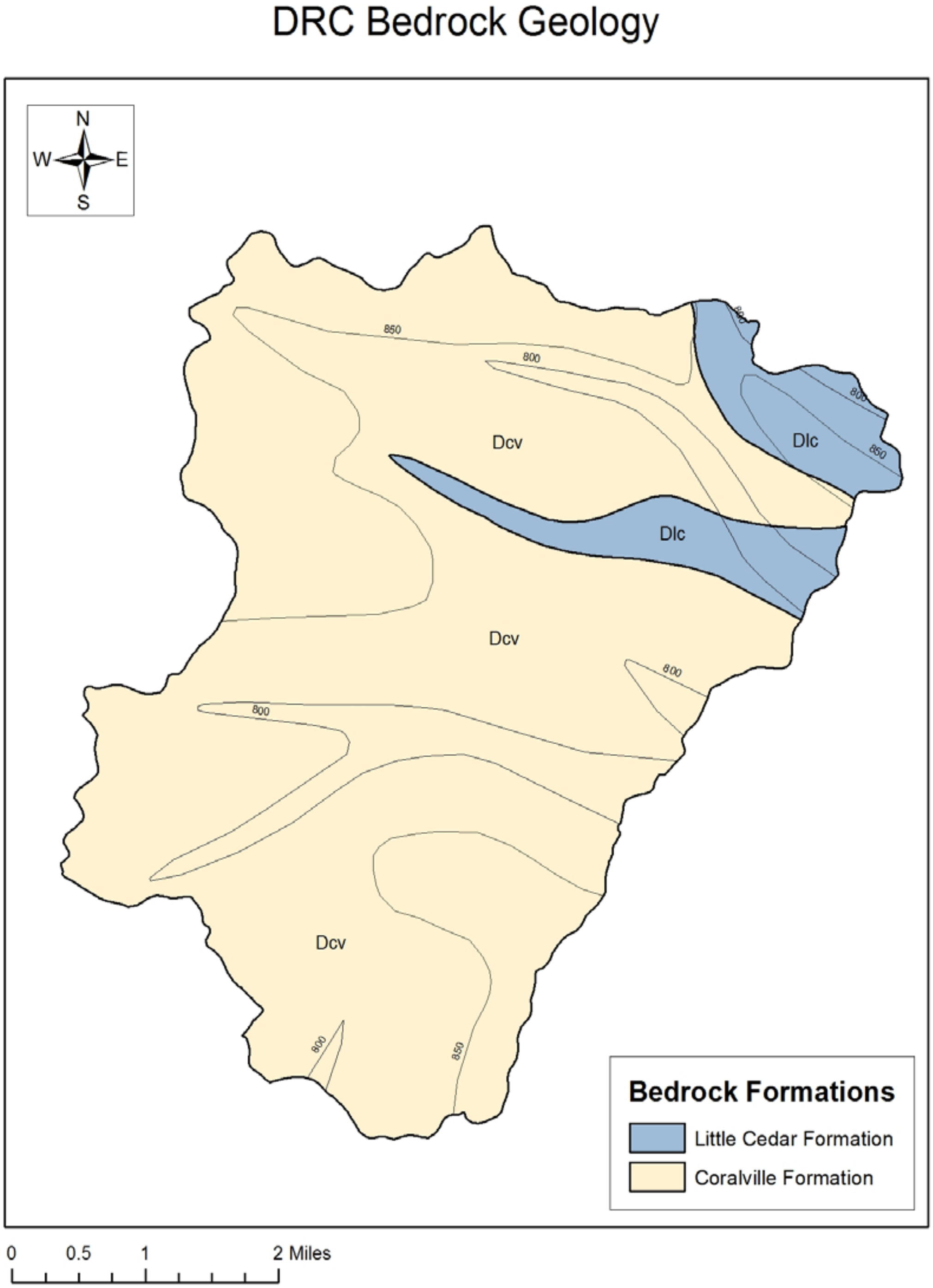

Figure 5. Bedrock geology map of the Dry Run Creek Watershed

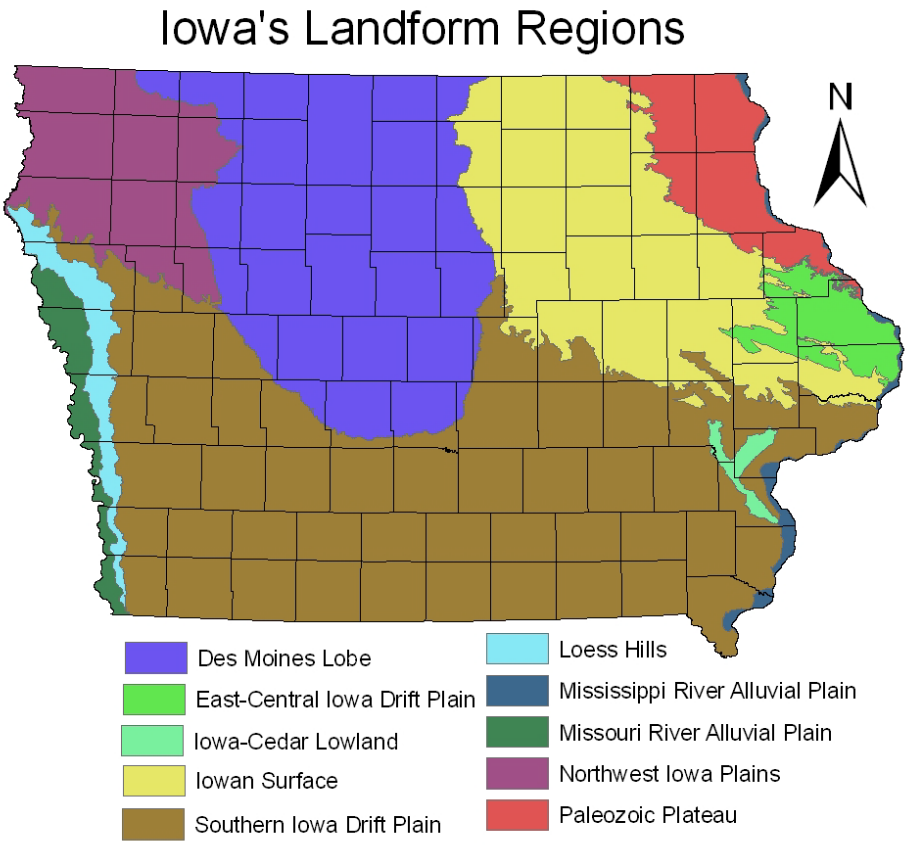

Figure 6. Map exhibiting the ten-landform regions of Iowa. Dry Run Creek falls within the Iowan Surface.

Current research suggests the IES was greatly impacted the development of periglacial environments during the Middle to Late Wisconsin stages (approx. 85,000 to 25,000 y.b.p.) (Mickelson and Colgan, 2004, Kerr et al., 2017). Prominent periglacial features within the IES include sediment-filled ice-wedge casts, polygonal patterned ground and a distinctive stone line separating underlying pre-Illinoian till and overlying loess to pedisediment (Walters, 1994; Davidson & Walters, 2010; Matzke et al., 2013). Distinctive northwest to southeast trending eolian features, paha and sand stringers, pepper the surface of the IES. These loess to sand deposits mark an active period of wind-driven sedimentation (approx. 28,000 to 14,000 y.b.p) (Halberg et al., 1978;

Zanner, 1999). The surficial geology of the DRC watershed contains four mappable units (Heinzel et al., 2012: Tassier-Surine et al., 2012) (Figure, 7):

Qal-Alluvium (3-16 ft.**)** Dry Run Creek sediment is an undifferentiated bed composed of a mixture of very dark gray to brown non calcareous to calcareous, massive to stratified silty loam, clay loam, sandy loam, and colluvium which makes up the streambed and soils directly surrounding the stream. Associated with low-relief modern floodplains and modern drainage ways, is easily eroded and characterizes some of the youngest soils in DRC.

Qe (3 to 12ft) Sand dunes and Sand Sheets (Peoria Formation-sand facies), yellowish brown, massive, calcareous loamy sand to fine sand. It may over lie yellowish-brown sand and gravel (Noah Creek Formation) or reworked unnamed loamy sediments associated with the Iowa Erosion Surface.

Qallt (3 to 15ft) – Low Terrace (DeForest Formation-Camp Creek Mbr. and Roberts Creek Mbr.). Very dark gray to brown, non-calcareous, stratified silty clay loam, loam, or clay loam, associated with the modern channel belt of the Des Moines River valley. Overlies Noah Creek Formation. Occupies lowest position on the floodplain i.e. modern channel belts. Seasonal high water table and frequent flooding potential.

Qnw2 (6-26 ft) is composed of yellowish brown to gray, poorly sorted to well-sorted, massive to well-stratified, coarse to fine feldspathic quartz sand, pebbly sand and gravel with few silty colluvial deposits.

Qnw (10 to 30ft) – Sand and Gravel (Noah Creek Formation), More than three meters of yellowish brown to gray, poorly to well sorted, massive to well stratified, coarse to fine feldspathic quartz sand, pebbly sand and gravel. In places mantled with one to three meters of fine to medium, well sand derived from wind reworking of the alluvium. This unit encompasses outwash or redeposited outwash that accumulated in stream valleys that drained the Des Moines Lobe during the Wisconsin Episode.

Qwa2 (3 to 45ft) Loamy and Sandy Sediment Shallow to Glacial Till (Unnamed erosion surface sediment), yellowish-brown to gray, massive to weakly stratified, well to poorly sorted loamy, sandy and silty erosion surface sediment. Map unit includes some areas mantled with less than 2 m (7 ft.) of Peoria Formation materials (loess and eolian sand). Overlies massive, fractured, firm glacial till of the Wolf Creek and Alburnett formations. Seasonally high water table may occur in this map unit.

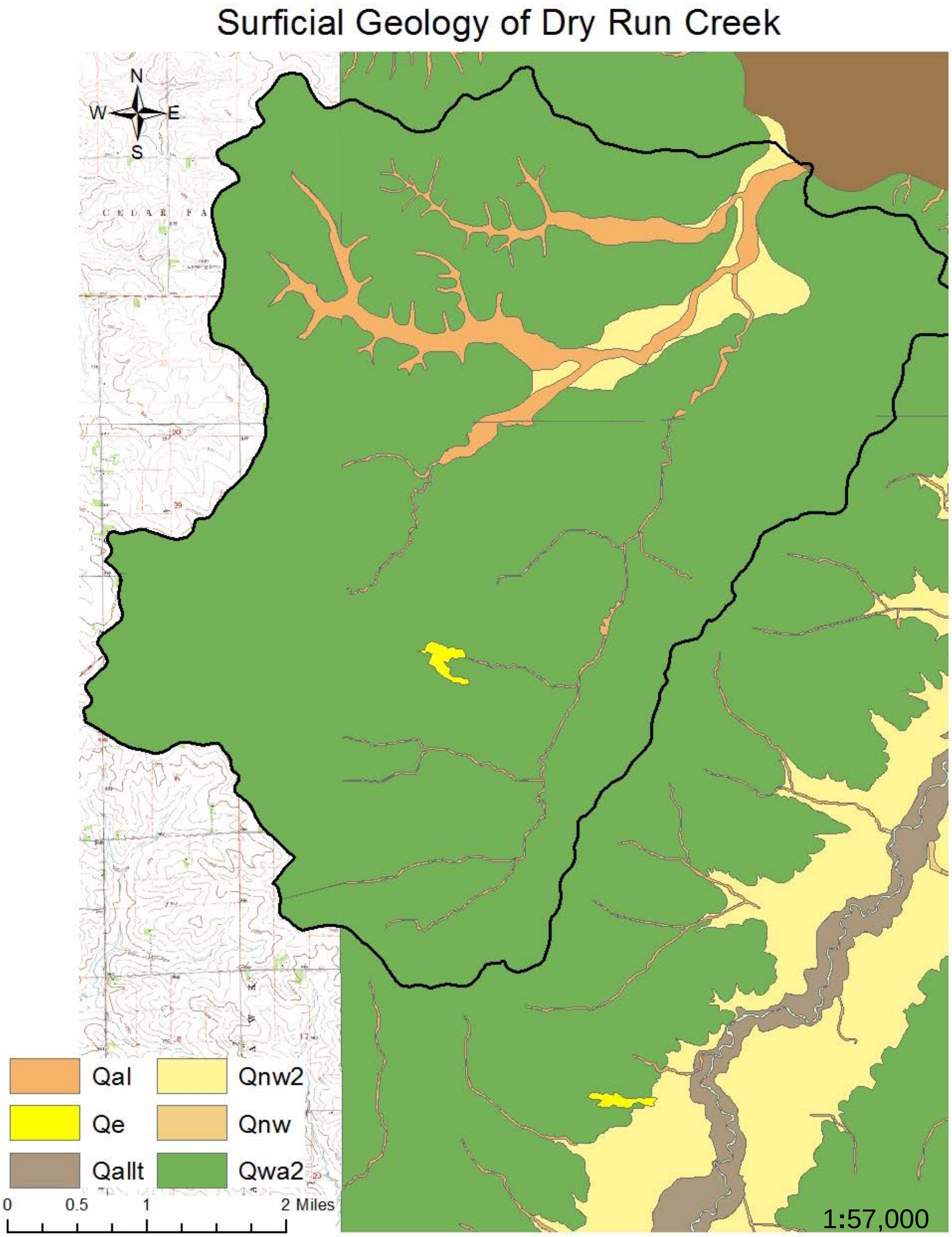

Figure 7. Map characterizing the surficial geology of the Dry Run Creek watershed (black line = boundary)

2.2.3 SOILS

Within the DRC watershed, there are approximately 33 different soil units (Table 1, Figure 8). This research did not considered urban soil types separately from their non-urban counterparts. The most dominant soil type found within the watershed is the Kenyon Loam; it appears most frequently throughout the area on slopes ranging between 2% and 5% and is composed of loamy sediments. The second most dominant soil type is the Clyde-Floyd Complex. This soil is composed of three different soil units – Clyde (50%), Floyd (40%), and minor components (10%). It appears most frequently throughout the area in drainage ways on slopes ranging between 1% and 4%, and is composed of silty clay loam to loam sediments. Another major soil type is the Maxfield Silty Clay Loam. It appears only in rural upland flats, on slopes ranging between 0% and 2%, and is composed of silty clay loam to loam sediments.

Soil Classification Tabulation

Parent Materials	Soil Classification	Area (Acres)	Percent of Watershed
Loam	Aredale, Bassett, Donnan, Floyd, Kenyon, Lawler, Marquis, Orthents, Readlyn, Sparta, Spillville-Coland, Saude, Waukee	8503.12	55.87%
Silty Clay Loam	Clyde, Clyde-Floyd, Colo, Colo-Ely, Dinsdale, Klinger, Klingmore, Maxfield, Maxmore, Nevin, Sawmill, Wiota	6142.69	40.36%
Sandy Loam	Burkhardt, Dickinson, Finchford, Lilah, Olin	384.44	2.53%
Clay Loam	Marshan, Tripoli	51.77	0.34%
Urban - Water	NA	137.98	0.9%

Table 1. Relative percentages of DRC primary parent materials and soil series.

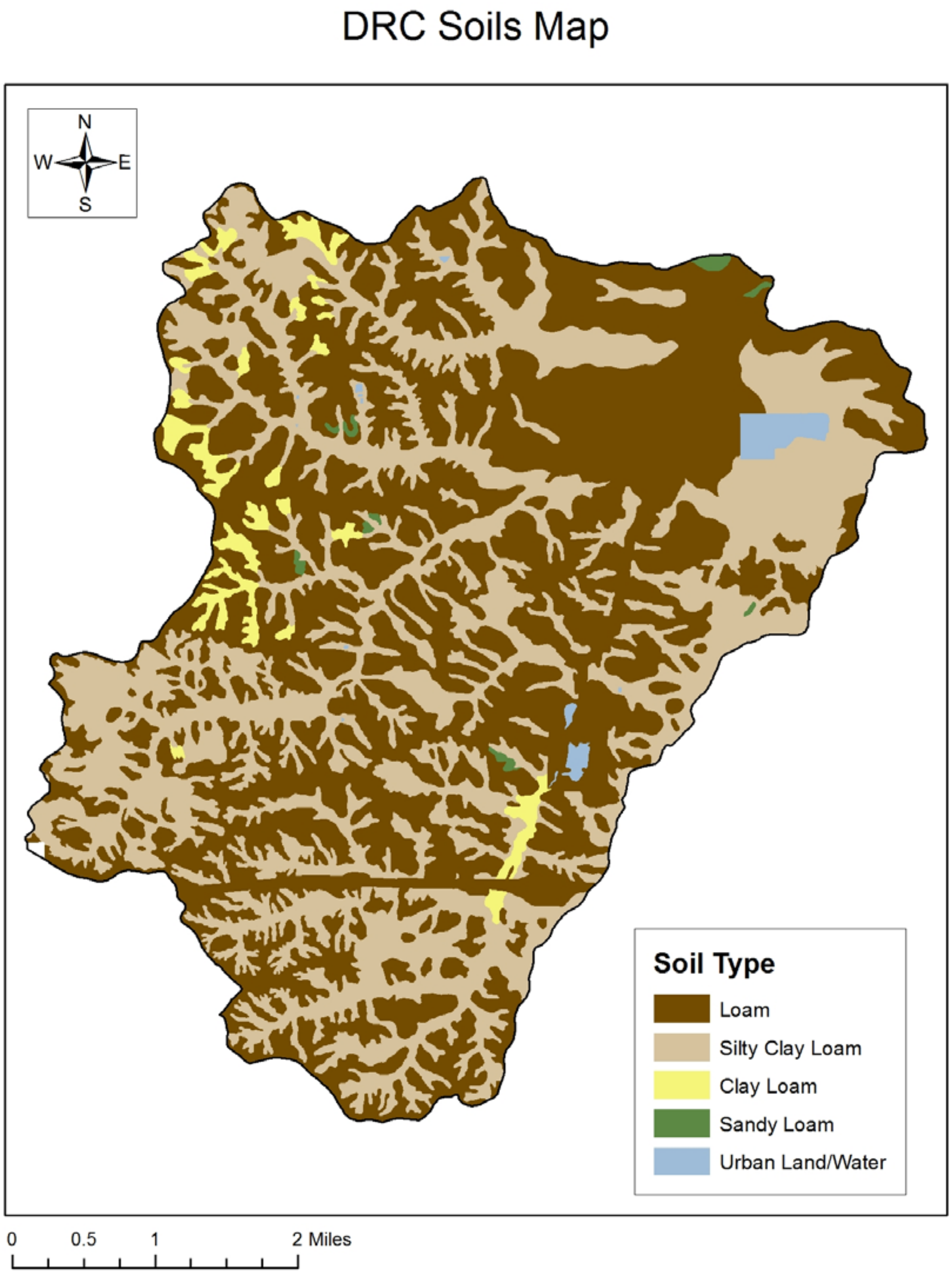

Figure 8. General soils map of the Dry Run Creek watershed, emphasizing parent material substrates

2.3 CLIMATOLOGY

Average temperature of 47.8°F, Waterloo-Cedar Falls has a moderate continental climate with cold winters and warm to hot summers. As for extremes, Waterloo-Cedar Falls reached a temperature of 112°F in 1936 and -34°F in 1962 and 2009. By season, average temperature is 21.3°F in winter, 48.4°F in spring, 71.6°F in summer, and 49.9°F in autumn. Yearly precipitation average for Waterloo-Cedar Falls is 34.60”, with summer receiving the most precipitation at 14.16”. Yearly snowfall average is 35.3”, with December accumulating the most snow at 9.9”.

The Iowa Climate Change Impacts Committee’s 2010 report, Iowa has been experiencing a particularly noticeable upward trend in precipitation, temperature, and humidity over the last 30 years. The majority of the precipitation increase has come in the first half of the year, leading to wetter springs and drier autumns. While year-to-year variability is high, Eastern Iowa has a higher upward trend than the statewide average. Severe precipitation events (heaviest 1%), which lead to enhanced runoff, and often flooding, have increased dramatically. The Cedar River, for example, has experienced its three largest flood events on record within the last 24 years (1993, 2008, and 2016). Temperatures across the state have also increased, although impacts have been much less severe. Overall, temperatures have increased six times more in winter than in summer, and nighttime temperatures have been increasing more than daytime temperatures (Figure 9 and 10) The humidity level across that state has risen substantially, particularly in summertime (Figures 11 and 12). Global and regional climate models predict that these trends are predicted to continue increasing (Takle, 2011).

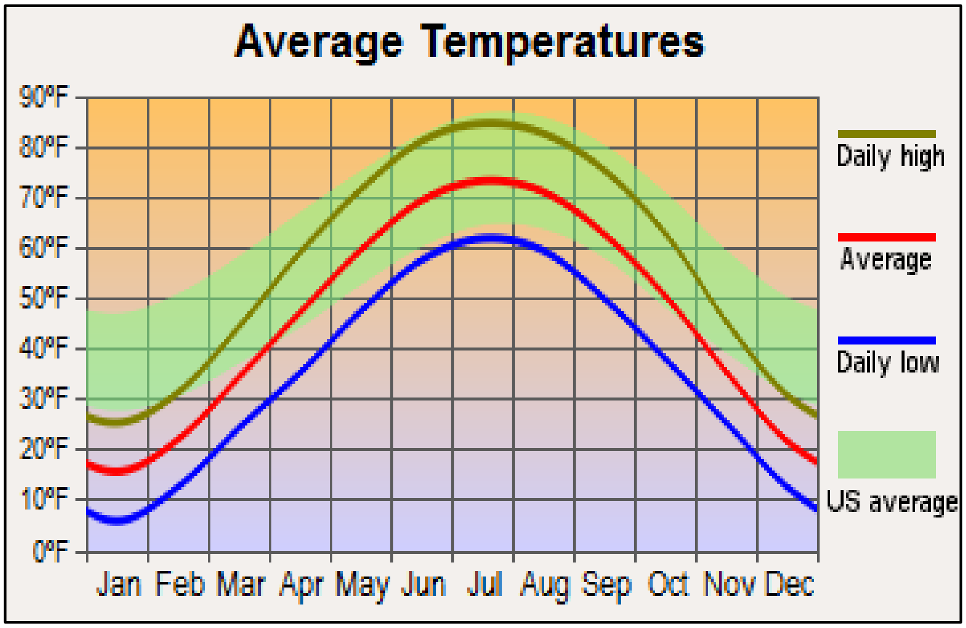

Figure 9. Average temperature variability for the Cedar Falls, Iowa area.

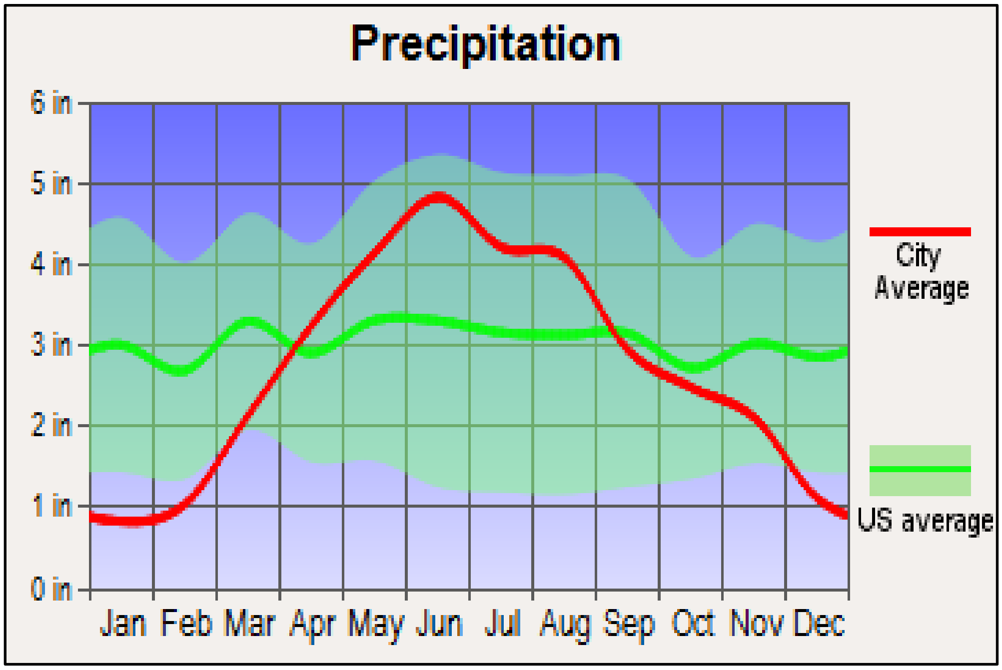

Figure 10. Average precipitate for the Cedar Falls, Iowa area.

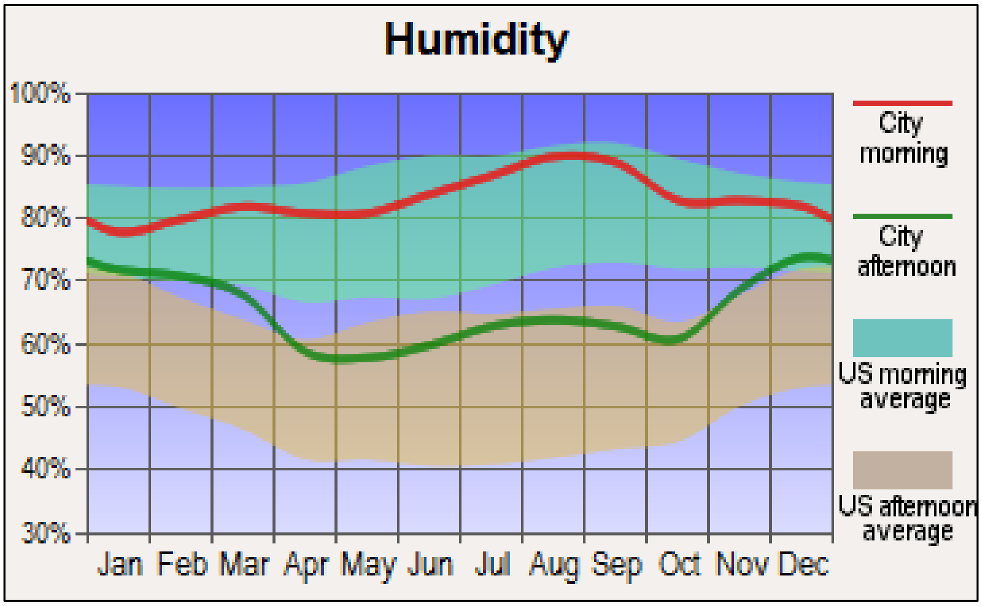

Figure 11. Average humidity for the Cedar Falls, Iowa area.

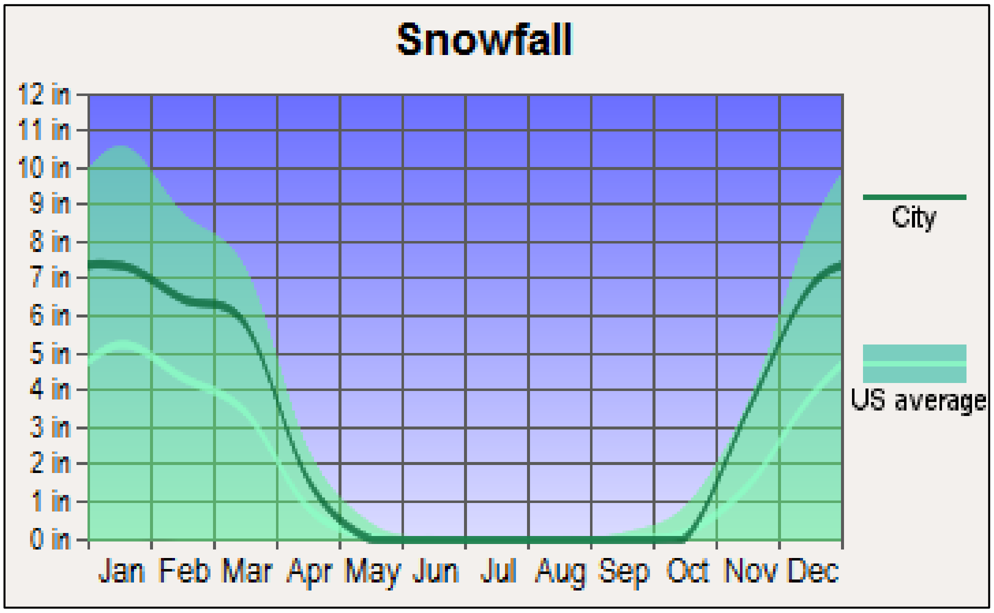

Figure 12. Average snowfall for the Cedar Falls, Iowa area.

2.4 ECOLOGY

Iowa’s native vegetation once consisted of vast prairie and savannas in upland areas, and dense forests and natural wetlands in floodplains and river valleys, which helped to establish very stable banks and stream systems. Modern landscapes lack the thick vegetation and natural buffer system of the past creating less stable streams, more artificially enforced banks, and poorer water quality from runoff. Once covering 30 million acres in Iowa, less than 1% of the tallgrass prairie remains intact. Currently four there are four threatened or endangered species in Blackhawk County, (http://www.iowadnr.gov/Conservation/Threatened-Endangered). (Figure 13)

Figure 13. Images of Black Hawk County’s (Iowa) four endangered species (from top left clockwise: Northern Long-eared Bat (Myotis septentrionalis), Rusty Patched Bumble Bee (Bombus affinis), Prairie Bush Clover (Lespedeza leptostachya), and the Western Prairie Fringed Orchid (Platanthera praeclara).

2.5 POPULATION

Population within the DRC watershed has been steadily increasing since 1870; aerial photographs taken throughout time show a steady growth in urban and agriculture throughout the basin (Figure 14). Most recent census data (2015) shows that the current population is 41,255 (96% urban, 5% rural). Population had been increasing since 2000 at a +13.0% rate, this trend is expected to continue. Population density is 1,365.7 per square mile.

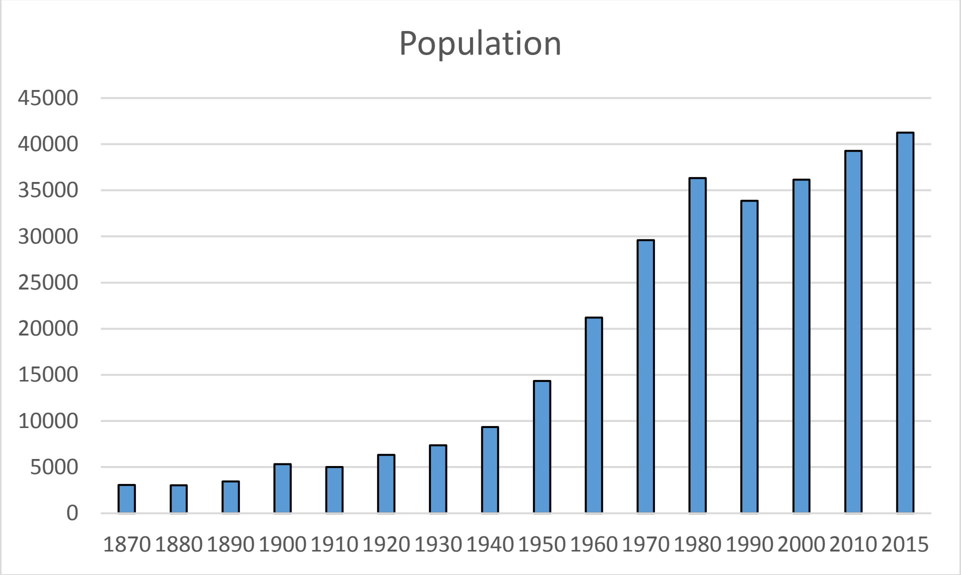

Figure 14. Population trends of Cedar Falls, Iowa.

2.6 HISTORIC LAND USE

Aerial photographs from 1930, 1960, 1990, and 2016 demonstrate how land use has changed within the watershed over time. The amount of agricultural land within the watershed has steadily been decreasing, with the largest reduction (18.69%) occurring between 1990 and 2016. This rapid change in surface coverage is the result of several new residential, commercial, and industrial developments (Table 2, Figure 15).

1930 Land Use Tabulation

Land Use	Area (Acres)	Percent of Watershed
Rural	14,400.24	94.61%
Urban	819.76	5.39%

1960 Land Use Tabulation

Land Use	Area (Acres)	Percent of Watershed
Rural	13,033.5	85.63%
Urban	2,186.5	14.37%

1990 Land Use Tabulation

Land Use	Area (Acres)	Percent of Watershed
Rural	11,370.76	74.71%
Urban	3,849.24	25.29%

2016 Land Use Tabulation

Land Use	Area (Acres)	Percent of Watershed
Rural	8,526.83	56.02%
Urban	6,693.17	43.98%

Table 2. Rural versus urban development from 1930 to 2016 within the DRC watershed.

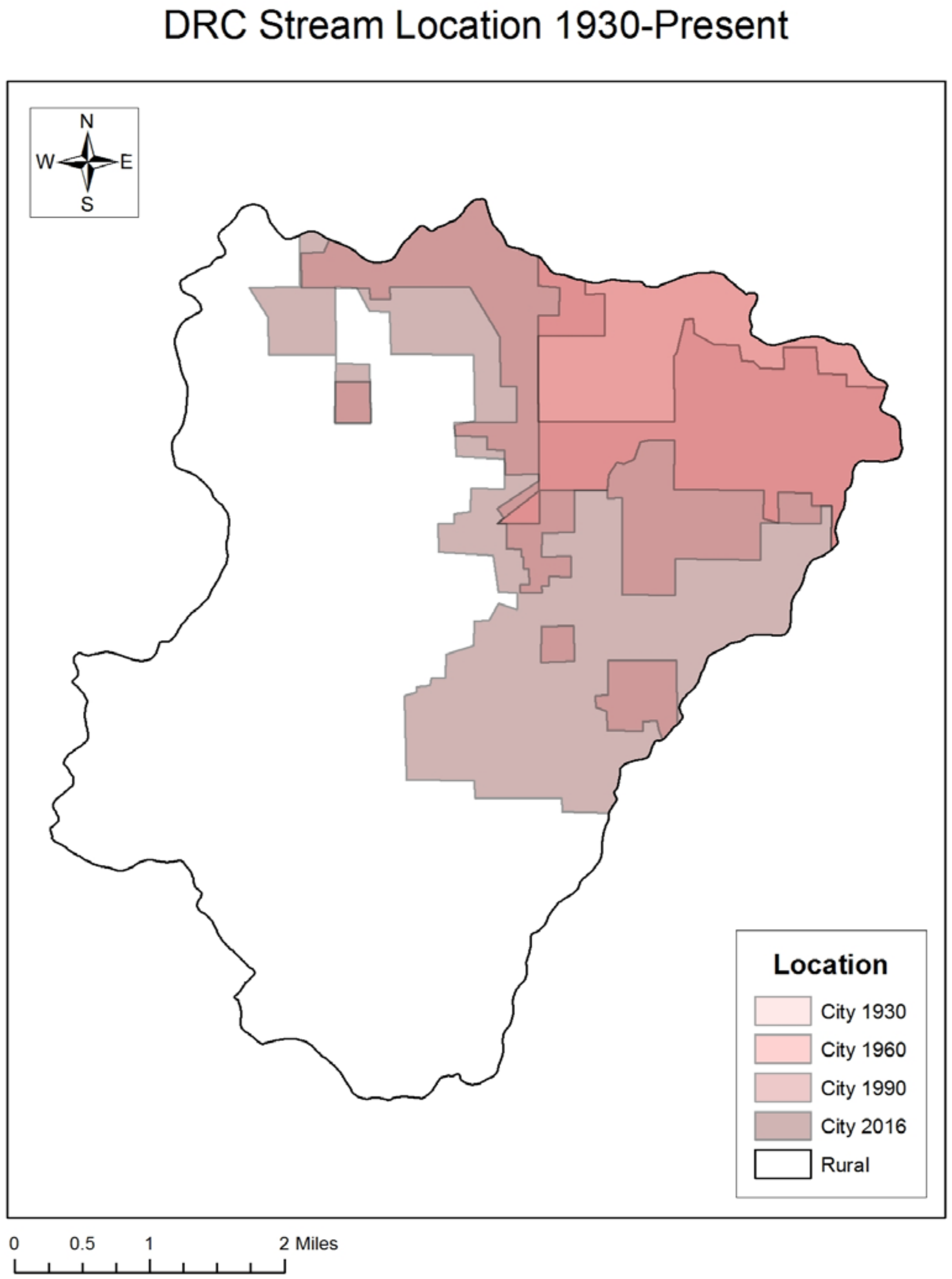

Figure 15. Cedar Falls city boundaries from 1930 to present.

3. METHODOLOGY

3.1 FIELD

Individual site locations were identified in successive order in accordance with their delineated stream segment's numbering scheme. Student scientists recorded geomorphic and biologic variables at each site using a standardized stream assessment protocol (Table 3). The geographic location of each site was recorded in the field at the time of assessment using Trimble Juno SB (2-5 m accuracy) and Trimble GeoXH (10-50 cm accuracy) devices running ESRI's ArcPad (v.10.2) software. ArcPad, facilitated geospatial identification (latitude and longitude) of each characterization point and were added to common/shared shapefile '2016_DRC_Analysis', along with geomorphic and biologic data for each point. Sediment samples (30 to 300 grams) were collected from each site's bedload and bank deposits.

3.2.1 LAB

After the field component of the research was completed, shapefiles were transferred from the GPS devices to each group's unique folder inside a shared student drive. Each group's shapefiles were then imported into ESRI's ArcMap software and merged together into single feature classes. All attribute data from the merged feature classes was then exported individually and compiled into a master spreadsheet using Microsoft Excel. Any attribute data that needed scrubbing (i.e. converting "Row Crop" to "Rowcrop", "0" to "null", etc.), or was not recorded in the data dictionary during the time of assessment, was manually amended later in Excel. Once the master spreadsheet contained all of the collected attribute data in a cohesive manner, it was imported back

Site Number =

Date & Weather =

Scientists:

Predominant Land Use (25 meters on either side of stream / looking downstream)

Left Bank:	Row crop		Trees		Grassland	Pasture		Urban	
RightBank	Row crop		Trees		Grassland	Pasture		Urban	

Livestock Access:	Left (1)		Right (2)		Both (3)
Riparian Grass:	Warm (1)		Cool (2)		Mixed (3)
Point-source Runoff:	Urban (1)		Agriculture		Other (3)

Degree of woody and/or herbaceous canopy	0-10%	10-25%	25-50%	50-75%	X > 75%
	1	2	3	4	5

If riparian trees are present identify the three most predominant species:

1	Hybrid poplar	8	Silvr Mapl	15	White Ash	22	Hackberry
2	Hybrid Cottonwood	9	Basswood	16	Green Ash	23	Ohio Buckeye
3	Cottonwood	10	Blk Walnu	17	Black Ash	24	Sycamore
4	Boxelder	11	Red Elm	18	White Elm	25	Honey Locust
5	Black Locust	12	Mulberry	19	Sugr Maple	26	Bitternut Hickory
6	Hybrid Willow	13	Red Oak	20	River Birch	27	Swamp White Oak
7	Black Willow	14	Burr Oak	21	Shellbark Hickory	28	Eastern Red Cedar
						29	Other

Avg. Bank Height =			Bank sediment		Boulder	Gravel	Sand	Silt
					1-------2------3------4------5-----6-----7			
		1	2	3	4	5	6	7

Bank Stability class	Stable		Mod. Stable		Mod. Unstable		Unstable	OR	Artificially
	1	1.5	2	2.5	3	3.5	4		stable

Degree of hydrologic/stream variablity	uniform		Somewhat		Natural
	width/depth		Variable		Pool&Riffle
	1	1.5	2	2.5	3

Frequency of pools deeper than 1 meter	None	< 1 pool per 85m		> 1 pool per 85m		Frequent>1m	
	1		2		3		4

Channel Bedload	Cobble		Gravel		Sand		Silt
	1	2	3	4	5	6	7

If cobble/gravel, to what degree are the clasts embedded in silt/clay?	Exposed	Partially	Fullly embedded
	1	2	3

Stream water Turbidity	High		Moderate		Low		Clear
	1	2	3	4	5	6	7

Degree of in-stream habitat (boulders, logs, root clusters)	None	< 30%	30-60%	> 60
	1	2	3	4

Table 3. Stream assessment worksheet used for the Dry Run Creek analysis.

into ArcMap, and data points were displayed using latitude and longitude coordinates and the NAD_1983_UTM_Zone_15N projection. A spring 2016 Orthographic image of the DRC drainage area was obtained from the Iowa Geographic Map Server website to be utilized as a base image for all maps.

3.2.2 Morphometric analysis

A morphometric analysis of the DRC watershed was conducted based on Strahler stream quantification methods (Strahler, 1952, 1957). The DRC GIS allowed for the quantification of important morphometric variables including: stream segment lengths, basin areas, topographic relief, sediment/soil characteristics, and rural versus urban drainage controls. These data were used to calculate: Bifurcation, length, relief ratios, along with Ruggedness numbers, gradients, drainage densities and other important stream values.

3.2.3 Particle size analysis

The initial coarse (>2mm) fraction including pebbles, cobbles, and boulders was visually estimated from each stratigraphic unit during field descriptions. In addition, the lithology, roundness, sphericity, and orientation of thirty to fifty coarse particles were recorded from three fluvial and seven alluvial fan stratigraphic sections. Each sample was subsequently sieved at 2mm to separate the coarse and fine particle fractions. The 2 mm coarse and fine fractions were placed in separate storage containers. Clay-rich units and samples were disaggregated to access homogenous samples. Forced air was used to clean the sieve and crusher between each use to avoid sample contamination of organics and sedimentary particles.

The fine particle size (>2mm) distribution for each sample was determined using the pipette method of Gee and Bauder (1986). The procedure categorizes sediment from each depositional unit into the Wentworth Geometric Progression Scale (Table 4). In addition, the USDA textural classes were also determined from the Wentworth classes.

Particle Size Analysis Distribution (Wentworth Scale) Categories

		(mm)			(μm)
Sand	VCS	2-1	Silt	VCSi	63-53
	CS	1-0.5		CSi	32-16
	MS	0.5-0.25		Msi	16-8
	FS	0.25-0.125		Fsi	8-4
	VFS	0.125-0.063		VFSi	4-2

*Abbreviations: V (very), C (coarse), M (medium), F (fine), S (sand), Si (silt).

Table 4. Particle-size group ranges.

Particle size analyses began with a visual color determination in the field for the presence of organic matter (OM). Samples possessing a low chroma (e.g., 1 or 2) likely contain greater than 1.7% organic carbon (e.g., A-horizons) and were pretreated with hydrogen peroxide to remove the organic matter. The organic removal procedure entails treating 9.9 to 10.10 g of air-dried sediment with 5 ml of hydrogen peroxide. A hot-water (approximately 60 °C) bath is used as a catalyst to quicken the reaction. The sediment was placed in a 105 °C oven for eight hours and immediately weighed to lessen the possibility of water gain.

Sediment containing less than 1.7% organic carbon did not undergo the pretreatment procedure. Twenty sediment samples were analyzed during each session, including one standard reference sample (internal control) and an isolated bottle to determine the salt factor (addition of dispersion solution). Ten milliliters of dispersing solution ($NaCO_3$) were added to each sample bottle to chemically disaggregate the sediment. In addition, each sample bottle received a specified amount of distilled water and underwent eight hours of reciprocal shaking at 120 oscillations per minute, physically separating individual particles.

Four pipetting sessions measured specific particle size fractions from each sample (16 μm, 8 μm, 4 μm, and 2 μm). The temperature was recorded from the salt factor (dispersion) bottle before each sampling period to achieve the proper sampling time. The sediment solutions were contained in crucibles and placed in an oven to evaporate the distilled water. The product (sediment and salt) was weighed to the 0.0000 decimal place after each crucible cooled in a dissector for no longer than fifteen minutes, again to lessen the possibility of gaining water.

The sand to coarse silt fraction (2 mm to 32 μm) of each sedimentation bottle was obtained by quantitatively washing the sediment through a 450 mesh (32 μm openings) sieve using tap water. The contents of the nineteen sedimentation bottles were rinsed in beakers and placed in an oven at 105 °C for 4 hours, completely evaporating the excess water. The sands and coarse silts were then carefully transferred into a sieve set (Table 5). Each sediment fraction was placed into a Gilson three-inch sieve shaker for one and one-half minutes to complete particle separation.

Each sieve and its contents were weighed individually on a top loading balance and measured to the nearest 0.01 g.

Particle Size Analysis Sieve Series

Sieve #	Opening
18	1.0
35	0.5
60	0.25
120	0.125
230	0.063
270	0.053
pan	0.032

Table 5. Categories of silt and sand-sized sieve sizes used.

4. Results

4.1 2017 Dry Run Creek Geomorphic Field Survey

The following graphs, maps, and data in this report reflect the fieldwork that has been done within several portions of DRC between September 1st, 2016 and February 28th, 2017. Overall, 225 sites were identified and assessed (Figure 16). Data reported and conclusions made do not represent the entirety of DRC and only represent the portions of the stream that were studied thoroughly.

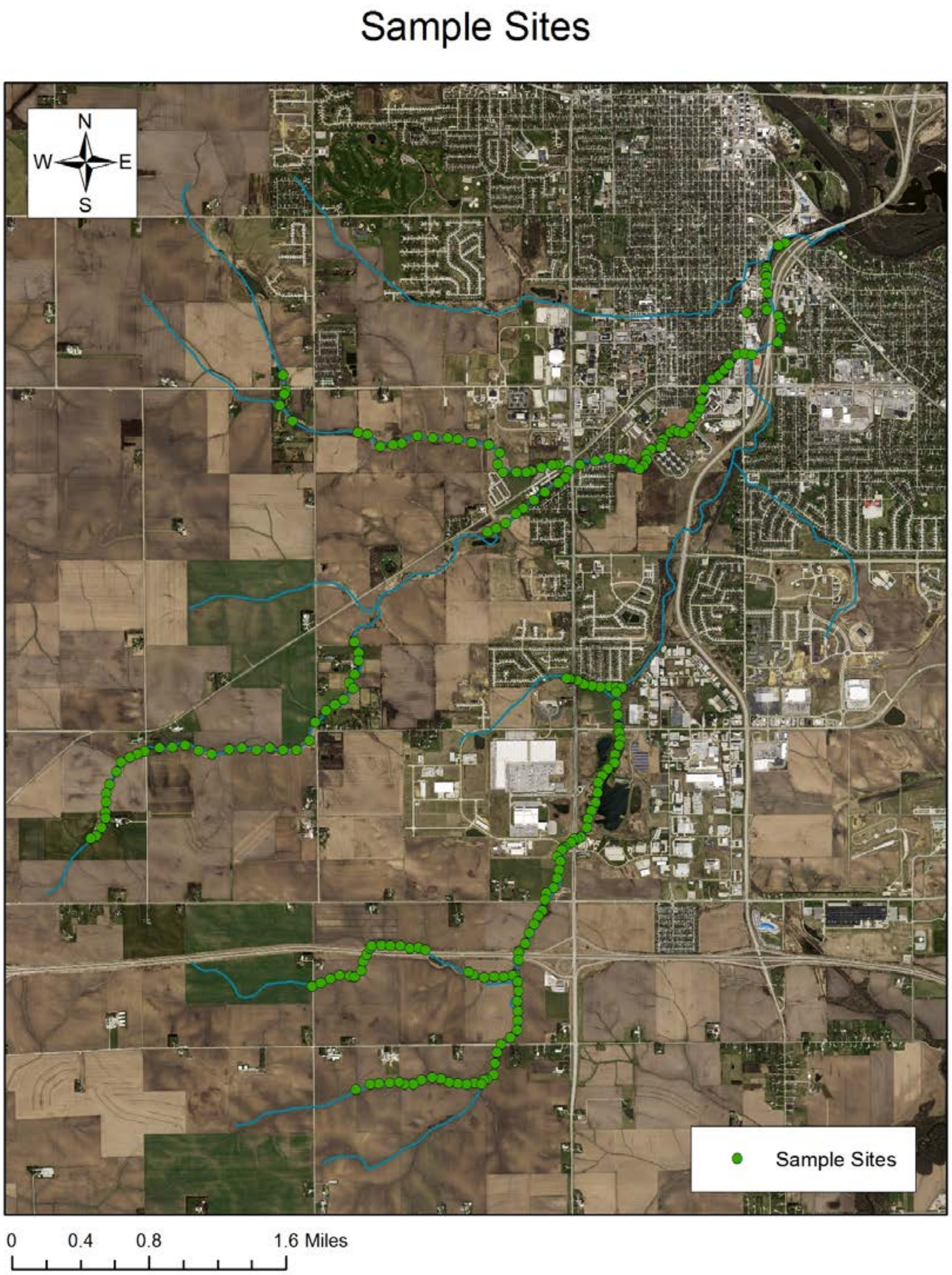

Figure 16. Sample sites for the 2017 Dry Run Creek study.

LAND USE

As time has progressed, the community of Cedar Falls has steadily grown, causing increasing portions of DRC to become further urbanized. As a result, land usage types surrounding the stream including agriculture, trees, grassland, and pasture have steadily declined and have been converted into urban landscapes. Currently, 37% of the Stream is surrounded by agriculture, and 35% of the stream is surrounded by urban areas. Grassland and trees represent 15% and 8%, respectively, and can often be found as a buffer between urban and agricultural landscapes. Pastures are least prevalent type, totaling only 5% (Figures 17, 18, 19 and 20).

CANOPY COVER

DRC is characterized by a lack of canopy cover along the majority of its course. 58% of the stream has 0-10% canopy cover, which predominantly represents areas of agriculture, but also includes various sections of the creek considered urban, grassland, and pasture. 21% of the stream has 10-25% canopy cover, but this percentage is heavily skewed towards 10%. 11% of the stream contains 25-50% canopy. Only 5% of the stream has 50-75% canopy cover, and 3% of the steam had greater than 75%. Most areas with greater than 25% canopy cover are found within city limits. The remaining 2% of areas sampled have no data on canopy cover because it was not estimated do to a lack of leaves because of the changing seasons (Figures 21 and 22).

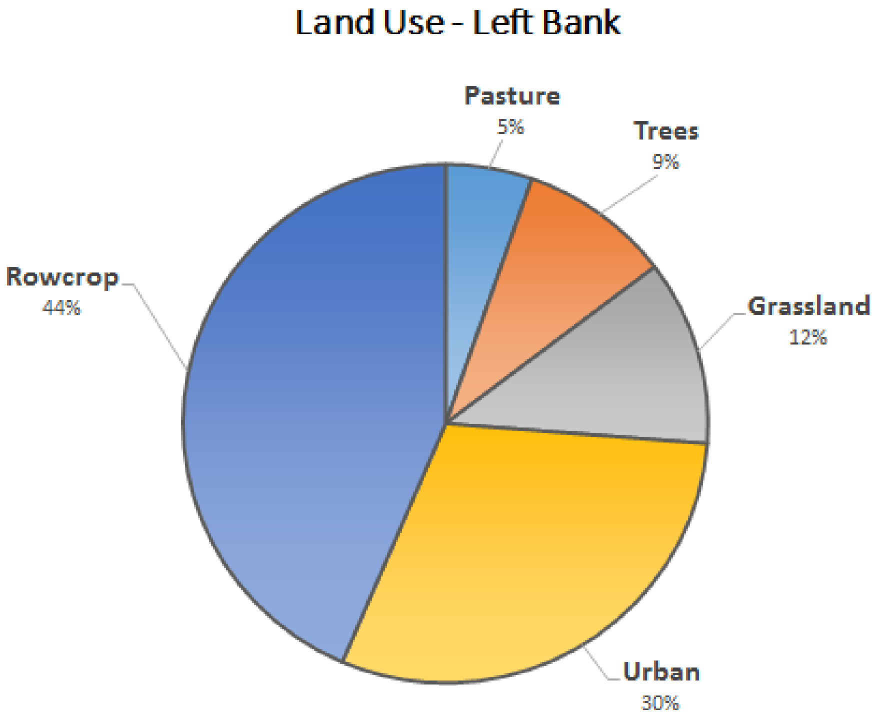

Figure 17. Land-use variability for DRC's left-bank.

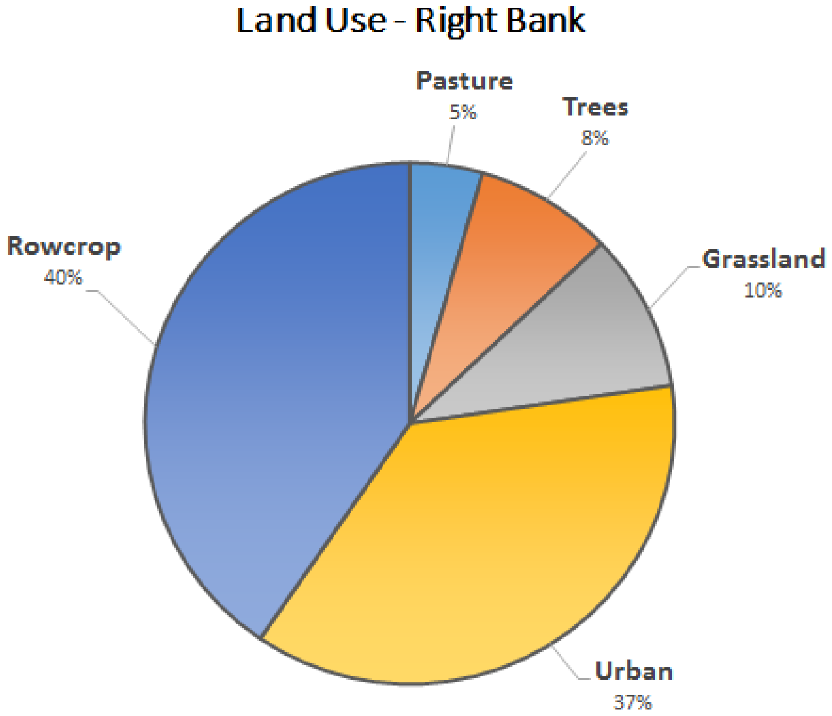

Figure 18. Land-use variability for the right bank of DRC.

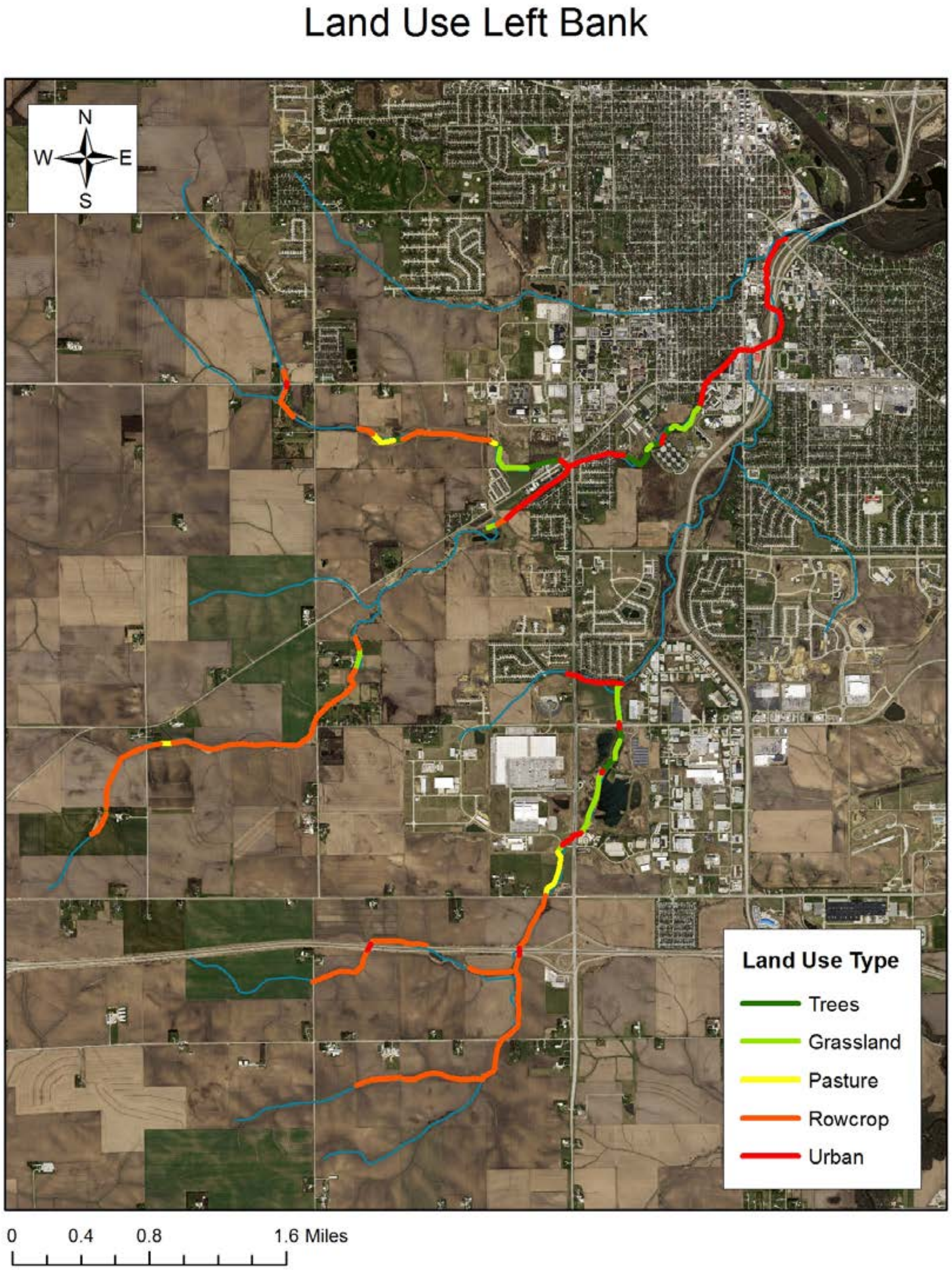

Figure 19. Left-bank land-use broken down into segments transposed onto a recent aerial photograph.

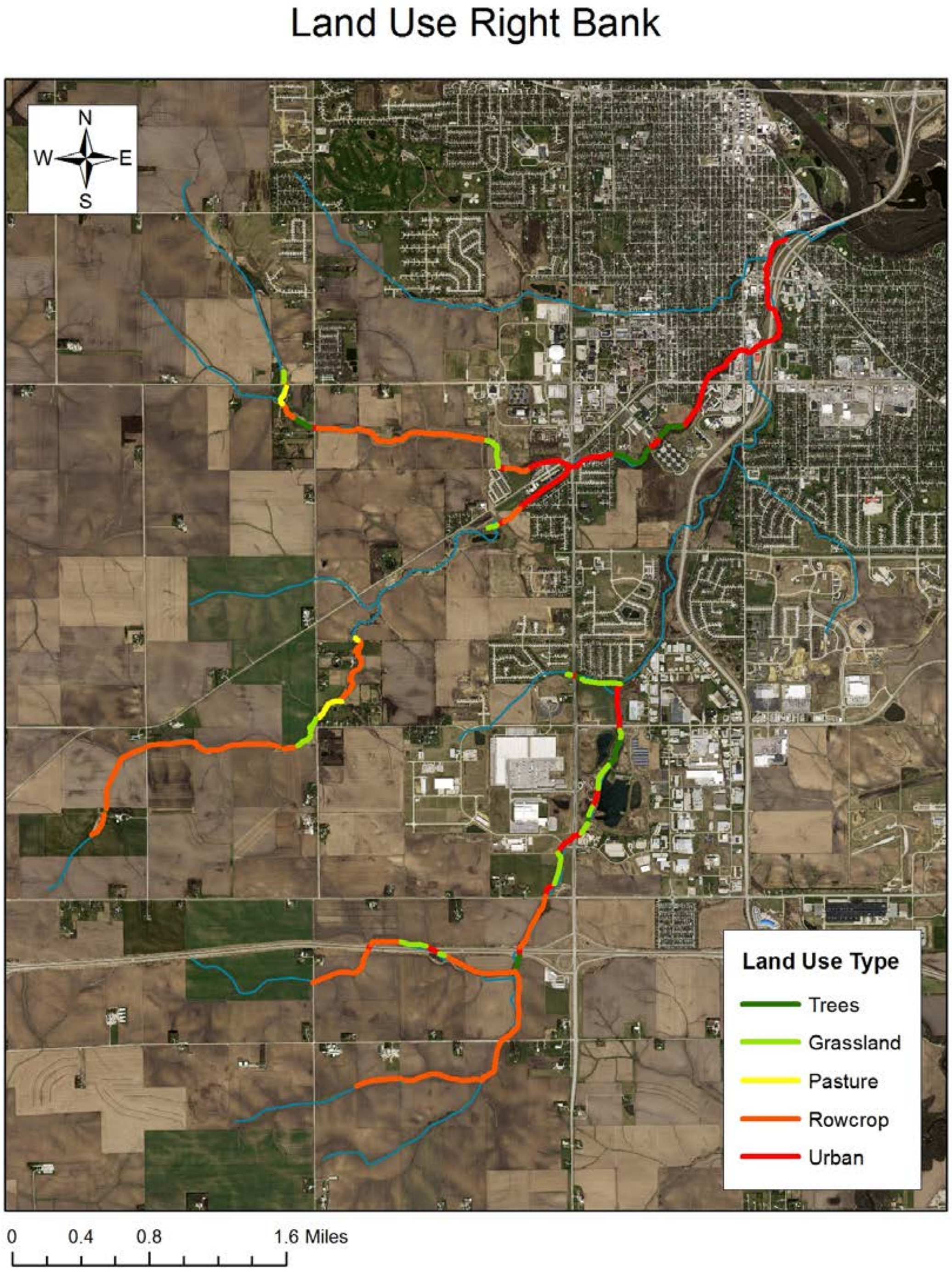

Figure 20. Right-bank land-use broken down into segments transposed onto a recent aerial photograph.

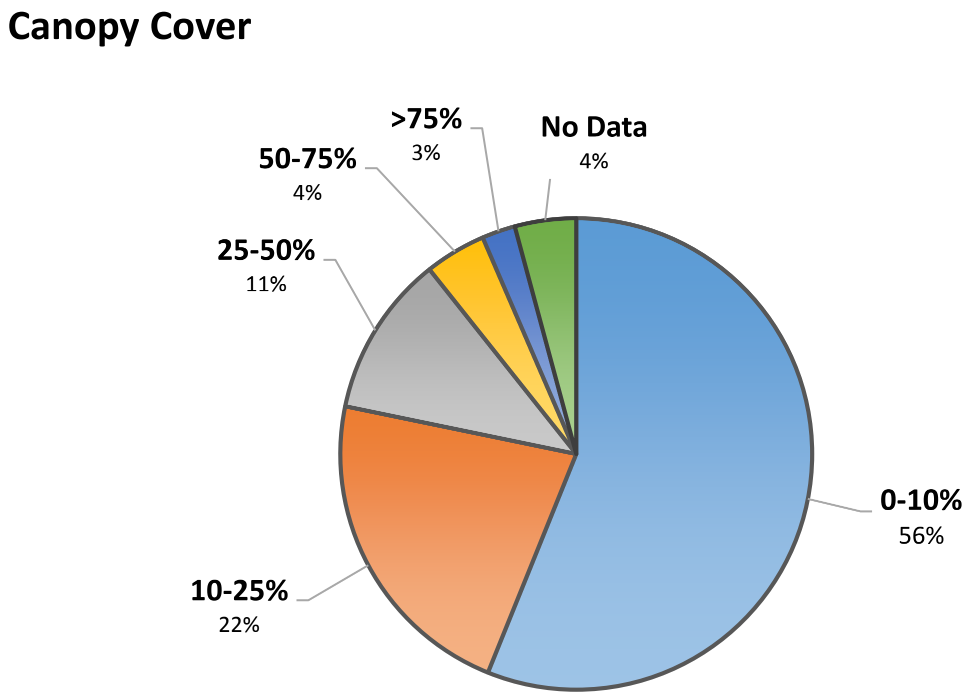

Figure 21. Variability of canopy cover along Dry Run Creek.

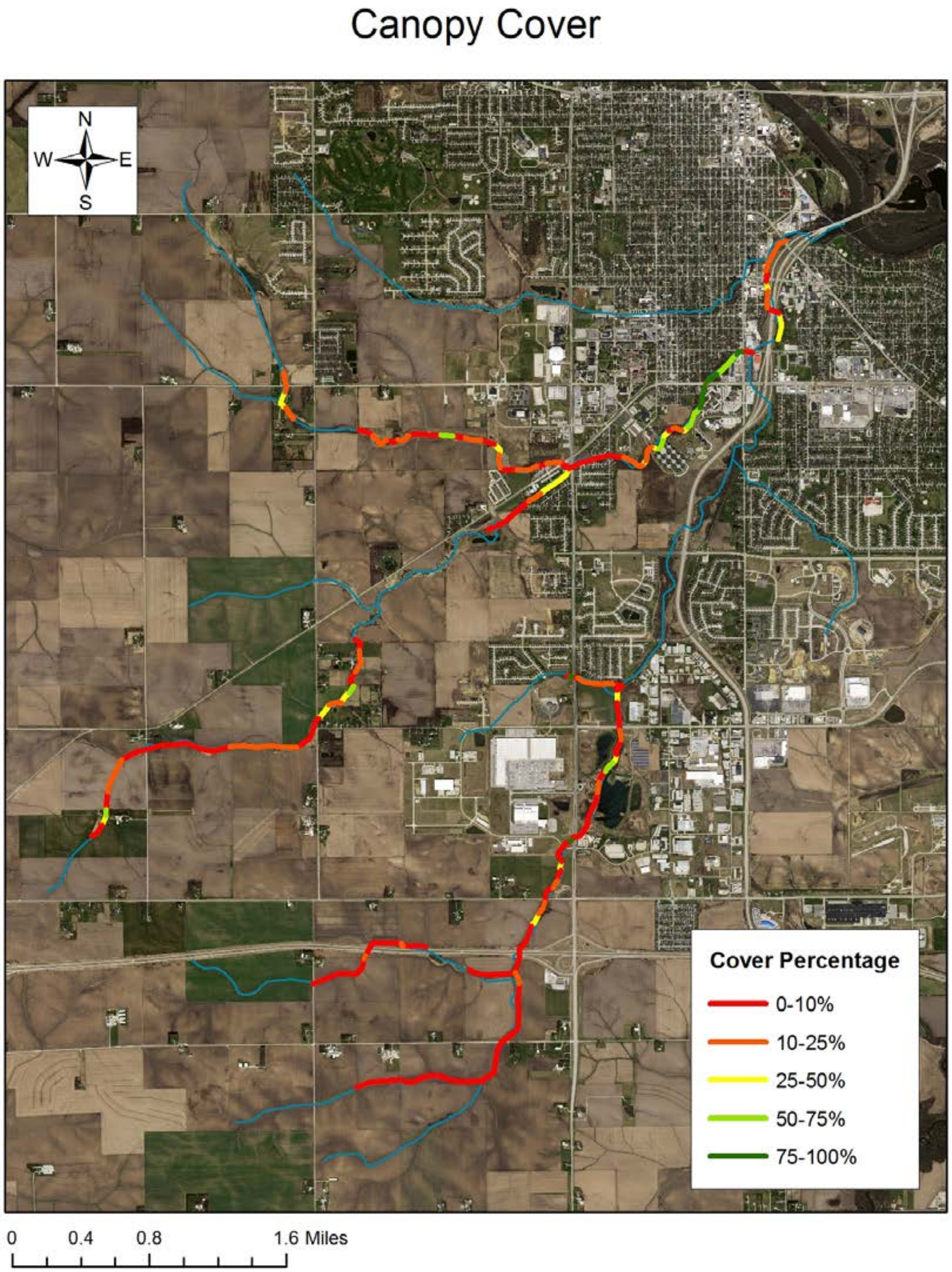

Figure 22. Canopy cover along Dry Run Creek, transposed onto a recent aerial photograph.

BANK STABILITY

The bank stability of DRC varies greatly throughout its course. It changes drastically at times due to changes in land use & recent climate variability. Bank stability is measured on a scale from stable to unstable. Stable represents banks that are fully vegetated, have an absence of undercutting, gradual incline, and little to no visible soil. Unstable banks are characterized by unvegetated banks, visible erosion, undercutting, and steep inclines. The most common bank stability class is moderately unstable, which represents 19% of the stream. It is followed by moderately stable/ moderately unstable banks at 14% and stable banks also at 14%. 13% of the stream is considered moderately stable, and 12% is considered moderately unstable / unstable. Stable / moderately stable banks compose 10% of the stream, and only 6% of the stream is considered as unstable. Currently, 8% of the stream is considered artificially stable, but this is likely to increase as Cedar Falls continues to grow as a community. The remaining 4% of areas sampled have no data concerning bank stability (Figure 23 & 24).

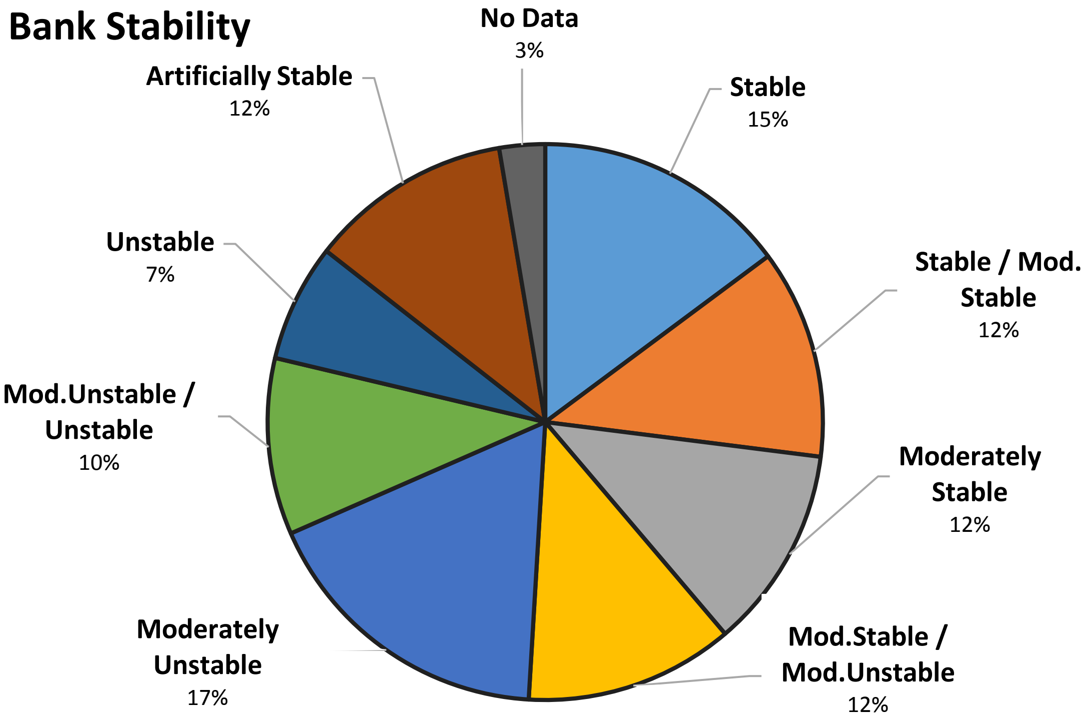

Figure 23. Bank stability along Dry Run Creek.

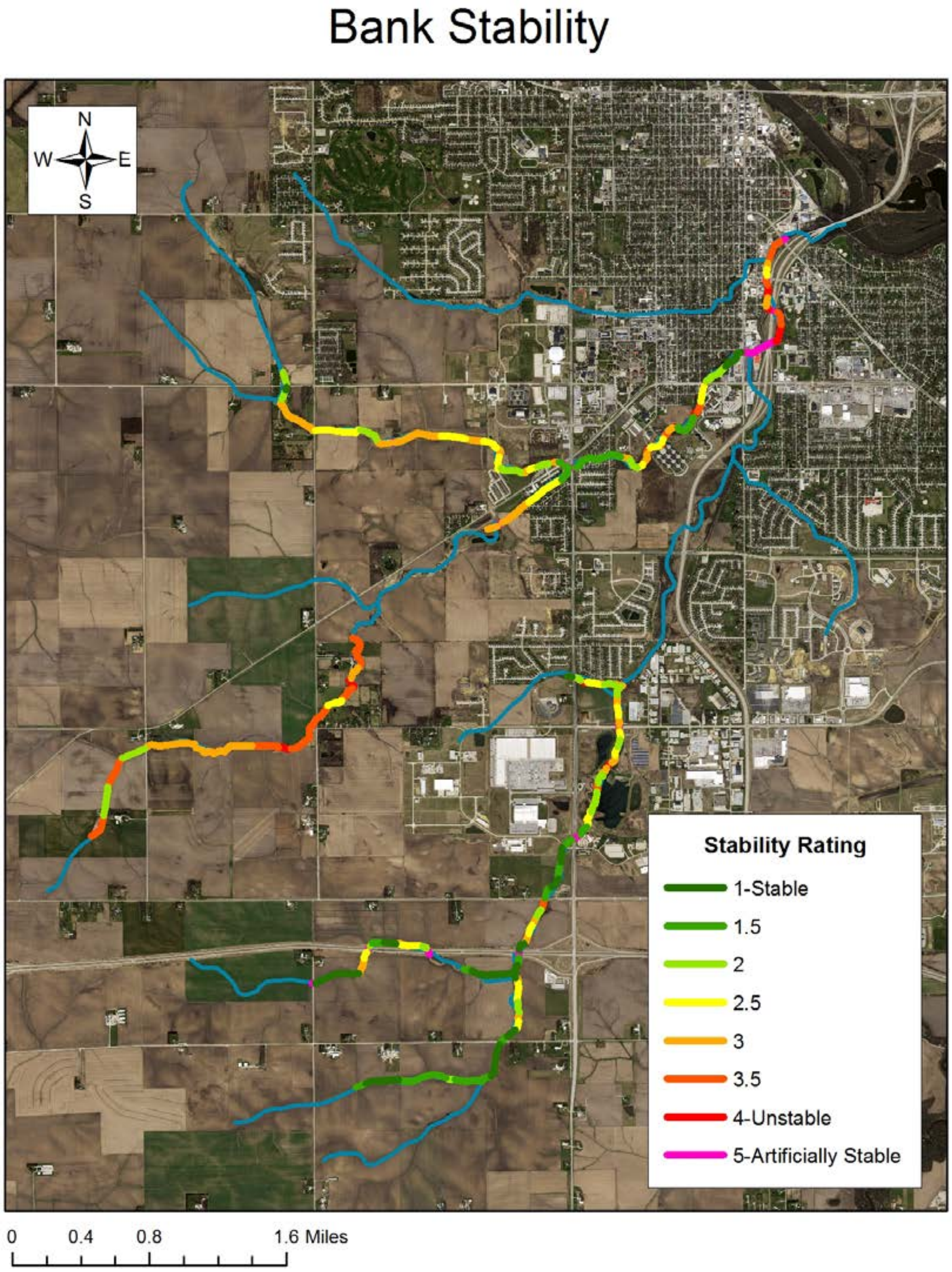

Figure 24. Bank stability broken down into segments transposed onto a recent aerial photograph.

DOMINATE SUBSTRATE

DRC has a dominant substrate composed of a variety of sediment types due to Iowa's history of glacial activity, its location in an alluvial basin, rich soils, and high amount of human activity. Most commonly, the substrate of Dry Run creek is composed of sand. However, mixtures of sand and other sediments are also common. 36% of the substrate was described as sand, 19% was sand/silt, and 13% was sand/gravel. The largest portion of Dry Run Creek's substrate without sand is gravel at 11%. Silt was found in 10 % of the streams substrate, and cobble/ gravel composed a close 7%. A mere 1% of the streams substrate consisted of large cobble. The remaining 3 % of areas sampled have no data concerning substrate (Figure 25).

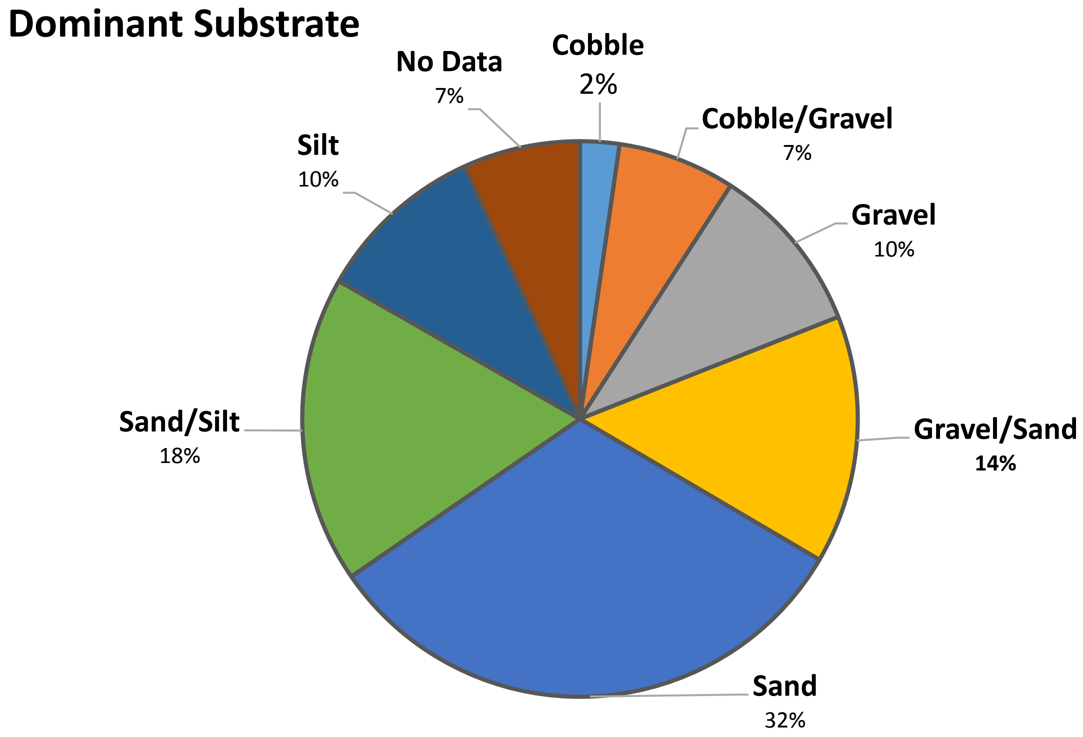

Figure 25. Substrate variability of Dry Run Creek.

IN-STREAM HABITAT

Habitat within DRC is highly dependent upon human interaction, land use, and water quality, as well as many other factors. Habitat in this study is defined as the relative abundance of logs, root clusters, pools, and boulders present in the stream. 25% of the stream is considered to have no habitat because these components were absent within the creek. 41% of the stream was considered to have < 30% habitat because only small amounts boulders, logs, and root clusters were present. 22% of the stream contains 30-60% habitat, and 9% of the stream contained > 60% habitat. The remaining 3 % of areas sampled have no data concerning in-stream habitat (Figure 26).

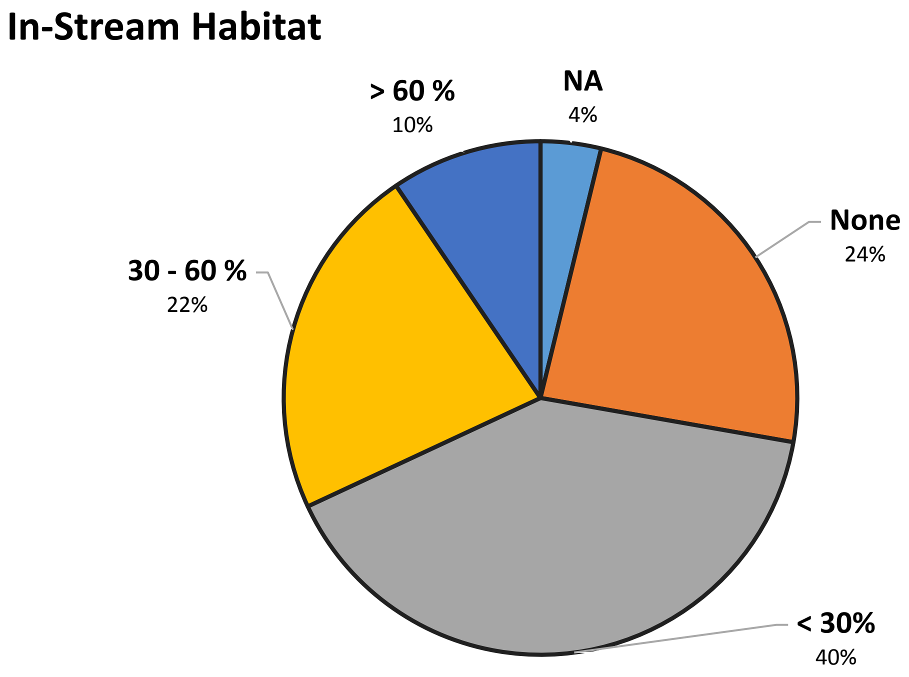

Figure 26. In-stream habitat percentages for Dry Run Creek.

BANK MATERIAL

The banks of DRC are composed primarily of silt, but have many accessory sediments that compose them. 62% of all stream banks sampled were predominately silt in nature. 22% of stream banks were a sand/silt mixture, and 7% were only sand. A mere 3% of stream banks were a sand/ gravel mixture, and 1% was gravel. Less than 1% of stream banks were composed of boulders and geologic outcrops. The remaining 3 % of areas sampled have no data concerning bank material (Figure 27).

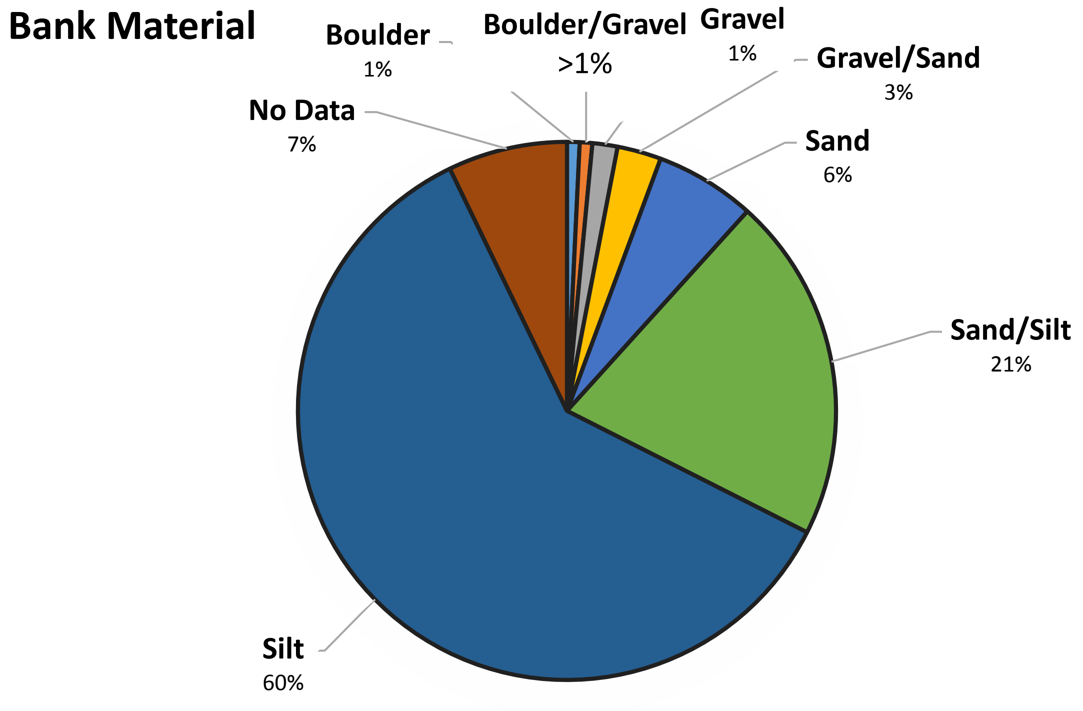

Figure 27. Bank material (sediment) for Dry Run Creek.

Average Bank Height

Average Bank heights within Dry Run Creek depend heavily upon land use type. Agricultural areas tended to have shorter, more gradual banks, and urban areas had higher, and more steeply sloping banks. The predominate bank heights within DRC were between 1.1 – 2 meters and consisted of 42% of the stream. The next largest percentage of bank heights lied between 0 -1 meters and consisted of 37% of the stream. 8 % of banks ranged from 2.1 -3 meters, and 3% ranged from 3.1 – 4 meters. Another 3% was higher than 4 meters. This section was completely urbanized and lied near an overpass of highway 58. 7% of the stream has no data at this time (Figures 28 & 29).

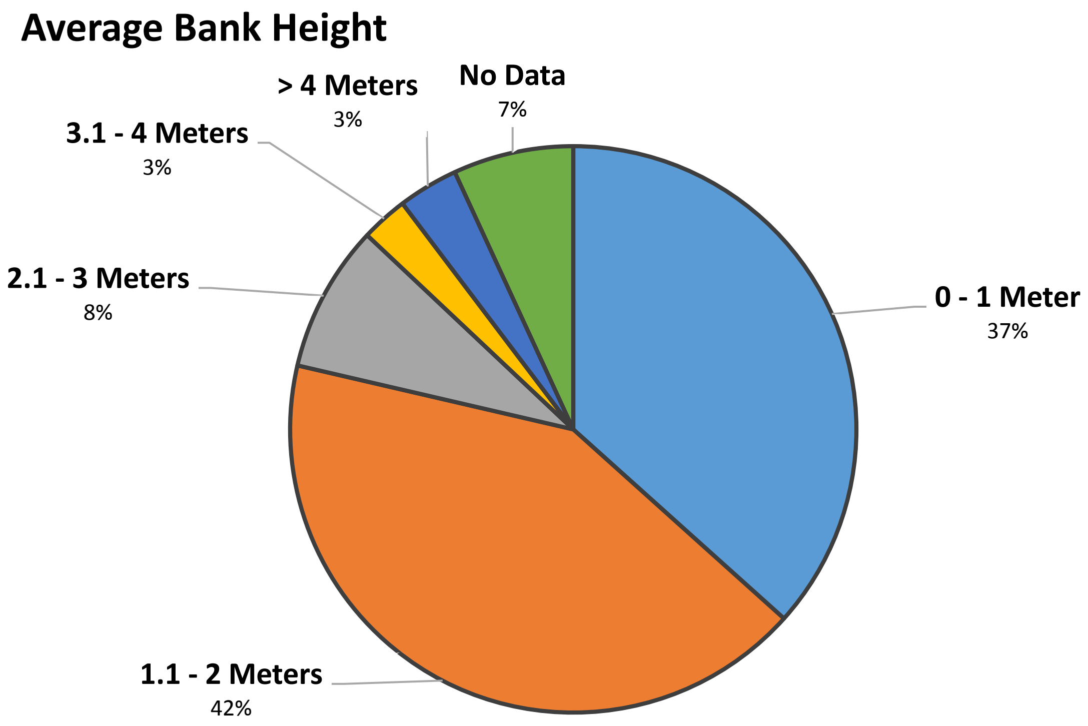

Figure 28. Average bank heights for Dry Run Creek.

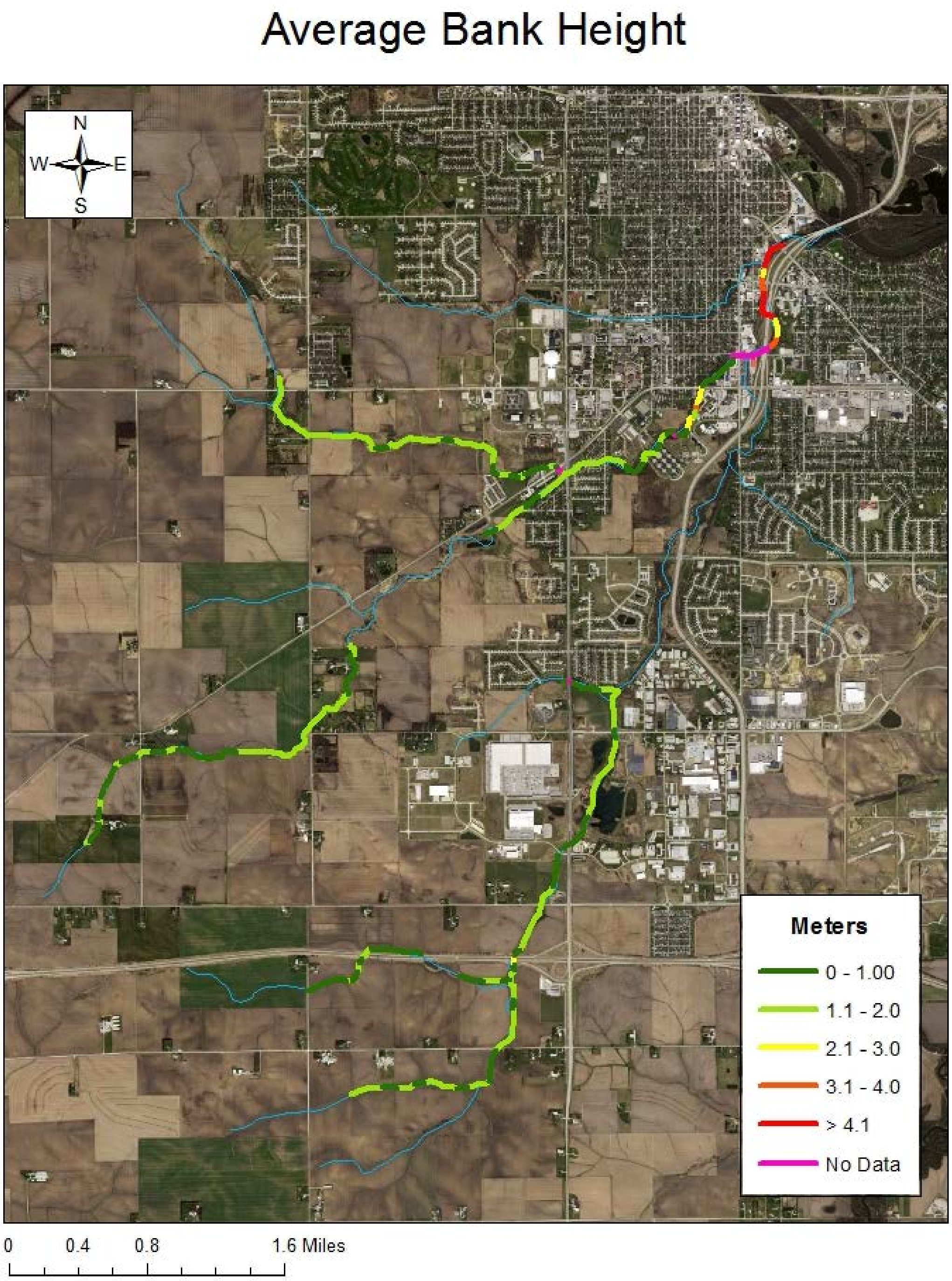

Figure 29. Average bank heights broken down into segments transposed onto a recent aerial photograph.

4.2 Morphometry Results

Dry Run Creek presents a classic dendritic drainage pattern, yet there are obvious signs of anthropogenic stream modifications (e.g. urbanization and agricultural tiling) that complicate our quantitative characterization of this rural to urban watershed (Table 6, appendix). The DRC watershed is a fourth-order drainage basin with the following segment distributions: 1st order, twenty-three, 2nd order, six; 3rd order, two (Figure 30). The bifurcation ratios ($R_B = N_0/N_{0+1}$) of the DRC segments are: 1st to 2nd (4.3:1), 2nd to 3rd (3.0:1), & 3rd to 4th (2.0/1). The length ratios ($R_L = L_0/L_{0+1}$ = Area/Length^2) of the DRC segments are: 1st to 2nd (20.33/11.19 miles = 1.8:1), 2nd to 3rd (11.19 / 6.14 = 1.8:1) and 3rd to 4th (6.14/ 1.29 = 4.8:1).

The constructed DRC Geographic Information System delineated drainage areas for each stream segment (Figure 31). Basin shapes ($R_f = A_0/L_B$^2) area values are: five representative 1st order (0.73, 1.49, 0.33, 0.52, 0.34), 2nd order (0.92, 0.46, 0.29, 2.08, 3.97, 2.04), 3rd order (3.75, 0.46) and 4th order (14.24). The DRC's drainage density ($D = \sum L/A$) is (1.38 miles). The relief ratio ($Rh = H/L_0$) is 0.004.

Three UNI Campus Sites along Dry Run Creek were surveyed for their cross-section geometries (Figure 32). These data provide support to the morphometric understanding of Dry Run Creek. Three stream profile cross-section exhibit diverse characteristics through a relatively short distance across campus. The depth range was 20 to 55 cm (Figures 33, 34 and 35). The width range was approximately 1020 to 580 cm (Figure 36). Averages (depth and bank height) and R^2 values were calculated for these stream geometries (Figures 37 and 38).

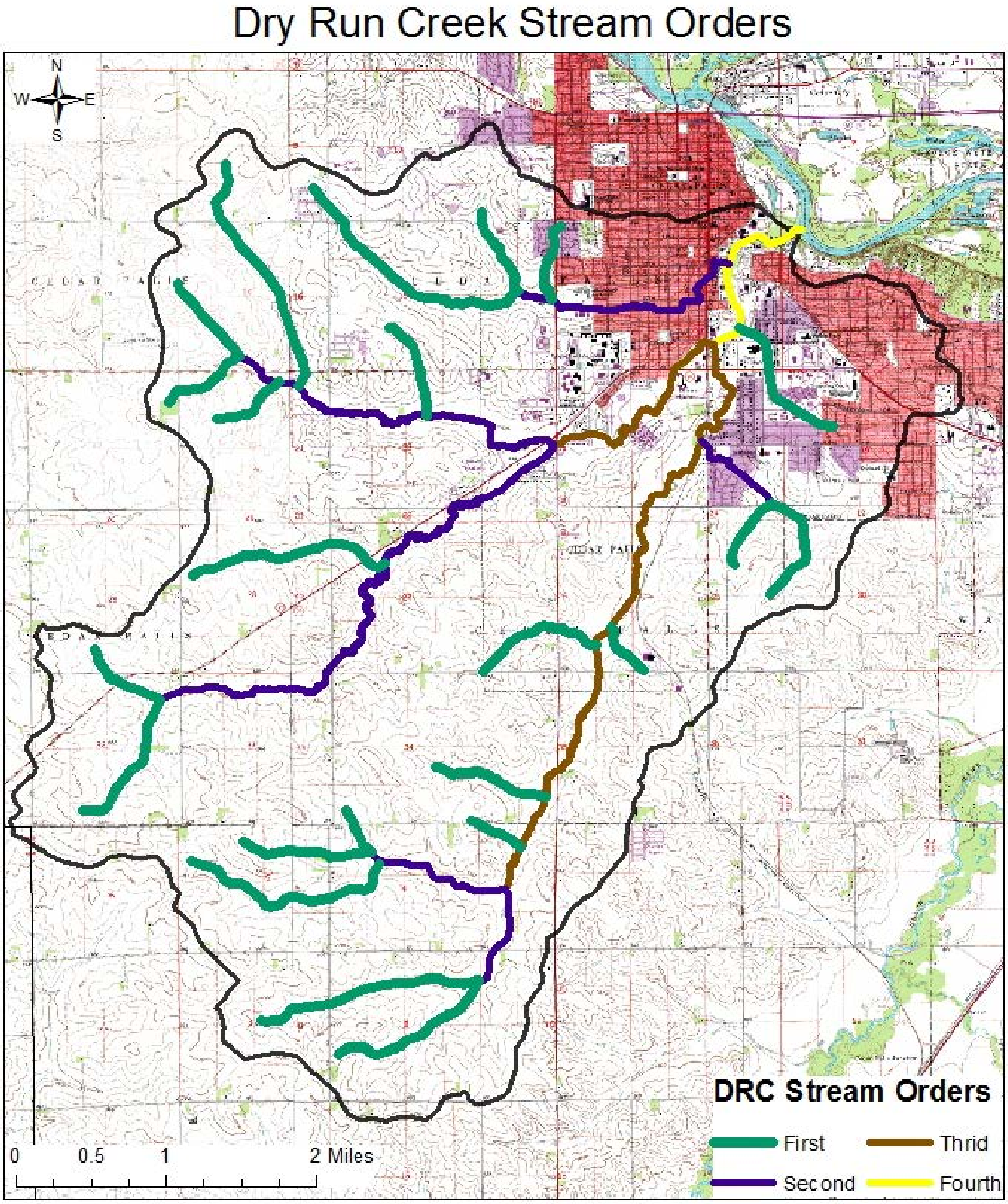

Figure 30. Delineated stream orders used for the Dry Run Creek Morphometric Analysis.

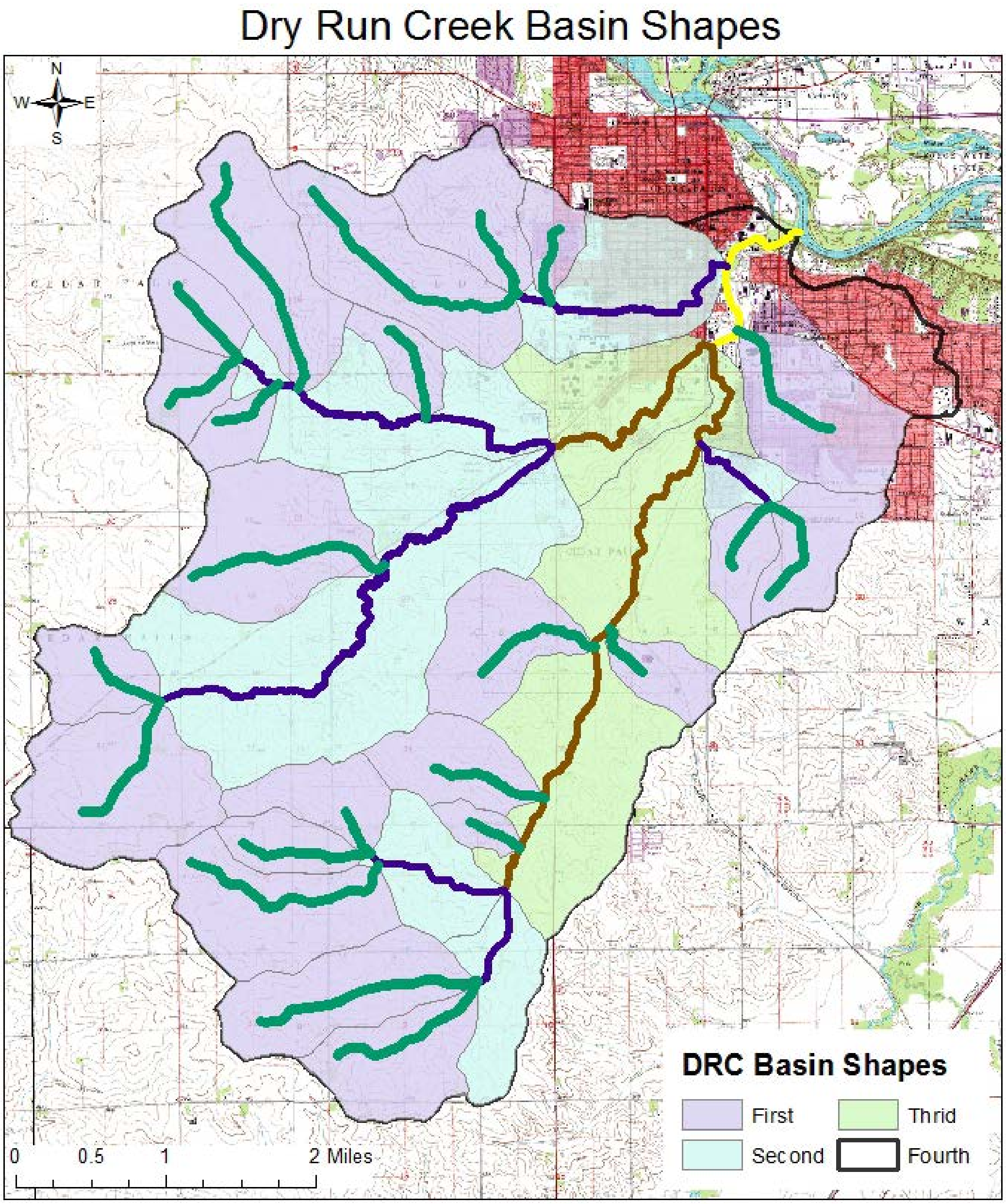

Figure 31. Delineated basin shape areas for each stream segment of Dry Run Creek.

Figure 32. Aerial photograph indicating the site locations for UNI sites 1, 2 and 3 used for stream geometry profiles.

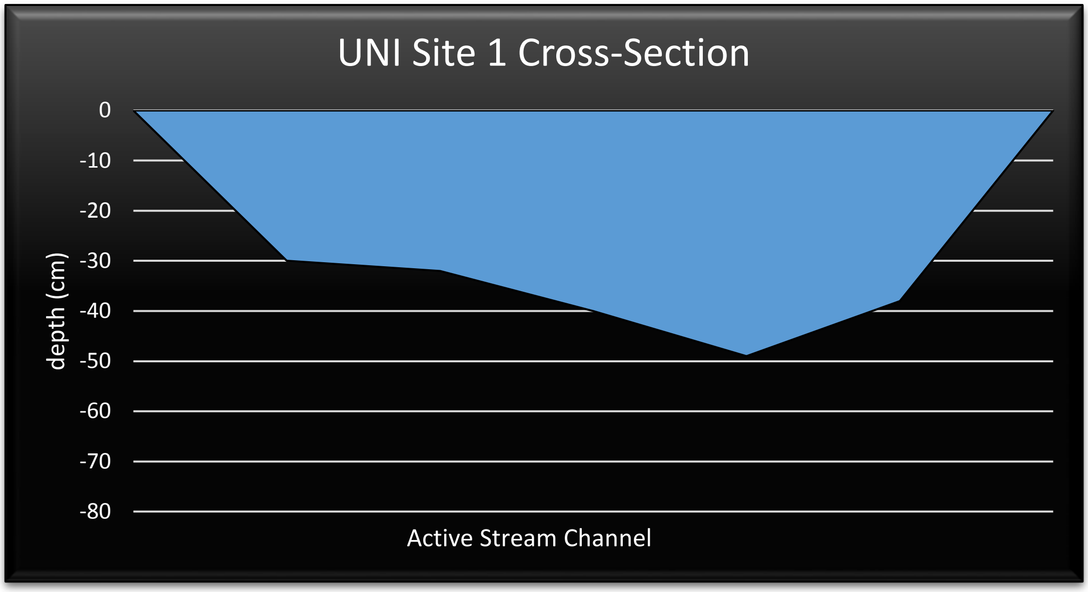

Figure 33. UNI site one stream geometry.

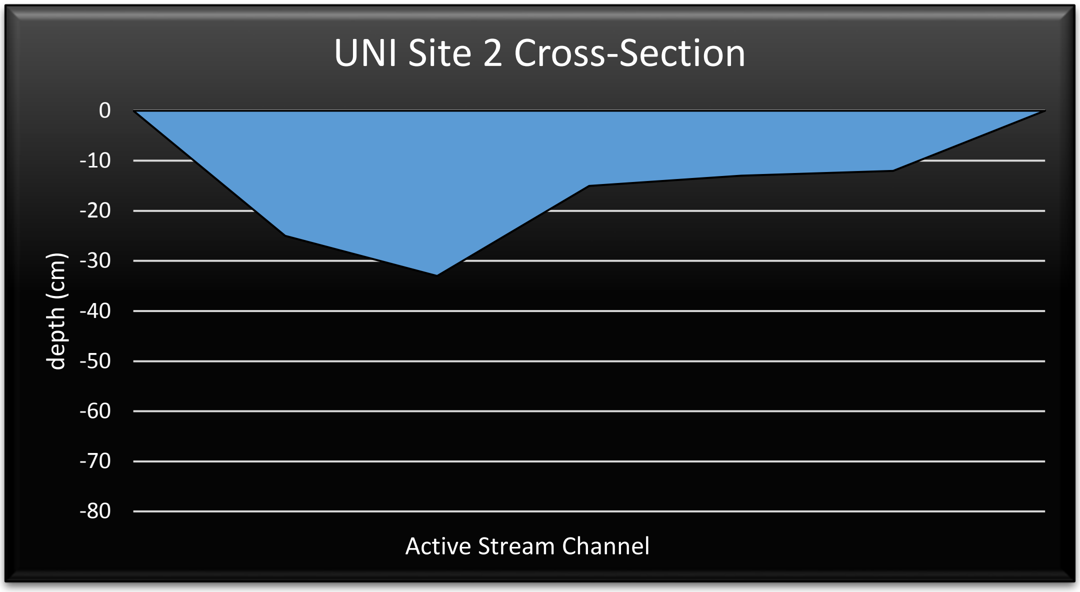

Figure 34. UNI site two-stream geometry.

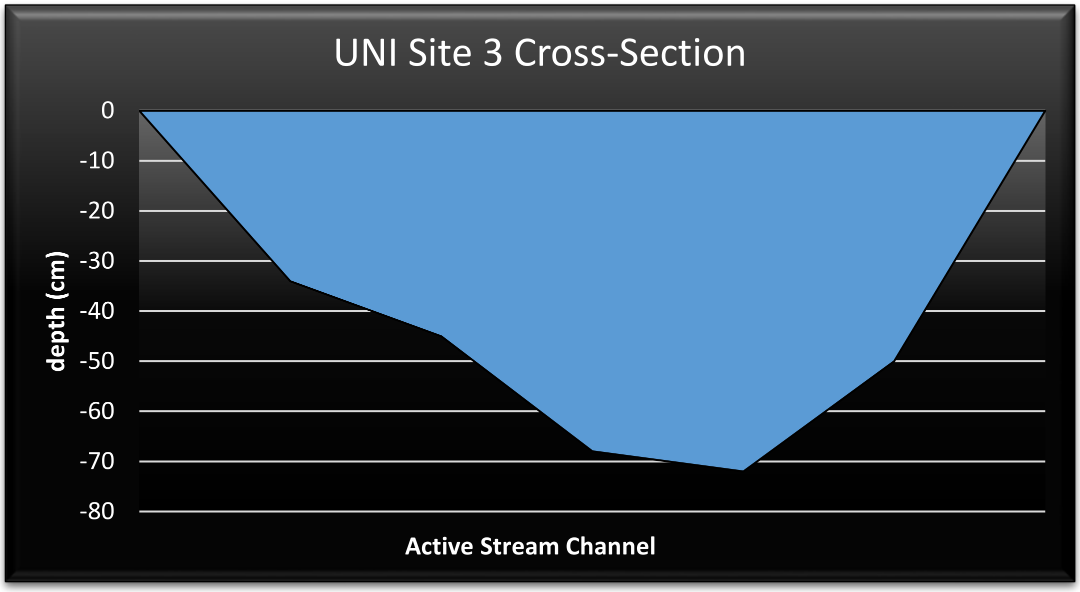

Figure 35. UNI site one stream geometry.

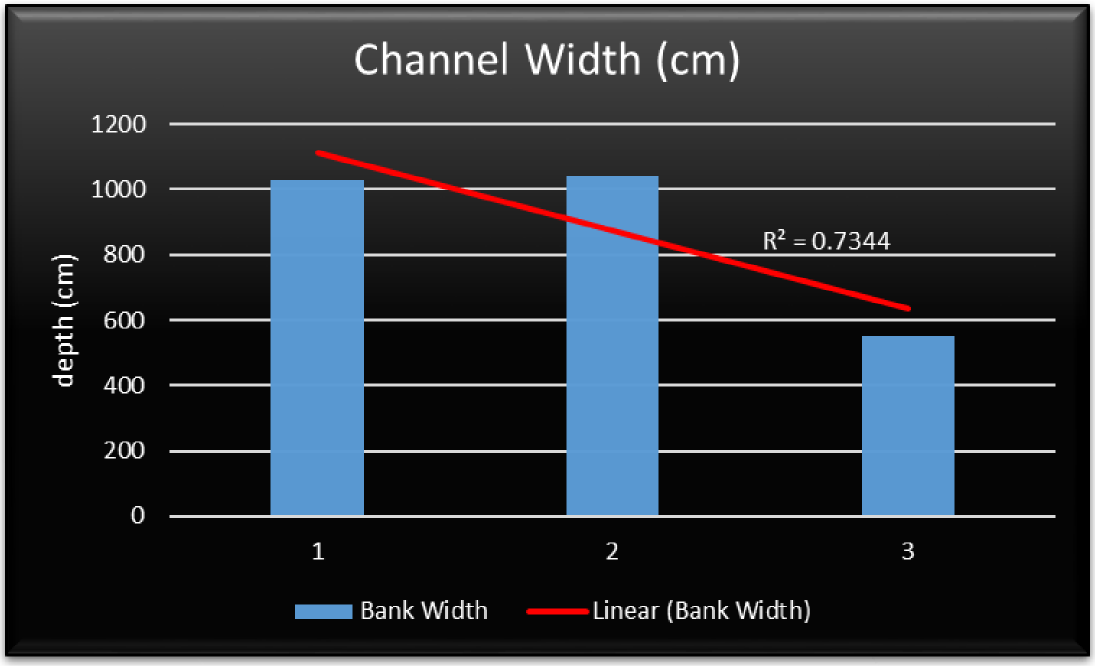

Figure 36. Stream widths for UNI Site 1, 2 and 3 with the R^2 value.

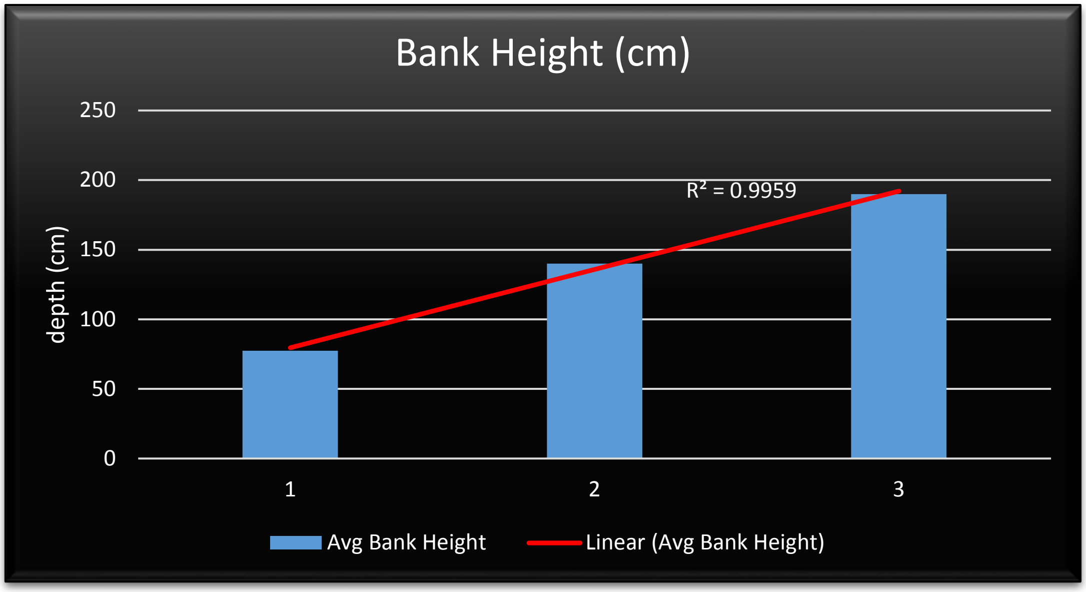

Figure 37. Average bank height (Site 1, 2 and 3) with the R^2 value.

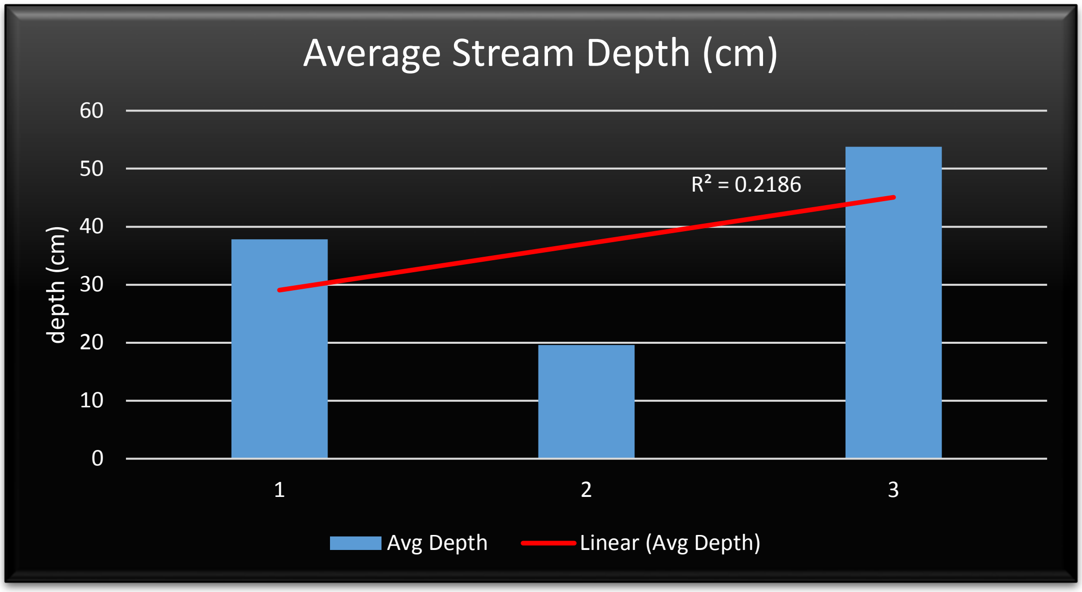

Figure 38. Average stream depths (Site 1, 2 and 3) with R^2 value.

4.3 Particle-size Analysis Results

Six bottom, left and right bank samples (from sites 3, 8, 26, 120, 125, and 131) were analyzed for their particle size distributions (Table 7). The analyses characterized matrix variability and did not account for coarse fragments. Bed matrix samples were predominantly sand 80 to 100%; samples at or approaching 100% sand led to inconsistencies in values of clay and silt due to very low amounts present Sample 120B, was disqualified due to incorrect percentages. Bank values were noticeably higher in silt and clay (between 10 and 70%, silt being dominant).

	USDA		
	Sand	Silt	Clay
Sample	TS	TSi	TC
ID	2-0.053 mm	53-2 µm	< 2 µm
008L	66.1	26.5	7.4
008R	70.5	19.5	10.0
008B	100.5	-1.3	0.8
003L	52.2	39.1	8.7
003R	68.9	22.4	8.7
003B	99.5	-1.0	1.5
026L	60.6	29.2	10.2
026R	65.2	25.4	9.4
026B	99.3	-0.3	1.0
120L	82.5	10.9	6.6
120R	77.2	14.7	8.1
120B	~~145.4~~	~~48.3~~	~~2.9~~
131L	61.1	29.6	9.3
131R	42.2	39.7	18.1
131B	59.3	30.2	10.5
125L	56.9	31.8	11.3
125R	34.0	55.8	10.2
125B	81.1	12.1	6.7
STD	26.3	70.0	3.7

Table 7. Particle-size values for a small sampling of DRC bank and bottom matrix samples. Red line indicates corrupt data.

5. Discussion and recommendations

These Dry Run Creek geomorphological data provide an accurate characterization of the watershed's geologic and hydrologic variables. This information facilitates the identification of problematic areas within the watershed that are highly susceptible to degradation. Our hope is that this research also provides campus and city planners, insight into effective remediation processes leading to the subsequent, biogeochemical/environmental, betterment of water quality and habitats within the DRC watershed. This geomorphic analysis identified variable (stable to unstable) stream bank conditions in the rural and urban portions of the watershed (Figure 39).

Agricultural and urban land coming directly up to the stream banks leaves little to no buffer zone capable of decreasing the velocity of water and/or contaminants moving from the land towards the stream. In order to improve water quality, in-stream habitat, and/or bank stability, the Dry Run Creek Improvement Project should continue encouraging remediation practices in these zones of high instability. Point source runoff from agricultural and urban tiling was identified throughout the watershed (Figure 40).

Retention ponds and constructed wetlands can be positive examples of remediation (Figure 41). With a growing number of urban development's proper retention pond educate really needs to be implemented to develop the most positive impact on the neighborhood as well as the streams health.

Figure 39. Photographs exhibiting urban (top) and agriculutre (bottom) stream health. Unstable conditions are dominant throughout the creek; these images show erosive/cut banks and row crops or a mowed and maintained yards come directly up to the stream. This amount of erosion on the banks throughout the stream promotes increased runoff leading to more erosion.

Figure 40. The images above provide examples of what this point source runoff looks like in the field. The image on the left show point source runoff in an urban area, while the image on the right shows a farm tile entering the stream.

Figure 41. The image on the right is an example of a retention pond constructed in a new housing development in Cedar Falls. Retention ponds can be used to slow the rate of flow and artificially managing water, although the example on the right has a drain where the water would go down into the sewer system instead of flowing naturally into the stream or being infiltrated into the ground. The photograph on the left provides an example of a relatively successful restoration project; Located on UNI's campus, this wetland project is beginning to manage water effectively while providing positive influences on the Dry Run Creek and its overall health.

Artificial stabilization in urbanized areas commonly occurs along Dry Run Creek through Cedar Falls. Rip rap is used mostly throughout these sections. Some of these stabilization projects are effective; others make stabilization worse (Figure 42).

Figure 42. The image on the left shows a poor example of bank stabilization, where debris and cement was slopped into the stream and down the bank. Concrete is not a good way to stabilize it gives no movement for the stream and will speed up the waters movement causing more erosion to occur. The image on the left is between UNI’s campus and College Street where apartments are being built, these apartments are right on the streams edge and rip rap was implemented to control bank erosion throughout this area. This kind of stabilization will help to prevent erosion, but not allow the steam to move at all.

Overall, the stabilization of banks along Dry Run Creek, should, demand our attention. With a growing urban population, it is imperative that stream monitoring, community outreach and education efforts continue for the future health of DRC and those that live, learn, work and play within its watershed. The Dry Run Creek Geomorphology Research Group plans to continue work this Summer and next Fall (2017). We are working to better characterize developments within the DRC watershed through field and laboratory (GIS, Geochemical, and particle-size analyses).

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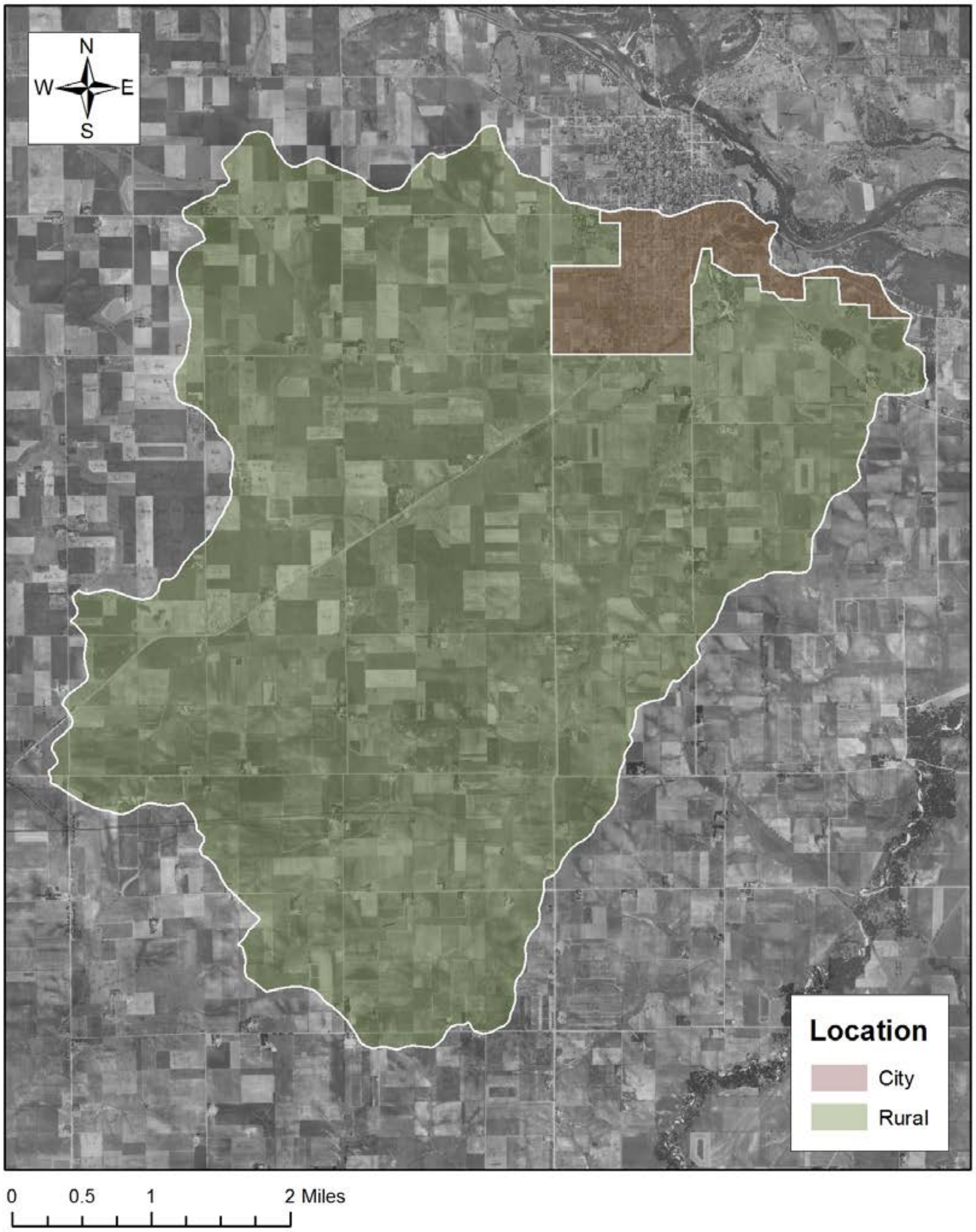
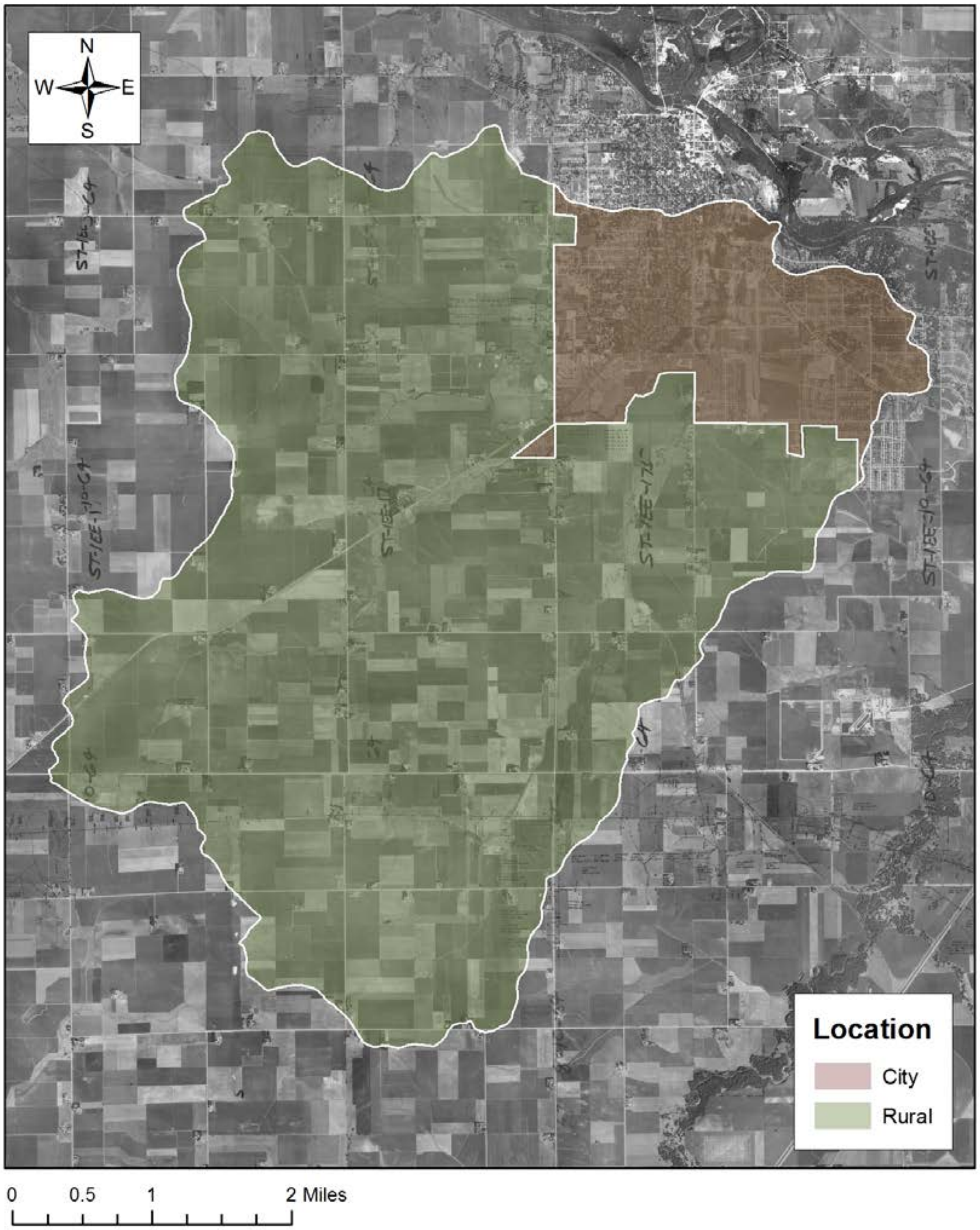
7. APPENDIX

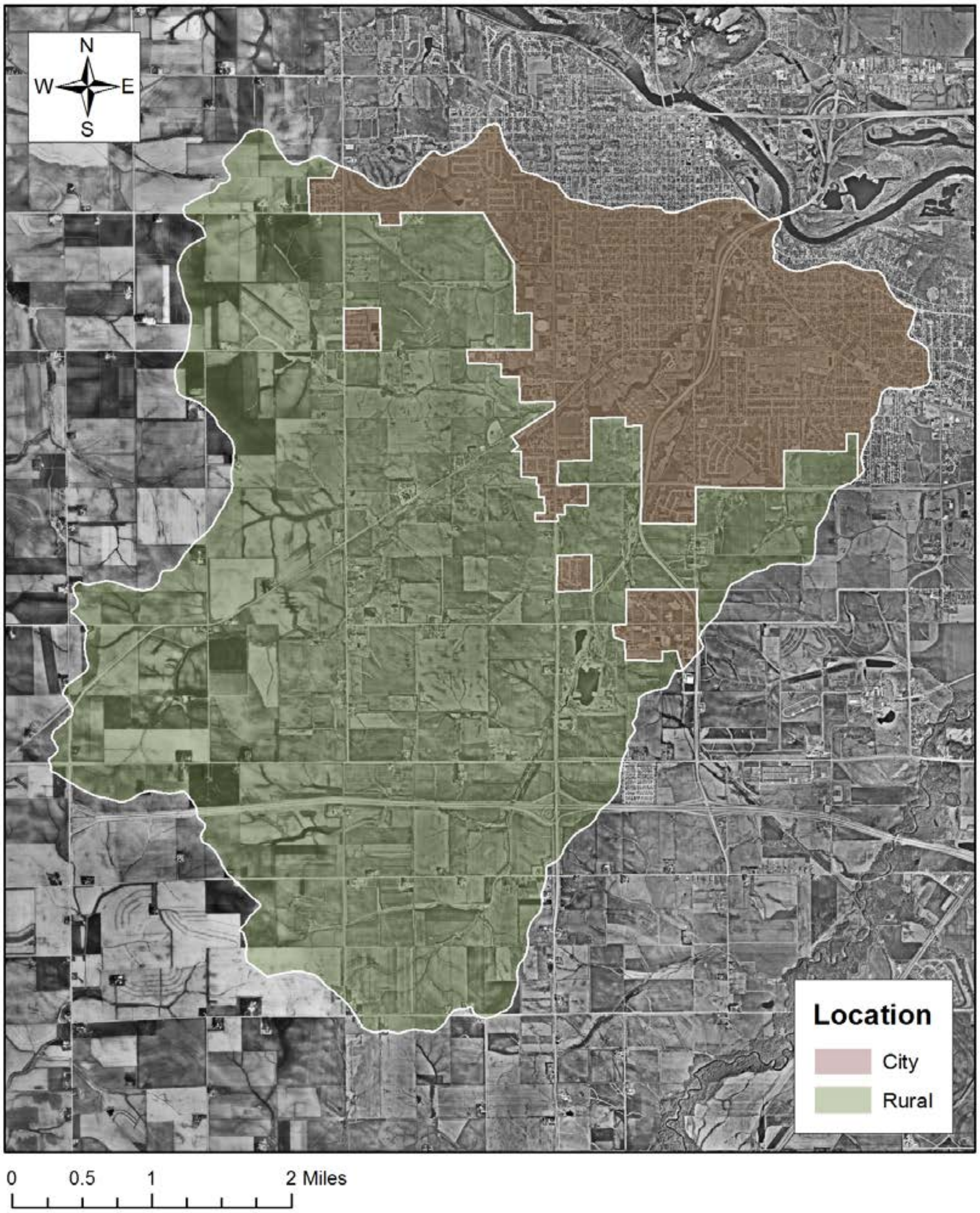
DRC Stream Location 1930



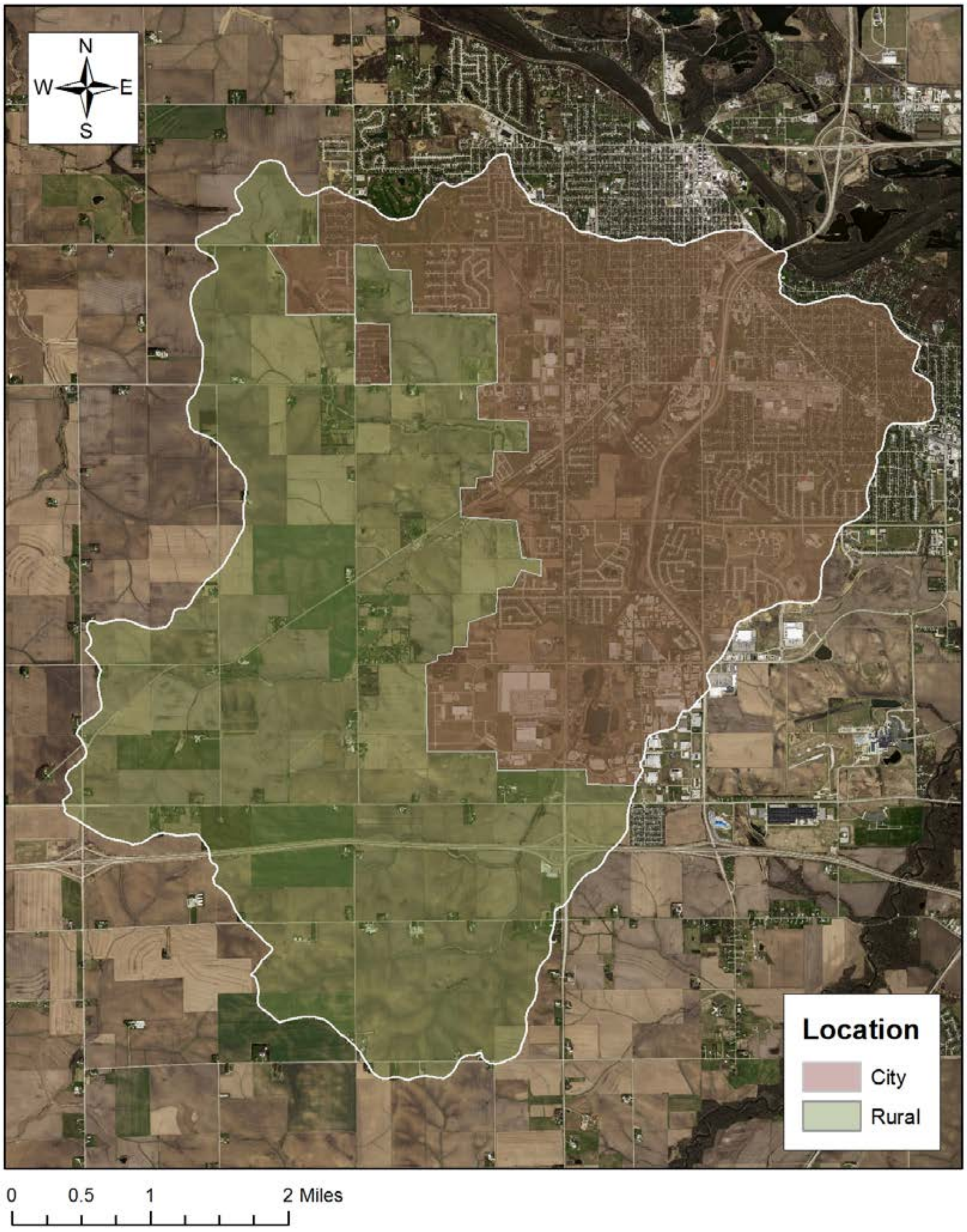
DRC Stream Location 1960



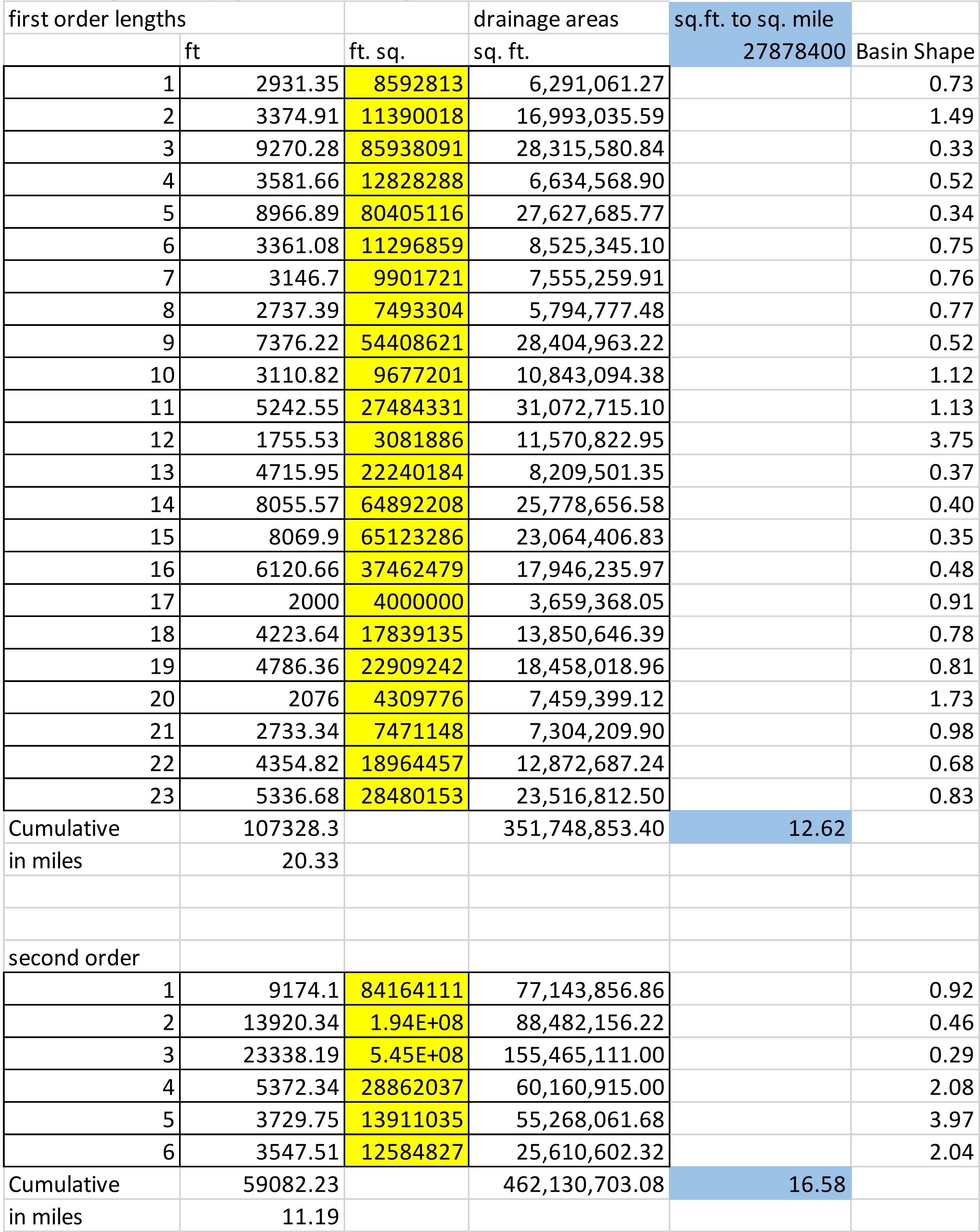
DRC Stream Location 1990



DRC Stream Location



DRC Morphometry (Raw numbers)



first order lengths			drainage areas	sq.ft. to sq. mile	
	ft	ft. sq.	sq. ft.	27878400	Basin Shape
1	2931.35	8592813	6,291,061.27		0.73
2	3374.91	11390018	16,993,035.59		1.49
3	9270.28	85938091	28,315,580.84		0.33
4	3581.66	12828288	6,634,568.90		0.52
5	8966.89	80405116	27,627,685.77		0.34
6	3361.08	11296859	8,525,345.10		0.75
7	3146.7	9901721	7,555,259.91		0.76
8	2737.39	7493304	5,794,777.48		0.77
9	7376.22	54408621	28,404,963.22		0.52
10	3110.82	9677201	10,843,094.38		1.12
11	5242.55	27484331	31,072,715.10		1.13
12	1755.53	3081886	11,570,822.95		3.75
13	4715.95	22240184	8,209,501.35		0.37
14	8055.57	64892208	25,778,656.58		0.40
15	8069.9	65123286	23,064,406.83		0.35
16	6120.66	37462479	17,946,235.97		0.48
17	2000	4000000	3,659,368.05		0.91
18	4223.64	17839135	13,850,646.39		0.78
19	4786.36	22909242	18,458,018.96		0.81
20	2076	4309776	7,459,399.12		1.73
21	2733.34	7471148	7,304,209.90		0.98
22	4354.82	18964457	12,872,687.24		0.68
23	5336.68	28480153	23,516,812.50		0.83
Cumulative	107328.3		351,748,853.40	12.62	
in miles	20.33				
second order					
1	9174.1	84164111	77,143,856.86		0.92
2	13920.34	1.94E+08	88,482,156.22		0.46
3	23338.19	5.45E+08	155,465,111.00		0.29
4	5372.34	28862037	60,160,915.00		2.08
5	3729.75	13911035	55,268,061.68		3.97
6	3547.51	12584827	25,610,602.32		2.04
Cumulative	59082.23		462,130,703.08	16.58	
in miles	11.19				

Table 6. Morphometric raw values for the Dry Run Creek Watershed.

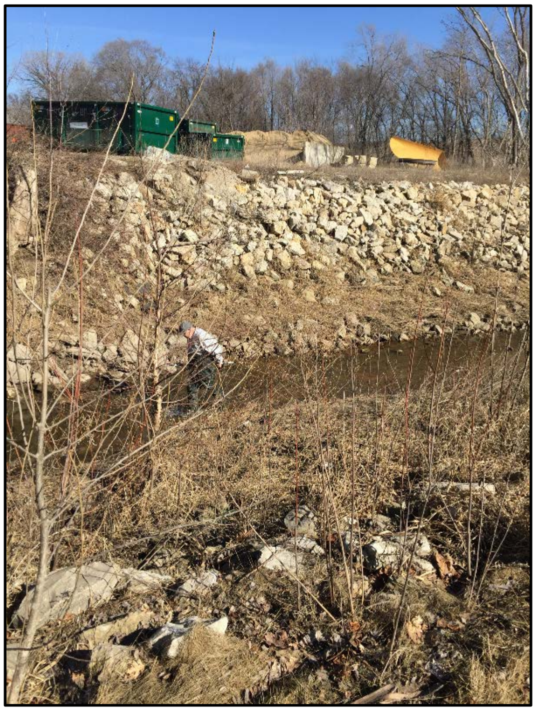
DRC Morphometry (Raw numbers) cont.

Third Order					
1	8462.63	71616107	268,217,836.44		3.75
2	23976.35	5.75E+08	263,897,900.00		0.46
Cumlative	32438.98		532,115,736.44	19.09	
in miles	6.14				
Fourth order					
1	6824.35	46571753	662,984,015.83		14.24
Cumlative	6824.35		662,984,015.83	23.78	
in miles	1.29			miles^2	
Overall sum	32.81	miles			
of length					
masterStreamS	42600.35				
longStreamN	34449.87				
Drainage density	1.38	miles			
Relief					
High	1025.00				
low	845.00				
	180.00				
Relief ratio	0.004				
	0.004 : 1				
Difference between cumlative 1,2,3 and the ov			130,868,279.39		

Table 6 *continued*. Morphometric raw values for the Dry Run Creek Watershed.

Effects of Agriculture

Effects of Urban Development



Water Pollution

Construction