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Trout habitat and stream restoration in Decorah

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EXECUTIVE SUMMARY

This report focuses on the restoration of Old-Dry Run creek in Decorah for trout habitat. It is a component of the stormwater management capstone project for the city of Decorah. The aim of this component was to undertake a comprehensive study of the existing conditions of Old-Dry Run creek and consider the prospects of restoring the creek for trout habitat. With help and support of stakeholders and the City Manager of Decorah, a comprehensive document has been developed that shows the near-stream and in-stream conditions of the creek using RASCAL assessment and assessment of water quality data provided by Professor Jodi Lynn Enos-Berlage of Luther College. The restoration of Old-Dry Run creek as trout habitat will make the creek an amenity for the residents of Decorah because trout need clean cold water for survival.

The stormwater management project started in August 2014 and the trout and the creek restoration component started in November 2014. An extensive literature review on trout habitat, local water quality problems and how to restore trout habitat indicate that unmanaged stormwater run-off contributes to the problem of bacterial contamination, the major source of impairment in streams and river in Decorah as well as high water temperature, inadequate dissolved oxygen and high turbidity, which all affect trout habitat in Old-Dry Run creek.

After reviewing the literature on trout and its habitat, goals, research questions and methodology were developed to guide the trout habitat and creek restoration component plan. The current conditions of Old-Dry Run creek were captured through RASCAL stream assessment and the analyses of water quality data of the creek. Stakeholders were interviewed for their inputs on the current or potential problems of Old-Dry Run creek and their opinions about the most effective ways to restore the creek as trout habitat. Their information served as a guide for the recommendations on how to restoration Old-Dry Run creek as trout habitat.

The problems in Old-Dry Run Creek are: high E.coli, acidic pH levels, inadequate dissolved oxygen, erosion along the creek banks, inadequate creek bank stability, inadequate riparian width, dominant silt/mud substrate and inadequate percentage of canopy cover. However, the clarity of the creek water was not a problem since 90% is tea color. In addition, the flow of the creek is mainly normal (84%).

The main recommendations for the creek restoration were formation of Old-Dry Run Creek sub-watershed group, rain gardens, ripraps, riparian buffers, education and dredging.
CHAPTER 1

Introduction: Importance of trout, problem statement, research questions and methodologies
INTRODUCTION

Background: Importance of trout and trout habitat

The city of Decorah, Iowa, is home to one of six Iowa streams known for receiving the highest angler visits and stands to gain economic and ecological benefits from the preservation and restoration of trout habitat (Steuck, 2011). In the United States, sport fishing contributes about $45 billion in retail sales (Kinsella et al, 2008). In Iowa, about $14.4 million is generated annually from activities related to trout fishing, mainly anglers’ usage of hotels & motels, dinning and drinking, transportation and fishing related expenses in the trout stream areas (Iowa Department of Natural Resources, 2006). Anglers spend roughly $27 per day when they go trout fishing (Iowa Department of Natural Resources, 2006). Trout Run stream, which passes through the south eastern portion of Decorah, was one of the six streams in Iowa that received the highest angler visits per mile in 2006 (Steuk, 2011). Increasing trout habitat provide healthy water bodies for recreational activities and support local businesses by promoting tourism. The Winneshiek County Tourism Director emphasized that decline in water quality would have a negative effect on recreational tourism in Winneshiek County (Iowa DNR, 2006). Water quality of local streams and river is important since it support both trout habitat and tourism.

Trout play a role in the productivity of the water body and are regarded as “keystone species” because of the function they play in the health of the ecosystem (Knight, 2009). The presence of trout in streams adds to the biodiversity of ecosystems. Trout serves as food to other animals and also helps to control the growth of other organisms (nymph) in their habitat (Washington Department of Fish & Wildlife, 2009). The carcass of a decomposing trout in a riparian system also serves as fertilizer for the soil and enhances tree growth around the streams. Clean cold water is the ideal water condition for trout. Old-Dry Run Creek needs to be restored to provide clean cold water and enough water flow.

Problem Statement

Unmanaged stormwater run-off contributes to the problem of bacterial contamination, the major source of impairment in streams and river in Decorah, as well as high water temperature, inadequate dissolved oxygen and high turbidity that affect trout habitat in Decorah (Wittman et al, 2013).

Information from the Iowa Department of Natural Resources (IDNR) was used to establish the cause of impairment of streams and river in Decorah. IDNR determines water use classification and the levels of impairment based on US Environmental and Protection Agency standards. Water bodies in Decorah are classified as class A1 and A2. Class A1 are for primary contact recreational use that involves extended risk of ingesting the water in amounts that poses health risk to the person in contact with the water body, example is swimming (IDNR, 2010). Class A2 are for secondary recreational use contact that entails a low chance of ingesting water in this category, example is fishing (US EPA, 2001). As already stated, the major impairment of the
streams and river in Decorah is bacteria (NRGIS Library, 2012). In the Trout Run creek, it was found out that the impairment is bacteria and the geometric mean of indicator bacteria in Trout Run Creek exceeded the class A2 criterion. Also, in Twin Spring Creek, the impairment is bacteria and the geometric mean of indicator bacteria in Twin Spring Creek was slightly higher than the class A1 criterion (IDNR, 2010). Furthermore, the impairment in Dry Run Creek is bacteria and the geometric mean of E. coli in Dry Run creek was greater than the class A1 criteria (IDNR, 2012). In the Upper Iowa River, the bacteria contamination is mostly from rural areas. The impairment of the Upper Iowa River in Decorah is related to flow alteration, nutrients, siltation and habitat modification (NRGIS Library data, 2012).

Figure 1: the impaired trout streams and rivers in Decorah

Figure 1 shows that Upper Iowa River, Twin Spring Creek, Dry Run and Trout Run are all impaired water bodies. There are trout in these streams and river (Iowa Department of Natural Resources, 2006). Decorah streams are normally stocked with trout by the Decorah Fish Hatchery. Also brown trout naturally reproduce in Trout Run stream (Michael Siepker, personal communication), yet natural reproduction of trout is not sufficient for a sustainable population (Steuck, 2011). Some of the reasons for the low natural reproduction are low water quality of the Trout Run creek and inadequate substrate or rock aggregates for spawning.
Research Questions and Methodologies

1. What are the underlying problems of trout habitat in Decorah?
   Methodology: Literature review on problems of trout habitat, analysis of water quality data and experts’ advice.

2. How feasible is the restoration of Old Dry-Run Creek as trout habitat in Decorah?
   Methodology: RASCAL stream assessment of Old Dry-Run Creek with help from expert, interview members of the public to ascertain their valuation of the creek and primary data analysis of pollutants.

3. What are the interventions and policies needed to restore Old Dry-Run creek as trout habitat?
   Methodology: Literature review, findings from the RASCAL assessment, interviews of experts from Iowa DNR, Decorah Water Department and fishing guides.

Goal 1
Identify the problems of trout habitat in Decorah

Methodology

A literature review on trout habitat was conducted to identify the main problems that inhibits trout habitat in streams. Also, water quality data gathered by Luther College Faculty was analyzed to understand local problems of trout habitat. In addition, expert advice from staff of Iowa Department of Natural Resources was sought on the potential and current problems of trout habitat such as local geomorphologic and ecological problems of trout habitat in Decorah.

Goal 2
Assess the feasibility of restoring Old Dry-Run Creek as trout habitat

Methodology

Stream habitat was assessed to evaluate prospects of restoring Old Dry-Run Creek as trout habitat. There was measurement of the stream temperature and pollution at specific points along Old-Dry Run Creek. In assessing water pollution, the indicators that were used are turbidity, E.coli, Nitrate and dissolved oxygen. Habitat suitability analysis was done to ascertain whether Old Dry-Run Creek has the qualities such as pools and riffles to harbor trout (Habberfield et al, 2014).

The Iowa Department of Natural Resources have modified the visual-based stream assessment and developed Rapid Assessment of Stream Conditions along Length (RASCAL) which is used for stream assessments. The RASCAL assessment was used to assess Old Dry-Run creek. The appendix presents the RASCAL variables.
In addition to the RASCAL assessment, water quality primary data collected by Luther College faculty and students on stream temperature and pollution have been analyzed. Currently, the data collected by Luther College were only non-rain events in September and October 2014. Existing water temperature data collected by Thomas Robert of the City of Decorah Water Department of Old Dry-Run which includes summer data was also analyzed. This enabled me to do year-round analysis of water temperature of Old Dry-Run creek.

Goal 3

Recommend interventions and policies to restore Old Dry-Run Creek

Methodology

After the identification of challenges of trout habitat and stream restoration and RASCAL stream assessment, recommendations for stream restoration are presented including interventions and policies. The recommendation of interventions is based on the analysis of water quality data, Old Dry-Run creek RASCAL assessment, literature review and expert advice.
CHAPTER 2

Literature review: trout, water quality, water quantity and suitable conditions for trout
LITERATURE REVIEW

Trout and Trout Habitat

Trout refers to “any of the various freshwater or anadromous food and game fishes of the genera Salvelinus and Salmo, usually having a speckled body” (American Heritage Dictionary, 1976). There are various species of trout, the common species are rainbow, brown, brook, lake trout and cutthroat trout. The trout found in Decorah are brook, brown and rainbow trout (Iowa Department of Natural Resources, 2006). Brook trout is native to Iowa and are normally found in abundance in many of the spring fed streams of northeastern Iowa. The Decorah Fish Hatchery is fed by Siewers Spring. Decorah Fish Hatchery rears St. Croix brook and Shasha rainbow trout, which are used to stock streams in and around Decorah.

Fish habitat includes “spawning grounds and nursery, rearing, food supply and migratory areas on which fish depend directly or indirectly in order to carry out their life process” (Broekhuizen et al, 2006). Trout are cold water fish that generally thrives in water temperatures of 75°F and below (Iowa DNR, 2006). Trout thrives better in clean cold streams that provide clean streambed rock for eating and spawning. The optimal growth temperatures for rainbow, brook and brown trout are 62.96-65.48°F, 54.32-59.72°F and 57.02°F respectively (US EPA, 2001). Trout feed on insects (may flies, stone flies, nymph and caddis flies), crustaceans and other fish. The insects that trout eats can be aquatic (nymph) or terrestrial.

Table 1: Maximum temperature of brook, rainbow and brown trout

<table>
<thead>
<tr>
<th>Species</th>
<th>Max weekly average temp for growth (juveniles)</th>
<th>Max temp for survival of short exposure (juveniles)</th>
<th>Max weekly average temp for spawning (a)</th>
<th>Max temp for embryo spawning (b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brook &amp; Rainbow</td>
<td>66</td>
<td>75</td>
<td>48</td>
<td>55</td>
</tr>
<tr>
<td>Brown</td>
<td>66</td>
<td>68</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>


From the table 1 above, the maximum water temperature that both brook and rainbow juvenile trout can tolerate is 75°F. Also, the maximum water temperature that brown trout juvenile can tolerate is 68°F (US EPA, 2001).

The main underlying problems of trout habitat are high stream temperature, high turbidity, inadequate dissolved oxygen, low pH values, unsuitable stream bottom (substrate), high calcium and inadequate cover (Wagner et al, 1997).

- Turbidity refers to the opacity of water caused by sediments and the effect on the ability of light to pass through the water body. Turbidity levels for trout habitats should be less than 10 NTU (North Carolina State University, n.d.). High turbidity are caused by sediments carried by stormwater run-off. High turbidity can also disturb the insects and other organisms that serve as food for the trout.
- Dissolved oxygen is the amount of oxygen present in the stream or river. Trout require dissolved oxygen amount of at least 6mg/L in their habitat to survive. The amount of dissolved oxygen is reduced by high levels of turbidity in the stream (Sweka et al, 2001).
- The pH amount of water measures the acidity level of the water body or stream. When the pH value falls below 5.0, plants and aquatic species die because the stream becomes acidic.
- Excessive stream flow have detrimental effects on trout in their habitats because it destroys cover for the trout (Kowalski, 2007).
- The presence of too much phosphorus and nitrogen in streams causes eutrophication (Carpenter et al, 1998). Eutrophication refers to “the process by which water acquires a high concentration of nutrients, especially phosphates and nitrates and promotes excessive growth of algae” (USGS, 2014). Too much phosphates and nitrates lead to algae growth and decomposing algae deplete the oxygen in the water. This could lead to the death of trout because of the depleted oxygen.
- The geometric mean threshold of E.coli (Escherichia coli) for freshwater is 126 colonies/100ml. One time sample has a threshold of 235 E.coli per 100 milliliters (Iowa Department of Natural Resources, 2010). The presence of E.coli in a stream implies that there are pathogens (disease causing organisms) in the stream as a result of contamination from animal or human waste. The presence of pathogens stresses the trout and could lead to their death. The common sources of E.coli pollution in Iowa water bodies are: “run-off from livestock feedlots containing manure, run-off from cropland with manure applications, illegal septic systems, fecal accidents, wildlife waste such as waterfowl & raccoons and stormwater run-off from urban areas carrying pet wastes” (Iowa DNR, 2010).
- High calcium levels in the stream inhibits the spawning of trout in the streams because it hardens the substrate after the laying of the eggs which kills the potential juveniles.

**Water Quality**

The health of a stream is a consequence of the land it flows through (Iowa DNR, 2006). Effective watershed management practices that help in the filtration of pollutants from stormwater run-off before it reaches the stream will contribute to clean water in the stream. A restored Old-Dry Run Creek can be used as recreational grounds. Also, restored cold stream with good water quality can serve as habitat for diverse organisms. Stormwater run-off when not properly managed can carry sediments into streams and increase the temperature of the streams. Increased water temperature caused by stormwater run-off will stress out trout in streams and can lead to their death.

The karst topography of Decorah allows for the mixing of ground and surface water through sinkholes and bedrock fractures (Decorah Comprehensive Plan, 2012). This mixing can cause water quality problems in the streams in terms of contamination. The major benefit of this is that it allows for underground spring water to mix with surface water that leads to the cooling of
stream temperature making the stream cold and congenial for trout. However, this is not an issue for Old-Dry Run creek.

**Water Quantity**

The base flow conducive for the survival of trout is at least 3 feet and above. During drought conditions, the volume of the water of streams reduces because of lack of precipitation and evaporation. In addition to the reduction in the base flow of water in streams, there can be a heating effect on the temperature of the water bodies especially when the amount of water over the stream bed is shallow (Hakala et al, 2004). Flood waters and heavy rainfall can increase the volume of streams and river beyond their natural banks. When streams and river spill over to adjacent land and the flow of the streams becomes very rapid, trout can be washed into uncongenial ponds and water bodies. In the 2008 floods in Decorah, muddy stream water extended beyond the stream banks to low lying land areas. This destroyed the food source of trout and the sediments reduced the amount of oxygen in the stream that other insects and organisms depended on. Juvenile trout can die because of high turbidity caused by floods and the destruction of their food source.

**Trout Predators, Geomorphology and Cover**

The general predators of trout are kingfishers, raccoons, river otters, mink, sea lampreys, great blue herons, mergansers, other trout and humans (National Wildlife Federation, n.d). The predators in Decorah are raccoons, kingfishers, other trout and humans. Apart from external predators, some species of trout hunt each other. For example Rainbow trout can eat other trout. Cover for trout in their habitat is an important aspect for trout habitat (Kenneth, 2011). Cover within the trout habitat serves as hiding place from predators, helps in the survival of trout during harsh winter conditions and could reduce antagonism among members of its specie living in the same territory by serving as visual isolation. Cover in streams makes it conducive for wild trout as well as hatchery reared trout to survive in streams in Decorah. Examples of cover are root debris, overhead shade by trees at the banks and rocks. Streams flow and patterns depend on the land around them. The type of soil, rock and slope of the land at the banks of the stream affect the size and shape of the stream. For example, through erosion the shape of the stream is altered.

**Connectivity of streams to Upper Iowa River**

Connectivity to Upper Iowa River will enable trout to move to feeding grounds from their local habitats. However, small streams without connectivity to a big stream or river could be appropriate depending on the type of trout and provided that the stream has these characteristics: cold clean water, food for the trout, cover to hide from predators and clean gravels or rocks for their eggs. Rainbow trout tend to migrate and will swim to bigger water bodies when there is not much food in their established territories (NRCS, 2000). In Decorah the presence of the flap gates will be problem, when it prevents fish in Old-Dry-Run Creek from joining the Upper Iowa River and also to swim back to Old-Dry Run creek. The flap gates open outwards so it can prevent a fish from swimming back to Old-Dry Run Creek when it is not wide open.
CHAPTER 3

Decorah planning area and trout habitat status
DECORAH PLANNING AREA AND TROUT HABITAT STATUS

Streams and river in Decorah planning area

The streams and river in the city of Decorah are Upper Iowa River, Dry-Run Creek, Coon Creek, Trout River, Trout Run, Old Dry-Run Creek and Twin Springs. See figure 2.

Figure 2: Cold Streams and Rivers in Decorah

Figure 2 presents all the streams and river in Decorah. Old Dry-Run Creek which is the focus of this study, starts flowing from the bluffs just beside the Implements in Decorah and flows to the north east to join the Upper Iowa River. The Old Dry-Run creek is mainly fed by urban stormwater run-off, rainfall and discharges by Deco located close to the bank of the creek.
Water Quality in Decorah

Water Temperature

Water temperature is important since trout are cold blooded and they rely on the temperature of their habitat.

Figure 3: Measurement History of Water Temperature in Old-Dry Run Creek
The measurement of water temperature from 2005 to 2012 in Old-Dry Run shown in figure 3 above was taken in the creek close to the bridge at Sumner Street. Water temperature was at 75°F or higher inimical to trout survival on three occasions, which are: August 2, 2005; August 1, 2006 and July 2, 2012.

Water quality testing was done by Luther College Professor Jodi Lynn Enos-Berlage and her students at specific locations in Decorah as shown on the map below on three non-rain events days: 9/19/2014, 9/26/2014 and 10/10/2014.

Figure 4: Decorah Test Sites
Figure 5 shows that none of the areas within the testing sites in the creek and river in Decorah is at the lethal point for trout habitation (75°F). For rainbow trout which has conducive water temperature ranging from 62.96°F-65.48°F, the temperature at these testing sites may not be a problem since the highest temperature reading recorded close to the Deco drain outlet is below 63.86°F. However, comparing it with the optimal temperature for brook trout which ranges from 54-59.72 °F, all the testing sites location except Case IH/Beginning Spring (refer to figure 4) will not provide the ideal temperature for brook trout. Likewise, brown trout will be okay only at the Case IH/Beginning spring since the trout optimal temperature is 57.02 °F. This implies that based on only temperature, Old Dry-Run creek will not be ideal for brook and brown trout but will be suitable for rainbow trout.

**Turbidity**

The average turbidity values on the three testing days are as follows:

Figure 6: the levels of turbidity at the testing sites in Decorah
The turbidity levels for trout waters should be less than 10 NTU. From figure 4 above, the testing site at Case IH/beginning spring (this is the Implement area where Old Dry-Run creek starts) is above 10 NTU, which is not good for trout habitat. However, all the other testing sites have turbidity levels below 10 NTU making those areas of the creek okay for trout habitat when only turbidity is used as the indicator. Looking at urban areas having the blue colors, all the testing sites within Old Dry-Run creek have acceptable levels of turbidity that can be tolerated by trout.

PH levels of Streams and Rivers

The pH levels of water bodies in Decorah was considered because acidic water kills trout. Water having a pH value of 7 is considered neutral. Water with a pH value less than 7 is considered acidic and pH value of water higher than 7 is considered alkaline. The pH values of the various testing sites in Decorah are shown below (figure 7):

![Average pH Values](image)

**Figure 7: pH levels at the testing locations in Decorah**

Trout are normally not affected by pH values between 7 and 5.5, so the pH value in the water at Case IH/beginning spring testing site even though acidic is not seriously harmful to trout. However, pH below 5 will kill all species of aquatic plants and animals. The most alkaline water is found at the testing site area at River road which represents rural contribution and is not the main focus of this study. The urban areas, shown in blue bars are okay for trout habitat.

Dissolved Oxygen

Dissolved oxygen was considered because it is needed by trout for survival.
Figure 8: Dissolved Oxygen at the various testing sites

From figure 8, the amount of dissolved oxygen in the creek and river is higher in the rural areas than the urban areas mainly because of stormwater run-off from impervious surfaces and concrete which are hot surfaces. Only two of the urban area testing sites have dissolved oxygen of at least 6mg/L which are good for trout.

E.coli Levels

E. coli as an indicator for trout habitat was considered because the presence of E.coli indicates that there are pathogens in the creek. The testing results of E.coli in Decorah is presented below:
E. coli concentration in urban areas are higher than the rural areas. Since Old Dry-Run creek receives a lot of E.coli from the urban areas this shows that urban areas contribute more of E.coli pollution to the creek. E.coli could come from pet fecal matter, birds and other wild animals. All the testing sites in the Old Dry-Run Creek shown in blue have a mean greater than 126 CFU/100ml, the acceptable level for aquatic habitat. So, E.coli levels in the creek is not conducive for trout.

**Conclusion on water quality**

Only on three occasions, did Old-Dry Run Creek register water temperature of 75°F or above. Old-Dry Run Creek will be conducive to rainbow trout when the optimal temperature (62.96°F-65.48°F) is considered. The creek does not have optimal temperature conditions for brook and brown trout. Turbidity was only a problem at the beginning of the creek, the other test sites in Old-Dry Run Creek are suitable for trout. The pH levels of the creek is tolerable to trout. Dissolved oxygen was okay for trout habitat at two test locations: Water Street and DRC end (refer to figure 4). Other test sites in Old-Dry Run Creek had dissolved oxygen below levels for trout habitat. E.coli levels in Old-Dry Run Creek at all the testing sites are above the maximum threshold for freshwater, so it will not be okay for trout.

**Interviews with Stakeholders**

Stakeholders (Staff of Iowa Department of Natural Resources, Anglers, fishing guides and staff of Decorah Water Department) were interviewed via phone from February 13, 2015 to March 15, 2015 to ascertain current and potential problems of trout habitat in Decorah and prospects to restore Old-Dry Run Creek. The interviews lasted for 20 minutes per respondent.

**Number of respondents and levels of experience**

Six professionals from Iowa Department of Natural Resources, sixteen anglers and fishing guides and a personnel from Decorah Water Department were interviewed. The working experiences of Iowa DNR experts ranged from 30 years to 1 year experiences and all six experts were familiar with the Decorah area. The experiences of these 16 anglers and fishing guides ranged from 45 to 5 years. Ten of these respondents (anglers and fishing guides) fish 24 times a year, six fish 50 times a year.

**Impairment assessment of Old-Dry Run Creek**

According to the six Iowa DNR experts, the main reason why Old-Dry Run Creek has not been assessed for impairment was attributed to the reason that the creek has not been included in Iowa surface water classification and a beneficial use for the creek has not been determined.

**Current and Potential Problems of trout habitat**

According to the six Iowa DNR experts and sixteen anglers & fishing guides, the major problem of urban stream is high water temperature caused by stormwater run-off, low base-flow of the
creek especially during summer and the amount of imperviousness of urban setting especially close to the stream. Water quality issues pointed out by Decorah Water Department were high turbidity, E.coli exceeding the required state levels for fresh water in sections of Old-Dry Run Creek and high creek temperature. The high amount of E.coli in Old-Dry Creek was attributed to urban contribution without any direct pollution source linkage. High calcium levels in streams was cited by Iowa DNR as a common phenomenon in Decorah. For example in Twin Springs the calcium levels inhibit spawning in that stream because calcium hardens the substrate and seals up eggs in the substrate which kills potential trout. According to the six Iowa DNR experts, aquatic plants are benign to trout because of the cover they provide, even though the plants can be harmful at night when plants use dissolved oxygen. There are no lampreys in Decorah according to Iowa DNR, therefore it is not an issue for Old-Dry Run Creek. No Fish kill in Decorah waterbodies since 1998. The 3 fishing guides stated that they have observed that high turbidity after heavy rains compelled trout to migrate to other sections of waterbodies (example, to Trout Run) in Decorah. The staff from Decorah Water Department pointed out that they have never investigated fish kill in Decorah before.

Current Trout Status of the Creek

All the sixteen anglers and fishing guides stated that currently Old-Dry Run creek is not a trout habitat, but has the potential to be a trout habitat. The one staff of Decorah Water Department said that he does not think that Old-Dry Run creek ever had trout. The six respondents who have fished in Old-Dry Run Creek have never caught a trout in the creek but minnows.

Opinions about the restoration of the creek as trout habitat

All six Iowa DNR experts believed that Old-Dry Run creek could be restored as trout habitat. The six anglers and fishing guides supported the idea of restoring the creek. The staff from Decorah Water Department supported the idea of restoring Old-Dry Run Creek as trout habitat. The respondent from Decorah Water Department pointed out that the creek could be restored. All the sixteen anglers and fishing guides and the staff from Decorah Water Department confirmed that they would fish for trout in Old-Dry Run Creek if the creek was turned into trout habitat and they all supported its restoration.

Measures for the creek restoration

The measures recommended by the six Iowa DNR experts, sixteen anglers and fishing guides for the restoration of Old-Dry Run are: rain gardens close to the creek for infiltration and riparian vegetation to serve as a buffer to reduce sediments. In addition, they suggested public access to the creek for fishing purposes, free parking space for people who visit Old-Dry Run Creek and continuous temperature logger needs to be installed along sections of the stream for continuous temperature monitoring.
RASCAL Stream Assessment of Old-Dry Run Creek

The Rapid Assessment of Stream Conditions Along Length (RASCAL) is an assessment that starts from up-stream to down-stream and notes the near-stream and in-streams conditions of waterbodies and changes in conditions along sections of the stream (IDNR RASCAL Protocol, n.d). Hand-held GPS unit and surveyors scale were used to conduct the stream assessment. I conducted the RASCAL on March 16 and March 28, 2015. GPS points were taken along various sections in the Old-Dry Run Creek; points were taken when in-stream and riparian zone conditions changed. The surveyor’s scale was used to measure the depth of the stream as well as the bank height. The variables that are considered in the RASCAL assessment were channel variables, in-stream features, riparian variables and bank variables. Refer to appendix A-RASCAL variables guide for details.

The basis for the rankings of in-stream habitat of the various sections of the Old-Dry Run creek were:

- Channel variables such as flow, channel pattern (straight or meandering), channel condition and stream type as well as in-stream parameters such as the number of 3-feet deep pools, number of riffles, substrate, sediment deposition, water clarity and canopy cover. The various ranking of the creek was based on the three established Iowa DNR rankings for in-stream habitat which are excellent, average and poor.

- Excellent ranking of stream section referred to a section of the stream with plethora examples of riffles, deep pools, aquatic species (fish and insects), logs, fallen trees, overhanging vegetation and so on. The section of the creek or stream with the excellent ranking looks better than the various other sections of the stream that is assessed.

- For the average ranking, the section of the creek has some examples of deep pools, riffles, clear water, aquatic vegetation and insects, fallen trees and so on.

- The poor ranking of in-stream habitat referred to the portion of the creek with very few examples of aquatic insects and fish, riffles, pools and so on. The poorly ranked section of the creek looks worse than all the other sections of the creek assessed.

The basis for the assessment of the near-stream conditions were riparian variables such as the zone width, riparian zone cover, adjacent land use and livestock access as well as bank variables such as bank vegetation, bank erosion, stream bank height, stream bank stability and stream bank material. The riparian and bank variables provided information on the exact width of the riparian zone, what kind of vegetative cover (grass, trees etc.) were located in the riparian zone and the immediate or adjacent land use close to the Old-Dry Run creek. According to staff of the fish hatchery in Decorah, livestock access was not a problem for Old-Dry Run creek. The result of the in-stream assessment of Old-Dry Run creek is presented as follows: Old-Dry Run creek had only average and poor rankings of in-stream habitat. The creek had none of its sections ranked excellent.
Figure 10: In-Stream Habitat Condition

From figure 10 above, section A, section C and section E have poor in-stream habitat conditions. However, section B and section D have average in-stream habitat conditions. Detailed descriptions about the conditions of the various sections of the creek and the reasoning behind their in-stream habitat rankings are explained below:

<table>
<thead>
<tr>
<th>Section</th>
<th>Pools</th>
<th>Riffles</th>
<th>Embeddedness</th>
<th>Substrate</th>
<th>Pattern Channel</th>
<th>Water Clarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>20</td>
<td>15</td>
<td>0-75%</td>
<td>Mostly Silt/Mud</td>
<td>Mostly Straight</td>
<td>Mostly Tea Color</td>
</tr>
<tr>
<td>B</td>
<td>30</td>
<td>37</td>
<td>0-25%</td>
<td>Mostly Gravel</td>
<td>Mostly Meandering</td>
<td>Clear</td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>3</td>
<td>0-25%</td>
<td>Mostly Gravel</td>
<td>Straight</td>
<td>Tea Color</td>
</tr>
<tr>
<td>D</td>
<td>6</td>
<td>9</td>
<td>0-25%</td>
<td>Mostly Cobble</td>
<td>Meandering</td>
<td>Clear</td>
</tr>
<tr>
<td>E</td>
<td>5</td>
<td>21</td>
<td>0-75%</td>
<td>Mostly Silt/Mud</td>
<td>Mostly Straight</td>
<td>Tea Color</td>
</tr>
</tbody>
</table>

Table 2: In-Stream Habitat Conditions

Section B and D were ranked average because these sections had the conditions as listed in table 2 to be ranked as such as per the Iowa DNR RASCAL rankings explained previously on page 23 (refer to appendix A-table 8). Average ranking is suitable for trout, hence section B and D are suitable for trout habitat.
Figure 11: Dominant Substrate of Old-Dry Run Creek

From figure 11, GPS coordinate point representing the creek substrate condition was taken when the conditions of in-stream and near stream conditions of the creek changed. So from the beginning of the creek upstream after the first silt/mud digitized point, the second point representing gravel was taken when the dominant substrate was gravel and the near stream conditions changed. Section E has most of the dominant substrate as silt/mud, which is not good for trout spawning. Section E of the creek that runs from the intersection of 2nd street and South Avenue and ends at the point where the creek joins the Upper Iowa River has mostly silt/mud as the dominant substrate. Within section E of the creek, the riparian zones have inadequate trees and grass that do not offer much protection to the banks and as a buffer, making the banks very susceptible to erosion. The sediments carried by stormwater run-off from the banks of the susceptible areas in section E and surrounding land uses including industrial oil company end up in the creek. Section B has dominant substrate made of cobble. The section B does not pose a problem to trout since trout requires clean gravel and cobbles for spawning. Section A has most of the dominant substrate as silt/mud. In section A, the problem areas with silt/mud are found at the stretch of the creek close to Short Street, Centrum Drive and Deco Industrial area.
From figure 12, the section E has most of it banks having moderate erosion, so the banks are not stable. Most of section B has concrete retaining wall at the banks and the other areas without the concrete reinforcement has soil at the banks which looks fairly stable because the banks do not show signs of erosion. However, the part of section B that stretches from Vernon Street to Jefferson Street (that is opposite Decorah Middle School area) has minor erosion along the banks. Section A has a mixture of stable and moderate erosion along the creek banks. The stretch of the creek banks in section A that have problems with bank stability are: close to Short Drive, Centrum Drive and Deco Industrial area. Section C also has moderate erosion. The section C starts from Main Street and ends at River Street.
Figure 13: Bank Erosion of Old-Dry Run Creek

From figure 13, section E has the most erosion problem. Section C of the creek has erosion at both banks. Section B has the major part of the creek not having erosion at the banks except the part of the creek adjacent to the Decorah Middle School (from Vernon Street to Jefferson Street). Section A has about half of the creek having alternate banks erosion and the other half has no erosion at the banks. In section A, the stretch of the creek with no erosion have rip-rap at the banks. Rip-rap refers to large stones used to protect the stream bank soil from erosion (US EPA, n.d). Spatially the problem areas are the same as locations stated in figure 10 and 11 above. Alternate erosion means that due to the meandering nature of the creek, the left bank of an area will experience erosion while the right bank of the same area of the creek will not have erosion, but will erode at other section of the meandering stretch of the creek. The areas along the creek with both banks erosion has signs of erosion showing at the left and right of the creek banks at the same area.
From figure 14, section E and section C have the least canopy cover within the range of 0-10% along the creek. The section E and C with the most canopy cover ranged from 25-50%. Section B is the only section with some of the creek banks (from Pearl Street to Franklin Street) having a canopy cover that falls within the range of 50-75%. Section A of the creek from the beginning upstream part to Highway 9, had canopy cover that ranged mostly from 0-25%. The low canopy cover from 0 to 10% are found at the stretch of the creek along South Avenue, River Street to the West Broadway Street, State Street to the intersection of 2nd Street & South Avenue and Short Street (opposite the McDonalds) to other point of the same street (opposite Subway). The amount of canopy cover along a section has an impact on the temperature of the creek. For the entire Old-Dry Run Creek: 0-10% canopy cover is found along 1.40 mile of the creek (50%), 10-25% canopy cover is found along 0.45 mile of the creek (16%) and 50-75% canopy cover is found along 0.33 mile of the creek.
Left riparian width is the left transition zone between the water (creek) and the upland zone, typically the width of natural vegetation (IDNR, n.d.). From figure 15, section E of the left riparian zone width of the creek has about half that falls within 10-30 feet and other half less than 10 feet. Section A has most of the left riparian width less than 10 feet. The width of the left riparian zone could affect the conditions of the creek. The bigger the riparian width with vegetative cover or protection, the better the ability of the creek to reduce the sediments and other pollutants from stormwater run-off that reaches the creek. For the entire Old-Dry Run Creek: less 10 feet of the left riparian zone width covers 1.59 miles along the creek (57%) and 10-30 feet of the left riparian zone width covers 1.21 miles of along the creek (43%).

**Figure 15: Left Riparian Width of Old-Dry Run Creek**
Figure 16: Right Riparian Zone Width of Old-Dry Run Creek

Right riparian width is the right transition zone between the water (creek) and the upland zone, typically the width of natural vegetation (IDNR, n.d.). From figure 16 above, section E shows that most of the right riparian zone is less than 10 feet. Section B has about half of the right riparian zone within 10-30 feet and the other half less than 10 feet. Section A has most of the right riparian zone width less than 10 feet. Section C has right riparian zone width of less than 10 feet. Small amount of vegetative cover coupled with a riparian width of less than 10 feet, makes the particular stretch of the creek more susceptible to the impact of stormwater run-off. Section E, the part of the creek that runs close to the intersection of 2nd Street and South Avenue to the point where the creek joins the Upper Iowa River, has essentially all the right riparian width zones less than 10 feet. Section B, the portion of the creek close to Jefferson Street to the part close to the Day Street has right riparian width less than 10 feet. For the entire Old-Dry Run Creek: less than 10 feet of the right riparian width covers 2.05 miles along the creek (73%) and 10-30 feet of the right riparian width covers 0.75 mile of the creek.
From figure 17, the sections with most tree cover in the left riparian zone are section A and D. In Sections A, the trees are found along the Deco area, from Winnebago Street to the point the creek reaches W. Broadway Street and after the W. Broadway Street to the point the creek reaches the W. Main Street. The Oil Industrial Company in section E is close to the creek and has the potential to create problems when oil spills onto the impervious surface and gets washed down into the creek by stormwater.
Figure 18: Right Riparian Zone Land Cover

From figure 18, in the right riparian zone, most trees are found in section B. In section B, the right riparian land cover has trees just after the Deco area to Jefferson street. In Section E, the trees in the right riparian cover are found at the stretch of the creek from W. Main Street to the intersection of 1st Street and South Avenue. For the entire creek, trees cover 46% of the right riparian land cover.
<table>
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<tr>
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<th>Stream Miles</th>
<th>% of Total</th>
<th>Left Riparian Width</th>
<th>Stream Miles</th>
<th>% of Total</th>
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<tr>
<td>Low</td>
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<td>30-60 Feet</td>
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<td>0%</td>
</tr>
<tr>
<td>No Flow</td>
<td>0.17</td>
<td>6%</td>
<td>&gt; 60 Feet</td>
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<td>0%</td>
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<td>Riffle</td>
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<td>Boulder</td>
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<td>Cobble</td>
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<td>Gravel</td>
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<td>Sand</td>
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<tr>
<td>Silt/Mud</td>
<td>Residential</td>
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<tr>
<td>Clay/Hard Pan</td>
<td>Commercial</td>
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<td>Industrial</td>
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<td></td>
<td>Farmstead</td>
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<td>Alternate Banks</td>
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<td>Both Banks</td>
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<td></td>
<td>Residential</td>
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<td>Farmstead</td>
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<td>25-50%</td>
<td>Moderate Erosion</td>
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</tr>
<tr>
<td>75-100%</td>
<td>Stable</td>
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From table 3, the dominant substrate of Old-Dry Run Creek is silt/mud, this is problematic to trout because trout requires clean substrate for spawning. 90% of the creek opacity was tea color as shown in the table and is not a problem for trout. 40% of the left riparian land cover were grass where as 46% of the right riparian land cover were trees. The grass and trees do not provide adequate cover for the entire creek, exposed sections of the creek can be warmed by sun rays and the inadequate grass cover cannot stop the movement of sediments in stormwater run-off. 1.59 miles of the creek (57%) had left riparian vegetation of less than 10 feet which offered minimal protection since 46% of the vegetation on the left riparian zone were grass. 1.31 miles (47%) of the creek had moderate erosion along its banks with 1.47 miles (53%) of the creek having alternate banks erosion. The erosion contributes to the collection of sediments in the creek.

Conclusion on the RASCAL Assessments of the Various Sections

- **Section A**: poor in-stream habitat ranking; dominant substrate was silt/mud; problem of bank stability; has moderate bank erosion; canopy cover ranged from 0-50%; left riparian width was mostly less than 10 feet; right riparian width was mostly less than 10 feet; left riparian land cover were trees, grass and industrial properties and right riparian land cover were also trees, grass and industrial properties. This section was considered not good for trout because of current conditions.
- **Section B**: average in-stream habitat ranking; dominant substrate was cobble; bank was mostly stable; bank erosion was mostly non-existent; canopy cover ranged from 0-75%; left riparian width fell within 10-30 feet; right riparian width were mostly less than 10 feet; left riparian land cover were trees, grass and trees, and right riparian land cover were trees, grass and commercial properties. This section was considered good for trout.
- **Section C**: poor in-stream habitat ranking; dominant substrate was gravel; bank was not stable because of moderate erosion; alternate erosion at the banks; canopy cover ranged from 0-10%; left riparian width fell within 10-30 feet; right riparian width was less than 10 feet; left riparian land cover was mostly commercial properties and right riparian land cover was mostly residential properties. This section was considered not good for trout.
- **Section D**: average in-stream habitat ranking; dominant substrate was cobble; bank was stable because there was minor erosion; bank erosion was alternate, canopy cover was within the range of 0-10%, left riparian width was mostly within 10-30 feet; right riparian width was mostly less than 10 feet; left riparian land cover was grass and right riparian land cover were commercial and grass. This section was considered okay for trout.
- **Section E**: poor in-stream habitat ranking; dominant substrate was silt and/mud; bank was not stable because of moderate erosion; erosion was mostly alternating at the banks; canopy cover ranged from 0-10%; left riparian width had half less than 10 feet and the other half that ranged from 10-30 feet; left riparian land cover were grass and industrial properties; right riparian land cover were trees, grass and industrial properties. This section was considered not good for trout.
The feasibility of restoring Old-Dry Run Creek

The characteristics of Old-Dry Run Creek that will be supportive of trout habitat are: clean substrate, pH value that ranges from 5.5 to 7, dissolved oxygen level of at least 6mg/L, turbidity below 10 NTU, e. coli levels of not more than 126 CFU/100ml, riffles, pools depth of at least 3 feet in the creek, adequate canopy cover, food for trout and creek with temperature below 75°F.

The suitability of the water temperature of Old-Dry Run Creek for trout habitat is as follows: water temperature in figure 4 and 3 depict that only on three occasions in the last ten years has the temperature of the creek reached 75°F. This is the maximum temperature tolerable to trout in general. So, using the maximum temperature tolerable to trout as the yardstick, the creek is mainly suitable for trout. However, the optimal temperature of creek for rainbow, brook and brown trout are below 75°F. For rainbow trout, the conducive water temperature ranges from 62.96°F-65.48°F. All the testing sites (refer to figure 4) in Old-Dry Run Creek are conducive to rainbow trout. However, for brook and brown trout only the beginning part of Old-Dry Run Creek close to the Implement has the conducive temperature of below 59.72°F and 57.02°F respectively. Generally, water temperature of Old-Dry Run is tolerable to trout.

The levels of E.coli in the creek exceeding the threshold for fresh water is a problem for trout since it indicates that other pathogens are present in the creek (refer to figure 9). High levels of E.coli can cause sickness among the trout and even lead to their death. The stakeholders that I interviewed did not provide the exact sources of the high E.coli levels in the creek in Decorah. Through literature review, pets and wildlife fecal matter were identified as common sources of E.coli in Iowa urban areas. Educating the residents close to the creek, on proper disposal of pets’ fecal matter will help in reducing the levels of E.coli in the creek. Fecal matter of pets left close to the creek will end up in the creek after stormwater run-off. Also the installation of infiltration practice like rain garden will help reduce E.coli levels entering the creek because the rain garden will allow particles to settle, hence reducing waste matter reaching the creek.

Erosion of the bank of the creek was identified as a problem. About 1.47 miles (53%) of the creek had alternate bank erosion because of the meandering nature of the creek in several areas (refer to figure 13) and the exposed nature (inadequate vegetative cover) of the stream bank. About 0.28 miles (10%) of the creek had erosion on both banks of the straight creek were channel. The creek banks could be reinforced and riparian buffers could be planted within the riparian zone to reduce erosion of the banks. The banks of the creek close to Short Street, Centrum Drive, Deco factory and 2nd Street & South Avenue to where the creek joins the Upper Iowa River, requires rip-rap to stabilize the bank because of erosion. Despite the substantial erosion along the creek, only the beginning part of the creek close to the Implements has turbidity that is above the required levels for trout habitat (refer to figure 6). The creek has no flow from the beginning part of the creek upstream from the Implements area to the area before US highway 52. The slow movement of creek flow just after the US Highway 52, allows sediments from stormwater run-off to gather at the beginning part of Case IH area (Implement area). It could be that the amount of sediments carried by the creek reduces as the creek flows downstream, since section B of the creek has minor erosion and stable bank (refer to figure 10...
and 11). According to Green Values National stormwater management calculator (CNT, 2006): the installation of 100 feet squared rain garden with prepared soil depth of 12 inches, prepared soil porosity of 0.35, underlying aggregate of 12 inches and 0.25 underlying porosity will capture 28.8% of the run-off volume required. So the installation of 100 square feet of rain gardens will improve the creek condition by reducing sediments in stormwater run-off by 28.8% and this will improve the creek conditions for trout habitat such as turbidity levels.

Conditions such as erosion of the soil of the creek bank, bank instability and water quality problems discussed above reveals that the creek could need an integrated approach in order to restore the creek. The effects of erosion from a section of the creek uphill will find its way downhill depending on the speed of flow of the creek especially after heavy rain events. Residents that live close to the creek are affected the most by the conditions of the creek. The current conditions of the current as presented in the water quality data analysis and RASCAL assessments show that the creek is generally not suitable for trout habitat except section B and D (refer to figure 10). The formation of Old-Dry Run Creek sub-watershed body will enable the residents within this watershed to tackle stormwater issues as one organized group.

In-stream habitat conditions of the creek was a problem except in sections B and D (refer to figure 10). RASCAL showed how the creek is affected by the urban area. The upstream of the creek (that is section A) and the section E of the creek (along South Avenue) that joins the Upper Iowa River had poor in-stream habitat (figure 8). Poor in-stream habitat is not good for trout habitat. The dominant substrate of the poor habitat areas of Old-Dry Run was silt/mud and covered 1.28 (46%) miles of the creek. Trout prefer clean substrate and rocks to spawn - the silt/mud will prevent spawning. The creek in-stream habitat condition became average in its middle section. Sections B and D of the creek had average in-stream habitat and gravel and cobble as the dominant substrate. The RASCAL assessment informed that in-stream conditions are not only based on the immediate land cover but had sediments and gravels contribution from uphill of the surrounding land uses. Through dredging, dominant silt/mud associated with the poor in-stream habitat would be removed from the creek.

Low canopy cover was a problem in Decorah - about 1.4 miles (50%) of the creek had canopy cover within the range of 0 to 10%. This low canopy cover are found at the stretch of the creek along South Avenue, River Street to the West Broadway Street and State Street to the intersection of 2nd Street & South Avenue and Short Street (opposite the McDonalds) to other point of the same street (opposite Subway), refer to figure 14. Low canopy cover contributes to increased temperatures of the creek, since the sun shines directly onto the creek surface without any protection. More trees at both sides of the creek could be planted along the problem areas enumerated above. There are not enough canopy cover along the left riparian zone because of the inadequate number of the trees and limited shading that the trees provide for the creek. The left riparian land cover is covered by grass along 1.12 miles (40%) of the creek. The trees cover about 35% of the left riparian area of the creek (refer to figure). The left riparian areas of the creek with no canopy cover are close to: Short Drive, Centrum Drive and intersection of 2nd Street & South Avenue Street. In addition, the riparian areas without trees will require the planting of trees that will offer canopy cover over the creek at those areas.
Generally culverts in the Old-Dry Run creek are not a problem if they allow fish to move from one section of the creek to other sections. During the RASCAL assessment and my previous tour of the creek, there were many rocks and boulders under culverts in Decorah so if the base flow of the creek reduces under the culvert, it will prevent connectivity with other sections of the creek. The long culvert that passes under Fareway is a typical example. It is suggested that the number of the rocks and boulders under culverts in Decorah be reduced to allow connectivity for trout or other fish from one section of the creek to other sections. The RASCAL assessment did not measure the exact conditions of the stretch of creek under the culverts because culvert is not a natural habitat and has lighting challenges for the assessment.

The Old-Dry Run creek has some of the needed conditions for trout habitat such as pools and riffles already. Through the RASCAL stream assessment, it was discovered that Old Dry Run creek has a total of 61 pools that are at least 3 feet deep, 85 riffles and majority (90%) of the water clarity of the creek is tea color. Tea color of the creek will not be a problem for trout. The presence of riffles increases the amount of dissolved oxygen and pools of at least 3 feet deep provide the needed environment for trout to hide and thrive. The restoration of the creek can be done because of the presence of riffles and pools of 3 feet deep. However, the creek will require additional riffles and deep pools for trout habitat because some sections had low base flow and riffles. The low base flow was found at the stretch of the creek close to Short Drive and where the Oil Company (2nd Street and South Avenue to Sumner Street) is located. The additional riffles and pools are required close to the South Avenue part of the creek. The additional riffles are important because it helps to improve the amount of dissolved oxygen in the creek. Trout prefers to hide in deep pools and could also be found within riffles because of the high levels of dissolved oxygen. Out of the 16 anglers and fishing guides, 15 respondents have not seen sections of the creek dry out before with the exception of one person, but as per my RASCAL assessment, some of sections have the potential to dry out. The beginning part of the creek from the Short Street to the True Value commercial area, has the potential to dry out because the base flow of the creek is low. The discharge of water by Deco into the creek can help supply constant water into creek if the company agrees to discharge water that would not worsen the water temperature of the creek. Constant water from Deco into the creek can help ensure constant water supply to the creek.

All the seventeen residents (anglers, fishing guides and one staff of Decorah Water Department) who were interviewed were in favor of the creek restoration. This shows that there is support already for the restoration of Old-Dry Run creek in Decorah.

The estimated cost of the creek restoration was not considered since it was outside the purview of this study. Benefit and cost analysis is one of the ways through which the feasibility of Old-Dry Run Creek restoration could be assessed. Benefit cost analysis entails the estimation of total costs and benefits of a project taking into consideration time element. When the quantified benefits outweigh the quantified costs then the city can undertake the creek restoration because the expenditure can be justified.
CHAPTER 4

Interventions and policies for stream restoration
INTERVENTIONS AND POLICIES FOR STREAM RESTORATION

The recommendations for the restoration of Old Dry-Run creek as trout habitat are: watershed management group, best management practices, and yearly RASCAL assessment. These recommendations were based on the analysis of water quality data, Old Dry-Run creek RASCAL assessment, interviews of stakeholders and experts’ advice.

It is suggested that Old-Dry Run Creek sub-watershed group be formed to advocate for the protection of the Creek. The drainage of water in the Upper Iowa Watershed are influenced by the flow of stormwater within the various sub-watersheds. Residents within Old-Dry Run Creek sub-watershed in Decorah (refer to figure 18) could form a sub-watershed group in the city of Decorah to protect the creek. This sub-watershed group could tackle stormwater problem areas within their sub-watershed for better infiltration of stormwater which will reduce the amount of pollutants that drains into Old-Dry Run creek, since residents within this sub-watershed are closer to the creek. The reason behind this is that when the creek becomes an amenity after restoration it will enhance property values of houses close to the creek because of recreational value of the creek.

Rip-rap and riparian buffers with native vegetation are recommended along the parts of the creek with bank erosion. The erosion of the creek banks (refer to figure 12) as already discussed in the previous feasibility part are: the stretch of the creek along the South Avenue, Short Street, Centrum Drive and close to Deco Industrial area. These same areas also have creek bank stability problems. Rip-rap will stabilize the banks of the creek and riparian buffers with native vegetation would slow down the movement of stormwater run-off into the creek from surrounding land uses (J. Kopaska, C. Larson, J. Palmer, T. Shay, M. Siepker & M. Steuck, personal communication, February 16, 2015).

Dredging, provision of riparian buffers and construction of rain gardens are recommended for the sections of the creek with dominant silt/mud problems. The stretches of the Old-Dry Run Creek with dominant silt/mud problems are: close to South Avenue, close to Short Street and Deco Industrial area. This mud/silt could be collected through creek dredging. In addition, riparian buffers should be planted along these stretches of the creek to slow down the movement of stormwater run-off after precipitation and allow some of the sediments to settle down before the stormwater run-off reaches the creek. Also, rain garden could be constructed at the portion of the creek close to the intersection of South Avenue with Summer Street, to allow for infiltration of sediments from stormwater run-off from reaching the creek.

Trees with more canopy could be planted at those locations with low canopy cover along the creek banks to protect the creek so that the direct rays of the sun will not hit the creek surface. The areas along the creek with low canopy cover are mainly: close to South Avenue, close to Bright Spot Car Wash and Short Street (opposite McDonalds). In addition, riparian buffers could be planted at the stretch of the creek close to the Bright Spot Car Wash. This will help slow the run-off from the car wash and stop some of the chemicals from the car wash from reaching the creek. Furthermore, rain garden could be constructed directly opposite the carwash to infiltrate
the stormwater run-off from the carwash before it reaches the creek. This process will also help reduce the temperature of the stormwater run-off since the water will settle before it finally joins the creek.

Education and construction of rain garden could be used to tackle the high E.coli levels in the creek. The areas that have high E.coli levels in the creek identified through the water quality testing are section of the creek close to the Water Street area where the creek joins the Upper Iowa River and the Deco area. The city are encouraged to continue collaboration with Luther College on educational programs concerning the potential effects of pets’ fecal matter especially close to the creek and how stormwater run-off aids in transporting E.coli into water bodies within the city. Also the installation of rain garden will help reduce E.coli levels entering the creek because of infiltration capabilities of rain garden. Reduced E.coli levels in the creek would help improve the creek condition, hence would make the creek suitable as trout habitat and an amenity.

Connectivity for easy maneuvering by trout is necessary in the restoration of Old-Dry Run Creek. It is suggested that the boulders under culvers be removed along the creek so that when the creek water levels reduces there will be enough base flow for fish to move from one section of the creek to the other section without much difficulty. Also, there is the need for enough flow of water by the creek at section where the flap gates is located (where South Avenue meets Sumner Street ) so that the opening of the gates will self-regulate to aid trout movement into the Upper Iowa River.

It is suggested that RASCAL assessment be undertaken yearly so that there will a continuous database on the Old-Dry Run creek in-stream and near-stream conditions to add to the first RASCAL assessment data of the creek. This will enable the city to assess the impacts of the best management practices like rain gardens and riparian buffers on the creek after the implementation of these practices.

It is recommended that the city enters into an agreement with Deco Company so that the company will continue to discharge water into the creek but at temperature that will not lead to a 2° F increase in Old-Dry Run Creek water temperature.

It is suggested that land easements be obtained by the city along the creek corridor at the South Avenue, for better management of the creek. The city of Decorah could construct rain gardens on these land easements along the creek corridor so that the pollutants in stormwater run-off will be filtered before it joins the Old-Dry Run Creek.
Figure 19: Recommended Practices

Figure 19 delineates where the recommendation practices are to be done to aid the restoration of Old-Dry Run Creek as trout habitat.
Guidelines for the recommended interventions and practices as well as the timelines for the implementation and evaluation are presented below:

<table>
<thead>
<tr>
<th>Rank</th>
<th>Practices/Interventions</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Evaluations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Land easements</td>
<td></td>
<td></td>
<td></td>
<td>After the 3rd year the city could assess whether the easements have resulted in improved creek management</td>
</tr>
<tr>
<td>2</td>
<td>Old-Dry Run Creek sub-watershed group</td>
<td></td>
<td></td>
<td></td>
<td>Every 3 years residents could assess the group impacts</td>
</tr>
<tr>
<td>3</td>
<td>Rip-raps &amp; Riparian Buffers</td>
<td></td>
<td></td>
<td></td>
<td>Assess in the 3rd year to check if the creek conditions are improving</td>
</tr>
<tr>
<td>4</td>
<td>Tree planting</td>
<td></td>
<td></td>
<td></td>
<td>After 10 years, the contributions of the tree canopy to the creek could be assessed</td>
</tr>
<tr>
<td>5</td>
<td>Rain gardens</td>
<td></td>
<td></td>
<td></td>
<td>After the 3rd year the city could assess whether the rain gardens have resulted in improved creek conditions</td>
</tr>
<tr>
<td>6</td>
<td>Yearly RASCAL Assessment</td>
<td></td>
<td></td>
<td></td>
<td>At the end of every RASCAL assessment, previous results can be compared with current to see if there is improvement of creek conditions</td>
</tr>
<tr>
<td>7</td>
<td>Education of residents</td>
<td></td>
<td></td>
<td></td>
<td>Every 3 years, water quality assessment could be undertaken to check if E.coli levels are reducing due to the education</td>
</tr>
<tr>
<td>8</td>
<td>Dredging of the creek</td>
<td></td>
<td></td>
<td></td>
<td>3 years after dredging, the creek could be assessed to see whether another dredging is required</td>
</tr>
</tbody>
</table>

Table 4: Guidelines for Implementation and Evaluations

Table 4 shows the suggested interventions and practices for the restoration of Old-Dry Run Creek with the timelines for implementation and evaluations. The practices and interventions have been ranked in order of importance. The land easement is needed before rip-raps, riparian buffers and rain-gardens on current private properties along the creek corridor could be implemented, that is the reason why it is ranked first. Old-Dry Run Creek sub-watershed group could be formed in the first year. Dredging is recommended to be done once a year and could continue if after 3 years there is still dominant silt/mud substrate in the creek. The yearly RASCAL assessment is recommended to be done once every year. The education of residents in Decorah is also suggested to be undertaken in collaboration with Luther College at least once every year. After the implementation of these suggested practices and interventions, evaluation is suggested to be undertaken as suggested in the table timelines to assess the impacts of each practice and intervention.
REFERENCES


Iowa Department of Natural Resources (n.d) Rapid Assessment of Stream Conditions Along Length Protocol.

Kenneth M.C. (2011) Trout Population Response to Cover Habitat Enhancement in the Batten Kill Main Stem. Retrieved from:

http://www.nrdc.org/globalwarming/trout/trout.pdf

Knight, K. (2009) Land Use Planning for Salmon, Steelhead and Trout: a land use planner’s guide to salmonid habitat protection and recovery. Retrieved from:


National Wildlife Federation (n.d) Rainbow-Trout-or-Steelhead. Retrieved from:

Natural Resources Geographic Information Systems Library (2012) Iowa’s 2012 Listing of Clean Water Act Section 303(d) Impaired Streams. Retrieved from:
https://programs.iowadnr.gov/nrgislibx/

Natural Resources Conservation Service (2000) Rainbow Trout (Oncorhynchus mykiss). Wildlife Habitat Institute, Number 13. Retrieved from:

North Carolina State University (n.d) Watersheds Turbidity. Retrieved from:
http://www.water.ncsu.edu/watershedss/info/turbid.html


Washington Department of Fish and Wildlife (2009) Land use planning for salmon, steelhead and trout: a land use planner’s guide to salmonid habitat protection and recovery. Retrieved from:


APPENDIX A – RASCAL Variables Guide

Stream Assessment Variables:

Flow: “the volume of water carried by a stream, relative to average, at the time of assessment” (Iowa Department of Natural Resources, n.d.).

*Table 1: Flow Categories*

<table>
<thead>
<tr>
<th>Flow Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Flow</td>
<td>Water levels below normal, dry or drought conditions are occurring in the watershed.</td>
</tr>
<tr>
<td>Normal Flow</td>
<td>Water levels appear to be normal levels, no recent rains have significantly impacted water levels.</td>
</tr>
<tr>
<td>High Flow</td>
<td>Water levels are above normal, recent rain or snowmelt-water has raised water levels.</td>
</tr>
<tr>
<td>No Flow</td>
<td>Stream bed is dry, could be a result of extreme drought or karst geology causing streams to disappear or flow underground.</td>
</tr>
</tbody>
</table>

Source: IDNR

Stream habitat type:

*Table 2: Stream habitat types*

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riffle</td>
<td>Shallow, broken water, fast moving, usually with coarse substrate.</td>
</tr>
<tr>
<td>Run</td>
<td>Shallow or deep moving water, surface is not broken, high velocity than pool/glide.</td>
</tr>
<tr>
<td>Pool/Glide</td>
<td>Deeper water area, surface is not broken, velocity is slow, often times an area of deposition.</td>
</tr>
<tr>
<td>Pond</td>
<td>Section of stream that is impounded by natural or unnatural causes.</td>
</tr>
<tr>
<td>Dry Channel</td>
<td>Dry segment of stream with no flow of water.</td>
</tr>
</tbody>
</table>

Source: IDNR
Dominant substrate: “the dominant material that forms the bed of the stream segment” (IDNR, n.d.)

Table 3: Dominant Substrate

<table>
<thead>
<tr>
<th>Bedrock</th>
<th>Boulder</th>
<th>Cobble</th>
<th>Gravel</th>
<th>Sand</th>
<th>Clay/Hard Pan</th>
<th>Silt/Mud</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedrock substrate occurs when streams flow directly on bedrock; often large flat limestone slabs indicate bedrock is present</td>
<td>Boulder substrate is characterized by the presence of rocks larger than cobbles but do not form bedrock</td>
<td>Cobble substrate is characterized by rock ranging in size from 1” in diameter to 10”. Cobble can be picked up with one hand</td>
<td>Gravel substrate characterized by rock smaller than 2’ in diameter and larger than particles</td>
<td>Sand substrate is fine rocky material that does not include silt or soil particles</td>
<td>Hardened soil layer, typically found where streambed erosion has exposed a compacted soil layer, often times clay</td>
<td>Fine particles of soil</td>
</tr>
</tbody>
</table>

Channel condition:

Table 4: Channel Conditions

<table>
<thead>
<tr>
<th>Natural Channel</th>
<th>Past Channel Alteration</th>
<th>Altered Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>No dikes or artificial structures are present limiting flow of floodwaters, also stream has not been straightened</td>
<td>Channel exhibits signs of dikes or structures but significant stream recovery has taken places to allow for some natural stream migration and flooding</td>
<td>Stream show evident signs of alteration, for example, straitening, dikes, levees, etc.</td>
</tr>
</tbody>
</table>

Source: IDNR
Pool frequency: “pools are defined as areas of slow moving water with depths greater than three feet” (INDR, n.d.)

Table 5: Pool frequency

<table>
<thead>
<tr>
<th>None</th>
<th>&lt; 1 Pool Every 250’</th>
<th>&gt; 1 Pool Every 250'</th>
<th>Frequency Pools</th>
</tr>
</thead>
<tbody>
<tr>
<td>No pools deeper than 3’ are present</td>
<td>Infrequent pools. Less than one pool deeper than 3’ can be found per 250’ of stream</td>
<td>Some pools. More than one pool deeper than 3’ can be found per 250’ of stream</td>
<td>Frequent pools deeper than 3’ are evident</td>
</tr>
</tbody>
</table>

Source: IDNR

Canopy Cover: “percent of stream channel area shaded or covered by vegetation during full leaf-on conditions” (IDNR, n.d.)

Table 6: Canopy cover categories

<table>
<thead>
<tr>
<th>0-10%</th>
<th>10-25%</th>
<th>25-50%</th>
<th>50-75%</th>
<th>75-100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10% of stream segment is shaded or covered by overhead vegetation growth</td>
<td>10-25% of stream segment is shaded or covered by overhead vegetation growth</td>
<td>25-50% of stream segment is shaded or covered by overhead vegetation growth</td>
<td>50-75% of stream segment is shaded or covered by overhead vegetation growth</td>
<td>75-100% of stream segment is shaded or covered by overhead vegetation growth</td>
</tr>
</tbody>
</table>

Source: IDNR
**Embeddedness**: “degree to which large particles (boulders, cobble, gravel) are surrounded or covered by silt or fine sediment” (IDNR, n.d.).

*Table 7: Embeddedness categories*

<table>
<thead>
<tr>
<th>Completely Exposed</th>
<th>Partially Exposed</th>
<th>Mostly Embedded</th>
<th>Completely Embedded</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rocky substrate is free of silt or fine sediment</td>
<td>Some silt or fine sediment is starting to fill spaces between rocky substrate</td>
<td>Spaces between rocky sediment are mostly filled with silt or fine sediment</td>
<td>Rocky substrate is completely surrounded by or covered with silt or fine sediment</td>
<td>Stream substrate is composed of sand, silt or mud, therefore embeddedness is not an issue</td>
</tr>
</tbody>
</table>

Source: IDNR

**In-stream habitat**: “examples of in-stream habitat include logs, fallen trees, backwater pools, overhanging vegetation, riffles, floating leaf matter, aquatic vegetation, root mats, undercut banks, etc.” (IDNR, n.d.).

*Table 8: In-stream habitat rankings*

<table>
<thead>
<tr>
<th>Excellent</th>
<th>Average</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Many examples of in-stream habitat exist; aquatic species (insects &amp; fish) are present. This type of segment appears significantly better than the other segment surveyed</td>
<td>Some examples of in-stream habitat are present</td>
<td>Very few to no examples of in-stream habitat exist in stream segment. Few fish or aquatic insects are present. This type of segment appears worse than other segments surveyed</td>
</tr>
</tbody>
</table>

Source IDNR
**Losing flow:** “primarily a function of karst geology, losing flow is characterized by stream segments losing flow to cracks in bedrock or stream sinks” (IDNR, n.d.).

*Table 9: Stream segment losing flow*

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stream segment loses some or all of its flow to cracks in bedrock or stream sinks. Normally occurs only in karst regions</td>
<td>Stream segment does not lose flow</td>
</tr>
</tbody>
</table>

Source: IDNR

**Riparian zone width:** “the width of the transition zone between the water and the upland zone, typically the width of natural vegetation (tress or grass)” (IDNR, n.d.).

*Table 10: Riparian zone width categories*

<table>
<thead>
<tr>
<th>&lt; 10 Feet</th>
<th>10-30 Feet</th>
<th>30-60 Feet</th>
<th>&gt; 60 Feet</th>
</tr>
</thead>
</table>

Source: IDNR

**Riparian zone cover:** “land cover in the transition zone between the water and the upland zone” (IDNR, n.d.).

*Table 11: Riparian zone cover*

<table>
<thead>
<tr>
<th>Grass</th>
<th>Mixed Grass/Trees</th>
<th>Trees</th>
</tr>
</thead>
</table>

Source: IDNR

**Adjacent land use:** “land cover in the upland areas outside the riparian zone” (IDNR, n.d.).

*Table 12: Adjacent land use classifications*

<table>
<thead>
<tr>
<th>Row Crop</th>
<th>Trees</th>
<th>Grass</th>
<th>Pasture</th>
<th>CRP</th>
<th>Residential</th>
<th>Commercial</th>
<th>Farmstead</th>
<th>Cliff</th>
<th>Other</th>
</tr>
</thead>
</table>

Source: IDNR
Livestock access: “specific livestock accessibility to stream segment” (IDNR, n.d).

Table 13: Livestock Access

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

Source: IDNR

Bank Variables

Bank Vegetation: “Type of vegetation covering streambanks, if any” (IDNR, n.d).

Table 14: Bank vegetation classifications

<table>
<thead>
<tr>
<th>None</th>
<th>Overhanging Only</th>
<th>Dislodged</th>
<th>Partially Established</th>
<th>Well Established</th>
</tr>
</thead>
</table>

Source: IDNR

Bank Erosion: If eroding streambanks are present, the location of the eroded banks.

Table 15: Bank erosion classifications

<table>
<thead>
<tr>
<th>None</th>
<th>Both Banks</th>
<th>Alternate Banks</th>
<th>Random</th>
</tr>
</thead>
<tbody>
<tr>
<td>No streambank erosion is present</td>
<td>Streambank erosion is present on both stream banks, often associated with a down-cutting stream</td>
<td>Streambank erosion is present on alternating banks, often associated with a meandering stream</td>
<td>No pattern to the location of eroding streambanks</td>
</tr>
</tbody>
</table>

Source: IDNR

Percent bare bank: “this characterizes the percent of stream bank area that is void of vegetation or other material that acts to stabilize soil” (IDNR, n.d.).

Table 16: Classification of percent bare bank

<table>
<thead>
<tr>
<th>0-20%</th>
<th>20-40%</th>
<th>40-60%</th>
<th>60-80%</th>
<th>80-100%</th>
</tr>
</thead>
</table>

Source: IDNR
Stream bank height: “the distance in feet from the bottom of the stream channel to the top of the stream bank” (IDNR, n.d.).

Stream bank stability: “this characterizes the stability of the banks and reflects the degree to which the bank is laterally eroding” (IDNR, n.d.).

*Table 17: Stream bank stability*

<table>
<thead>
<tr>
<th>Stable</th>
<th>Moderately Stable</th>
<th>Moderately Unstable</th>
<th>Unstable</th>
<th>Artificially Stable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: IDNR

Stream bank material: “the dominant material that makes up both stream banks” (Iowa Department of Natural Resources, n.d.).

*Table 18: Stream bank material classifications*

<table>
<thead>
<tr>
<th>Rock/Rip Rap</th>
<th>Cobble/Gravel</th>
<th>Sand</th>
<th>Soil/Silt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: IDNR
APPENDIX B - Interview Questions

Anglers’ resident in Decorah and anglers who regularly visit Decorah

Purpose: to collect data about trout habitat for a stream restoration study in Old-Dry Run Creek. This project is part of a collaboration between the city of Decorah and the School of Urban and Regional Planning of the University of Iowa, under the auspices of Iowa Initiative for Sustainable Communities. The information collected from this interview will be given to city of Decorah and the University of Iowa for academic purpose.

1. For how long have you been trout fishing in Decorah?
2. How often do you go for trout fishing in Decorah?
3. What do you know about ODRC? Have you ever fished there? Is it trout habitat?
4. Can ODRC be restored as trout habitat? What will it take to restore ODRC? Do you think that ODRC should be restored as trout habitat?
5. Have you witnessed or seen fish kill in any stream or river in Decorah? If yes, which location?
6. Will you consider trout fishing in Old-Dry Run creek if the creek is restored as trout habitat? Why?

Please below is a map of Decorah showing the location of Old-Dry Run creek.

Figure 1: Map of Decorah showing Old-Dry Run Creek
**Decorah Water Department**

**Purpose:** to collect data about trout habitat for a stream restoration study in Old Dry Run Creek. This project is part of a collaboration between the city of Decorah and the School of Urban and Regional Planning at the University of Iowa, under the auspices of Iowa Initiative for Sustainable Communities. The information collected from this interview will be given to city of Decorah and the University of Iowa for academic purpose.

1. What is your job title in the Decorah Water Department?
2. Do you think there are now (or ever were) trout in ODRC?
3. Can you tell me what you know about water quality in ODRC? I have data indicating e coli, and do know about sources. Do you know about how water quality impact on trout?
4. Has your department conducted any fish kill investigation in Decorah? Do you know if other department has investigated fish kills? If yes when was it conducted? Where? Cause and main findings?
   *Dry Run, Upper Iowa River, Old-Dry Run creek, Twin Spring creek and Trout Run*
5. Do you think that Old-Dry Run creek should be restored as trout habitat? In your opinion, what would it take to restore the creek?
**North East Iowa Fly Fishing Guides in Decorah**

**Purpose:** to collect data about trout habitat for a stream restoration study in Old-Dry Run Creek. This project is part of a collaboration between the city of Decorah and the School of Urban and Regional Planning of the University of Iowa, under the auspices of Iowa Initiative for Sustainable Communities. Information collected from this interview will be given to city of Decorah and the University of Iowa for academic purpose.

1. For how long have been working as fishing guide within Decorah?
2. How often do you take people for trout fishing within Decorah? Which water body? Dry Run, Twin Spring creek, Upper Iowa River, Old Dry-Run creek or Trout Run
3. Have you seen any negative impacts on trout and its habitat from floods (example: 2008 floods) and storm water runoff within Decorah? Can you describe these impacts? Could you distinguish between rural stormwater runoff and urban stormwater runoff? If yes, which river or stream?
4. Based on current creek conditions (eg: water temperature, turbidity, spawning grounds and canopy cover etc.) should Old-Dry Run creek be restored as trout habitat? Is Old-Dry Run Creek a trout habitat? How will you rank the creek: excellent, average or poor trout habitat and why?
5. What they will take to restore the ODRC as trout habitat? Should the creek be restored?
6. Will you consider trout fishing in Old-Dry Run creek if the creek is restored as trout habitat? If yes why or if no why.

Please below is a map of Decorah showing the location of Old-Dry Run creek.

![Map showing the location of Old-Dry Run Creek](image)

*Figure 2: Map showing the location of Old-Dry Run Creek*
Iowa Department of Natural Resources

Purpose: to collect data about trout habitat for a stream restoration study in Old-Dry Run Creek. This project is part of a collaboration between the city of Decorah and the School of Urban and Regional Planning of the University of Iowa, under the auspices of Iowa Initiative for Sustainable Communities. Information collected from this interview will be given to city of Decorah and the University of Iowa for academic purpose.

1. What is your role in Iowa Department of Natural Resources? How long have you worked for DNR? Are you familiar with the Decorah area and water quality issues in Decorah?
2. In the Iowa impaired water body list, all the water bodies in Decorah are listed as impaired except for Old-Dry Run creek. Can you tell me why?
3. Has Iowa Department of Natural Resources (IDNR) ever assessed Old-Dry Run creek? If yes, when was the assessment done and what did it find? If not, why?
4. Are there geologic problems that negatively impact these water bodies in Decorah as trout habitat (e.g., sink holes, embededness or karst geology)?
   Dry Run, Upper Iowa River, Twin Spring creek, Old Dry-Run creek, Trout Run stream
5. Are there geomorphic problems of these water bodies in Decorah as trout habitat (e.g., dominant substrate, channel condition)?
   Dry Run, Upper Iowa River, Twin Spring creek, Old Dry-Run creek and Trout Run stream.
6. Are there any ecological problems that negatively impact these water bodies in Decorah as trout habitat (e.g. other fish population and aquatic plants)?
   Dry Run, Upper Iowa River, Twin Spring creek, Old Dry-Run creek and Trout Run stream.
7. Are there water pollution from metals/inorganic pollutants to water bodies in Decorah? Location?
   Dry Run, Upper Iowa River, Twin Spring creek, Old Dry-Run creek and Trout Run Stream.
8. Based on your knowledge, do you think Old-Dry Run creek could be restored as trout habitat for fishing purposes? What would it take? Should it be done? Why or why not?
9. I have not come across any fish kill in Decorah. Has the IA DNR conducted any fish kill investigation in Decorah? If yes when and where?

Please on the next page is a map of Decorah showing the location of Old-Dry Run creek.
Figure 3: Map of Decorah showing the various streams and rivers