5-1-2010

Critique of a Wildlife Habitat Evaluation Method Applied to Residential Open Space

Sarah Rigard
Utah State University

CRITIQUE OF A WILDLIFE HABITAT EVALUATION METHOD

APPLIED TO RESIDENTIAL OPEN SPACE

by

Sarah Rigard

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF LANDSCAPE ARCHITECTURE

Approved:

_____	_____
Craig W. Johnson Major Professor	Elizabeth A. Brabec Committee Member
_____	_____
David Bell Committee Member	Keith Christensen Committee Member

_____
Byron R. Burnham
Dean of Graduate Studies

UTAH STATE UNIVERSITY
Logan, Utah

2010

ABSTRACT

Critique of a Wildlife Habitat Evaluation Method

Applied to Residential Open Space

by

Sarah Rigard, Master of Landscape Architecture

Utah State University, 2010

Major Professor: Craig W. Johnson
Department: Landscape Architecture and Environmental Planning

To this date, little research has been done evaluating the quality of wildlife habitat provided by open space in residential areas. Quality wildlife habitat for the purposes of this study is defined as those areas which contain the physical and biological characteristics necessary to support native wildlife species of the region. This thesis critiqued a wildlife habitat assessment method used in a nationwide study of residential open space for the purpose of better understanding the research conducted by the study and to inform similar, future habitat evaluations of landscapes altered by human activity to accommodate residential land use. The methodology critiqued was a low resolution, habitat based, rapid assessment. The methodology provided information on the ecological function of the open space in each development and related that information to individual wildlife species needs to provide an estimation of habitat quality. However, an increase in sampling frequency and additional data collection would have improved the assessment. (188 pages)

DEDICATION

To Garrett: Thank you for your patience!

ACKNOWLEDGMENTS

The entire Landscape Architecture and Environmental Planning department faculty has each had a great influence on the success of my graduate school career. First I would like to thank John Ellsworth for providing me with direction and opportunities from day one. I truly appreciate his support and sarcasm.

I would like to thank Elizabeth Brabec for entrusting me to work on this study with her. Because my life crossed paths with hers, I got to travel (and learn) a lot! This project has been a great experience, one I will reflect back on throughout my career for inspiration, and for which I am truly grateful!

I would like to thank David Bell and Keith Christensen for being very supportive and accommodating throughout this process. I am grateful for Kathy Allen's guidance and her ability to always get me pointed in the right direction.

And, lastly I would like to thank Craig Johnson. He has influenced the direction of my career and life path more than any one teacher. Thank you!

Sarah Rigard

This thesis was supported by the US Forest Service Urban and Community Forestry Program on the recommendation of the National Urban and Community Forestry Advisory Council.

CONTENTS

Page
ABSTRACT iii

DEDICATION iv

ACKNOWLEDGMENTS v

LIST OF TABLES vii

LIST OF FIGURES ix

INTRODUCTION 1

LITERATURE REVIEW 4

Elements Specific to an Evaluation 5
of Residential Open Space 5
Major Considerations of Assessment Methodologies 12
Types of Wildlife Habitat Evaluation Methodology 22

SUBDIVISION ASSESSMENT METHODOLOGY 47

Wetland Functional Assessment Protocol 49
Upland Vegetation Functional Assessment Protocol 52
Modified Habitat Evaluation Procedure 54

SAMPLE ANALYSES 61

Southeast Atlantic: Spring Island, SC 62
Mid-west: Prairie Crossing, IL 82

DISCUSSION 96

CONCLUSION 103

REFERENCES 106

APPENDIX 112

Appendix A: Example assessment forms 113

LIST OF TABLES

Table		Page
1	Sampling methods summary chart	19
2	Table 1 from Sayre (2004) comparing research methods	24
3	Wildlife habitat methodologies compared	46
4	Subdivision study methodology summary matrix	47
5	Calculation tables	60
6	Case study site matrix	61
7	Score sheet rating definitions	71
8	Spring Island transect summary	71
9	Spring Island open space summary	72
10	Sheet 1 of Spring Island's site characteristic calculations	75
11	Sheet 2 of Spring Island's site characteristic calculations	76
12	Spring Island habitat quality for pileated woodpecker	78
13	Spring Island habitat quality for southern fox squirrel	78
14	Spring Island habitat quality for southern hognose snake	79
15	Spring Island habitat quality for black rail	79
16	Spring Island habitat quality for white ibis	80
17	Spring Island habitat quality for osprey	80
18	Spring Island habitat quality for mink	81
19	Prairie Crossing transect summary	88
20	Prairie Crossing open space summary	93
21	Prairie Crossing habitat quality for great blue heron	94
22	Prairie Crossing habitat quality for bobolink	94

23 Prairie Crossing habitat quality for veery……..95

24 Prairie Crossing habitat quality for blue-winged teal……..……..95

25 Prairie Crossing habitat quality for American kestrel…….……..95

26 Subdivision study methodology summary matrix……...…….….97

27 Critique of vegetation sample size……...…….…….98

LIST OF FIGURES

Figure		Page
1	Spring Island Trail System	62
2	Spring Island context map	63
3	Spring Island open space map	66
4	Spring Island open space management map	67
5	Spring Island transect locations map	68
6	Spring Island Transect 1, Maritime Fringe Wetland	69
7	Spring Island Transect 3, Recently Burned Pine Woodland	70
8	Spring Island land cover types map	73
9	Spring Island core acreage map	74
10	Prairie Crossing context map	83
11	Prairie Crossing open space map	84
12	Prairie Crossing open space management map	85
13	Prairie Crossing Homes and Wetland near Lake Aldo Leopold	87
14	Prairie Crossing Transect 2, Sanctuary Pond	89
15	Prairie Crossing Transect 4, Private Landscape	89
16	Prairie Crossing land cover types map	90
17	Prairie Crossing core acreage map	91

INTRODUCTION

The effectiveness and value of wildlife habitat evaluations has long been debated (Van Horne 1983; Garshelis 2000). The major problem with habitat evaluation is not misinformation or faulty studies in and of themselves but the application of those results to management decisions (Garshelis 2000; Morrison, Marcot, and Mannan 2006). These well intentioned, but flawed management decisions subsequently have potential for negative impacts to wildlife and habitat. Only the most carefully designed studies will provide the closest approximation of present habitat conditions for wildlife (Garshelis 2000).

The scope and nature of ecological assessments vary greatly based on the goals of the assessment, discipline, methods, the evaluator, and information used (Jensen and Bourgeron 2001), and are fraught with problems (Garshelis 2000; Deakin, Curwell, and Lombardi 2002). Assumptions made, method of data collection, and method of analysis are the source of most problems, and can all influence the outcome of a study (Garshelis 2000; Morrison, Marcot, and Mannan 2006). It is important to understand the influence of these methodological elements in order to know the true value of research conclusions (Van Horne 1983; Garshelis 2000; Morrison, Marcot, and Mannan 2006).

Because there is no standard, accepted means of assessing ecological function in any one situation (Jensen and Bourgeron 2001), methods are developed or existing methods modified for application to a new project. A wide range of evaluation methods of varying resolution are available for modification. This thesis is a critique of a wildlife habitat evaluation method that was modified and applied in a new and somewhat different research context.

A nationwide, post occupancy evaluation of open space contained in residential subdivisions (the subdivision study) encompassing 8 states was undertaken in 2007 – 2008 to determine which development strategies produce higher quality wildlife habitat within areas designated as open space. The subdivision study looked to specifically link wildlife habitat quality with development style (conventional, conservation, and neo-traditional), the design process, and current management practices with the purpose of educating design professionals and future residential design endeavors (Brabec and Johnson 2007). Wildlife habitat is a perceived benefit of open space and/or green infrastructure (Ada County 2004; Austin 2004), however, this perception has little empirical reinforcement (Sinclair et al. 2005).

To meet the goal of assessing wildlife habitat quality within landscapes developed for residential use an existing evaluation method was modified for this project as a project of this scale and scope had never been proposed before. The methodology had to meet the following characteristics:

1. Rapid, due to project time constraints
2. Economical, due to project budget constraints
3. Practical, allowing for easy and consistent replication at each site
4. Flexible to regional conditions
5. Provide an estimation of quality wildlife habitat available in each subdivision
6. Provide information on the constraints influencing the quality of habitat provided.

A methodology combining the use of a Geographic Information System (GIS) and rapid field assessments, satisfying the characteristics outlined above, was utilized. The

methodology used for the subdivision study is described in detail in the section of this thesis titled “Subdivision Assessment Methodology.”

A methodological process used to evaluate wildlife habitat can vary significantly by study and by evaluator discipline, thus allowing for a variety of outcomes of varying resolution. It is the goal of this thesis to detail the methodology used for the subdivision study, review its application, and detail its strengths and weaknesses. This critique will also provide insight to inform future, similar studies by highlighting major considerations of methodological development and the subdivision study methodology strengths and weaknesses. Below are the steps taken to achieve the goal stated above:

1. Review relevant literature on small scale wildlife habitat assessments
2. Summarize common themes from the literature review developing a basis on which to critique the methodology used in the nationwide study
3. Detail the methodology created for the nationwide study
4. Review an application of the method to two residential developments
5. Discuss the limitations or strengths of the methodology based on the literature review and insight provided by the case study analyses and suggest modifications to the methodology to compensate for weak points.
6. Suggest further research.

LITERATURE REVIEW

The purpose of this literature review is to identify the common elements and methods of evaluating wildlife habitat evaluation within the context of residential subdivisions. Its purpose is not to be an exhaustive review of all methods, but only to describe common themes in habitat evaluations, identify those that are applicable to the scope and scale of the subdivision study, and develop a framework for a methodological critique. This literature review details methods and information appropriate to evaluations of residential open space through the following outline:

1. Elements specific to an evaluation of residential open space:
    - 1.1. Anthropogenic influences on wildlife habitat quality
        - 1.1.1. Spatial configuration of open space patches
            - 1.1.1.1. Patch size
            - 1.1.1.2. Patch shape / edge to core area ratio
            - 1.1.1.3. Connectivity / fragmentation
        - 1.1.2. Land management regimes
            - 1.1.2.1. Suppression of natural disturbances
            - 1.1.2.2. Vegetation structure
            - 1.1.2.3. Plant types / amount of native vegetation
        - 1.1.3. Land use on adjacent properties / Zone of influence
    - 1.2. Major considerations of assessment methodologies
        - 1.2.1. Evaluator discipline
        - 1.2.2. Regional differences
        - 1.2.3. Replicability of methods

1.2.4. Spatial scale

1.2.5. Temporal scale

1.2.6. Sample size and sampling methods

1.2.7. GIS and remotely sensed data

1.2.8. Land use and vegetative land cover classification systems

2. Types of wildlife habitat evaluation methodology:

2.1.1. Level 1: Highest resolution

2.1.1.1. Demographic response method

2.1.1.2. Use-availability method

2.1.1.3. Site attribute method

2.1.2. Level 2: Medium resolution

2.1.2.1. Indirect evaluations of habitat for individual species

2.1.3. Level 3: Lowest resolution

2.1.3.1. Indirect evaluations of habitat for wildlife communities

2.1.3.2. Rapid assessments (ecological indices, spatial diversity)

3. Summary of literature review and framework for methodological critique

Elements Specific to an Evaluation of Residential Open Space

The wildlife habitat quality of a residential development, or urban / suburban environment, is influenced by ecological and social factors. A habitat assessment methodology created for assessing such an environment should describe these ecological and social influences. Since each wildlife habitat assessment methodology relies on different inputs, different methodologies can lead to varying conclusions for the same

site. The following section describes some anthropogenic alterations to the landscape associated with residential development which alter the function and quality of the landscape for wildlife species and should be considered in an evaluation of wildlife habitat quality.

Anthropogenic Influences on Wildlife Habitat Quality

Spatial configuration of open space patches. Residential developments and associated open space can be described in terms of spatial configuration and patch characteristics. Patches of different land cover serve to support different wildlife species and maintain ecological function in the landscape. The spatial pattern of these patches in a region can affect both the region it is in and neighboring regions (Forman 1995). Anthropogenic changes to the spatial configuration of the landscape and increased fragmentation of otherwise contiguous habitat by humans has been shown to negatively impact wildlife species abundance and dispersal, as well ecological function of the landscape (Soule et al. 1988; Turner 1989; Germaine et al. 1998; McWilliam 2000; Larsson 2001; Tiner 2004). Patch size, shape and connectivity are specific landscape characteristics that would be protected or impacted during the design phase of a subdivision and would be a necessary part of an evaluation of a subdivision's planning / design phase.

Patch size. Residential development can alter the size of landscape patches. The size of a landscape patch determines how that area will function in the landscape and which types of wildlife species it will support. Large patches provide core habitat and escape cover for interior dwelling wildlife species and species with large home ranges (Forman 1995). Small patches work as stepping stones for species dispersal and provide

habitat for those species preferring edge environments and habitat generalists (Forman 1995). Residential development typically decreases the size of existing landscape patches to allow for home sites and other human uses favoring wildlife generalists and depleting habitat for sensitive, interior dwelling species.

Patch shape / edge to core area ratio. Residential development can alter the shape of landscape patches and at times increase the amount of edge, favoring edge preferring species and reducing core habitat necessary for interior dwelling species. Patch shape can be altered by residential development by the introduction of roads, trails, recreation areas, home sites, etc.

McWilliam (2000) studied a patch of forest designated as open space within a residential development in the City of London, Ontario. The residential development altered the shape of the forested patch, but conserved a large, continuous portion of forest identified as valuable bird habitat. Comparing pre- and post-development bird inventories McWilliam (2000) found interior, development-sensitive bird species declined significantly within the forest patch and attributed this result to the changes in the spatial configuration of the landscape and a reduction in plant community types. Post development, the forest fragment had changes to its spatial pattern such as reduced size, decreased interior space, and increased edge habitat with fewer plant communities represented on site (McWilliam 2000).

Connectivity / fragmentation. Residential development can impact the connectivity of the landscape, which is important for species persistence and maintaining genetic diversity (Turner 1989). Species dispersal, or the ability of an animal to travel through the landscape to other preferred habitats to meet life requirements, is negatively

impacted by landscape fragmentation (Turner 1989; Opdam 1991), and is species specific, depending on dispersal capabilities (Opdam 1991). Wildlife populations can tolerate some fragmentation as long as critical movement corridors are maintained (Turner 1989). The degree at which a subdivision has maintained connectivity in the larger landscape will serve as an indication as to how it impacted, maintained, or enhanced its wildlife habitat quality through the design phase.

Connectivity in the landscape can be impacted by many human introduced features. Several studies have been done confirming that linear features of development such as roads and trails negatively impact habitat quality, species distribution, species richness (Turner 1989; Miller, Knight, and Miller 1998; Forman 2000; Tiner 2004; Holmes and Geupel 2005; Sinclair et al. 2005), and in and of themselves constitute a loss of habitat (Turner 1989). Roads and trails fragment otherwise continuous core habitat creating an edge effect which allows for increased predation of interior species (Miller, Knight, and Miller 1998; Holmes and Geupel 2005; Sinclair et al. 2005).

Soule et al. (1988) studied bird dispersal in canyon chaparral habitats in San Diego County CA. These canyon areas were being developed for residential uses, fragmenting and isolating patches of chaparral habitat and thus altering the overall spatial configuration of the landscape. It was found in this study that chaparral requiring birds declined significantly post development due to their inability to disperse through developed and non-chaparral habitats. The fragmentation of the native landscape due to residential development had negatively impacted this avian community. It is suggested by this research that maintaining connectivity in the landscape and planned development

focused on protecting important habitats would maintain sensitive wildlife species populations (Soule et al. 1988).

Land Management Regimes

Urbanization can have a substantial impact on the ecological integrity of the landscape (Turner, Lefler, and Freedman 2005). Land management and adjacent land uses, two activities which are a part of urbanization, are important factors in habitat evaluations of human altered environments (Gerrard et al. 2001; Weiers et al. 2004) and should be considered in an evaluation of residential open space. These factors often change the vertical and horizontal structure of the landscape, suppress natural disturbances while introducing other disturbances such as noise and pollution which alter the quality of the environment for wildlife. Site specific management practices, such as suppression of natural disturbances, changes to vegetation structure, introduction of non-native plants, preservation of native plants, and the use of insecticides or herbicides, can have a major impact on biodiversity, plant community composition and function (Germaine et al. 1998; Livingston, Shaw, and Harris 2003; Turner, Lefler, and Freedman 2005), and water quality (Tiner 2004).

Suppression of natural disturbances. Land management activities which work to reduce natural disturbance regimes, such as fire, interfere with the maintenance and renewal of the native plant communities and overall ecological system of the managed area. Natural disturbance suppression can also adversely affect adjacent protected lands if a particular disturbance typically originated in the now managed landscape. In such cases the health of the neighboring landscape would also be negatively impacted by the policies enforced on the managed lands (Hansen and DeFries 2007).

Vegetation structure. Residential development alters both vertical and horizontal vegetation structure. Vertical vegetation structure pertains to the layers of vegetation in a plant community from the ground layer to canopy. Horizontal vegetation structure refers to the spacing of plants in the landscape. Land management activities control the vegetation structure of an urban site, and thus has a substantial affect on its general habitat quality (Livingston, Shaw, and Harris 2003). Urban habitats can vary greatly in vegetation structure and function (Germaine et al. 1998; Turner, Lefler, and Freedman 2005), therefore, performing field investigations are necessary for fine grained assessments of subdivisions as assumptions cannot be made about the vegetative conditions from an aerial photograph (i.e. some subdivisions may have completely cleared the understory). Urban and suburban areas which maintain native plant communities with their typical horizontal and vertical vegetation structure provide higher quality wildlife habitat (Sandström, Angelstam, and Mikusiński 2006).

Sandström, Angelstam, and Mikusiński (2006) found in their study of four different types of urban greenspace that there is a positive correlation between avian species richness and vertical and horizontal vegetation structure. Using avian ecological diversity as a proxy, they evaluated the functionality of four generalized urban landscapes: the city center, residential, greenway, and periphery greenspaces of Örebro, Sweden. Urban greenspace areas tend to have a more simple vertical vegetation structure since shrub layers may be removed to improve visibility across a site or dead vegetation removed to prevent injuries from falling trees or limbs. The city center and residential greenspaces had the poorest vertical vegetation structure and the lowest avian species diversity of the four landscapes studied. Forests containing large trees with

developed, multiple layers of understory vegetation are important for birds in urban areas and had higher avian species diversity (Sandström, Angelstam, and Mikusiński 2006).

Plant types / amount of native vegetation. Residential developments can alter plant community composition by reducing coverage of native plants and introducing ornamental plant species. The protection and enhancement of native vegetation is currently the most important management action maintaining wildlife habitat in urban environments (Livingston, Shaw, and Harris 2003).

In another study of residential developments, Germaine et al. (1998) found a strong correlation between housing density and vegetation structure in breeding bird densities in Tucson, AZ. Germaine et al. (1998) studied 334 random plots ranging from pristine natural vegetation outside of the city's edge to highly developed landscapes for bird-habitat relationships. The land cover was defined by 19 variables to describe plant composition and structure and was correlated to the abundances of 21 avian species. This study found a strong correlation between low housing density and presence of native vegetation with higher native bird species diversity and abundance (Germaine et al. 1998).

Land Use on Adjacent Properties / Zone of Influence

Land use activities influence habitat quality on neighboring lands. A zone of influence extends from areas inhabited or used by humans, negatively impacting plant and animal biodiversity on the neighboring landscape with impacts increasing with development intensity (Sinclair et al. 2005; Smith and Wachob 2005; Hansen and DeFries 2007). Residential development has been shown to impact wildlife, particularly breeding birds in nearby landscapes. Riparian areas are especially important to birds and

are one of the more vulnerable habitats prone to residential development. In their study of breeding birds along the Snake River in Jackson Hole, Wyoming, Smith and Wachob (2005) found that food generalists, ground gleaners, and avian nest predators, all types associated with decreasing avian species diversity, increased as residential densities increased along the river, while species richness and diversity declined. Neotropical migrant bird species were found to be impacted the most (Smith and Wachob 2005).

Roads negatively affect wildlife and habitat quality 100 to 1500 meters from their location depending on the amount of traffic and surrounding plant cover. Roads are a source of noise, exotic plant species, heavy metals, dust, road salt (depending on region), altered stream and wetland drainage, and are a barrier to wildlife movement isolating some groups and causing genetic impacts (Forman 2000). Development sensitive species will avoid areas near roads reducing the area of functional habitat for that animal (Turner 1989).

A correlation between the width of the trail or road, the type of land cover it is found in, and the amount of use it receives and their impact on species diversity has been noted in several studies (Forman 2000; Holmes and Geupel 2005; Sinclair et al. 2005; Sandström, Angelstam, and Mikusiński 2006). Holmes and Geupel (2005) found in their study that species diversity was impacted less by trails under 2 meters in width. Forman (2000) found the impacts of roads were less in dense, forested environments compared to areas of more open landscape cover such as prairie.

Major Considerations of Assessment Methodologies

Several other considerations, common to all evaluation methodologies, are critical to this study. They include evaluator disciplines, regional differences, replicability of

methods, spatial scale, temporal scale, sample size and sampling methods, GIS and remotely sensed data, and land use and vegetative land cover classifications systems. However, project goals and constraints such as budget and time will determine many of the characteristics of a habitat evaluation method used for a particular study.

Evaluator Discipline

Evaluation methodologies can differ in scope and nature due to evaluator discipline (Jensen and Bourgeron 2001). Evaluator discipline and thus the ability of the evaluator to effectively apply a methodology is an important consideration in the development of an evaluation methodology. The expertise of the evaluator will influence various aspects of an evaluation such as data collection methods, assumptions made, and research conclusions.

Regional Differences

Assessment methods exist for evaluating wildlife habitat for a particular environment based on keystone species. A keystone species is a plant or animal species that exerts great influence on an ecosystem (i.e. a top level predator) and can serve as an indicator of the environmental health of a particular area. The definition of suitable habitat for a species changes with the region the species is located due to different environmental conditions and plant communities, therefore it cannot be assumed that suitable habitat for a species in one region is same for the same species in a different region (U.S. Fish and Wildlife Service 1980b). Depending on the type of assessment method used adaptations may have to be made to account for regionally appropriate definitions of habitat quality if assessing habitat for an individual wildlife species (U.S.

Fish and Wildlife Service 1980b). Therefore, if using a common keystone wildlife species as a proxy to define and compare habitat quality in a study looking at several regions, the definition of suitable habitat will have to be modified as necessary to reduce error and bias in analysis.

Replicability of Methods

When assessing multiple sites one standard method of data collection should be developed and its procedure thoroughly detailed to limit bias between sites and evaluators. Procedural inconsistencies can invalidate data for comparisons over time and/or comparisons between sites (Ratti and Garton 1996). Even the most minor changes in data collection can bias research outcomes and produce false correlations. It is important to have a detailed methodology which can be executed in the same manner each time, especially when studying animal behavior and detailing changes over time (Ratti and Garton 1996).

Spatial Scale

Habitat quality of a site can be evaluated at many different spatial scales (Garshelis 2000; Jensen, Christensen, and Bourgeron 2001). The spatial scale(s) used in an assessment should be clearly defined and will depend on research goals (Jensen, Christensen, and Bourgeron 2001). The spatial scale of an assessment influences many aspects from data collection to the detail and accuracy of results. And, results are only valid for the scale in which they were derived (Corsi, De Leeuw, and Skidmore 2000; Garshelis 2000).

Ecological assessments are conducted in a variety of spatial scales. Four typical categories for spatial scale are the bio-geographical scale, regional scale, local – between plot scale, and local – within plot scale (Morrison, Marcot, and Mannan 2006). Many assessment methodologies are developed for scales too large to be useful in an urban context, such as residential open space, which require a fine grained, plot scaled analysis (Young and Jarvis 2001; Deakin, Curwell, and Lombardi 2002). For example the bio-geographical and regional scales are too coarse and would over simplify finite changes which may impact habitat quality significantly at a local scale. However, most local-level assessments are limited in scale, address a reduced number of issues, ignore significant regional influences on the site (i.e. connectivity), and do not capture the full complexity of the site (Garshelis 2000; Jensen and Bourgeron 2001). Therefore, single scale habitat evaluations fail to represent the habitat quality of a site for an individual species because animals react to their environment on a variety of scales (Garshelis 2000).

Habitat quality of residential open space can be defined, by its site specific characteristics, by the role it plays in the regional landscape in its ability, or lack there of, to provide linkages for wildlife within an urban or suburban context. Small scale changes to the landscape, such as the construction of a residential subdivision, can have impacts on the function of an ecosystem at a larger scale (Hansen and DeFries 2007), therefore subdivisions should be assessed at a minimum of two spatial scales (i.e. local and regional) to gain a better understanding of how the development has impacted or enhanced habitat quality. A very detailed assessment would include evaluations at multiple spatial scales.

Temporal Scale

Ecosystems are highly variable, nonlinear systems (Jensen and Bourgeron 2001) and are not completely predictable (Jensen, Christensen, and Bourgeron 2001) therefore they should be evaluated over an appropriate temporal scale. Environmental conditions are constantly changing and in turn influence ecosystem pattern and process. By not assessing the temporal dynamics of a system its true complexity is not represented in the assessment (Jensen and Bourgeron 2001). Evaluating temporal changes aids in depicting the composition and function of a site for all spatial scales (U. S. Fish and Wildlife Service 1980a; Dale and Beyeler 2001).

Habitat preference and use by a species, which in turn can be used to deduce habitat quality of a site, can produce false correlations with site attributes if the temporal scale of the study is too small (Garshelis 2000). For example, habitat evaluations at one point in time may actually reflect past habitat conditions or temporary present conditions rather than depict long term trends in habitat quality (Van Horne 1983). High quality habitat will provide for changing seasonal requirements in range and needs which are paramount to the health and persistence of an animal (Van Horne 1983). Studies which observe a species while its needs are met will assume it is adequately supported whether or not it is throughout the rest of the year. A study of residential open space would benefit by performing an evaluation at a large temporal scale which looks at site conditions prior to development, during construction, and several years post occupancy while accounting for seasonal variations to understand the extent each particular development impacted or enhanced wildlife habitat. A study could be performed at a

smaller temporal scale of several months or years to depict its current wildlife habitat quality.

Sample Size and Sampling Methods

Direct sampling of present wildlife and plant species can be used to field verify conditions of the site and assess habitat quality. Vegetation sampling is often one aspect of habitat evaluation and would be valuable in a study of residential open space. Residential open space can vary greatly in horizontal and vertical vegetation structure and plant community composition as previously discussed.

When developing a direct sampling protocol, establishing a proper sample size is extremely important and can greatly influence the outcome of an evaluation, since inadequate sample sizes can invalidate statistical comparisons (Ratti and Garton 1996; Johnson, Pitts, and Porreca 2005). A large body of statistical literature exists to aid the establishment of proper sample size required for an estimate of a variable (Ratti and Garton 1996). Sampling efforts should be proportional to the area or population studied, otherwise pertinent information will be lost in large study sites (Forman 1995; Ratti and Garton 1996; Johnson, Pitts, and Porreca 2005).

The type of sampling protocol used and information collected will also depend on evaluator discipline and research goals. For example, a wildlife biologist would be the most qualified to sample wildlife and estimate population size; those without a wildlife background would not. However, knowledge of the vegetation of a site is a very useful tool in understanding what wildlife species can be supported by an area (Livingston, Shaw, and Harris 2003) and can be performed by those with a interdisciplinary background. Sampling can be outsourced to experts if necessary to reach research goals.

There are many methods of sampling that are either random or systematic or some combination of the two. Selecting one method would depend on the time available, size of the study area, and goals of the study. Sampling methods frequently used in wildlife habitat evaluation are categorized as simple random, systematic, stratified random, cluster, plots along transects, and line transect (Ratti and Garton 1996). All types would have an application in residential open space for either wildlife or vegetation sampling. However, each sampling method has its benefits and problems (Ratti and Garton 1996). Please see Table 1 for a definition of each method and its benefits and problems as summarized from Ratti and Garton (1996).

GIS and Remotely Sensed Data

Geographic information system (GIS) data layers have been shown to be valuable in the study of landscapes. However, the use of GIS is limited by the accuracy of the data used. Data layers compiled in a GIS can have an additive effect of errors producing a final product of limited accuracy (Forman 1995).

Several wildlife habitat assessment methods utilize GIS analyses and data to supplement research (Tiner 2004). Assessment of habitats in urban settings are generally limited due to the lack of available GIS information at the fine grained resolution of the local scale such as specific land uses, vegetation structure, and detailed vegetation composition (Livingston, Shaw, and Harris 2003).

Remotely sensed data, or data collected by satellites, is more commonly available and can be used for wildlife habitat evaluations (Quattrochi and Pelletier 1991), however, it is typically developed for large scale applications and has limitations when used for urban settings. Remotely sensed data cannot make distinctions between such wide

Table 1: Sampling methods summary chart

Sampling Methods Summary Chart			
	Description	**Benefits**	**Problems**
Simple random	Sample units are randomly selected across the entire study area or through overall population.	Each sample unit has an equal chance of being selected, minimizing evaluator bias. Accuracy of results can be easily estimated.	Potential to produce poor estimates by missing large important areas or populations of interest. The same sample unit may be sampled multiple times.
Systematic	A target area or population is located. From a randomly selected starting point sample units are then taken at a regular interval.	Each sample unit has an equal chance of being selected, minimizing evaluator bias, and focuses on targeted areas and populations.	Potential to under represent the overall population. Overall accuracy is difficult to quantify and it is considered less accurate than simple random sampling.
Stratified random	Distinctly different areas or populations are defined as individual, homogenous subgroups and sample units proportional to each subgroup are randomly taken.	Information can be related to specific subgroups providing a more detailed analysis that would not occur with a more generalized sample.	More complex and time consuming than a typical random sample. Evaluator bias can occur in the selection of subgroups. Subgroups may be unrelated to research question.
Cluster	Multiple areas are selected, then within those areas several samples are taken. Unlike stratified random sampling cluster groups are considered the sampling unit and variation is expected to exist within each cluster.	Simple, economical method of sampling for large studies. Each cluster would be a small scale representation of the total population.	Estimates will change with cluster locations. Potential for bias in selection of cluster locations if not randomized. Potential for high sampling error.
Plots along transects	Sample plots are surveyed along a linear transect. All elements within a plot are recorded.	Gathers more information than point sampling such as abundance data. Easier to locate than randomly selected plots.	Time consuming, placement of transect can cause bias.
Line transects	Sample units are taken at points at regular intervals along a straight, linear path. Only those elements touching the interval point are recorded.	Allows for continuous systemic sampling in a targeted or randomly selected area.	Does not work well in small areas, placement of line transect can cause bias, may over or under estimate density estimations if study population is spatially clustered.

variations in land cover such as urban/recreational grasses and quarries, strip mines, and gravel pits. And, natural features such as wetlands and lower vegetation such as grasses and shrubs are hard to distinguish at a 30 m cell resolution (Corsi, De Leeuw, and Skidmore 2000; Cunningham 2006). Ecologically important characteristics such as wetlands, canopy openings, and ephemeral water bodies which are smaller than 30 m are also lost in the resolution offered by remotely sensed data (Cunningham 2006).

Remotely sensed assessments that require a fine scale analysis often require field investigations to augment data and verify actual conditions when mapping natural or semi-natural areas like those found in residential open space (Young and Jarvis 2001; Weiers et al. 2004; Cunningham 2006). The more heterogeneous, variable, and complex the landscape cover is, the less accurately it will be portrayed in remotely sensed data. When working at fine scales, such as the local level, maps of the highest available resolution are required (Corsi, De Leeuw, and Skidmore 2000; Young and Jarvis 2001; Weiers et al. 2004), which are typically more expensive than lower resolution data (Quattrochi and Pelletier 1991).

Habitat analysis in residential open space requires the highest resolution data available while supplementing with data from other studies or field investigations to reduce error. These are more expensive to implement due to the need for high resolution data and on-site investigations.

Land Use and Vegetative Land Cover Classification Systems

Land use can be defined as man's activities on the land (Anderson et al. 1976), and vegetative land cover can be described by its vegetative structure (horizontal and vertical configuration) and its taxonomic composition (Anderson et al. 1976; Morrison,

Marcot, and Mannan 2006). Land use and cover and their subsequent spatial attributes are used in many forms of ecological and wildlife habitat assessments; their implications to wildlife habitat have been previously discussed in this literature review.

There are many classification systems available for land use and land cover that have been created to meet the needs of a variety of study types and scales. Land cover type and use can be determined or inferred by GIS data, Landsat imagery, aerial photographs (Anderson et al. 1976; Fraterrigo and Wiens 2005; Cunningham 2006) and/or through field sampling (Anderson et al. 1976). The resolution level of the classification system corresponds with the cartographic scale of the map and with the resolution of the data used when developed. Maps of small scale and higher resolution are needed when creating effective classification systems for use at the subdivision level, and depending on the project, may require supplemental ground surveys (Anderson et al. 1976).

The widely available land use and land cover classification system created by the U.S. Department of Agriculture as described in Anderson et al. (1976) is too broad for residential open space analysis. All open space is clustered into general categories such as rural parks, open land, or residential land which is the equivalent of a classification level I or II making no distinction between structure and composition of each site (Anderson et al. 1976). Additional sampling is required when studying urban natural areas to classify land cover and use at a resolution acceptable for a wildlife habitat assessment at a local scale (Livingston, Shaw, and Harris 2003). High resolution classifications systems have been developed at the local level in many cities and counties across the country. These high resolution systems are individual to the location and vary

in resolution and classifications. The current nationwide land classification systems of land use and land cover are too low in resolution for application to residential subdivisions therefore a study must develop its own classification or use a locally developed, finer resolution system if available.

Types of Wildlife Habitat Evaluation Methodology

Van Horne (1983) offers a three level hierarchical categorization of wildlife habitat quality assessments. Level 1, providing the highest resolution, use an a direct evaluation of habitat quality for a single species using on-site data. Studies of this level are the most intensive, site and species specific evaluations. Level 2 studies use an indirect evaluation of habitat quality for a single species using inferences from a level 1 study. And, level 3, providing the lowest resolution, use an indirect evaluation of habitat quality for a wildlife community and are based primarily on vegetational structure and plant community diversity. Level 3 investigations ignore the species interrelationships such as competition and predation and make assumptions based on the expected wildlife population. Habitat diversity and species diversity are not always positively correlated therefore assumptions of areas of diverse plant communities of having more value in a level 3 type study ignores the needs of some specialist species. Level 2 and 3 evaluations allow for rapid assessment of habitat without a direct censusing of wildlife species (Van Horne 1983).

Within these resolutions wildlife habitat quality can be assessed either quantitatively or qualitatively, depending on the parameters of the study, because wildlife habitat quality is the result of environmental and social processes. Social influences on habitat quality are sometimes best described qualitatively while environmental influences

are easily described quantitatively (Sayre 2004). Level 1 evaluations are more frequently quantitative studies, however expert observation, a qualitative method, can and has been used to detail the life requirements of an individual wildlife species for the creation of a high resolution species model. Level 2 and 3 evaluations occur in all forms, either quantitative or qualitative or some combination of the two.

Sayre (2004) argues for increased use of qualitative methods to describe social factors in rangeland management. He argues that qualitative methods are better suited for research pertaining to the social, historical, political, and economic factors influencing land management because they are flexible and account for context. Quantitative methods applied to rangeland management have been ineffective in finding useful correlations between management practices and demographic characteristics, and between management practices and the motives and values of ranchers (Sayre 2004). The same quantitative / qualitative argument could be made for residential development and other urban areas impacted by human activity. The project goals, time constraints, economic budget, and several other factors will determine whether or not a qualitative or quantitative or combination method would be used to illustrate a wildlife species / habitat relationship. See Table 2 for a useful table illustrating the differences between quantitative and qualitative research methods from (Sayre 2004, 671).

The resolution levels offered by Van Horne (1983) will be used in this study as a framework in which to describe the basic types of evaluation within those levels and categorize existing published habitat evaluation methodologies and their relevance to an evaluation of residential open space.

Table 2: Table 1 from Sayre (2004) comparing research methods

Characteristic or application	Quantitative	Qualitative
Sample size or area	Larger	Smaller
Sample	Randomized	Not randomized
Method	Determined in advance	Can evolve during research
Variables	Limited to those identified in advance	Can be discovered during research
Research tools	Surveys, questionnaires, statistics	Interviews, observations, participation, archives
Research encounter	Standardized, brief	Open ended, longer
Appropriate for	Testing hypotheses and models	Discovering variables, refining hypotheses
Results are	Replicable, generalizable	Not necessarily replicable, difficult to generalize
Logical underpinnings	Hypothetico-deductive	Inductive

The resolution levels offered by Van Horne (1983) will be used in this study as a framework in which to describe the basic types of evaluation within those levels and categorize existing published habitat evaluation methodologies and their relevance to an evaluation of residential open space.

Level 1: Highest Resolution

Garshelis (2000) offers three general research designs in which the habitat quality of a site can be directly inferred: demographic response, use-availability, and site attributes. A demographic response study relates population characteristics to habitat quality for a species. The basic assumption in this method is that positive demographic characteristics equates to high quality habitat for a species. Use-availability studies monitor time spent in a variety of habitats by an animal proportional to availability of all habitats to determine individual species preference through which habitat quality for the species can be inferred. For example, if an animal spends most of its time in a forest of a

particular structure and function that habitat would be its preferred habitat and thus high quality habitat for the animal. Site attribute studies attempt to relate specific site characteristics to species preference independent of time spent in the site.

Species specific data can be obtained in a variety of ways from simple observation to physically measuring attributes of an animal. Condition indices are measurements of the physical attributes of wildlife species to evaluate the quality of the habitat in which they reside and can be used with any of the level 1 study designs. Measurements of body fat and weight, kidney fat, bone marrow fat, blood and urine characteristics, etc. can be used to illustrate whether or not the animal is being adequately supported by its environment (U.S. Fish and Wildlife Service 1980b; Sinclair, Fryxell, and Caughley 2006). Each condition index (i.e. kidney fat, body weight, etc.) has its limitations both in application and information value of its results. Sampling tends to be biased towards those animals which are healthy and active. Age, sex, and time of year can also affect the outcomes of condition measurements (Sinclair, Fryxell, and Caughley 2006).

Each of the three research designs described by Garshelis (2000) are reliant upon direct observations of species and site specific data and can be combined to provide a more accurate assessment of habitat (Garshelis 2000). Evaluations of these types are typically used in broader scale studies and have the potential application to the evaluations of the role of residential open space in meeting the life requirements of a species. The three study designs described by Garshelis (2000) are reviewed in more detail below:

Demographic response method. In the demographic response study design method a more direct approach for assessing habitat quality is used and is considered the best method to determine the value of habitat in relation to a species. Habitat is assessed by comparing demographics (density, reproduction, survival, etc…) of an individual species in different habitats. The basic assumptions of use-availability and site attribute studies are that the habitat variables studied are related to an animal's fitness. Demographic response studies test this assumption more directly through the documentation of population characteristics within a habitat, and by not making assumptions on animal behavior (i.e. time spent in area). Changes in animal densities or nesting success of an area are examples of demographic response studies (Garshelis 2000). A study which compares nesting success in residential open space to other locations in the same region is an example of how this study design could be used to infer habitat quality of residential open space for a species.

The majority of demographic response design studies research potential relationships between habitat and animal density. However, the best measures of habitat quality are demographic studies of population growth and carrying capacity of a site. These types of studies are extremely difficult and seldom done (Garshelis 2000). Carrying capacity describes the natural limit to the number of animals which can be supported by the resources of a particular area (U. S. Fish and Wildlife Service 1980a; Sinclair, Fryxell, and Caughley 2006). Carrying capacity can be used to approximate the impacts of future actions by estimating the changes in population numbers for various management decisions (U. S. Fish and Wildlife Service 1980a).

The demographic variables of species abundance and diversity are more commonly used as an indicator of habitat quality. However, species diversity and density can be a misleading indicator of habitat quality as they may reflect increased numbers of generalist species providing false correlations with the quality of the site studied. In order to avoid this bias, the ratio of generalist to specialist species should be noted in studies of this type (Van Horne 1983).

Avian species diversity is a commonly used index for habitat quality. Birds require a wide variety of habitats at different scales making them especially useful as indicators of habitat quality (Sandström, Angelstam, and Mikusiński 2006). Several studies of green infrastructure have combined demographic response and site attribute study methods to illustrate a correlation between population characteristics of a wildlife community and habitat configuration using species diversity as an indicator (i.e. Soule et al. 1988; McWilliam 2000; Sinclair et al. 2005; Sandström, Angelstam, and Mikusiński 2006).

McWilliam (2000) studied bird diversity changes within a forest fragment of the City of London, Ontario Canada. The 84 ha forest fragment was one continuous patch of forest predevelopment; post development 45 ha was fragmented by roads and several single-family detached housing units with 39 ha protected as open space. A significant portion of important bird habitat was protected in the design of the residential development. McWilliam quantified many spatial characteristics of the pre and post development illustrating the changes in core habitat, edge, and overall shape of the forest patch. Using pre and post development bird inventories McWilliam concluded changes in spatial patterns effect bird species diversity. Avian species preferring edge

environments increased significantly post development, while bird species which prefer interior habitat declined significantly (McWilliam 2000). McWilliam based conclusions of changes in bird species diversity solely on the changes in spatial pattern of the landscape and not other disturbances inherent with residential development.

Sinclair et al. (2005) evaluated bird habitat provided by greenways in North Carolina by using a combination of demographic response and site attribute methods. In their study they quantified habitat variables using GIS analysis such as greenway width, trail width, and adjacent land uses, as well as performing field investigations of vegetation condition and structure to develop a context in which to describe the differences between greenways. Bird and mammal inventories were conducted in thirty-four 300-m long greenway segments over five nights in 2002. The abundance of nest predators was estimated to illustrate how the habitat characteristics of the greenways influence the reproductive success of bird species. Sinclair et al. (2005) found mammalian nest predators increased significantly as the greenway width decreased or as the trail width increased. However, no significant relationship between mammalian nest predator abundance and adjacent land uses was observed in this study (Sinclair et al. 2005). This study drew conclusions between design practices and habitat quality indicating wide forested corridors with narrower, unpaved trails reduce the abundance of nest predators.

Sandström, Angelstam, and Mikusiński (2006) studied four different types of green space (urban, residential, greenway, and periphery) within the city of Örebro, Sweden using avian species diversity as an indicator of habitat quality. This study looked at landscape characteristics as well as performing bird counts. The greenway and

periphery locations of the city had higher avian species diversity than urban and residential green space (Sandström, Angelstam, and Mikusiński 2006).

The direct approach offered by demographic response studies is not without limitations. Species density is not always an indicator of habitat quality (Van Horne 1983; Garshelis 2000). Habitat selection by an animal is based on the attributes of the site *and* the social interactions of species. Some species may choose to inhabit an area of lower quality to avoid conflict with another species present in the higher quality site (Van Horne 1983). It is predicted by Van Horne (1983) that species density will not positively correlate in studies containing patchy sites, seasonal habitat, and/or temporally unpredictable environments. Residential open space, depending on its spatial configuration and proximity to larger natural areas, could constitute a patchy landscape favoring generalist species by Van Horne's definition making species density a poor predictor of habitat quality in this situation. However, density of rare species would be an indicator of good habitat in a patchy landscape because they are susceptible to local extinction (Van Horne 1983). Animal density, if combined with another variable such as body weight, a condition index, has been found to provide a more accurate view of habitat quality than density alone (Garshelis 2000).

Reproduction and survival rates may offer a better indication of habitat quality, but the relationship between habitat and reproduction and survival can be complex. Only the most carefully designed studies of this type have been successful in discerning a relationship between habitat and reproduction or survival (Garshelis 2000). Overall, demographic response investigations should be performed at several scales to account for annual variation and variables effecting population demography (Garshelis 2000).

Use-availability method. Use-availability study design is one of the most popular methods in the study of birds and mammals habitat selection, preference, or quality. In general terms this study design compares the portion of time an animal spends in each available habitat type to the relative area of each habitat type. The amount of use or nonuse is the dependent variable and changes in use or nonuse are documented over time. Use-availability studies typically deal with broad habitat types and look at the geographic distribution of a species, home range characteristics, or use of habitats within a home range. In this study design, as well as in site attributes design, measures of selection are developed for habitats or habitat attributes based on animal behavior which in turn are used to describe habitat quality or importance (Garshelis 2000). Virtually all classes of statistical techniques could be used in a use-availability study depending on the nature of the assessment (Morrison, Marcot, and Mannan 2006). How often an animal uses residential open space in comparison to other areas within in its home range is an example of how habitat quality of residential open space could be inferred through this type of study design.

One problem with use-availability design is the fact that defined habitat evaluated in each study can be described in many inconsistent ways. One study may define a habitat by its vegetational composition and another may focus on its structure hampering comparisons between sites or species preferences. The definition of habitat as well as the number of habitat types used can diminish the power of statistical comparisons. The method used to measure an animal's use of a habitat can also lend itself to sampling biases skewing results. Habitat use is measured for individuals then typically pooled for

comparisons. Microhabitat selection is based on the individual's preferences and social interactions and typically does not translate to the species as a whole.

There are three problems with use-availability studies: the scale chosen, the measurement of available habitat, and the potential inclusion of known non-habitat. Use-availability studies need to be performed at large temporal scales to depict annual variation otherwise they produce false correlations (Garshelis 2000). Another problem with use-availability studies is the measurement of available habitat. Implicit in this study design is the assumption that all habitat types are available to all species thus the amount of time spent in a particular habitat depicts the species preference or quality of habitat. Other factors at play such as geographical limitations, species competition, and other social interactions determine the amount of time spent in each type of habitat by a species. Another issue with the measurement of available habitat is the potential inclusion of known non habitat, or habitat never used by a particular species, which would diminish statistical results and value of the study (Garshelis 2000).

Site attributes method. Site attributes studies measure a multitude of habitat-related variables in specific locations to attempt to identify the value of those habitat variables or attributes which are preferred by a single species for a particular activity (i.e. breeding, nesting, feeding, etc…). Where a demographic response study would relate nest success with the habitat quality of the nest location, site attribute study would relate the attributes of nest locations with habitat preference and in turn use habitat preference as a way of describing habitat quality for a species. The amount of use is not an important element of site attribute studies, only whether or not the site is used by a species for a particular activity. Use can be either directly or indirectly observed in the

field through physical observation of the animal or by its tracks and other alterations left in the landscape (Garshelis 2000). Habitat variables are quantified and various statistical analyses can be used to illustrate relationships between habitat variables and wildlife use, nonuse, or predicted use (Garshelis 2000; Fraterrigo and Wiens 2005).

Common site attributes used in these studies includes quantifying the spatial characteristics of the site used by an animal species such as patch size, connectivity to other patches, corridor size, lineal amount of edge, interior core acreage, ratio of edge to interior core acreage (U.S. Fish and Wildlife Service 1980b; McWilliam 2000; Dale and Beyeler 2001; Morris 2004; Weiers et al. 2004; Sinclair et al. 2005; Cunningham 2006), percent canopy closure, permanent and seasonal water bodies size, distance from patches to water sources (U.S. Fish and Wildlife Service 1980b; Dale and Beyeler 2001; Weiers et al. 2004; Cunningham 2006), building and road densities (Gerrard et al. 2001; Fraterrigo and Wiens 2005), vegetation structure and function, plant composition, and adjacent land uses (Sinclair et al. 2005). These site characteristics are then compared to site specific wildlife species data to make inferences on habitat preference and quality for a single wildlife species (Garshelis 2000).

Site attribute studies focus on habitats presumed to be of biological importance to a species and meet the life requirements of a species. Assumptions implicit in site attribute design studies are that used habitat is suitable and unused habitat is not. As previously discussed many other factors are at play (i.e. competition) in which attributes alone cannot be used to accurately portray habitat quality for a species. Site attribute design studies can be augmented by including demographic measurements to increase the value of the results by focusing on trends in population characteristics in relation to site

attributes and therefore reducing the reliance on animal behavior and preference to determine habitat quality (Garshelis 2000).

Level 2: Medium Resolution

Medium resolution studies rely on information provided by related or unrelated higher resolution studies to make inferences on habitat quality. This level of study is typically executable in a shorter time frame than resolution level 1 studies and may not rely on the direct observation of wildlife or site conditions. Level 2 studies focus on measurable characteristics of the site and are appropriate for situations in which measurable and predictable habitat changes are the key variable, i.e. impact assessments (U. S. Fish and Wildlife Service 1980a). This type of assessment provides a static view of habitat and does not consider all behavioral and environmental characteristics which would more accurately portray habitat quality for an individual species (U. S. Fish and Wildlife Service 1980a)

Indirect evaluation of habitat for individual species. There are several methods of medium resolution studies which compare site characteristics to previously established wildlife species habitat requirements. The habitat requirements of a species are determined through a level 1 resolution study which physically observed the species and made inferences on its preferred habitat(s) based on this direct observation. Wildlife species requirements are then described in models or reports which are used in the level 2 studies.

The U. S. Fish and Wildlife Service's Habitat Evaluation Procedures (HEP) offers one methodology to evaluate wildlife habitat in which species preferences are indirectly obtained through the use of habitat suitability index (HSI) models (U.S. Fish and Wildlife

Service 1980b; Van Horne 1983). HSI models detail the life requirements and habitat needs of a single species based on their determined preferences within a specific region (Bender, Roloff, and Haufler 1996). HSI models are typically created through expert observation with limited empirical data (Garshelis 2000), however, they are considered a higher level study because direct observation of the species is required for their development. HSI models in turn can be used to estimate whether or not the species would be able to inhabit a site based on the site's characteristics (Rennie, Clark, and Sweeney 1998) as outlined in the HEP which would equate to a resolution level 2 evaluation of habitat quality.

If using an HSI model, in any method of evaluation, it is important to use a tested model (Bender, Roloff, and Haufler 1996) at the appropriate scale for which it was created (U. S. Fish and Wildlife Service 1981; Bender, Roloff, and Haufler 1996), and in the geographic regions in which they were developed (Rennie, Clark, and Sweeney 1998). Untested models are merely a hypothesis of the species-habitat relationship (Garshelis 2000). A combination of site specific data collected in the field and other sources such as aerial photographs or GIS data are necessary to use most HSI models (Rennie, Clark, and Sweeney 1998).

The HEP is used extensively by federal and state resource management agencies (Bender, Roloff, and Haufler 1996). The HEP protocol is based on the assumption that habitat quality and quantity can be numerically described, and those numeric values in turn can be used to describe present and future habitat conditions for a species. The HEP is a species specific habitat assessment which numerically rates habitat elements using HSI models. HSI models are used to evaluate habitat for a particular species based on

environmental variables necessary for the species to meet its life requirements on a scale of zero to one (U.S. Fish and Wildlife Service 1980b; Rennie, Clark, and Sweeney 1998). An HSI value of zero equates to unsuitable habitat, while a one is assigned to habitats of the highest quality for a particular species. The HSI value obtained through the evaluation describes the carrying capacity of the species for the site studied based on availability of welfare factors. The accuracy of the HEP evaluation is reliant upon the user to assign a correct HSI value based on the characteristics of the site. Habitat evaluated for a specific species describes the quality of habitat only in relation to that species needs. The results of the evaluation can be used to discuss general habitat quality for species of the same guilds or life requirements, but the results cannot be translated to all species (U.S. Fish and Wildlife Service 1980b).

Two criticisms of the HEP are that knowledge of species requirements is usually not adequate enough to provide an accurate rating of habitat variables and synergistic effects among resources are ignored (Van Horne 1983). The effectiveness of HSI models in predicting habitat suitability has been disputed with some research results found to support HSI model accuracy, whereas other research negates this (Bender, Roloff, and Haufler 1996; Garshelis 2000). HSI models are quasi scientific relying on both qualitative and quantitative data making their verification difficult, if not impossible in some cases (Garshelis 2000). Model parameters do not always allow for natural variation between sites and sampling errors (Bender, Roloff, and Haufler 1996; Garshelis 2000). Several assumptions are made when indirectly predicting the suitability of a site for a species and can be problematic for land management decisions; one assumption being higher ranked habitats are in fact suitable for a species. For example, it has been shown,

through the testing of some species models, that population sinks have been rated as high quality habitat when in fact they were the complete opposite (Garshelis 2000). The only way to reduce error in the aforementioned situation would be to use a validated species model and correlate the results to the species' demographic performance and mortality data for the area (Garshelis 2000), thus increasing the resolution level of the overall study.

Another medium resolution habitat evaluation method is the Habitat Assessment Model (HAM) produced by the Colorado Division of Wildlife for the purposes of evaluating elk and mule deer habitat. This model compares predicted available forage, wildlife winter range, and wild and domestic ungulate off take or consumption. Predicted available forage is determined based soil surveys and weather information to determine below average, average, and above average range forage production for each soil type. Winter range polygons were developed for the model based on previous direct observations of herd over a large temporal scale to determine their range in average and severe winters. Daily foraging off take was averaged for each species based on average animal weight and approximate numbers of population for each area. Once the data is mathematically and graphically described it is combined in a GIS model to show areas of high quality habitat. No wildlife species are directly observed for this method. Species specific information such as seasonal ranges, and herd numbers is collected from local biologists and is averaged for the specific study location to determine the forage necessary to support native grazers (Wockner et al. 2007). The basic assumption of this model is if there is enough available forage to meet the needs of both livestock and wild

ungulates than the site is good habitat for wild ungulates such as elk or mule deer. The model does not look at interspecies specific competition.

The HAM has been developed for a specific guild (large native ungulate grazers) within a specific region (Colorado). Similar assessment models, like the HAM, could be used to determine if residential open space would meet the requirements of a species. However, a model should be developed for an appropriate indicator species for urban environments, and may only be appropriate for the region for which it was developed further limiting its application to multiple geographic locations. For example elk and mule deer require large tracts of land for grazing and would not be appropriate indicators for suburban areas. The HEP has been designed to incorporate more species, making it more applicable to a wide variety of habitats in all regions of the country.

Level 3: Lowest Resolution

Level 3 studies are indirect studies of habitat for a wildlife population. Also included under this heading are any studies that do not link habitat with wildlife either by species or a population and look at landscape characteristics as a means of general habitat assessment.

Indirect habitat evaluations for wildlife communities. Similar to the HEP and HAM analysis, there are methodologies which have been developed to evaluate habitat quality for a wildlife community in a specific geographic location. The U.S. Army Corps of Engineers (USACE) have developed community models to be used in accordance with the HEP to expedite the evaluation process. Instead of evaluating the landscape individually for several different wildlife species requiring the use of several HSI models,

the USACE community models allow for a more rapid, generalized assessment for a community of animals with related life requirements.

One model developed for the U.S. Army Corps of Engineers by Schroeder (1996) outlines a method for evaluating wildlife habitat provided by deciduous palustrine forested wetlands of Maryland for forest interior birds, and reptiles and amphibians instead of evaluating the site individually for each species as required by the typical application of the HEP. These wildlife groups are of special concern in Maryland and serve as an indicator for the overall habitat quality of the site for the entire expected wildlife population. The model has been developed in a similar method to individual species HSI models used in the HEP but have been expanded to accommodate the needs of several species of the same guild or community (Schroeder 1996). The model concentrates on identifying characteristics deemed important for species diversity and richness such as buffer widths, patch size, core area and plant cover which have been determined in higher resolution studies.

Methods which evaluate habitat for a wildlife community are typically used by land managers to economically identify important areas for conservation and restoration. The method does not evaluate the site specifically to each species needs, but averages the needs of a community and focuses more generally on landscape characteristics to determine value. The same problems and level of error inherent in medium resolution studies are greater in low resolution studies. One source of error with lower resolution studies is the subjectivity of the assessments and the reliance on the evaluator to properly assign habitat values. Methods such as these are appropriate for many scales and could be used in an evaluation of residential open space to provide a general approximation of

habitat quality. However, in the case of the subdivision study no consistent set of community wildlife models were available for all sites so this type of evaluation was not a viable option.

Rapid assessments (ecological indices, spatial diversity). Rapid assessments are used to describe the ecosystem integrity and/or wildlife habitat value of an area using ecological indicators. Rapid assessments are typically quantitative based evaluations and begin with inventories of observable or measurable physical, chemical, and biological features through either field work or remotely using GIS, or both. These assessments are an efficient and economical way to make an approximation of the status of a system. Rapid assessments typically gather information on a limited number of ecological indices deemed necessary to understand the system or habitat being evaluated. Rapid assessments are low resolution studies because they do not always link wildlife needs to habitat quality. The indirect assumption made by these evaluations is that a "healthy" or "diverse" site can support a "healthy" and/or "diverse" wildlife population.

Ecological indices can be used at a variety of scales, including finer scales, to assess environmental condition and trends (U. S. Fish and Wildlife Service 1980a; Dale and Beyeler 2001; Corry and Nassauer 2005). Ecological indices can be based on wildlife species needs, human disturbances, landscape condition, or landscape pattern, and should be chosen in accordance with a defined protocol which represents the goals of the evaluation (Dale and Beyeler 2001). Indices chosen for an evaluation should represent the composition, structure, and function of the site within several scales (landscape/region, ecosystem/community, and population/species) and depict the full complexity of the system studied (Dale and Beyeler 2001). There is no standard method

set for selecting and using indicators, however Dale and Beyeler (2001) offer guidance in their study: ecological indicators should be easily measured; be sensitive to stresses on the system; respond to stress in a predictable manner; signify impending changes in key characteristics of the ecological system; predict changes that can be averted by management actions; are integrative and cover gradients across the system; have a known response to disturbance, anthropogenic stresses and changes over time; and have a low variability in response (Dale and Beyeler 2001).

One criticism of ecological indices is that results are dependent upon the type and number of indices chosen by the evaluator (Corry and Nassauer 2005) and may not capture the complexity of the ecological system studied (Dale and Beyeler 2001). Indices can be chosen to force desired or biased outcomes, therefore they must be carefully selected (Dale and Beyeler 2001; Corry and Nassauer 2005).

Tiner (2004) evaluated one remotely sensed method of assessing habitat integrity using ten environmental indicators, six for habitat and four for human disturbance, and the method's application to the Delaware's Nanticoke River watershed, a significantly man-altered environment. Geospatial data depicting land use, land cover, wetland and aquatic habitats, soils, transportation routes, and current and historic aerial photographs was used for the study. Tiner (2004) used the land cover and land use classification system described by Anderson et al. (1976) to characterize upland habitats. Tiner (2004) categorized natural habitats as all undeveloped sites ranging from the pristine to those limitedly used for hunting, fishing, timber harvest, and made no distinction between plant communities. Natural habitat integrity of the watershed was defined by the spatial characteristics and amount of human disturbance of the designated natural habitats found

in the study location. Each of the ten indices was given a numerical value from 1.0 to 0.0 (1.0 is considered pristine) then the scores were averaged to produce an overall score for the watershed. This study only ranked the quality of the watershed and did not link site conditions to wildlife requirements.

Tiner (2004) illustrated the benefits and weaknesses the application of this rapid assessment method to watersheds. Without field verification, or qualitative data the score cannot accurately predict the overall quality of the watershed or subbasin. It can, however, rapidly and economically estimate the integrity of watersheds and can be used to rank watersheds based on these indices. Landscape level studies such as these are beneficial in prioritizing restoration and conservation efforts as well as depicting status and trends (Tiner 2004).

The use of a geographic information system (GIS) is becoming an integral part of natural resource planning and can be used in a variety of spatial and temporal scales to assess habitats, document land use change, or estimate future impacts (Young and Jarvis 2001). There are several rapid assessment methods utilized to evaluate wildlife habitat quality which rely solely on remotely sensed or GIS data. With such methods the results are based on a selected number of indicators and no field work is performed to verify site conditions. Previously collected data from higher level studies are used to inform the status of the chosen indices. The scale of this type of study is typically larger, encompassing whole watersheds, and is not appropriate for smaller sites such as residential developments. As previously discussed in this literature review, remotely sensed and GIS data are typically developed for a scale too large or crude for evaluations at the site scale.

Another rapid assessment method developed to evaluate wildlife habitat quality for a general population is the Texas Parks and Wildlife Department Wildlife Habitat Appraisal Procedure (WHAP). This qualitative method assesses habitat based on indices chosen to depict vegetation structure, diversity, and composition. The primary assumption of the WHAP is: areas of diverse plant communities with natural horizontal and vertical structure will support more wildlife than other sites. The procedure of the WHAP is simple, allowing for rapid assessment. The first step requires that dominate landscape cover for the study location be delineated on an aerial photograph. The second step is to determine the appropriate number of inspection sites needed to represent the study area. The third step is to field verify the vegetative conditions of the inspection sites using Field Evaluation Key (FEK). The FEK has predetermined points for several site characteristics such as soils, successional stage, uniqueness and abundance, plant species diversity, structural diversity, condition, and land management. Points are assigned to each category and tallied to provide an overall score. One form must be completed per cover type. After all sites are inspected the average habitat quality for each cover type is calculated using the form (Texas Parks and Wildlife 1995).

The WHAP, like other lower resolution studies, is a subjective assessment; relying on the ability of the evaluator to assign appropriate scores. This methodology was specifically created for the Texas landscape and could not be applied to other locations, however it could be used as a model for the development of a method for another region.

Spatial variation in land cover across the landscape does have an influence on wildlife population persistence (White 2000). There are methods of habitat evaluation

which look at the spatial structure of the landscape to infer habitat quality. The primary assumption of such studies is that certain spatial configurations maintain biodiversity in an area. Field investigations may or may not be performed to verify present wildlife or plant species. Although past research indicates there is an important relationship between pattern and process (Turner et al. 1991), using landscape pattern solely as an indicator of ecological function has been criticized since landscape pattern and ecological process have not been explicitly linked (Corry and Nassauer 2005).

Morris (2004) evaluated the spatial characteristics and perceived habitat value of the residential open space of an award winning residential development design chosen in a design competition held in Ontario, Canada. Morris (2004) based the evaluation on spatially measurable landscape ecology principles such as patch size, edge, interior habitat, connectivity, and pattern. This evaluation was based on the proposed design of residential open space, not the actual developed site. In this study Morris ranks existing patches of vegetation on their spatial characteristics and compares how well the proposed design protects and connects higher ranking, important habitat of the site. Morris proposed an alternate design, detailing a decision process in selecting open space areas based on ecology principles and stressing the importance of strong upfront planning in protecting habitat (Morris 2004). This evaluation was based solely on landscape pattern and did not connect that pattern to specific wildlife needs.

The use of rapid assessments and ecological indices could be used to make an approximation of wildlife habitat quality in site scale investigations. As with any study the methodology should be well designed, choose appropriate indicators, and properly collect data to provide the status of each indicator. Spatial scale varies greatly with rapid

assessments, therefore if using a previously developed method it is paramount that the spatial scale and purpose of the study be the equivalent to which the method was created.

Summary of Literature Review and Framework for Methodological Critique

This literature review presented a variety of wildlife habitat assessment concepts to be considered in wildlife habitat evaluations of urban / suburban environments. Many of the assessment methods and their elements covered in this literature review are typically combined to increase the thoroughness of an evaluation, however it is important to understand the benefits and implications of each singular element and the basic concepts behind habitat evaluation in order to perform a methodological critique of the subdivision study method. Not all of the reviewed elements will be implemented in all evaluations. And, no one method of study has been shown to be the best, all have their own set of strengths and weaknesses in methodology, value of results produced, and commitment necessary for completion. See table 3 for a summary of methodology types. The highest resolution studies may provide the most accurate picture of habitat for a site only if executed properly at a large temporal scale, and are the most expensive, complicated, and time intensive methods. Lower resolution studies, though more economical, in many cases, are merely an educated guess at habitat suitability. Lower resolution studies are typically developed and executed to determine habitat quality for more species which is a need of land managers.

The methodology developed for the subdivision study will meet the characteristics of the medium and low resolution studies as per the project parameters stated in the introduction of this thesis. Medium and low resolution studies are

economical and flexible to wide variety of situations which encompass both environmental and social influences on habitat. The next page (Table 3) contains a matrix summarizing the characteristics of the methods discussed in the literature review.

Table 3: Wildlife habitat methodologies compared

Wildlife Habitat Evaluation Methods Compared									
	Study design resolution	Classification system resolution	Typical evaluator discipline	Requires direct sampling of vegetation	Requires direct sampling of wildlife	Flexible for use at multiple spatial scales	Can be used for quantitative applications	Can be used for qualitative applications	Economical?
Demographic response	High resolution	High resolution	Wildlife biologist	Yes	Yes	Yes	Yes	Not as effective	Depends on size of study
Use-availability	High resolution	High resolution	Wildlife biologist	Yes	Yes	Yes	Yes	Not as effective	Depends on size of study
Site attribute	High resolution	High resolution	Wildlife biologist	Yes	Yes	Yes	Yes	Not as effective	Depends on size of study
Indirect evaluations of habitat for individual species	Medium resolution	Variable	Various experts	No	No	Yes	Yes	Yes	Yes
Indirect evaluations of habitat for wildlife communities	Low resolution	Variable	Various experts	No	No	Typically for large scale studies	Yes	Yes	Yes
Rapid assessments	Low resolution	Variable	Varies, in some cases no expertise required	No	No	Depends on particular method	Yes	Yes	Yes

SUBDIVISION ASSESSMENT METHODOLOGY

The methodology used to evaluate wildlife habitat of residential open space for the subdivision study was a habitat based evaluation for individual wildlife species. The land was directly evaluated to indirectly determine the habitat quality for individual species using established species models. The methodology used satisfied the constraints of the subdivision study outlined in the introduction. Table 4 summarizes the elements of the subdivision assessment methodology.

Table 4: Subdivision study methodology summary matrix

Methodology used in the subdivision study	
Methodology characteristics:	
Study design	Indirect, habitat based
Resolution level	Medium/low resolution
Spatial scale	Local and regional
Temporal scale	N/A, one assessment
Data sources	Varying resolution
Land cover and use classification	Developed for study
Repeatable	Yes
Addresses regional differences	Yes
Sample method	Representative stratified random
Vegetation sampling	Direct sampling
Direct observation of wildlife	Incidental, not sampled
Anthropogenic influences evaluated:	
Fragmentation	Quantitatively
Spatial configuration	Quantitatively
Connectivity	Quantitatively
Adjacent land uses	Qualitatively
Land management	Qualitatively
Execution considerations:	
Economical	Yes
Time frame for completion	Short, 1 year
Discipline of evaluator	Landscape architects with the aid of native plants experts in each region

The methodology used to evaluate wildlife habitat of residential open space was a combination and modification of three established assessment methods. Two of the assessment methods evaluate plant community function and structure and were used as a means of site data collection to inform the third, overall method which related the vegetational quality of the site to individual (evaluation) wildlife species needs. The evaluation wildlife species were chosen in consultation with a local wildlife biologist. Up to eight wildlife species were chosen for each development. The physical and biological site attributes required by these species were considered indicative of high quality habitat. Wildlife habitat quality, for the purposes of the study, was inferred by the ability or inability of the development to support the evaluation species as determined by results of the analysis.

The two plant community evaluation methodologies used were the Utah Department of Transportation's (UDOT) Wetland Functional Assessment Method (Johnson, Pitts, and Porreca 2005) and the National Agroforestry Center: Riparian Buffer Design Guidelines (RBDG) Manual's upland vegetation assessment method (Johnson and Buffler 2006). These two methods are on-site rapid functional assessments and were used to collect field data and evaluate plant community quality of several locations within each residential development. The United States Department of Agriculture (USDA) Forest Service's Habitat Evaluation Procedure (HEP) (U.S. Fish and Wildlife Service 1980b) was modified with the purpose of evaluating the suitability of the open space to regionally appropriate wildlife species needs. The unmodified HEP is a medium resolution study which is adaptable to regional conditions, economical, habitat based allowing for evaluation to be performed by non-biologists, and meets many of the criteria

established by the subdivision study. The three individual methods, as modified for the nationwide study, are described below.

Wetland Functional Assessment Protocol

The Utah Department of Transportation's (UDOT) Wetland Functional Assessment Method (WFAM) was used to evaluate wetland quality within the case study sites. The information collected through the use of this protocol was used to inform the modified HEP analysis on site conditions. The UDOT WFAM is a science-based method that allows for rapid, economical, and repeatable evaluations of wetland function and value. Information on the following environmental and social influences on wetland quality are collected (Johnson, Pitts, and Porreca 2005):

1. Functions
    1.1. Biological
        1.1.1. Level of disturbance
        1.1.2. Plant community composition
        1.1.3. Habitat for federally listed or proposed listed T & E species, or imperiled and/or vulnerable species
        1.1.4. General wildlife habitat
        1.1.5. General fish/aquatic habitat
        1.1.6. General amphibian habitat
    1.2. Hydrological
        1.2.1. Flood attenuation (riverine classification only)
        1.2.2. Short and long term surface water storage
        1.2.3. Sediment/ nutrient/ toxicant retention and removal

1.2.4. Sediment/ shoreline stabilization (riverine and lacustrine classifications only)

2. Values:

2.1. Visual quality

2.2. Recreation/ education potential

The UDOT WFAM protocol involves the completion of an evaluation form and simple transects for each wetland or waterway studied. A native plants specialist was employed at each development site to aid in plant identification. The transect protocol recommends selecting areas which are representative of the site or randomly selecting points if studying larger areas. For the study, a stratified random sample was selected for each residential development in order to represent changes in water regimes, vegetative structure, and topography across the developed site. Wetland transects were performed perpendicular to the water's edge, and data was collected at ten evenly spaced intervals, approximately one pace length. At each step (or point) all plant species directly above or under the toe of the evaluator's shoe was recorded, and thus documenting all of the vertical layers of the site from the ground layer to tree canopy in the location of each point in accordance with the UDOT WFAM protocol.

Sufficient sampling is necessary to depict site conditions. The UDOT WFAM recommends at least 10 points (preferably 20) be taken at each wetland feature. It is also recommended that one point be sampled at a minimum of once per acre in larger wetland areas.

The subdivision study employed a stratified random sample technique as outlined in the UDOT WFAM and RBDG functional assessment methods. This type of sampling

method is appropriate when the study site can be easily divided into different habitats or stratum. With other methods, such as systematic and the simple random method, some habitats may be inadvertently skipped. Once the 'strata' are defined, a simple random sampling method is then employed within each to obtain data. By collecting data in this manner changes between habitats can be illustrated and all habitats within the site will be represented.

The UDOT WFAM developed separate evaluation forms for each of the five naturally occurring wetland types in Utah: riverine, slope, depressional, mineral flat, and lacustrine. These forms were completed during the subdivision study site visits for the corresponding wetland type or similar wetland type as the UDOT WFAM does not accommodate all wetland types found throughout the nation. The general methodology that was followed is outlined below: (as modified from Johnson, Pitts, and Porreca 2005)

1. Define project context such as: ecoregion, watershed, and county.
2. Define the assessment area (AA) (the immediate area of the wetland), and expanded assessment area (EAA) (the area within 600 feet of the AA) are defined.
3. Determine and document whether or not the AA is primary habitat for threatened or endangered (T & E) species, or state listed species through internet research. For this step it was determined as to whether or not these species may reside on site, but the remainder of the protocol for T & E species was not followed as this was a post occupancy evaluation.
4. Select one of the five wetland classification types as outlined in the appendices of the WFAM that described or closely described the wetland being evaluated (i.e. riverine, depressional, slope, mineral flat, and lacustrine). If the wetland does not fall under

those categories the most closely related form was used. For example, in the case of estuarine wetlands, like those found in South Carolina, the lacustrine forms were used with additional notations.

5. Complete the transects with the aid of a regionally appropriate native plants expert.
6. Complete the evaluation forms as indicated.

Points were assigned through the evaluation sheet categories which corresponded to the function and value of the wetland. The points were tallied to assign a ranking of Category I, II, III, or IV wetland. A Category I wetland would be of the highest quality and ranking. Each AA was assessed separately. The function and value of each wetland assessed under this protocol was used to inform the proposed HEP methodology. See Appendix A for all UDOT WFAM evaluation forms.

Upland Vegetation Functional Assessment Protocol

The United State Department of Agriculture (USDA) Riparian Buffer Design Guidelines (RBDG) contains a methodology for assessing riparian and upland plant community condition (Johnson and Buffler 2006). The upland plant assessment protocol as outlined in RBDG was used to evaluate vegetation quality in non-wetland areas of the subdivision study sites. The following biological functions are assessed by the RBDG (Johnson and Buffler 2006):

1. Functions
    1.1. Biological
        1.1.1. Level of disturbance
        1.1.2. Plant community composition

1.1.3. Habitat for federally listed or proposed listed T & E species, or imperiled and/or vulnerable species

1.1.4. General wildlife habitat.

The RBDG methodology is very similar to the UDOT WFAM and includes performing the same transect protocol and completing evaluation sheets to determine a numerical score which rates the condition of the plant community. This information was used to inform the modified HEP analysis on site conditions. The general methodology that was followed is outlined below (as summarized from Johnson and Buffler 2006):

1. Define project context such as: ecoregion, watershed, and county.
2. Define the assessment area (AA) (the immediate area of the feature), and expanded assessment area (EAA) (the area within 600 feet of the AA) are defined.
3. Determine and document whether or not the AA is primary habitat for threatened or endangered (T & E) species, or state listed species. This step was completed through internet research for the subdivision study.
4. Select the form that corresponds with the evaluated feature; either riparian or upland.
5. Complete the transects with the aid of a native plants expert.
6. Complete the evaluation forms as indicated. The forms contain ratings for hydrological processes, plant community structure and composition, plant ages and vigor, land management activities, land alteration levels, and presence / abundance of non-native vegetation. Ratings for each section are then tallied to produce a score of proper functioning condition (PFC), functional - at risk (FAR), or non-functioning (NF). See Appendix A for RBDG evaluation forms.

Modified Habitat Evaluation Procedure

For the nationwide study the HEP was proposed as a means to evaluate current wildlife habitat quality by relating site characteristics with individual wildlife species needs. The HEP was developed by the USDA Forest Service for wildlife habitat assessments both baseline and future conditions, trade-off analyses, and compensation analyses (U.S. Fish and Wildlife Service 1980b). The HEP was significantly modified for the purposes of the subdivision study to allow for a rapid assessment and incorporate the use of the previously described functional assessment methods. The HEP is a strictly quantitative assessment and was modified to be used as a predominately qualitative method for the subdivision study. The steps are basically the same but do not require the measurement of all site characteristics and the use of the numerically described species needs. More time at each site than what was available in the project schedule would have been necessary to collect the field data required to perform the assessment as outlined by the USDA Forest Service. The following outline describes the modified procedure:

1. Define site characteristics
    1.1. Define study area. Study area includes the residential development and other significant biological linkages in the immediate region such as any areas of native / natural vegetation near the development.
    1.2. Delineate land cover types. Land cover types will depict data from field work (the functional assessments), and include the management and alteration level of each area (see Table 5 page 60).
        1.2.1. Vegetation: This determines which wildlife species are selected for evaluation. Vegetation data will come from the transects and functional

assessments (UDOT WFAM, RBDG) performed on site. The following categories will be used and will be altered by management level as necessary:

1.2.1.1. Forest. Area dominated by trees.

1.2.1.2. Prairie. Area dominated by grasses and forbs

1.2.1.3. Hedgerow. Area with trees planted as a divider.

1.2.1.4. Wetland. Area dominated by plants associated with saturated soil.

1.2.1.5. Lakes / ponds / streams. Any open body of water will be in one category.

1.2.1.6. Agriculture. Areas actively farmed.

1.2.1.7. Fields. Areas previously farmed or altered, dominated by non-native plant species.

1.2.1.8. Pasture. Areas associated with grazing.

1.2.1.9. Marsh. Fresh and saltwater marshes will be distinguished.

1.2.1.10. Landscaped. Area is planted with ornamental vegetation which lacks natural horizontal and vertical vegetation structure.

1.2.2. Management level categories:

1.2.2.1. Unmanaged. Receives little to no maintenance.

1.2.2.2. Managed. Human intervention to mimic natural state (i.e. prescribed burns).

1.2.2.3. Ultra-managed. Receives regular maintenance (i.e. mowed area).

1.2.3. Alteration level categories:

1.2.3.1. Natural. Area was not altered during development or currently.

1.2.3.2. Restored. Area returned to historic / natural conditions.

1.2.3.3. Landscaped. Area is planted with ornamental vegetation which lacks natural horizontal and vertical vegetation structure.

2. Quantify the spatial characteristics of the site to describe the habitat characteristics. The following spatial characteristics will be manually digitized based on data collected during field investigations and aerial photographs: (Please see page 54 for an example matrix of all calculations performed for each development.)

   2.1. Acreage of each patch of each land cover type corresponding to management and alteration level.

   2.2. Linear distance of edge of each patch.

   2.3. Edge ratio of each patch. A 50m and 100m buffer will be applied inside the patches and the acreage of the buffer calculated and divided by patch size to obtain an edge variable for each.

   2.4. Core acreage of each patch. Buffer acreage will be subtracted from patch size acreage to obtain the core variable.

   2.5. Distance to water onsite. Calculated by measuring the distance of the centroid of each patch of land cover onsite to the nearest water source onsite.

   2.6. Distance to water offsite. Calculated by measuring the distance of the centroid of each patch of land cover onsite to the nearest water source offsite.

   2.7. Distance to patch of similar cover type within the development. Will be calculated by measuring the distance between the centroid of each patch.

2.8. Distance to patch of similar cover type offsite. Will be calculated by measuring the distance between the centroid of each patch onsite to the centroid of similar land cover offsite.

2.9. Describe adjacent land use. Will be done through field evaluation and aerial photographs.

3. Select evaluation wildlife species.

3.1. Contact a local wildlife biologist and ask for suggestions on appropriate wildlife indicator species of high quality habitat for the area in which the subdivision is located. Dominate native plant cover types will be given to the biologist if unfamiliar with the site to ensure only animals suited for the site are suggested.

3.1.1. Out of list of suggested wildlife species select animals that represent different feeding guilds (i.e. carnivore, omnivore, or herbivore), strata locations of where feeding occurs (i.e. surface, shrub layer, canopy, etc…), and reproductive guilds (i.e. locations of reproductive activity. This will provide a diverse set of indicator species. Where appropriate use the same indicator species when developments exist in close proximity for comparison.

4. Detail life requirements of indicator species.

4.1. Where applicable a tested species model developed for the HEP will be used to describe the life requirements of the indicator species. If a HEP model is unavailable a literature review will be performed.

4.2. The following information will be detailed for each species:

4.2.1. Nesting habitat. This describes the reproductive environment required by the animal.

4.2.2. Foraging habitat. This will describe that areas used for obtaining food.

4.2.3. Water needs. This describes the water needs of the animal and the range it is capable of traveling to obtain it.

4.2.4. Area needs. This will describe the home range needs of the animal and will be compared to the available amount of preferred habitat on site and whether or not this area requirement is met.

4.2.5. Status. This will state whether or not the animal is listed on state or federal protection or concern lists.

4.2.6. Overall. This will summarize the ability of the site to support the species and any specific elements not previously mentioned that are required to support the species.

5. Compare the life requirements of each species with the site characteristics assessed and quantified for each development for a reasonable approximation of the suitability of the habitat provided. The site will be rated in the following manner:

5.1. High quality: The site received the highest functional ratings (proper functioning condition for uplands and category 1 or 2 for wetlands) in the field assessments, and meets life requirements and has the preferred spatial characteristics for the species as determined in the GIS analysis and literature review.

5.2. Moderate quality: The site received mid-range ratings (functional at risk for uplands and category 3 for wetlands) in the field assessment and / or one or more life requirements or spatial characteristics are not met as determined by the GIS

analysis or literature review. Even though some preferred characteristics are not met for the species a known limiting factor is not present.

5.3. Poor quality: The site received poor ratings (nonfunctional for upland and category 4 for wetlands) in the field assessment and a limiting factor for the species was found in the GIS analysis or literature review (i.e. distance to water beyond tolerance.)

Table 5: Calculation tables

Residential development:	Spring Island, Beaufort County, SC					
	Un-managed		Managed		Ultra managed	
	Natural		Natural	Restored	Landscaped	
Spatial characteristics of the site	Land cover	Land cover	Land cover	Land cover	Land cover	Land cover
Total acreage	Acres	Acres	Acres	Acres	Acres	Acres
Percentage of open space	Percent	Percent	Percent	Percent	Percent	Percent
Acreage of largest patch	Acres	Acres	Acres	Acres	Acres	Acres
Percentage of largest patch of open space acreage	Acres	Acres	Acres	Acres	Acres	Acres
Average area of remaining patches (acres)	Acres	Acres	Acres	Acres	Acres	Acres
Linear distance of edge (ft)	Feet	Feet	Feet	Feet	Feet	Feet
Core acreage with 50m buffer total	Acres	Acres	Acres	Acres	Acres	Acres
Largest patch of 50m core acreage	Acres	Acres	Acres	Acres	Acres	Acres
50m buffer acreage	Acres	Acres	Acres	Acres	Acres	Acres
Edge ratio 50m buffer to total size	Percent	Percent	Percent	Percent	Percent	Percent

Residential development:	Spring Island, Beaufort County, SC					
	Un-managed		Managed		Ultra managed	
	Natural		Natural	Restored	Landscaped	
Spatial characteristics of the site	Land cover	Land cover	Land cover	Land cover	Land cover	Land cover
Core acreage with 100m buffer	Acres	Acres	Acres	Acres	Acres	Acres
Largest patch of core acreage (100m)	Acres	Acres	Acres	Acres	Acres	Acres
100m buffer acreage	Acres	Acres	Acres	Acres	Acres	Acres
Edge ratio 100m buffer to total size	Percent	Percent	Percent	Percent	Percent	Percent
Distance to water onsite (ft)	Feet	Feet	Feet	Feet	Feet	Feet
Distance to similar cover onsite (ft)	Feet	Feet	Feet	Feet	Feet	Feet
Shortest distance to similar cover offsite (ft)	Feet	Feet	Feet	Feet	Feet	Feet
Maximum distance to similar cover offsite (ft)	Feet	Feet	Feet	Feet	Feet	Feet
Average distance to similar cover offsite (ft)	Feeet	Feeet	Feeet	Feeet	Feeet	Feeet
Trail length	Miles					

SAMPLE ANALYSES

The site visits for the subdivision study took place from June 2007 through April 2008. Approximately 1 ½ days were spent at each development. The GIS analyses and literature reviews were performed after the field work was completed from June 2007 through June 2008. The residential developments and regions evaluated in the subdivision study are described in Table 6.

To aid in the critique of the method used by the subdivision study the analysis performed on two developments will be reviewed: Spring Island, SC and Prairie Crossing, IL. Spring Island, SC had the most positive assessment of all the developments studied. Prairie Crossing, IL ranked the highest in wildlife habitat quality for the Midwestern sites assessed by this study.

Table 6: Case study site matrix

Region	Subdivision Type		
	Neo-traditional	**Conservation**	**Conventional**
Mid-Atlantic	Kentlands City of Gaithersburg Maryland	Wesley Chapel Woods Baltimore County Maryland	Dufief City of Gaithersburg Maryland
Southeast Atlantic	I'on Mt. Pleasant South Carolina	Spring Island Beaufort County South Carolina	Sea Pines Hilton Head Island South Carolina
Mid-West	Prairie Crossing Lake County, Illinois	The Fields of St. Croix Lake Elmo, Minnesota	Cloverdale Farms, Washington County, Minnesota; Tana Ridge, Lake Elmo, Minnesota
Mountain West	Stapleton Denver, Colorado	Hidden Springs Boise, Idaho	Rosecreek Estates Herriman, Utah
Pacific Northwest	Northwest Landing DuPont, Washington	The Uplands King County, Washington; Lincoln Green Whatcom County, Washington	High Point, Seattle Washington

Southeast Atlantic: Spring Island, SC

Spring Island is a private conservation community located near the town of Bluffton in Beaufort County, SC. The island is approximately 3,000 acres in size and surrounded by 3,500 acres of saltwater marsh (Spring Island 2008). Approximately 1,848 acres are reserved as open space on the island itself, with 1,200 of the acres set aside as a nature preserve. The open space of Spring Island consists of maritime forest, a private golf course, fresh and salt water marshes, manmade ponds, and open fields. See Figure 1 for a picture depicting the trail system and Figure 2 for a context map of the island.

Figure 1: Spring Island Trail System

Figure 2: Spring Island context map

An additional 450+ acres of private property is protected through an easement and required to be maintained in a natural state. The minimum requirements state a 50 foot buffer is maintained along roads, 25 foot buffer on each side of neighboring property lines, and 30 feet from marsh edges are to be left natural. The Spring Island Trust encourages the homeowners to leave larger buffers of native vegetation, especially near the marsh edges.

Previous land uses on the island were a cotton plantation and a private hunting preserve (Riddle 1992). Open fields and historic structures remain and are maintained on the island. Clearing of lots for homes and facilities was kept to a minimum and was kept to previously open areas where possible. The golf course was built in areas of old cornfields from the old hunting preserve where possible (Riddle 1992).

The open space of Spring Island is governed by three entities: the Low Country Institute, the Property Owner's Association (POA), and the Spring Island Trust. The Low Country Institute is based on Spring Island but works with the community of Beaufort County to conserve land and educate the public (The Low Country Institute 2007). The POA manages all landscaped areas such as the golf course, athletic fields, equestrian center, etc., as well as a few natural areas. The Spring Island Trust is the organization in charge of maintaining and protecting Spring Island's natural resources and educating residents. The Trust oversees the majority of Spring Island's open space and the nature preserve. The staffs of the Low Country Institute and Spring Island Trust are one in the same. The Spring Island Trust has set the following goals for the protection of the island's resources:

1. Safeguard the environmental integrity of the Island.
2. Provide maximum plant and wildlife diversity.

3. Ensure the needs of wildlife species are met (including managing for overpopulation of species such as deer when necessary).
4. Create an aesthetically pleasing environment.
5. Provide for low impact recreation (hiking, horseback riding, biking, bird watching, fishing, nature photography, kayaking, camping).
6. Provide education and research opportunities. (Spring Island Trust 2008)

The Spring Island Trust is responsible for developing management plans and their implementation. The Trust is responsible for organizing prescribed burns which provide a range of early to late successional vegetation (Spring Island Trust 2008). This range of age classes was not found in the other two South Carolina sites evaluated in this study, Sea Pines and I'on, where natural disturbances, such as fire, are suppressed. See Figures 3 and 4 for maps depicting the open space characteristics of Spring Island.

Site Visit and Evaluation

The site visit for Spring Island occurred on November 30th 2007. Transect locations were chosen after consultation with onsite biologists in order to sample as many different plant communities as possible in one day. Transect locations were chosen based on aspect, proximity to roads and trails (both near and far), dominant plant cover, stand age, and management practices. Upland forested areas, shrub areas, managed fields, and wetland edges were sampled. Once locations were compared to the ownership map it was discovered that most sampling occurred on the lands managed by the Spring Island Trust (Figure 5).

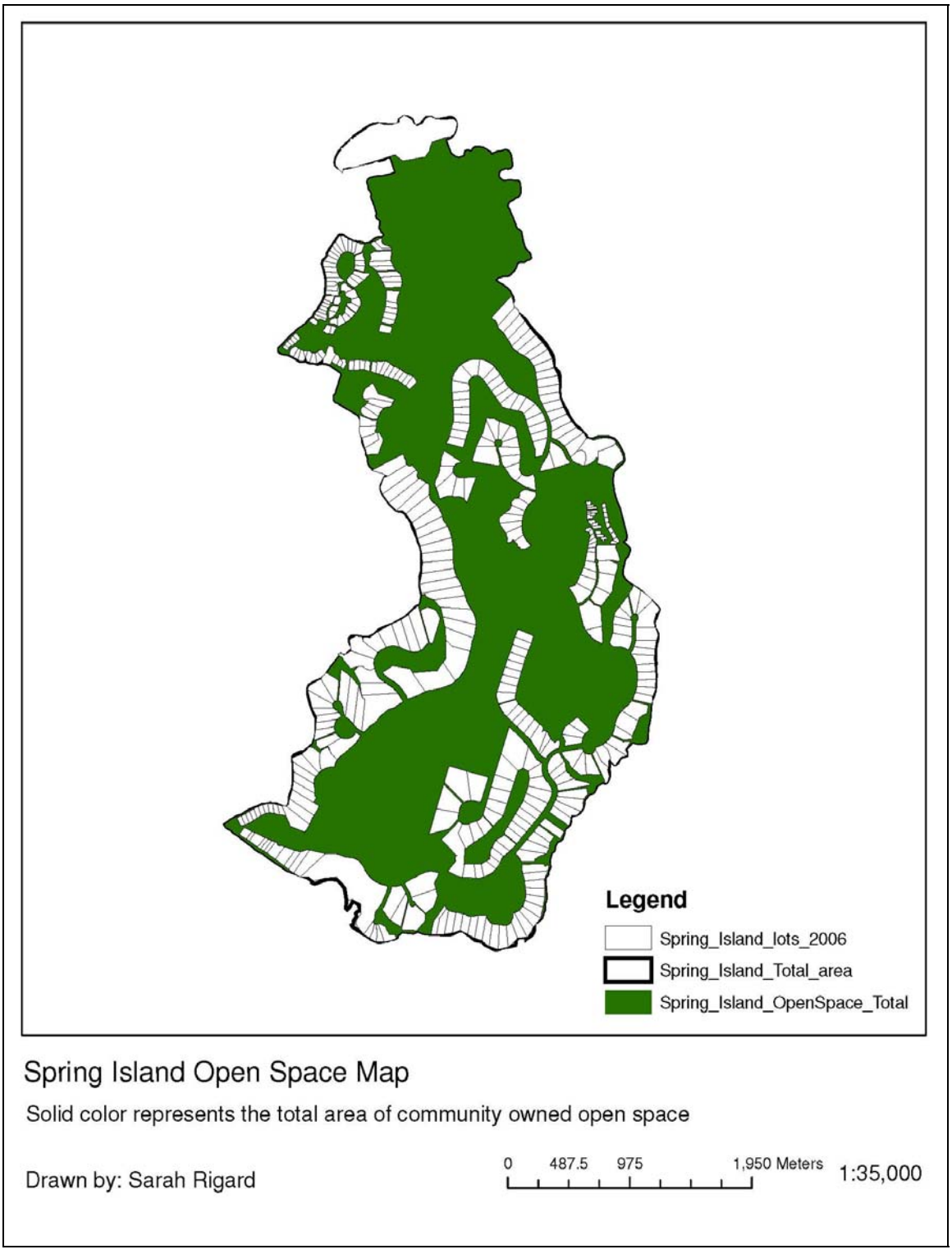


Figure 3: Spring Island open space map

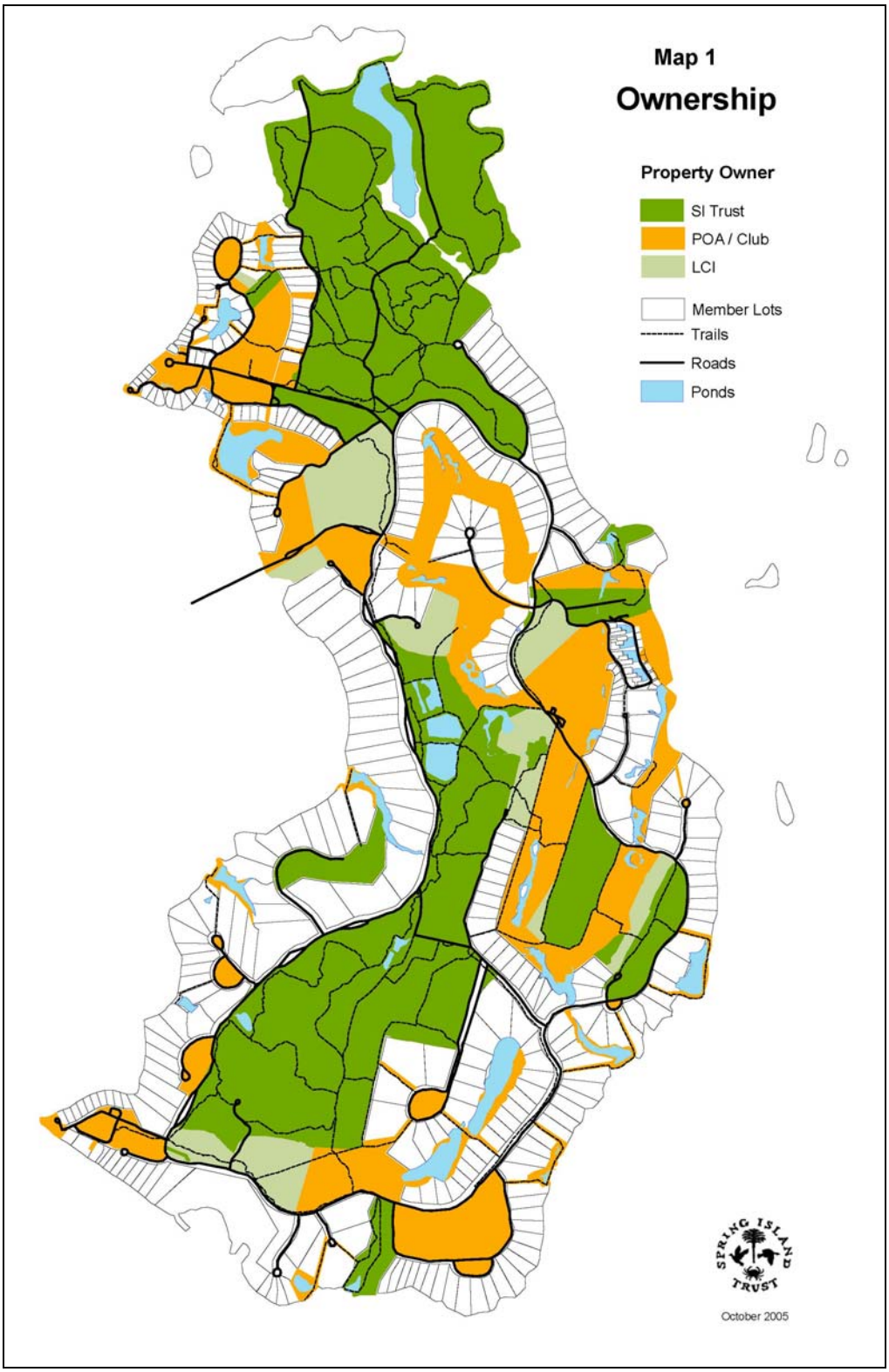


Figure 4: Spring Island open space management map (www.springislandtrust.org)

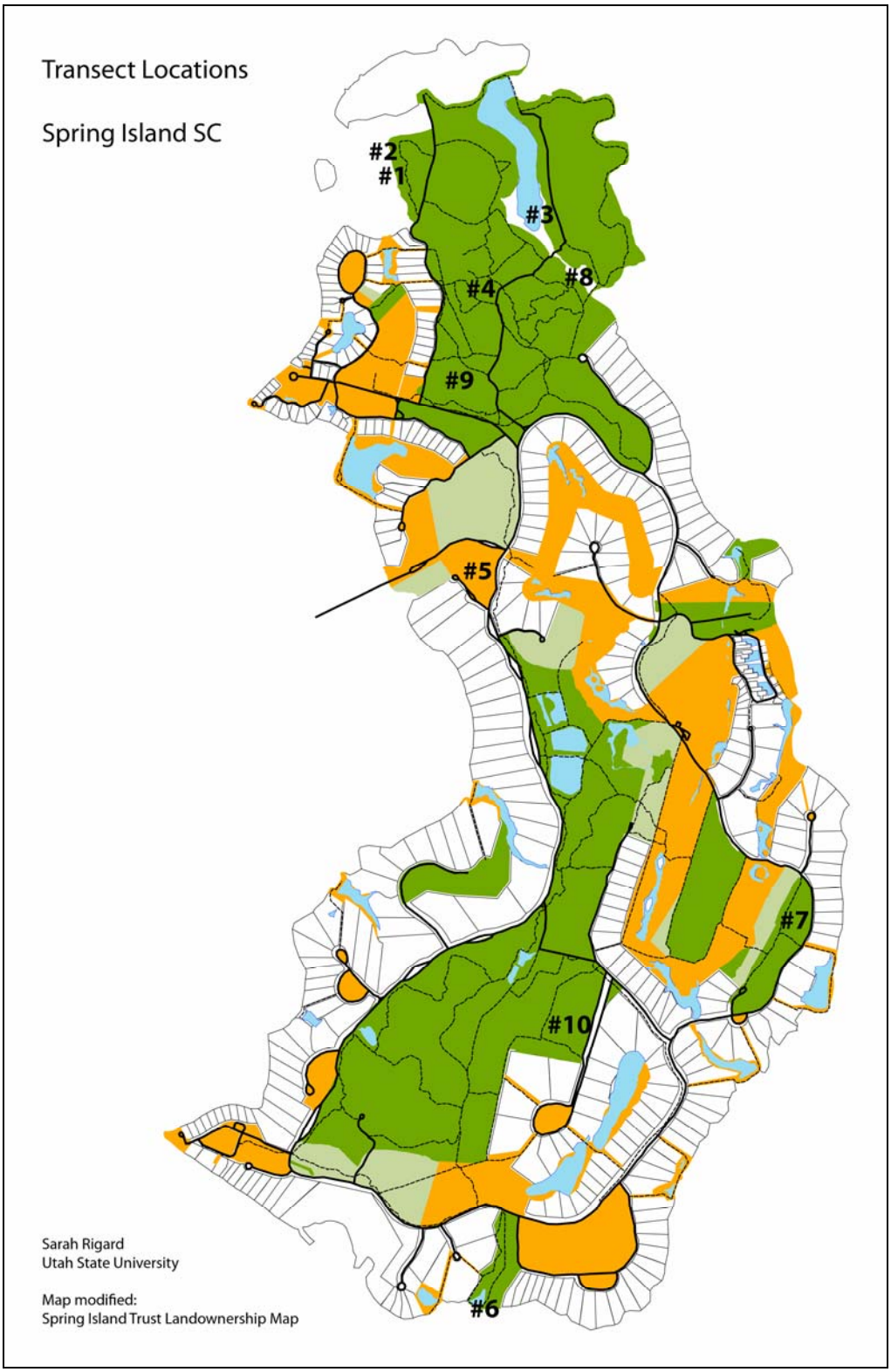


Figure 5: Spring Island transect locations map

The vegetation sampling produced a diverse plant list dominated by native species. More native plants were found here than in the other two sites in South Carolina. The only areas with higher occurrences of non-native plants were near or in the managed fields which is to be expected due to past land uses and current management practices which work to maintain them as open fields. The sampling of Spring Island is deemed representative by the author. The majority of the site was traveled throughout the day and general observations of the development as a whole were consistent with the sample locations and ratings. Figures 6 and 7 depict the vegetation quality at two transect locations.

Figure 6: Spring Island Transect 1, Maritime Fringe Wetland

Figure 7: Spring Island Transect 3, Recently Burned Pine Woodland

The functional characteristics of the areas of vegetation sampled were assessed using upland and wetland function assessment forms as described in the third chapter of this thesis. The functional score sheets rank areas according to the grading system (Table 7). See Appendix A for example forms and further explanation of the grading system.

When the functional score sheets were tabulated for each sampling location, 7 out of 10 locations had the highest possible rating. The three locations rated "functional, at risk" were the managed fields and some areas directly adjacent to roads. No locations sampled at Spring Island were rated as "non-functioning." See Table 8 for a breakdown of information by location.

Table 7: Score sheet rating definitions

Rating definitions		
Upland assessment		
PFC	Proper functioning condition (best)	Score ≥ 80%
FAR	Functional, at risk	Score ≥ 60%, < 80%
NF	Nonfunctional, severely impaired	Score < 60%
Wetland assessment		
C-1	Category 1 wetland (best)	Score ≥ 80%
C-2	Category 2 wetland	Score ≥ 65%, < 80%
C-3	Category 3 wetland	Score ≥ 30%, < 65%
C-4	Category 4 wetland	Score < 30%

Table 8: Spring Island transect summary

Transect Summary:		**Spring Island, Beaufort County, SC**			
Transect #	**Native species %**	**Plant cover %**	**Score**	**Rating**	**Description**
1	100.00%	92.59%	96.67%	C-1	Maritime fringe, tidal, near trail
2	100.00%	81.25%	93.33%	PFC	Upland maritime forest, near trail
3	100.00%	83.33%	93.33%	PFC	Recently burned woods (2006)
4	68.75%	94.12%	73.33%	FAR	Mature woods near old open field
5	100.00%	85.71%	96.67%	PFC	Wooded slope near entrance
6	100.00%	100.00%	96.67%	C-1	Tidal marsh at end of ravine, near trail
7	100.00%	100.00%	60.00%	FAR	Disked field, native low quality plants
8	100.00%	86.67%	93.33%	PFC	Burned 2006, near road
9	100.00%	88.24%	83.33%	PFC	Old pine forest
10	95.24%	100.00%	76.67%	FAR	Narrow strip of shrubs along road
Average	96.40%	91.19%	86.33%		*

* No T & E species found during transects. Several rare plants for county observed.

Spring Island, though fragmented by trails and roads, had the most significant core acreage of the residential developments studied. In most developments, no core acreage was observed. Spring Island also had the highest coverage of native plant species, the highest scores from the functional assessments, the largest percentage of

protected open space, and greatest percent of natural cover when compared to the other sites. See Table 9 for a summary of Spring Island's open space characteristics. The spatial characteristics of the island's land cover are depicted in Figure 8 and 9. And, the calculations for Spring Island's site characteristics are shown in Tables 10 and 11.

Table 9: Spring Island open space summary

Spring Island, Beaufort County SC	
Total area of development (acres)	2968.00
Community open space	
Total acreage of community owned open space (including water)	1848.22
Open water (acres)	112.78
Percentage of community owned open space acreage of development acreage (includes water)	62.27%
Private open space (protected by covenants or easements)	
Total acreage of privately owned open space (including water)	451.27
Privately owned open water (acres)	0.00
Percentage of private open space acreage of development acreage (includes water)	15.20%
Total	
Total acreage protected as open space	2299.49
Percent of development protected as open space	77.48%
Total area of protected natural cover in development (acres)	2066.23
Percent of protected natural cover in development	69.62%
Miles of Trails	36.09

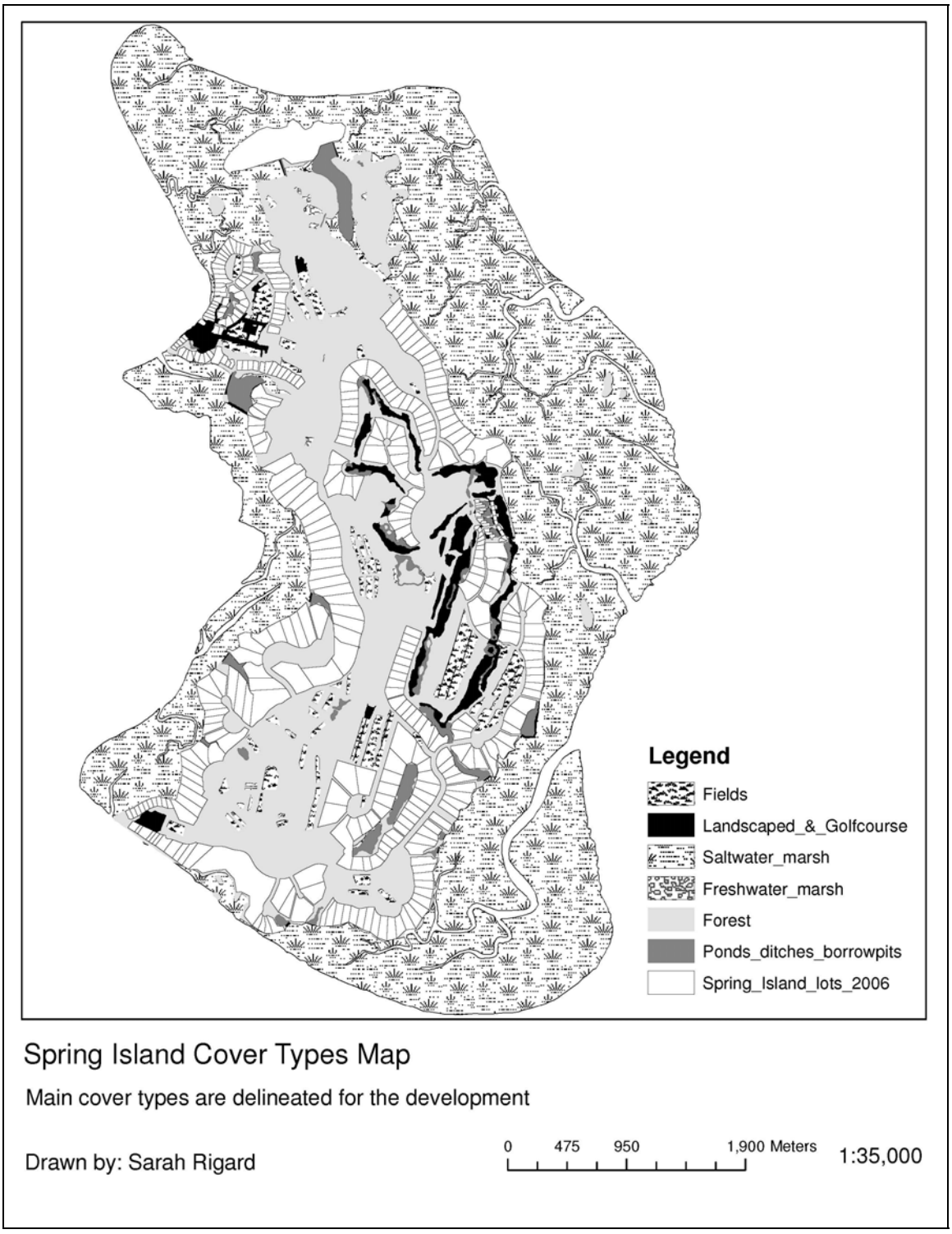


Figure 8: Spring Island cover types map

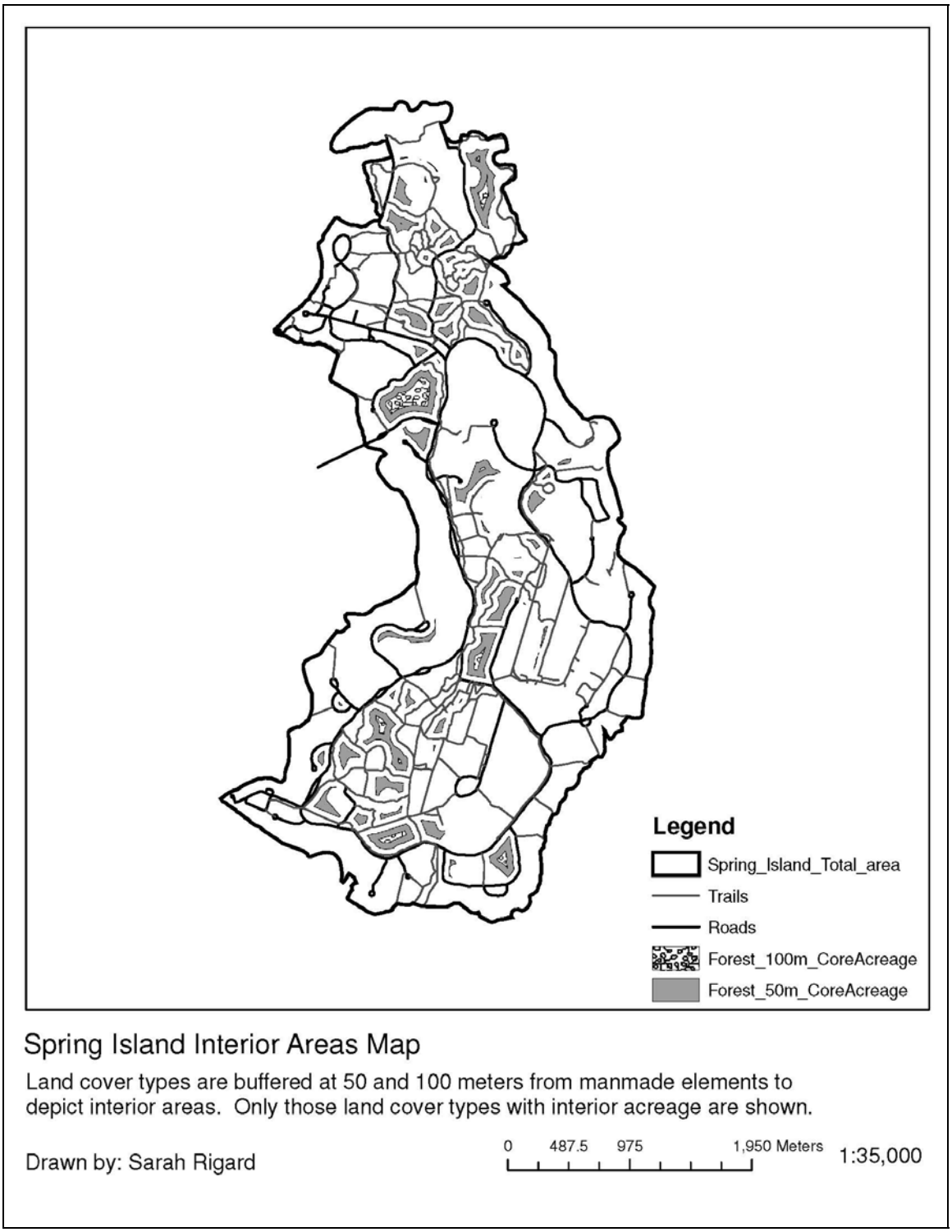


Figure 9: Spring Island core acreage map

Table 10: Sheet 1 of Spring Island's site characteristic calculations

Residential development:	Spring Island, Beaufort County, SC					
	Un-managed		Managed		Ultra managed	
	Natural		Natural	Restored	Landscaped	
Spatial characteristics of the site	Salt water marsh	Fresh water marsh	Forest	Fields	Landscaped	Golf Course
Total acreage	40.18	5.79	1279.85	176.36	52.28	109.54
Percentage of open space	2.17%	0.31%	69.25%	9.54%	2.83%	5.93%
Acreage of largest patch	17.45	3.60	91.43	17.85	21.89	35.61
Percentage of largest patch of open space acreage	43.44%	62.09%	7.14%	10.12%	41.86%	32.51%
Average area of remaining patches (acres)	2.84	0.55	3.11	1.69	N/A	N/A
Linear distance of edge (ft)	26364.01	5514.25	858625.13	125681.37	N/A	N/A
Core acreage with 50m buffer total	0.00	0.00	173.42	0.00	N/A	N/A
Largest patch of 50m core acreage	0.00	0.00	27.90	0.00	N/A	N/A
50m buffer acreage	40.18	5.79	1106.43	176.36	N/A	N/A
Edge ratio 50m buffer to total size	100.00%	100.00%	86.45%	100.00%	N/A	N/A

Table 11: Sheet 2 of Spring Island's site characteristic calculations

Residential development:	Spring Island, Beaufort County, SC					
	Un-managed		Managed		Ultra managed	
	Natural		Natural	Restored	Landscaped	
Spatial characteristics of the site	Salt water marsh	Fresh water marsh	Forest	Fields	Landscaped	Golf Course
Core acreage with 100m buffer	0.00	0.00	21.52	0.00	N/A	N/A
Largest patch of core acreage (100m)	0.00	0.00	12.40	0.00	N/A	N/A
100m buffer acreage	40.18	5.79	1258.33	176.36	N/A	N/A
Edge ratio 100m buffer to total size	100.00%	100.00%	98.32%	100.00%	N/A	N/A
Distance to water onsite (ft)	N/A	N/A	0.026 min, 456.49 max, 45.10 mean	0.012 min, 344.48 max, 41.67 mean	N/A	N/A
Distance to similar cover onsite (ft)	N/A, marshes are connected	0.00 min, 5424.48max,1334.00mean	9.10 min, 1037.57max, 303.34 mean	0.00 min, 632.67max, 68.63 mean	N/A	N/A
Shortest distance to similar cover offsite (ft)	N/A, marshes are connected	1692808.10	10833.33	776.05	N/A	N/A
Maximum distance to similar cover offsite (ft)	N/A, marshes are connected	72660.14	73293.46	65779.61	N/A	N/A
Average distance to similar cover offsite (ft)	N/A, marshes are connected	45242.25	40458.50	33813.80	N/A	N/A

For the habitat evaluation of Spring Island the vegetation and spatial characteristics of the island were compared to the habitat requirements of the pileated woodpecker (*Oryocopus pileatus*), southern fox squirrel (*Sciurus niger niger*), black rail (*Laterallus jamaicensis*), osprey (*Pandion haliaetus carolinensis*), mink (*Mustela vison*), southern hognose snake (*Heterodon simus*), and white ibis (*Eudoncimus albus*). These species were chosen because they are managed for by the wildlife biologists of the Spring Island Trust and combined they require a wide variety of habitats and are sensitive to development and land management. These species represent herbivores, carnivores, and predators requiring many habitats found within the coastal zone of South Carolina. It was not confirmed in the field work whether or not these species exist on the island, rather it was determined whether or not the species' habitat needs are met by the characteristics of the island.

Based on the review of literature on each species and the characteristics of the open space of Spring Island it was determined to be moderate habitat for the white ibis and high quality habitat for each of the remaining seven species (Allen 1982; Schroeder 1982; Hingtgen, Mulholland, and Repenning 1985; Allen 1986; Vana-Miller 1987; Jordan 1998; The Nature Conservancy 1998; Bennett and Buhlmann 2005; Butfiloski and Baker 2005; Cely 2005; Ciuzio and Murphy 2005; Guynn et al. 2005). The following Tables (12-18) summarize habitat quality for each species.

Table 12: Spring Island habitat quality for pileated woodpecker

Habitat Quality Summary			
Pileated woodpeckers		Spring Island SC	
	Requirements:	**Site**	**Rating**
Nesting habitat	Tree cavities	Present	Acceptable
Foraging habitat	Late successional forest vegetation, including dead and decaying trees and stumps	Present	Acceptable
Water	Maximum distance from nest to water 492 ft	456 ft max	Acceptable
Area	173 acres, however 320 acres is accepted minimum.	1279 acres	Acceptable
Status	Unlisted, indicator species for hole nesting birds		
Overall	Potentially high quality habitat for woodpeckers based on Spring Island specific literature and species requirements as determined in the general literature review.		

Table 13: Spring Island habitat quality for southern fox squirrel

Habitat Quality Summary			
Southern fox squirrel		Spring Island SC	
	Requirements:	**Site**	**Rating**
Nesting habitat	Tree cavities, large branches	Present	Acceptable
Foraging habitat	Pine dominated forest cover with open understory and mature mast producing trees.	Present	Acceptable
Water	Met by diet, N/A		N/A
Area	5-10+ acres	1279 acres	Acceptable
Status	Moderate priority species for South Carolina, state rank S4, G5		
Overall	Potentially high quality habitat for southern fox squirrels based on literature on the island and species requirements.		

Table 14: Spring Island habitat quality for southern hognose snake

Habitat Quality Summary			
Southern hognose snake		Spring Island SC	
	Requirements:	**Site**	**Rating**
Nesting habitat	Underground burrows below stumps, rocks, or other structures	Present	Acceptable
Foraging habitat	Pine dominated forests with herbaceous ground cover and open midstory.	Present	Acceptable
Water	Met by diet, N/A		N/A
Area	2740 acres?, rough estimate	1279 acres	Inconclusive
Status	Highest priority species for South Carolina, global rank G2		
Overall	High quality habitat for the southern hognose snake. The necessary habitat is present and it is managed in a manner compatible with the snakes needs. The spatial ecology of the snake is not well known therefore a comparison cannot be made concerning the home range of the species.		

Table 15: Spring Island habitat quality for black rail

Habitat Quality Summary			
Black rail		Spring Island SC	
	Requirements:	**Site**	**Rating**
Nesting habitat	Herbaceous marsh edge vegetation	Present	Acceptable
Foraging habitat	Freshwater, saltwater marshes, water impoundments	Present	Acceptable
Water	Tidal, or limited standing water	Present	Acceptable
Area	1 acre, 0.25 acre interior space	3500+ acres	Acceptable
Status	Highest priority species for South Carolina, unranked, indicator for marsh birds		
Overall	High quality habitat for the black rail based on literature and species requirements.		

Table 16: Spring Island habitat quality for white ibis

Habitat Quality Summary			
White Ibis		Spring Island SC	
	Requirements:	**Site**	**Rating**
Nesting habitat	Large trees surrounded by water or on water edges preferably 1 mile away from human disturbances	Limited availability	Moderate
Foraging habitat	Freshwater, saltwater marshes, water impoundments with shallow or intermittent water.	Present	Acceptable
Water	Shallow water	Present	Acceptable
Area	Usually do not inhabit islands over 321 acres	Limited small islands present	Moderate
Status	Conservation concern, indicator for colonial nesting/wading birds		
Overall	Limited high quality habitat appears to be available for the white ibis as homes are concentrated on the island's edge which would also be prime habitat for this disturbance sensitive bird. A buffer is maintained along the marsh edge, but human disturbances are nearby. Ample foraging habitat is provided by the island, nesting habitat may be limited.		

Table 17: Spring Island habitat quality for osprey

Habitat Quality Summary			
Osprey		Spring Island SC	
	Requirements:	**Site**	**Rating**
Nesting habitat	Tall trees, snags, poles, cliffs, etc.. with good visibility of foraging habitat	Present	Acceptable
Foraging habitat	Open waters for fishing	Present	Acceptable
Water	Met by diet, N/A		N/A
Area	Unknown, not a limiting factor		N/A
Status	Not listed, indicator species for predatory bird group		
Overall	Potentially good habitat for the osprey based on literature and species requirements.		

Table 18: Spring Island habitat quality for mink

Habitat Quality Summary			
Mink		Spring Island SC	
	Requirements:	**Site**	**Rating**
Nesting habitat	Irregular, complex shorelines with dense wooded vegetation	Present	Acceptable
Foraging habitat	Open waters for fishing, wooded upland habitat for hunting	Present	Acceptable
Water	Will not inhabit dry areas	Present	Acceptable
Area	Unknown, not a limiting factor		N/A
Status	Not listed, declining populations		
Overall	Potentially good habitat for the mink based on literature and species requirements.		

Spring Island was developed and managed in a manner that is compatible with many species needs. The development serves as a model for preserving a diversity of wildlife species. Only the needs of the most sensitive species, such as the white ibis, are not well accommodated for by the island, but this would be the case in most human altered environments. This is not to say the white ibis does not inhabit the island, only to say that the level of human disturbance is higher than the white ibis typically tolerates. The design and management of Spring Island appears to, currently, provide high quality wildlife habitat for the indicator species used in the study while also providing many of the amenities of a private, residential community that are identified in their goal statement detailed on pages 64-65.

Mid-west: Prairie Crossing, IL

Prairie Crossing is a conservation/neo-traditional development, though the developer Vicki Ranney, of the Prairie Holdings Corporation, would prefer that it not be classified in either category. For the purposes of this study, Prairie Crossing was chosen as an example of Midwestern neo-traditional residential development. Prairie Crossing is located 40 miles northwest of Chicago Illinois (Prairie Crossing 2007). Original plans in the early 1970's for the 677 acre parcel called for 2,400 homes (Gibson 2006; Prairie Crossing 2007). A 15 year legal battle ensued brought by the county and local governments and area property owners to block the original development plan (Gibson 2006). The lawsuit was settled when the land was purchased in 1987 by the Prairie Holdings Corporation headed by Gaylord Donnelley and seven other area property owners including George and Vicki Ranney. Prairie Holdings Corporation purchased the land with the intent to develop it responsibly while preserving open space and agricultural lands (Prairie Crossing 2007). See Figures 10, 11, and 12 for maps depicting the location and open space characteristics of Prairie Crossing. George and Vicki Ranney established ten guiding principles to guide Prairie Crossings development. They are (Prairie Crossing 2007):

- Environmental protection and enhancement
- A healthy lifestyle
- A sense of place
- A sense of community
- Economic and racial diversity
- Convenient and efficient transportation
- Energy conservation
- Lifelong learning and education
- Aesthetic design and high-quality construction
- Economic viability

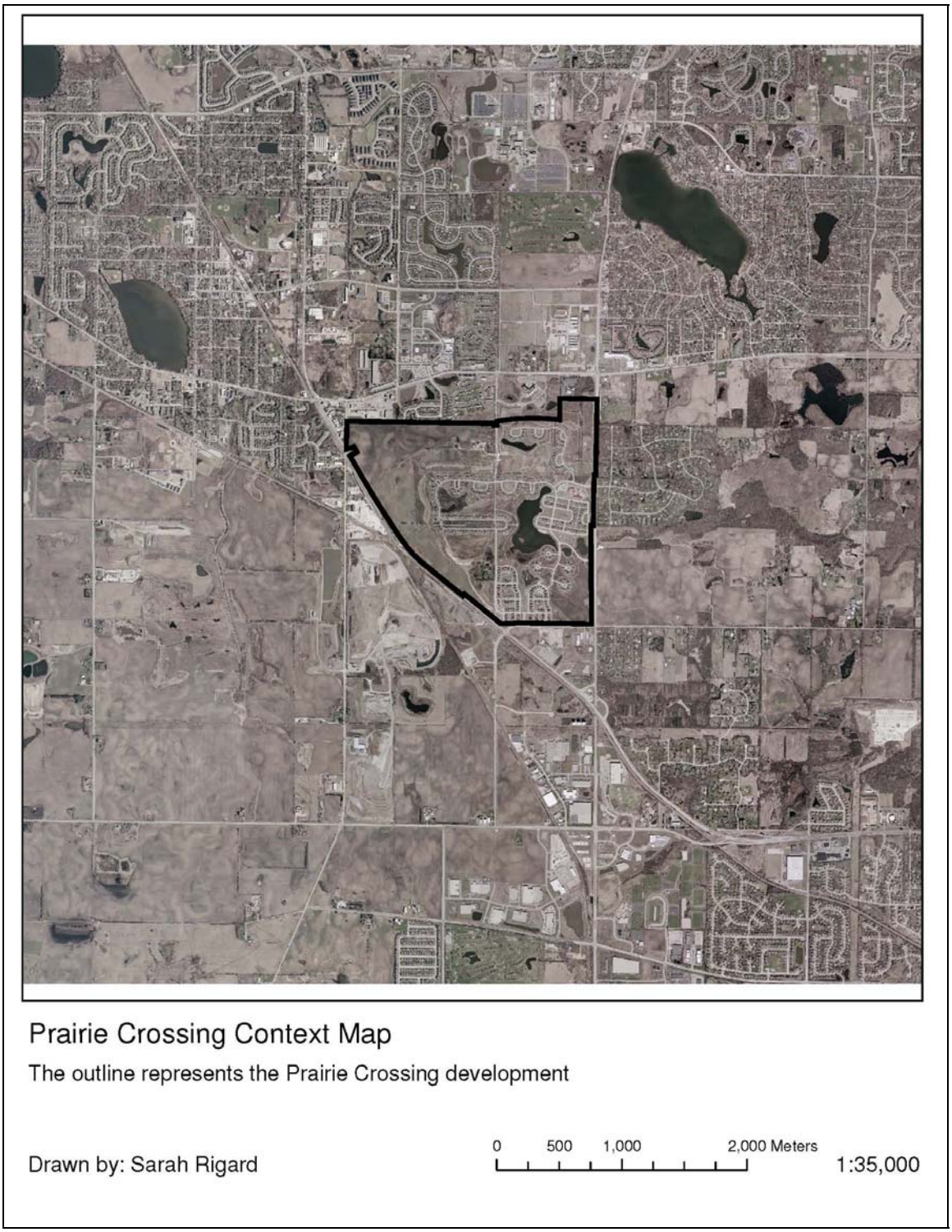


Figure 10: Prairie Crossing context map

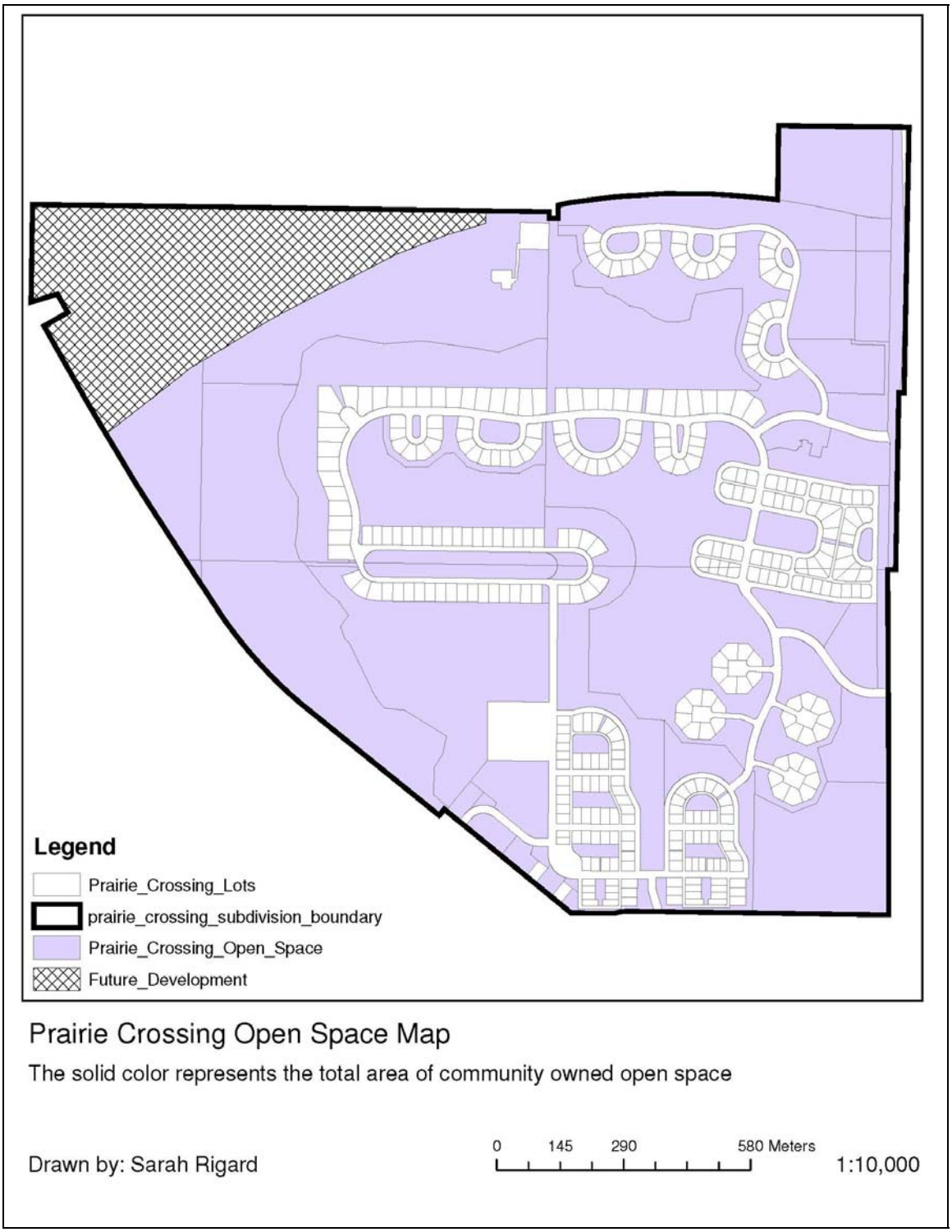


Figure 11: Prairie Crossing open space map

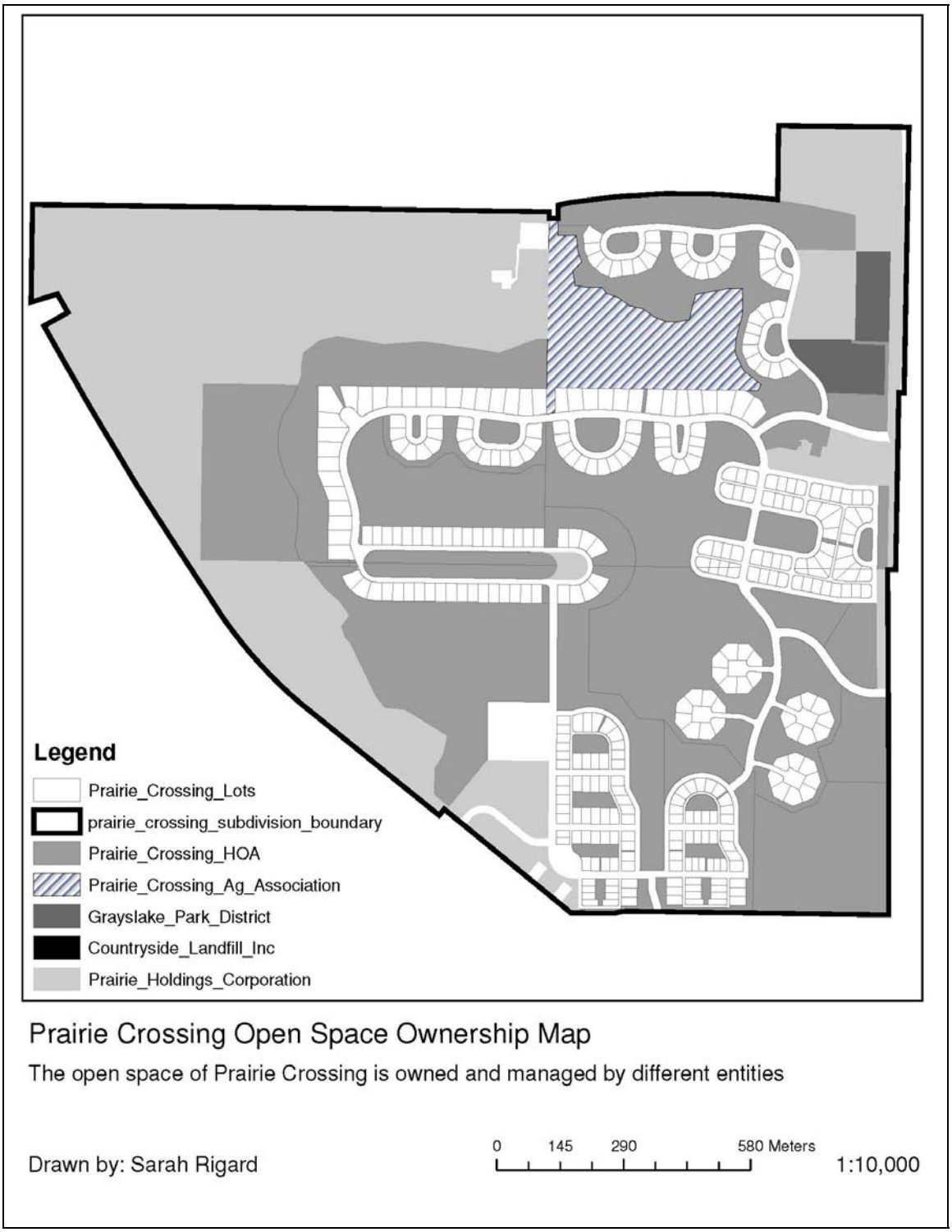


Figure 12: Prairie Crossing open space management map

Donnelley and the Ranney's interviewed several landscape architects and chose Bill Johnson, of the firm Johnson, Johnson and Roy, to design their community (Kane 2003). As the development began to take form other landscape architects and architects were hired to complete later phases. Calthorpe Associates of Berkely CA were hired to design the Station Village which includes a transit stop and commercial space (Kane 2003).

Open space at Prairie Crossing consists of farm fields, pastures, greenways, lakes and ponds, native prairies and wetlands, and 165 acres of restored prairie. Prairie Crossing also has a 9 acre village green, neighborhood playgrounds, tennis courts, ice skating, cross-country skiing, and fishing and boating docks. Over 60% of the land is preserved open space. An easement has been placed over the 150 acres of farmland through the Washington D.C.-based Conservation Fund. In total, 350 acres are legally protected from development by the Conservation Fund, and the Liberty Prairie Conservancy. Recreation opportunities are provided by the trails, Lake Aldo Leopold, various open space areas on-site. Residents have access to trails on-site that connect with regional trails (Prairie Crossing 2007). See Figure 13 for a picture of homes near Lake Aldo Leopold.

Prairie Crossing was designed to protect and increase critical prairie habitat for native plant species and attract wildlife. Egrets (*Ardea* sp.), blue herons (*Ardea herodias)*, muskrats (*Ondatra zibethicus*), and coyotes (*Canis latrans*) exist on site (Gibson 2006). The water in Lake Aldo Leopold has been found clean enough by the Illinois Department of Natural Resources (DNR) that they chose to stock the lake with the largest population of 'at risk' fish species in the Des Plaines watershed. The 'at risk'

fish species stocked by the DNR include the blackchin (*Notropis heterodon*) and blacknose shiners (*Notropis heterolepis*), the Iowa darter (*Etheostoma exile*), and the banded killfish (*Fundulus diaphanus*). The Illinois DNR also uses the lake as a research site (Kane 2003).

Drainage tiles, the remnants of the previous agricultural land use, were removed returning natural hydrological processes to the site. Wetlands were restored, and vegetative swales created which treat stormwater runoff on-site. Sediments and contaminants are removed and the water significantly cleaned before it enters Lake Aldo Leopold. The stormwater treatment system at Prairie Crossing has reduced the runoff conveyance off-site by 60%. Stormwater runoff quantity has been minimized by the construction of narrow streets (Kane 2003).

Figure 13: Prairie Crossing Homes and Wetland near Lake Aldo Leopold

Approximately 30 rain gardens were installed to collect rain water between the houses. The range in size from 200 to 500 square feet and most were created to retain water and some were created to allow water to infiltrate into the soil. They were planted with native, moisture loving plants (Gibson 2006).

Site Visit and Evaluation

The fieldwork conducted by this study was completed July 26, 2007. The fieldwork revealed many high quality prairie patches as well as a few low quality prairie patches. The areas found to be of low quality were small patches found in cul-de-sac plantings and other small areas. The large expanses of maintained prairie were found to be of high quality most likely attributed to exhaustive maintenance such as removal of non-native plant species and prescribed burns which mimic natural grassland processes. See Table 19 for a summary of fieldwork. See Figures 14 and 15 for pictures of transect locations. See Figures 16 and 17 for maps depicting site characteristics.

Table 19: Prairie Crossing transect summary

Fieldwork Summary:		**Prairie Crossing, Lake County IL**			
Transect #	**Native species %**	**Plant cover %**	**Score**	**Rating**	**Description**
1a*	54.55%	100.00%	N/A		Prairie across from school
1b	66.67%	90.00%	70.00%	PFC	Prairie across from school
2	100.00%	100.00%	92.25%	C-1	Sanctuary pond
3	60.00%	100.00%	33.33%	NF	Prairie within large cul-de-sac
4**	100.00%	100.00%	63.33%	FAR	Home on Wild Iris Lane
5**	63.64%	100.00%	26.67%	NF	Prairie within cul-de-sac
6	57.89%	100.00%	36.67%	NF	Hedgerow near soccer field
7	100.00%	100.00%	95.00%	C-1	Lake Aldo Leopold
8	100.00%	100.00%	80.00%	PFC	Prairie near Lake Leopold
Average	78.08%	98.89%	62.16%		

* Only one score sheet completed for location number 1
** Endangered plant species observed in these locations

Figure 14: Prairie Crossing Transect 2, Sanctuary Pond

Figure 15: Prairie Crossing Transect 4, Private Landscape

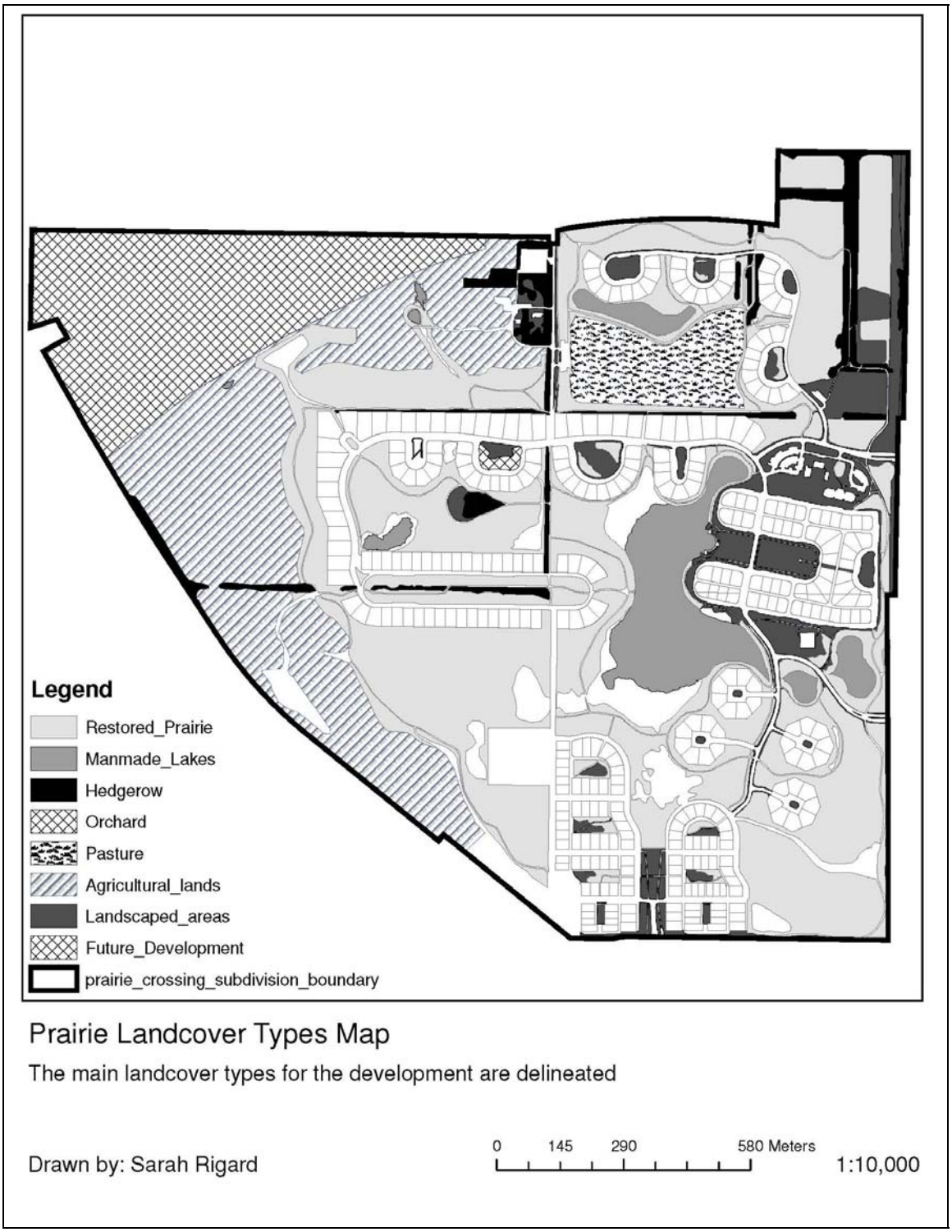


Figure 16: Prairie Crossing land cover types map

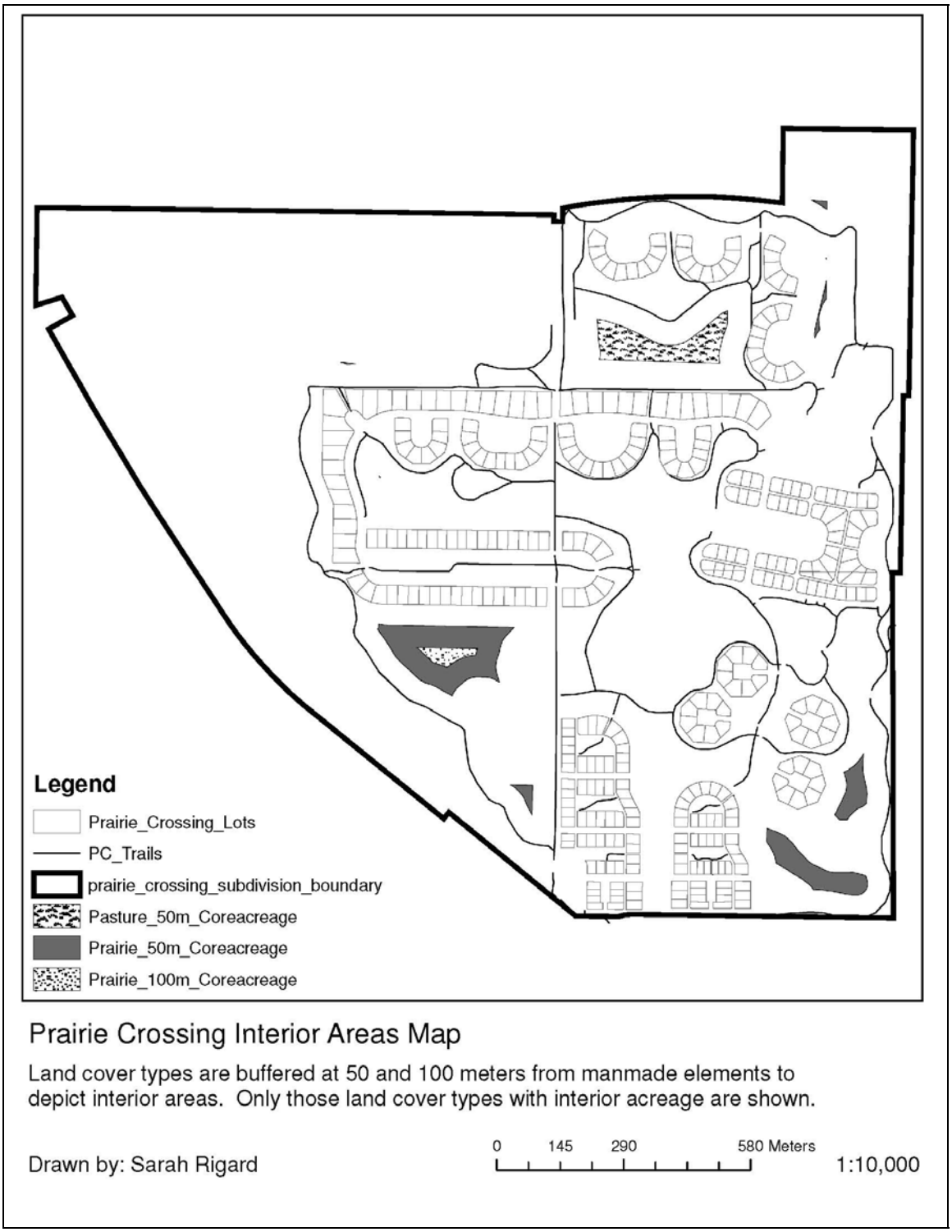


Figure 17: Prairie Crossing core acreage map

The site characteristics of the open space of Prairie Crossing (Figures 16, 17, and Tables 20 and 21) were qualitatively compared to the following bird species (Tables 22-26). These species were suggested by a Department of Natural Resources wildlife biologist as indicator species for the Minnesota developments. These same species have all been observed at Prairie Crossing (Sands 2007) and were used to aid in comparison between the Midwestern sites. The red-eyed vireo (*Vireo olivaceus*), an interior woodland avian species, was used in the assessments of Cloverdale Farms and The Fields of St. Croix, but not in the comparison of Prairie Crossing due to the absence of woodland patches. The species used for this development by habitat type are:

1. Woodland:
    1.1.1. Veery (*Catharus fuscescens*)
2. Grassland:
    2.1.1. American kestrel (*Falco sparverius*)
    2.1.2. Bobolink (*Dolinchonyx oryzivorus*)
3. Wetlands:
    3.1.1. Blue-winged teal (*Anas discors*)
    3.1.2. Great blue heron (*Ardea herodias)*

Prairie Crossing was developed and managed in a manner that is compatible with many prairie species needs. The environmental team at Prairie Crossing manages for the dominant habitat types (prairie and water) and the positive impacts of this management effort for those habitat types was apparent in the fieldwork conducted by the subdivision study.

Table 20: Prairie Crossing open space summary

Prairie Crossing, Grayslake IL	
Total area of development (acres) includes undeveloped acerage*	629.23
Community open space*	
Total acreage of community owned open space (including water)	419.17
Open water (acres)	29.55
Percentage of community owned open space acreage of development acreage (includes water)	66.62%
Private open space (protected by covenants or easements)	
Total acreage of privately owned open space (including water)	0.00
Privately owned open water (acres)	0.00
Percentage of private open space acreage of development acreage (includes water)	0.00%
Total*	
Total acreage protected as open space	419.17
Percent of development protected as open space	66.62%
Total area of protected natural cover in development (acres)	263.02
Percent of protected natural cover in development	41.80%
Miles of Trails	9.77
*Acres not yet developed which will change percentages once completed:	66.13

Table 21: Prairie Crossing habitat quality for great blue heron

Habitat Quality Summary			
Great blue heron		Prairie Crossing, IL	
	Requirements:	**Site**	**Rating**
Nesting habitat	Trees within 1 km of foraging habitat	Present	Acceptable
Foraging habitat	Shallow water bodies to hunt fish and other small animal prey located 100 meters from residences	Limited availability	Moderate
Water	Required for foraging habitat	Present	Acceptable
Area	1 to 12 acres	Present	Acceptable
Status			
Overall	Potentially moderate quality habitat for great blue herons based on data on the development and species requirements. The birds are sensitive to human disturbances and their preferred nesting habitat, trees, are in limited availability in this prairie dominated development.		

Table 22: Prairie Crossing habitat quality for bobolink

Habitat Quality Summary			
Bobolink		Prairie Crossing, IL	
	Requirements:	**Site**	**Rating**
Nesting habitat	Ground or low to the ground in grassland habitats	Present	Acceptable
Foraging habitat	Open grasslands	Present	Acceptable
Water	Unknown, not found in literature		N/A
Area	25 to 75 acres of continuous habitat	30 acres, 190 fragmented acres overall	Acceptable
Status	Conservation priority species for MN		
Overall	The minimum habitat requirements for the bobolink appear to be met by the open space of Prairie Crossing. Lack of core acreage and fragmentation of habitat may be limiting to the bird providing high to moderate quality habitat.		

Table 23: Prairie Crossing habitat quality for veery

Habitat Quality Summary			
Veery		Prairie Crossing, IL	
	Requirements:	**Site**	**Rating**
Nesting habitat	Forest floor in early successional forests with well developed shrub and herbaceous layers	Very limited availability	Limiting
Foraging habitat	Damp forest floor	Very limited availability	Limiting
Water	Close proximity to water	Present	Acceptable
Area	> 0.1 acres minimum	19.11 acres	Acceptable
Status			
Overall	Poor quality habitat for the veery. There are 19 acres of lineal patches of trees in the form of hedgerows. The bird has been observed onsite.		

Table 24: Prairie Crossing habitat quality for blue-winged teal

Habitat Quality Summary			
Blue-winged teal		Prairie Crossing, IL	
	Requirements:	**Site**	**Rating**
Nesting habitat	Grassland vegetation near wetlands	Present	Acceptable
Foraging habitat	Wetlands with a 50:50 ratio of open water to emergent vegetation	Limited availability	Moderate
Water	Required for foraging	Present	Acceptable
Area	Minimum habitat area not found in literature	N/A	N/A
Status			
Overall	Areas of Prairie Crossing may provide high quality habitat for the blue-winged teal based on the literature review.		

Table 25: Prairie Crossing habitat quality for American kestrel

Habitat Quality Summary			
American kestrel		Prairie Crossing, IL	
	Requirements:	**Site**	**Rating**
Nesting habitat	Cavity nester, trees, artificial nest boxes, holes in buildings	Mature trees present	Acceptable
Foraging habitat	Open grassland, ag land, parklands for hunting insects and small animals	Present	Acceptable
Water	Water needs are assumed to be met through diet	N/A	N/A
Area	Not discussed in literature	N/A	N/A
Status	Not listed, thriving population throughout country		
Overall	The open space of Prairie Crossing has the potential to provide high quality habitat for the American kestrel. Foraging and nesting needs met.		

DISCUSSION

The subdivision study method evaluated wildlife habitat quality quantitatively and qualitatively on several elements deemed important by the literature review. The method quantitatively measures: native vegetation coverage across the site, general plant community composition, presence of non-native vegetation, function of habitat types (wetland, riparian, upland), percent impervious cover (a measure of fragmentation), core habitat area, and habitat interspersion characteristics such as patch size and distance to water and similar cover both on and off site. Qualitatively those site characteristics, adjacent land uses, and land management practices were related to individual conservation priority and development sensitive wildlife species needs to infer habitat quality. And, through that analysis it was determined which developments have the potential to provide high quality wildlife habitat and rank them accordingly.

The subdivision study method would fall between resolution levels 2 and 3 as a greater level of detail was included than the typical low resolution assessment but less detail than a well defined and executed medium resolution study. The functional assessments and transects alone used as a proxy to determine habitat value for wildlife would constitute a level 3 / lowest resolution study as it would assume well functioning areas dominated by native plant species would benefit wildlife communities. Had the indicator wildlife species been chosen before the site visits, a more thorough method of site data collection proposed, and more time allowed for field work (however not in the project budget), specific data for those indicator species could have been collected, increasing the resolution level of the subdivision study. Examples of specific data not collected by the subdivision study methods that would have increased the resolution level

are: percentages of dead snags and fallen logs, diameter at breast height (DBH) of trees, depth of water, etc.

The summary matrix (Table 27) outlines the methodological elements of the subdivision studied as executed. To better understand the value of this research's analysis individual elements of the methodology and their successes or limitations will be discussed separately and in relation to all developments studied, not just the two developments discussed in the Sample Analyses chapter.

The field work was reliant on a rapid assessment which, in the case with the largest developments, was not completed at a high enough frequency as outlined in the protocol, reducing the value of the analysis for those sites. The UDOT WFAM protocol states:

> 100 sample points per acre should be collected within the AA. (Example: if AA equals 0.25 acres, then 25 sample points should be taken.) Never use less then 10 sample points within any AA, even when AA is less then 0.10 acres in size. (Johnson, Pitts, and Porreca 2005, 104)

Table 26: Subdivision study methodology summary matrix

Methodology used in the subdivision study	
Methodology characteristics:	
Study design	Indirect, habitat based
Resolution level	Med/low resolution
Spatial scale	Local and regional
Temporal scale	N/A, one assessment
Data sources	Varying resolution
Land cover and use classification	High resolution
Repeatable	Yes
Addresses regional differences	Wetland assessment had regional limitations
Sample method	Representative stratified random
Vegetation sampling	Adequate for smaller sites
Direct observation of wildlife	Not performed

The manual also suggests following the guidelines provided by Severinghaus (1980) in determining sample size (Severinghaus 1980):

0 to 40 acres = 1 point/acre
41 to 80 acres = 1 point/ 2 acres
81 to 200 acres = 1 point/ 4 acres
> 200 acres = 1 point/ 10 acres

Each transect would count as 10 sample points. The number of sample points taken at each development ranged between 40 to 130 points. During the subdivision study, sample size was determined by time on site and observed consistency, rather than by size of the site or area of each cover type. Based on the guidelines of Severinghaus (1980) the following chart (Table 28) illustrates which sites had an adequate sample size collected sufficient for analysis.

The chart clearly illustrates a deficit in sample points in any development over 1,000 acres. An attempt was made at each development to perform each transect in a random, yet representative location and record as many surrounding plants as possible to

Table 27: Critique of vegetation sample size

Vegetation sample size chart:				
	Number of sampled points*	**Open space acreage in natural cover**	**Ideal number of sample points**	**Difference**
Southeast Atlantic				
I'on	41	50.69	25	16
Sea Pines	72	1530.64	153	(81)
Spring Island	100	2066.23	207	(107)
Mid-west				
Prairie Crossing	90	263.02	26	64
Cloverdale Farms	63	120.09	30	33
The Fields of St. Croix	72	104.60	26	46
* Transects were 10 sample points each; Estimates were counted as 1 sample point.				

fully describe each area. However, since an inadequate number of sample points were taken in the larger developments, the scores and percentages developed from these are of limited value. The time budgeted for field work was adequate for the smaller developments and those dominated by one to three general land cover types, but more time was needed in the larger more complex developments, such as Sea Pines SC. Though understanding the inherent problems with inadequate sample sizes, due to the observed consistency of Spring Island SC, the author does not agree that further field work would have significantly altered the scores at that particular location.

Representative random locations were chosen in the vegetation sampling efforts of the subdivision study. Evaluator bias can occur in the selection of "representative" random samples (Ratti and Garton 1996), as previously described in the literature review. These "representative" areas may be chosen for inconsistent reasons such as location or lack of thorny vegetation. Adhering to a standard simple random or stratified random sample design reduces the biases produced by "representative" sampling (Ratti and Garton 1996). Alterations to this method, such as 'haphazard' or 'representative' random sampling which attempt to incorporate more locations or populations expected to be on site lead to substantial evaluator bias and should be avoided in favor of another method (Ratti and Garton 1996). Due to the sampling method evaluator bias exists within the vegetation survey data and estimates produced from this data would reflect this bias and therefore do not truly represent site conditions.

There are some limitations to the UDOT WFAM wetland functional assessment in its application to different regions. The UDOT WFAM was developed to assess 5 wetland types typical to Utah. These wetland types were the dominant types found in

most of the developments; however estuarine wetlands with a tidal influence are not covered by the UDOT WFAM. In the case of the south east Atlantic developments, the lacustrine fringe evaluation sheets were used for the salt water marshes which are predominately estuarine wetlands subject to heavy tidal influence. The functional assessments of these wetlands have not taken into consideration all influential elements, however the author feels the functional rating for each are representative based on the conditions observed throughout the study and supportive comments from native plants experts.

As discussed in the literature review, GIS data can have an additive affect of errors when utilizing many layers developed by several sources. The subdivision study collected data from many sources in order to obtain complete data sets. The calculations produced by the subdivision study are only as accurate as the layers from which they were developed. In some cases some data was not available or was not produced due to lack of additional data sources. In one example, a trail layer could not be produced for Sea Pines SC due to the dense tree canopy. Without a trail layer the site scale fragmentation of Sea Pines could not be fully represented so contiguous patches of the landscape and core acreage calculations are inflated for this development. If this problem had been identified before the field visit, and more field time budgeted for the project, the trail system could have been mapped during the site visit. Also, GAP data was utilized to determine the distances to similar land cover types and water sources offsite in the analysis of connectivity in the region for each animal. GAP data is created for landscape level assumptions, and is not appropriate for site level assessments,

therefore the accuracy of off site distance calculations is only an approximation and greatly limited by the data used.

For the subdivision study a custom land cover and classification system was developed. Site level classification systems were not found for all sites, therefore the land cover was delineated using an aerial for each development, information gathered during field work, and parcel data layers. Spring Island had the only pre-existing site level land cover data layer which was modified to categorize the land in the same manner as the rest. Each area of each development's open space was categorized in the same manner by general plant cover and land management practices as outlined in the methodology. The accuracy of this classification system is dependent upon aerial image resolution and date the image was produced. Aerial imagery varied between developments due to information sources, however an effort was made to be as consist as possible between developments.

The methodology used was flexible to regional differences. Appropriate wildlife indicator species were chosen for each region, however not all of the same guilds were represented in each location limiting the extent of regional comparison. In some cases, such as with the southeastern developments, many of the present habitat types are not found in the land locked developments' therefore representing the same guilds was not appropriate, and would limit the study by ignoring dominant habitats. The developments have been compared, in the final analysis not reviewed by this thesis, on other elements such as land management, plant community function and composition, and spatial characteristics.

Change over time was not evaluated by the subdivision study. It cannot be determined from this research if the landscapes in question are increasing or decreasing in quality, or are in a state of equilibrium. In some cases this can be qualitatively determined from previous studies of the site; i.e. water quality reporting and natural resource monitoring in the Midwest developments and the bird diversity study on Spring Island which will be published in the near future discussing pre and post development avian diversity. As discussed in the literature review, assessments at one point in time may actually reflect past, not current conditions (Van Horne 1983). A caveat should be placed on the results of the subdivision study and its guidance for future developments based on the temporal element of this research. The wildlife habitat quality evaluation conducted by the subdivision study is best served as a base line estimation of the post occupancy habitat quality of the case study developments. Whether or not the development had a positive or negative impact on the land cannot be determined from this research as pre-development characteristics were not evaluated.

CONCLUSION

The methodology used in the subdivision study was appropriate for landscape architects and those looking to estimate habitat quality in an economical, efficient manner. In many ways the methodology met the goals of the subdivision study. A higher resolution study would have provided a more accurate indication of habitat quality but such a study can only be successfully performed by wildlife biologists at a significantly greater cost and over a longer period of time. Beyond high resolution level 1 studies, the lower resolution assessment methods, as were used in the subdivision study, are an educated approximation of the species/habitat relationship based on a reduced number of measurable indices that do not account for synergistic circumstances unique to each environment and individual animal, such as competition. Without direct, onsite documentation it cannot be known whether or not a species is supported by an area, and as illustrated in the literature review, even then there is still a significant opportunity for error. The subdivision study would not have benefited by using another lower resolution method because the end results would also be an estimate on the habitat suitability of the site.

Because the subdivision study methodology has served as a medium to low resolution means to rank residential developments based on their habitat quality at one point in time, the results of the study should not be considered a validation of the habitat quality of the case study sites. The subdivision study could only rank developments through a number of indices on its potential to provide habitat. A higher resolution study, preferably a demographic response study, conducted at a larger temporal scale would be necessary to verify which developments are providing better habitat. However, the

results of the subdivision study does support a growing body of knowledge linking low impact development practices, sensitive land management, preservation of native plant species, and maintaining connectivity within the landscape as necessary elements of protecting wildlife habitat within our urbanizing landscape.

This thesis critiqued a method, illustrating the resolution level and value of analysis performed by a nationwide study. More importantly this thesis illustrates the obsolescence of simplistic wildlife habitat studies performed by singular disciplines. It is not enough for a wildlife biologist to show a direct negative impact of human development on wildlife, nor is it enough for a landscape architect to estimate habitat quality of design elements. Only through collaboration between disciplines can we work towards solutions that will have a direct, positive impact on our natural resources. Wildlife habitat research should continue to focus on determining the real world design elements and practices which have a positive impact to educate landscape architects, land planners, civil engineers, etc.

By reexamining the data collected for the subdivision study, further analysis can help determine a number of crucial points. For example, policy issues, such as whether the perceived propensity to protect open space by development style played a role in the quality of the open space or if the pre construction design process (regardless of style) and/or continued land management were more influential. The data collected can also be examined to estimate the role of the design process in producing higher quality wildlife habitat such as the amount of time spent in the design phase, the type of environmental reviews conducted, whether or not there was a public participation element, and the influence of the city / county government.

A vast amount of data was collected for the subdivision study and a continued examination of the data can increase of understanding of the impact of residential development in the ecological landscape in further studies of the case study sites. In addition, future residential development research could focus on higher resolution wildlife habitat studies conducted by interdisciplinary teams at the sites determined to be quality sites by the subdivision study. Such studies should be completed at larger temporal scales (years) and could focus on the demographic performance of species through each construction phase. Recovery time and the reestablishment of native species could also be used as indicators of residential development quality if good baseline data is collected pre-development and if the study term is extended several years post occupancy. Good baseline data is paramount in defining the actions that have a negative or positive impact on wildlife habitat quality.

REFERENCES

Ada County. 2004. *Written responses to 2004 Hidden Springs Survey*. [cited 10 November 2007]. Available from http://www.adaweb.net/Departments/DevelopmentServices/documents/2004HiddenSpringsSurveyWrittenComments.pdf.

Allen, Arthur W. 1982. Habitat Suitability Index Models: Fox Squirrel, ed. U.S. Department of Interior. Fort Collins, CO: U.S. Fish and Wildlife Service.

———. 1986. Habitat Suitability Index Model: Mink, ed. U.S. Department of Interior. Fort Collins, CO: Fish and Wildlife Service.

Anderson, James R., Ernest E. Hardy, John T. Roach, and Richard E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. In *Geological Survey Professional Paper*, ed. U.S. Geological Survey, 36. Washington, D.C.: U.S. Department of the Interior.

Austin, Maureen E. 2004. Resident perspectives of the open space conservation subdivision in Hamburg Township, Michigan. *Landscape and Urban Planning* 69 (2-3):245-253.

Bender, Louis C., Gary J. Roloff, and Jonathan B. Haufler. 1996. Evaluating confidence intervals for habitat suitability models. *Wildlife Society Bulletin* 24 (2):347-352.

Bennett, Stephen H., and Kurt A. Buhlmann. 2005. *Longleaf Pine Reptile Guild*, ed. Comprehensive Wildlife Conservation Strategy. Columbia: South Carolina Department of Natural Resources.

Brabec, Elizabeth A., and Craig W. Johnson. 2007. Project Proposal: Post Occupancy Evaluation of Urban Forest and Open Space Protection within Residential Developments. Logan: Utah State University.

Butfiloski, Jay, and Buddy Baker. 2005. *Mink*, ed. Comprehensive Wildlife Conservation Strategy. Columbia: South Carolina Department of Natural Resources.

Cely, John E. 2005. *Marsh Birds*, ed. Comprehensive Wildlife Conservation Strategy. Columbia: South Carolina Department of Natural Resources.

Ciuzio, Elizabeth A., and Thomas M. Murphy. 2005. *Colonial Nesting Wading Birds*. Columbia: South Carolina Department of Natural Resources.

Corry, Robert C., and Joan Iverson Nassauer. 2005. Limitations of using landscape pattern indices to evaluate the ecological consequences of alternative plans and designs. *Landscape and Urban Planning* 72:265-280.

Corsi, Fabio, Jan De Leeuw, and Andrew Skidmore. 2000. Modeling species distribution in GIS. In *Research and Techniques in Animal Ecology: Controversies and Consequences*, ed. L. Boitani and T. K. Fuller, Chapter 11. New York, NY: Columbia University Press.

Cunningham, Mary Ann. 2006. Accuracy assessment of digitized and classified land cover data for wildlife habitat. *Landscape and Urban Planning* 78 (3):217-228.

Dale, Virginia H., and Suzanne C. Beyeler. 2001. Challenges in the development and use of ecological indicators. *Ecological Indicators* 1:3-10.

Deakin, Mark, Steve Curwell, and Patrizia Lombardi. 2002. Sustainable urban development: The framework and directory of assessment methods. *Journal of Environmental Assessment Policy and Management* 4 (2):171-107.

Forman, R. T. 2000. Estimate of the area affected ecologically by the road system in the United States. *Conservation Biology* 14 (1):31-35.

Forman, R. T. T. 1995. *Land Mosaics: The Ecology of Landscapes and Regions*. Cambridge, MA: Cambridge University Press.

Fraterrigo, Jennifer M., and John A. Wiens. 2005. Bird communities of the Colorado Rocky Mountains along a gradient of exurban development. *Landscape and Urban Planning* 71 (2-4):263-275.

Garshelis, David L. 2000. Delusions in habitat evaluation: Measuring use, selection, and importance. In *Research Techniques in Animal Ecology: Controversies and Consequences*, ed. L. Boitani and T. K. Fuller, Chapter 4. New York, NY: Columbia University Press.

Germaine, Stephen S., Steven S. Rosenstock, Raymond E. Schweinsburg, and W. Scott Richardson. 1998. Relationships among breeding birds, habitat, and residential development in greater Tucson, Arizona. *Ecological Applications* 8 (3):11.

Gerrard, Ross, Peter Stine, Richard Church, and Michael Gilpin. 2001. Habitat evaluation using GIS: A case study applied to the San Joaquin Kit Fox. *Landscape and Urban Planning* 52 (4):239-255.

Gibson, L. 2006. Prairie Lights. *University of Chicago Magazine*. [cited 2007]. Available from: http://magazine.uchicago.edu/0612/features/prairie.shtml

Guynn, David, John Edwards, Susan Guynn, and Judy Barnes. 2005. *Southern Fox Squirrel: Sciurus niger niger*. Columbia: South Carolina Department of Natural Resources.

Hansen, Andrew J., and Ruth DeFries. 2007. Ecological mechanisms linking protected areas to surrounding lands. *Ecological Applications* 17 (4):974-988.

Hingtgen, T. M., R. Mulholland, and R. W. Repenning. 1985. Habitat Suitability Index Model: White Ibis, ed. U.S. Department of Interior. Washington, D.C.: Fish and Wildlife Service, 18.

Holmes, A. L., and G. R. Geupel. 2005. *Effects of Trail Width on the Densities of Four Species of Breeding Birds in Chaparral*, ed. USDA Forest Service. Albany, CA: Pacific Southwest Research Station.

Jensen, Mark E., and Patrick S. Bourgeron, eds. 2001. *A Guidebook for Integrated Ecological Assessments*. New York, NY: Springer-Verlag.

Jensen, Mark E., Norman L. Christensen, and Patrick S. Bourgeron. 2001. An overview of ecological assessment principles and applications. In *A Guidebook for Integrated Ecological Assessments*, ed. M. E. Jensen and P. S. Bourgeron, 13-28. New York, NY: Springer.

Johnson, Craig W., and Susan Buffler. 2006. *Riparian Buffer Design Guidelines for Water Quality and Wildlife Habitat Functions on Agricultural Landscapes in the Intermountain West.* Lincoln, NE: USDA National Agroforestry Center and NRCS, USDA Forest Service.

Johnson, Craig W., Ryan Pitts, and Lori Porreca. 2005. *Utah Department of Transportation Wetland Functional Assessment Method.* Salt Lake City, UT: Utah Department of Transportation.

Jordan, Robert A. 1998. Species profile: Southern Hognose Snake (*Hererodon simus*) on military installations in the southeastern United States, ed. U.S. Army Engineer Waterways Experiment Station. Chapel Hill, NC: Nature Conservancy, Southeastern Regional Office. Available from: http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA342677&Location=U2&doc=GetTRDoc.pdf

Kane, Rene C. 2003. Prairie Flower: An ecologically conscious housing development begins to mature west of Chicago. *Landscape Architecture*, October. [cited 2007]. Available from: http://www.asla.org/lamag/lam03/october/feature1.html

Larsson, T. B. 2001. Biodiversity Evaluation Tools for European Forests. *Ecological Bulletins* 50 (1):1-236

Livingston, Margaret, William W. Shaw, and Lisa K. Harris. 2003. A model for assessing wildlife habitats in urban landscapes of eastern Pima County, Arizona (USA). *Landscape and Urban Planning* 64 (3):131-144.

McWilliam, Wendy Janine. 2000. The ecological effects of a typical housing development on bird species diversity within a forest fragment. Thesis, University of Guelph.

Miller, S. G., R. L. Knight, and C. K. Miller. 1998. Influence of recreational trails on breeding bird communities. *Ecological Applications* 8 (1):162-169.

Morris, Conor. 2004. Investigating residential scale applications of landscape ecology principles: The case of the A.P.A.O. Rehabilitation Design Competition. Thesis, The University of Guelph.

Morrison, Michael L., Bruce G. Marcot, and R. William Mannan. 2006. *Wildlife-Habitat Relationships: Concepts and Applications*. Washington, D.C.: Island Press.

Opdam, Paul. 1991. Metapopulation theory and habitat fragmentation: A review of holarctic breeding birds. *Landscape Ecology* 5 (2):93-106.

Prairie Crossing. 2007. *Prairie Crossing: A Conservation Community* 2007 [cited 2007]. Available from www.prairiecrossing.com.

Quattrochi, Dale A., and Ramona E. Pelletier. 1991. Remote sensing for analysis of landscapes: An introduction. In *Quantitative Methods for Landscape Ecology*, ed. M. G. Turner and R. H. Gardner, Chapter 3. New York, NY: Springer.

Ratti, John T., and Edward O. Garton. 1996. Research and experimental design. In *Research and Management Techniques for Wildlife and Habitats*, ed. T. A. Bookout, 1-23. Betheseda, MD: The Wildlife Society.

Rennie, John C., Joseph D. Clark, and James M. Sweeney. 1998. Evaluation of Habitat Suitability Index Models for Assessing Biotic Resources. Paper read at Integrated Tools for Natural Resources: Inventories in the 21st Century, at Boise, ID.

Riddle, Lyn. 1992. Focus: Spring Island, SC; Development with an Environmental Bent. *The New York Times*, June 28.

Sands, Michael. 2007. *Prairie Crossing Development Bird Inventory*. Grayslake, IL. Unpublished work.

Sandström, U. G., P. Angelstam, and G. Mikusiński. 2006. Ecological Diversity of Birds in relation to the Structure of Urban Green Space. *Landscape and Urban Planning* 77:39-53.

Sayre, Nathan F. 2004. The Need for Qualitative Research to Understand Ranch Management. *Journal of Range Management* 57 (6):668-674.

Schroeder, R. L. 1982. Habitat suitability index models: Pileated woodpecker, ed. U.S. Department of Interior: Fish and Wildlife Service, 15.

———. 1996. Wildlife Community Habitat Evaluation: A Model for Deciduous Palustrine Forested Wetlands in Maryland, ed. Wetlands Research Program, 1-39. Vicksburg, MS: U.S. Army Engineer Waterways Experiment Station.

Severinghaus, W D. 1980. *Guidelines for Terrestrial Ecosystem Survey*, Champaign, IL: Construction Engineering Research Lab (Army).

Sinclair, Anthony R.E., John M. Fryxell, and Graeme Caughley. 2006. *Wildlife Ecology, Conservation, and Management*. 2nd ed. Malden, MA: Blackwell Publishing.

Sinclair, Kristen E., George R. Hess, Christopher E. Moorman, and Jamie H. Mason. 2005. Mammalian nest predators respond to greenway width, landscape context and habitat structure. *Landscape and Urban Planning* 71 (2-4):277-293.

Smith, C. M., and D. Wachob. 2005. Trends associated with residential development in riparian breeding bird habitat along the Snake River in Jackson Hole, WY, USA: Implications for conservation planning. *Biological Conservation* 128:431-446.

Soule, Michael, Douglas T. Bolger, Allison C. Alberts, John Wright, Marina Sorice, and Scott Hill. 1988. Reconstructed dynamics of rapid extinctions of chaparral-requiring birds in urban habitats. *Conservation Biology* 2 (1):75-92.

Spring Island. 2008. *Spring Island Webpage* 2008 [cited May 6 2008]. Available from http://www.springisland.com/Club/Scripts/Home/home.asp.

Spring Island Trust. 2008. *Spring Island Trust Website* 2008 [cited March 24 2008]. Available from http://www.springislandtrust.org.

Texas Parks and Wildlife. 1995. Wildlife Habitat Appraisal Procedure (WHAP). Texas Parks & Wildlife Department. Austin, TX.

The Low Country Institute. 2008. *The Low Country Institute Webpage* 2007 [cited May 6 2008]. Available from *http://www.lowcountryinstitute.org/*.

The Nature Conservancy. 1998. *Species Management Abstract: Black Rail* (*Laerallus jamaicensis*). Arlington, VA: The Nature Conservancy.

Tiner, Ralph W. 2004. Remotely-sensed indicators for monitoring the general condition of "natural habitat" in watersheds: An application for Delaware's Nanticoke River watershed. *Ecological Indicators* 4:227-243.

Turner, K., L. Lefler, and B. Freedman. 2005. Plant communities of selected urbanized areas of Halifax, Nova Scotia, Canada. *Landscape and Urban Planning* 71 (2-4):191-206.

Turner, Monica Goigel. 1989. Landscape ecology: The effect of pattern on process. *Annual Review of Ecology and Systematics* 20:171-197.

Turner, Sandra J., Robert V. O'Neill, Walt Conley, Marsha R. Conley, and Hope C. Humphries. 1991. Pattern and Scale: Statistics for Landscape Ecology. In *Quantitative Methods in Landscape Ecology*, ed. M. G. Turner and R. H. Gardner, Chapter 2. New York, NY: Springer.

U.S. Fish and Wildlife Service. 1980a. ESM 101. Washington, D.C.: Division of Ecological Services, U.S. Fish and Wildlife Service.

———. 1980b. Habitat Evaluation Procedures (HEP) ESM 102. Washington, D.C.: Division of Ecological Services, U.S. Fish and Wildlife Service.

———. 1981. Standards for the Development of Habitat Suitability Index Models 103 ESM. Washington, D.C.: Division of Ecological Services, U.S. Fish and Wildlife Service.

Van Horne, B. 1983. Density as a misleading indicator of habitat quality. *Journal of Wildlife Management* 47 (4):893-901.

Vana-Miller, S. L. 1987. Habitat Suitability Index Models: Osprey, ed. U.S. Department of Interior. Fort Collins, CO: Fish and Wildlife Service, 46.

Weiers, Stefan, Michael Bock, Michael Wissen, and Godela Rossner. 2004. Mapping and indicator approaches for the assessment of habitats at different scales using remote sensing and GIS methods. *Landscape and Urban Planning* 67 (1-4):43-65.

White, Gary C. 2000. Population viability analysis. In *Research Techniques in Animal Ecology: Controversies and Consequences*, ed. L. Boitani and T. K. Fuller, Chapter 9. New York, NY: Columbia University Press.

Wockner, G., R. Boone, N. Thompson Hobbs, and D. Freddy. 2007. *The Habitat Assessment Model: A Tool to Improve Wildlife Habitat Management.* Fort Collins: Colorado Division of Wildlife and Natural Resources Ecology Lab Colorado State University.

Young, Christopher H., and Peter J. Jarvis. 2001. A simple method for predicting the consequences of land management in urban habitats. *Environmental Management* 28 (3):375-387.

APPENDIX

Appendix A: Example assessment forms

Utah's Department of Transportation's Wetland Functional Assessment Method forms (Johnson, Pitts, and Porreca 2005):

Point sampling form (Johnson, Pitts, and Porreca 2005, 108):

Point Sampling

1. Project Name:	2. Project Number:
3. USCOE Permit Number:	Project Pin Number:
4. Evaluation Date:	5. Evaluating Agency:
6. Evaluators:	7. Purpose of Evaluation:
8. Wetland/Site Number(s):	9. Wetland Location(s):
10. Wetland Size:	11. Assessment Area:

Station 1	Species	Hits			Native	Non-Native
		H	S	T		
Herbaceous						
Shrub						
Tree						
Station 2						
Herbaceous						
Shrub						
Tree						
Station 3						
Herbaceous						
Shrub						
Tree						
Station 4						
Herbaceous						
Shrub						
Tree						
Station 5						
Herbaceous						
Shrub						
Tree						
Station 6						
Herbaceous						
Shrub						
Tree						
Station 7						
Herbaceous						
Shrub						
Tree						
Station 8						
Herbaceous						
Shrub						
Tree						
Station 9						
Herbaceous						
Shrub						
Tree						
Station 10						
Herbaceous						
Shrub						
Tree						

$$\% \text{ Cover} = \frac{\text{Total Hits}}{\text{Total Points Sampled}} \times 100$$

Total Hits			
% Cover			
Total % Cover			

% Native Species	

$$\% \text{ Native Species} = \frac{\text{Total Number of Native Species}}{\text{Total Number of Plants Sampled}} \times 100$$

Assessment forms (Johnson, Pitts, and Porreca 2005, 110-169):

UDOT Wetland Assessment Form (Riverine)

1. Project Name:

2. Project Number:

3. USCOE Permit Number: **Project Pin Number:**

4. Evaluation Date (MM/DD/YYYY):

5. Evaluating Agency:

6. Evaluator(s):

7. Purpose of Evaluation (check one): ____Wetlands potentially affected by UDOT project
____ Mitigation wetlands, pre-construction
____ Mitigation wetlands, post-construction
____ Other (explain):

8. Wetland/Site Number(s):

9. Wetland Location(s):
Ecoregion (see map Appendix A):_____
Watershed (see map Appendix A):_____
County (see map Appendix A): _____
Legal: T_____N or S; R_____E or W; S_____;T_____N or S; R_____E or W; S_____
Approximate Stationing or Mileposts:_____
_____
GPS Reference Number:_____
Other Location information:

10. Wetland Size (total acres, measured by GPS if applicable):

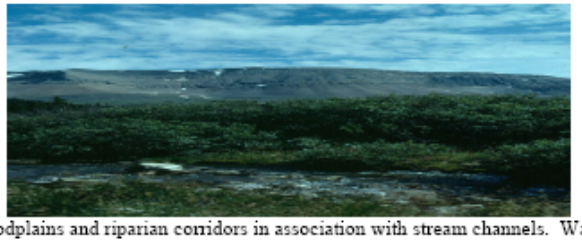
11. Assessment Area (AA) (total acres, measured by GPS if applicable, see appendix):

12. Habitat for Federally Listed or Proposed Threatened or Endangered Plants or Animals or State Listed S1 Species
It is required that the evaluator contact USFWS with regards to the presence or absence of threatened or endangered (T or E) species and UDWR concerning the presence or absence of a state listed S1, S2 or S3 species. The documented habitat of a federally listed or proposed threatened or endangered plant or animal species or a state listed S1 species results in an automatic Red Flag categorization of the assessed site. Coordination with USFWS and UDWR is required. (However, the evaluation proceeds as normal so that the COE receives an assessment of function and value consistent with the UDOT assessment method.)
Is the AA documented to contain primary habitat for T or E or S-1 species? _____Yes _____No
If yes, list the species:
(This field assesses habitat for species receiving protection under provision of the Endangered Species Act and Utah critically imperiled species.)

13. Selecting a Wetland Classification
Refer to the glossary to determine the correct wetland class. Refer to Appendix E for reference photos and lists of the most common native species in each classification. Turn to appropriate colored pages to continue functional assessment as noted below.
Riverine: Blue
Slope: Pink
Depressional: Yellow
Mineral Flat: Green
Lacustrine Fringe: Purple
Roadside Ditch Wetland: If AA qualifies as a non-jurisdictional 'roadside ditch wetland', AA is classified as Category IV. Further assessment is not necessary, although all documentation must be completed.

***Toned questions or functional categories on the assessment form do not apply to this wetland class, do not answer. They are excluded from the individual function rating as well as the final overall functional assessment rating.**

Riverine



Riverine wetlands: Occur in floodplains and riparian corridors in association with stream channels. Water source is river or stream flow or over bank flow at peak hydrological periods. (Overbank flow should occur once every two years or 50% of the time. If flooding does not occur at this minimal rate, it is probably not a riverine based wetland). Dominant hydrodynamics are unidirectional and horizontal. A subsurface hydraulic connection between the wetland and stream does not necessarily indicate a riverine system.

14. Identify subclass _____ (Classification after Rosgen…check appendix for graphic representations)
The evaluator uses the information below together with information in Appendix E to identify the AA subclass. This information is not used directly to rate the AA.

Subclasses--Single Channel Systems: (be aware that there may be more than one subclass in the AA)

A Very steep gradient, very entrenched (no floodplain), very narrow valley, narrow channel
Entrenchment ratio < 1.4 Width/depth ratio < 12 Gradient ≥ .04

G Deeply incised, grade control problems (headcuts), much bank erosion, high sediment supply, virtually no floodplain
Entrenchment ratio <1.4 Width/depth ratio < 12 Gradient ≥ .02

F Entrenched, little floodplain development, low gradient, unstable banks, significant bar deposition, increasing channel width, high sediment supply, channel wide and shallow
Entrenchment ratio ≤ 1.5 Width/depth ratio ≥ 12 Gradient ≤ .02

B Narrow, gently sloping valleys, colluvial deposition from side slopes and/or structural control restrict width of floodplain but there is a small, relatively flat floodplain, low sediment supply, well-vegetated
Entrenchment ratio 1.5-2.0 Width/depth ratio ≥ 12 Gradient ≥ .02 B Gradient < .02 B_C

C Low gradient, slightly entrenched, well-defined floodplain with terraces, point bars, cut banks, developed in alluvial material, often bare below bankfull/ cottonwood-willow complexes
Entrenchment ratio ≥ 2.0 Gradient < .02 Width/depth ratio ≥ 12 C Width/depth ratio < 12 C_G

E Low gradient, narrow, deep channels in broad valleys/meadows, large floodplains, little sediment deposition, well-vegetated willow/sedges, sinuous, overhanging banks
Entrenchment ratio ≥ 2.0 Width/depth ratio < 12 Gradient < .01

Subclasses--Multichannel Systems

D Abundant sediment supply, shifting channels, very broad floodplains. Bold subclass in riparian class may have wetlands

Identify soil type: organic or mineral
Refer to glossary for definitions of organic and mineral soils.
Determine the pH range _____

Organic soils	Mineral soils
≤ 4.9	≤ 6.0
5.0 - 6.5	6.1-7.3
> 6.5	≥ 7.4 - 8.4
	≥ 8.5

Measure the water salinity _____
< 5 dS/m
5-10 dS/m
10-16 dS/m
16-35 dS/m
≥ 35 dS/m

Presence of heavy metals or toxicants?
Yes No

Subclass is:
_____ Single channel A
_____ Single channel G
_____ Single channel F
_____ Single channel B
_____ Single channel C
_____ Single channel E
_____ Multichannel Systems D

Reference Appendix D for definitions of water class and salinity.
Soil type, pH range, salinity and presence of heavy metals are determined using accepted wetland science protocols.

Biological Assessment

Sources of assessment criteria for each field are adopted from MDT, *Montana Wetland Assessment Method* and are listed under methods on page 5. Additional criteria sources are listed with each assessment field.

15a. Level of Disturbance

This field assesses the level of disturbance in the AA and EAA. Source: Soule (1991), Forman and Godron (1986), Fahrig (1997), Buffler (2005), and Spackman and Hughes (1995).

Use matrix below to determine level of disturbance (H = high, M = moderate, or L = low). Circle the appropriate answer.

	Predominant conditions found in EAA (600 feet from perimeter of AA)		
Conditions within AA	Land managed in predominantly natural state; is not grazed, hayed, landscaped, or otherwise converted; does not contain roads or buildings.	Land not cultivated, but moderately grazed or hayed; or has been subject to minor clearing, fill placement or hydrological alteration; contains few roads, buildings, ditches or canals.	Land cultivated or heavily grazed or landscaped; subject to substantial fill placement, grading, clearing, or hydrological alteration; high road or building density, and or numerous ditches or canals.
AA occurs and is managed in predominantly natural state; is not grazed, hayed, landscaped, or otherwise converted; does not contain human induced trails.	L	L	M
AA not cultivated, but moderately grazed or hayed; or has been subject to relatively minor clearing or hydrological alteration; contains few human induced trails, ditches or canals.	M	M	H
AA cultivated or heavily grazed or landscaped; subject to relatively substantial grading, clearing, or hydrological alteration; and numerous human induced trails, ditches or canals.	H	H	H

Comments: Note types of disturbance, intensity, season, etc.

15b. Plant Community Composition

This field assesses the plant community within the AA. Source: Keate (2004) and Padgette et al. (1989).

Refer to Appendix E for photographs, plan views, cross sectional diagrams, the range of expected coverage and wetland specific vegetation lists. Refer to Appendix F for transect protocol (step point). Draw a simple boundary of the AA and illustrate all plant transect locations and approximate distances on page 11 of this form. See glossary for definition of native wetland plants.

i. Do you find all layers of vegetation that are expected for this wetland type? Circle: Y N

ii. What is the percent ground cover (within the AA) dominated by native wetland vegetation?

High ≥ 80%, Moderate 79-60%, Low < 60%

iii. What is the percent of native wetland plants to non-native or non-wetland plants observed using the transect protocol?

High ≥ 80%, Moderate 79-60%, Low < 60%

iv. Rating for riverine and lacustrine wetlands.

Layers (i)	Y									N								
Cover (ii)	H			M			L			H			M			L		
Native Wetland Species (iii)	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L
Rating	1H	.9H	.8H	.7M	.6M	.5M	.4M	.3L	.2L	.9H	.8H	.7M	.6M	.5M	.4M	.3L	.2L	.1L

iv. Rating for depressional, mineral flat, and slope wetlands.

Cover (ii)	H			M			L		
Native Wetland Species (iii)	H	M	L	H	M	L	H	M	L
Rating	1H	.8H	.6M	.8H	.6M	.4M	.6M	.4M	.2L

Comments:

15c. Habitat for Federally Listed or Proposed Threatened or Endangered Plants or Animals

This field assesses documented or suspected use of the AA by Federally listed or proposed threatened or endangered plants or animals. Source: Consultation with USFWS biologist.

Refer to the U.S. Fish and Wildlife Services website at www.fws.gov or visit the Utah Data Conservation Center website at http://dwrcdc.nr.utah.gov/ucdc/ . Circle one category below based on definitions contained in the instructions and after consultation with USFWS biologist.

i. AA is Documented (D) or Suspected (S) to contain:

*Documented primary habitat for T or E or State listed S-1 species has been addressed in #12

Primary habitat (list species)	*	S _____
Secondary habitat (list species)	D	S _____
Incidental habitat (list species)	D	S _____
No usable habitat	D	S _____

ii. Rating

Evaluator uses the conclusions from i above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Highest Habitat Level	Primary/S	Secondary/D	Secondary/S	Incidental/D	Incidental/S	None
Rating	.9 H	.8 H	.7 M	.5 M	.3 L	0 L

Sources for documented use (e.g. observations, records, etc):

15d. Habitat for plant or animals rated S2 or S3 by the Utah Natural Heritage Program

This field assesses documented or suspected use of the AA by S2 or S3 species listed by the Utah Natural Heritage Program (UNHP). Source: Consultation with UDWR regional biologist.

Refer to the UNHP website or the Utah Sensitive Species List at http://dwrcdc.nr.utah.gov/ucdc/ .

Do not include species listed in 15c from above. Circle one category below based on definitions contained in the instructions and after consultation with UDWR biologist.

i. AA is Documented (D) or Suspected (S) to contain:

Primary habitat (list species and S rating)	D	S _____
Secondary habitat (list species and S rating)	D	S _____
Incidental habitat (list species and S rating)	D	S _____
No usable habitat	D	S _____

ii. Rating

Evaluator uses the conclusions from i above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low).

Highest Habitat Level	Primary/D	Primary/S	Secondary/D	Secondary/S	Incidental/D	Incidental/S	None
Rating	.9 H	.8 H	.7 M	.6 M	.2 L	.1 L	0 L

Sources for documented use (e.g. observations, records, etc.):

15e. General Wildlife Habitat

This field assesses general wildlife habitat conditions in the AA. Source: Hammer (1992), Mitch and Gosselink (1993) and Weller and Spatcher (1965).

i. Wildlife habitat features

Working from top to bottom, circle appropriate AA attributes in matrix to arrive at a rating (H = high, M = moderate, or L = low).

Disturbance Level (15a)	L			M			H		
Plant Community (15b)	H	M	L	H	M	L	H	M	L
Rating	H	H	M	H	M	L	M	L	L

Wildlife habitat features rating.	1H	.6M	.2L

ii. Modified Wildlife Habitat Rating

The wildlife habitat features rating may be modified based on documented wildlife use and levels of use of the AA. Consult with the UDWR regional wildlife biologist to determine the level of wildlife use in the AA using the procedures detailed below.

UDWR biologist consulted: Name(s)_____ _____Date(s)_____

First circle the appropriate answer to the following question: Does the UDWR have sufficient knowledge of the AA to determine a level of general wildlife use. Yes No

If the answer is No do not modify your answer to 15e(i) above. If you answer is Yes and after further consultation with a UDWR biologist and using the level of use descriptive categories on page 14. Select the descriptive category (H, M or L) that best describes the level of wildlife use in the AA. Circe the appropriate answer. H M L

If the level of use circled is:
H – add .2 to the wildlife habitat features rating 15e(i)
M – add .1 to the wildlife habitat features rating
L – do not modify the wildlife habitat features rating

iii. Rating

Use the conclusions from i and ii above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Modified wildlife habitat features rating	1H			.6M			.2L		
Rating	1.2H	1.1H	1H	.8H	.7M	.6M	.4M	.3L	.2L

Comments:

15f. General Fish/Aquatic Habitat

This field assesses general fish and aquatic habitat in the AA. Source: Sigler and Miller (1963), Gore (1985), Williams et al (1997) and National Research Council (1992).

Assess this function if the AA is used by fish or the existing situation is "correctable" such that the AA could be used by fish [i.e., fish use is precluded by perched culvert or other barrier, etc.]. If the AA is not or was not historically used by fish due to lack of habitat, excessive gradient, etc., circle NA here and proceed to the next function. If fish use occurs in the AA but is not desired from a resource management perspective [such as fish use within an irrigation canal], then Habitat Quality [i below] should be marked as "Low", applied accordingly in ii below, and noted in the comments.)

i. Habitat Quality

Refer to the glossary for further definitions of these terms. Circle appropriate AA attributes in matrix to arrive at the quality rating (H = high, M = moderate, or L = low).

Duration of surface water in AA	Permanent / Perennial			Seasonal / Intermittent			Temporary / Ephemeral		
Cover: % of water body in AA containing cover objects such as submerged logs, large rocks & boulders, overhanging banks, floating-leaved vegetation, etc.	>25%	10–25%	<10%	>25%	10–25%	<10%	>25%	10–25%	<10 %
Shading: >75% of stream bank or shoreline within AA contains riparian or wetland scrub-shrub or forested communities	H	H	H	H	H	M	M	M	M
Shading: 50 to 75% of stream bank or shoreline within AA contains riparian or wetland scrub-shrub or forested communities	H	H	M	M	M	M	M	L	L
Shading: < 50% of stream bank or shoreline within AA contains riparian or wetland scrub-shrub or forested communities	H	M	M	M	L	L	L	L	L

ii. Modified Habitat Quality

Circle the appropriate response. If answer is Y, then reduce rating in i above by one level (H = M, M = L, L = L)

Is fish use of the AA precluded or significantly reduced by a culvert, dike, or other man-made structure or activity or is the water body included on the UDEQ list of water bodies in need of TMDL development with listed "Probable Impaired Uses" including cold or warm water fishery or aquatic life support? Y N

Modified habitat quality rating = (circle) H M L

iii. **Rating**

Refer to the Utah Division of Wildlife Resource website for fish species. Use the conclusions from i and ii above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Types of fish known or suspected within AA	Modified Habitat Quality (ii)		
	H	M	L
Native fish	1 H	.8H	.6 M
Introduced fish*	.5 M	.4 M	.3 L
No fish	.3 L	.2 L	.1 L

Note: reduce the score by .1 if the AA has carp present.						
.9H	.7M	.5M	.4M	.3L	.2L	.1L	0L

*Many rivers and streams in Utah have both native and introduced fish species present. For example, non native brown trout introduced into Blacksmith Fork River have become established as a self sustaining population that provides an ecological function to the system as do the native cutthroat trout which persist. Other streams are stocked with hatchery raised rainbow trout on a "put and take" basis for sport fishing. These fish are short lived, seldom reproduce and do not provide ecological function equivalent to native fish species. In AA's where a native/non native mix of fish species exists the evaluator is required to consult with USFWS and UDWR fisheries biologists to determine the appropriate fish/aquatic habitat rating.

15g. General Amphibian Habitat

This field assesses general amphibian habitat within the AA. Source: Consultation with UDWR regional biologist.

UDWR biologist(s) consulted: Name(s)_____ Date(s)_____

Circle the appropriate answer to the following question after consulting with UDWR regional biologist. The UDWR has documented the presence of amphibians in the AA or, habitat and water quality characteristics are such that they would support amphibians.

Rating: Yes No

If the answer is Yes, add **.2** under the functional points/rating column in the Functional Assessment Rating Section at the end of this form.

Hydrological/Biophysical Assessment

Draw a simple boundary of the AA on page 12 of this form and illustrate the hydrological conditions found within the AA. Include water source locations, directions of flow (if applicable), approximate depths, and any significant site features that influence site hydrology.

15h. Flood Attenuation

This field assesses the capability of the AA to slow in channel or over bank flow during high water/flood events. This applies to riverine wetlands only. Source: Kleinschmidt Associates (1993), Munson (1974) and Strom et al (2004).

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Within the AA, estimate % ground coverage with high surface roughness*	≥65%	64%-50%	49%-35%	>35%
Rating	1H	.8H	.6M	.4M

*See glossary for definition of surface roughness rating criteria.

ii. There are residences, businesses, or other features, which may be significantly damaged by floods located within 0.5 miles downstream of the AA. Yes No

Comments:

15i. Short and Long Term Surface Water Storage

This field assesses the potential of the AA to capture and hold surface water originating from inundation, precipitation, upland surface (sheet flow) or subsurface (groundwater flow). Source: Munson (1974), Strom et al (2004), Hammer (1986) and Mitch and Gosselink (1993).

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Duration of surface water is implied in the definition of wetland class or of the subclass and thus reflects the natural function. Circle the appropriate answer.

Wetlands are inundated	≥ 5 out of 10 years		< 5 out of 10 years	
Has the wetland's natural ability to store water been disturbed negatively?	N	Y	N	Y
Rating	1H	.8H	.6M	.4M

In order to properly assess this function, examination of the area down gradient from the AA may aid in determining whether or not dams, water control structures, overflow aprons, ditches, canals, drain tiles or other forms of outlet or modification exist.

Comments:

15j. Sediment/Nutrient/Toxicant Retention and Removal

This field assesses the ability of the AA to retain and capture sediments, nutrients and toxicants. Source: Kleinschmidt Associates (1999), Hammer (1986) and Hammer and Kadlec (1983).

This function applies to wetlands which could receive excess sediments, nutrients or toxicants through influx of surface or groundwater or direct input. If no wetlands in the AA are subject to such input, circle NA here and proceed with evaluation.

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Sediment, nutrient, and toxicant input levels within AA	AA receives or surrounding land use with potential to deliver low to moderate levels of sediments, nutrients, or compounds such that other functions are not substantially impaired. **Minor** sedimentation, sources of nutrients or toxicants, or signs of eutrophication present.				AA is in close proximity to or receives input from or is on UDEQ list of water bodies in need of TMDL development for "probable causes" related to sediment, nutrients, or toxicants **or** AA receives or surrounding land use with potential to deliver high levels of sediments, nutrients, or compounds such that other functions are substantially impaired. **Major** sedimentation, sources of nutrients or toxicants, or signs of eutrophication present.			
Within the AA, estimate % ground coverage with high to moderate surface roughness*	≥ 50%		<50%		≥ 50%		<50%	
Has the wetland's natural ability to store water been disturbed negatively?	N	Y	N	Y	N	Y	N	Y
Rating	1H	.9H	.8H	.7M	.6M	.5M	.4M	.3L

*See glossary for definition of surface roughness.

Comments:

15k. Sediment/Shoreline Stabilization

This field assesses the ability of the AA to dissipate flow or wave energy in order to reduce erosion. This applies to riverine and lacustrine wetlands only. Source: Kleinschmidt Associates (1999), Keate (2004), Padgette et al (1989) and Mitch and Gosselink (1993).

Applies only if AA occurs on or within the banks or a river, stream, or other natural (vegetated swale) or man-made drainage, or on the shoreline of a standing water body, which is subject to wave action. It does not apply, circle NA here and proceed to next function)

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function.

Within the AA, estimate % ground coverage with high surface roughness*	Duration of surface water adjacent to rooted vegetation	
	Permanent	Seasonal
≥ 65%	1H	.7M
64% - 50%	.8H	.5M
49% - 35%	.6M	.3L
< 35%	.4M	.1L

Comments:

Social Value Assessment

The following are not functions but values, which are important to society. Plus answers would suggest important societal assets, which should guide any future mitigation planning.

16. Visual Quality*

Refer to the glossary to distinguish between "wildland wetland" and "urban/exurban wetland".

If AA is considered "wildland wetland" answer the following three questions based on information gathered from suggested sources. Each 'yes' answer receives a plus (+) rating in the space provided.

i. Is the wetland in public ownership (city, county, state or federal)? _____
ii. Has wetland experienced moderate to low level of disturbance (refer to glossary)? _____
iii. Is there an absence of human structures or other human induced disturbances (refer to glossary)? _____

If AA is considered to be an "urban/exurban wetland", answer the following six questions based on information gathered from suggested sources. Each 'yes' answer receives a plus (+) rating in the space provided.

i. Is the wetland in public ownership (city, county, state or federal)? _____
ii. Is there potentially a large number of viewers? _____
iii. Is the viewing distance in the fore or middle grounds for most viewers (refer to glossary)? _____
iv. Has the wetland experienced a moderate to low level of disturbance (refer to glossary)? _____
v. Is there an absence of human structures or other human induced disturbances (refer to glossary)? _____
vi. Is the wetland a part of a larger open space, green space, park, buffer or corridor? _____

17. Recreational/Educational Quality*

Answer the following seven questions for both "wildland wetlands" and "urban/exurban wetlands". Each 'yes' answer receives a plus (+) rating in the space provided.

i. Is the wetland in public ownership (city, county, state or federal)? _____
ii. Is the wetland presently used for recreation/education? _____
iii. Is the wetland ¼ mile or less from and elementary school? _____
iv. Is the wetland five miles or less from a high school? _____
v. Is there vehicular, trail, boat or canoe access to the site? _____
vi. Has the wetland experienced a moderate to low level of disturbance (refer to glossary)? _____
vii. Is the wetland visible from a county, state or federal highway, heavily used recreation trail, residential development or other situations where large numbers of people would have visual access to the wetland? _____

*Note: In some cases wetlands many contain plant or wildlife species or perform functions that would be diminished by human activity. In these cases recreational and educational activities would be prohibited.

Summary Comments for entire Wetland AA Evaluated

Functional Assessment Rating

Function Variables	General Evaluation	Actual Functional Points/Rating	Possible Functional Points	Functional Units: (Actual Points x Estimated AA Acreage)
15b. Plant Community Composition			1	
15c. Listed/Proposed T&E Species Habitat			.9	
15d. UT Natural Heritage Program Species Habitat			.9	
15e. General Wildlife Habitat			1	
15f. General Fish/Aquatic Habitat			1	
15g. General Amphibian Habitat			0	
15h. Flood Attenuation			1	
15i. Short and Long Term Surface Water Storage			1	
15j. Sediment/Nutrient/Toxicant Removal			1	
15k. Sediment/Shoreline Stabilization			1	
Totals:				

If functional variables other than those toned are not applicable (NA) to the AA of concern, enter NA in the possible functional points box and subtract the possible functional points for that variable when calculating percent of total functional points.
Note: % total functional points = actual functional points ÷ possible functional points.

	% total functional points

Overall Assessment Area Category

Circle appropriate category based on the criteria outlined below. **I II III IV**

Red Flag Category
___ Documented habitat for a federally listed or proposed threatened or endangered plant or animal species was found. (Yes response to question 12)
___ Documented habitat for a species rated S1 by the Utah Natural Heritage Program. (Yes response to question 12)
Wetlands in this category are a special case and require consultation with the COE, USFWS, and UDWR throughout the entire application process.

Category I Wetland: (Must satisfy one of the following criteria; if it does not meet criteria, go to Category II)
___ Score of .9 functional point for Species Rated primary documented S2 by the Utah Natural Heritage Program **or** .8 for primary suspected S2 species, level of disturbance is also rated low; **or**
___Score of 1 functional point for Flood Attenuation (riverine only) and answer to Question 15i. ii is "yes"; **or**
___Score 1 function point for Plant Community Composition; **or**
___Total actual functional points > 80% (round to nearest whole #) of total possible functional points.

Category II Wetland: (Criteria for Category I not satisfied and meets any one of the following criteria; if not satisfied, go to Category IV)
___Score of .9 functional point for Species Rated primary documented S3 by the Utah Natural Heritage Program, **or** .8 functional point for Species Rated primary suspected S3 species; level of disturbance is rated low **or**
___Score of ≥.9 functional point for General Wildlife Habitat; **or**
___Score of ≥.9 functional point for General Fish/Aquatic Habitat (riverine and lacustrine only); **or**
___Score of >.7 ≤.8 functional point for Plant Community Composition
___Total Actual Functional Points > 65% (round to nearest whole #) of total possible functional points.

Category III Wetland: (Criteria for Categories I, II or IV not satisfied)

Category IV Wetland: (Criteria for Categories I or II are not satisfied and all of the following criteria are met; if it does not satisfy criteria, place wetland in Category III)
___Total actual functional points < 30% (round to nearest whole #) of total possible functional points
___Roadside Ditch Wetland Classification

Supplemental Diagram A

15b. Plant Community Composition Diagram

Draw a simple boundary of the AA and illustrate all plant transect locations and approximate distances.
Please note that 100 sample points per acre should be collected within the AA. (Example: if AA equals .25 acres, then 25 sample points should be taken.) Never use less then 10 sample points within any AA, even when AA is less then .10 acres in size. Placement of transect(s) should accurately represent the AA. Be sure to place transect(s) through different water regimes, vegetative structure, and topographic changes that may exist within the AA.

Supplemental Diagram B

Hydrological/Biophysical Assessment Diagram

Draw a simple boundary of the AA and illustrate the hydrological conditions found within the AA. Include water source locations, directions of flow (if applicable), approximate depths, and any significant site features that influence site hydrology.

UDOT Wetland Assessment Form (Slope)

1. Project Name:

2. Project Number:

3. USCOE Permit Number: **Project Pin Number:**

4. Evaluation Date (MM/DD/YYYY):

5. Evaluating Agency:

6. Evaluator(s):

7. Purpose of Evaluation (check one): ____Wetlands potentially affected by UDOT project
____ Mitigation wetlands, pre-construction
____ Mitigation wetlands, post-construction
____ Other (explain):

8. Wetland/Site Number(s):

9. Wetland Location(s):
Ecoregion (see map Appendix A):_____
Watershed (see map Appendix A):_____
County (see map Appendix A): _____
Legal: T_____N or S; R_____E or W; S_____;T_____N or S; R_____E or W; S_____
Approximate Stationing or Mileposts:_____
_____
GPS Reference Number:_____
Other Location information:

10. Wetland Size (total acres, measured by GPS if applicable):

11. Assessment Area (AA) (total acres, measured by GPS if applicable, see appendix):

12. Habitat for Federally Listed or Proposed Threatened or Endangered Plants or Animals or State Listed S1 Species
It is required that the evaluator contact USFWS with regards to the presence or absence of threatened or endangered (T or E) species and UDWR concerning the presence or absence of a state listed S1, S2 or S3 species. The documented habitat of a federally listed or proposed threatened or endangered plant or animal species or a state listed S1 species results in an automatic Red Flag categorization of the assessed site. Coordination with USFWS and UDWR is required. (However, the evaluation proceeds as normal so that the COE receives an assessment of function and value consistent with the UDOT assessment method.)
Is the AA documented to contain primary habitat for T or E or S-1 species? _____Yes _____No
If yes, list the species:
(This field assesses habitat for species receiving protection under provision of the Endangered Species Act and Utah critically imperiled species.)

13. Selecting a Wetland Classification
Refer to the glossary to determine the correct wetland class. Refer to Appendix E for reference photos and lists of the most common native species in each classification. Turn to appropriate colored pages to continue functional assessment as noted below.
Riverine: Blue
Slope: Pink
Depressional: Yellow
Mineral Flat: Green
Lacustrine Fringe: Purple
Roadside Ditch Wetland: If AA qualifies as a non-jurisdictional 'roadside ditch wetland', AA is classified as Category IV. Further assessment is not necessary, although all documentation must be completed.

***Toned questions or functional categories on the assessment form do not apply to this wetland class, do not answer. They are excluded from the individual function rating as well as the final overall functional assessment rating.**

Slope

Slope wetlands: Occur at points of surface changes, breaks in slope or stratigraphic changes. Surface water runoff and groundwater outflow (i.e. – spring or seep) are the primary water sources. Water flow is unidirectional (down slope/gradient). Water may discharge to a stream, lake or depression. Wetland complexes can be comprised of a slope wetland with several depressions or low-points interspersed throughout. Relying on topographic maps, aerial photographs, and field evaluation will help determine which classification is dominant and or most appropriate.

14. Identify subclass

The evaluator uses the information below together with information in Appendix D to identify the AA subclass. This information is not used directly to rate the AA.

Identify the soil type (circle): organic or mineral

Refer to glossary for definitions of organic and mineral soils.

What is the depth water table?

Circle appropriate answer.

Water table < 20 in.

Water table ≥ 20 in.

Presence of heavy metals or toxicants?

Yes No

Determine the pH range _____

Soil and water pH range

Organic soils	Mineral soils
≤ 4.9	≤ 6.0
5.0 - 6.5	6.1-7.3
> 6.5	≥ 7.4 - 8.4
≥ 8.5	

Determine the salinity_____

Water salinity

< 5 dS/m

5-10 dS/m

10-16 dS/m

16-35 dS/m

≥ 35 dS/m

Subclass is:

_____ Seasonal and persistent freashwater

_____ Seasonal and persistent saline and very saline

Reference Appendix D for definitions of water class and salinity.

Depth to water table, pH range, salinity and presence of heavy metals are determined using accepted wetland science protocols.

For montane wetlands, salinity is not listed as all are nonsaline.

Biological Assessment

Sources of assessment criteria for each field are adopted from MDT, *Montana Wetland Assessment Method* and are listed under methods on page 5. Additional criteria sources are listed with each assessment field.

15a. Level of Disturbance

This field assesses the level of disturbance in the AA and EAA. Source: Soule (1991), Forman and Godron (1986), Fahrig (1997), Buffler (2005), and Spackman and Hughes (1995).

Use matrix below to determine level of disturbance (H = high, M = moderate, or L = low). Circle the appropriate answer.

	Predominant conditions found in EAA (600 feet from perimeter of AA)		
Conditions within AA	Land managed in predominantly natural state; is not grazed, hayed, landscaped, or otherwise converted; does not contain roads or buildings.	Land not cultivated, but moderately grazed or hayed; or has been subject to minor clearing, fill placement or hydrological alteration; contains few roads, buildings, ditches or canals.	Land cultivated or heavily grazed or landscaped; subject to substantial fill placement, grading, clearing, or hydrological alteration; high road or building density, and or numerous ditches or canals.
AA occurs and is managed in predominantly natural state; is not grazed, hayed, landscaped, or otherwise converted; does not contain human induced trails.	L	L	M
AA not cultivated, but moderately grazed or hayed; or has been subject to relatively minor clearing or hydrological alteration; contains few human induced trails, ditches or canals.	M	M	H
AA cultivated or heavily grazed or landscaped; subject to relatively substantial grading, clearing, or hydrological alteration; and numerous human induced trails, ditches or canals.	H	H	H

Comments: Note types of disturbance, intensity, season, etc.

15b. Plant Community Composition

This field assesses the plant community within the AA. Source: Keate (2004) and Padgette et al. (1989).

Refer to Appendix F for photographs, plan views, cross sectional diagrams, the range of expected coverage and wetland specific vegetation lists. Refer to Appendix G for transect protocol (step point). Draw a simple boundary of the AA and illustrate all plant transect locations and approximate distances on page 11 of this form. See glossary for definition of native wetland plants.

i. Do you find all layers of vegetation that are expected for this wetland type? Circle: Y N

ii. What is the percent ground cover (within the AA) dominated by native wetland vegetation?

High ≥ 80%, Moderate 79-60%, Low < 60%

iii. What is the percent of native wetland plants to non-native or non-wetland plants observed using the transect protocol?

High ≥ 80%, Moderate 79-60%, Low < 60%

iv. Rating for riverine and lacustrine wetlands.

Layers (i)	Y									N								
Cover (ii)	H			M			L			H			M			L		
Native Wetland Species (iii)	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L
Rating	1H	.9H	.8H	.7M	.6M	.5M	.4M	.3L	.2L	.9H	.8H	.7M	.6M	.5M	.4M	.3L	.2L	.1L

iv. Rating for depressional, mineral flat, and slope wetlands.

Cover (ii)	H			M			L		
Native Wetland Species (iii)	H	M	L	H	M	L	H	M	L
Rating	1H	.8H	.6M	.8H	.6M	.4M	.6M	.4M	.2L

Comments:

15c. Habitat for Federally Listed or Proposed Threatened or Endangered Plants or Animals

This field assesses documented or suspected use of the AA by Federally listed or proposed threatened or endangered plants or animals.
Source: Consultation with USFWS biologist.
Refer to the U.S. Fish and Wildlife Services website at www.fws.gov or visit the Utah Data Conservation Center website at http://dwrcdc.nr.utah.gov/ucdc/ . Circle one category below based on definitions contained in the instructions and after consultation with USFWS biologist.

i. AA is Documented (D) or Suspected (S) to contain:

*Documented primary habitat for T or E or State listed S-1 species has been addressed in #12

Primary habitat (list species)	*	S _____
Secondary habitat (list species)	D	S _____
Incidental habitat (list species)	D	S _____
No usable habitat	D	S _____

ii. Rating

Evaluator uses the conclusions from i above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Highest Habitat Level	Primary/S	Secondary/D	Secondary/S	Incidental/D	Incidental/S	None
Rating	.9 H	.8 H	.7 M	.5 M	.3 L	0 L

Sources for documented use (e.g. observations, records, etc):

15d. Habitat for plant or animals rated S2 or S3 by the Utah Natural Heritage Program

This field assesses documented or suspected use of the AA by S2 or S3 species listed by the Utah Natural Heritage Program (UNHP).
Source: Consultation with UDWR regional biologist.
Refer to the UNHP website or the Utah Sensitive Species List at http://dwrcdc.nr.utah.gov/ucdc/ .
Do not include species listed in 15c from above. Circle one category below based on definitions contained in the instructions and after consultation with UDWR biologist.

i. AA is Documented (D) or Suspected (S) to contain:

Primary habitat (list species and S rating)	D	S _____
Secondary habitat (list species and S rating)	D	S _____
Incidental habitat (list species and S rating)	D	S _____
No usable habitat	D	S _____

ii. Rating

Evaluator uses the conclusions from i above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low).

Highest Habitat Level	Primary/D	Primary/S	Secondary/D	Secondary/S	Incidental/D	Incidental/S	None
Rating	.9 H	.8 H	.7 M	.6 M	.2 L	.1 L	0 L

Sources for documented use (e.g. observations, records, etc.):

15e. General Wildlife Habitat

This field assesses general wildlife habitat conditions in the AA. Source: Hammer (1992), Mitch and Gosselink (1993) and Weller and Spatcher (1965).

i. Wildlife habitat features

Working from top to bottom, circle appropriate AA attributes in matrix to arrive at a rating (H = high, M = moderate, or L = low).

Disturbance Level (15a)	L			M			H		
Plant Community (15b)	H	M	L	H	M	L	H	M	L
Rating	H	H	M	H	M	L	M	L	L

Wildlife habitat features rating.	1H	.6M	.2L

ii. Modified Wildlife Habitat Rating

The wildlife habitat features rating may be modified based on documented wildlife use and levels of use of the AA. Consult with the UDWR regional wildlife biologist to determine the level of wildlife use in the AA using the procedures detailed below.

UDWR biologist consulted: Name(s)_____Date(s)_____

First circle the appropriate answer to the following question: Does the UDWR have sufficient knowledge of the AA to determine a level of general wildlife use. Yes No

If the answer is No do not modify your answer to 15e(i) above. If you answer is Yes and after further consultation with a UDWR biologist and using the level of use descriptive categories on page 14. Select the descriptive category (H, M or L) that best describes the level of wildlife use in the AA. Circe the appropriate answer. H M L

If the level of use circled is:
H – add .2 to the wildlife habitat features rating 15e(i)
M – add .1 to the wildlife habitat features rating
L – do not modify the wildlife habitat features rating

iii. Rating

Use the conclusions from i and ii above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Modified wildlife habitat features rating	1H			.6M			.2L		
Rating	1.2H	1.1H	1H	.8H	.7M	.6M	.4M	.3L	.2L

Comments:

15f. General Fish/Aquatic Habitat

This field assesses general fish and aquatic habitat in the AA. Source: Sigler and Miller (1963), Gore (1985), Williams et al (1997) and National Research Council (1992).

Assess this function if the AA is used by fish or the existing situation is "correctable" such that the AA could be used by fish [i.e., fish use is precluded by perched culvert or other barrier, etc.]. If the AA is not or was not historically used by fish due to lack of habitat, excessive gradient, etc., circle NA here and proceed to the next function. If fish use occurs in the AA but is not desired from a resource management perspective [such as fish use within an irrigation canal], then Habitat Quality [i below] should be marked as "Low", applied accordingly in ii below, and noted in the comments.)

i. Habitat Quality

Refer to the glossary for further definitions of these terms. Circle appropriate AA attributes in matrix to arrive at the quality rating (H = high, M = moderate, or L = low).

Duration of surface water in AA	Permanent / Perennial			Seasonal / Intermittent			Temporary / Ephemeral		
Cover: % of water body in AA containing cover objects such as submerged logs, large rocks & boulders, overhanging banks, floating-leaved vegetation, etc.	>25%	10–25%	<10%	>25%	10–25%	<10%	>25%	10–25%	<10 %
Shading: >75% of stream bank or shoreline within AA contains riparian or wetland scrub-shrub or forested communities	H	H	H	H	H	M	M	M	M
Shading: 50 to 75% of stream bank or shoreline within AA contains riparian or wetland scrub-shrub or forested communities	H	H	M	M	M	M	M	L	L
Shading: < 50% of stream bank or shoreline within AA contains riparian or wetland scrub-shrub or forested communities	H	M	M	M	L	L	L	L	L

ii. Modified Habitat Quality

Circle the appropriate response. If answer is Y, then reduce rating in i above by one level (H = M, M = L, L = L)

Is fish use of the AA precluded or significantly reduced by a culvert, dike, or other man-made structure or activity or is the water body included on the UDEQ list of water bodies in need of TMDL development with listed "Probable Impaired Uses" including cold or warm water fishery or aquatic life support? Y N

Modified habitat quality rating = (circle) H M L

iii. **Rating**

Refer to the Utah Division of Wildlife Resource website for fish species. Use the conclusions from i and ii above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Types of fish known or suspected within AA	Modified Habitat Quality (ii)		
	H	M	L
Native fish	1 H	.8H	.6 M
Introduced fish*	.5 M	.4 M	.3 L
No fish	.3 L	.2 L	.1 L
Note: reduce the score by .1 if the AA has carp present.			

.9H	.7M	.5M	.4M	.3L	.2L	.1L	0L

15g. General Amphibian Habitat

This field assesses general amphibian habitat within the AA. Source: Consultation with UDWR regional biologist.

UDWR biologist(s) consulted: Name(s)_____Date(s)_____

Circle the appropriate answer to the following question after consulting with UDWR regional biologist. The UDWR has documented the presence of amphibians in the AA or, habitat and water quality characteristics are such that they would support amphibians.

Rating: Yes No

If the answer is Yes, add **.2** under the functional points/rating column in the Functional Assessment Rating Section at the end of this form.

Hydrological/Biophysical Assessment

Draw a simple boundary of the AA on page 12 of this form and illustrate the hydrological conditions found within the AA. Include water source locations, directions of flow (if applicable), approximate depths, and any significant site features that influence site hydrology.

15h. Flood Attenuation

This field assesses the capability of the AA to slow in channel or over bank flow during high water/flood events. This applies to riverine wetlands only. Source: Kleinschmidt Associates (1993), Munson (1974) and Strom et al (2004).

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Within the AA, estimate % ground coverage with high surface roughness*	≥65%	64%-50%	49%-35%	>35%
Rating	1H	.8H	.6M	.4M

*See glossary for definition of surface roughness rating criteria.

ii. There are residences, businesses, or other features, which may be significantly damaged by floods located within 0.5 miles downstream of the AA. Yes No

Comments:

15i. Short and Long Term Surface Water Storage

This field assesses the potential of the AA to capture and hold surface water originating from inundation, precipitation, upland surface (sheet flow) or subsurface (groundwater flow). Source: Munson (1974), Strom et al (2004), Hammer (1986) and Mitch and Gosselink (1993).

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Duration of surface water is implied in the definition of wetland class or of the subclass and thus reflects the natural function. Circle the appropriate answer.

Wetlands are inundated	≥ 5 out of 10 years		< 5 out of 10 years	
Has the wetland's natural ability to store water been disturbed negatively?	N	Y	N	Y
Rating	1H	.8H	.6M	.4M

In order to properly assess this function, examination of the area down gradient from the AA may aid in determining whether or not dams, water control structures, overflow aprons, ditches, canals, drain tiles or other forms of outlet or modification exist.

Comments:

15j. Sediment/Nutrient/Toxicant Retention and Removal

This field assesses the ability of the AA to retain and capture sediments, nutrients and toxicants. Source: Kleinschmidt Associates (1999), Hammer (1986) and Hammer and Kadlec (1983).

This function applies to wetlands which could receive excess sediments, nutrients or toxicants through influx of surface or groundwater or direct input. If no wetlands in the AA are subject to such input, circle NA here and proceed with evaluation.

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Sediment, nutrient, and toxicant input levels within AA	AA receives or surrounding land use with potential to deliver low to moderate levels of sediments, nutrients, or compounds such that other functions are not substantially impaired. **Minor** sedimentation, sources of nutrients or toxicants, or signs of eutrophication present.				AA is in close proximity to or receives input from or is on UDEQ list of water bodies in need of TMDL development for "probable causes" related to sediment, nutrients, or toxicants **or** AA receives or surrounding land use with potential to deliver high levels of sediments, nutrients, or compounds such that other functions are substantially impaired. **Major** sedimentation, sources of nutrients or toxicants, or signs of eutrophication present.			
Within the AA, estimate % ground coverage with high to moderate surface roughness*	≥ 50%		<50%		≥ 50%		<50%	
Has the wetland's natural ability to store water been disturbed negatively?	N	Y	N	Y	N	Y	N	Y
Rating	1H	.9H	.8H	.7M	.6M	.5M	.4M	.3L

*See glossary for definition of surface roughness.

Comments:

15k. Sediment/Shoreline Stabilization

This field assesses the ability of the AA to dissipate flow or wave energy in order to reduce erosion. This applies to riverine and lacustrine wetlands only. Source: Kleinschmidt Associates (1999), Keate (2004), Padgette et al (1989) and Mitch and Gosselink (1993).

Applies only if AA occurs on or within the banks or a river, stream, or other natural (vegetated swale) or man-made drainage, or on the shoreline of a standing water body, which is subject to wave action. It does not apply, circle NA here and proceed to next function)

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function.

Within the AA, estimate % ground coverage with high surface roughness*	Duration of surface water adjacent to rooted vegetation	
	Permanent	Seasonal
≥ 65%	1H	.7M
64% - 50%	.8H	.5M
49% - 35%	.6M	.3L
< 35%	.4M	.1L

Comments:

Social Value Assessment

The following are not functions but values, which are important to society. Plus answers would suggest important societal assets, which should guide any future mitigation planning.

16. Visual Quality*

Refer to the glossary to distinguish between "wildland wetland" and "urban/exurban wetland".

If AA is considered "wildland wetland" answer the following three questions based on information gathered from suggested sources. Each 'yes' answer receives a plus (+) rating in the space provided.

i. Is the wetland in public ownership (city, county, state or federal)? _____
ii. Has wetland experienced moderate to low level of disturbance (refer to glossary)? _____
iii. Is there an absence of human structures or other human induced disturbances (refer to glossary)? _____

If AA is considered to be an "urban/exurban wetland", answer the following six questions based on information gathered from suggested sources. Each 'yes' answer receives a plus (+) rating in the space provided.

i. Is the wetland in public ownership (city, county, state or federal)? _____
ii. Is there potentially a large number of viewers? _____
iii. Is the viewing distance in the fore or middle grounds for most viewers (refer to glossary)? _____
iv. Has the wetland experienced a moderate to low level of disturbance (refer to glossary)? _____
v. Is there an absence of human structures or other human induced disturbances (refer to glossary)? _____
vi. Is the wetland a part of a larger open space, green space, park, buffer or corridor? _____

17. Recreational/Educational Quality*

Answer the following seven questions for both "wildland wetlands" and "urban/exurban wetlands". Each 'yes' answer receives a plus (+) rating in the space provided.

i. Is the wetland in public ownership (city, county, state or federal)? _____
ii. Is the wetland presently used for recreation/education? _____
iii. Is the wetland ¼ mile or less from and elementary school? _____
iv. Is the wetland five miles or less from a high school? _____
v. Is there vehicular, trail, boat or canoe access to the site? _____
vi. Has the wetland experienced a moderate to low level of disturbance (refer to glossary)? _____
vii. Is the wetland visible from a county, state or federal highway, heavily used recreation trail, residential development or other situations where large numbers of people would have visual access to the wetland? _____

*Note: In some cases wetlands many contain plant or wildlife species or perform functions that would be diminished by human activity. In these cases recreational and educational activities would be prohibited.

Summary Comments for entire Wetland AA Evaluated

Functional Assessment Rating

Function Variables	General Evaluation	Actual Functional Points/Rating	Possible Functional Points	Functional Units: (Actual Points x Estimated AA Acreage)
15b. Plant Community Composition			1	
15c. Listed/Proposed T&E Species Habitat			.9	
15d. UT Natural Heritage Program Species Habitat			.9	
15e. General Wildlife Habitat			1	
15f. General Fish/Aquatic Habitat			1	
15g. General Amphibian Habitat			0	
15h. Flood Attenuation			1	
15i. Short and Long Term Surface Water Storage			1	
15j. Sediment/Nutrient/Toxicant Removal			1	
15k. Sediment/Shoreline Stabilization			1	
Totals:				

If functional variables other than those toned are not applicable (NA) to the AA of concern, enter NA in the possible functional points box and subtract the possible functional points for that variable when calculating percent of total functional points.
Note: % total functional points = actual functional points ÷ possible functional points.

	% total functional points

Overall Assessment Area Category

Circle appropriate category based on the criteria outlined below. **I II III IV**

Red Flag Category
___ Documented habitat for a federally listed or proposed threatened or endangered plant or animal species was found. (Yes response to question 12)
___ Documented habitat for a species rated S1 by the Utah Natural Heritage Program. (Yes response to question 12)
Wetlands in this category are a special case and require consultation with the COE, USFWS, and UDWR throughout the entire application process.

Category I Wetland: (Must satisfy one of the following criteria; if it does not meet criteria, go to Category II)
___ Score of .9 functional point for Species Rated primary documented S2 by the Utah Natural Heritage Program **or** .8 for primary suspected S2 species, level of disturbance is also rated low; **or**
___Score of 1 functional point for Flood Attenuation (riverine only) and answer to Question 15i. ii is "yes"; **or**
___Score 1 function point for Plant Community Composition; **or**
___Total actual functional points > 80% (round to nearest whole #) of total possible functional points.

Category II Wetland: (Criteria for Category I not satisfied and meets any one of the following criteria; if not satisfied, go to Category IV)
___Score of .9 functional point for Species Rated primary documented S3 by the Utah Natural Heritage Program, **or** .8 functional point for Species Rated primary suspected S3 species; level of disturbance is rated low **or**
___Score of ≥.9 functional point for General Wildlife Habitat; **or**
___Score of ≥.9 functional point for General Fish/Aquatic Habitat (riverine and lacustrine only); **or**
___Score of >.7 ≤.8 functional point for Plant Community Composition
___Total Actual Functional Points > 65% (round to nearest whole #) of total possible functional points.

Category III Wetland: (Criteria for Categories I, II or IV not satisfied)

Category IV Wetland: (Criteria for Categories I or II are not satisfied and all of the following criteria are met; if it does not satisfy criteria, place wetland in Category III)
___Total actual functional points < 30% (round to nearest whole #) of total possible functional points
___Roadside Ditch Wetland Classification

Supplemental Diagram A

15b. Plant Community Composition Diagram
Draw a simple boundary of the AA and illustrate all plant transect locations and approximate distances.
Please note that 100 sample points per acre should be collected within the AA. (Example: if AA equals .25 acres, then 25 sample points should be taken.) Never use less then 10 sample points within any AA, even when AA is less then .10 acres in size. Placement of transect(s) should accurately represent the AA. Be sure to place transect(s) through different water regimes, vegetative structure, and topographic changes that may exist within the AA.

Supplemental Diagram B

Hydrological/Biophysical Assessment Diagram
Draw a simple boundary of the AA and illustrate the hydrological conditions found within the AA. Include water source locations, directions of flow (if applicable), approximate depths, and any significant site features that influence site hydrology.

UDOT Wetland Assessment Form (Depressional)

1. Project Name:

2. Project Number:

3. USCOE Permit Number: **Project Pin Number:**

4. Evaluation Date (MM/DD/YYYY):

5. Evaluating Agency:

6. Evaluator(s):

7. Purpose of Evaluation (check one): ____Wetlands potentially affected by UDOT project
____ Mitigation wetlands, pre-construction
____ Mitigation wetlands, post-construction
____ Other (explain):

8. Wetland/Site Number(s):

9. Wetland Location(s):
Ecoregion (see map Appendix A):_____
Watershed (see map Appendix A):_____
County (see map Appendix A): _____
Legal: T_____N or S; R_____E or W; S_____;T_____N or S; R_____E or W; S_____
Approximate Stationing or Mileposts:_____
_____
GPS Reference Number:_____
Other Location information:

10. Wetland Size (total acres, measured by GPS if applicable):

11. Assessment Area (AA) (total acres, measured by GPS if applicable, see appendix):

12. Habitat for Federally Listed or Proposed Threatened or Endangered Plants or Animals or State Listed S1 Species
It is required that the evaluator contact USFWS with regards to the presence or absence of threatened or endangered (T or E) species and UDWR concerning the presence or absence of a state listed S1, S2 or S3 species. The documented habitat of a federally listed or proposed threatened or endangered plant or animal species or a state listed S1 species results in an automatic Red Flag categorization of the assessed site. Coordination with USFWS and UDWR is required. (However, the evaluation proceeds as normal so that the COE receives an assessment of function and value consistent with the UDOT assessment method.)
Is the AA documented to contain primary habitat for T or E or S-1 species? _____Yes _____No
If yes, list the species:
(This field assesses habitat for species receiving protection under provision of the Endangered Species Act and Utah critically imperiled species.)

13. Selecting a Wetland Classification
Refer to the glossary to determine the correct wetland class. Refer to Appendix E for reference photos and lists of the most common native species in each classification. Turn to appropriate colored pages to continue functional assessment as noted below.
Riverine: Blue
Slope: Pink
Depressional: Yellow
Mineral Flat: Green
Lacustrine Fringe: Purple
Roadside Ditch Wetland: If AA qualifies as a non-jurisdictional 'roadside ditch wetland', AA is classified as Category IV. Further assessment is not necessary, although all documentation must be completed.

***Toned questions or functional categories on the assessment form do not apply to this wetland class, do not answer. They are excluded from the individual function rating as well as the final overall functional assessment rating.**

Depressional

Depressional wetlands: Occur in topographic depressions with closed contours. Water sources are precipitation, runoff and groundwater. Water flow vectors are toward the center of the depression. Dominant hydrodynamics are vertical. May or may not have inlets or outlets. Depressions that are full, may release water down slope/gradient and tend to be a part of a larger slope complex. Relying on topographic maps, aerial photographs, and field evaluation will help determine which classification is dominant and or most appropriate.

14. Identify subclass

The evaluator uses the information below together with information in Appendix D to identify the AA subclass. This information is not used directly to rate the AA.

Identify water class _____

Ephemeral – surface water is present for brief periods in some years (< 3 mo/yr)
Seasonal – surface water is present for longer periods in most years (3-6 mo/yr)
Semi-permanent – surface water is common to persistent in all years (6-12 mo/yr)
Permanent – surface water is continuously present in all years

Identify the soil Organic or Mineral

Refer to glossary for definitions of organic and mineral soils.

Determine the pH range _____

Organic soils	Mineral soils
≤ 4.9	≤ 6.0
5.0 - 6.5	6.1-7.3
> 6.5	≥ 7.4 - 8.4
≥ 8.5	

Determine the salinity _____ **Presence of heavy metals or toxicants?**

Water Salinity	Yes	No
< 5 dS/m		
5-10 dS/m		
10-16 dS/m		
16-35 dS/m		
≥ 35 dS/m		

Subclass is:

_____ Ephemeral
_____ Seasonal Freshwater
_____ Semi-permanent and permanent freshwater
_____ Semi-permanent and permanent slightly to strongly saline
_____ Seasonal and semi-permanent hypersaline

Water class, soil type, pH range, salinity and presence of heavy metals are determined using accepted wetland science protocols.

Reference Appendix D for definitions of water class and salinity.

Biological Assessment

Sources of assessment criteria for each field are adopted from MDT, *Montana Wetland Assessment Method* and are listed under methods on page 5. Additional criteria sources are listed with each assessment field.

15a. Level of Disturbance

This field assesses the level of disturbance in the AA and EAA. Source: Soule (1991), Forman and Godron (1986), Fahrig (1997), Buffler (2005), and Spackman and Hughes (1995).

Use matrix below to determine level of disturbance (H = high, M = moderate, or L = low). Circle the appropriate answer.

	Predominant conditions found in EAA (600 feet from perimeter of AA)		
Conditions within AA	Land managed in predominantly natural state; is not grazed, hayed, landscaped, or otherwise converted; does not contain roads or buildings.	Land not cultivated, but moderately grazed or hayed; or has been subject to minor clearing, fill placement or hydrological alteration; contains few roads, buildings, ditches or canals.	Land cultivated or heavily grazed or landscaped; subject to substantial fill placement, grading, clearing, or hydrological alteration; high road or building density, and or numerous ditches or canals.
AA occurs and is managed in predominantly natural state; is not grazed, hayed, landscaped, or otherwise converted; does not contain human induced trails.	L	L	M
AA not cultivated, but moderately grazed or hayed; or has been subject to relatively minor clearing or hydrological alteration; contains few human induced trails, ditches or canals.	M	M	H
AA cultivated or heavily grazed or landscaped; subject to relatively substantial grading, clearing, or hydrological alteration; and numerous human induced trails, ditches or canals.	H	H	H

Comments: Note types of disturbance, intensity, season, etc.

15b. Plant Community Composition

This field assesses the plant community within the AA. Source: Keate (2004) and Padgette et al. (1989).

Refer to Appendix E for photographs, plan views, cross sectional diagrams, the range of expected coverage and wetland specific vegetation lists. Refer to Appendix F for transect protocol (step point). Draw a simple boundary of the AA and illustrate all plant transect locations and approximate distances on page 11 of this form. See glossary for definition of native wetland plants.

i. Do you find all layers of vegetation that are expected for this wetland type? Circle: Y N

ii. What is the percent ground cover (within the AA) dominated by native wetland vegetation?

High ≥ 80%, Moderate 79-60%, Low < 60%

iii. What is the percent of native wetland plants to non-native or non-wetland plants observed using the transect protocol?

High ≥ 80%, Moderate 79-60%, Low < 60%

iv. Rating for riverine and lacustrine wetlands.

Layers (i)	Y									N								
Cover (ii)	H			M			L			H			M			L		
Native Wetland Species (iii)	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L
Rating	1H	.9H	.8H	.7M	.6M	.5M	.4M	.3L	.2L	.9H	.8H	.7M	.6M	.5M	.4M	.3L	.2L	.1L

iv. Rating for depressional, mineral flat, and slope wetlands.

Cover (ii)	H			M			L		
Native Wetland Species (iii)	H	M	L	H	M	L	H	M	L
Rating	1H	.8H	.6M	.8H	.6M	.4M	.6M	.4M	.2L

Comments:

15c. Habitat for Federally Listed or Proposed Threatened or Endangered Plants or Animals
This field assesses documented or suspected use of the AA by Federally listed or proposed threatened or endangered plants or animals.
Source: Consultation with USFWS biologist.
Refer to the U.S. Fish and Wildlife Services website at www.fws.gov or visit the Utah Data Conservation Center website at http://dwrcdc.nr.utah.gov/ucdc/ . Circle one category below based on definitions contained in the instructions and after consultation with USFWS biologist.
i. AA is Documented (D) or Suspected (S) to contain:
*Documented primary habitat for T or E or State listed S-1 species has been addressed in #12

Primary habitat (list species)	*	S _____
Secondary habitat (list species)	D	S _____
Incidental habitat (list species)	D	S _____
No usable habitat	D	S _____

ii. Rating
Evaluator uses the conclusions from i above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Highest Habitat Level	Primary/S	Secondary/D	Secondary/S	Incidental/D	Incidental/S	None
Rating	.9 H	.8 H	.7 M	.5 M	.3 L	0 L

Sources for documented use (e.g. observations, records, etc):

15d. Habitat for plant or animals rated S2 or S3 by the Utah Natural Heritage Program
This field assesses documented or suspected use of the AA by S2 or S3 species listed by the Utah Natural Heritage Program (UNHP).
Source: Consultation with UDWR regional biologist.
Refer to the UNHP website or the Utah Sensitive Species List at http://dwrcdc.nr.utah.gov/ucdc/ .
Do not include species listed in 15c from above. Circle one category below based on definitions contained in the instructions and after consultation with UDWR biologist.
i. AA is Documented (D) or Suspected (S) to contain:

Primary habitat (list species and S rating)	D	S _____
Secondary habitat (list species and S rating)	D	S _____
Incidental habitat (list species and S rating)	D	S _____
No usable habitat	D	S _____

ii. Rating
Evaluator uses the conclusions from i above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low).

Highest Habitat Level	Primary/D	Primary/S	Secondary/D	Secondary/S	Incidental/D	Incidental/S	None
Rating	.9 H	.8 H	.7 M	.6 M	.2 L	.1 L	0 L

Sources for documented use (e.g. observations, records, etc.):

15e. General Wildlife Habitat

This field assesses general wildlife habitat conditions in the AA. Source: Hammer (1992), Mitch and Gosselink (1993) and Weller and Spatcher (1965).

i. Wildlife habitat features

Working from top to bottom, circle appropriate AA attributes in matrix to arrive at a rating (H = high, M = moderate, or L = low).

Disturbance Level (15a)	L			M			H		
Plant Community (15b)	H	M	L	H	M	L	H	M	L
Rating	H	H	M	H	M	L	M	L	L

Wildlife habitat features rating.	1H	.6M	.2L

ii. Modified Wildlife Habitat Rating

The wildlife habitat features rating may be modified based on documented wildlife use and levels of use of the AA. Consult with the UDWR regional wildlife biologist to determine the level of wildlife use in the AA using the procedures detailed below.

UDWR biologist consulted: Name(s)_____Date(s)_____

First circle the appropriate answer to the following question: Does the UDWR have sufficient knowledge of the AA to determine a level of general wildlife use. Yes No

If the answer is No do not modify your answer to 15e(i) above. If you answer is Yes and after further consultation with a UDWR biologist and using the level of use descriptive categories on page 14. Select the descriptive category (H, M or L) that best describes the level of wildlife use in the AA. Circe the appropriate answer. H M L

If the level of use circled is:
H – add .2 to the wildlife habitat features rating 15e(i)
M – add .1 to the wildlife habitat features rating
L – do not modify the wildlife habitat features rating

iii. Rating

Use the conclusions from i and ii above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Modified wildlife habitat features rating	1H			.6M			.2L		
Rating	1.2H	1.1H	1H	.8H	.7M	.6M	.4M	.3L	.2L

Comments:

15f. General Fish/Aquatic Habitat

This field assesses general fish and aquatic habitat in the AA. Source: Sigler and Miller (1963), Gore (1985), Williams et al (1997) and National Research Council (1992).

Assess this function if the AA is used by fish or the existing situation is "correctable" such that the AA could be used by fish [i.e., fish use is precluded by perched culvert or other barrier, etc.]. If the AA is not or was not historically used by fish due to lack of habitat, excessive gradient, etc., circle NA here and proceed to the next function. If fish use occurs in the AA but is not desired from a resource management perspective [such as fish use within an irrigation canal], then Habitat Quality [i below] should be marked as "Low", applied accordingly in ii below, and noted in the comments.)

i. Habitat Quality

Refer to the glossary for further definitions of these terms. Circle appropriate AA attributes in matrix to arrive at the quality rating (H = high, M = moderate, or L = low).

Duration of surface water in AA	Permanent / Perennial			Seasonal / Intermittent			Temporary / Ephemeral		
Cover: % of water body in AA containing cover objects such as submerged logs, large rocks & boulders, overhanging banks, floating-leaved vegetation, etc.	>25%	10–25%	<10%	>25%	10–25%	<10%	>25%	10–25%	<10 %
Shading: >75% of stream bank or shoreline within AA contains riparian or wetland scrub-shrub or forested communities	H	H	H	H	H	M	M	M	M
Shading: 50 to 75% of stream bank or shoreline within AA contains riparian or wetland scrub-shrub or forested communities	H	H	M	M	M	M	M	L	L
Shading: < 50% of stream bank or shoreline within AA contains riparian or wetland scrub-shrub or forested communities	H	M	M	M	L	L	L	L	L

ii. Modified Habitat Quality

Circle the appropriate response. If answer is Y, then reduce rating in i above by one level (H = M, M = L, L = L)

Is fish use of the AA precluded or significantly reduced by a culvert, dike, or other man-made structure or activity or is the water body included on the UDEQ list of water bodies in need of TMDL development with listed "Probable Impaired Uses" including cold or warm water fishery or aquatic life support? Y N

Modified habitat quality rating = (circle) H M L

iii. **Rating**

Refer to the Utah Division of Wildlife Resource website for fish species. Use the conclusions from i and ii above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Types of fish known or suspected within AA	Modified Habitat Quality (ii)		
	H	M	L
Native fish	1 H	.8H	.6 M
Introduced fish*	.5 M	.4 M	.3 L
No fish	.3 L	.2 L	.1 L

Note: reduce the score by .1 if the AA has carp present.

.9H	.7M	.5M	.4M	.3L	.2L	.1L	0L

15g. General Amphibian Habitat

This field assesses general amphibian habitat within the AA. Source: Consultation with UDWR regional biologist.

UDWR biologist(s) consulted: Name(s)_____ _____Date(s)_____

Circle the appropriate answer to the following question after consulting with UDWR regional biologist. The UDWR has documented the presence of amphibians in the AA or, habitat and water quality characteristics are such that they would support amphibians.

Rating: Yes No

If the answer is Yes, add **.2** under the functional points/rating column in the Functional Assessment Rating Section at the end of this form.

Hydrological/Biophysical Assessment

Draw a simple boundary of the AA on page 12 of this form and illustrate the hydrological conditions found within the AA. Include water source locations, directions of flow (if applicable), approximate depths, and any significant site features that influence site hydrology.

15h. Flood Attenuation

This field assesses the capability of the AA to slow in channel or over bank flow during high water/flood events. This applies to riverine wetlands only. Source: Kleinschmidt Associates (1993), Munson (1974) and Strom et al (2004).

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Within the AA, estimate % ground coverage with high surface roughness*	≥65%	64%-50%	49%-35%	>35%
Rating	1H	.8H	.6M	.4M

*See glossary for definition of surface roughness rating criteria.

ii. There are residences, businesses, or other features, which may be significantly damaged by floods located within 0.5 miles downstream of the AA. Yes No

Comments:

15i. Short and Long Term Surface Water Storage

This field assesses the potential of the AA to capture and hold surface water originating from inundation, precipitation, upland surface (sheet flow) or subsurface (groundwater flow). Source: Munson (1974), Strom et al (2004), Hammer (1986) and Mitch and Gosselink (1993).

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Duration of surface water is implied in the definition of wetland class or of the subclass and thus reflects the natural function. Circle the appropriate answer.

Wetlands are inundated	≥ 5 out of 10 years		< 5 out of 10 years	
Has the wetland's natural ability to store water been disturbed negatively?	N	Y	N	Y
Rating	1H	.8H	.6M	.4M

In order to properly assess this function, examination of the area down gradient from the AA may aid in determining whether or not dams, water control structures, overflow aprons, ditches, canals, drain tiles or other forms of outlet or modification exist.

Comments:

15j. Sediment/Nutrient/Toxicant Retention and Removal

This field assesses the ability of the AA to retain and capture sediments, nutrients and toxicants. Source: Kleinschmidt Associates (1999), Hammer (1986) and Hammer and Kadlec (1983).

This function applies to wetlands which could receive excess sediments, nutrients or toxicants through influx of surface or groundwater or direct input. If no wetlands in the AA are subject to such input, circle NA here and proceed with evaluation.

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Sediment, nutrient, and toxicant input levels within AA	AA receives or surrounding land use with potential to deliver low to moderate levels of sediments, nutrients, or compounds such that other functions are not substantially impaired. **Minor** sedimentation, sources of nutrients or toxicants, or signs of eutrophication present.				AA is in close proximity to or receives input from or is on UDEQ list of water bodies in need of TMDL development for "probable causes" related to sediment, nutrients, or toxicants **or** AA receives or surrounding land use with potential to deliver high levels of sediments, nutrients, or compounds such that other functions are substantially impaired. **Major** sedimentation, sources of nutrients or toxicants, or signs of eutrophication present.			
Within the AA, estimate % ground coverage with high to moderate surface roughness*	≥ 50%		<50%		≥ 50%		<50%	
Has the wetland's natural ability to store water been disturbed negatively?	N	Y	N	Y	N	Y	N	Y
Rating	1H	.9H	.8H	.7M	.6M	.5M	.4M	.3L

*See glossary for definition of surface roughness.

Comments:

15k. Sediment/Shoreline Stabilization

This field assesses the ability of the AA to dissipate flow or wave energy in order to reduce erosion. This applies to riverine and lacustrine wetlands only. Source: Kleinschmidt Associates (1999), Keate (2004), Padgette et al (1989) and Mitch and Gosselink (1993).

Applies only if AA occurs on or within the banks or a river, stream, or other natural (vegetated swale) or man-made drainage, or on the shoreline of a standing water body, which is subject to wave action. It does not apply, circle NA here and proceed to next function)

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function.

Within the AA, estimate % ground coverage with high surface roughness*	Duration of surface water adjacent to rooted vegetation	
	Permanent	Seasonal
≥ 65%	1H	.7M
64% - 50%	.8H	.5M
49% - 35%	.6M	.3L
< 35%	.4M	.1L

Comments:

Social Value Assessment

The following are not functions but values, which are important to society. Plus answers would suggest important societal assets, which should guide any future mitigation planning.

16. Visual Quality*

Refer to the glossary to distinguish between "wildland wetland" and "urban/exurban wetland".

If AA is considered "wildland wetland" answer the following three questions based on information gathered from suggested sources. Each 'yes' answer receives a plus (+) rating in the space provided.

i. Is the wetland in public ownership (city, county, state or federal)? _____
ii. Has wetland experienced moderate to low level of disturbance (refer to glossary)? _____
iii. Is there an absence of human structures or other human induced disturbances (refer to glossary)? _____

If AA is considered to be an "urban/exurban wetland", answer the following six questions based on information gathered from suggested sources. Each 'yes' answer receives a plus (+) rating in the space provided.

i. Is the wetland in public ownership (city, county, state or federal)? _____
ii. Is there potentially a large number of viewers? _____
iii. Is the viewing distance in the fore or middle grounds for most viewers (refer to glossary)? _____
iv. Has the wetland experienced a moderate to low level of disturbance (refer to glossary)? _____
v. Is there an absence of human structures or other human induced disturbances (refer to glossary)? _____
vi. Is the wetland a part of a larger open space, green space, park, buffer or corridor? _____

17. Recreational/Educational Quality*

Answer the following seven questions for both "wildland wetlands" and "urban/exurban wetlands". Each 'yes' answer receives a plus (+) rating in the space provided.

i. Is the wetland in public ownership (city, county, state or federal)? _____
ii. Is the wetland presently used for recreation/education? _____
iii. Is the wetland ¼ mile or less from and elementary school? _____
iv. Is the wetland five miles or less from a high school? _____
v. Is there vehicular, trail, boat or canoe access to the site? _____
vi. Has the wetland experienced a moderate to low level of disturbance (refer to glossary)? _____
vii. Is the wetland visible from a county, state or federal highway, heavily used recreation trail, residential development or other situations where large numbers of people would have visual access to the wetland? _____

*Note: In some cases wetlands many contain plant or wildlife species or perform functions that would be diminished by human activity. In these cases recreational and educational activities would be prohibited.

Summary Comments for entire Wetland AA Evaluated

Functional Assessment Rating

Function Variables	General Evaluation	Actual Functional Points/Rating	Possible Functional Points	Functional Units: (Actual Points x Estimated AA Acreage)
15b. Plant Community Composition			1	
15c. Listed/Proposed T&E Species Habitat			.9	
15d. UT Natural Heritage Program Species Habitat			.9	
15e. General Wildlife Habitat			1	
15f. General Fish/Aquatic Habitat			1	
15g. General Amphibian Habitat			0	
15h. Flood Attenuation			1	
15i. Short and Long Term Surface Water Storage			1	
15j. Sediment/Nutrient/Toxicant Removal			1	
15k. Sediment/Shoreline Stabilization			1	
Totals:				

If functional variables other than those toned are not applicable (NA) to the AA of concern, enter NA in the possible functional points box and subtract the possible functional points for that variable when calculating percent of total functional points.
Note: % total functional points = actual functional points ÷ possible functional points.

	% total functional points

Overall Assessment Area Category

Circle appropriate category based on the criteria outlined below. **I II III IV**

Red Flag Category
___ Documented habitat for a federally listed or proposed threatened or endangered plant or animal species was found. (Yes response to question 12)
___ Documented habitat for a species rated S1 by the Utah Natural Heritage Program. (Yes response to question 12)
Wetlands in this category are a special case and require consultation with the COE, USFWS, and UDWR throughout the entire application process.

Category I Wetland: (Must satisfy one of the following criteria; if it does not meet criteria, go to Category II)
___ Score of .9 functional point for Species Rated primary documented S2 by the Utah Natural Heritage Program **or** .8 for primary suspected S2 species, level of disturbance is also rated low; **or**
___Score of 1 functional point for Flood Attenuation (riverine only) and answer to Question 15i. ii is "yes"; **or**
___Score 1 function point for Plant Community Composition; **or**
___Total actual functional points > 80% (round to nearest whole #) of total possible functional points.

Category II Wetland: (Criteria for Category I not satisfied and meets any one of the following criteria; if not satisfied, go to Category IV)
___Score of .9 functional point for Species Rated primary documented S3 by the Utah Natural Heritage Program, **or** .8 functional point for Species Rated primary suspected S3 species; level of disturbance is rated low **or**
___Score of ≥.9 functional point for General Wildlife Habitat; **or**
___Score of ≥.9 functional point for General Fish/Aquatic Habitat (riverine and lacustrine only); **or**
___Score of >.7 ≤.8 functional point for Plant Community Composition
___Total Actual Functional Points > 65% (round to nearest whole #) of total possible functional points.

Category III Wetland: (Criteria for Categories I, II or IV not satisfied)

Category IV Wetland: (Criteria for Categories I or II are not satisfied and all of the following criteria are met; if it does not satisfy criteria, place wetland in Category III)
___Total actual functional points < 30% (round to nearest whole #) of total possible functional points
___Roadside Ditch Wetland Classification

Supplemental Diagram A

15b. Plant Community Composition Diagram

Draw a simple boundary of the AA and illustrate all plant transect locations and approximate distances.
Please note that 100 sample points per acre should be collected within the AA. (Example: if AA equals .25 acres, then 25 sample points should be taken.) Never use less then 10 sample points within any AA, even when AA is less then .10 acres in size. Placement of transect(s) should accurately represent the AA. Be sure to place transect(s) through different water regimes, vegetative structure, and topographic changes that may exist within the AA.

Supplemental Diagram B

Hydrological/Biophysical Assessment Diagram

Draw a simple boundary of the AA and illustrate the hydrological conditions found within the AA. Include water source locations, directions of flow (if applicable), approximate depths, and any significant site features that influence site hydrology.

UDOT Wetland Assessment Form (Mineral Flat)

1. Project Name:

2. Project Number:

3. USCOE Permit Number: **Project Pin Number:**

4. Evaluation Date (MM/DD/YYYY):

5. Evaluating Agency:

6. Evaluator(s):

7. Purpose of Evaluation (check one): ____Wetlands potentially affected by UDOT project
____ Mitigation wetlands, pre-construction
____ Mitigation wetlands, post-construction
____ Other (explain):

8. Wetland/Site Number(s):

9. Wetland Location(s):
Ecoregion (see map Appendix A):_____
Watershed (see map Appendix A):_____
County (see map Appendix A): _____
Legal: T_____N or S; R_____E or W; S_____;T_____N or S; R_____E or W; S_____
Approximate Stationing or Mileposts:_____
_____
GPS Reference Number:_____
Other Location information:

10. Wetland Size (total acres, measured by GPS if applicable):

11. Assessment Area (AA) (total acres, measured by GPS if applicable, see appendix):

12. Habitat for Federally Listed or Proposed Threatened or Endangered Plants or Animals or State Listed S1 Species
It is required that the evaluator contact USFWS with regards to the presence or absence of threatened or endangered (T or E) species and UDWR concerning the presence or absence of a state listed S1, S2 or S3 species. The documented habitat of a federally listed or proposed threatened or endangered plant or animal species or a state listed S1 species results in an automatic Red Flag categorization of the assessed site. Coordination with USFWS and UDWR is required. (However, the evaluation proceeds as normal so that the COE receives an assessment of function and value consistent with the UDOT assessment method.)
Is the AA documented to contain primary habitat for T or E or S-1 species? _____Yes _____No
If yes, list the species:
(This field assesses habitat for species receiving protection under provision of the Endangered Species Act and Utah critically imperiled species.)

13. Selecting a Wetland Classification
Refer to the glossary to determine the correct wetland class. Refer to Appendix E for reference photos and lists of the most common native species in each classification. Turn to appropriate colored pages to continue functional assessment as noted below.
Riverine: Blue
Slope: Pink
Depressional: Yellow
Mineral Flat: Green
Lacustrine Fringe: Purple
Roadside Ditch Wetland: If AA qualifies as a non-jurisdictional 'roadside ditch wetland', AA is classified as Category IV. Further assessment is not necessary, although all documentation must be completed.

***Toned questions or functional categories on the assessment form do not apply to this wetland class, do not answer. They are excluded from the individual function rating as well as the final overall functional assessment rating.**

Mineral Flat

Mineral flat wetlands: Occur on large relict lakebeds. Dominant water source is precipitation. Dominant hydrodynamics are vertical. Typically are large features in the landscape, associated with old Lake Bonneville bottom deposits with close proximity to GSL or other large permanent, semi-permanent or ephemeral water bodies. (e.g. – Sevier Lake) Only found in basin and range ecoregions. Example: Great Salt Lake mud flats and salt flats. Subclasses are not known.

14. Subclasses not known

Biological Assessment

Sources of assessment criteria for each field are adopted from MDT, *Montana Wetland Assessment Method* and are listed under methods on page 5. Additional criteria sources are listed with each assessment field.

15a. Level of Disturbance

This field assesses the level of disturbance in the AA and EAA. Source: Soule (1991), Forman and Godron (1986), Fahrig (1997), Buffler (2005), and Spackman and Hughes (1995).

Use matrix below to determine level of disturbance (H = high, M = moderate, or L = low). Circle the appropriate answer.

	Predominant conditions found in EAA (600 feet from perimeter of AA)		
Conditions within AA	Land managed in predominantly natural state; is not grazed, hayed, landscaped, or otherwise converted; does not contain roads or buildings.	Land not cultivated, but moderately grazed or hayed; or has been subject to minor clearing, fill placement or hydrological alteration; contains few roads, buildings, ditches or canals.	Land cultivated or heavily grazed or landscaped; subject to substantial fill placement, grading, clearing, or hydrological alteration; high road or building density, and or numerous ditches or canals.
AA occurs and is managed in predominantly natural state; is not grazed, hayed, landscaped, or otherwise converted; does not contain human induced trails.	L	L	M
AA not cultivated, but moderately grazed or hayed; or has been subject to relatively minor clearing or hydrological alteration; contains few human induced trails, ditches or canals.	M	M	H
AA cultivated or heavily grazed or landscaped; subject to relatively substantial grading, clearing, or hydrological alteration; and numerous human induced trails, ditches or canals.	H	H	H

Comments: Note types of disturbance, intensity, season, etc.

15b. Plant Community Composition

This field assesses the plant community within the AA. Source: Keate (2004) and Padgette et al. (1989).

Refer to Appendix E for photographs, plan views, cross sectional diagrams, the range of expected coverage and wetland specific vegetation lists. Refer to Appendix F for transect protocol (step point). Draw a simple boundary of the AA and illustrate all plant transect locations and approximate distances on page 11 of this form. See glossary for definition of native wetland plants.

i. Do you find all layers of vegetation that are expected for this wetland type? Circle: Y N

ii. What is the percent ground cover (within the AA) dominated by native wetland vegetation?

High ≥ 80%, Moderate 79-60%, Low < 60%

iii. What is the percent of native wetland plants to non-native or non-wetland plants observed using the transect protocol?

High ≥ 80%, Moderate 79-60%, Low < 60%

iv. Rating for riverine and lacustrine wetlands.

Layers (i)	Y									N								
Cover (ii)	H			M			L			H			M			L		
Native Wetland Species (iii)	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L
Rating	1H	.9H	.8H	.7M	.6M	.5M	.4M	.3L	.2L	.9H	.8H	.7M	.6M	.5M	.4M	.3L	.2L	.1L

iv. Rating for depressional, mineral flat, and slope wetlands.

Cover (ii)	H			M			L		
Native Wetland Species (iii)	H	M	L	H	M	L	H	M	L
Rating	1H	.8H	.6M	.8H	.6M	.4M	.6M	.4M	.2L

Comments:

15c. Habitat for Federally Listed or Proposed Threatened or Endangered Plants or Animals

This field assesses documented or suspected use of the AA by Federally listed or proposed threatened or endangered plants or animals.
Source: Consultation with USFWS biologist.
Refer to the U.S. Fish and Wildlife Services website at www.fws.gov or visit the Utah Data Conservation Center website at http://dwrcdc.nr.utah.gov/ucdc/ . Circle one category below based on definitions contained in the instructions and after consultation with USFWS biologist.

i. AA is Documented (D) or Suspected (S) to contain:
*Documented primary habitat for T or E or State listed S-1 species has been addressed in #12

Primary (list species)	*	S _____
Secondary habitat (list species)	D	S _____
Incidental habitat (list species)	D	S _____
No usable habitat	D	S _____

ii. Rating
Evaluator uses the conclusions from i above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Highest Habitat Level	Primary/S	Secondary/D	Secondary/S	Incidental/D	Incidental/S	None
Rating	.9 H	.8 H	.7 M	.5 M	.3 L	0 L

Sources for documented use (e.g. observations, records, etc):

15d. Habitat for plant or animals rated S2 or S3 by the Utah Natural Heritage Program

This field assesses documented or suspected use of the AA by S2 or S3 species listed by the Utah Natural Heritage Program (UNHP).
Source: Consultation with UDWR regional biologist.
Refer to the UNHP website or the Utah Sensitive Species List at http://dwrcdc.nr.utah.gov/ucdc/ .
Do not include species listed in 15c from above. Circle one category below based on definitions contained in the instructions and after consultation with UDWR biologist.

i. AA is Documented (D) or Suspected (S) to contain:

Primary (list species and S rating)	D	S _____
Secondary habitat (list species and S rating)	D	S _____
Incidental habitat (list species and S rating)	D	S _____
No usable habitat	D	S _____

ii. Rating
Evaluator uses the conclusions from i above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low).

Highest Habitat Level	Primary/D	Primary/S	Secondary/D	Secondary/S	Incidental/D	Incidental/S	None
Rating	.9 H	.8 H	.7 M	.6 M	.2 L	.1 L	0 L

Sources for documented use (e.g. observations, records, etc.):

15e. General Wildlife Habitat

This field assesses general wildlife habitat conditions in the AA. Source: Hammer (1992), Mitch and Gosselink (1993) and Weller and Spatcher (1965).

i. Wildlife habitat features

Working from top to bottom, circle appropriate AA attributes in matrix to arrive at a rating (H = high, M = moderate, or L = low).

Disturbance Level (15a)	L			M			H		
Plant Community (15b)	H	M	L	H	M	L	H	M	L
Rating	H	H	M	H	M	L	M	L	L

Wildlife habitat features rating.	1H	.6M	.2L

ii. Modified Wildlife Habitat Rating

The wildlife habitat features rating may be modified based on documented wildlife use and levels of use of the AA. Consult with the UDWR regional wildlife biologist to determine the level of wildlife use in the AA using the procedures detailed below.

UDWR biologist consulted: Name(s)_____Date(s)_____

First circle the appropriate answer to the following question: Does the UDWR have sufficient knowledge of the AA to determine a level of general wildlife use. Yes No

If the answer is No do not modify your answer to 15e(i) above. If you answer is Yes and after further consultation with a UDWR biologist and using the level of use descriptive categories on page 14. Select the descriptive category (H, M or L) that best describes the level of wildlife use in the AA. Circe the appropriate answer. H M L

If the level of use circled is:

H – add .2 to the wildlife habitat features rating 15e(i)

M – add .1 to the wildlife habitat features rating

L – do not modify the wildlife habitat features rating

iii. Rating

Use the conclusions from i and ii above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Modified wildlife habitat features rating	1H			.6M			.2L		
Rating	1.2H	1.1H	1H	.8H	.7M	.6M	.4M	.3L	.2L

Comments:

15f. General Fish/Aquatic Habitat

This field assesses general fish and aquatic habitat in the AA. Source: Sigler and Miller (1963), Gore (1985), Williams et al (1997) and National Research Council (1992).

Assess this function if the AA is used by fish or the existing situation is "correctable" such that the AA could be used by fish [i.e., fish use is precluded by perched culvert or other barrier, etc.]. If the AA is not or was not historically used by fish due to lack of habitat, excessive gradient, etc., circle NA here and proceed to the next function. If fish use occurs in the AA but is not desired from a resource management perspective [such as fish use within an irrigation canal], then Habitat Quality [i below] should be marked as "Low", applied accordingly in ii below, and noted in the comments.)

i. Habitat Quality

Refer to the glossary for further definitions of these terms. Circle appropriate AA attributes in matrix to arrive at the quality rating (H = high, M = moderate, or L = low).

Duration of surface water in AA	Permanent / Perennial			Seasonal / Intermittent			Temporary / Ephemeral		
Cover: % of water body in AA containing cover objects such as submerged logs, large rocks & boulders, overhanging banks, floating-leaved vegetation, etc.	>25%	10–25%	<10%	>25%	10–25%	<10%	>25%	10–25%	<10 %
Shading: >75% of stream bank or shoreline within AA contains riparian or wetland scrub-shrub or forested communities	H	H	H	H	H	M	M	M	M
Shading: 50 to 75% of stream bank or shoreline within AA contains riparian or wetland scrub-shrub or forested communities	H	H	M	M	M	M	M	L	L
Shading: < 50% of stream bank or shoreline within AA contains riparian or wetland scrub-shrub or forested communities	H	M	M	M	L	L	L	L	L

ii. Modified Habitat Quality

Circle the appropriate response. If answer is Y, then reduce rating in i above by one level (H = M, M = L, L = L)

Is fish use of the AA precluded or significantly reduced by a culvert, dike, or other man-made structure or activity or is the water body included on the UDEQ list of water bodies in need of TMDL development with listed "Probable Impaired Uses" including cold or warm water fishery or aquatic life support? Y N

Modified habitat quality rating = (circle) H M L

iii. **Rating**

Refer to the Utah Division of Wildlife Resource website for fish species. Use the conclusions from i and ii above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Types of fish known or suspected within AA	Modified Habitat Quality (ii)		
	H	M	L
Native fish	1 H	.8H	.6 M
Introduced fish*	.5 M	.4 M	.3 L
No fish	.3 L	.2 L	.1 L

Note: reduce the score by .1 if the AA has carp present.

.9H	.7M	.5M	.4M	.3L	.2L	.1L	0L

15g. General Amphibian Habitat

This field assesses general amphibian habitat within the AA. Source: Consultation with UDWR regional biologist.

UDWR biologist(s) consulted: Name(s)_____ _____Date(s)_____

Circle the appropriate answer to the following question after consulting with UDWR regional biologist. The UDWR has documented the presence of amphibians in the AA or, habitat and water quality characteristics are such that they would support amphibians.

Rating: Yes No

If the answer is Yes, add **.2** under the functional points/rating column in the Functional Assessment Rating Section at the end of this form.

Hydrological/Biophysical Assessment

Draw a simple boundary of the AA on page 12 of this form and illustrate the hydrological conditions found within the AA. Include water source locations, directions of flow (if applicable), approximate depths, and any significant site features that influence site hydrology.

15h. Flood Attenuation

This field assesses the capability of the AA to slow in channel or over bank flow during high water/flood events. This applies to riverine wetlands only. Source: Kleinschmidt Associates (1993), Munson (1974) and Strom et al (2004).

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Within the AA, estimate % ground coverage with high surface roughness*	≥65%	64%-50%	49%-35%	>35%
Rating	1H	.8H	.6M	.4M

*See glossary for definition of surface roughness rating criteria.

ii. There are residences, businesses, or other features, which may be significantly damaged by floods located within 0.5 miles downstream of the AA. Yes No

Comments:

15i. Short and Long Term Surface Water Storage

This field assesses the potential of the AA to capture and hold surface water originating from inundation, precipitation, upland surface (sheet flow) or subsurface (groundwater flow). Source: Munson (1974), Strom et al (2004), Hammer (1986) and Mitch and Gosselink (1993).

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Duration of surface water is implied in the definition of wetland class or of the subclass and thus reflects the natural function. Circle the appropriate answer.

Wetlands are inundated	≥ 5 out of 10 years		< 5 out of 10 years	
Has the wetland's natural ability to store water been disturbed negatively?	N	Y	N	Y
Rating	1H	.8H	.6M	.4M

In order to properly assess this function, examination of the area down gradient from the AA may aid in determining whether or not dams, water control structures, overflow aprons, ditches, canals, drain tiles or other forms of outlet or modification exist.

Comments:

15j. Sediment/Nutrient/Toxicant Retention and Removal

This field assesses the ability of the AA to retain and capture sediments, nutrients and toxicants. Source: Kleinschmidt Associates (1999), Hammer (1986) and Hammer and Kadlec (1983).

This function applies to wetlands which could receive excess sediments, nutrients or toxicants through influx of surface or groundwater or direct input. If no wetlands in the AA are subject to such input, circle NA here and proceed with evaluation.

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Sediment, nutrient, and toxicant input levels within AA	AA receives or surrounding land use with potential to deliver low to moderate levels of sediments, nutrients, or compounds such that other functions are not substantially impaired. **Minor** sedimentation, sources of nutrients or toxicants, or signs of eutrophication present.				AA is in close proximity to or receives input from or is on UDEQ list of water bodies in need of TMDL development for "probable causes" related to sediment, nutrients, or toxicants **or** AA receives or surrounding land use with potential to deliver high levels of sediments, nutrients, or compounds such that other functions are substantially impaired. **Major** sedimentation, sources of nutrients or toxicants, or signs of eutrophication present.			
Within the AA, estimate % ground coverage with high to moderate surface roughness*	≥ 50%		<50%		≥ 50%		<50%	
Has the wetland's natural ability to store water been disturbed negatively?	N	Y	N	Y	N	Y	N	Y
Rating	1H	.9H	.8H	.7M	.6M	.5M	.4M	.3L

*See glossary for definition of surface roughness.

Comments:

15k. Sediment/Shoreline Stabilization

This field assesses the ability of the AA to dissipate flow or wave energy in order to reduce erosion. This applies to riverine and lacustrine wetlands only. Source: Kleinschmidt Associates (1999), Keate (2004), Padgette et al (1989) and Mitch and Gosselink (1993).

Applies only if AA occurs on or within the banks or a river, stream, or other natural (vegetated swale) or man-made drainage, or on the shoreline of a standing water body, which is subject to wave action. It does not apply, circle NA here and proceed to next function)

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function.

Within the AA, estimate % ground coverage with high surface roughness*	Duration of surface water adjacent to rooted vegetation	
	Permanent	Seasonal
≥ 65%	1H	.7M
64% - 50%	.8H	.5M
49% - 35%	.6M	.3L
< 35%	.4M	.1L

Comments:

Social Value Assessment

The following are not functions but values, which are important to society. Plus answers would suggest important societal assets, which should guide any future mitigation planning.

16. Visual Quality*

Refer to the glossary to distinguish between "wildland wetland" and "urban/exurban wetland".

If AA is considered "wildland wetland" answer the following three questions based on information gathered from suggested sources. Each 'yes' answer receives a plus (+) rating in the space provided.

i. Is the wetland in public ownership (city, county, state or federal)? _____
ii. Has wetland experienced moderate to low level of disturbance (refer to glossary)? _____
iii. Is there an absence of human structures or other human induced disturbances (refer to glossary)? _____

If AA is considered to be an "urban/exurban wetland", answer the following six questions based on information gathered from suggested sources. Each 'yes' answer receives a plus (+) rating in the space provided.

i. Is the wetland in public ownership (city, county, state or federal)? _____
ii. Is there potentially a large number of viewers? _____
iii. Is the viewing distance in the fore or middle grounds for most viewers (refer to glossary)? _____
iv. Has the wetland experienced a moderate to low level of disturbance (refer to glossary)? _____
v. Is there an absence of human structures or other human induced disturbances (refer to glossary)? _____
vi. Is the wetland a part of a larger open space, green space, park, buffer or corridor? _____

17. Recreational/Educational Quality*

Answer the following seven questions for both "wildland wetlands" and "urban/exurban wetlands". Each 'yes' answer receives a plus (+) rating in the space provided.

i. Is the wetland in public ownership (city, county, state or federal)? _____
ii. Is the wetland presently used for recreation/education? _____
iii. Is the wetland ¼ mile or less from and elementary school? _____
iv. Is the wetland five miles or less from a high school? _____
v. Is there vehicular, trail, boat or canoe access to the site? _____
vi. Has the wetland experienced a moderate to low level of disturbance (refer to glossary)? _____
vii. Is the wetland visible from a county, state or federal highway, heavily used recreation trail, residential development or other situations where large numbers of people would have visual access to the wetland? _____

*Note: In some cases wetlands many contain plant or wildlife species or perform functions that would be diminished by human activity. In these cases recreational and educational activities would be prohibited.

Summary Comments for entire Wetland AA Evaluated

Functional Assessment Rating

Function Variables	General Evaluation	Actual Functional Points/Rating	Possible Functional Points	Functional Units: (Actual Points x Estimated AA Acreage)
15b. Plant Community Composition			1	
15v. Listed/Proposed T&E Species Habitat			.9	
15d. UT Natural Heritage Program Species Habitat			.9	
15e. General Wildlife Habitat			1	
15f. General Fish/Aquatic Habitat			1	
15g. General Amphibian Habitat			0	
15h. Flood Attenuation			1	
15i. Short and Long Term Surface Water Storage			1	
15j. Sediment/Nutrient/Toxicant Removal			1	
15k. Sediment/Shoreline Stabilization			1	
Totals:				

If functional variables other than those toned are not applicable (NA) to the AA of concern, enter NA in the possible functional points box and subtract the possible functional points for that variable when calculating percent of total functional points.

Note: % total functional points = actual functional points ÷ possible functional points.

	% total functional points

Overall Assessment Area Category

Circle appropriate category based on the criteria outlined below. **I II III IV**

Red Flag Category
___ Documented habitat for a federally listed or proposed threatened or endangered plant or animal species was found. (Yes response to question 12)
___ Documented habitat for a species rated S1 by the Utah Natural Heritage Program. (Yes response to question 12)
Wetlands in this category are a special case and require consultation with the COE, USFWS, and UDWR throughout the entire application process.

Category I Wetland: (Must satisfy one of the following criteria; if it does not meet criteria, go to Category II)
___ Score of .9 functional point for Species Rated primary documented S2 by the Utah Natural Heritage Program **or** .8 for primary suspected S2 species, level of disturbance is also rated low; **or**
___Score of 1 functional point for Flood Attenuation (riverine only) and answer to Question 15i. ii is "yes"; **or**
___Score 1 function point for Plant Community Composition; **or**
___Total actual functional points > 80% (round to nearest whole #) of total possible functional points.

Category II Wetland: (Criteria for Category I not satisfied and meets any one of the following criteria; if not satisfied, go to Category IV)
___Score of .9 functional point for Species Rated primary documented S3 by the Utah Natural Heritage Program, **or** .8 functional point for Species Rated primary suspected S3 species; level of disturbance is rated low **or**
___Score of ≥.9 functional point for General Wildlife Habitat; **or**
___Score of ≥.9 functional point for General Fish/Aquatic Habitat (riverine and lacustrine only); **or**
___Score of >.7 ≤.8 functional point for Plant Community Composition
___Total Actual Functional Points > 65% (round to nearest whole #) of total possible functional points.

Category III Wetland: (Criteria for Categories I, II or IV not satisfied)

Category IV Wetland: (Criteria for Categories I or II are not satisfied and all of the following criteria are met; if it does not satisfy criteria, place wetland in Category III)
___Total actual functional points < 30% (round to nearest whole #) of total possible functional points
___Roadside Ditch Wetland Classification

Supplemental Diagram A

15b. Plant Community Composition Diagram
Draw a simple boundary of the AA and illustrate all plant transect locations and approximate distances.
Please note that 100 sample points per acre should be collected within the AA. (Example: if AA equals .25 acres, then 25 sample points should be taken.) Never use less then 10 sample points within any AA, even when AA is less then .10 acres in size. Placement of transect(s) should accurately represent the AA. Be sure to place transect(s) through different water regimes, vegetative structure, and topographic changes that may exist within the AA.

Supplemental Diagram B

Hydrological/Biophysical Assessment Diagram
Draw a simple boundary of the AA and illustrate the hydrological conditions found within the AA. Include water source locations, directions of flow (if applicable), approximate depths, and any significant site features that influence site hydrology.

UDOT Wetland Assessment Form (Lacustrine Fringe)

1. Project Name:

2. Project Number:

3. USCOE Permit Number: **Project Pin Number:**

4. Evaluation Date (MM/DD/YYYY):

5. Evaluating Agency:

6. Evaluator(s):

7. Purpose of Evaluation (check one): ____Wetlands potentially affected by UDOT project
____ Mitigation wetlands, pre-construction
____ Mitigation wetlands, post-construction
____ Other (explain):

8. Wetland/Site Number(s):

9. Wetland Location(s):
Ecoregion (see map Appendix A):_____
Watershed (see map Appendix A):_____
County (see map Appendix A): _____
Legal: T_____N or S; R_____E or W; S_____;T_____N or S; R_____E or W; S_____
Approximate Stationing or Mileposts:_____
_____
GPS Reference Number:_____
Other Location information:

10. Wetland Size (total acres, measured by GPS if applicable):

11. Assessment Area (AA) (total acres, measured by GPS if applicable, see appendix):

12. Habitat for Federally Listed or Proposed Threatened or Endangered Plants or Animals or State Listed S1 Species
It is required that the evaluator contact USFWS with regards to the presence or absence of threatened or endangered (T or E) species and UDWR concerning the presence or absence of a state listed S1, S2 or S3 species. The documented habitat of a federally listed or proposed threatened or endangered plant or animal species or a state listed S1 species results in an automatic Red Flag categorization of the assessed site. Coordination with USFWS and UDWR is required. (However, the evaluation proceeds as normal so that the COE receives an assessment of function and value consistent with the UDOT assessment method.)
Is the AA documented to contain primary habitat for T or E or S-1 species? _____Yes _____No
If yes, list the species:
(This field assesses habitat for species receiving protection under provision of the Endangered Species Act and Utah critically imperiled species.)

13. Selecting a Wetland Classification
Refer to the glossary to determine the correct wetland class. Refer to Appendix E for reference photos and lists of the most common native species in each classification. Turn to appropriate colored pages to continue functional assessment as noted below.
Riverine: Blue
Slope: Pink
Depressional: Yellow
Mineral Flat: Green
Lacustrine Fringe: Purple
Roadside Ditch Wetland: If AA qualifies as a non-jurisdictional 'roadside ditch wetland', AA is classified as Category IV. Further assessment is not necessary, although all documentation must be completed.

***Toned questions or functional categories on the assessment form do not apply to this wetland class, do not answer. They are excluded from the individual function rating as well as the final overall functional assessment rating.**

Lacustrine Fringe

Lacustrine Finge wetlands: Adjacent to large lakes and reservoirs whose area is greater than 20 acres / dominant water source is lake water level / hydrodynamics are bidirectional / subject to waves and seiches.

14. Identify subclass
The evaluator uses the information below together with information in Appendix D to identify the AA subclass. This information is not used directly to rate the AA.

Saline lacustrine fringe – Great Salt Lake fringe is the current lake level plus 2 feet.
Fresh lacustrine fringe – fringes of lakes and reservoirs

Subclass is:	**Presence of heavy metals or toxicants?**	
_____ Saline lacustrine fringe	Yes	No
_____ Freshwater lacustrine fringe		

Presence of heavy metals is determined using accepted wetland science protocols.

Reference Appendix D for definitions of water class and salinity.

Biological Assessment

Sources of assessment criteria for each field are adopted from MDT, *Montana Wetland Assessment Method* and are listed under methods on page 5. Additional criteria sources are listed with each assessment field.

15a. Level of Disturbance

This field assesses the level of disturbance in the AA and EAA. Source: Soule (1991), Forman and Godron (1986), Fahrig (1997), Buffler (2005), and Spackman and Hughes (1995).

Use matrix below to determine level of disturbance (H = high, M = moderate, or L = low). Circle the appropriate answer.

	Predominant conditions found in EAA (600 feet from perimeter of AA)		
Conditions within AA	Land managed in predominantly natural state; is not grazed, hayed, landscaped, or otherwise converted; does not contain roads or buildings.	Land not cultivated, but moderately grazed or hayed; or has been subject to minor clearing, fill placement or hydrological alteration; contains few roads, buildings, ditches or canals.	Land cultivated or heavily grazed or landscaped; subject to substantial fill placement, grading, clearing, or hydrological alteration; high road or building density, and or numerous ditches or canals.
AA occurs and is managed in predominantly natural state; is not grazed, hayed, landscaped, or otherwise converted; does not contain human induced trails.	L	L	M
AA not cultivated, but moderately grazed or hayed; or has been subject to relatively minor clearing or hydrological alteration; contains few human induced trails, ditches or canals.	M	M	H
AA cultivated or heavily grazed or landscaped; subject to relatively substantial grading, clearing, or hydrological alteration; and numerous human induced trails, ditches or canals.	H	H	H

Comments: Note types of disturbance, intensity, season, etc.

15b. Plant Community Composition

This field assesses the plant community within the AA. Source: Keate (2004) and Padgette et al. (1989).

Refer to Appendix E for photographs, plan views, cross sectional diagrams, the range of expected coverage and wetland specific vegetation lists. Refer to Appendix F for transect protocol (step point). Draw a simple boundary of the AA and illustrate all plant transect locations and approximate distances on page 11 of this form. See glossary for definition of native wetland plants.

i. Do you find all layers of vegetation that are expected for this wetland type? Circle: Y N

ii. What is the percent ground cover (within the AA) dominated by native wetland vegetation?

High ≥ 80%, Moderate 79-60%, Low < 60%

iii. What is the percent of native wetland plants to non-native or non-wetland plants observed using the transect protocol?

High ≥ 80%, Moderate 79-60%, Low < 60%

iv. Rating for riverine and lacustrine wetlands.

Layers (i)	Y									N								
Cover (ii)	H			M			L			H			M			L		
Native Wetland Species (iii)	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L
Rating	1H	.9H	.8H	.7M	.6M	.5M	.4M	.3L	.2L	.9H	.8H	.7M	.6M	.5M	.4M	.3L	.2L	.1L

iv. Rating for depressional, mineral flat, and slope wetlands.

Cover (ii)	H			M			L		
Native Wetland Species (iii)	H	M	L	H	M	L	H	M	L
Rating	1H	.8H	.6M	.8H	.6M	.4M	.6M	.4M	2L

Comments:

15c. Habitat for Federally Listed or Proposed Threatened or Endangered Plants or Animals

This field assesses documented or suspected use of the AA by Federally listed or proposed threatened or endangered plants or animals.
Source: Consultation with USFWS biologist.
Refer to the U.S. Fish and Wildlife Services website at www.fws.gov or visit the Utah Data Conservation Center website at http://dwrcdc.nr.utah.gov/ucdc/ . Circle one category below based on definitions contained in the instructions and after consultation with USFWS biologist.

i. AA is Documented (D) or Suspected (S) to contain:

*Documented primary habitat for T or E or State listed S-1 species has been addressed in #12

Primary habitat (list species)	*	S _____
Secondary habitat (list species)	D	S _____
Incidental habitat (list species)	D	S _____
No usable habitat	D	S _____

ii. Rating

Evaluator uses the conclusions from i above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Highest Habitat Level	Primary/S	Secondary/D	Secondary/S	Incidental/D	Incidental/S	None
Rating	.9 H	.8 H	.7 M	.5 M	.3 L	0 L

Sources for documented use (e.g. observations, records, etc):

15d. Habitat for plant or animals rated S2 or S3 by the Utah Natural Heritage Program

This field assesses documented or suspected use of the AA by S2 or S3 species listed by the Utah Natural Heritage Program (UNHP).
Source: Consultation with UDWR regional biologist.
Refer to the UNHP website or the Utah Sensitive Species List at http://dwrcdc.nr.utah.gov/ucdc/ .
Do not include species listed in 15c from above. Circle one category below based on definitions contained in the instructions and after consultation with UDWR biologist.

i. AA is Documented (D) or Suspected (S) to contain:

Primary habitat (list species and S rating)	D	S _____
Secondary habitat (list species and S rating)	D	S _____
Incidental habitat (list species and S rating)	D	S _____
No usable habitat	D	S _____

ii. Rating

Evaluator uses the conclusions from i above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low).

Highest Habitat Level	Primary/D	Primary/S	Secondary/D	Secondary/S	Incidental/D	Incidental/S	None
Rating	.9 H	.8 H	.7 M	.6 M	.2 L	.1 L	0 L

Sources for documented use (e.g. observations, records, etc.):

15e. General Wildlife Habitat

This field assesses general wildlife habitat conditions in the AA. Source: Hammer (1992), Mitch and Gosselink (1993) and Weller and Spatcher (1965).

i. Wildlife habitat features

Working from top to bottom, circle appropriate AA attributes in matrix to arrive at a rating (H = high, M = moderate, or L = low).

Disturbance Level (15a)	L			M			H		
Plant Community (15b)	H	M	L	H	M	L	H	M	L
Rating	H	H	M	H	M	L	M	L	L

Wildlife habitat features rating.	1H	.6M	.2L

ii. Modified Wildlife Habitat Rating

The wildlife habitat features rating may be modified based on documented wildlife use and levels of use of the AA. Consult with the UDWR regional wildlife biologist to determine the level of wildlife use in the AA using the procedures detailed below.

UDWR biologist consulted: Name(s)_____Date(s)_____

First circle the appropriate answer to the following question: Does the UDWR have sufficient knowledge of the AA to determine a level of general wildlife use. Yes No

If the answer is No do not modify your answer to 15e(i) above. If you answer is Yes and after further consultation with a UDWR biologist and using the level of use descriptive categories on page 14. Select the descriptive category (H, M or L) that best describes the level of wildlife use in the AA. Circe the appropriate answer. H M L

If the level of use circled is:
H – add .2 to the wildlife habitat features rating 15e(i)
M – add .1 to the wildlife habitat features rating
L – do not modify the wildlife habitat features rating

iii. Rating

Use the conclusions from i and ii above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Modified wildlife habitat features rating	1H			.6M			.2L		
Rating	1.2H	1.1H	1H	.8H	.7M	.6M	.4M	.3L	.2L

Comments:

15f. General Fish/Aquatic Habitat

This field assesses general fish and aquatic habitat in the AA. Source: Sigler and Miller (1963), Gore (1985), Williams et al (1997) and National Research Council (1992).

Assess this function if the AA is used by fish or the existing situation is "correctable" such that the AA could be used by fish [i.e., fish use is precluded by perched culvert or other barrier, etc.]. If the AA is not or was not historically used by fish due to lack of habitat, excessive gradient, etc., circle NA here and proceed to the next function. If fish use occurs in the AA but is not desired from a resource management perspective [such as fish use within an irrigation canal], then Habitat Quality [i below] should be marked as "Low", applied accordingly in ii below, and noted in the comments.)

i. Habitat Quality

Refer to the glossary for further definitions of these terms. Circle appropriate AA attributes in matrix to arrive at the quality rating (H = high, M = moderate, or L = low).

Duration of surface water in AA	Permanent / Perennial			Seasonal / Intermittent			Temporary / Ephemeral		
Cover: % of water body in AA containing cover objects such as submerged logs, large rocks & boulders, overhanging banks, floating-leaved vegetation, etc.	>25%	10–25%	<10%	>25%	10–25%	<10%	>25%	10–25%	<10 %
Shading: >75% of stream bank or shoreline within AA contains riparian or wetland scrub-shrub or forested communities	H	H	H	H	H	M	M	M	M
Shading: 50 to 75% of stream bank or shoreline within AA contains riparian or wetland scrub-shrub or forested communities	H	H	M	M	M	M	M	L	L
Shading: < 50% of stream bank or shoreline within AA contains riparian or wetland scrub-shrub or forested communities	H	M	M	M	L	L	L	L	L

ii. Modified Habitat Quality

Circle the appropriate response. If answer is Y, then reduce rating in i above by one level (H = M, M = L, L = L)

Is fish use of the AA precluded or significantly reduced by a culvert, dike, or other man-made structure or activity or is the water body included on the UDEQ list of water bodies in need of TMDL development with listed "Probable Impaired Uses" including cold or warm water fishery or aquatic life support? Y N

Modified habitat quality rating = (circle) H M L

iii. **Rating**

Refer to the Utah Division of Wildlife Resource website for fish species. Use the conclusions from i and ii above and the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Types of fish known or suspected within AA	Modified Habitat Quality (ii)		
	H	M	L
Native fish	1 H	.8H	.6 M
Introduced fish*	.5 M	.4 M	.3 L
No fish	.3 L	.2 L	.1 L

Note: reduce the score by .1 if the AA has carp present.							
.9H	.7M	.5M	.4M	.3L	.2L	.1L	0L

*Most of the lacustrine wetlands in Utah, with the exception of the Great Salt Lake are reservoir impoundments. Many of these impoundments have been stocked with warm water non native game fish. These warm water species frequently become established as self sustaining populations that provide ecological functions to the reservoir system. In some reservoirs native fish species persist in this artificial environment. Were native and introduced species coexist in impoundments it is required that the evaluator consult with USFWS and UDWR fisheries biologists to determine the appropriate fish/aquatic habitat rating.

15g. General Amphibian Habitat

This field assesses general amphibian habitat within the AA. Source: Consultation with UDWR regional biologist.

UDWR biologist(s) consulted: Name(s)_____Date(s)_____

Circle the appropriate answer to the following question after consulting with UDWR regional biologist. The UDWR has documented the presence of amphibians in the AA or, habitat and water quality characteristics are such that they would support amphibians.

Rating: Yes No

If the answer is Yes, add **.2** under the functional points/rating column in the Functional Assessment Rating Section at the end of this form.

Hydrological/Biophysical Assessment

Draw a simple boundary of the AA on page 12 of this form and illustrate the hydrological conditions found within the AA. Include water source locations, directions of flow (if applicable), approximate depths, and any significant site features that influence site hydrology.

15h. Flood Attenuation

This field assesses the capability of the AA to slow in channel or over bank flow during high water/flood events. This applies to riverine wetlands only. Source: Kleinschmidt Associates (1993), Munson (1974) and Strom et al (2004).

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Within the AA, estimate % ground coverage with high surface roughness*	≥65%	64%-50%	49%-35%	>35%
Rating	1H	.8H	.6M	.4M

*See glossary for definition of surface roughness rating criteria.

ii. There are residences, businesses, or other features, which may be significantly damaged by floods located within 0.5 miles downstream of the AA. Yes No

Comments:

15i. Short and Long Term Surface Water Storage

This field assesses the potential of the AA to capture and hold surface water originating from inundation, precipitation, upland surface (sheet flow) or subsurface (groundwater flow). Source: Munson (1974), Strom et al (2004), Hammer (1986) and Mitch and Gosselink (1993).

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Duration of surface water is implied in the definition of wetland class or of the subclass and thus reflects the natural function. Circle the appropriate answer.

Wetlands are inundated	≥ 5 out of 10 years		< 5 out of 10 years	
Has the wetland's natural ability to store water been disturbed negatively?	N	Y	N	Y
Rating	1H	.8H	.6M	.4M

In order to properly assess this function, examination of the area down gradient from the AA may aid in determining whether or not dams, water control structures, overflow aprons, ditches, canals, drain tiles or other forms of outlet or modification exist.

Comments:

15j. Sediment/Nutrient/Toxicant Retention and Removal

This field assesses the ability of the AA to retain and capture sediments, nutrients and toxicants. Source: Kleinschmidt Associates (1999), Hammer (1986) and Hammer and Kadlec (1983).

This function applies to wetlands which could receive excess sediments, nutrients or toxicants through influx of surface or groundwater or direct input. If no wetlands in the AA are subject to such input, circle NA here and proceed with evaluation.

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function. Circle the appropriate answer.

Sediment, nutrient, and toxicant input levels within AA	AA receives or surrounding land use with potential to deliver low to moderate levels of sediments, nutrients, or compounds such that other functions are not substantially impaired. **Minor** sedimentation, sources of nutrients or toxicants, or signs of eutrophication present.				AA is in close proximity to or receives input from or is on UDEQ list of water bodies in need of TMDL development for "probable causes" related to sediment, nutrients, or toxicants **or** AA receives or surrounding land use with potential to deliver high levels of sediments, nutrients, or compounds such that other functions are substantially impaired. **Major** sedimentation, sources of nutrients or toxicants, or signs of eutrophication present.			
Within the AA, estimate % ground coverage with high to moderate surface roughness*	≥ 50%		<50%		≥ 50%		<50%	
Has the wetland's natural ability to store water been disturbed negatively?	N	Y	N	Y	N	Y	N	Y
Rating	1H	.9H	.8H	.7M	.6M	.5M	.4M	.3L

*See glossary for definition of surface roughness.

Comments:

15k. Sediment/Shoreline Stabilization

This field assesses the ability of the AA to dissipate flow or wave energy in order to reduce erosion. This applies to riverine and lacustrine wetlands only. Source: Kleinschmidt Associates (1999), Keate (2004), Padgette et al (1989) and Mitch and Gosselink (1993).

Applies only if AA occurs on or within the banks or a river, stream, or other natural (vegetated swale) or man-made drainage, or on the shoreline of a standing water body, which is subject to wave action. It does not apply, circle NA here and proceed to next function)

i. Rating

Working from top to bottom, use the matrix below to arrive at the functional points and rating (H = high, M = moderate, or L = low) for this function.

Within the AA, estimate % ground coverage with high surface roughness*	Duration of surface water adjacent to rooted vegetation	
	Permanent	Seasonal
≥ 65%	1H	.7M
64% - 50%	.8H	.5M
49% - 35%	.6M	.3L
< 35%	.4M	.1L

Comments:

Social Value Assessment

The following are not functions but values, which are important to society. Plus answers would suggest important societal assets, which should guide any future mitigation planning.

16. Visual Quality*

Refer to the glossary to distinguish between "wildland wetland" and "urban/exurban wetland".
If AA is considered "wildland wetland" answer the following three questions based on information gathered from suggested sources. Each 'yes' answer receives a plus (+) rating in the space provided.

i. Is the wetland in public ownership (city, county, state or federal)? _____
ii. Has wetland experienced moderate to low level of disturbance (refer to glossary)? _____
iii. Is there an absence of human structures or other human induced disturbances (refer to glossary)? _____

If AA is considered to be an "urban/exurban wetland", answer the following six questions based on information gathered from suggested sources. Each 'yes' answer receives a plus (+) rating in the space provided.

i. Is the wetland in public ownership (city, county, state or federal)? _____
ii. Is there potentially a large number of viewers? _____
iii. Is the viewing distance in the fore or middle grounds for most viewers (refer to glossary)? _____
iv. Has the wetland experienced a moderate to low level of disturbance (refer to glossary)? _____
v. Is there an absence of human structures or other human induced disturbances (refer to glossary)? _____
vi. Is the wetland a part of a larger open space, green space, park, buffer or corridor? _____

17. Recreational/Educational Quality*

Answer the following seven questions for both "wildland wetlands" and "urban/exurban wetlands". Each 'yes' answer receives a plus (+) rating in the space provided.

i. Is the wetland in public ownership (city, county, state or federal)? _____
ii. Is the wetland presently used for recreation/education? _____
iii. Is the wetland ¼ mile or less from and elementary school? _____
iv. Is the wetland five miles or less from a high school? _____
v. Is there vehicular, trail, boat or canoe access to the site? _____
vi. Has the wetland experienced a moderate to low level of disturbance (refer to glossary)? _____
vii. Is the wetland visible from a county, state or federal highway, heavily used recreation trail, residential development or other situations where large numbers of people would have visual access to the wetland? _____

*Note: In some cases wetlands many contain plant or wildlife species or perform functions that would be diminished by human activity. In these cases recreational and educational activities would be prohibited.

Summary Comments for entire Wetland AA Evaluated

Functional Assessment Rating

Function Variables	General Evaluation	Actual Functional Points/Rating	Possible Functional Points	Functional Units: (Actual Points x Estimated AA Acreage)
15b. Plant Community Composition			1	
15c. Listed/Proposed T&E Species Habitat			.9	
15d. UT Natural Heritage Program Species Habitat			.9	
15e. General Wildlife Habitat			1	
15f. General Fish/Aquatic Habitat			1	
15g. General Amphibian Habitat			0	
15h. Flood Attenuation			1	
15i. Short and Long Term Surface Water Storage			1	
15j. Sediment/Nutrient/Toxicant Removal			1	
15k. Sediment/Shoreline Stabilization			1	
Totals:				

If functional variables other than those toned are not applicable (NA) to the AA of concern, enter NA in the possible functional points box and subtract the possible functional points for that variable when calculating percent of total functional points.
Note: % total functional points = actual functional points ÷ possible functional points.

	% total functional points

Overall Assessment Area Category

Circle appropriate category based on the criteria outlined below. **I II III IV**

Red Flag Category
___ Documented habitat for a federally listed or proposed threatened or endangered plant or animal species was found. (Yes response to question 12)
___ Documented habitat for a species rated S1 by the Utah Natural Heritage Program. (Yes response to question 12)
Wetlands in this category are a special case and require consultation with the COE, USFWS, and UDWR throughout the entire application process.

Category I Wetland: (Must satisfy one of the following criteria; if it does not meet criteria, go to Category II)
___ Score of .9 functional point for Species Rated primary documented S2 by the Utah Natural Heritage Program **or** .8 for primary suspected S2 species, level of disturbance is also rated low; **or**
___Score of 1 functional point for Flood Attenuation (riverine only) and answer to Question 15i. ii is "yes"; **or**
___Score 1 function point for Plant Community Composition; **or**
___Total actual functional points > 80% (round to nearest whole #) of total possible functional points.

Category II Wetland: (Criteria for Category I not satisfied and meets any one of the following criteria; if not satisfied, go to Category IV)
___Score of .9 functional point for Species Rated primary documented S3 by the Utah Natural Heritage Program, **or** .8 functional point for Species Rated primary suspected S3 species; level of disturbance is rated low **or**
___Score of ≥.9 functional point for General Wildlife Habitat; **or**
___Score of ≥.9 functional point for General Fish/Aquatic Habitat (riverine and lacustrine only); **or**
___Score of >.7 ≤.8 functional point for Plant Community Composition
___Total Actual Functional Points > 65% (round to nearest whole #) of total possible functional points.

Category III Wetland: (Criteria for Categories I, II or IV not satisfied)

Category IV Wetland: (Criteria for Categories I or II are not satisfied and all of the following criteria are met; if it does not satisfy criteria, place wetland in Category III)
___Total actual functional points < 30% (round to nearest whole #) of total possible functional points
___Roadside Ditch Wetland Classification

Supplemental Diagram A

15b. Plant Community Composition Diagram
Draw a simple boundary of the AA and illustrate all plant transect locations and approximate distances.
Please note that 100 sample points per acre should be collected within the AA. (Example: if AA equals .25 acres, then 25 sample points should be taken.) Never use less then 10 sample points within any AA, even when AA is less then .10 acres in size. Placement of transect(s) should accurately represent the AA. Be sure to place transect(s) through different water regimes, vegetative structure, and topographic changes that may exist within the AA.

Supplemental Diagram B

Hydrological/Biophysical Assessment Diagram
Draw a simple boundary of the AA and illustrate the hydrological conditions found within the AA. Include water source locations, directions of flow (if applicable), approximate depths, and any significant site features that influence site hydrology.

National Agroforestry Center: Riparian Buffer Design Guidelines Manual's Upland Vegetation Assessment Method (Johnson and Buffler 2006, 79-87):

Appendix B

Data Form and Plant Community Condition Worksheet: Riparian and Upland Vegetation Management

Date:_____ Stream Name:_____

County:_____ Inventory Mapping Unit# _____

City:_____

Site Name:_____

Authority(s) Responsible for Management: _____

Phone # Day:_____

A. RED FLAG ATTRIBUTE
Rating criteria – check the appropriate answer below

The presence of or habitat for federally listed or proposed threatened or endangered (T or E) plants or wildlife within the project site may require special planning procedures to meet requirements of the species of concern. Formal consultations with the US Fish and Wildlife Service may be required. The US Fish and Wildlife Service will respond to the action agencies (NRCS) Biological Assessment with their own Biological Opinion. The Biological Opinion will identify "reasonable and prudent" conservation alternatives from which NRCS (or other consulting Federal agency) can select, or serve as the basis for negotiating other alternatives amenable to all parties. The vegetation management plan and permitted uses within the project site may be altered to meet the specific habitat or behavioral requirements of the species of concern. Check with the Utah State Division of Wildlife Resources if there are any questions or concerns. In some cases funding may be available for habitat protection or restoration as part of the species recovery plan.

Threatened or endangered species listed or proposed are present on the project site Y____ N ____

Source calculation method _____

USFW Service web site: http://www.fws.gov/ UDWR web site: http://wildlife.utah.gov/index.php

B. YELLOW FLAG ATTRIBUTE
Rating criteria – check the appropriate answer below

Some riparian open spaces may be inhabited by State listed species of concern (S-1, S-2 or S-3). These species do not receive the level of protection afforded Federally listed T and E species. Nevertheless, in the interest of conserving biodiversity, the riparian vegetation management plan should give special consideration to conservation of State listed species. Consultation with the Utah State Division of Wildlife Resources is recommended. The vegetation management plan and permitted uses within the site may be altered in order to meet the habitat requirements or behavioral characteristics of the species of concern. Check with the Utah State Division of Wildlife Resources if there are any questions or concerns.

State listed species of concern are present on the project site Y____ N____
Source calculation method _____

PRIMARY BUFFER ATTRIBUTES

C. ATTRIBUTE: PLANT COMMUNITY VIGOR INVENTORY (Riparian/wetland and upland plant communities)
Criteria - Use matrix below to determine resource presence or absence and rate % of native species.
(Circle the appropriate answers in the matrix below) (H=High, M=Moderate or L=Low)

	RIPARIAN			UPLAND		
Criteria	YES	NO	NO	YES	NO	NA
*Hydrological processes that operate across the site are sufficient to sustain riparian/wetland vegetation	Y	N	NA	N/A	N/A	NA
**Plant horizontal and vertical structure normally associated with plant community type is present	Y	N	NA	Y	N	NA
***Native plant species normally associated with plant community type are present based on estimated from sampling transects. Reported as percent of native species	≥ 90%	75-90%	<75%	≥ 90%	75-90%	<75%
	H	M	L	H	M	L
****Range of age classes of dominant tree and or shrub species is present in the management site (1)	Y	N	NA			

General condition of plants by type:	EXCELLENT	GOOD	FAIR	POOR
Trees				
Shrubs				
Grasses and Forbs				

Matrix criteria BLM (1998), Berglund (1999), Keate (2004)

COMMENTS

Source calculation method _____

* Indicators of natural hydrological processes sufficient to sustain riparian/wetland vegetation include but are not limited to: absence of upstream or on-site human made dams or diversions, over-bank flow across the active flood plain at least once every 2-3 years, channel alignment, cross section and gradient in balance with the geomorphic setting or mean depth to water table in the riparian zone is <20 inches.

** Estimate by comparing project site to reference site, literature descriptions, or historical reference (if landscape setting is largely unchanged).

*** Calculate the percentage of native of trees, shrubs, and herbaceous species in the sampling transects for the management unit: high >90%, moderate 75-90%, low <75% based on plant sampling procedure detailed in Appendix D. Refer to Appendix F and G for a general list of the most common native riparian and upland plant species. Note: the plant list may require modification to reflect unique sub regional characteristics.

**** Estimate by comparing project site to reference site, literature descriptions, or historical references (if landscape setting is largely unchanged). Note: in the study area, age stands are not uniformly distributed along the stream channel. Typically, greatest stand age diversity occurs on point bars and transition areas between pools and riffles. In multiple channel or braided streams recruitment is high on in-stream bars and islands. Mature and senescent plants are most prevalent along straight reaches and abandoned channels (oxbows).

(1) The evaluator, aggregating stand age for woody species in the riparian plant community, estimates from all management sites, stand age class diversity (YES or NO), for the entire project site by comparing the length of project site reach with similar length of reach in the references notes above.

Source calculation method _____

D. ATTRIBUTE: PLANT COMMUNITY VIGOR RATING BASED ON HYDROLOGY AND VEGETATION CHARACTERISTICS IN THE RIPARIAN/WETLAND COMMUNITY

Rating Criteria - Use the matrix below with circled responses from Step C to estimate plant community vigor. Circle the appropriate answers in the boxes below. (H=High, M=Moderate or L=Low)

Criteria												
Hydrological processes that operate the site are sufficient to sustain riparian/wetland vegetation (from step C above)	Y						N					
Plant community horizontal and vertical structure normally associated with plant community type is present (from Step C above)	Y			N			Y			N		
Native plant species normally associated with plant community type are present (use H, M or L from Step C above)	H	M	L	H	M	L	H	M	L	H	M	L
Rating calculated (circle rating and record in rating box below)	H	H	L	H	M	L	M	M	L	M	L	L
Actual functional points	1	.9	.4	.8	.7	.3	.6	.5	.2	.4	.2	.1

Matrix criteria BLM (1998), Berglund (1998), Keate (2004)

RATING	High	Moderate	Low
Score - report the functional point score from matrix above			

(Actual functional points)
Comments:

Source/calculation method _____

ATTRIBUTE: PLANT COMMUNITY VIGOR BASED ON VEGETATION CHARACTERISTICS IN THE UPLAND PLANT COMMUNITY

Rating Criteria - Use the matrix below with circled responses from Step C above to estimate plant community vigor (circle the appropriate answers in the boxes below the matrix (H=High, M=Moderate or L=Low)

Criteria						
Plant Community horizontal and vertical structure normally associated with plant community type is present (from Step C above)	Y			N		
Native plant species normally associated with plant community type are present (use H, M or L from Step C above)	H	M	L	H	M	L
Rating calculated (circle rating and record in rating box below)	H	M	L	M	L	L
Actual functional points	1	.7	.4	.6	.3	.1

Matrix criteria Mee et al. (2003), Pagette and Ritter (1999)

RATING	High	Moderate	Low
Score - report the functional point score from matrix above			

Comments:

E. ATTRIBUTE: LEVEL OF HUMAN INDUCED DISTURBANCE/FRAGMENTATION IN THE VEGETATION MANAGEMENT PLANT COMMUNITIES COMBINED

Rating criteria – use the matrix below to estimate the level of human induced disturbance/fragmentation in the management site and adjacent area (circle the appropriate answer in the matrix below and record the score in the rating box below) (H=High, M=Moderate or L=Low)

Criteria	Predominant conditions adjacent to (within 600 feet of) the project boundary		
Conditions within vegetation management site	Land occurs and is managed in predominately natural state; is not grazed, minimal recreation use; or otherwise converted; does not contain buildings	Land not cultivated, but moderately grazed, moderate recreation use; or has been subject to minor clearing; contains few roads or buildings	Land cultivated or heavily grazed, heavy recreation use ; subject to substantial fill placement, grading, clearing, or hydrological alteration; high road or building density
Vegetation management site occurs and is managed in predominately natural state; is not grazed, receives minimal recreation use*; or otherwise converted; does not contain roads or occupied buildings	L - 1	L - .9	M - .7
Vegetation management site not cultivated, but moderately grazed, receives moderate recreation use**; or otherwise converted; does not contain roads or occupied buildings	M - .7	M - .5	H - .3
Cultivated or heavily grazed; subject to relatively substantial fill placement, grading, clearing or hydrological alteration, heavy recreation use***; high road or building density	H - .5	H - .2	H - .1

Matrix from Bergland (1998) and Johnson et. al (2004)

* Minimal recreation use includes no more than 1 improved trail.
** Moderate recreation use includes more than 1 improved trail or one improved trail and informal areas for picnicking, bank fishing, swimming, and other types of water related recreation.
*** Heavy recreation use includes more than 1 improved trail, and one or more improved picnicking sites with support facilities where numerous areas are used for bank fishing, swimming and other types of water related recreation.

RATING	High	Moderate	Low
Score - report the functional point score from matrix above			

Comments: Note types of disturbance, intensity, season, etc._____

Mapping: Outline on the base map any areas >300 square feet with high levels of disturbance.

Source/calculation Method_____

Record on the base map the level of human induced disturbance/fragmentation for both the riparian/wetland and upland plant community (or segments of that community) in the vegetation management site.

F. ATTRIBUTE: RELATIVE ABUNDANCE OF INVASIVE EXOTIC VEGETATION IN THE RIPARIAN/WETLAND PLANT COMMUNITY

Rating criteria – Use the matrix below to determine relative abundance of invasive exotic vegetation in the riparian plant community. Circle the appropriate answer in the rating box below the matrix (H=High, M=Moderate or L=Low).

Criteria	H	M	L
>25% of the area of the riparian plant community in the management site is occupied by invasive plant species	H - .3		
Between 10 and 25% of the area of the upland plant community in the management site is occupied by invasive plant species		M - .7	
<10% of the area of the riparian plant community in the management site is occupied by invasive exotic plant species			L - 1

Matrix criteria Keate (2004), Johnson et al. (2004)

RATING	High	Moderate	Low
Score - report the functional point score from matrix above			

Comments:

Mapping: Outline on the base map any areas (dimensions follow) with greater than 75% invasive exotic vegetation - grasses and forbs (>300 square feet), shrubs (>600 square feet) and trees (>900 square feet).

Source/calculation method_____

ATTRIBUTE: RELATIVE ABUNDANCE OF INVASIVE EXOTIC VEGETATION IN THE UPLAND PLANT COMMUNITY

Rating criteria - Use the matrix below to determine relative abundance of invasive exotic vegetation in the upland plant community (circle the appropriate answer in the matrix below and record the score in the rating box below) (H=High, M=Moderate or L=Low)

Criteria	H	M	L
>25% of the area of the riparian plant community in the management site is occupied by invasive exotic plant species	H - .3		
Between 10 and 25% of the area of the upland plant community in the management site is occupied by invasive plant species		M - .7	
<10% of the area of the upland plant community in the management site is occupied by invasive exotic plant species			L - 1

Matrix criteria Keate (2004), Johnson et al. (2004)

RATING	High	Moderate	Low
Score - report the functional point score from matrix above			

Comments:

Mapping: Outline on the base map any areas (dimensions follow) with greater than 75% invasive exotic vegetation - grasses and forbs (>300 square feet), shrubs (>600 square feet) and trees (>900 square feet).

Source/calculation method_____

G. PRIMARY PROJECT SCALE ATTRIBUTE

Attribute: Range of age classes of dominant native riparian tree and or shrub species for all vegetation management sites combined (Applies only to management projects with a stream length ≥ 1200 feet (Johnson et al. 2004; Keate 2004).

Rating criteria - Range of age classes in project site (check the appropriate answer to the questions below).

1. The stream bank length in the project site is ≥1200 feet Y___ N___
If the answer is NO circle NA in the rating box below and proceed to the next step; if the answer is YES answer question #2.

2. The riparian plant community in the management site has the diversity of age classes of dominant native trees and or shrubs typical of riparian zones in this stream class Y___ N___. Enter your response in the rating box below.

If, after evaluating all vegetation management site units, the conclusion is that the project site does not have the expected level of stand age diversity circle N in the project scale rating box. Then proceed to Step J, **subtracts .2 from the % functional points and enter the new score in the modified % total functional points box in Step**

		Y	N	NA
Vegetation Management Site Rating Box				
Project Site Rating Box	Adjust the vegetation management site score as described above - The adjusted score is recorded in the modified % total functional points rating box in Step J.	Z		

H. RIPARIAN PLANT COMMUNITY ECOLOGICAL FUNCTIONAL CONDITION RATING FORM (UNADJUSTED)

Enter the general evaluation ratings (H,M,L) and actual functional points (0-1) from the previously rated primary site attributes for the vegetation management site.

Function variables (Primary site attributes)	General Evaluation H-M-L	Actual Functional Points/Rating	Possible Functional Points
Plant community vigor Step D			1
Levels of human induced disturbance/fragmentation Step E			1
Relative abundance of invasive exotic plant species Step F			1
Totals			3

Modified Rating

If the answer to the question in Step G (Primary Project Scale Attribute) is NO, subtract .2 from the unadjusted habitat quality rating (% total functional points) and enter the new modified habitat quality rating score in the rating box. If a modification is made as described above use the modified score to estimate the Function Condition Category for the management site, otherwise use the unadjusted score in the rating box above.

Unadjusted Plant Community Quality Rating (% functional points=actual functional points ÷ possible functional points x 100		% of total functional points
Modified Plant Community Quality Rating Y____N____		Modified % of total functional points

UPLAND PLANT COMMUNITY ECOLOGICAL FUNCTIONAL CONDITION RATING FORM
(Unadjusted)
Enter the general evaluation ratings (H,M,L) and actual functional points (0-1) from the previously rated primary site attributes

Function variables (Primary site attributes)	General Evaluation H-M-L	Actual Functional Points/Rating	Possible Functional Points
Plant community vigor Step D			1
Levels of human induced disturbance/fragmentation Step E			1
Relative abundance of invasive exotic plant species Step F			1
Totals			3

Unadjusted Habitat Quality Rating % functional points=actual functional points ÷ possible functional points x 100		% of total functional points

OVERALL UNADJUSTED FUNCTIONAL CONDITION RATING, MANAGEMENT RECOMMENDATION AND LAND USE ZONE DESIGNATION

Circle the appropriate functional condition for the riparian/wetland and upland plant communities using the rating criteria below.

Proper Functioning Condition (PFC)
To be rated as Proper Functioning Condition, the plant community in the management site must: **Riparian/wetland** Score >80% (0.8) of the possible functional points **Upland** •Score ≥ 80% of the possible functional points Proper functioning condition plant communities are high quality habitats with numerous niches for a diversity of species. They are generally uncommon in the study area. These high quality remnants are critical to the persistence of biodiversity in the study area.
Management recommendation: Preservation Land Use Zone 1

Functional – at Risk (FAR)
To be rated as Functional at-Risk, the plant community or segment of plant community in the management site must: **Riparian/wetland** • Score < 80% (.8) but >60% (.6) of the possible functional points **Upland** • Score < 80% but > 60% of the possible functional points Functional – at Risk plant communities are moderate quality habitat for some species but typically have fewer niches and do not support the diversity of species associated with plant communities rated PFC. Functional – at Risk plant communities are more common than PFC communities; they are less stable and thus susceptible to further degradation.
Management Recommendation: Enhancement/Rehabilitation Land Use Zone: NA

Nonfunctional (NF)
To be rated as nonfunctional the plant community in the management site must: **Riparian/wetland** •Not meet the scoring criteria described above Nonfunctional plant communities or segments of communities are typical low quality habitat for most wildlife species; they have few niches and wildlife species diversity is low. The nonfunctional condition will persist if the causes of dysfunction are not addressed. •Not meet the scoring criteria described above **Upland** •Same as above
Management Recommendation: Reclamation Land Use Zone: NA

Rating Box

	Riparian	PFC	FAR	NF
	Upland	PFC	FAR	NF

I. FUNCTIONAL CONDITION RATING ADJUSTMENT KEY

Make functional condition rating adjustments (if necessary) to segments within the management site using the specific single attribute criteria below. Make adjustments across vegetation management site boundaries (including single attribute adjustments) when preparing the final project scale functional condition map using the criteria below.

Adjustment 1 - Specific Single Attribute	
	Adjustment
Areas >300 square feet with high levels of human induced disturbance (reference adjustment Map Overlay from Step E	**Reduce the Unadjusted Ecological Functional Condition by one level in areas outlined as having high levels of human induced disturbance on adjustment Map Overlay #1: PRC=FAR, FAR=NF, NF=NF**
Areas >300 square feet (grasses and forbs) - >600 square feet (shrubs) and >900 square feet (trees) with >75% invasive exotic plant species (reference Overlay #2 from Step F	**Reduce the Unadjusted Ecological Functional Condition by one level in areas outlined as having >75% invasive exotic plant species on adjustment Map Overlay #2: PFC=FAR, FAR=NF, NF=NF**
Adjustment 2 –Across Buffer Unit Boundaries	
Evaluators using aerial photographs, NRCS County Soils Maps, field notes, additional field work, apply best professional judgment, modify the boundaries of functional condition rating across vegetation management site units to more accurately reflect on the ground conditions.	
Mapping – Final Adjusted Ecological Functional Condition Map	
Record the adjustments on a copy of the base map and redraw the map with adjustments included. The redrawn map is the final Adjusted Ecological Functional Condition Map. This map is used to determine final habitat management recommendations and land use zones for the entire project site.	

MANAGEMENT RECOMMENDATIONS BASED ON FUNCTIONAL CONDITION RATING

Management Recommendations	
Functional Conditions from Step 4	Management Recommendations
Proper Functioning Condition	Preservation Zone
Functioning at-Risk	Enhancement/Rehabilitation Zone
Non Functional	Reclamation/Restoration Zone

Comments:

Record on the base map the functional condition rating, management recommendation and land use zone derived from the matrix above for both plant communities inside the project site boundary.

Product

- A map showing plant community management recommendations and land use zones for the project site Zones 1-2. In addition, any habitat plans or recommendations outside Zone 2 in the planning area boundary or connection to off-site habitats are delineated on the base map.