Managing Human and Wildlife Interactions: Developing a Low-impact Community within Jackson, Wyoming | By Celeste Valle

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Figure 1.1

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I would like to thank my family and friends who've supported and encouraged me to follow my dreams. Without their love and guidance none of this would have been possible. I would also like to thank Elizabeth Scott for her patience, guidance, and advice through this entire project process.

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LUMION
EDUCATIONAL

# ABSTRACT

When growth and development of communities occur it often leads to encroachment on wildlife habitat. This interference can start to encroach on important pathways of wildlife movement which can lead to dangerous and unwanted conflicts with wildlife. Being able to plan and design future communities that address these issues is important not only for the safety of the community members but to also maintain healthy wildlife populations.

In Jackson, Wyoming these issues are starting to arise. The availability of lands within the city limits is rapidly shrinking. Lands bordering the existing town have protected status of one type or another, which severely limits the availability of land for new development. However finding suitable land for development is only half of the battle. The other is that, due to the growing population being mainly wealthy newcomers, the land value is extremely high making it very difficult for local residents to afford living in their own community. In order to help resolve some of these issues in Jackson, Wyoming, attention needs to be not only at a site scale but also a regional scale in order to be successful.

This project focuses on creating a community for residents of Jackson to live where minimal disturbance to wildlife movement and habitat occur. The design itself works to avoid attracting undesired conflict species, provide habitat for smaller non-disruptive species, and create a deeper connection and understanding of nature and the region's ecology.

The design decisions and planning for the project were influenced by the multiple methods implemented. The first of these methods encompassed the research phase of the project starting with a literature review. The literature review covered important influential topics such as the urban wildlife interface, ecological corridors, tourism impacts, and low-impact development. The second part of the research consisted of case studies. The case studies provided successful design practices that help to aid and influence design decisions that were made for the project. Another part of the methods of the project consisted of an analysis phase. A suitability analysis was conducted to locate the regional influence of wildlife movement and habitat of the area. A locational analysis was performed in order to find a site location based on the needs of the residents of Jackson.  A housing and demographic analysis was performed to know who the site was being designed for and what type of housing is needed for Jackson. Lastly, a further site analysis was conducted to identify the immediate site conditions. The last method for the project consisted of implementation of the traditional design process.

The final design consists of a low-impact community development for residents of Jackson, Wyoming. It's in-depth analysis and careful planning locates the development outside of wildlife conflict areas and works to provide habitat for smaller wildlife that help add value to the community such as birds that allow for birdwatching or honey bees that allow for beekeeping. The design provides a stronger awareness for wildlife and habitat importance of the area and creates a stronger connection to nature.

Figure 1.2


Figure 1.3


Figure 1.4

# INTRODUCTION

# HISTORICAL BACKGROUND

The fight for conservation of the Jackson Hole area and the importance of its wildlife is not a new battle for this area. In fact much of the way Jackson is today is directly related to the creation of the Grand Teton National Park that occurred in 1929 (Burns, 2009). Originally, when the area was first proposed, land for a new national park included the Grand Teton mountain range as well as the valley below where the town of Jackson lies today (Burns, 2009). However when the park was created by Congress they left the valley out of the park boundaries (Burns, 2009). This spurred one powerful man who cared deeply about the vision for the original park boundaries to take action (Burns, 2009). John D. Rockefeller Jr. started to buy up land anonymously in the valley with the intentions of giving it all to the park. Once the word was out on his plan, however, Wyoming politicians against Rockefeller's idea were able to stop his attempts at giving the land to Grand Teton National Park for 15 years (Burns, 2009). After this, Rockefeller along with other powerful influencers in establishing Grand Teton National Park took the project straight to President Roosevelt, who, on March 15,1943 established Jackson Hole National Monument on the valley land on the east side of the Teton Mountains (Burns, 2009). This caused 221,610 acres of public land to be converted into protected lands (Burns, 2009). This was the spark that ignited the fury of a full-on political war between Wyoming officials and the federal government (Burns, 2009). After Roosevelt vetoed a bill to abolish the Monument, Wyoming took it to court where the case was dismissed (Burns, 2009). After World War II ended both sides came to an agreement. "Teton County would be reimbursed for lost property taxes; ranchers' existing grazing rights were grandfathered in; and the migratory elk herd would be managed by both the Park Service and the state, which would be permitted to stage supervised hunts" (Burns, 2009). As for the Park, the majority of the Monument became a continuation of Grand Teton National park, including the 30,000 acres that Rockefeller had bought and attempted to give away (Burns, 2009).

Tourism really started to take hold in the Jackson area starting in 1908 with the creation of dude ranches providing a reliable source of income for local ranchers (Ford, n.d.). This trend continued with huge popularity from 1908 until the great depression hit (Ford, n.d.). After the depression and two world wars a movement was occurring across America to "rediscover America" encouraging families across the nation to take a road trip as their next vacation (Ford, n.d.). This caused tourism to increase drastically in Jackson and caused a new wave of development in motels and lodging (Ford, n.d.). Other developments in the Jackson area after World War II also led to a drastic increase in tourism. The first was the construction of an airport which first started facilitating commercial flights in 1946 (Caden & Sullivan, n.d.). The second major influence on increased tourism to the area was as discussed previously, the expansion of the park bringing major summer tourism (Caden & Sullivan, n.d.). Lastly, the skiing industry had a huge impact on Jackson. With the first ski area in Jackson, the Snow King, opening in 1939 and the opening of the Jackson Hole ski resort in the 1960's, it brought a whole new wave of tourism in the winter months, making Jackson a year-round tourist destination (Caden & Sullivan, n.d.). Ever since, Jackson has continued to grow, experiencing a 63% population increase between 1990 and 2000 (Caden & Sullivan, n.d.). This has brought the town of Jackson to a current population of 10,135 residents. Many of these newcomers were wealthy folks claiming land for their second homes because of the opportunities and beauty that Jackson provides but also because "Wyoming has no state income tax and property tax rates are quite low compared to other upscale parts of the U.S." (Caden & Sullivan, n.d.). Because of this desire for second homes, and with Teton county's limited privately owned lands, "the median cost for a home in the Teton county nearly tripled between 1990 and 2000" (Caden & Sullivan, n.d.). This trend has continued so that in 2011, Wyoming's median home value was "less than ¼ of the Teton county median value" (Caden & Sullivan, n.d.).

Figure 1.5 Dude ranches early form of tourism in Jackson


Figure 1.6 "Rediscover America" movement increased road trip popularity.

Figure 1.7 The development of the ski industry had a huge impact on Jackson.

# CONTEMPORARY CONTEXT

Jackson and its surrounding region has predominately been influenced and defined by the tourism that it experiences every year. From its proximity to two national parks, to its large array of recreational opportunities and its borders with Bridger Teton National Forest and a National Elk Refuge, Jackson has become a famous tourist destination. This tourism has in turn impacted the development of the area. Many homes in Jackson as well as private lands surrounding Jackson have an extremely high market value as tourists and part-time residents purchase these properties for their second homes (Jackson Hole Conservation Alliance, 2015a). This makes it impossible for local residents to find housing options that are affordable in the area. With this need for new communities comes the need for appropriate planning of areas that provide the least amount of environmental impact. The private rural development around Jackson has been fragmenting the land causing an increase in the ecological disturbance of the area, thus hindering the migration of wildlife and disrupting habitat areas. This becomes a concern for the Jackson community as they constantly rank wildlife as one of their top community values (Jackson Hole Conservation Alliance, 2015b). Creating a low-impact community can provide benefits for Jackson beyond just providing places to live. One benefit is the environmental benefits that could otherwise be neglected (Arendt, 1999). Besides just benefiting the wildlife it can also help to keep waterways clean and protected from erosion by establishing natural vegetation and habitat buffers around developed areas (Arendt, 1999). Along with this, implementation of best storm-water management practices helps water to recharge the aquifer (Arendt, 1999). Other benefits also include a better quality of life for residents as well as the desire to live in these environments (Arendt, 1999). Lastly, these community developments can provide economic benefits such as potential reduced costs for building and storm-water management, as well as faster appreciation in property values (Arendt, 1999).

As it pertains to landscape architecture, this type of planning and land management defines specific areas in which development is recommended to minimize the destruction of habitat and interference with wildlife populations. Connecting and creating corridors enables wildlife to safely maintain migration patterns, which helps maintain genetic diversity. Then, within these areas, low impact design can be implemented at the site scale to further minimize the ecological impacts. These low-impact developments create a better quality of living for residents by encouraging community interaction, providing a walkable, pedestrian- friendly neighborhood, as well as providing greenways and trails for enjoyment of recreation and scenery (Arendt, 1999).

Figure 1.8 Development of large single-family homes in the Jackson area.

Figure 1.9 Continued increase in population for Jackson due to its surrounding recreational opportunities.

Figure 1.10 Jackson continues to be a major tourist destination today.

# IDENTIFYING THE PROBLEM

The need for low-impact residential communities in Jackson, Wyoming is a growing concern (Jackson Hole Conservation Alliance, 2015a). However, because the town of Jackson borders Bridger Teton National forest and the National Elk Refuge, as well as being in close proximity to both Grand Teton National Park and Yellowstone National Park, mindful planning is needed to preserve critical habitat and corridors for wildlife to migrate throughout the area. In order to create a low impact development (LID), attention needs to be directed beyond just the site scale to the larger regional scale.

# RESEARCHABLE QUESTION

By identifying key wildlife habitat and connecting ecological corridors can areas best suited for low-impact community development be identified? And further, what site scale practices can be applied to further reduce the community's impact on the environment?

Figure 1.11

# METHODOLOGY

The methods used in this study consist of GIS analysis, a locational analysis, case studies, and schematic design of a low-impact residential development. The GIS analysis uses public data and addresses key conditions and contributing factors that affect the outcome of the locational analysis. These conditions include:

- Flood plain/ riparian area
- Elevation/ Slopes
- Soils
- Habitat types
- Road networks/ development
- Trails
- Zoning
- Land use/ ownership

The information is gathered and distilled into thematic maps, which are used for locational analysis. The locational analysis is based on criteria determined to best identify areas for development that will have the least impact on the surrounding environment. Some of these ideal locations include:

- Near existing development/ town and infrastructure
- Outside 100 year flood plain and important riparian habitat
- Ideal slopes < 15%
- Outside habitat connections
- Near trail systems

Case studies are used to analyze other projects that have the same goals, and identify practices and methods that have proven to be successful in similar situations. Lastly, the design process involves iterative analysis and design development to determine a successful design solution for a low-impact development in the Jackson area.

Figure 1.12

Figure 1.13

Figure 1.14

# OUTCOME

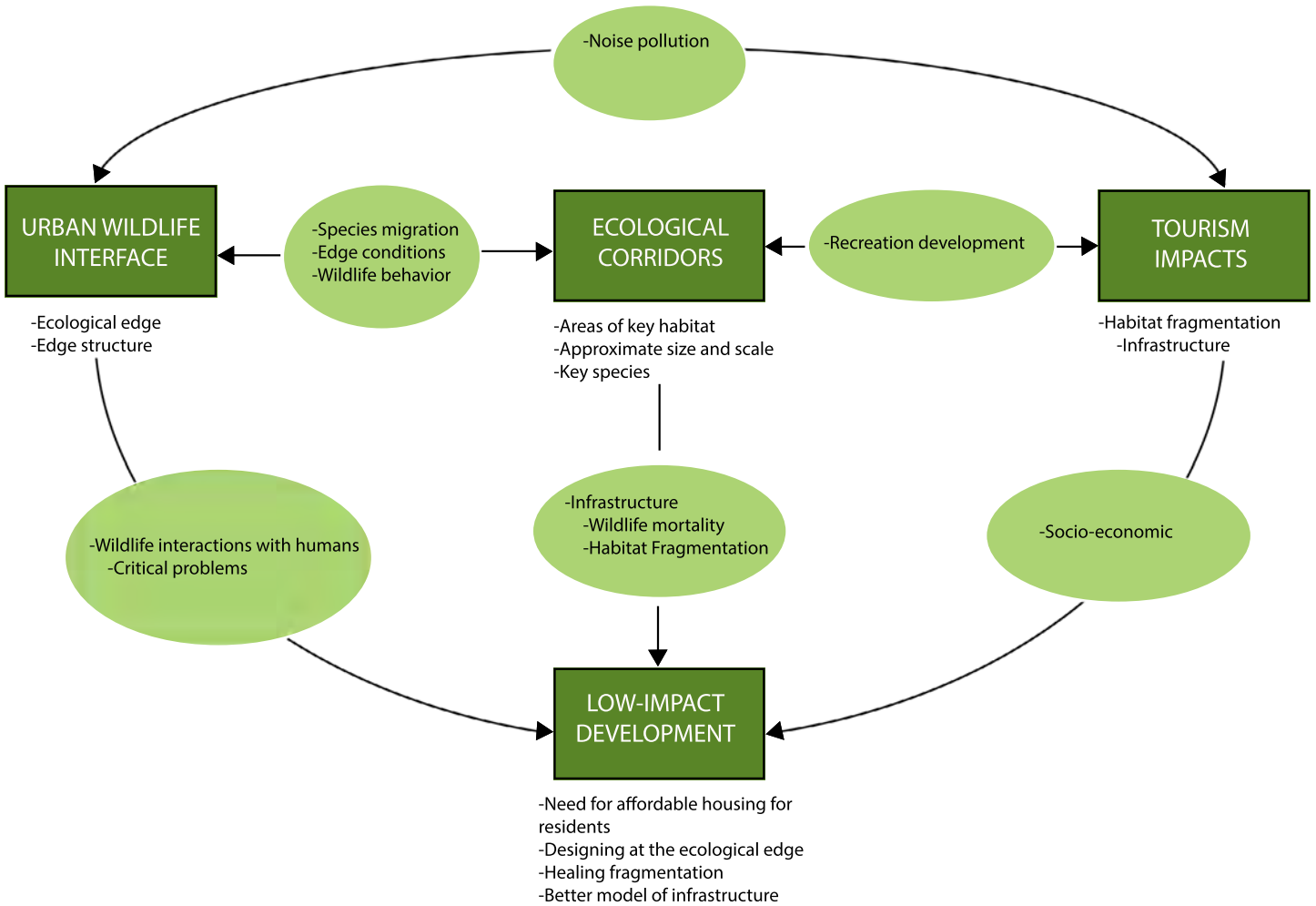
## Project Goals

The goals of this project are:

1. To identify and protect key habitats for wildlife migration
2. Create low-impact housing for residents of Jackson, Wyoming
3. Reduce conflicts between humans and wildlife.

## Scope of design work

The scope of the project first looks at the regional scale. A suitability analysis identifies key habitat areas and corridor connections for an array of key species in the Jackson area. Finding areas of priority wildlife corridor connections is necessary to provide safe wildlife movement. Once these areas are designated, analysis of the surrounding land determines which areas are the least disruptive and most suitable for development. One site is chosen from these suitable development areas to be designed as a low-impact residential community. The design work at the site scale will address issues of community design, storm-water management, conservation design, and other low-impact sustainable design issues.




# THEORETICAL FRAMWORK

The theoretical framework as illustrated above demonstrates which information is needed when creating low- impact development that focuses on the issue of wildlife disturbance and migration. The framework consists of four topics that need understanding in order to develop a well thought out design. These topics include the urban wildlife interface, ecological corridors, tourism impacts, and low-impact development. The three topics consisting of the urban wildlife interface, ecological corridors and tourism impacts all deal with the regional scale of wildlife migration and habitat conservation. All three topics are interrelated to each other and then in turn influence the low-impact development. Low impact development then deals with the site scale and implementing known influences of the urban wildlife interface, ecological corridors and tourism impacts into the design considerations for the community development.

The topic of the urban wildlife interface is integrated into the design process by providing knowledge on the ecological edge of a habitat into development. This knowledge then helps to define species migration through these areas. It can describe the conditions of the habitat found at these edges. Knowledge of wildlife behavior can help to determine how wildlife respond and interact with human disturbance. All of these conditions are then directly interrelated to ecological corridors. The urban wildlife interface is also interrelated with tourism impacts on the area. This includes things like noise pollution and tourists getting too close to observe wildlife. All this knowledge can then be applied to influence the low impact design by providing information of wildlife behavior and the critical problems that occur at the edge of development and wildlife habitat.

The topic of ecological corridors is integrated into the design process by providing knowledge on

the areas around Jackson that provide key habitat to wildlife. It also provides knowledge on the types of key species in the Jackson area that must be protected to keep a high level of biodiversity for the area. Lastly, the topic of ecological corridors provides specifics on the construction and scale of the corridors so that successful and frequent use will occur by wildlife. Ecological corridors then create direct relations with the urban wildlife interface through the migration of the species within the corridors as well as the edge conditions of the corridor. These are also interrelated in terms of knowing the species behavior, and understanding how it can then influence ways that species will react to the design and placement of ecological corridors. An understanding of ecological corridors can be used to migrate tourism impacts by recreational development. This development can create fragments in the landscape, and the need for corridors to connect these fragmented pieces of habitat that are important for species migration. All of this is then taken into account in the community design by acknowledging how infrastructure influences the patterns of wildlife behavior and migration and how it can cause issues such as wildlife mortality and habitat fragmentation.

The topic of tourism impacts is integrated into the design process by providing knowledge on how tourism affects the ecological surroundings of Jackson through physical impacts such as the development of new infrastructure as well as non-physical impacts such as rising populations, changing demographics and others. We see this influence occur through increasing recreation and development that effect corridor structure and wildlife behavior interactions by issues such as noise pollution and tourists coming in too close proximity of wildlife. Understanding tourism impacts on Jackson, along with understanding local socio-economic factors, helps provide a basis for design of a low-impact community in a way that captures and reflects the unique qualities of Jackson.

Lastly, the topic of LID deals with what is occurring at the site scale of the design. The previously discussed topics influence the outcome and approach to Low-impact development going into the process. What low-impact development addresses on its own is how much affordable housing is needed for the residents of Jackson, successful practices of designing near the ecological edge, ways through development to heal fragmentation, as well as implementing other best practices to the community design in order to further reduce the ecological impact. Thus, all the information comes together to create a cohesive design for community members that continues to protect the surrounding wildlife that Jackson values so much.

Figure 2.1

Figure 2.2

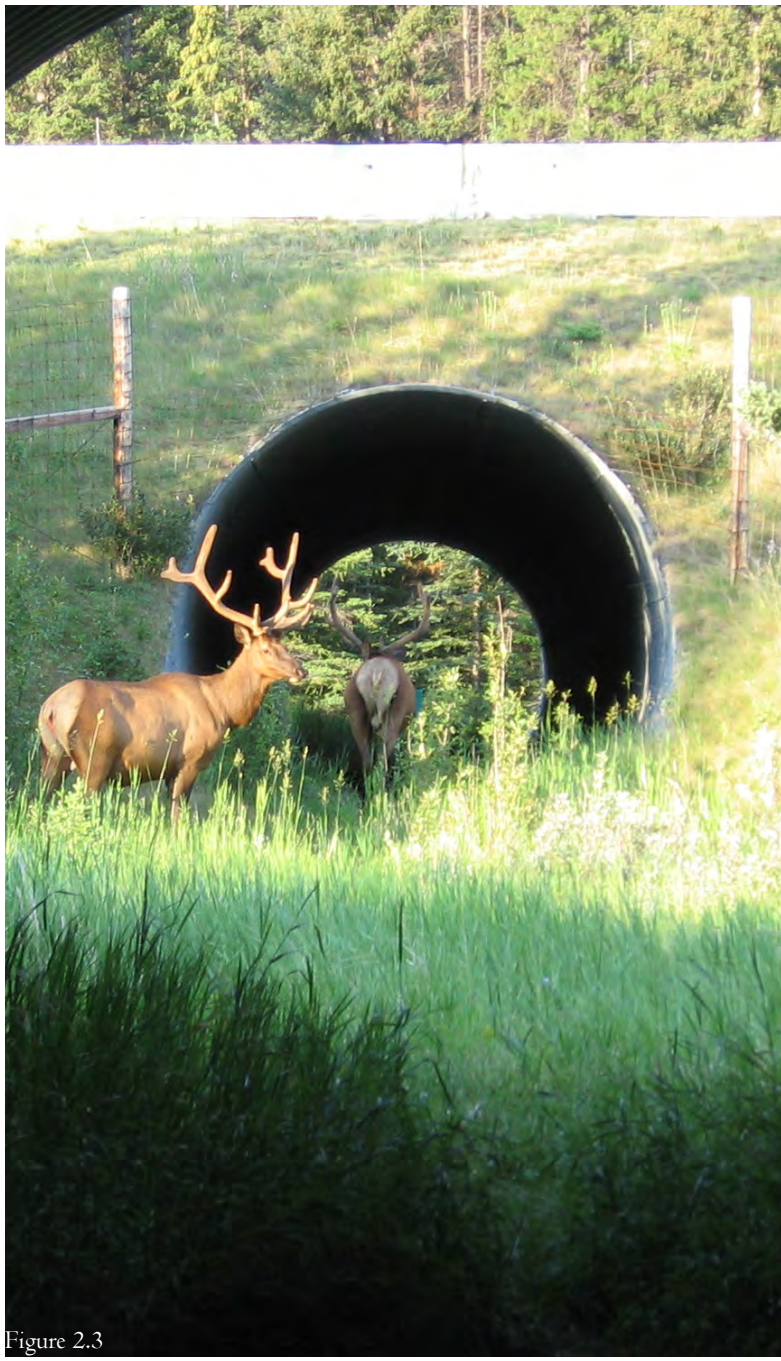


Figure 2.3

# LITERATURE

# THE URBAN WILDLIFE INTERFACE

The topic of the urban wildlife interface focuses on wildlife migration near development. It encompasses wildlife behavior at the urban edge and in response to human disturbance. It also describes how we can lessen developmental impacts on wildlife along the edge, as well as the interactions that take place where human development transitions into wild lands. To understand the urban wildlife interface around Jackson, Wyoming the information that is needed includes the key species of the area, the species behavior at the edge, the edge effects and how to create transitions between, and the migration patterns of key species throughout the area. Also, the dynamic where the two meet could create issues or hazards either to the wildlife or humans.

Figure 2.4 Example of attraction.

Figure 2.5 Example of habituation.

Knowing where the current development in Jackson is located and where theses edges already occur is valuable information. Knowing the urban wildlife interface will then allow for the creation of low-impact development by understanding the effects that the current edges and new edges have on the wildlife and how they can be developed in areas of least impact to key habitat areas. This knowledge can then impact how ecological corridors are created and maintained surrounding development. And lastly, knowing how wildlife behaves, especially around humans, is important when looking at the increased amount of interaction brought about by tourism.

When thinking about the urban wildlife interface one of the most important aspects is knowing the different ways in which wildlife behave. Wildlife behavior can be described (Whittaker & Knight, 1998) in three classes. The first, Attraction, is defined as "the strengthening of an animal's behavior because of positive reinforcement and implies movement toward the stimuli" (Whittaker & Knight, 1998). Examples of this are seen by humans feeding ducks or seagulls, or providing shelter for birds or bats through constructed houses. The second class is habituation. It is "a waning of response to a repeated, neutral stimuli". The second class is habituation which is defined as "a waning of response to a repeated, neutral stimuli" (Whittaker & Knight, 1998). Habituation is the most confusing of the three to understand. It's an animal's ability to ignore or become de-sensitized to human stimuli such as a crow ignoring a scarecrow (Whittaker & Knight, 1998).The third class is avoidance (Whittaker & Knight, 1998). It is defined as "the opposite of attraction, an aversion to negative consequences associated with a stimulus". Avoidance can range from unconditioned to conditioned response such as "a deer's ability to learn to avoid touching an electrical fence, and wolves learning to avoid towns or roads because they associate them with human persecution" (Whittaker & Knight, 1998). These animal behaviors then influence the three basic issues that are observed and need to be considered when studying animal behavior.

The first issue with animal behavior is "wildlife responses and causality" which explains how more research needs to take place to fully understand the three responses and their links to each other (Whittaker & Knight, 1998). For example, "bears while learning to ignore people and be habituated it can lead to them having greater opportunities to find attraction stimuli in our human environments" (Whittaker & Knight, 1998). By understanding all the possible links of behavior, a better understanding of how wildlife reacts to human disturbance can be achieved. The second issue is "Response events or response tendencies?" (Whittaker & Knight, 1998). This brings to light issues such as misjudgment of an entire species behavior from an observation of a small population group (Whittaker & Knight, 1998). Also, consideration of different responses for different situations needs to occur as all animals are unique (Whittaker & Knight, 1998). The third issue is "evaluating wildlife responses" (Whittaker & Knight, 1998). This can be described as how an application to a species may not seem altering or disrupting but the wildlife responses may not be apparent, direct, or immediate and could cause positive or negative consequences (Whittaker & Knight, 1998). An example is how "Black bears become adept at using areas of intense human use while still avoiding people . . . but it prevents the bears from using

their entire home range. Extreme avoidance may be an effective survival strategy for an isolated sub population but it may also have detrimental long-term effects on their genetic viability, because they may be unable to use narrow corridors that would connect them to other subpopulations"(Whittaker & Knight, 1998). By knowing these animal behaviors and complexity in the degree of their responses, better assumptions can be made on how to design at the ecological edge that will reduce conflict and negative interactions with wildlife.

Conflicts between humans and wildlife have been increasing in recent years due to three reasons (Manfredo, Vaske, Brown, Decker, & Duke, 2009). The first reason is that "human uses of wildlife habitat area expanding in many regions" (Manfredo et al., 2009). This can be seen in the U.S. through increased development and urban sprawl, exploitation of natural resources, and outdoor recreation and tourism. The second reason is that "a few wildlife populations are recovering and expanding into areas with people and property" (Manfredo et al., 2009). And the third reason is that "environmental changes such as climate change are driving some sensitive species into areas with more people and property" (Manfredo et al., 2009). There can also be problematic conflict with wildlife especially around protected lands (Manfredo et al., 2009). When wildlife leaves their protected lands they could eat "crops, livestock and other resources" and even in some cases cause attacks (Manfredo et al., 2009). This can cause pressure between the relationship between humans and wildlife conservation, and cause a loss of support for such efforts (Manfredo et al., 2009).

Continued urbanization is leading to fragmentation and degradation of habitats around the world as well as causing the isolation of species populations which leads to detrimental effects of species biodiversity (Villaseñor et al., 2014). A study conducted in Australia worked to determine what changes to the edge caused changes in animal behavior and how to evaluate the best approach to minimize the impacts of urban development (Villaseñor et al., 2014). They suggested three factors to consider for "predicting animal responses across edges 1) habitat quality/ preference 2) species response with the proximity to the adjacent habitat 3) extent of the spillover/ sensitivity to habitat boundaries" (Villaseñor et al., 2014). The study observed low density and high density housing found at the forest edge and its effects on arboreal marsupials which are sensitive to changes in the landscape (Villaseñor et al., 2014). From the study, they found in order to accurately mitigate the issues arising at the edge by urbanization first understanding is needed on the specifics of the key species as well as the environment (Villaseñor et al., 2014). Another consideration observed is that lower density around the edge allowed for a lower contrast (Villaseñor et al., 2014). This allowed the animals to continue to partially occupy the space, unlike high density on the edge which created a drastic hard edge for the animals (Villaseñor et al., 2014). This also showed negative impacts on sensitive species living in the forest (Villaseñor et al., 2014). From the results they also concluded with 2 "fundamental strategies to minimize impacts of urban developments 1) reduce loss of forest core area at the planning stage, to limit impacts on sensitive species 2) mitigate the environmental impact of high-density housing developments on forest-dwelling species by providing key habitat structures that may facilitate movement of animals and promote colonization of urban environments"(Villaseñor et al., 2014). By utilizing these strategies, preservation of key habitat and connections can be made that will help to protect sensitive species. Careful planning of communities will allow for minimal damage at the habitat edge and still encourage wildlife movement.

One threat created by wildlife and human conflict is the mortalities of birds due to buildings (Adams, Kieran, & Ash, 2006). It's reported that "34% of Avian mortality every year is caused by collisions with windows" (Adams et al., 2006). These deaths can happen in one of two ways. One is that birds can collide with the glass because they can't see that

Figure 2.6 Example of avoidance.


Figure 2.7 Example of conflicts that occur in the Jackson area.

Figure 2.8 An increase in private development along the Snake River is leading to more habitat fragmentation.

there is a surface there (Adams et al., 2006). This mainly occurs to birds who live and nest closer to the ground plane (Adams et al., 2006). The other way is that birds who migrate at night can be disoriented by the light coming from the windows (Adams et al., 2006).

While the urban wildlife interface poses an interesting dilemma for development happening all over the world, specific interactions have been measured in the Jackson Hole area. With increased development in the Jackson Hole area more development is happening along the Snake River riparian area (Smith & Wachob, 2006). This increase in development has caused species richness and diversity of birds in the area to decline due to habitat fragmentation, increased human disturbance, and an increase in deciduous trees (Smith & Wachob, 2006). The birds documented as most affected were the Dark-eyed Juncos, Dusky Flycatchers, Tree swallows, Warbling vireos, Yellow-rumped warblers, and Yellow warblers (Smith & Wachob, 2006). When development occurs in key habitat areas, a decline in these native species starts to occur (Smith & Wachob, 2006). When this decline happens, in this case of native birds, other common domestic bird species such as magpies start to move in and dominate the developed areas leading to a loss in species richness (Smith & Wachob, 2006). Preservation of these key habitat areas are necessary to conserve species richness but the connection between the patches also needs to remain in order to encourage healthy breeding of species(Smith & Wachob, 2006).

Another study that takes place is in the greater Yellowstone, Grand Teton area. It helps to better understand the areas of most critical habitat that could lead to loss of protected species if not well managed and protected. Human activity and development can “interrupt ecological flows between protected areas and adjacent areas” leading to a loss of biodiversity (Piekielek & Hansen, 2012). When addressing the visual change from past to present in habitat loss to human land use the habitats with the least amount of area remaining were found to be sagebrush, riparian, and deciduous (Piekielek & Hansen, 2012). This has a direct correlation with the private lands that are found in the area (Piekielek & Hansen, 2012). These private lands are found within the lower-elevation river valleys where key habitat is vulnerable for destruction due to the desire for private development of these areas (Piekielek & Hansen, 2012). Knowing about key habitat concerns such as these can help to protect species such as the pronghorn and sage grouse which are currently a management concern (Piekielek & Hansen, 2012).

# ECOLOGICAL CORRIDORS

The topic of ecological corridors adresses how corridors allow wildlife to migrate successfully and safely among development as well as preserving key habitat connections. Information is needed on the areas of key habitat and species found within the region to create and protect existing ecological corridors around Jackson. The specifics of the corridor itself also needs to be known, such as the approximate size and scale of the corridor for the key species to feel comfortable using. The current use of the land also needs to be known such as where the species migration is happening currently. Also, areas of critical habitat that may need restoring should be identified in the area. Knowing about ecological corridors is dependent on the urban wildlife interface because knowing how key species react to being close to human activity will affect the design and scale of the corridors. These corridor characteristics are also tied to major landscape ecology principles. Ecological corridors is interrelated to low-impact development because current wildlife migration could be crossing areas of development or resulting infrastructure such as roads that lead to wildlife mortality and conflict. And lastly, by knowing about the current ecological corridors, key habitat areas that are at risk of fragmentation by tourism can be addressed.

When thinking about key species of the area, a wide range of representation is suggested so that biodiversity of the area can be maintained (Majka, Jenness, & Beier, 2007). It is suggested that species be chosen based on the consideration of these topics- "area-sensitive species, habitat specialists, dispersal limited, barrier-sensitive species, metapopulations, and ecologically important species" (Majka et al., 2007). It's noted that in Mountain resort areas biodiversity of the area might be naturally low due to the extreme environmental conditions (Strong, Rimmer, McFarland, & Hagen, 2001). It has been documented that the key predator species of the Jackson area are grizzly bear and grey wolf and key prey species are elk, deer, and moose (Johnson, Maxwell, & Aspinall, 2003). Species that are territorial are said to be more susceptible to fragmentation (Strong, Rimmer, McFarland, & Hagen, 2001). However, key species can be identified based on the species of concern documented by the U.S. Forest Service.

Figure 2.9 Example of a wildlife overpass in Banff National Park- Alberta, Canada.

Within the Bridger-Teton National forest surrounding Jackson, WY, the U.S. forest service has documented two endangered species, four threatened species, one proposed threatened species, and 19 sensitive species living within the forest region ("INTERMOUNTAIN REGION (R4) THREATENED, ENDANGERED, PROPOSED, AND, SENSITIVE SPECIES," 2016). For a more accurate representation of the species located within the actual range of the project area a five mile radius was established. A tool provided by the U.S. Fish and wildlife service was able to narrow down the Threatened and endangered species as well as sensitive bird species of the five mile radius (U.S. Fish & Wildlife Service, 2016a). The tool is provided on a website to identify environmental impacts that development projects could have on a certain area. The tool allows the user to draw a boundary for the project area on a map and then it produces a list of sensitive species and habitat that have been identified within the project boundary. Found within the area is one threatened bird- the yellow-billed cuckoo, two threatened mammals- the Canada Lynx and the grizzly bear, two experimental populations- the black-footed ferret and the grey wolf, and one proposed threatened species- the North American wolverine (U.S. Fish & Wildlife Service, 2016a). There was also an abundant amount of migratory birds within this area but by comparing it to the U.S. forest service's sensitive species list only four in the area are considered sensitive ("INTERMOUNTAIN REGION (R4) THREATENED, ENDANGERED, PROPOSED, AND, SENSITIVE SPECIES," 2016). These sensitive bird species are the bald eagle and the greater sage-grouse, which can be found year-round in the area, and the peregrine falcon and flammulated owl, which can be found in the area during their breeding season (U.S. Fish & Wildlife Service, 2016a). By looking at each of these species' life history, habitats can better be protected and corridors can be implemented to better serve theses species in an effort to save these dwindling populations that are vital to the surrounding ecosystem (Anderson & Jenkins, 2006).

The Canada lynx is found within boreal forests where it finds its main source of food, the snowshoe Hare (U.S. Fish & Wildlife Service, 2016c). It uses the matrix habitat, meaning the non-boreal forest, to travel between the patches of boreal forest habitat to find its food (U.S. Fish & Wildlife Service, 2016c). With the snowshoe hare being the lynx's primary food source, their population has a direct effect on the population size of the lynx. The more dense the hare population, the larger the population of lynx

Figure 2.10 Canada lynx

Figure 2.11 Grizzly bear

Figure 2.12 North American wolverine



that can be supported (U.S. Fish & Wildlife Service, 2016c). So, in order to plan for the conservation of the Canada lynx, consideration of the hare's habitat also needs to occur. Although the lynx's main food source is the snowshoe hare it's prey also includes "squirrel, grouse, porcupine, beaver, mice, voles, shrews, and fish" (U.S. Fish & Wildlife Service, 2016c). The home range of the Canada lynx can range "between 12 to 83 square miles" (U.S. Fish & Wildlife Service, 2016c). It's important to know their home range because it helps to define the structure of the corridors as well as the distances they may need to travel in order to find food. The reason the Canada lynx has such a wide varying home range is because they have to expand their home range when they can't find food (U.S. Fish & Wildlife Service, 2016c). And lastly the biggest threat to the Canada lynx seen in the U.S. is the "predominant land uses" of "timber harvest, recreation, and their related activities" (U.S. Fish & Wildlife Service, 2016c). Fatalities caused on roadways has also contributed to their declining populations due to the large distances traveled by the Canada lynx (U.S. Fish & Wildlife Service, 2016c). "The primary factor that caused the lynx to be listed was the lack of guidance for the conservation of lynx and snowshoe hare habitat in plans for federally managed lands" (U.S. Fish & Wildlife Service, 2016c).

The grizzly bear is actually currently proposed for de-listing in Wyoming but its symbolic meaning to the west still makes it a valuable species to study (U.S. Fish & Wildlife Service, 2007). Although the grizzly population may be doing well in Wyoming, the grizzly bear is still only found in "2% of its original range" (U.S. Fish & Wildlife Service, 2007). Much of this is caused by the barriers found within the grizzly's large home range. The home range of female grizzly bears ranges from "50-300 square miles" while the male's stretches even further from "200-500 square miles" (U.S. Fish & Wildlife Service, 2007). The grizzly bear's habitat ranges from forests, to meadows and grasslands (U.S. Fish & Wildlife Service, 2007). They make their way to lower elevations in the spring time and winter they return to the higher elevations for hibernation (U.S. Fish & Wildlife Service, 2007). The grizzly bear's diet is made up mainly of "80-90% green vegetation, fruits and berries, nuts, bulbs, and roots" (U.S. Fish & Wildlife Service, 2007). Grizzly bears also eat insects found on the bottom of logs and rocks and most of the meat found in their diet comes from carcasses (U.S. Fish & Wildlife Service, 2007). The threats currently to the grizzly bear population is "degradation of habitat due to rural or recreational development, road building, energy and mineral exploitation" (U.S. Fish & Wildlife Service, 2007). One major issue that is harmful to the grizzly bear is the "habitat destruction in valley bottoms and riparian areas" since these are vital for the grizzly bears to use when migrating in search of food (U.S. Fish & Wildlife Service, 2007). However the biggest threat mentioned to the grizzly bear is human caused mortality(U.S. Fish & Wildlife Service, 2007). This can occur either through hunters mistaking them for black bears or through behavioral instances such as becoming food conditioned or habituated as discussed earlier (U.S. Fish & Wildlife Service, 2007). This habituation can lead to dangerous conflict leading to the mortality of grizzly bears (U.S. Fish & Wildlife Service, 2007).

The North American wolverine has a unique habitat that isn't characterized by vegetation, or geology, but instead by climate (U.S. Fish & Wildlife Service, 2016g). The North American wolverine needs "cold temperatures and receive enough winter precipitation to reliably maintain deep persistent snow late into warm seasons" (U.S. Fish & Wildlife Service, 2016g). So because of Jackson's geographical location they will be found at high elevations (U.S. Fish & Wildlife Service, 2016g). The primary food source of the wolverine is scavenging for carrion but they also use their strong sense of smell to locate prey such as "small animals, birds, fruits, berries and insects" below the snow (U.S. Fish & Wildlife Service, 2016g). The wolverine's home range is between less than 38 square miles to 348 square miles (U.S. Fish & Wildlife Service, 2016g). Like the lynx, their range depends on their ability to find food (U.S. Fish & Wildlife Service, 2016g). Unfortunately, "the primary threat to the wolverine is from habitat and range loss due to climate warming" (U.S. Fish & Wildlife Service, 2016g). The North American wolverine is pendent on the deep snow lasting until spring and cool summers at higher elevations (U.S. Fish & Wildlife Service, 2016g). There are other threats to the wolverine but none are as detrimental as climate

change but they could lead to further suppression of "an already stressed population" (U.S. Fish & Wildlife Service, 2016g). These threats include "trapping, human recreational disturbance, infrastructure developments, and transportation corridors (U.S. Fish & Wildlife Service, 2016g). After careful consideration of all its traits, the North American wolverine would not be as impactful to map as other species due to its presence at high elevations as well as its uncontrollable threat of climate change for this project.

The grey wolf is an introduced species to the region so it's classified as a non-essential species (U.S. Fish & Wildlife Service, 2016e). The grey wolf are habitat generalists, so as long as they can find food and avoid high human caused mortality rates they can survive with a healthy population(U.S. Fish & Wildlife Service, 2016e). The primary food source of the grey wolf is "Ungulates (wild and domestic)" but they also "readily scavenge" for food (U.S. Fish & Wildlife Service, 2016e). Wolves are very territorial of their land and have a home range from "25- 1,500 square miles"(U.S. Fish & Wildlife Service, 2016e). Like other animals, this range depends on their ability to find enough food within their territory (U.S. Fish & Wildlife Service, 2016e).

The black-footed ferret is also an introduced species classified as non-essential however, it is considered one of the most endangered animals in the world ("Black-footed Ferret :: Documents," 2013). This is due to the fact that they are a "highly specialized predator that depends on prairie dogs for survival" ("Black-footed Ferret :: Documents," 2013). Ninety percent of the black-footed ferret's diet consists of prairie dogs but they also use their burrows for shelter from weather and predators and a place to raise their young ("Black-footed Ferret :: Documents," 2013). The primary cause of their endangerment is from habitat and prey loss ("Black-footed Ferret :: Documents," 2013). The black-footed ferret occupies "less than 2% its original range" due to the "conversion of native grasslands into agricultural lands, widespread prairie dog eradication programs, and fatal, non-native diseases" ("Black-footed Ferret :: Documents," 2013). The habitat that still exists is highly fragmented by agricultural lands and development ("Black-footed Ferret :: Documents," 2013).

The yellow-billed cuckoo is a threatened species found within the area ("Yellow-billed Cuckoo, Life History, All About Birds - Cornell Lab of Ornithology," 2015). Its habitat is tree canopies of deciduous trees where there are "woodland patches with gaps and clearings" and are located near water ("Yellow-billed Cuckoo, Life History, All About Birds - Cornell Lab of Ornithology," 2015). They can usually be found in willows or groves of cottonwoods along riparian areas ("Yellow-billed Cuckoo, Life History, All About Birds - Cornell Lab of Ornithology," 2015). The main threat to the yellow-billed cuckoo is its loss of habitat along the riparian corridors due to development and agricultural lands ("Yellow-billed Cuckoo, Life History, All About Birds - Cornell Lab of Ornithology," 2015). Another threat to these birds is development that blocks their flight patterns ("Yellow-billed Cuckoo, Life History, All About Birds - Cornell Lab of Ornithology," 2015). Tall buildings, wind turbines, cell towers, and other such structures block the path of these birds when they travel at night leading to collisions and possible deaths ("Yellow-billed Cuckoo, Life History, All About Birds - Cornell Lab of Ornithology," 2015).

The bald eagle, a symbol of our nation, has been marked a sensitive species within the area as well (U.S. Fish & Wildlife Service, 2016b). The bald eagle's habitat is found in large trees with an open canopy and often found near large bodies of water (U.S. Fish & Wildlife Service, 2016b). The bald eagle's diet covers a wide range of small animals as it is known as an "opportunistic forager" (U.S. Fish & Wildlife Service, 2016b). This means that the Eagle attempts to scoop up most of its prey while in flight (U.S. Fish & Wildlife Service, 2016b). Currently the major threats to the bald eagle's population is the ingestion of contaminants and lead, as well as possible collision with objects (U.S. Fish & Wildlife Service, 2016b). Also a major threat to the species is the "degradation of shoreline habitat and disturbances at nest and roosting sites" (U.S. Fish & Wildlife Service, 2016b).

The greater sage grouse is a sensitive species in this area because it only has one habitat type being sagebrush steppe (U.S. Fish & Wildlife Service, 2016f). This causes the sage grouse to be very sensitive to

Figure 2.13 Grey wolf

Figure 2.14 Black-footed ferret

Figure 2.15 Yellow-billed cuckoo

Figure 2.16 Bald eagle

Figure 2.17 Greater sage grouse

Figure 2.18 Peregrine falcon



disturbances (U.S. Fish & Wildlife Service, 2016f). Their diet consists of leaves, buds, flowers, forbs, and insects found within the sagebrush steppe (U.S. Fish & Wildlife Service, 2016f). Sage grouse behavior can either be found to migrate seasonally or to stay in one area, often depending on the weather (U.S. Fish & Wildlife Service, 2016f). Major threats occurring for the sage grouse has been habitat loss, fragmentation, and alteration (U.S. Fish & Wildlife Service, 2016f). Disturbances such as noise and human presence in these areas has effected sage grouse by limiting their habitat use as well as reducing species productivity in effected areas (U.S. Fish & Wildlife Service, 2016f).

The peregrine falcon, once an endangered species, is a sensitive species found within the area (U.S. Fish & Wildlife Service, 2016h). Peregrine falcons can be found within the urban environment and build their nests upon "high ledges of rocks or man-made structures" (U.S. Fish & Wildlife Service, 2016h). Their diet consists mostly of small birds and some mammals such as bats or squirrels and they tend to have a "patchy breeding distribution" (U.S. Fish & Wildlife Service, 2016h). The major threats that the falcon faces are "degradation of habitat, collisions, pesticides, and shooting" (U.S. Fish & Wildlife Service, 2016h).

Lastly, The flammulated owl is a sensitive species found within the area due to its unique habitat and diet (U.S. Fish & Wildlife Service, 2016d). The flammulated owl is found within mountainous open pine forests, especially ponderosa pine (U.S. Fish & Wildlife Service, 2016d). Their nests are found within tree cavities they find such as old woodpecker cavities (U.S. Fish & Wildlife Service, 2016d). Their diet is mainly made up of nocturnal arthropods and are found in the Jackson Hole area during their breeding season (U.S. Fish & Wildlife Service, 2016d). The major threat to the flammulated owl is habitat loss due to the clearing of dead trees which provide the owls with their nest cavities (U.S. Fish & Wildlife Service, 2016d). Also during the 1990's pressure was put on the owl due to silviculture and fire suppression causing a decline in numbers but now numbers are starting to increase again (U.S. Fish & Wildlife Service, 2016d).

By observing the life history of each of these wildlife species, important conclusions can then be made on how to protect them. For example, many of the species use the riparian area as either habitat where they reside or they use it as a corridor for travel. Another important conclusion is the travel ranges of the species and how the availability of prey can extend their range even further. This indicates not only do they need to be able to travel further distances but also that their food source is at low population numbers. Also noted is the human caused endangerment of some of the species due to ignorant practices such as fragmentation, noise pollution, and overuse of areas.

Another issue when discussing ecological corridors is what the current development's effects on the wildlife and habitat have been. When habitat fragmentation occurs it can cause wildlife to be separated, eventually causing the two groups to be isolated from each other (Strong, Rimmer, McFarland, & Hagen, 2001). When this happens, increases in inbreeding occur which leads to the decrease of the heterozygosity and fitness of the species (Strong, Rimmer, McFarland, & Hagen, 2001). As these edges are created they no longer provide the same habitat as the interior of the forest and the edge then experiences change due to factors such as sunlight, wind, etc. that no longer support the existing wildlife (Strong, Rimmer, McFarland, & Hagen, 2001). Thus, the decline in a species population in the area due to fragmentation is dependent on how well the animal can tolerate the edge effects as well as their ability to cross these now open spaces between patches (Strong, Rimmer, McFarland, & Hagen, 2001). If the wildlife then are willing to cross the gaps, they are now more prone to predation in these areas making it dangerous for animals to cross (Strong, Rimmer, McFarland, & Hagen, 2001). An example of where such events occurs that can be seen within the Jackson area is the development of ski areas which have high negative edge effects among elk and songbirds (Strong, Rimmer, McFarland, & Hagen, 2001).

Another influence of wildlife movement caused by development is the creation of roads that cut through wildlife habitat and creates linear boundaries (Huber, Shilling, Thorne, & Greco, 2012). This leads to fatal wildlife interactions within

Jackson, seeing on average, 114 mule deer, 35 elk, and 15 moose killed every year by vehicles (Jackson Hole Conservation Alliance, 2015b). However by the incorporation of overpasses, underpasses, and culverts, safe passage across roads to connecting habitat is possible (Majka et al., 2007). Overpasses provide safe travels for large wildlife such as grizzly bears, wolves, bighorn sheep, deer, elk, and moose to cross roadways (Majka et al., 2007). The typical overpass is between 100 to 165 feet wide but can be as wide as 650 feet (Majka et al., 2007). Underpasses and culverts are used by many types of wildlife such as "mice, shrews, foxes, rabbits, armadillos, river otters, opossums, raccoons, ground squirrels, skunks, coyotes, bobcats, mountain lions, black bear, great blue heron, long-tailed weasel, amphibians, lizards, snakes, and southern leopard frogs" (Majka et al., 2007). These structures allow for the creation of a corridor for safe passage of wildlife to connecting areas of habitat.

Urbanization is looked at as having devastating impacts on habitat because the effects they create can't be reversed back to its previous state (MARKOVCHICK-NICHOLLS et al., 2008). It creates a new environment that can't sustain the biodiversity that area once had (MARKOVCHICK-NICHOLLS et al., 2008). Modeling habitat fragmentation at a ski resort indicated "when a landscape is fragmented to the point at which less than 58% remains forested, then the landscape no longer percolates or retains connectivity" (Strong, Rimmer, McFarland, & Hagen, 2001). This is why identifying key areas of habitat and their connecting corridors is important before deciding where future development should occur. In order to identify key corridor connections to habitat all areas of potential linkages need to be identified even if it includes areas of current urbanization (Majka et al., 2007). Each of these areas need to define "what wildland areas the linkage would connect" as well as knowing the species that need to travel between those areas (Majka et al., 2007). And lastly, knowing "what activities threaten the linkage and the severity of each threat" should be known by measuring each threat on a scale (Majka et al., 2007). After all the potential linkages have been identified they then need to be prioritized (Majka et al., 2007). Prioritizing linkages of least to greatest importance is achieved by evaluating the conditions of what exists there now and what can occur in the future (Majka et al., 2007). One consideration is biological value (Majka et al., 2007). If that linkage were to be lost, would the species be able to continue to survive? Or would it affect the species gene flow? (Majka et al., 2007). Another consideration is what is called threat and opportunity (Majka et al., 2007). If this linkage is lost, would there ever be a way to reverse it (Majka et al., 2007)? An example of a threat would be a road, and an opportunity would be current conservation efforts (Majka et al., 2007). Identification of "wildland blocks" is needed (Majka et al., 2007). These are the key large habitat patches that the corridors will connect together (Majka et al., 2007).

After identification of where key linkages should occur, specifics characteristics are used to describe the actual structure of these corridors. There are three structural elements that make up a corridor: width, connectivity, and habitat quality (Anderson & Jenkins, 2006). The width of the corridor "determines how much of the corridor interior is exposed to disturbances or edge effects, whether natural or human-induced, from the surrounding matrix" (Anderson & Jenkins, 2006). It is suggested that " a minimum width for a corridor dweller should be at least two home range widths along all or most of the length of the corridor" (Majka et al., 2007). This allows for species that live within the corridor to comfortably migrate and avoid predator species. For "passenger species the path can be narrower than their home range but still needs to be wide enough for animals to feel comfortable utilizing" (Majka et al., 2007). It also depends on the ratio of length to width, the longer the corridor the wider it needs to be to accommodate more biodiversity (Anderson & Jenkins, 2006). If the habitat found within the corridor does not correlate with the habitat within the matrix then severe edge effects will occur (Anderson & Jenkins, 2006). Connectivity of the corridor "refers to the degree to which gaps interrupt corridor habitat" (Anderson & Jenkins, 2006). Depending on certain species behavior, some species may thrive more where there isn't a continuous corridor but instead "stepping stones" of forest is provided to help the animal see

Figure 2.19 Flammulated owl

Figure 2.20 Example of fragmentation by Snow King ski resort.

Figure 2.21 Example of a wildlife underpass

impending threats (Anderson & Jenkins, 2006). When creating corridors between patches it's important to provide multiple routes the animal can take, this allows more biodiversity to traverse between the patches as well as avoidance of predators (Anderson & Jenkins, 2006). Lastly, habitat quality as a structural element in corridor design "should provide the highest-quality habitat possible for the most sensitive species targeted for conservation" (Anderson & Jenkins, 2006). The best way to be able to determine these areas of highest quality habitat is to observe where current animal movement patterns are taking place (Anderson & Jenkins, 2006).

In their book "Applying Natures Design", Anderson and Jenkins have outlined a list of design guidelines to follow when designing corridors:

- "Link only patches that were formerly connected and that contain naturally contiguous habitat types. This should help to avoid unnatural range expansion or introduction of invasive species to patches of high quality habitat"
- "Minimize connection of artificial or disturbed patches"
- "Identify and preserve existing natural corridors such as riparian zones and migration routes. Riparian zones can often help protect water quality and maintain high concentrations of biodiversity, particularly in arid regions"
- "Place corridors along altitudinal and latitudinal gradients to incorporate maximum biodiversity and mitigate effects of climate change"
- "Avoid long stretches (>12 km) without nodes, and build redundant connections via alternative pathways or networks"(Anderson & Jenkins, 2006)

These guidelines help to create successful corridors for a large range of biodiversity. Another important aspect of modeling habitat corridors is attention to the scale of the data being used (Anderson & Jenkins, 2006). The connectivity of the habitat changes when moving from coarser data to more defined data (Anderson & Jenkins, 2006). For example, in a study done in the San Joaquin Valley in California their research resulted in different findings of connectivity depending on what scale of data was being evaluated (Huber, Shilling, Thorne, & Greco, 2012).For the five and ten kilometer extents, it showed high connectivity in patches, especially through the riparian forest. At 20 kilometer extent, however, there were lower levels of connectivity around the city. It was found that having a grain size of 100 m grid cells was inappropriate for modeling habitat that is highly fragmented because it was too coarse to see small patches in the study area. The corridors near the city were reduced to zero connectivity when the scale became larger. From their method of modeling, their approach allows for more flexibility in wildlife movement because it identifies that there is a number of possible connections. Their research looks at areas where movement is least impacted instead of where there are areas of constricted flow. Least cost connectivity may identify a path for wildlife but if barriers like land cover gaps, roads, and other barriers exist, this hinders movement. (Huber et al., 2012)

# LOW-IMPACT DEVELOPMENT

Low impact development creates housing that is needed in the growing development of Jackson, Wyoming. Not only does it provide homes for the residents but, it creates an environmentally conscious design with minimal disturbance to wildlife and their surrounding habitat. For creating low-impact development within Jackson, information is first needed on Jackson's affordable housing demands. From there, how to design better infrastructure that has minimal negative environmental impact is needed. Another piece of information needed is what the effect of development on the ecological edge is as well as how fragmentation can be healed and corridors can be created within a development. It is necessary to understand wildlife interactions with humans at the urban edge to generate design strategies for new development that will control and mitigate unsafe interactions. Low-impact development can be better informed by ecological corridors by knowing where the key habitat areas are and current patterns of migration. Development can then be planned to avoid conflict with these corridors to prevent wildlife mortality or fragmentation of critical habitat. And lastly, low-impact development is influenced by tourism impacts by socio-economic impacts and the amount of affordable housing that is needed for Jackson.

After identifying areas best suited for future development based on the analysis at the regional scale, conservation efforts need to be considered at the site scale. One approach to this design thinking is called conservation subdivision design (Arendt, 1996). Conservation subdivision design is an approach where "half or more of the buildable land area is designated as undivided, permanent open space and half for development" (Arendt, 1996). For design, the land to be preserved gets split into "Primary Conservation Areas" and "Secondary Conservation Areas" (Arendt, 1996). Primary areas are areas that can't be built upon such as steep slopes or wetlands (Arendt, 1996). Secondary conservation areas are areas that shouldn't be built on because of its critical habitat or significance such as old growth forests or a historical site (Arendt, 1996). Of the half open space, half should be retained as its current habitat and the other half can be managed open space such as recreation opportunities (Arendt, 1996). Randall Arendt's process for designing conservation subdivisions are as follows:

"Phase 1 –background stage (4 steps)

1.Understanding the locational context- new development should reflect historical context

2.Mapping natural, cultural, and historic features

a.Soils

b.Wetlands- identified with upland buffer areas around them

c.Floodplains- develop beyond 100 year floodplain with a recommended set back 50-100 feet from edge of floodplain

d.Slopes- greater than 25% should be left alone, 15-25% should avoid if possible

e.Significant wildlife habitats- threatened or endangered species habitat or corridors

f.Woodlands- should be kept

g.Farmland- contributes to water pollution large scale development discouraged in these areas

h.Historic, archeological, cultural

i.Views into and out from the site

j.Aquifers and their recharge areas

3.These maps then become integrated into layers and these layers are overlaid to see areas best for conservation

4.Prioritizing objectives- wetlands floodplains and slopes should be most closely considered because they are most sensitive for ecological resources" (Arendt, 1996).

"Phase 2- Design stage (4 steps)

1.Identifying all potential conservation areas

2.Locating the house sites- optimizing number of "view lots"

3.Designing street alignments and trails- streets should avoid disturbing important environmental aspects as well as minimizing the amount of length needed. Suggested uses are "terminal vistas", "reverse curves", and "single-loaded" streets. It's also suggested to minimize dead-ends.

4.Drawing in the lot lines- if open space is located behind lots then smaller lot depth is appropriate" (Arendt, 1996).

In order to achieve a low impact design attention needs to be given to creating a sustainable design as well. This is achieved not only through the physical attributes of a site design but also through the attention to the attributes that positively

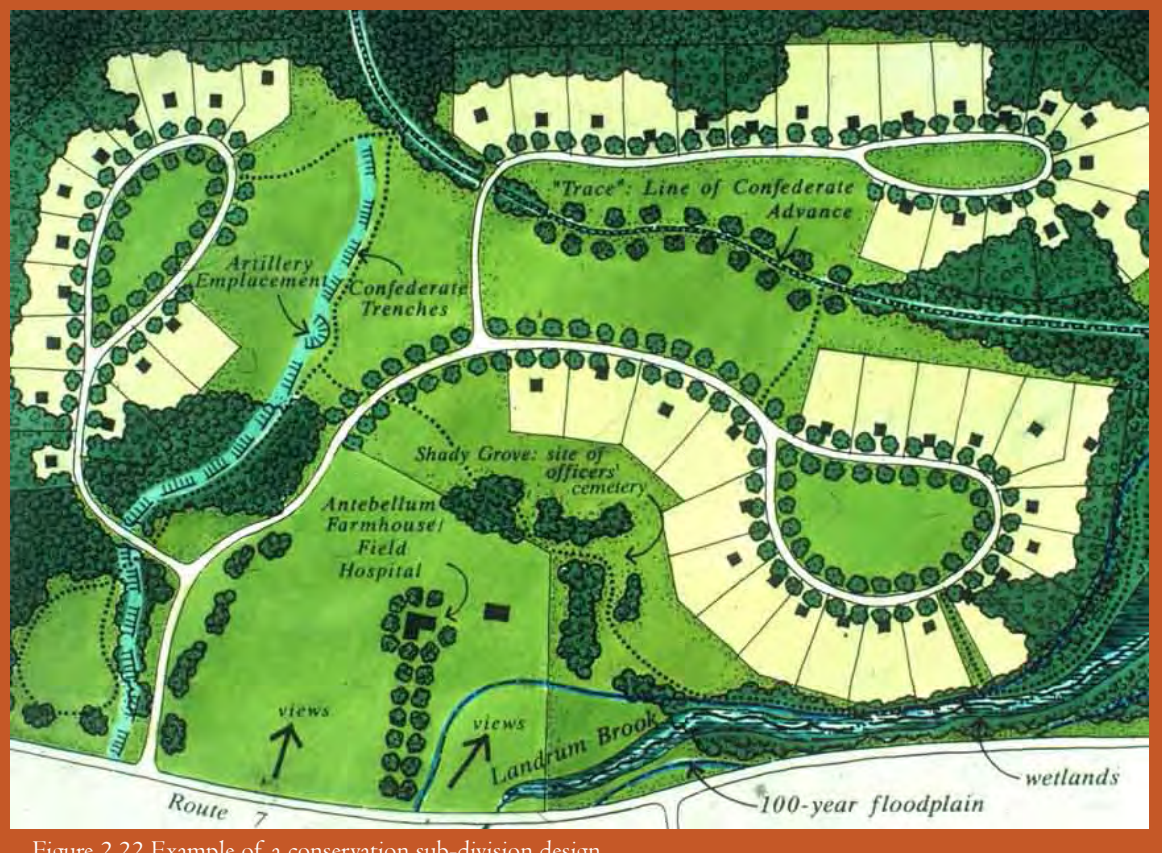



Figure 2.22 Example of a conservation sub-division design.

impact the community members. When accounting for human health and well-being in a design it has the power to strengthen the connection between human and nature, "inspire and encourage a sense of stewardship", and improve "physical, mental, and social health" in everyday lives (Venhaus & Dreisitl, 2012). Some of these variables can be quantified and measured through programs such as the sustainable SITES initiative and LEED but all can be improved by keeping in mind key factors when working through the design process.

One aspect of human health is physical health. By creating more opportunities for the community to engage in physical activities it helps users to "prevent disease, boost energy levels, mental health, help prevent depression, and maintain self-esteem" (Venhaus & Dreisitl, 2012). By incorporating these opportunities into the site design it encourages people to be physically active everyday through various different strategies. Such strategies to "make outdoor physical activity convent and inviting" are:

- "Link community to surrounding sidewalks and trails
- Encourage walking by providing centrally located amenities
- Limit parking and provide other amenities that encourage walking or biking such as bike racks, changing rooms, etc.
- Multi-functional spaces that can hold organized or casual meeting spaces for physical activity"(Venhaus & Dreisitl, 2012)

With the creation of opportunities for physical activity, the need for making sure that the users are safe is an important element. In order to see outdoor spaces successful the user needs to be able to feel safe and comfortable using the area (Venhaus & Dreisitl, 2012). Some strategies to make these spaces safe and comfortable are:

- "Protection from climate conditions. Provide spaces in both sun and shade
- Implement Crime Prevention through Environmental Design (CPTED)
- Walkways and trails visible and easily accessible
- Multiple entrances and exits of the site
- Avoid routing trails near roads
- Wide un-obstructive pathways with interval seating
- Easy to navigate
- Open sight lines"(Venhaus & Dreisitl, 2012)

The second aspect of human health is mental health. Interesting research has been done to find the connection between nature and mental well-being such as "Researches in Illinois Landscape and Human Health Laboratory have found direct access to green space to be associated with lower levels of irritability and aggression and an improved ability to concentrate" (Venhaus & Dreisitl, 2012). As long as quality spaces are provided for the users it has a profound ability to improve mental health. Strategies for providing restorative settings include:

- "Frame and direct views to wilderness
- Screen undesirable views to electrical equipment, transmission towers, HVAC equipment, power lines, etc.
- Avoid design features that stimulate stress such as cave-like spaces, pointed pierced forms, abstract art, etc.
- Provide focal point  or positive distraction
- Use landscape elements such as low walls, fences, vegetation screening or topography to create sense of closure that is both comfortable and safe
- Encourage site users to explore landscape more fully
  - -Provide multi-sensory experiences
  - -Provide moveable seating for users to modify their needs
  - -Create a comfortable microclimate
  - -Implement safety strategies
- Mitigate noise pollution
  - -Maximum accessible noise level standard 55 decibels
  - -Traffic calming helps reduce noise
  - -Strategically locate outdoor noise barrier
  - -Design in pleasurable sounds such as water, leaves, etc." (Venhaus & Dreisitl, 2012).

Lastly, the third aspect of human health is social interaction. Social interaction, especially in a community, is important because it leads to health benefits such as a heightened immune system, a longer life expectancy, as well as sense of belonging (Venhaus & Dreisitl, 2012). By creating more opportunities for social interactions these areas then develop a stronger sense of community (Venhaus & Dreisitl, 2012). The way that this is achieved is by

Figure 2.23 Children playing in a natural environment.

Figure 2.24 Example of a nature-based playground

Figure 2.25 Demonstrates how green roofs can also provide habitat.

providing community spaces such as trails, parks, and other common spaces where people can interact with each other on a daily basis (Venhaus & Dreisitl, 2012). Some strategies for achieving higher social interaction are:

- "Variety of comfortable gathering spaces that accommodate different sizes, year-round use, micro-climate conditions, and visual safety
- Provide comfortable spaces for people to sit and socialize
- Gathering spaces should be located in convent spaces near areas that naturally attract activity
- Provide a focal point
- Design space for community activities that attract visitors
- Provide amenities that attract visitors" (Venhaus & Dreisitl, 2012).

Other design strategies to consider are those that effect children. When designing a community, more times than not children need to be considered as members who are also present in the community (Venhaus & Dreisitl, 2012). As good design can influence the health and well-being of adults, it can also help in the development of children. By using good design strategies it can "enhance children's attention span and reduce symptoms of ADHD" (Venhaus & Dreisitl, 2012). These design strategies include:

- "Design landscapes that encourage children to play spontaneously without adult assistance
- Encourage independent mobility of children through neighborhood paths and trails separate from vehicular traffic
- Use a mosaic of vegetation, natural materials, and varied topography to encourage versatile play and exploration
- Consider seasoned change and the different play environments they provid
- Select resilient materials that tolerate active play
- Avoid boring designs and design with challenges that create safe risks
- Provide age appropriate access to water
- Create landscapes that attract wildlife and allow children to catch and release creatures such as fish, frogs, and insects
- Provide adult size seating and spaces to encourage adult /child interactions in play areas"(Venhaus & Dreisitl, 2012)

When designing a LID other environmental practices can be implemented through small details and choice made while designing. Air pollution is one aspect that, through strategic design choices, can help to reduce its negative impact on the environment (Venhaus & Dreisitl, 2012). The main source of air pollution in Jackson comes from the amount of motor vehicle use that occurs there. The best way to help mitigate this pollution is through vegetation. Vegetation helps to filter out the toxic pollutants released into the air (Venhaus & Dreisitl, 2012). Another important consideration is helping to reduce heat caused by the heat island effect (Venhaus & Dreisitl, 2012). This can be achieved though vegetation by helping to shade heat absorbing surfaces, reduction of impervious surfaces, as well as to pick materials that have a high solar reflection (Venhaus & Dreisitl, 2012).

Another LID consideration is how to reduce the energy of a site. Jackson is already notorious for a high energy use so being able to reduce a site's energy use would help to relieve some pressure. One way energy can be reduced during the construction of a site is by using reclaimed and recycled material, "minimally processed" materials as well as local materials (Venhaus & Dreisitl, 2012). This allows for less energy to be used when these materials are being manufactured as well as the amount of energy exerted delivering the materials on site (Venhaus & Dreisitl, 2012). Other energy reductions that can occur is through the operating energy of buildings (Venhaus & Dreisitl, 2012). Strategies to achieve this are:

- "orientation of buildings to use suns energy perpendicular to true North and South
- Obstruct or channel wind flow to create favorable microclimates ( windbreaks can reduce a building's winter heating costs by approximately 1/3)
- Strategically shade buildings"(Venhaus & Dreisitl, 2012).

Lastly, and LID tool that can be implemented is intensive or extensive green roofs (Venhaus & Dreisitl, 2012). Green roofs not only provide environmental benefits, they also help to increase the life span of the roof (Venhaus & Dreisitl, 2012). Green roofs can actually aid in providing habitat for birds, lizards, and insects that might have otherwise been lost during construction (Venhaus & Dreisitl, 2012). The green roof should consist of native soil and vegetation in order to provide a habitat for local wildlife (Venhaus & Dreisitl, 2012).

# TOURISM IMPACTS

Tourism impacts address the dynamic of the proximity of Jackson, Wyoming to two national parks. Tourism has severely impacted the development of Jackson as well as the interactions with wildlife. It has increased habitat fragmentation, traffic in the area, as well as closer interactions with the wildlife. For tourism impacts on the Jackson, Wyoming area information is needed on the socio-economic conditions within Jackson. Also needed is knowledge on the habitat fragmentation that has already occurred in the area compared to the historic conditions. Other negative impacts that tourism has had on the wildlife, such as noise pollution and infrastructure need to be understood as well. Knowing the tourism impacts will help influence low-impact development because knowing the socio-economic state of Jackson due to tourism is important in order to know how to create successful low-impact development and how much is needed. Tourism impacts influence the urban wildlife interface by creating pollution such as noise pollution which is going to affect the wildlife behavior. And lastly, tourism impacts helps to define ecological corridors because by knowing where recreational development is happening and where tourist travel patterns are, placement of corridors can be implemented where safe passage is possible for wildlife.

An increase in population in areas such as Jackson can be seen as people are making the decision to move to areas filled with amenities of tourism and recreation (Johnson, Maxwell, & Aspinall, 2003). With rapid growth in these areas, development is affecting the landscape as well as impacting the habitat and wildlife found there (Johnson, Maxwell, & Aspinall, 2003). One way in which Tourism impacts the habitat and wildlife is through depletion of natural resources (Srinivas, 2001). Natural resources include water and other local resource depletion, as well as land degradation such as deforestation due to increased development (Srinivas, 2001). Another main impact of tourism is pollution (Srinivas, 2001). Noise pollution from cars, buses, airplanes, and recreational vehicles cause distress on wildlife and can cause them to "alter their natural activity patterns" (Srinivas, 2001). Pollution of littering on trails leads to degradation of habitat (Srinivas, 2001). Sewage and other forms of aesthetic pollution can occur as well where development doesn't design with the native landscape in mind (Srinivas, 2001). Tourism also has physical impacts (Srinivas, 2001). Tourism leads to development that causes construction activities and infrastructure development of roads and facilities that cause habitat loss and negative wildlife interactions (Srinivas, 2001). Deforestation and intensified or unsustainable use of land occurs too such as clearing for ski resorts (Srinivas, 2001). Tourist activities can also consist of overuse on trails leading to loss of biodiversity (Srinivas, 2001). And lastly, tourist activities such as getting too close to observe wildlife can lead to behavioral changes in the wildlife leading to responses as drastic as the wildlife neglecting their young or failing to mate (Srinivas, 2001). These impacts produce devastating effects not only on the surrounding habitat, but on the wildlife that occupies them as well.

Tourism also has a big impact on the economic state of Jackson as well (Johnson, Maxwell, & Aspinall, 2003). Many of the businesses in Jackson are related to tourism or provide tourism services (Johnson, Maxwell, & Aspinall, 2003). Of the large number of people moving to the area, the largest group is identified as retirees and semi- retired people (Johnson, Maxwell, & Aspinall, 2003). This then puts the demand on Jackson to provide amenities and services for this demographic group (Johnson, Maxwell, & Aspinall, 2003). There is usually a decrease in support of "tax and levies for schools, parks and other public infrastructure" associated with an influx of retirees, which has a negative impact on the community (Johnson, Maxwell, & Aspinall, 2003). A second large group identified moving to the area is what is called "lifestyle migrants" (Johnson, Maxwell, & Aspinall, 2003). These are people that move to the area for the recreation and adventure, but often aren't there for long and are not invested in the community (Johnson, Maxwell, & Aspinall, 2003). As these demographics are growing in the area there also is a group that is declining, the "agricultural producers" (Johnson, Maxwell, & Aspinall, 2003). The Jackson area is largely populated by farmers and ranchers but many farmers have started selling their land due to declining income or having no one to take over the business (Johnson, Maxwell, & Aspinall, 2003). This leads to the land being sold either for development or kept for recreational use (Johnson, Maxwell, & Aspinall, 2003), as well as land being subdivided into parcels that aren't ecologically maintained well.

Figure 2.26 Tourism activity that can be disruptive to wildlife.

Figure 2.27 Example of litter polution that occurs in Jackson.

Figure 2.28 Tourist activities that could lead to wildlife behavioral changes.

# CASE STUDIES

## Project name
Tassafaronga Village

## Location
Oakland, California
81-85th Ave, E-G streets
930 84th Ave (property management)
Oakland, California  94612
United States

## Date designed and planned
Planning started in 2005 ("Tassafaronga Village | AIA Top Ten," 2016).

## Construction completed
Construction was completed in June, 2010. It took 24 months to complete (Kimmelman, 2012).

## Cost
The cost of the project was  $52,800,000.00 excluding the land cost ("Tassafaronga Village | AIA Top Ten," 2016). A total cost was $54 Million, falling $1.45 Million under budget (Kimmelman, 2012).

## Size
The size of the project is seven and a half acres ("David Baker Architects: Tassafaronga Village," n.d.).

## Landscape architect(s)
The landscape architects on the project was PGA design, a local firm ("David Baker Architects: Tassafaronga Village," n.d.). The architects for the project were David Baker Architects which are also a local firm ("David Baker Architects: Tassafaronga Village," n.d.).

## Client
Oakland Housing Authority

## Context
Tassafaronga Village is a community development designed to provide high density affordable housing for its residents. It offers the community a "range of affordable housing, green pathways, pocket parks, and open spaces" ("David Baker Architects: Tassafaronga Village," n.d.). The site land on which it sits is located on a remediated brown-field site between industrial use on one side and housing developments on the other. It's located within a temperate inland coastal zone ("Tassafaronga Village | AIA Top Ten," 2016). The project consists of 157 total units: 7 studios, 77 townhomes, 16 one bedroom apartments, 34 two bedroom apartments, 23 three bedroom apartments, and 22 habitat for humanity sites ("David Baker Architects: Tassafaronga Village," n.d.). This creates a high density housing community with 25 units per acre and 1.2 parking spaces per unit ("David Baker Architects: Tassafaronga Village," n.d.).

## Site analysis
The site, located within Oakland, California, is surrounded by amenities such as a public library, local schools, a city park, and a community center. As well as it is located within a half mile of bus and rapid-transit lines ("Tassafaronga Village | AIA Top Ten," 2016). It's location on the edge of both the industrial uses and housing provided a unique opportunity for the designers to incorporate both images into the design inspiration.

## Project background and history
The project is a redevelopment of a brown-field site that originally was war-worker housing built in 1945. Before the project was started, the site was old public housing, an abandoned pasta factory, as well as had old railroad tracks crossing through it. The area was high in crime. Tassafaronga Village became OHA's "first self-developed tax-credit property" ("Tassafaronga Village | AIA Top Ten," 2016).

## Genesis of project
The project started with the planning by the Oakland Housing Association in 2005 where the first steps consisted of a neighborhood outreach that spanned two and a half years ("Tassafaronga Village | AIA Top Ten," 2016). Unfortunately during that process an investor helping to fund the project, Hope IV backed out so the OHA had to pull from its reserve funds in order to keep the project going ("Tassafaronga Village | AIA Top Ten," 2016). The first phase of the project built the 137 townhouses and the apartments ("Tassafaronga Village | AIA Top Ten," 2016). The second phase of the project incorporated the redevelopment of the pasta factory apartments and the on-site medical clinic ("Tassafaronga Village | AIA Top Ten," 2016).

## Design development and decision making processes
The goals set for this project were to "strengthen the existing urban fabric, elevate the quality of life, and achieve the highest sustainability"


Figure 2.29 Shared community courtyard area.


Figure 2.30 Shared open space.


Figure 2.31 View of green roof and solar panels.

("Tassafaronga Village | AIA Top Ten," 2016). In order to achieve the LEED sustainability goal a green charrette took place between the designers ("Tassafaronga Village | AIA Top Ten," 2016). A range of housing types were included in the project such as town houses, 3 story apartments, a reclaimed pasta factory into apartments, and site area left for habitat for humanity. A public plaza was implemented to provide community engagement as well as rooftop courtyards for more restricted privacy ("David Baker Architects: Tassafaronga Village," n.d.). Due to the history of crime in the area the "eyes on the street" approach was taken by having all entrances face either the street, the park, or the courtyards ("Tassafaronga Village | AIA Top Ten," 2016). In order to create a cohesive site design the OHA facilitated a "land swap/lot line exchange" with an adjacent piece of land so that the whole site was connected ("Tassafaronga Village | AIA Top Ten," 2016).

## Role of landscape architects

The role of the landscape architects was to create a more safe community engaging atmosphere while reaching the goal of providing 100% storm-water management ("Tassafaronga Village | AIA Top Ten," 2016). Also they were to follow the Bay Friendly Landscaping Guidelines projected to have reduced the irrigation usage by 81% ("Tassafaronga Village | AIA Top Ten," 2016).

## Program elements

The design was programmed to meet LEED ND gold certification ("Tassafaronga Village | AIA Top Ten," 2016). This entailed certain elements to be implemented to reach such a high level of neighborhood sustainability. The storm-water treatment was designed to handle a 24 hour 2 year storm event ("Tassafaronga Village | AIA Top Ten," 2016). This was achieved through elements such as flow-through curbs, permeable gutters, infiltration planters from rooftop runoff, as well as green roofs ("Tassafaronga Village | AIA Top Ten," 2016). Open space was also maximized on site by incorporating the parking into the apartment buildings as well as providing on street parking ("Tassafaronga Village | AIA Top Ten," 2016).

The design also achieved the LEED for homes platinum rating, further increasing the sustainability of the project. This was achieved by incorporating solar power on site to generate electricity and hot water ("David Baker Architects: Tassafaronga Village," n.d.). It was documented that "88% of the demolition waste was sorted on site and re-used or recycled", 93% of the existing factory was re-used on site, and 40% of the development is planted landscape ("Tassafaronga Village | AIA Top Ten," 2016). Low flow fixtures were installed to reduce 30% of potable water use ("Tassafaronga Village | AIA Top Ten," 2016). Energy reduction was achieved by using all energy star appliances, high-efficiency lighting, as well as solar power to heat the water which concluded in a reduction of 40-48% per building and 30% for the pasta factory ("Tassafaronga Village | AIA Top Ten," 2016). The concrete mix used on site was locally extracted and manufactured and contains 10% recycled aggregate ("Tassafaronga Village | AIA Top Ten," 2016). All materials were selected to be sustainable, durable, and easy to replace ("Tassafaronga Village | AIA Top Ten," 2016).


2.32 Re-use of pasta factory for apartments on site.

## User/ use analysis.

Before the project was built, the site was riddled with crime. Now after the project has been implemented it has become a place for families to live and gather. The bike and pedestrian trails have given better access to the surrounding schools and other amenities not only for the residents but the larger community as well (Budds, 2010). Due to the efforts put forth to engage the community in the early stages of conceptualization there seems to be a tremendous positive reaction to the development as well as community members wishing to live there. This new development has made the residents feel safer so much so that they have organized a community garden (Kimmelman, 2012).

## Peer reviews

In a review by the New York Times, Tassafaronga Village was seen as creating "healthy urbanism" for these poor communities (Kimmelman, 2012). They admired the design for its open feeling to the rest of the neighborhood instead of creating a closed community (Kimmelman, 2012). One important element was the design's ability to provide amenities for the residents that most poor don't get to experience such as nice views from the buildings as well as natural light (Kimmelman, 2012). Through the incorporation of safety features as a high priority the crime rate saw a drop of 25 percent in the area (Kimmelman, 2012). One community member said the area used to be known as the "scariest place around" and now it has become a place where families feel safe to live (Kimmelman, 2012). It was reported that in the neighborhood park there is now a community garden that has been started where they grow crops that the kids then sell throughout the neighborhood to go into their savings for their education (Kimmelman, 2012). The ability for this development to bring together a community in a safe environment seems to be an impressive accomplishment in which most developments are not successful in doing.

Another review done by Diana Budds for Dwell found Tassafaronga Village to be a success. One of the highly successful aspects of this development was its ability to create linkages the surrounding neighborhoods and amenities in an area that used to be closed off (Budds, 2010). Budds also praised the development for having a "dynamic visual presence" due to its unique color palette, it's strategically placed vertical windows, as well as the illusion of the building footprints to make it look like there are multiple buildings instead of just one large building (Budds, 2010). Another intriguing aspect of the project that was mentioned is its hidden elements that are only visible by residents from within the building, such as the large open lobby


2.33 View of the pathway through the site that provides easy pedestrian access.

areas, the second story courtyards that provide playgrounds, and more greenery, and places to sit and gather, as well as the ability to see the green roofs and solar panels that top the buildings (Budds, 2010). The development was seen to have a mostly positive public reaction (Budds, 2010). The first 3 days of open applications yielded 6,000 responses of completed forms, thus validating that this kind of development is needed (Budds, 2010). However, of the 78 original residents of the area, only 10 returned after the development was completed (Budds, 2010). This is said to be a normal reaction in these kinds of cases but it seems like they were hoping to get a higher than average return rates (Budds, 2010).

## Criticism

One issue that may become problem as the development ages is if one of these pieces of technology needs replacing such as a solar panel, will the management still be actively involved in replacing an element like this quickly. And, do they have the funds to do so? Another issue is that for a high crime neighborhood, some of the planters and plantings seem to hinder areas of visibility and reach beyond the recommended three feet visibility height. If plants were to be left unmanaged, it could lead to some dangerous situations.

## Significance and uniqueness of the project

A unique aspect of this project is that it is California's first LEED ND certified project and is affordable housing none the less. Interesting design challenges that arise from this dynamic are the need to provide safety in a high crime neighborhood as well as materiality that would deter vandalism. This project through its implementation of energy efficiency and other such sustainable practices has also allowed for lower bills for the residents. Another unique aspect of this project was their ability to reuse 93% of the buildings that were previously on the site. This also helps to cut down on the construction cost allowing for lower rental prices. Another significant feature of the project is the implementation of the second story courtyards. They allow residents to spend community time outdoors in a less public place improving the residents' sense of safety. Other measures taken for safety within the development is increasing the safety within the streets. The implementation of speed tables help to slow down traffic throughout the neighborhood to make it safer for pedestrians ("Tassafaronga Village | AIA Top Ten," 2016). Also, parking for residents has been designed with safety in mind. A majority of the parking is located within the building in a parking garage ("Tassafaronga Village | AIA Top Ten," 2016). This increases the residents' safety by allowing only resident access to the area decreasing the crime that could occur otherwise such as someone being robbed on the way to their car at night or having their vehicle stolen. There is still some parking that occurs on the street but safety has been increased there by using the "eyes on the street" approach ("Tassafaronga Village | AIA Top Ten," 2016). This technique puts the building entrances and resident windows looking onto the street decreasing crime due to the high visibility. One unique aspect of this project that makes it so successful is the location near public transit. On either side of the site is a major bus line that residents can use as well as within a half a mile from rapid transit. This can be extremely important in low income housing for residents who can't afford a car. With the residents that live here it seems to be a huge success as it's reported that 75% of them use public transportation ("Tassafaronga Village | AIA Top Ten," 2016).

## Limitations

One limitation of the project is their management of the storm water runoff. They implemented many different types of great storm-water treatment practices such as flow-through street curbs, pervious concrete and bio infiltration planters that treat 100% of the storm water on site. Yet, all of the treated water then goes directly to the city storm water. If they were to have gone one step further and implemented storm water holding tanks they could have used all the treated storm water on site for irrigation and even toilet water to further reduce the amount of potable city water being used. Another limitation that comes with the storm water management practices is that although the use of pervious concrete is effective at filtering storm-water, it increases the need for maintenance as pervious concrete needs to be vacuumed and/or pressure washed annually to retain its original permeability. Another limitation of the site is the shape of its footprint. Most of the site is located within a square parcel shape except for the north end juts out on a small thin rectangular piece where the pasta factory apartments and Habitat for Humanity houses are located. This seems to divide the community and

lessen the cohesiveness of the neighborhood as a whole. Whether this division was intentional or not is unclear, but it was probably a result of the abnormal property lines they were given to work within.

## General features and lessons

Tassafaronga Village has incorporated many features in order to create a safe, sustainable, high quality, affordable housing community. Their success can only be attributed to the thought and time put in to designing these aspects. The features that led to the success of the projects safety is its priority to the pedestrian and bicycle access through the site. Orienting the design around pedestrian use has increased its use and vitality. Encouragement of community interaction through design has contributed to safety. Tassafaronga Village helped to show how low income housing doesn't equal low quality housing. By being California's first LEED ND gold certified community as well as having LEED for homes platinum certification it has raised the bar for what this type of development can do. If this low income housing project can create a sustainable living community, than surely others can as well. Not only does it provide sustainable practices but it also provides high-quality materials in order to achieve the sustainability. The re-use of recycled materials on site is a noble task that was accomplished as many don't take the time or effort to do so because it's a difficult process. The implementation of high quality efficient materials and appliances has allowed for significant decreases of residents bills suggesting that just because the materiality is of high quality, doesn't mean the cost of living has to be high as well. It's incorporation of quality community spaces and access to surrounding amenities and public transportation has helped to create a better quality of living for all residents within the area. Tassafaronga Village was able to create a vibrant low income housing community without having to sacrifice quality or its sustainability.

Figure 2.34 Wildlife underpass in Bow Valley.

## Project name

Bow Valley Wildlife Corridor

## Location

Bow Valley, Alberta, Canada

## Date designed and planned

1998-Present

## Context

The valley has been an actively used space for decades. There has been a "Long history of first nations activity" in the Bow valley ("Wildlife Corridors in the Bow Valley," n.d.). Today the valley includes three growing towns of Banff, Jasper, and Canmore ("Wildlife Corridors in the Bow Valley," n.d.). All of these towns continued growth has led to narrower corridors and barriers for wildlife trying to travel through the area ("Wildlife Corridors in the Bow Valley," n.d.). One of the towns, Canmore, hosted the 1988 winter Olympics which brought with it more popularity and a continuing population increase (Anderson & Jenkins, 2006). This caused pressure for increased development of resorts and residential housing in a narrow space constraining the valley (Anderson & Jenkins, 2006). The Bow valley is a long narrow valley and contains the "last intact linkage for wildlife from Banff National Park to the greater Y2Y corridor" (Anderson & Jenkins, 2006). The Y2Y corridor is the Yellowstone to Yukon Conservation Initiative, which works to create a continuous wildlife corridor through the Rocky Mountain Range.

## Site analysis

The trans-Canada highway established in 1962 was built straight through Banff National Park and Bow valley("Wildlife Corridors in the Bow Valley," n.d.). This was done at the time without the knowledge of its effects on the wildlife ("Wildlife Corridors in the Bow Valley," n.d.). It led to many wildlife fatalities as the road divided key habitat for the wildlife of the area ("Wildlife Corridors in the Bow Valley," n.d.). The road was then widened to 4 lanes to accommodate the increased traffic of the area as well as fences were put up to stop wildlife from attempting to cross the road ("Wildlife Corridors in the Bow Valley," n.d.). This reduced wildlife fatalities by 80% ("Wildlife Corridors in the Bow Valley," n.d.). Then underpasses and overpasses for wildlife where installed so that wildlife could still migrate across the highway to other areas of habitat ("Wildlife Corridors in the Bow Valley," n.d.). It was found that grizzlies, wolf, elk, and deer preferred to use overpasses while cougars and black bears preferred the closed spaces of underpasses ("Wildlife Corridors in the Bow Valley," n.d.).

## Genesis of project.

They created a "Bow Corridor Ecosystem Advisory Group" (Anderson & Jenkins, 2006). "BCEAG is a partnership involving the Government of Alberta, the Town of Canmore, Banff National Park and the Municipal District of Bighorn" (Herrero & Jevons, 2000). And they also made the "designation of corridors part of their municipal growth management plan" (Anderson & Jenkins, 2006). The BCEAG's main goal was to evaluate the viability of the corridors and patches within the valley (Herrero & Jevons, 2000). They produced science based guidelines that would describe the specific applications in order to have a functional corridor

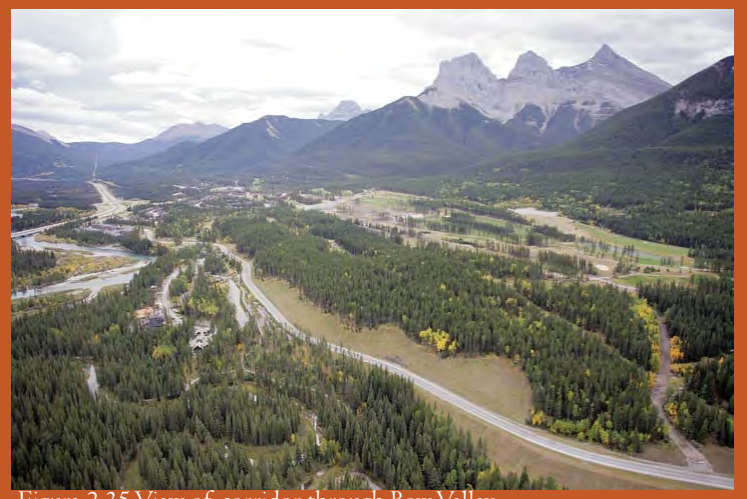


Figure 2.35 View of corridor through Bow Valley.

(Herrero & Jevons, 2000).

## Program elements

One goal was to reduce human wildlife conflict in the area. It's noted that when an area is overused by human activities that habitat will often become abandoned by the animals (BCEAG, 1999). They developed guidelines for both human use within the corridor areas as well as guidelines for development near the corridors. The recommended guidelines when talking about the human use within the corridor are seasonal/temporary trail closures, human-use monitoring, enforced leash laws, and educational awareness of corridors (BCEAG, 1999). These are all important for limiting conflict between humans and wildlife but also protecting and providing safe habitat for animals at sensitive times of the year such as calving (BCEAG, 1999). When it comes to development, other recommendations are made as not to disturb or block the surrounding wildlife's ability to travel through the area ("Wildlife Corridors in the Bow Valley," n.d.). These guidelines are:

- "We leave broad strips of wild land around the development where wildlife can easily travel
- These strips should be no more than eight kilometers long between larger wild patches
- The longer the obstacle (village, town, etc.), the wider the wildlife strip or corridor needs to be
- There should be good forest cover for animals to hide in and feel secure within, while crossing.
- We shouldn't expect wildlife to walk along side slopes of 25 degrees or more
- Wildlife corridors are for wildlife; mountain bikers, hikers, dogs, and excessive city noise can seriously compromise their effectiveness" ("Wildlife Corridors in the Bow Valley," n.d.)

## User/ use analysis.

The guidelines implementation that has occurred seems to be having a positive impact on the wildlife. The wildlife have been using the over and underpasses as well as the connection between the park and the Y2Y corridor is still intact and facilitating wildlife movement. Since these practices are new, the success of these practices can't be fully measured until more research has been conducted.

## Criticism

One criticism of the project would be that it doesn't seem to influence as much of where development should happen as much as how to maintain wildlife corridor around where they have already picked for development.

## Significance and uniqueness of the project

The significance of this project is that they brought the planning and management into an advisory group that oversees all the changes that take place. This advisory group sets rules and regulations that must be followed in order to develop or recreate in the habitat corridor space. The management allows for protection of the animals as well as paths that the wildlife take while migrating through the area. The protection of these corridors helps to keep the wildlife at healthy populations, keeping healthy amounts of biodiversity in the area.

## Limitations

In Canmore, the city tried to limit human use near the golf course in the off season, but it found to be too much of a challenge due to other recreational uses in the area as well as maintenance taking place ("Wildlife Corridors in the Bow Valley," n.d.). Because of this failed effort, more wildlife movement has been observed North of the Trans-Canada highway ("Wildlife Corridors in the Bow Valley," n.d.). This causes a limitation in the range of movement for the wildlife because of the development's inability to restrict access.

## General features and lessons

One main lesson from this project and its process is that if wildlife corridors are designed and implemented before developments are built than they are more cost effective and easier to design ("Wildlife Corridors in the Bow Valley," n.d.). This has led to further corridors being included in projects around the Canadian Rockies ("Wildlife Corridors in the Bow Valley," n.d.). Also, the guidelines provide great boundaries and starting points when looking to develop in areas that are surrounded by wildlife habitat. The development of an advisory group has proven to be successful, and can be an effective way to keep the corridors a priority when future development opportunities arise.

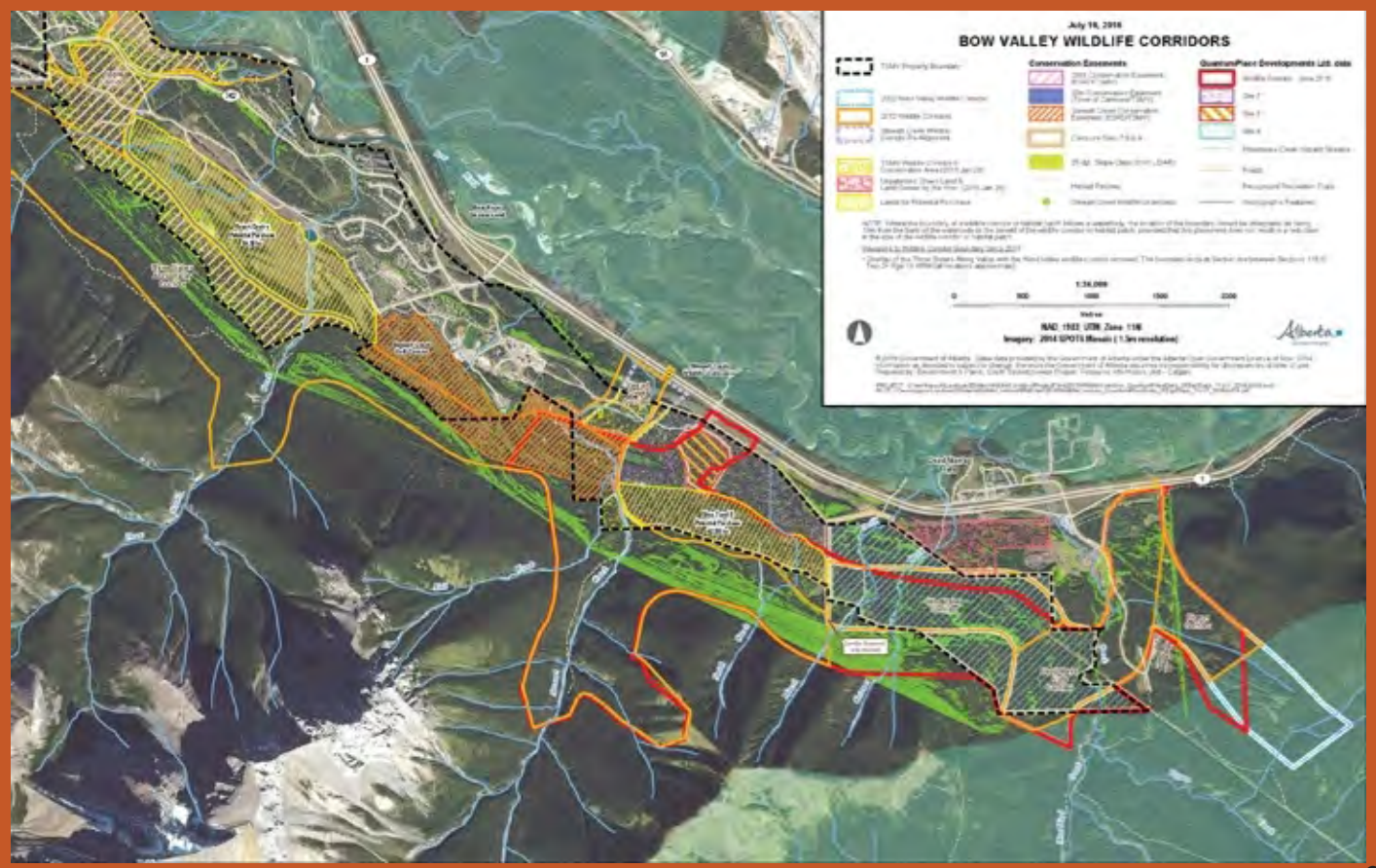



Figure 2.36 Plan view of the Bow Valley corridor.

## Project name
Village Homes

## Location
Davis, California located in Central Valley, Putah/ Cache Creek Bioregion, 60 miles northeast of San Francisco and 15 miles west of Sacramento

## Date designed and planned
1973-1975

## Construction completed
Built in phases (50 units at a time) from groundbreaking in 1975 to build out in 1982

## Cost
Land cost: 434,000 (in 1974) Development Costs: $2,329,241 (in 1974) Site Improvement Costs: $313,107 for swimming pool, bike paths, landscaping.

## Size
60 acres
4 dwelling units/acre (7.7 dwelling units/acre not counting common landscape)
25% open Space

## Landscape architect(s)
Michael Corbett, Town Planners, Davis, California

## Client
Michael and Judy Corbett

## Context
The design of Village Homes has taken inspiration from the greenbelt designs of Brittan and the United States(Francis, 2002). Also taken into consideration during design was the criticism of the Urban Renewal movement during the 1960's (Francis, 2002).

## Project background and history
When the project was first proposed it was met with huge backlash because it went against every traditional idea of planning (Francis, 2002). In fact Village Homes broke many codes that a traditional neighborhood would have to meet in order to be built (Francis, 2002).

## Genesis of project.
The vision of Village Homes was "a better place to live" (Francis, 2002). This was envisioned through emphasis on environmental sensitivity and social responsibility (Francis, 2002). Early development of Village Homes started with around 30 families coming together to develop what they wanted to see in their community (Francis, 2002). The group met for about a year before it fell apart due to the assumption that there would be a lack of funding (Francis, 2002). The two major goals of the community were described by the developers, Michael and Judy Corbett, as "designing a neighborhood which would reduce the amount of energy required to carry out the families' daily activities and establishing a sense of community" (Francis, 2002).

In the early building phases of Village Homes there were a lot of community building projects such as constructing paths and footbridges. The development incorporated community involvement and inclusiveness from the very beginning (Francis, 2002).

## Design development and decision making processes
The design in its beginning phases was based on a participatory design approach where the group's vision was focused on concern for the environmental implications and how they could design a modern neighborhood to be reminiscent of a village with a sustainable approach (Francis, 2002). Once the group fell apart, the final plan was created by Judy and Michael Corbett reflecting the influence of their environmental physiology, architecture and ecology influences (Francis, 2002). "The plan was one of the first to combine natural ecology and social ecology into an integrated vision of people, nature, economy, and community" (Francis, 2002).

The final plan was submitted to city officials in the 1970's where it was met with "considerable resistance and hostility" (Francis, 2002). Many departments found issues with it such as the police,

Figure 2.37 Site plan of Village Homes.

fire, public works, and planning departments (Francis, 2002). The officials argued that they could eliminate common areas and create larger lots for personal gardens for each house but this then defeated the purpose of the original goals of the project for encouraging community interaction (Francis, 2002). The Corbetts continued to press their design by demonstrating accessibility of the site such as the ability for emergency vehicles to traverse the narrow streets as well as convincing the police that the sidewalks behind the houses would improve safety and provide lower crime (Francis, 2002). It took three years and an appeal to the city council to be approved (Francis, 2002). Construction finally started in 1975 (Francis, 2002)

It took multiple attempts to get funding for the project (Francis, 2002). The Corbetts visited 30 banks before they found one that was willing to give them a loan (Francis, 2002). Many banks turned down their loan request due to the unconventional aspects of the design a well as their "lack of past experience as developers" (Francis, 2002).

Many of the community buildings and open space were left to the community to construct through funds from the Home Owners Association (Francis, 2002). This caused the need for neighbors to get to know each other and collaborate together on creating these areas (Francis, 2002). This created a stronger sense of belonging as well as of ownership for the community (Francis, 2002).

## Role of landscape architects

The Corbetts have been a part of the project since the beginning making sure that their vision was being implemented in every aspect of the design (Francis, 2002). The two are so dedicated to it that they reside in the neighborhood and have invested in the neighborhood businesses (Francis, 2002).

## Program elements

Many of the planning decisions were made based on social and environmental goals (Francis, 2002). All the streets were oriented east-west while the lots were oriented north-south to optimize the energy from the sun (Francis, 2002). The narrow 25 ft. streets limit the amount of pavement absorbing heat (Francis, 2002). The common open areas provide natural drainage and storm water management through creek beds, swales, and pond areas as well as they provide visual interest (Francis, 2002).

There are six main elements to the design identified by the Corbetts- community, energy conservation and use of solar energy, walking and bicycling, a "design closer to nature, neighborhood agriculture and natural drainage" (Francis, 2002). There are several types of open space demonstrated in Village Homes. There is private gardens, common areas, agricultural lands, turf areas for sports, and landscaped areas (Francis, 2002). These areas are all said to hold three main purposes by the home owners association for "enjoyment, flowers and food, and profit" (Francis, 2002).

The plant materials used for the site are either edible or native (Francis, 2002). This provides residents to pick the food right outside their homes (Francis, 2002). The community holds annual harvest festivals for the collection of food, such as from the almond trees (Francis, 2002). Some observers from outside the community, however, view the natural growth as an "eyesore" (Francis, 2002).

The circulation of the site was designed by creating the pathway system first and then creating the streets (Francis, 2002). The streets were narrow, to de-emphasize vehicular circulation (Francis, 2002). This turned the emphasis on pedestrian circulation which provides safety for the residents by providing trails behind the housing with limited areas of paths crossing the roads (Francis, 2002).

The community also provides some amenities such as a community center with a pool, a day care center, a restaurant, and a dance studio (Francis, 2002). All are located within a five minute walk from any house in the community with minimal street crossings (Francis, 2002).

The drainage of the site was designed as "creek-like" channels to catch the rainwater runoff and allow it to percolate back into the water table (Francis, 2002). These areas then provide natural play areas for children in the summer months when they are dry (Francis, 2002). This saved $200,000 in development costs and provided aesthetic value for the community (Francis, 2002).

The energy use and conservation of the site is achieved by orienting the housing north-south for optimal solar power usage (Francis, 2002). Also the street trees provide shade on the road lowering the temperatures as much as ten degrees (Francis, 2002).

Water conservation is achieved on site by the use of native drought tolerant plants (Francis, 2002). Irrigation is then only heavily applied to areas of high use such as the common turf areas (Francis, 2002).

The management of the site is mostly taken care of by a highly involved HOA and the dues paid to them (Francis, 2002). Reduction in dues is available for residents if they maintain their portion of the common area landscapes (Francis, 2002).

Village Homes was envisioned as an economically self-sufficient community (Francis, 2002). The plan was that money would be made by agriculture, office developments, and an Inn (Francis, 2002). However, only some of this has come to fruition such as renting of the offices owned by the HOA and the community center for events (Francis, 2002). Also, through the daycare center and the restaurant on site, there are a few job opportunities within the community (Francis, 2002). The community organizes and plans special events around the neighborhood, such as a back to school party, yoga and tai chi classes, musician circle, as well as an Easter egg hunt (Francis, 2002).

Figure 2.38 Pathway located behind housing.

Food production takes place through the community garden area as well as the trees on site that produce fruit and nuts (Francis, 2002). In fact 25 percent of the residents' fruit and vegetable consumption is from on-site gardens (Francis, 2002).

Harvesting parties take place in the orchards and allows residents to buy products at a 50 percent discount (Francis, 2002).
Safety and traffic calming was achieved by creating narrow streets and cul-de-sacs to provide safety and reduction in traffic speed (Francis, 2002). The narrow roads however, provide visitor parking problems as there is no on street parking available (Francis, 2002).

## Peer reviews

Village Homes has been reviewed many times by the press on sustainable development both nationally and worldwide (Francis, 2002). Also numerous case studies have been done on the community for its unique design as well as published reports by residents of Village Homes on their stories (Francis, 2002).

## Criticism

There are a few criticisms that come with evaluating the success of Village Homes. One criticism comes from the National association of Home Builders pointing out that not all of the original expectations of the design have been realized (Francis, 2002). For example, greywater recycling was intended to take place for the orchards but was rejected by the department of health (Francis, 2002). Another criticism of the community design is the question of is the community successful because of the design? Or because of the residents that live there? (Francis, 2002). This is due to the fact that the community attracts a certain type of resident that works to make the community successful (Francis, 2002).

One criticism that seems to puzzle the minds of critics is how the design of Village Homes goes against many of the principles of smart growth, yet it is still one of the most desired places to live in Davis (Francis, 2002).

Criticism that comes from the Corbetts is that the density of the development could have been higher with a smaller overall site area to foster a stronger community (Francis, 2002). Also placement of the front door would have been better on the front of the houses since they were placed on the sides of the houses and are often hard to find (Francis, 2002). Another observation is that the open space isn't used as much during the weekdays and winter months as it is during the weekends and evenings (Francis, 2002).

An important criticism has to do with the security of the site. It's criticized that the site, if built today, wouldn't pass any of the current Davis security code because of the narrow streets for emergency vehicles, not easily visible household numbers, and shrubs blocking visions for safety (Francis, 2002). This however is at odds with the crime rate of Village Homes being 90 percent below the rest of Davis according to the Police department (Francis, 2002).

The biggest criticism of Village Homes though is the fact that is hasn't been replicated anywhere else (Francis, 2002). Speculation of why is that developers see it as too risky due to its unique design (Francis, 2002).

Figure 2.39 Natural play environment for children.

## Significance and uniqueness of the project

Some of the most unique aspects of the project are how people enjoy living there (Francis, 2002). The sense of community is strong and "encourages and fosters participation of residents" (Francis, 2002). Another aspect is how the community is good for children and families. The design creates areas of play for children in a natural environment around the site (Francis, 2002). Lastly, a unique aspect of Village Homes is how safe it is compared to the rest of the city even with some of its design elements being critiqued on its safety (Francis, 2002).

## Limitations

The limitations and issues that have arisen from the Village Homes design are lack of storage for the residents (Francis, 2002). Due to the fact that there are only car ports provided to the residents and not garages, it has caused a lot of visual clutter (Francis, 2002). Another limitation that has emerged is the level of involvement of the residents (Francis, 2002). In the earlier days of the development there was a huge level of involvement but over the years it has slowly declined (Francis, 2002). With Village Homes having such an involved HOA this can limit the success of the development goals (Francis, 2002).

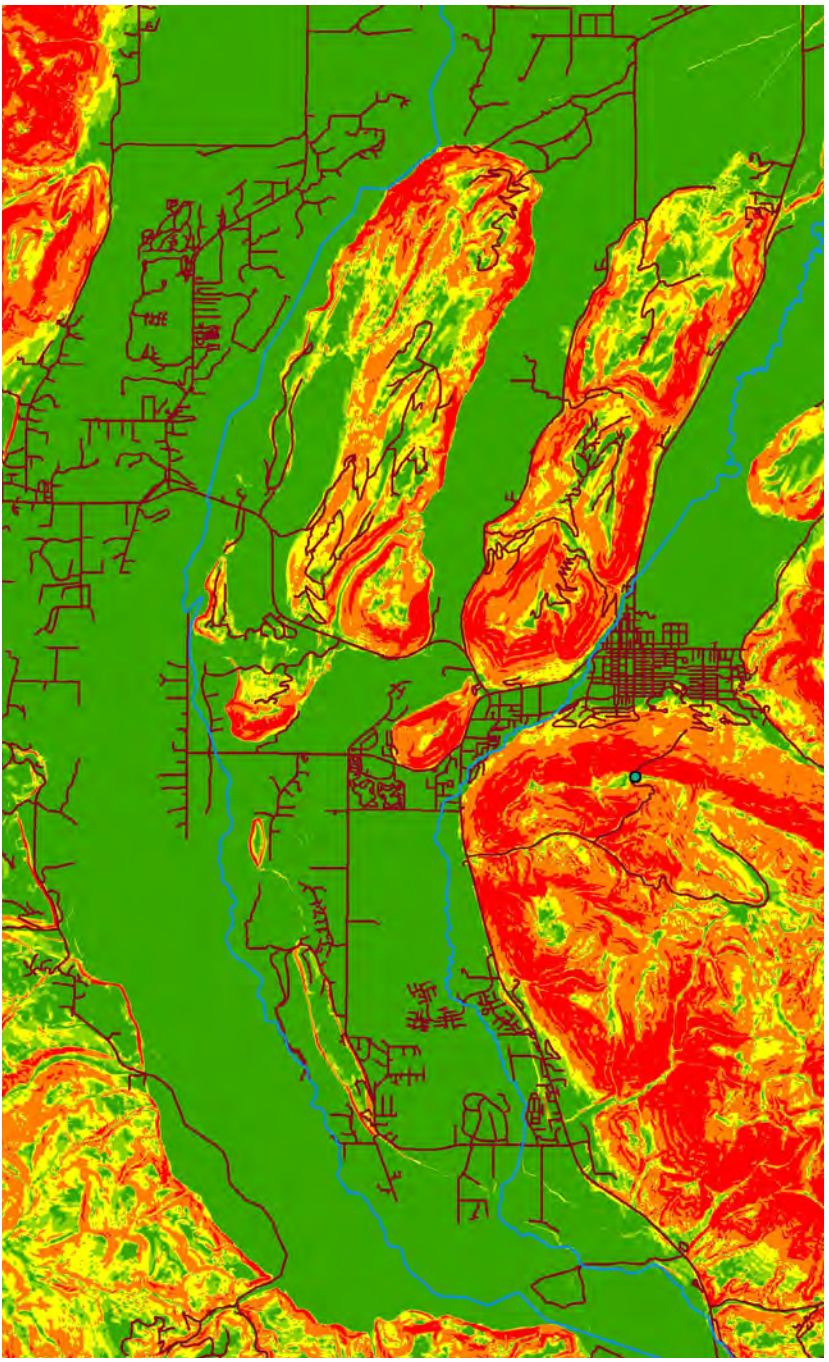
## General features and lessons

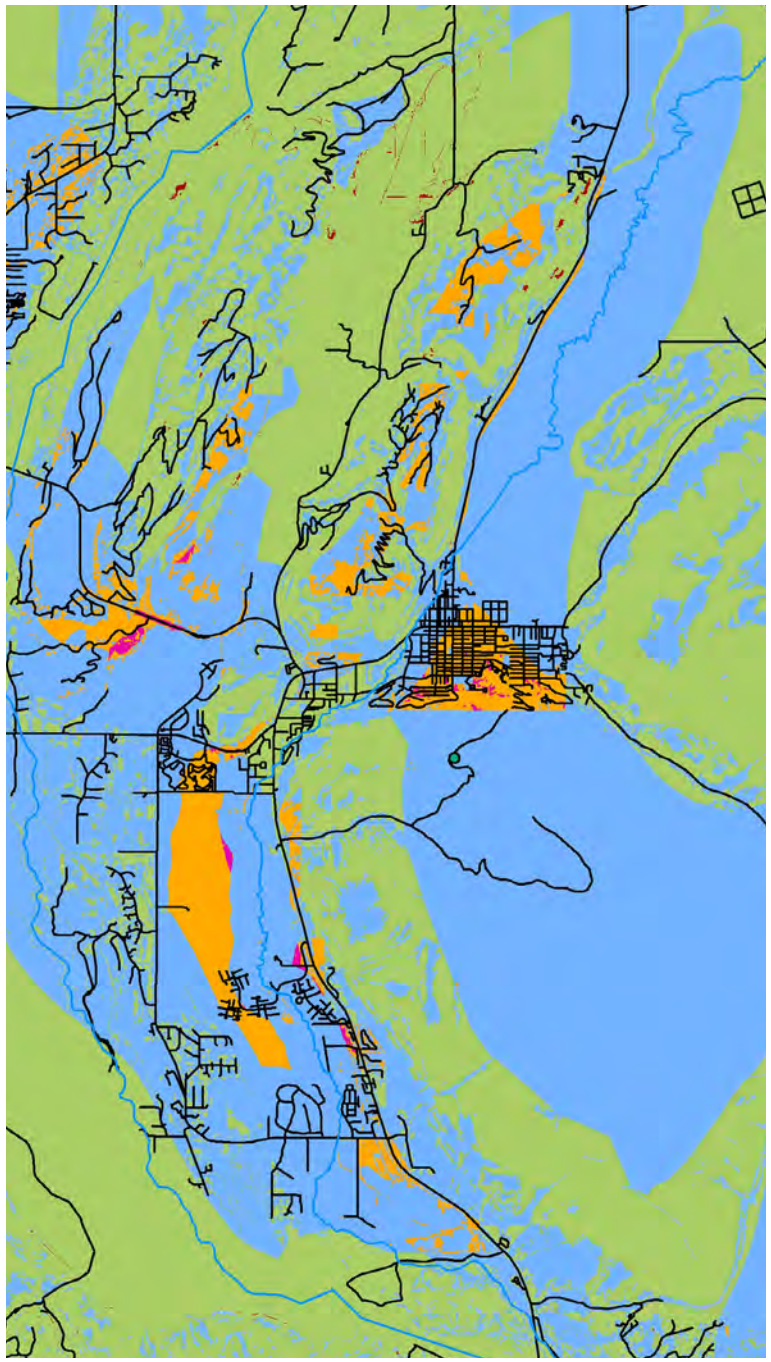
The general features and lessons learned from Village homes are its ability for its design principles to be applied over other projects (Francis, 2002). One of these is the emphasis that is put on the pedestrian and bicycle circulation first and vehicular circulation second (Francis, 2002). Another good lesson taken from Village Homes is how the "informal and naturalistic open space fosters community participation and sense of place" (Francis, 2002).

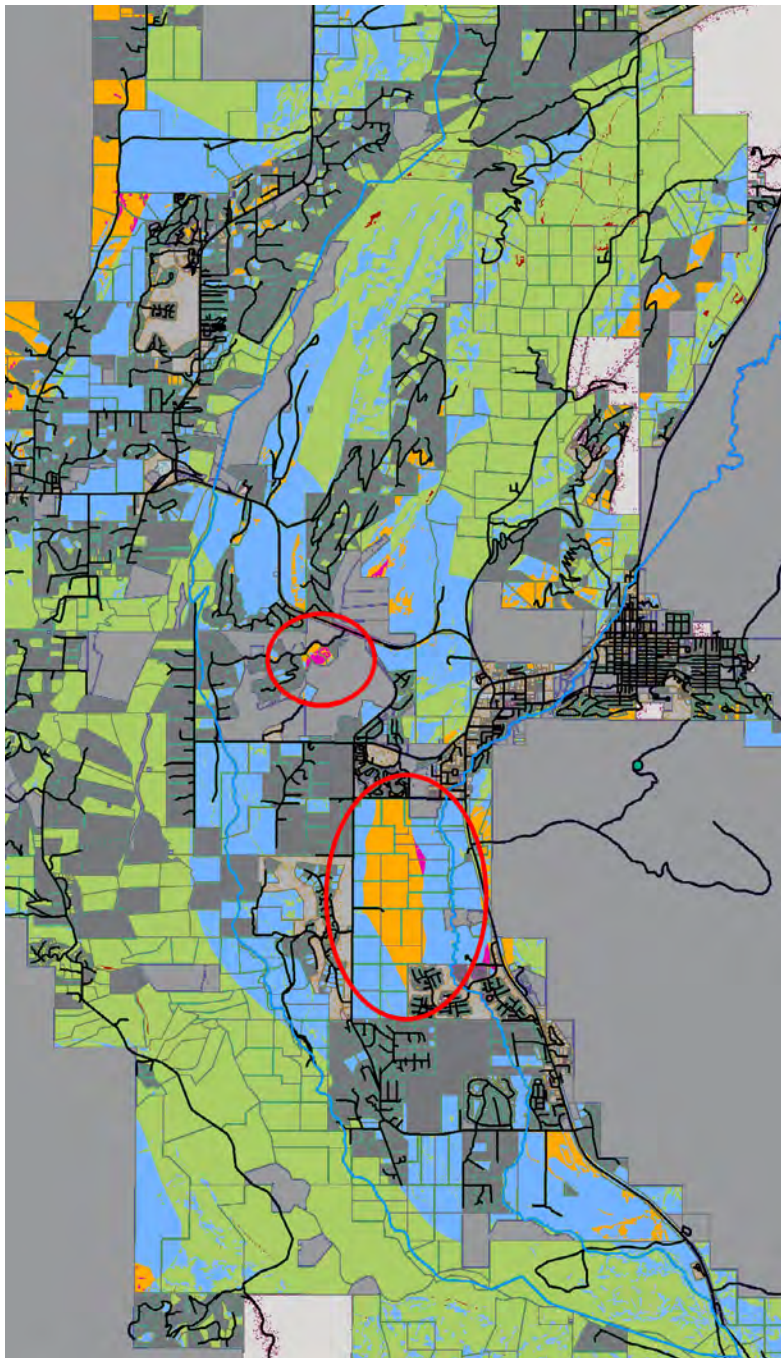
# DESIGN IMPLICATIONS

Based on the findings of the research through the literature review and case studies, the following conclusions were made on how the information found will inform the design:

- Strengthen habitat connections for smaller, non-disruptive wildlife and avoid interference with major corridor connections
- Preserve areas of native habitat with emphasized importance on key species
- With wildlife behavioral issues, the design should work to avoid attracting undesired wildlife through design choices such as plant selection
- Provide habitat for non-disruptive wildlife such as birds, pollinator bees, and small wildlife of the areas
- Restrict housing to local residents with lower incomes to help restore economic balance and relieve some of the pressures on the supply and demand for housing
- Acknowledge the areas of wildlife disturbances due to development and recreational activity
- Design by first locating areas of highest conservation priority, then housing design
- Enhance residents' physical, mental, and social health by creating a connection to nature through design decisions
- Provide environmental sustainable practices such as storm-water management, green roofs, and vegetation that not only contribute to a low-impact design but also provide habitat







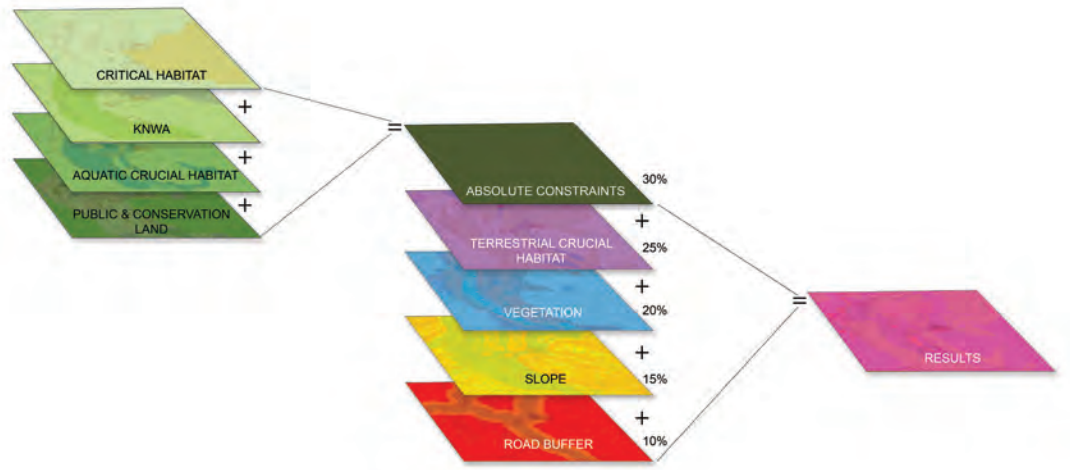
# ANALYSIS

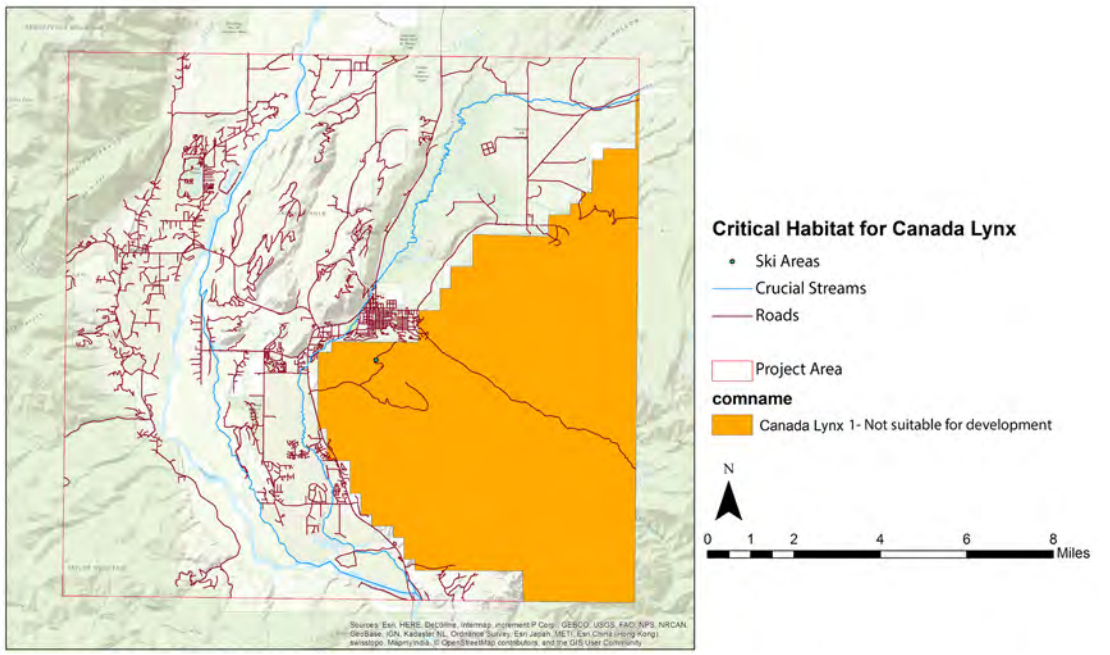
# SUITABILITY ANALYSIS

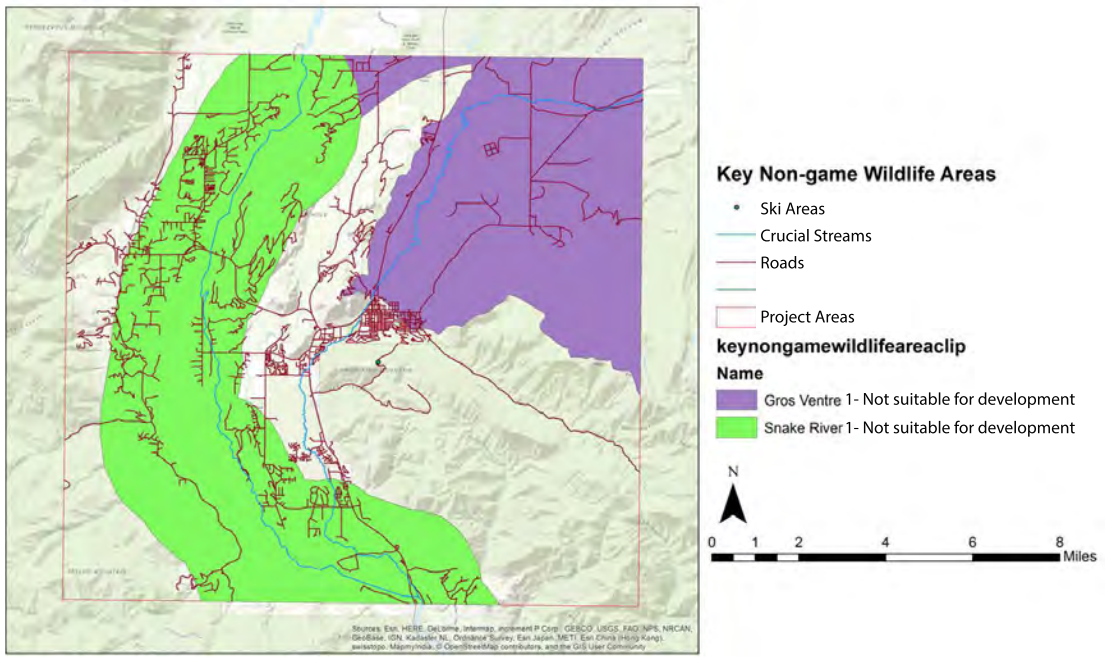
The suitability analysis focused on identifying areas best suited for development that would have the least amount of environmental impact to the surrounding habitat and wildlife corridors. Eight sets of data were mapped to create the suitability analysis. Four sets of data were given a binary suitability ranking and the other four were evaluated and ranked along a suitability scale. The suitability scale chosen for this evaluation is a ranking of one to five, one meaning least suitable for development, two meaning not suitable for development, three meaning neutral, four meaning suitable for development and five meaning most suitable for development. Each layer and the process and reasoning that occurred to result in the final suitability analysis map will be further explained in detail.

The first set of data is called "Critical Habitat". This data shows the key habitat area for Canada lynx, a highly endangered species in the area. Because Canada lynx is an endangered species and it's also been identified as one of the key species for the area for this study, this data set is given a binary suitability ranking. So after the data is mapped and rasterized it has been reclassified to reflect a value of one where the critical habitat is found and a value of five representing the non-critical habitat area.

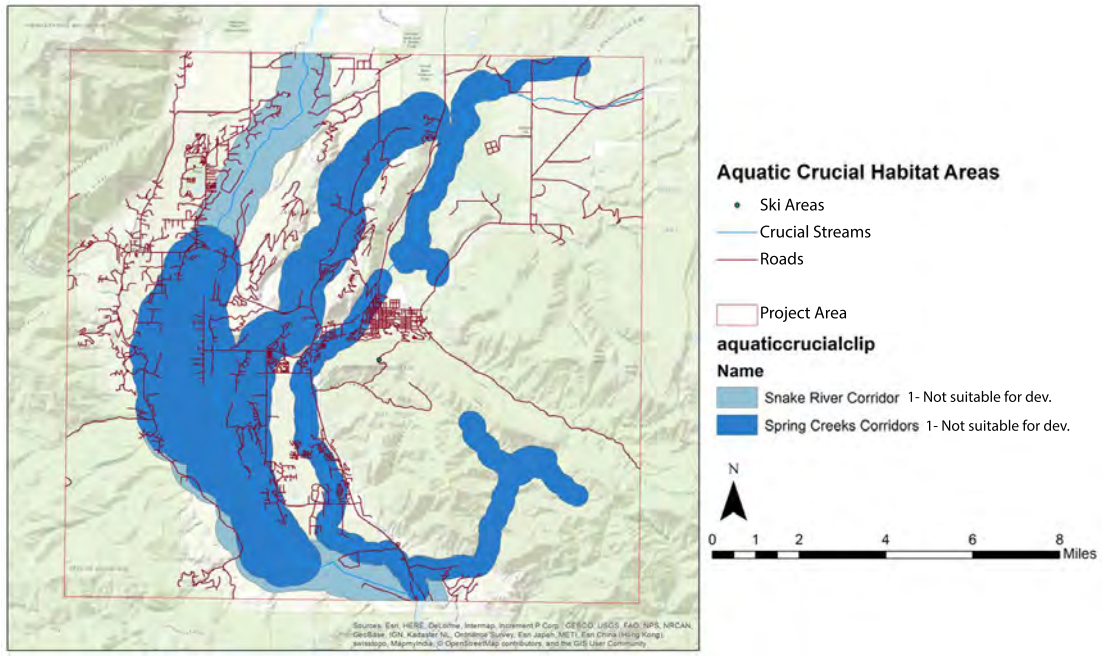
The second data set is called "Key Non-game Wildlife Areas" (KNWA). This data set identifies "important areas for non-game avian and mammalian species of greatest conservation need. These key areas were identified by considering faunal diversity and density, uniqueness of habitat, intactness of habitat, and importance to maintaining native species of greatest concern fauna in Wyoming" ("Key Nongame Wildlife Areas," n.d.). The data identifies two areas within the project boundary, one is labeled "Gros Venture" and the other is labeled "Snake River". The "Gros Venture" area is labeled as containing 24 bird and 18 mammal species of greatest concern with "a large portion of the area classified as highest ranking for species diversity" ("Key Nongame Wildlife Areas," n.d.). The "Snake River" area is labeled as the "highest number of species of greatest concern" containing 24 bird and 19 mammal species. It also specifically says it has a "significant core of bald eagle nesting pairs" which is listed as one of the key species for this study ("Key Nongame Wildlife Areas," n.d.). As well as the entire area is "classified as the highest ranking for species diversity by WY Gap" ("Key Nongame Wildlife Areas," n.d.). Because of this data's high ecological importance to key wildlife and habitat, this data set is also given a binary suitability ranking. After the data is mapped and rasterized it has been reclassified so that both the "Gros Venture" and "Snake River" areas are given a value of one meaning least suitable for development and the surround area where no data is found is given a five meaning most suitable for development.



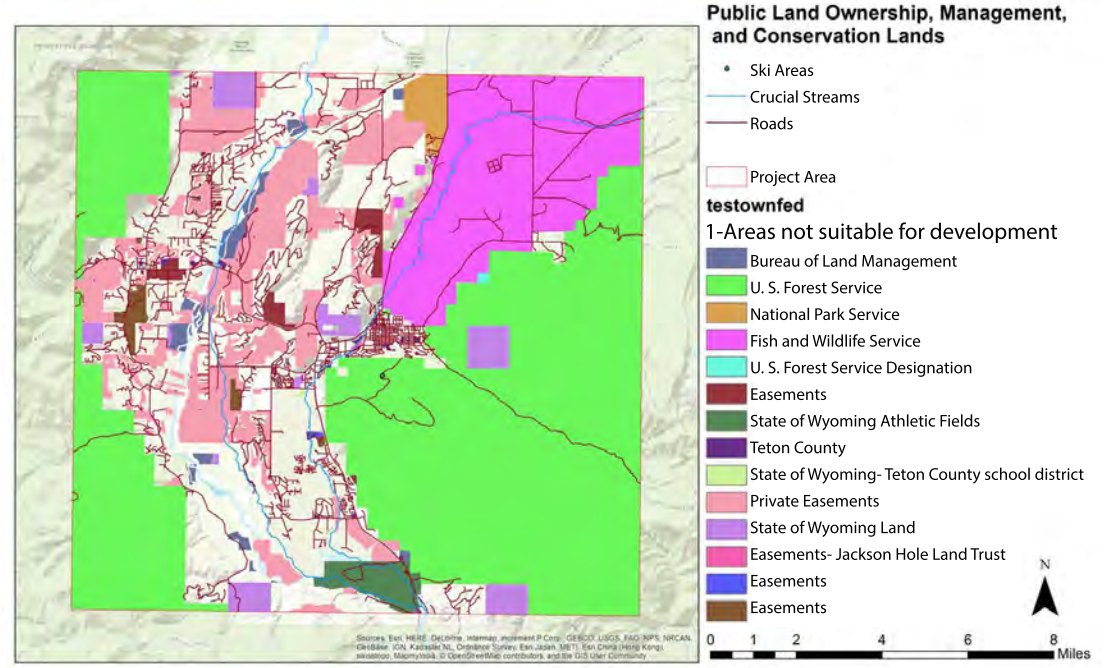



The third data set is called “Aquatic Crucial”. This data set identifies the 2 crucial river corridors that occur within the project boundary. There is the “Snake River Corridor” and the “Spring Creek Corridor”. These corridors are extremely important to the ecological function of the area. River corridors provide key connections and habitat for a wide diversity of wildlife. Through the research of the key species in this study many of them have been found to use this area as their habitat or as a migration corridor. Due to this high importance and correlation of the river corridors to the key species the Aquatic Crucial layer is given a binary suitability ranking. After the data is mapped and rasterized it has been reclassified so that both the Snake River and Spring Creek corridors have been given a value of one and the surrounding area where no data is found is given a five.

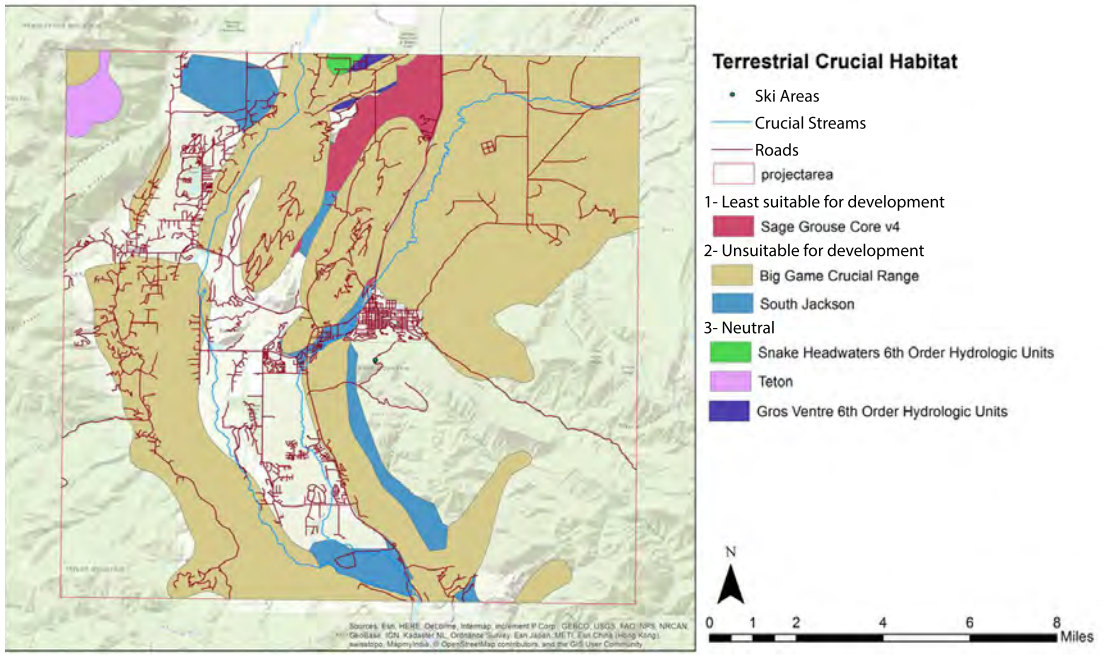



The fourth data set is called “Ownership”. This data layer shows public land ownership, management, and conservation lands within the project boundaries. This includes all land owned by the National Park Service, the United States Forest Service, the State of Wyoming, the Bureau of Land Management, and well as private easements for the Jackson Hole Land Trust and other such conservation programs. Because these are all publicly owned land or land dedicated to the conservation of habitat and wildlife this layer is given a binary suitability ranking. After the data has been mapped and rasterized, it has been reclassified where all the public land data has been given a suitability ranking of one and any other area where no data is found is given a five.

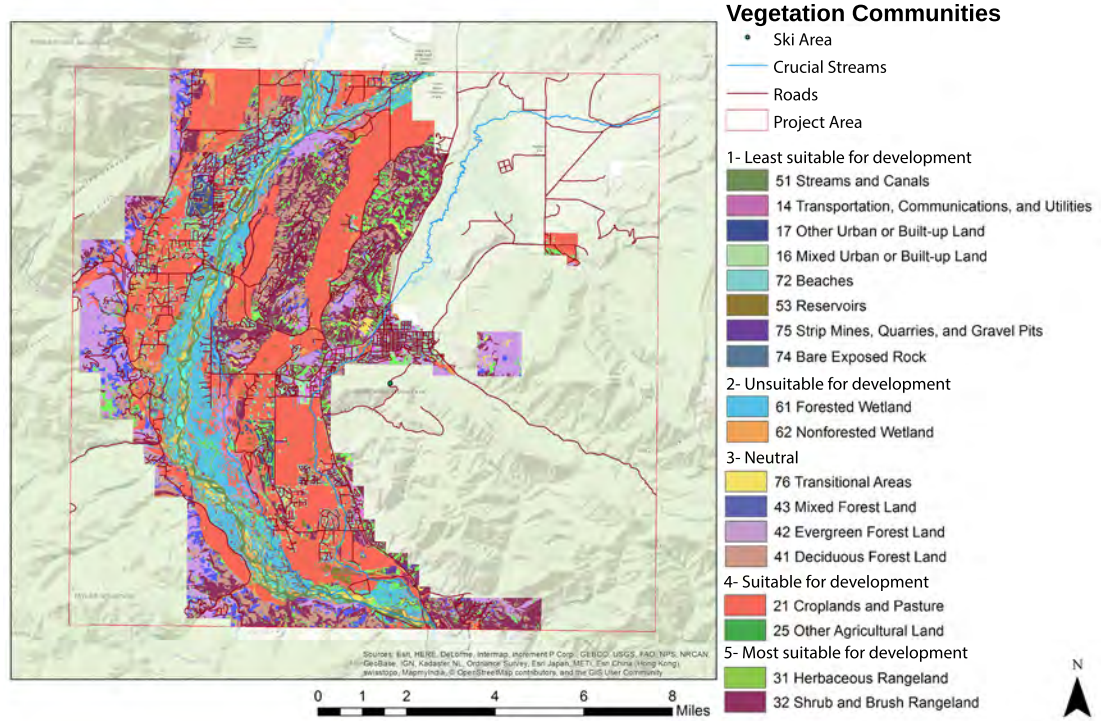



Once these four binary layers have been reclassified they then go through the process of a weighted sum and another reclassification. Since all layers are binary and represent either areas suitable or not suitable for development they can be combined into one layer that represents where these unsuitable areas are and what areas are left that could be suitable for development. So the Critical habitat, KNWA, Aquatic Crucial, and Ownership layer are all combined into one layer where it is then reclassified so that any area representing where these data sets occur as the one value stays at a one value for all those areas combined. And any area where there was a five ranking that isn’t overlapped with a one value of a different data set, stays at a five value. This produces a new simplified layer that then will be imported into the suitability analysis representing all four of the data sets that it incorporates.

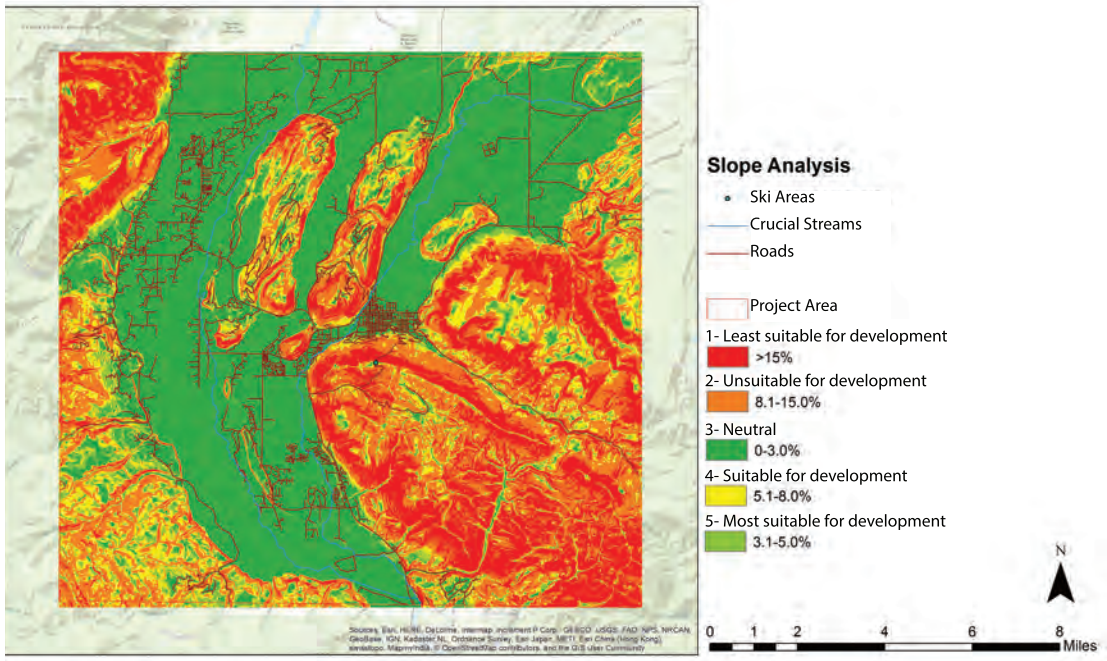
The fifth dataset is labeled “Terrestrial Crucial”. This data set represents 6 different areas of the strategic habitat plan priority areas for the state of Wyoming. They represent “areas that need to be protected or managed to maintain viable healthy populations of wildlife for the present and the future and areas where there is a high potential in the next five years to successfully address wildlife habitat issues by improving, enhancing or restoring wildlife habitats”. The six areas are named “Gros Ventre 6th Order Hydrological Units”, “Snake Headwaters 6th Order Hydrological Units”, “South Jackson”, “Teton”, “Sage Grouse Core v4”, and “Big Game Crucial Range”. For the suitability ranking a value of one was given the the “Sage Grouse Core v4” because it is listed as one of the key species for this study as well as it is a highly endangered species due to habitat loss and disturbances. A value of two was given to the “Big Game Crucial Range” as well as the “South Jackson” area. The “Big game Crucial Range” was given a two because even though none of the key species in this study are considered a big game animal it still provides crucial habitat and a corridor for wildlife movement. The “South Jackson” area was also given a two because it is located at the edge of the forest service land this is a crucial area to help mitigate the issue of edge effects that could occur on the boundary between the forest service land and the developed land. The “Gros Ventre 6th Order Hydrological Units”, “Snake Headwaters 6th Order Hydrological Units”, and “Teton” areas were all given a suitability ranking of three. They were all given a neutral ranking of three because a very small amount of their area lies within the project boundary and seems to have little influence on the environmental impact.



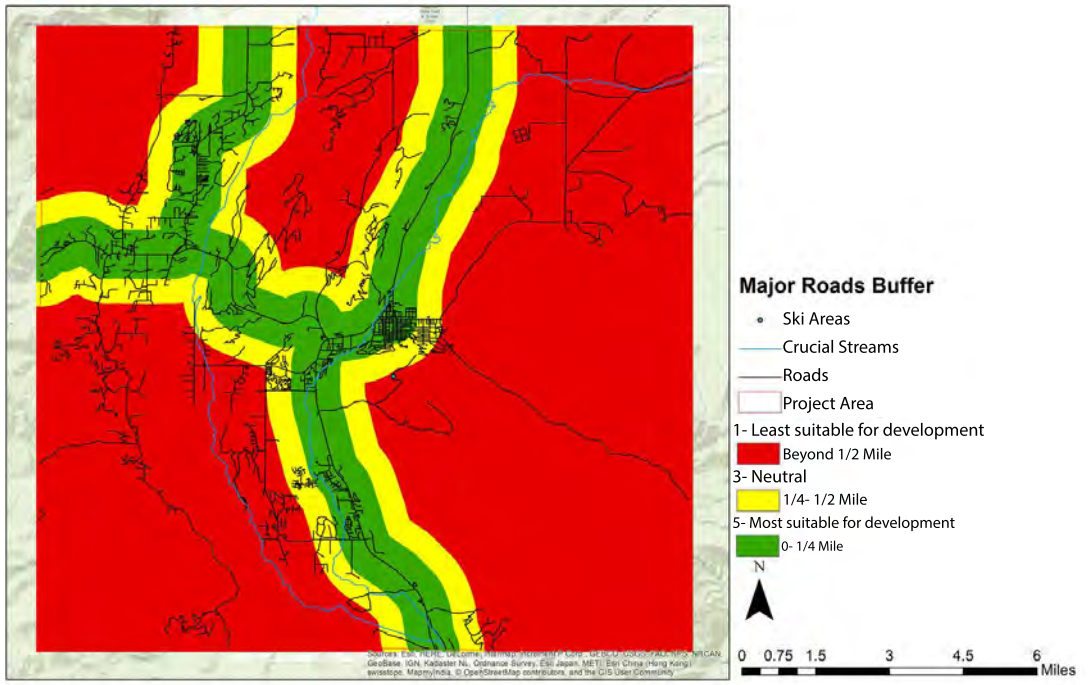

The sixth dataset is labeled “vegetation”. This dataset represents 18 different vegetation communities and land use classifications. A one suitability ranking was given to the areas identified as “Streams and Canals”, “Transportation, Communications, and Utilities”, “Other Urban or Built up Land”, “Mixed urban or Built-up land”, “Reservoirs”, “Strip mines, Quarries, and Gravel pits”, and “Bare Exposed Rock”. These areas were given a one ranking because they’re all areas that physically can’t be built on because they are either bodies of water, or have already been built and developed on. A two suitability ranking was given to areas identified as “Forest Wetland” and “Non-forest Wetland”. These areas were assigned a ranking of two because they shouldn’t be built on, not only for their ecological value but also for the difficulty and risk that comes with converting wetland area to development. A three suitability ranking was given to the areas identified as “Transitional Areas”, “Mixed Forest Land”, “Evergreen Forest Land”, and “Deciduous Forest Land”. These areas were assigned a three because although forest land can be cleared for development it possesses a high ecological value for wildlife habitat. A four suitability ranking was given to areas of “Cropland and Pasture” and “Other Agriculture Lands” because although these lands provide less ecological value to wildlife and provide less habitat they still provide a high economic value for the area. Lastly, a suitability ranking of five was given to the areas identified as “Herbaceous Rangeland” and “Shrub and Brush Rangeland”. These areas were given a ranking of five being most suitable for development because these areas tend to possess the best qualities for development as well as a lower ecological impact.



The seventh data set is “Slope”. The data represents the different range in slopes within the project area. The raster has been reclassified to reflect to represent five different ranges in value, “0-3%”, “3-5%”, “5-8%”, “8-15%”, and “>15%”. This raster was then reclassified and given a suitability ranking of one to five based on what slopes are best for development. A one was given to “>15%” slopes because these slopes are too steep to be able to develop on. A two was given to slopes of “8-15%”. These slopes are fairly steep so although they can be built on they often propose challenging and risky areas for development. A three was given slopes of “0-3%”. These slopes provide easy flat land to develop on but it there is not enough of a slope issues of standing water and flooding can occur. A four was given to slopes of “5-8%”. These slopes provide a small enough slope to build on easily making for an ideal location. However getting more towards an 8% slope can provide some challenging access for ADA conditions. Lastly, a five was given to slopes of “3-5%”. These provide just enough slope that standing water is no longer an issue and not enough of a slope that development issues arise. It also makes for more easier and manageable slopes for ADA access.

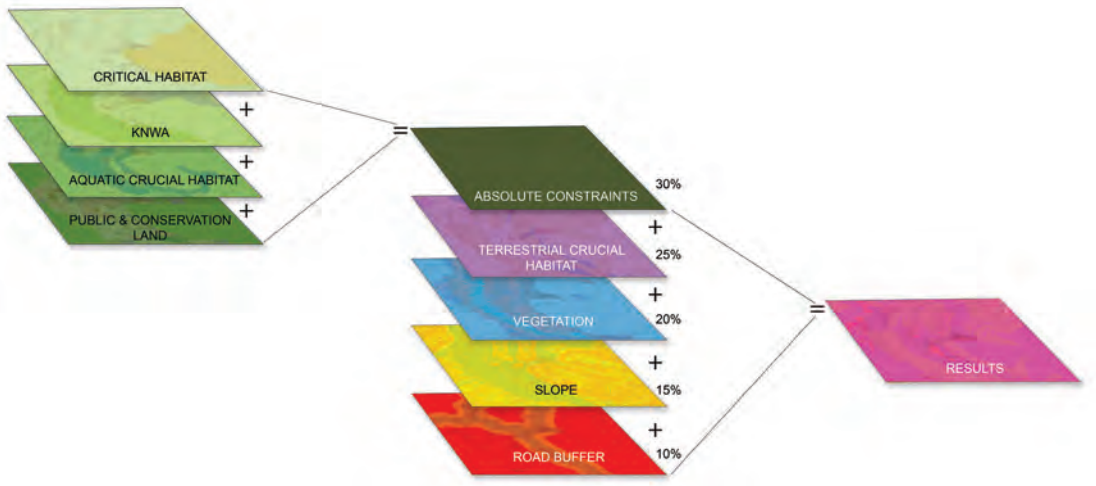


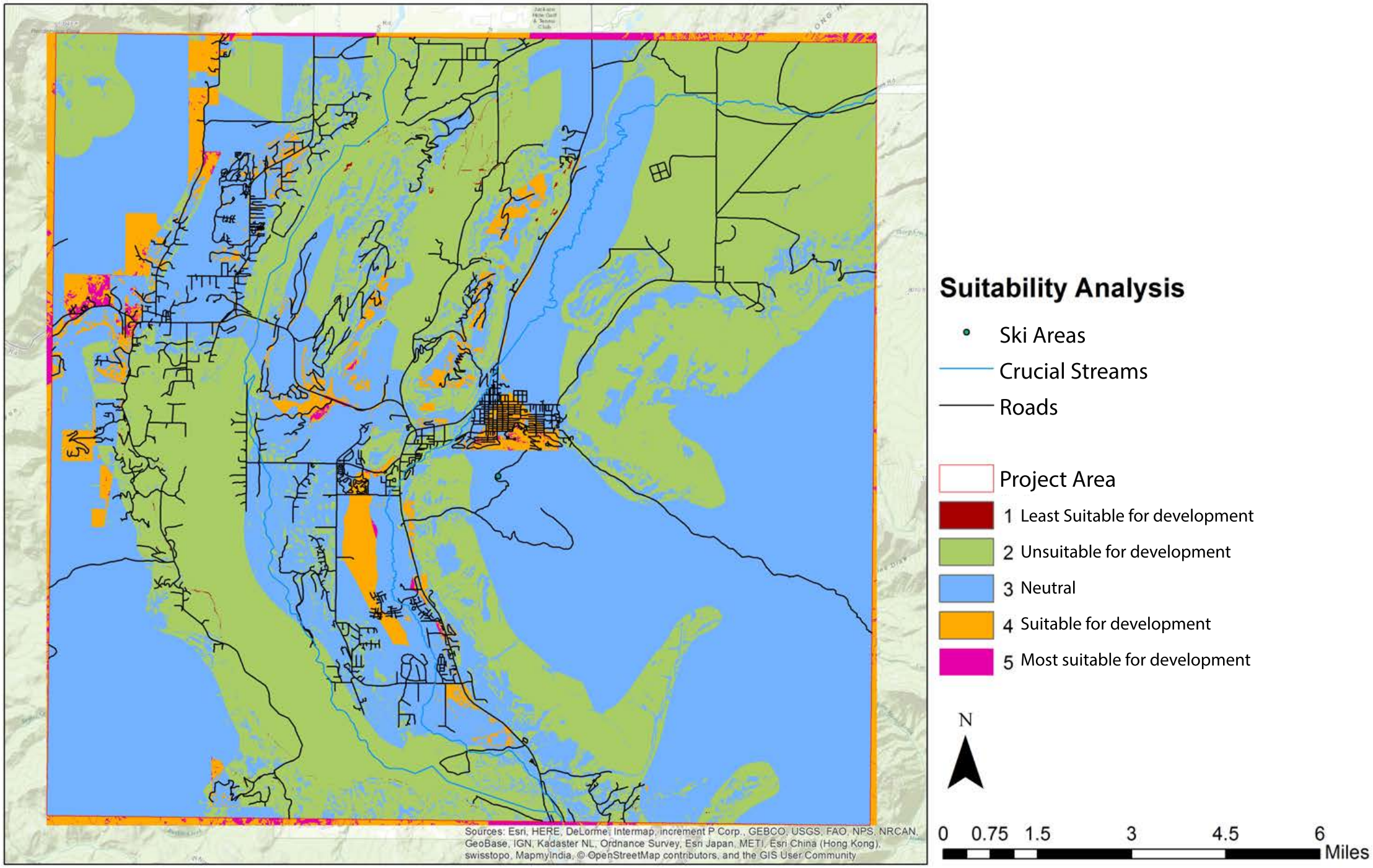

The eighth and final dataset was “Major Roads”. This data represents the major roads that run through the project area. This layer was given a multiple ring buffer and then rasterized and reclassified to show a suitability ranking of how having development near the existing major roads would be an ideal housing area. A five suitability ranking was given to areas within a quarter a mile from existing major roads. Having development in these areas allows it to be closer to other development that way less disturbance of wildlife habitat takes place. A three suitability ranking was given to areas beyond a quarter of a mile, but less than a half a mile away from major roads. This area was given a three because as development starts to happen further away from these areas more natural habitat areas are then disturbed or destroyed due to the development of housing as well as the creation of new roads to be able to access those areas. Lastly, a one suitably ranking was given to all areas beyond a half a mile away from the major roads. These areas become too far removed from the connection to the major roads and provide too high of a threat to disturbance of the wildlife movement in the area.



## Weighted Average

After all these datasets have been reclassified with their suitability rankings, they are then entered into a weighted overlay where each layer is given a weighted percent out of one hundred. The layers with a higher percent in the overlay have a higher influence on the outcome of the final suitability analysis map. For this study, the highest percent, 30%, is given to the layer with the combined binary data. This layer is the highest because it deals directly with areas of influence on key habitat and wildlife identified in this study as well as vital areas for wildlife movement. The second highest percent of 25% was given to the "Terrestrial Crucial" layer. Again, this layer contains data specifically highlighting areas of movement for wildlife as well as key habitat for a key species in this study. A percent of 20% was given to the "Vegetation" layer because although it represents the plant communities of the area, the data doesn't represent any correlation to wildlife movement through these areas or if they are being utilized as habitat. A weighted average of 15% was given to slopes and a weighted average of 10% was given to roads. These two were given the lowest percent because, although they have an important impact on where development should occur, they are specifically bound by development needs whereas the focus of this suitability analysis was to locate areas with the lowest environmental impact to wildlife movement and habitat. After each layer has been assigned a weighted average, the model can be run to achieve the final output of the final suitability analysis map.



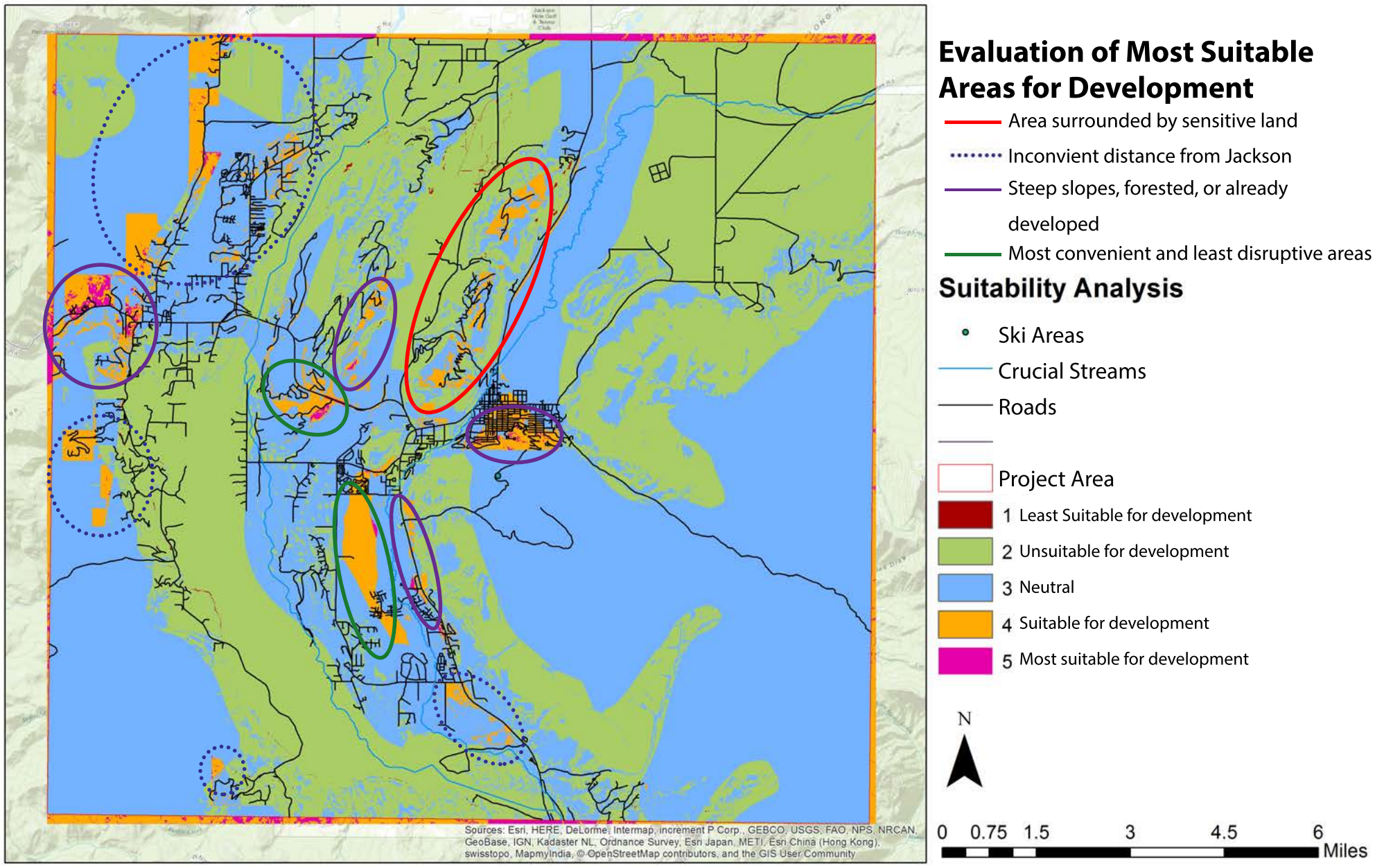



## Results

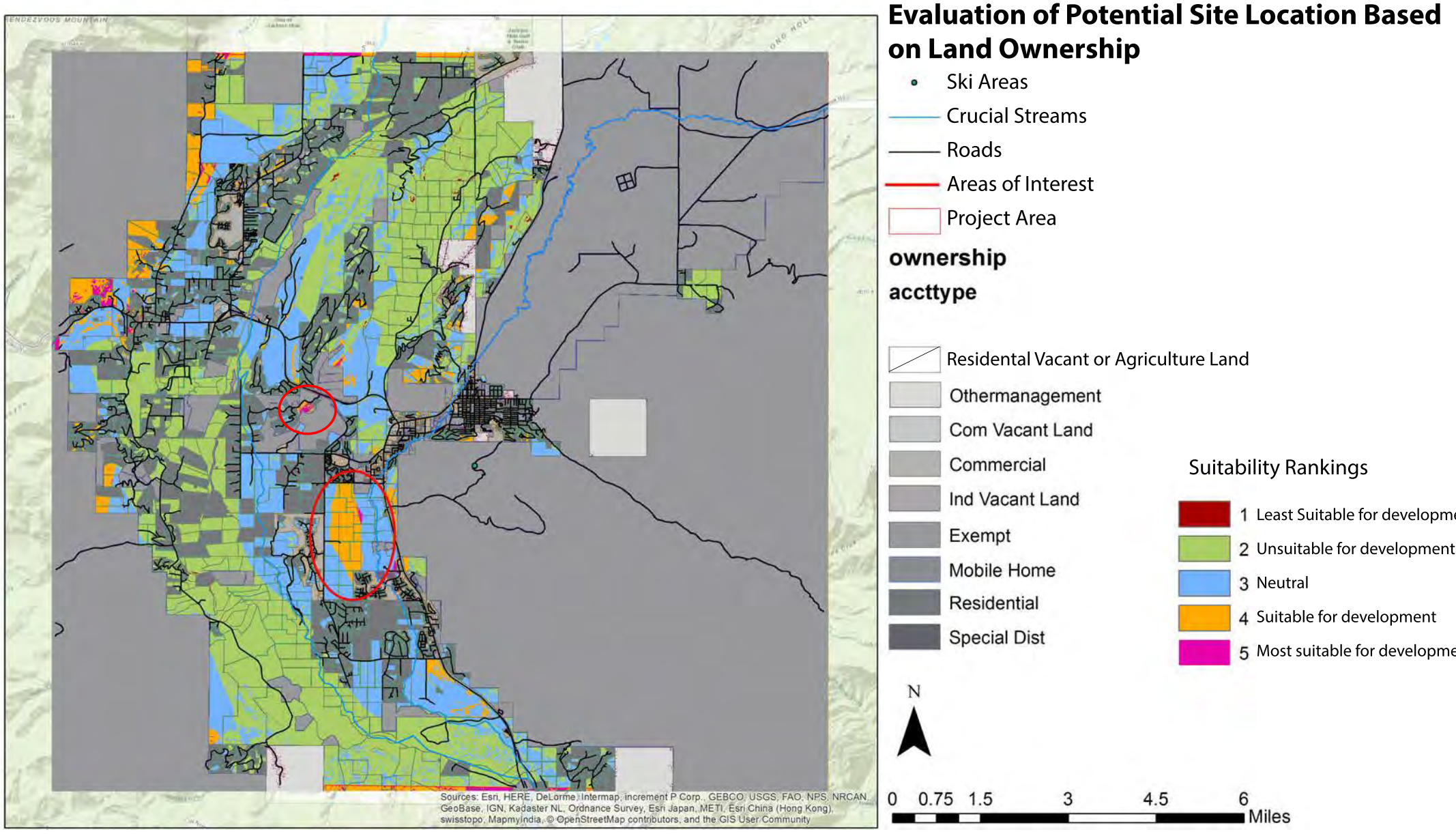
When looking at the results of the suitability analysis there are a few things to consider. The areas given a suitability ranking of one, meaning least suitable for development, are very small areas. The reason more areas aren't reflecting a value of one is that although the highest weighted average had a lot of area ranked as one, the other layers that were given a suitability ranking of higher than a one that overlapped these areas would influence these areas to reflect a slightly higher value than one. The areas reflecting a value of two, meaning unsuitable for development, can be seen as those areas encompassing the riparian areas as well as the areas where the big game wildlife corridor is located. The areas reflecting a ranking of three, meaning neutral, can be seen as reflecting some riparian area, areas of public land, and a large area of the agricultural lands. For the lowest impact on wildlife movement and habitat, only areas given a four and a five suitability ranking will be considered as possible places for development to occur. These areas reflect places with the least amount of disturbance to wildlife movement and habitat.

# LOCATIONAL ANALYSIS

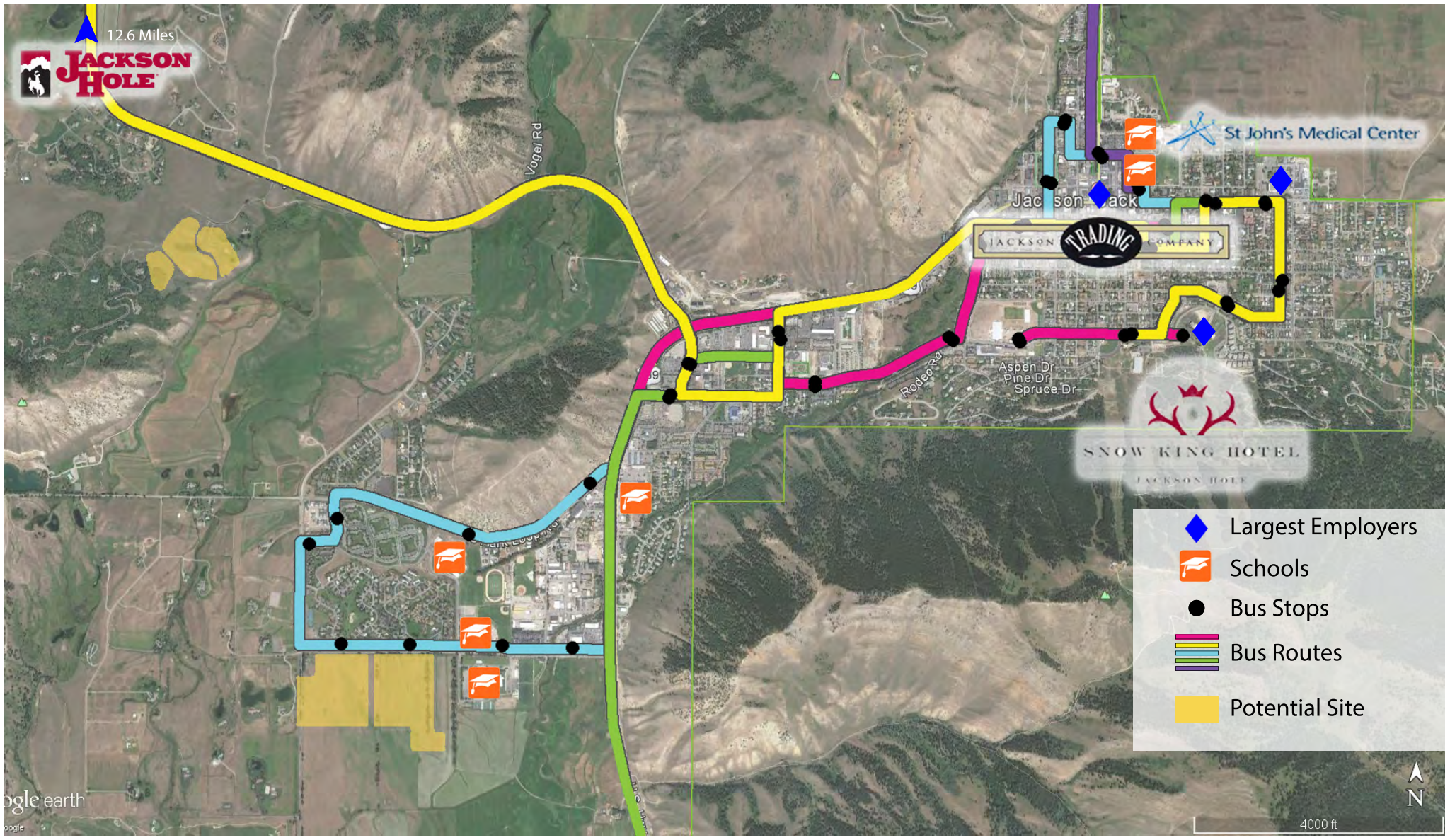
The suitability analysis has provided areas in which development would be best suited in the Jackson, Wyoming region based on the importance of wildlife habitat and migration. A locational analysis further pinpoints the most suitable areas will further pinpoint a site location for development based on the specific site conditions as well as the needs of the residents of Jackson, Wyoming. Looking at the map results produced by the suitability analysis, there are roughly ten areas displaying a 4 and 5 ranking of most suitable development areas. These areas can be seen in the diagram to the right. Each of these 10 areas was then further analyzed to determine which could be potential site locations. Four of these areas were determined to be an inconvenient distance from the town of Jackson, Wyoming. One area was ruled out due to its surroundings being sensitive areas for ecological importance. Development of these areas would result in disturbing important ecological areas between the area's location and the road. Three areas were discovered to have steep slopes, forested, or already developed lands. The steep slopes provide challenges and restrictions for building on and the forested land provides habitat and ecological importance that is valuable to maintain. This leaves two areas that provide the most convenient and less disruptive areas for consideration of the site.



These two areas best suited for development were then compared based on their land use and ownership of the parcels. Only parcels with a land use of "Residential Vacant" and "Agricultural Land" were considered for the site location. The site to the north is located on vacant residential land while the site to the south is located on agricultural lands. The northern site, while highly suitable for development, proved to be limited for development based on the soils and the slopes present. Also the northern site is surrounded by conservation easement land to the north and south and would contribute to fragmentation and possibly higher conflicts with wildlife in the area. The southern site is located on agricultural land. Although it has a slightly lower rating for suitability it proved to be less ecologically disruptive based on its surrounding land use. The soils proved to be good for development and the slope of the site is relatively flat. This provides for more possibilities for development without any restrictions. The only negative drawback of the southern site is its location on agricultural land and its economic value. However, the fields have proven to be hayfields for cattle which yields a lower economic value than other crops.

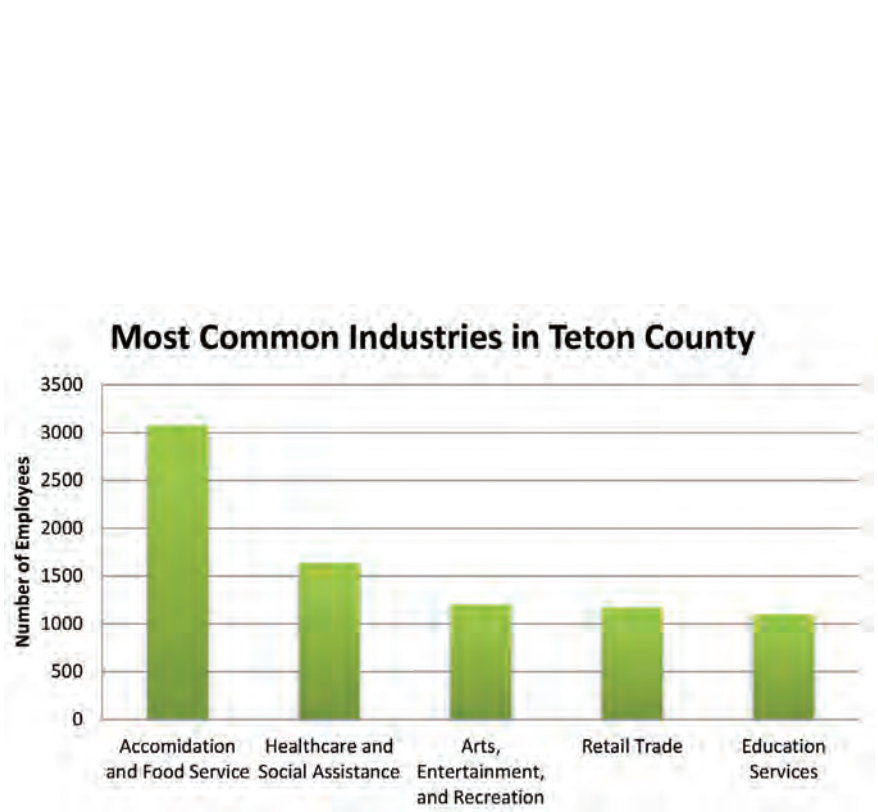


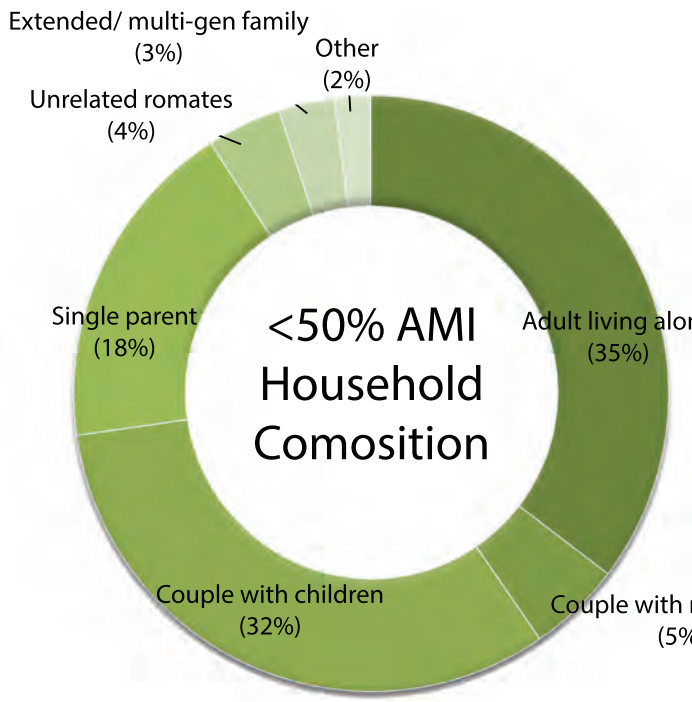
Once the physical land was evaluated for the two sites further analysis was conducted based on the needs of the residents of Jackson. The two sites were given site boundaries based on the available lots that would provide an appropriate amount of land to dedicate to the development. The northern site is roughly 30 acres and the southern site is roughly 80 acres. Next, evaluation of the largest employers for the area was considered for the site's location. Three out of four of the major employers for Jackson are located within the town, those being St. John's Medical Center, Jackson Trading Company, and the Snow King Resort ("Wyoming's Largest Employers," 2010). The other major employer for Jackson is the Jackson Hole resort which is located 12.6 Miles to the north-west of town ("Wyoming's Largest Employers," 2010). Each site is located about an equal distance from the center of town and the majority of the major employers yet, the northern site would be slightly closer in distance to the Jackson Hole resort. However, the southern site provides direct access to the public transportation system of Jackson including two bus stops already in place adjacent to the site, whereas the northern site is located approximately a quarter of a mile from the major road with no current bus stops nearby. Another advantage of the southern site is its location to multiple schools within the area. Such as two high schools and a middle school just in the immediate vicinity of the site. Based on the 2014 Western Greater Yellowstone Regional Housing Needs Assessment for Teton County Wyoming schools is a feature that local buyers are most concerned about. In Conclusion, based on the analysis for the needs of the residents of Jackson and the physical sites themselves, the southern site was chosen as the best suited for the implementation of a low-impact community for Jackson. Here it's important to note that the suitability analysis was very successful in locating areas that would be least impactful to the surrounding habitat and wildlife movement as well as a well desired location for residents to live.

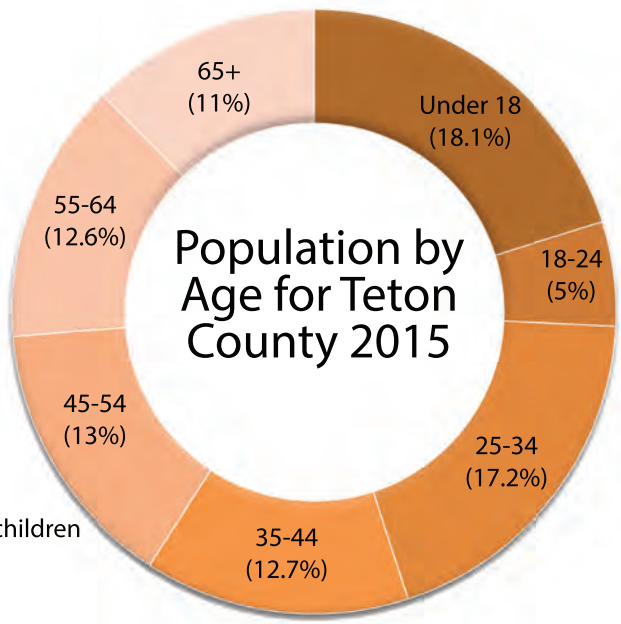


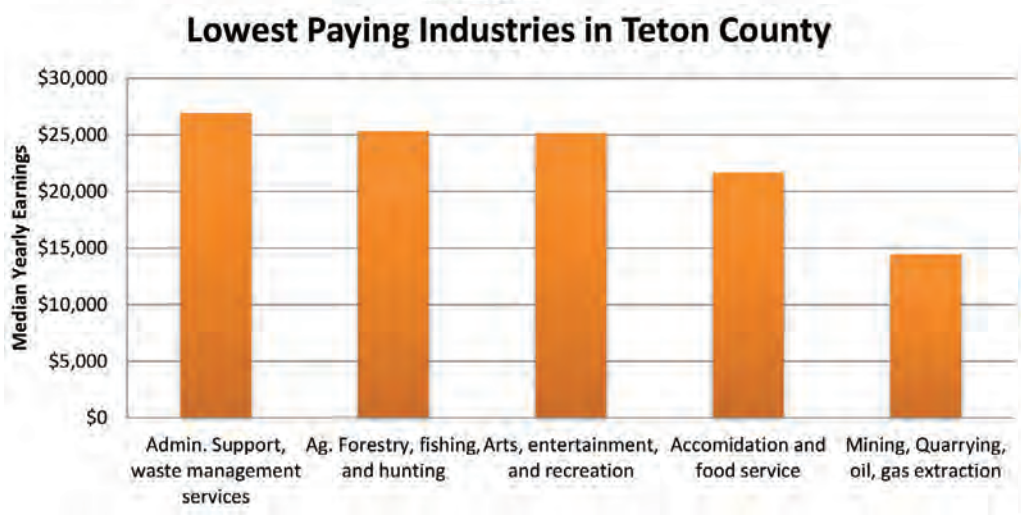
# DEMOGRAPHIC ANALYSIS

The next analysis conducted evaluates the demographics of Teton County to determine who will be the users of the site. Teton County as a whole is made up of 22,311 people with a fairly even distribution by age ("Data USA | Teton County, WY," 2015). When looking at the most common industries for Teton County there is a direct correlation to that of the lowest paying industries. For example, the most common industry in Teton County is the accommodation and food service industry; however it is the second lowest paying industry bringing in only $21,677 for a yearly median income ("Data USA | Teton County, WY," 2015). Another highly common industry is the Arts, Entertainment, and Recreation industries that also have a low yearly median income of only $25,155 ("Data USA | Teton County, WY," 2015). Based on this finding attention was targeted to finding the demographic group that would include these local residents that would fall within the low-income range for Teton County. By looking at the 2014 Western Greater Yellowstone Regional Housing Needs Assessment for Teton County Wyoming, the main targeted demographic for this development would be residents with very low-income falling below 50% Average Median Income (< $38,750 maximum income). Of these < 50% AMI residents, the majority of them are adults living alone, couples with children, and single parents (2014 Western Greater Yellowstone Regional Housing Needs Assessment - Teton Cnty Wyoming, 2014). These will be the main targeted demographic groups for the community development. The development will also provide low-income housing for Teton County in the 51-80% Average Median Income (80% max income $51,150) in order to insure all the units will be able to be filled and to provide some diversity within the development. In order to guarantee restrictions of the housing to the specific targeted demographic group, Teton County Housing Authority has programs and strategies that can be implemented to achieve this.




**Max. Affordable Rents and Purchase Prices by Income, Teton County, WY**

| | AMI | | | |
|---|---|---|---|---|
| | < 50% | 50.1%-80% | 80.1%-120% | >120% |
| **Max. Income*** | $38,750 | $51,150 | $93,000 | >$93,000 |
| **Max. Affordable Rent w/ Utilities** | $970 | $1,280 | $2,330 | >$2,330 |
| **Max. Affordable Purchase Price**** | $143,900 | $189,800 | $345,600 | >$345,600 |

Source: Teton Housing Authority 2014 Housing Survey Team Calculations

* Varies by Household size; for 2 person households used based on average household size of 2.34 persons. The number of households at each AMI category is based on the actual size of those households and the corresponding income range

** Assumes 30-year fixed mortgage at 5.5% interest with 20% of payment covering taxes, insurance and HOA fees and 5% down.

# HOUSING ANALYSIS

## How Much is Needed

The first part of the analysis to address is how much housing is needed within Teton County. According to the 2014 Western Greater Yellowstone Regional Housing Needs Assessment for Teton County Wyoming there is an extreme shortage of rental units within the county of only a 0.5% vacancy rate. This is extremely low when considering a balanced market should have a 6% vacancy rate (2014 Western Greater Yellowstone Regional Housing Needs Assessment - Teton Cnty Wyoming, 2014). This low vacancy means there would need to be 300 new units in order to meet the demands for all renters in Teton County (2014 Western Greater Yellowstone Regional Housing Needs Assessment - Teton Cnty Wyoming, 2014). Based on the targeted income for this development, 100 units would be needed to meet the < 50% AMI residents and an additional 55 units for the 51%-80% AMI residents (2014 Western Greater Yellowstone Regional Housing Needs Assessment - Teton Cnty Wyoming, 2014).

For ownership units many residents want to own their own homes and be able to move into ownership in the future(2014 Western Greater Yellowstone Regional Housing Needs Assessment - Teton Cnty Wyoming, 2014). This generates a high demand for 470 ownership units just within the low-income AMI bracket for Teton County (2014 Western Greater Yellowstone Regional Housing Needs Assessment - Teton Cnty Wyoming, 2014). However, this need is more difficult to address because they require substantial subsides (2014 Western Greater Yellowstone Regional Housing Needs Assessment - Teton Cnty Wyoming, 2014). Also there are other factors besides cost such as "inability to qualify for mortgages, lack of down payment, and inability to sell homes now owned (2014 Western Greater Yellowstone Regional Housing Needs Assessment - Teton Cnty Wyoming, 2014). This is why the Teton County Housing Authority advises not to attempt to address 100% of the demand (2014 Western Greater Yellowstone Regional Housing Needs Assessment - Teton Cnty Wyoming, 2014).

**Rental Units Needed by AMI in Teton County, WY**

| | AMI | | | |
|---|---|---|---|---|
| | ≤ 50% | 50.1%-80% | 80.1%-120% | >120% |
| **Max. Income** | $38,750 | $51,150 | $93,000 | >$93,000 |
| **Max. Affordable Rent** | $970 | $1,280 | $2,330 | >$2,330 |
| **Renter Income Distribution** | 33% | 19% | 35% | 13% |
| **Rental Units Needed by AMI** | 100 | 55 | 105 | 40 |

Source: Teton Housing Authority 2014 Housing Survey Team Calculations

**Ownership Housing Needs in Teton County, WY**

| | AMI | | | |
|---|---|---|---|---|
| | ≤ 50% | 50.1%-80% | 80.1%-120% | >120% |
| **Max. income** | $38,750 | $51,150 | $93,000 | >$93,000 |
| **Max. Affordable Purchase Price** | $143,900 | $189,800 | $345,600 | >$345,600 |
| **Income Distribution Households Plan to Move & Own** | 11% | 13% | 47% | 29% |
| **Ownership Units Needed by AMI** | 212 | 258 | 913 | 562 |
| **For Sale Listings** | -0- | -0- | 8 | 400 |
| **Net Units Needed** | 212 | 258 | 905 | 132 |

Source: Teton Housing Authority 2014 Housing Survey

Single-Family
(1st Choice)

Townhouse
(2nd Choice)

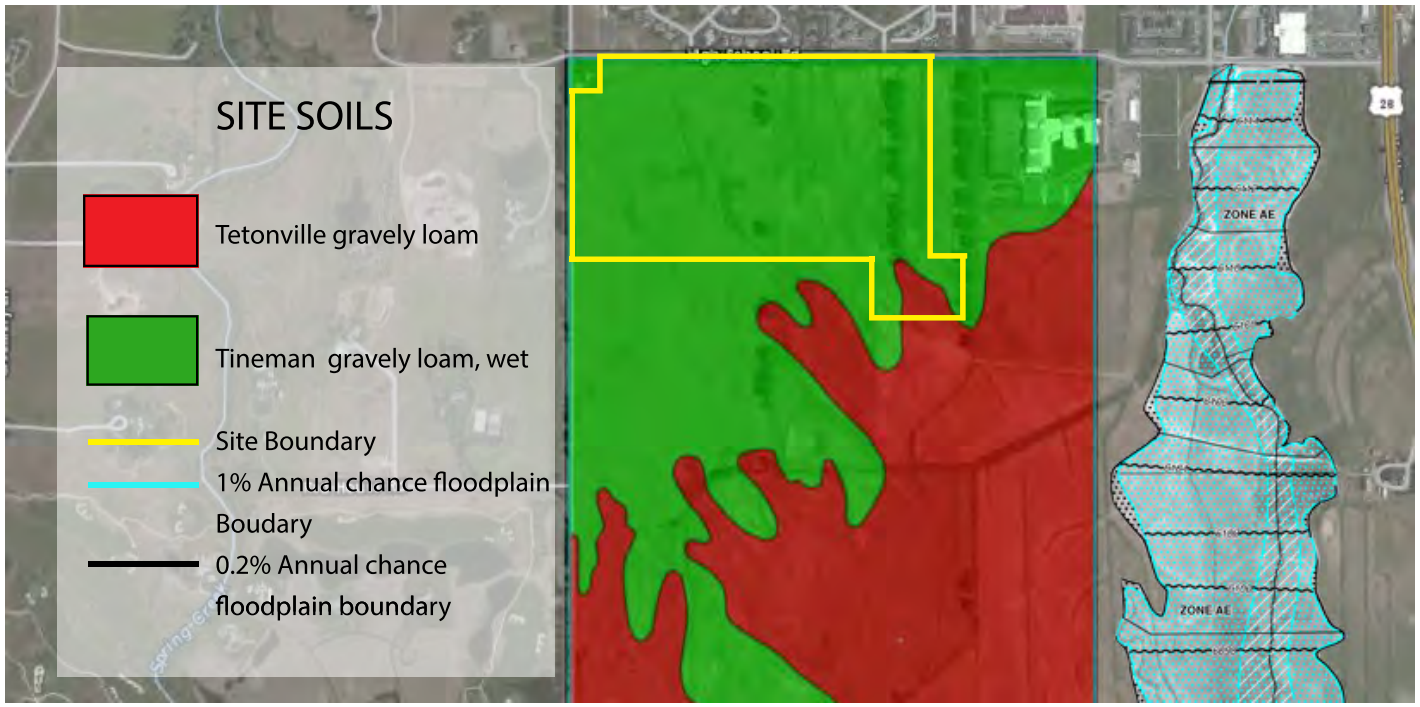
Senior Dedicated
(Threatened)

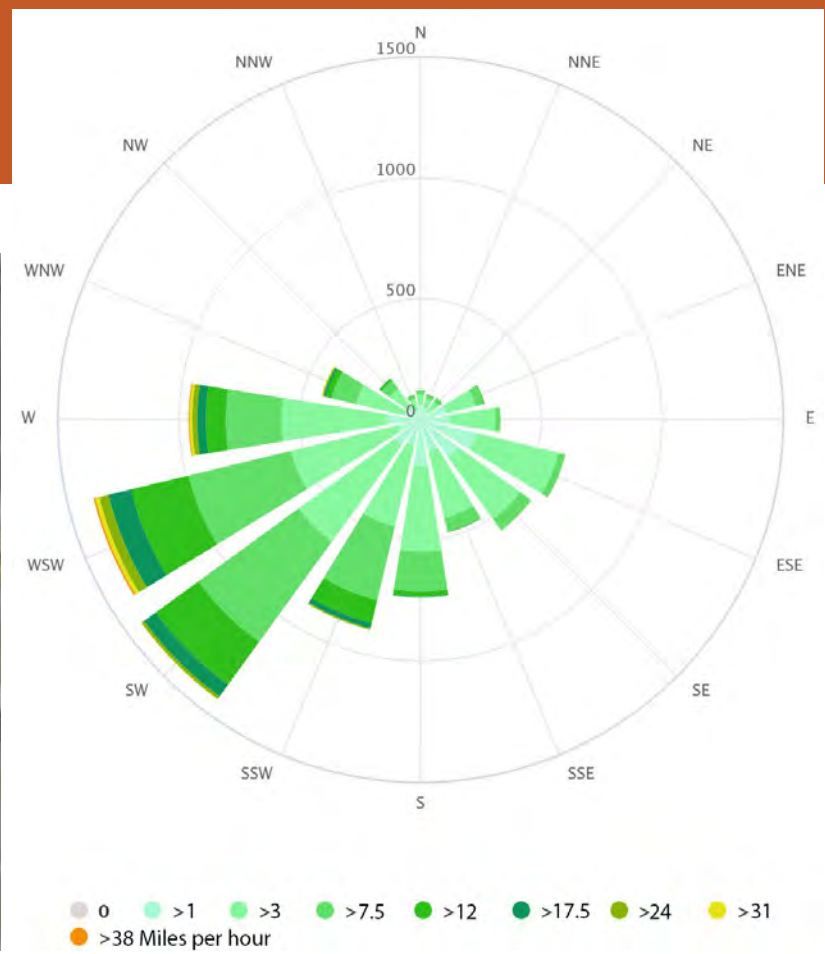
## What Kind is Needed

For the type of housing desired by residents of Teton County, the first choice is single family homes and the second choice is Duplex/townhouses (2014 Western Greater Yellowstone Regional Housing Needs Assessment - Teton Cnty Wyoming, 2014). Another housing need is seen to be senior and special needs housing. Half of the residents see it as a threat with 28% being a moderate threat and 22% being a serious threat (2014 Western Greater Yellowstone Regional Housing Needs Assessment - Teton Cnty Wyoming, 2014). The average low-income household is seen to need 2.4 bedrooms (2014 Western Greater Yellowstone Regional Housing Needs Assessment - Teton Cnty Wyoming, 2014). An observation that has been made is that residents "tend to be more firm on location but more willing to compromise on unit type and size" (2014 Western Greater Yellowstone Regional Housing Needs Assessment - Teton Cnty Wyoming, 2014). As well as the top concerns for local buyers include garages, outdoor space/yards, schools, & HOA dues (2014 Western Greater Yellowstone Regional Housing Needs Assessment - Teton Cnty Wyoming, 2014). All of these factors are important in determining what the balance of housing should look like on site as well as the typology and configuration of the housing.

# SITE ANALYSIS

Further analysis of the immediate site was conducted to make sure that the site conditions were appropriate to build a community development on. The soil on site proved to be adequate for building as well as the site was located well outside the flood plain. The winds on site mostly come from the southwest. As well as the site has good views in all directions due to the surrounding mountain range. All these factors will be taken into consideration when making important design decisions.




# SUMMARY OF ANALYSIS

In summary, the analysis phase of the project determined three fundamental design characteristics:

- The suitability analysis focused on finding areas best suited for development regarding wildlife movement and habitat.
- Further analysis of the site location was based on resident's needs and land ownership.
- The housing needs for the development proved to be for the lowest income residents and seniors.


# DESIGN

# PROGRAMMING

## A. Multi-family housing

a.Support facility types
- i.2 bed/ 2 bath- 1,208 sq. ft.
- ii.3 bed/2.5 bath- 1,669 sq. ft.

b.Size
- i.~45% housing on site
- ii.2 stories max.
- iii.7 units per acre

c.Performance Criteria
- i.Visually cohesive with other design elements
- ii.Easily accessible to bus stop, public amenities, open spaces, and parking
- iii.Full amenities
- iv.Green roofs
- v.Decks and patio spaces
- vi.Energy efficient
- vii.Re-use of grey water
- viii.1 car garage per unit

d.Activities
- i.Sleeping
- ii.Living
- iii.Relaxation

e.Users
- i.Adults living alone
- ii.Couples with no children
- iii.Single parents
- iv.Roommates

f.Season/ time of day
- i.Annual

## B. Single-Family housing

a.Support facility types
- i.2 bed/ 2.5 bath- 1,427 sq. ft.
- ii.3 bed/ 2.5 bath- 1,691 sq. ft.
- iii.3 bed/ 2.5 bath (flex space)- 1,706 sq. ft.

b.Size
- i.~ 30% of housing on site
- ii.2 stories max.
- iii.4 units per acre

c.Performance criteria
- i.Visually cohesive with other design elements
- ii.Easily accessible to bus stop, open space, public amenities, and surrounding paths
- iii.2 car garage per household

d.Activities
- i.Sleeping
- ii.Living
- iii.Relaxing
- iv.Recreating

e.Users
- i.Couple with children
- ii.Extended multi-family
- iii.Other

f.Season/ time of day
- i.Annual

## C. Senior dedicated housing

a.Support facility types
- i. 1 bed/1.5 bath- 1,060 sq. ft.
- ii.2 bed/2 bath- 1,187 sq. ft.
- iii.4 units form a building with a center courtyard

b.Size
- i.~25% housing on site
- ii.Max. 1 story

c.Performance criteria
- i.Visually cohesive with other design elements
- ii.Easily accessible to paths, bus stop, and amenities
- iii.Easy emergency vehicle access
- iv.Good views
- v.Center courtyard to foster interaction with neighbors
- vi.1 car garage per unit
- vii.Limited street parking in close proximity to units

d.Activities
- i.Sleeping
- ii.Living
- iii.Relaxing

e.Users
- i.Seniors/retirees

f.Seasonal time of day
- i.Annual

## D. Open Space

a.Support facility types
- i.Open space
- ii.Passive recreation- open park, seating
- iii.Active recreation- playground, walking/bike path
- iv.Gathering spaces-plazas for gathering, areas for outdoor gatherings

b.Size
- i.At least 20% of site

c.Performance Criteria
- i.Accessible from housing
- ii.Play areas allow for safe visibility for parents
- iii.Walking path easily accessible from entire site
- iv.Areas for impromptu sport play
- v.Limited street parking in close proximity to park space
- vi.Areas to sit and rest
- vii.Areas for community interaction

d.Activities
- i.Passive recreation- reading walking, picnic
- ii.Active recreation- biking, running, sports
- iii.Gatherings, birthday parties, family reunions, picnics, wedding receptions

e.Users
- i.Residents
- ii.Children
- iii.Families

f.Season/ time of day
- i.Use during daylight hours
- ii.Seasons- heavier use in spring/ summer/ fall
- iii.Less use in winter

## E. Daycare Facility

a.Support facility types
- i.Daytime daycare facility for children

b.Size

i.Building 2,800 sq. ft. (25 sq. ft. per kid)
ii.Outdoor play area (fenced) 8,325 sq. ft. (75 sq. ft. per kid)
iii.Accommodating if every single-family and multi-family unit has 1 child

c.Performance criteria
i.Closer to multi-family units for single parents
ii.Safe location away from major roads
iii.Easily accessible by walking path
iv.Safety in visibility
v.Parking available

d.Activities
i.Childcare
ii.Child recreation
iii.Learning

e.Users
i.Employees
ii.Children from surrounding neighborhood

f.Season/time of day
i.All year during business hours

## F. Community center

a.Support facility types
i.Event/ art center
ii.Gym
iii.Court gymnasium
iv.Locker rooms/ showers

b.Size
i.vent/ art center- 3,500 sq. ft.
ii.Gym- 2,200 sq. ft.
iii.Gymnasium- 6,600
iv.Locker rooms/ showers- 1,400 sq. ft.
v.Total = 13,700 sq. ft.

c.Performance criteria
i.Centrally located for access to all
ii.Easy to locate
iii.ADA accessible
iv.Parking available

d.Activities
i.Meeting/ gathering
ii.Working out
iii.Events
iv.Socializing

e.Users
i.Community residents

f.Season/ time of day
i.All year
ii.6am- 10pm

## G. Child engagement with wildlife and habitat

a.Support facility types
i.Playground
ii.Pathway impromptu play
iii.Interaction with water and small wildlife

b.Size
i.Playground- 3,500-6,000 sq. ft. curbed area or 2 sub-areas for ages 2-5 and 6-12
ii.Impromptu play areas every 300'

c.Performance criteria
i.Nature-based play area
ii.Safety
iii.Areas for interaction with water
iv.Opportunities for learning
v.Multi-sensory
vi.Areas for parents to interact with children and watch children

d.Activities
i.Child play ages 2-12
ii.Recreation and education

e.Users
i.Community children  with parents

f.Season/ time of day
i.Daylight hours mainly during warmer months

## H. Foster sustainable community interaction

a.Support facility types
i.Community Garden
ii.Bee boxes

b.Size
i.Community garden- boxes 12'x4'x2.5- roughly one bed per volunteer
ii.Standard bee boxes- 4 to begin with

c.Performance Criteria
i.Community garden
1.Close proximity to street for transportation of food
2.ADA accessible
3.Shed for tools and equipment
4.Area for expansion if the demand increases
ii.Bee Boxes
1.Provide pollination for plants on site
2.Located in a place away from paths and high pedestrian activity
3.Room for the addition of bee boxes if more are desired

d.Activities
i.Community Garden
1.Gardening
2.Production of food
3.Educational opportunities
ii.Bee Boxes
1.Bee keeping- educational
2.Collection of honey
3.Bees pollinate plants on site

e.Users
i.Community members on site
ii.Possibly a bee keeping club consisting of community members or the nearby high school students

f.Season/Time of day
i.Growing season/warmer months

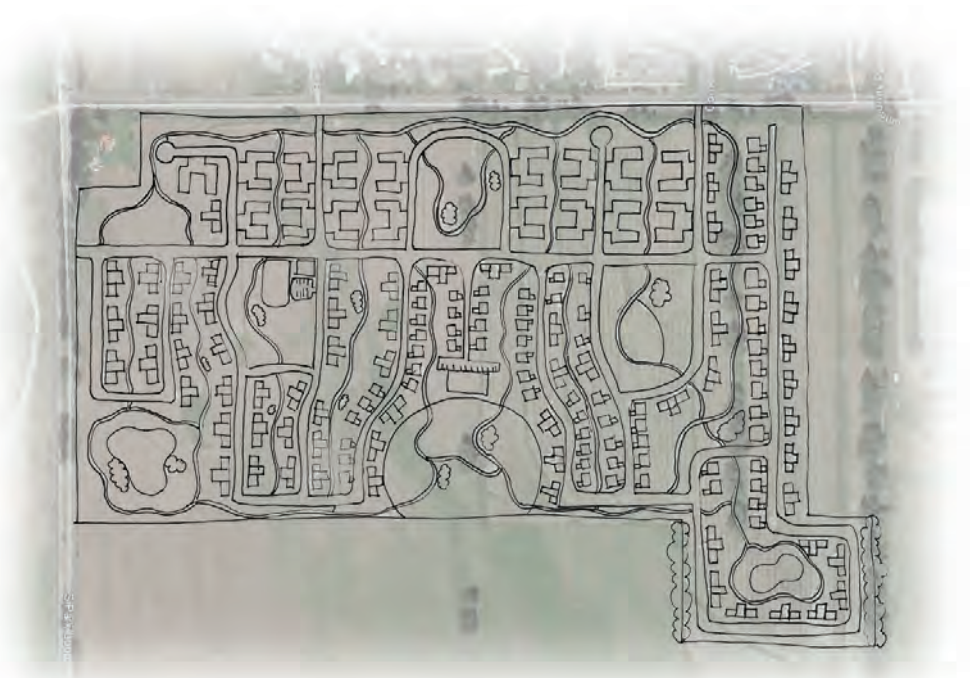
# CONCEPTUAL DESIGN

The conceptual design of the project provided a vision of the arrangement of the multiple types of housing and amenities offered on site as well as the flow and form of the site. The design is heavily influenced by the system of pathways that encircle and connect the entire site. This encourages residents to explore the site, increase their physical activity, and foster interactions with other community members. As seen through the design there is a strong linearity to the design from the north to south. This design decision was made in order to help strengthen and maintain the connection from the agricultural fields to the south of the site to the residential neighborhood park area to the north of the site. This connection can provide habitat and corridor connections for small non-disruptive wildlife in the area.

The main focal points of the site are found it the circular open spaces of the site. A circular form was chosen based on its reminiscent form of habitat patch diagrams as inspiration. Each of these areas provides open space with the opportunity for wildlife habitat, aesthetic value, as well as education on ecological importance's of the region.

The focal point on the left side of the site provides a park with a nature based play area for kids to enjoy and interact with nature. The focal point on the right side provides park space with the opportunity for a community garden for residents to learn and continue to foster community interaction. The central focal point  that includes the community center provides open space that could include bee boxes that would not only help to provide pollination on site but also a learning opportunity and another way to bring community members together by allowing them to harvest the honey.

## Preliminary Concepts



Final Concept

# SITE ZONING & SYSTEMS

## Site Zoning

The site zoning shows the location of the housing on site as well as the property lines of the individual lots that make up the development. Also zoned are the areas of natural open space making up a majority of the site and then select areas within the focal point park areas that would provide limited areas of turf. This reduces water-use for the site as well as maintenance needs. Also displayed are the civic uses and community amenities that are provided within the site. That of the community center, daycare center, nature-based play area, as well as the community garden area.

With this configuration a total of 371 units were created on site. Of the 371 units, 68 units were senior dedicated, 210 were townhouse, and 93 were single family. This met the 100 units in demand for low-income rental units and contributed a substantial amount to the 212 housing units in demand for Teton County. The senior dedicated housing typology is configured of 4 units per building, one-story, a central courtyard, and a one-car garage space for each unit. The townhouse typology is three units per building, 2 stories, provides a back balcony, and a one car garage per unit. The single family housing typology is more diverse in their configuration. Some are one story and some are two stories, their lot size ranges in 4,000 to 4,500 square feet, and each home is provided a two car garage.

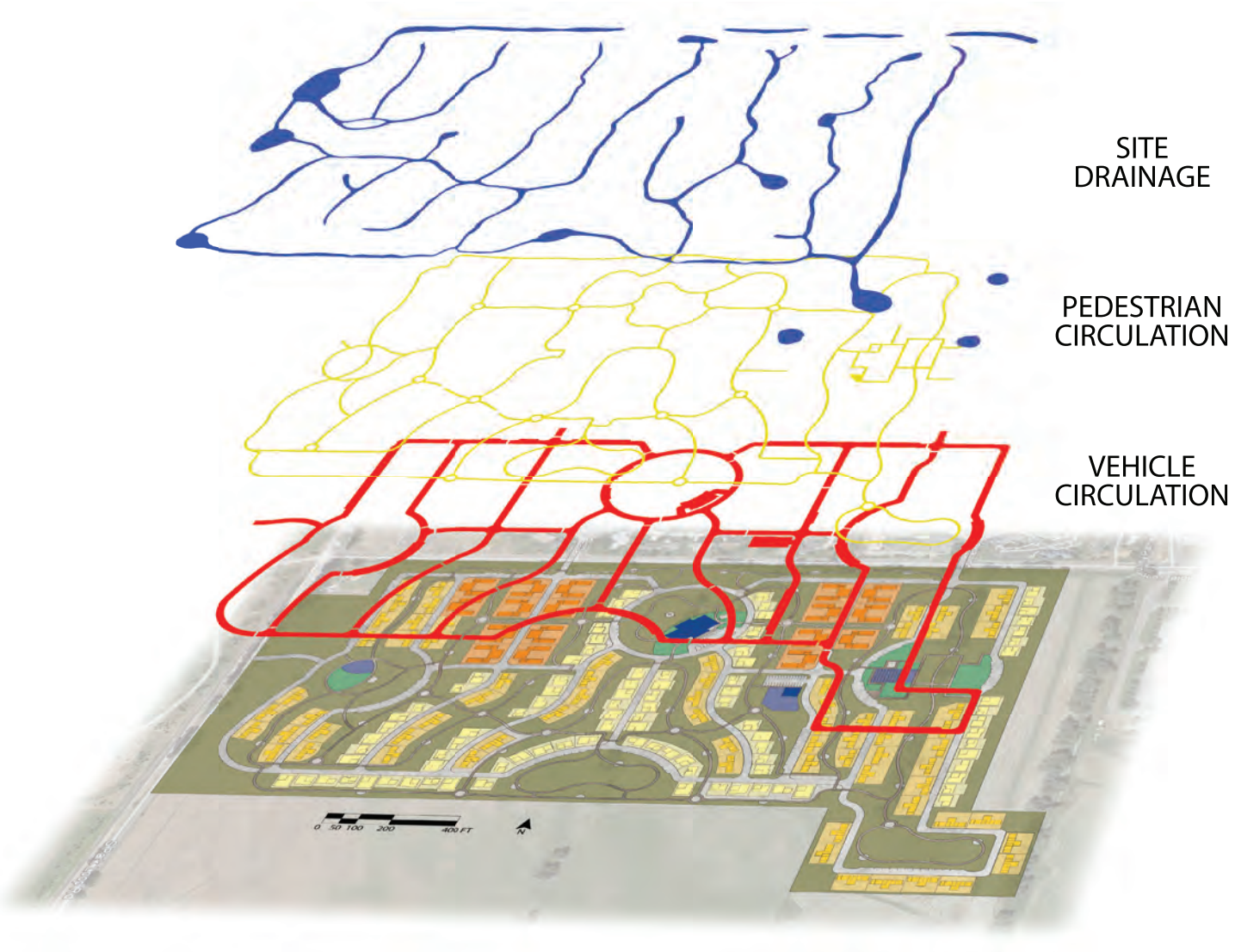
For location, the senior dedicated housing was placed toward the northern edge of the site where the main entrances are located. This allows for closer access for seniors to the bus stops located nearby as well as closer access for emergency vehicles if necessary. The townhouses and single-family housing is then distributed throughout the site intermixed in order to not create a feeling of separation within the community. The community center was placed so that it would provide a central location for all residents but also have shorter distance and easier access for the seniors who may have disabilities. Another amenity provided is the daycare center. The daycare center was placed in an area close to easy access for many townhouses in the area. This was done because of single parents making up around 18% of the targeted demographic they would be more likely to reside in the townhouse units.

## Site Systems

The drainage, pedestrian, and vehicular circulation can be seen in the exploded diagram. The drainage on site flows to creek-like channels located behind the housing along the community pathways. This water then follows these drainage paths to various drainage ponds throughout the site. These areas not only collect storm water on site but provide aesthetic value as well as habitat opportunities.

The pedestrian circulation on site focuses on connecting all aspects of the design. It's location in between the homes takes focus off of the vehicular circulation and puts the focus on the pedestrian. This also creates a safer environment away from vehicular movement and limited areas of crossing to limit the amount of interaction pedestrians have with moving vehicles on site.

The vehicular circulation on site provides access through the entire development with three entry access points. Two are located along the northern edge of the site and one is located on the Western edge. The streets are only 24 feet wide with a rolled curb at the edge. These narrower streets help to slow down traffic. There is no street parking provided except in a select few areas on site. Most street parking provided is located next to the open space areas and park access throughout the site. Combined there is a total of 151 street parking spaces available. There is also two parking lots provided on site. One is for the community center with 22 parking spaces available and the other is for the daycare center with 28 parking spaces available.



# SCHEMATIC PLAN

The schematic plan shows the design for the entire site. The pathway system connects the entire site through corridors located behind the housing. Along the pathway are areas for impromptu exploration. These provide opportunities for children, families, and members of the community to learn about wildlife, ecological importance, and history of the region. Also dispersed along the pathway are picnic shelter areas. This allows for residents to utilize the space for family gatherings, parties, and other events where, due to their small lots, they may not have the room in their own backyards. The pathway system also connects to the main focal points of the site that provide community amenities as well as open space.

The first focal point, being the main focal point, is located in the center of the site. Here the community center acts as a centrally located amenity for the entire community. Also within this focal point is a wildflower meadow. This not only provides aesthetic value for the  community but also opportunities of habitat  for smaller non-disruptive species of wildlife in the area. The wildflower meadow would also be the location of the bee boxes on site. This would provide a home for the bees at a comfortable distance to users of the site as well as provide pollination.

The second focal point located on the right side of the site provides open space for activities as well as a community garden area. The community garden provides raised planter boxes that allow ADA accessibility so that all members of the community can participate in gardening if they choose to. The planter boxes are located close to the edge of the park near parking to make harvesting of crops easier. There is also open room left to expand the community garden if there is ever an increase in participation. A shed is also provided on site to be able to store tools and supplies needed for the maintenance and care of the garden. Another feature to this focal point is that it provides areas of turf and a picnic shelter in order to provide some area of a traditional park where activities such as Frisbee, soccer, or other lawn sports could occur.

The third focal point is located on the left side of the site and provides a park focuses on connecting children to nature. As with the second focal point there is some land of traditional turf provided within the park. A picnic shelter is located within the park for events such as birthday parties and family reunions. The major emphasis of this area however is on the playground provided. The play area would be a nature based play area. This means that all play elements on site would be made and shaped out of something from nature. This allows children to explore and learn about nature in safe environment where they can create a deeper connection to the importance of our natural environments.

There are a few other park areas throughout the site that provide areas for habitat and open space. The ponds found within these areas also function in storm water management on site. These native areas provide aesthetic value for the residents as well as evoking a sense of being surrounded by nature.


WILDFLOWER MEADOW
BEE BOXES
COMMUNITY CENTER
DRAINAGE /SNOW REMOVAL AREA
IMPROMPTU EXPLORATION AREAS
NATURE BASED PLAY AREA
PICNIC SHELTER
NATIVE GRASS AREA
ROAD
GREEN ROOF
EXISTING VEGETATION
DRAINAGE PATH
COVERED GATHERING AREA
BIO-RETENTION SWALE
TURF AREA
COMMUNITY GARDEN
DAYCARE CENTER
PATHWAY
STREET PARKING
POND
0 50 100 200 400 FT
N

# PLANT PALETTE

The suggested plant palette for the site includes only native species with the exception of the turf areas. This native vegetation has been suggested based on its drought tolerance, fire resistance, non-toxic properties, non-attractive species to bears, as well as a fairly low attraction of species for browsing and grazing animals of the area. This data on the plant species was provided by the Teton Conservation District.

## Trees


Figure 3.1
Bur Oak


Figure 3.2
Rocky Mountain Maple


Figure 3.3
Scouler's Willow

## Shrubs


Figure 3.4
Mallow/ Mountain Ninebark


Figure 3.5
Thinleaf Alder


Figure 3.6
Dwarf Birch

## Wildflowers/ Forbs


Figure 3.7

Indian Paintbrush


Figure 3.11

Arrowleaf Balsamroot


Figure 3.8

Lupine


Figure 3.12

Penstemon


Figure 3.9

Common Woody Sunflower


Figure 3.13

Mountain Shooting Star


Figure 3.10

Old Man's Whiskers


Figure 3.14

Mountain Bluebell

## Native Grass Mix


Figure 3.15

Bluebunch Wheatgrass
(10%)


Figure 3.19

Western Wheatgrass
(15%)


Figure 3.16

Montana Wheatgrass
(10%)


Figure 3.20

Elk Sedge
(30%)


Figure 3.17

Big Bluegrass
(10%)


Figure 3.21

Mountain Brome
(10%)


Figure 3.18

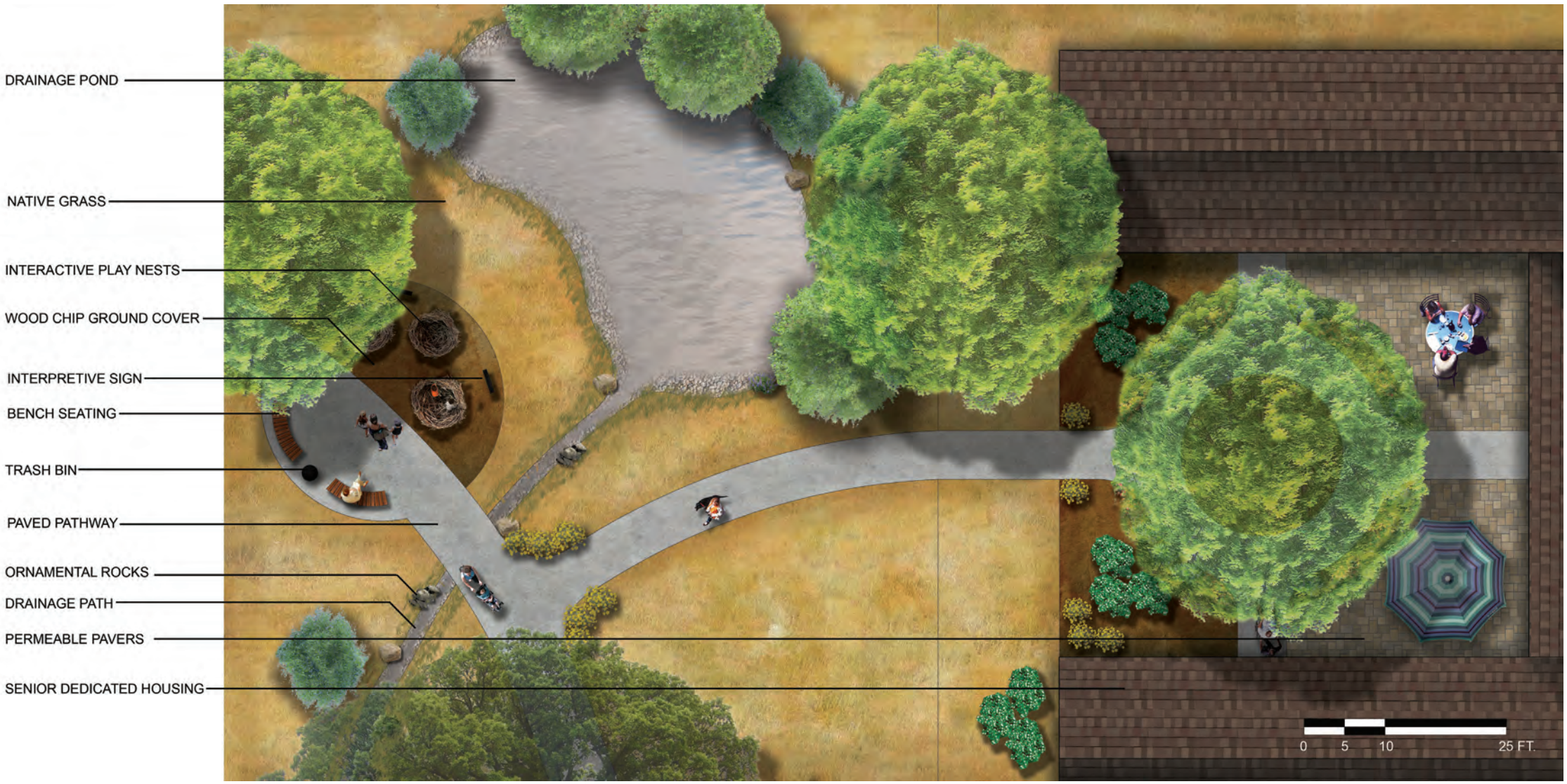
Slender Wheatgrass
(35%)


Figure 3.22

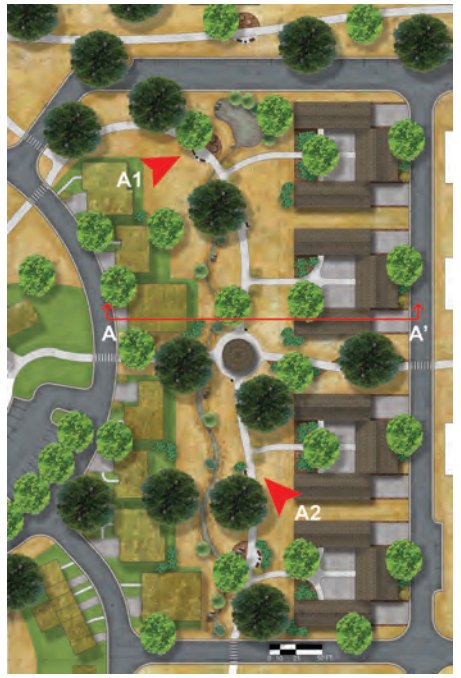
American Vetch
(2%)

# FOCUS AREA A

The first focus area demonstrates the area between the single family and the senior dedicated housing. The detailed area shown highlights the relationship between the senior dedicated housing and their access to the main pathway. The senior dedicated housing provides its own private courtyards for senior residents to be able interact and socialize with each other. This interaction is important for senior health. The seniors then have a pathway that connects to the main pathway through the neighborhood. Along the main path are impromptu exploration areas for children and families to learn about the regional ecology, wildlife, and other learning opportunities. This detailed area shows an example of one of these areas. The interpretive signs here provide information on the different bird species that can be found within the region and their habitat. Then there are large bird nests made of recycled branches that allow kids to climb and play in an interactive learning environment. There is also seating provided for parents to sit and watch their children play or users of the path to have a place to sit and rest. Also you can see how the drainage provides aesthetic value through the creek-like pathways and drainage pond.


DRAINAGE POND
NATIVE GRASS
INTERACTIVE PLAY NESTS
WOOD CHIP GROUND COVER
INTERPRETIVE SIGN
BENCH SEATING
TRASH BIN
PAVED PATHWAY
ORNAMENTAL ROCKS
DRAINAGE PATH
PERMEABLE PAVERS
SENIOR DEDICATED HOUSING
0
5
10
25 FT.

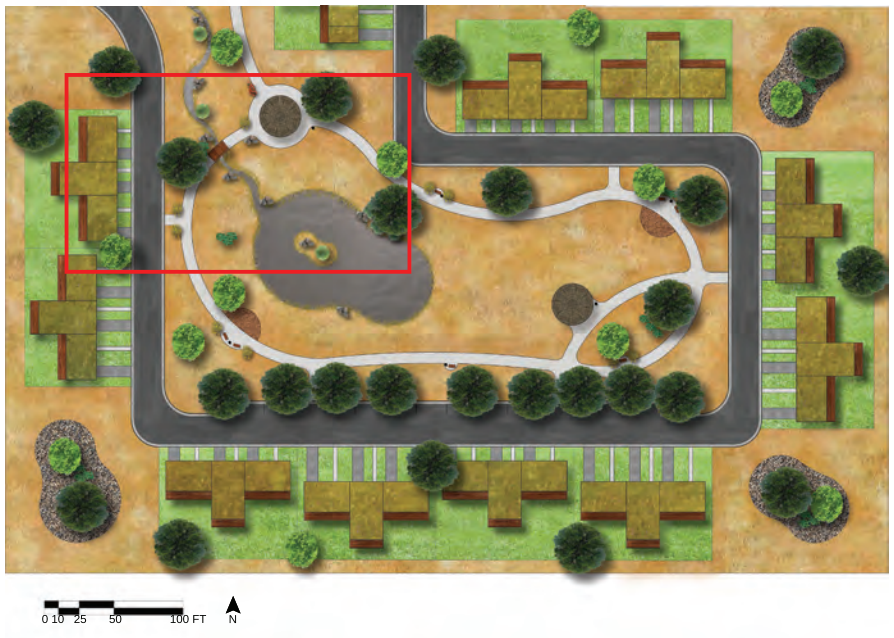
Perspective A1 demonstrates what the impromptu exploration area looks like within the context of the housing development. The pathway provides access from all the senior dedicated housing in order to provide a convenient access point for those with ADA disabilities. The second perspective A2 demonstrates how the path meanders through the common open space between the backs of the housing. Along the pathway runs the creek-like drainage channel where they provide not only functionality for drainage but also provides aesthetic value for the community and strengthening the connection and feeling of being surrounded by nature.  The section A-A' illustrates how even though the pathway cuts through the back yard areas of the housing they still reserve the feeling of privacy for the residents in their own back yard due to the distance of the path from the housing as well as strategically placed plantings.




A2

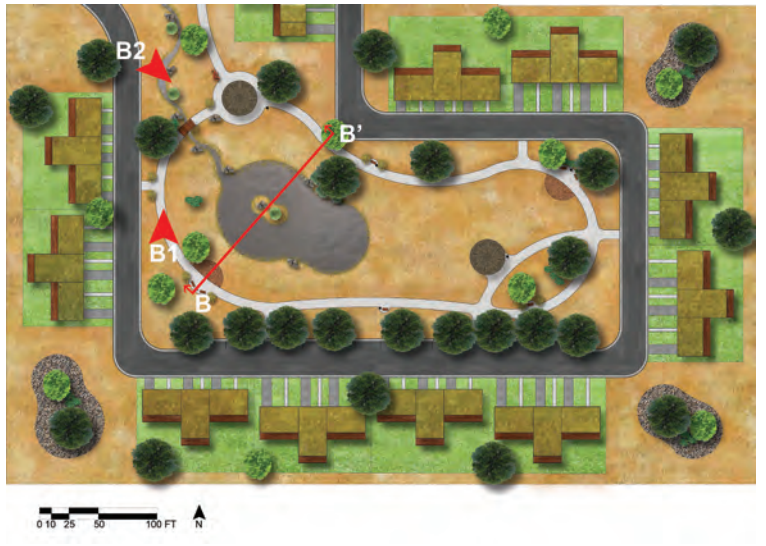

# FOCUS AREA B

Focus area B demonstrates a cluster of townhouses located on the southeast section of the site. The area focuses on the natural park area near the pond. Looking at the details, the pond with its island provides habitat for small wildlife on site such as birds, ducks, frogs, and other similar creatures. Also demonstrated is one of the covered picnic areas that are provided throughout the site along the pathway. These allow area for residents to hold events that they may not have the room to do in their own backyards due to the smaller lot lines. The one located here in the park could provide a place for residents to bird watch or enjoy a picnic lunch. The townhouses provided good views looking both in at the natural park area and from the back balconies out towards the agricultural fields. They also have green roofs providing storm water management and habitat. Also demonstrated here is a sense of how narrow the roads are. With the roads only being 25 feet wide there is no parallel parking provided along the street except for a few select areas near open space throughout the site.

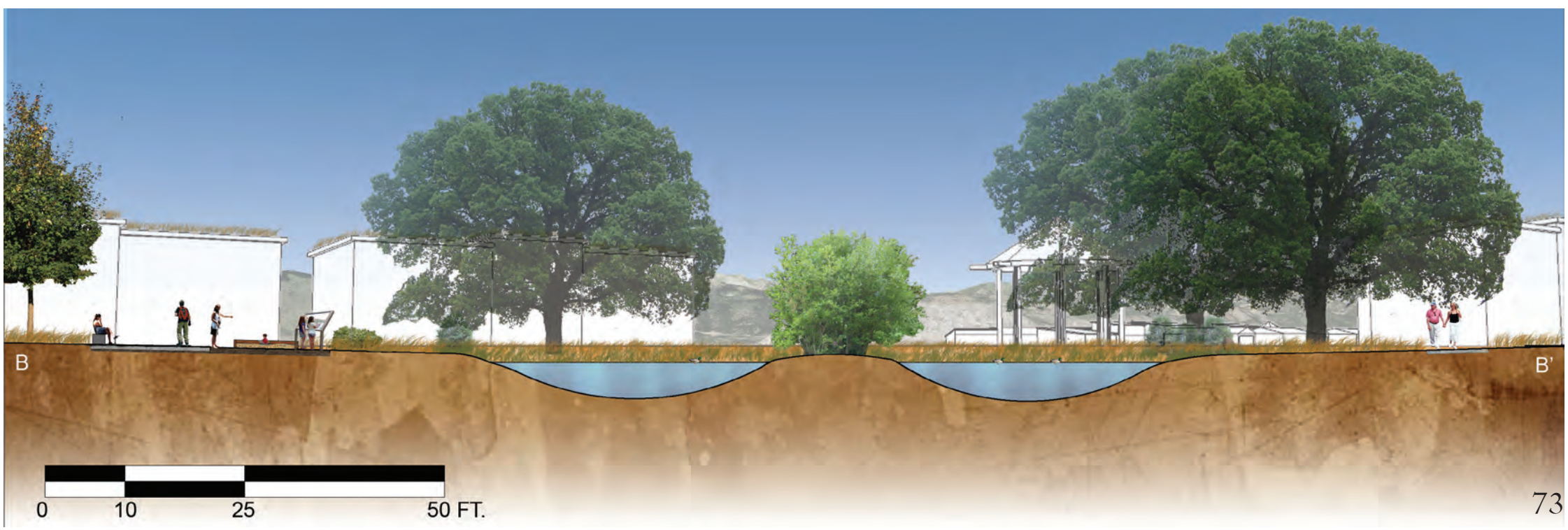




ROLLED CURB
DRAINAGE PATH
ORNAMENTAL ROCKS
PICNIC SHELTER
PAVED PATHWAY
GREEN ROOF ON TOWNHOUSES
FOOTBRIDGE WITH SEATING
LAWN INSIDE PROPERTY LINE
SIDEWALK
PERMEABLE PAVER DRIVEWAY
DECK
NATIVE GRASS
ISLAND FOR WILDLIFE
0 5 10 25 FT.

Perspective B1 illustrates the view of the pond area from the path facing toward the rest of the development. It demonstrates how the area provides a scenic landscape that feels like being a part of nature with the native vegetation and opportunities for habitat. Perspective B2 illustrates the view looking from the river-like drainage channels towards the rest of the open park area. This perspective helps to better illustrate what the rest of the natural park area looks like. Also shown in the distance is a few parallel parking spaces provided for visitors of the site that allows direct access to the pathway. The section B-B' demonstrates the scale between the pond and the island with the adjacent pathway. Also shown is another example of one of the impromptu exploration areas. This one provides interpretive signs talking about the archeology of the region. There are also sandboxes where kids could dig and discover replicas of artifacts that have been found in the area.

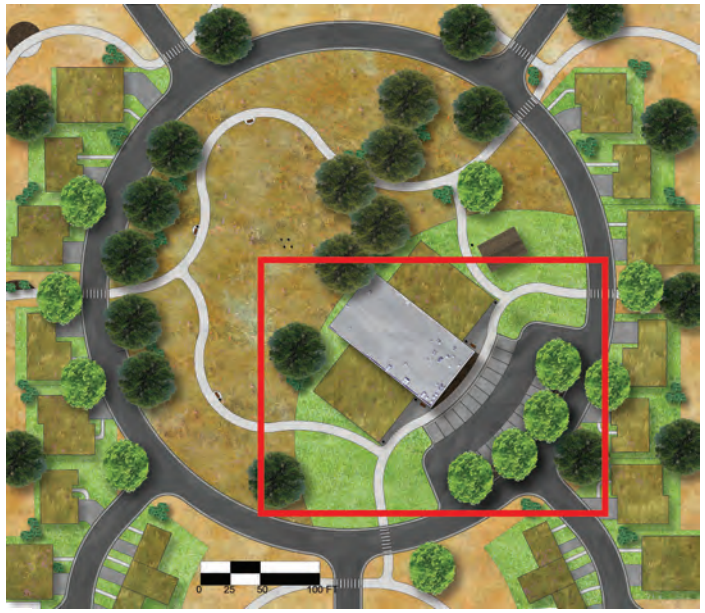



B2

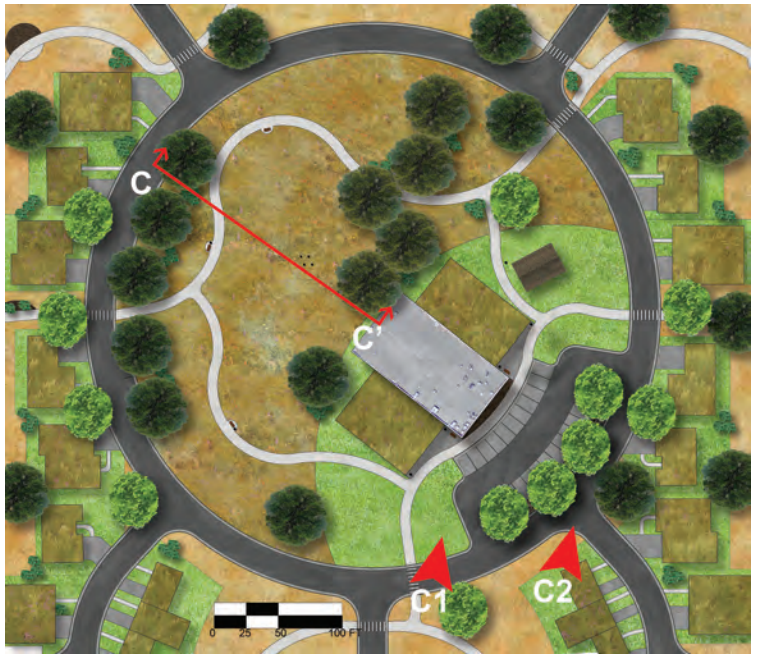
# FOCUS AREA C

Focus area 3 illustrates the area of the main focal point of site being the location of the community center as well as the wildflower meadow. The detailed plan focuses in on the community center with its parking lot and immediate grounds. One observation is that the community center has a partially green roof that would consist of the same native grass mix found on the ground of most of the site. In fact most of the buildings on site provide green roofs. This stemmed from the idea that if someone were to take a picture of the development from above the buildings would start to blend into the surrounding landscape and be reminiscent of the riparian and rangeland habitat that would have been found there prior to human disturbance. The plan illustrates how the pathways diverge from multiple directions and all converge to the entrance of the community center. This allows residents from all over the site to be able to follow the path and end up at the community center if they desire. There is also some parking provided for the community center as well. The parking stalls of the parking lot would consist of permeable paving to collect any run-off occurring from the parking lot and then any access water that the pavers can't absorb will be directed to the southeast side of the parking lot where it will drain through outlets in the curbing and into a bio-retention swale. The front entrance outside of the community center provides seating for residents to rest and wait for their friends or family as well as bike racks to park their bicycles if they ride to the community center. This front entrance area also is made up of permeable pavers to allow for storm-water management. Surrounding the community center there is a select area that is made up of turf. This is provided for use of possible activities occurring at the community center. For example, if there was a yoga class taking place at the community center and they wanted to do the class outside for the day, this turf area would provide an appropriate space to be able to do that. Then, the turf slowly blends into the wildflower meadow beyond.




WILDFLOWER MEADOW
COMMUNITY CENTER GREEN ROOF
INFORMAL FOOTPATH
PERMEABLE PAVERS
TRASH BIN
MULCH PLANTING BED
BENCH
BIKE RACK
PERMEABLE PAVERS
DRAINGAE CURB OUTLET
BIORETENTION SWALE
PAVED PATHWAY
ROLLED CURB
TURF LAWN AREA
0
10
25
50 FT

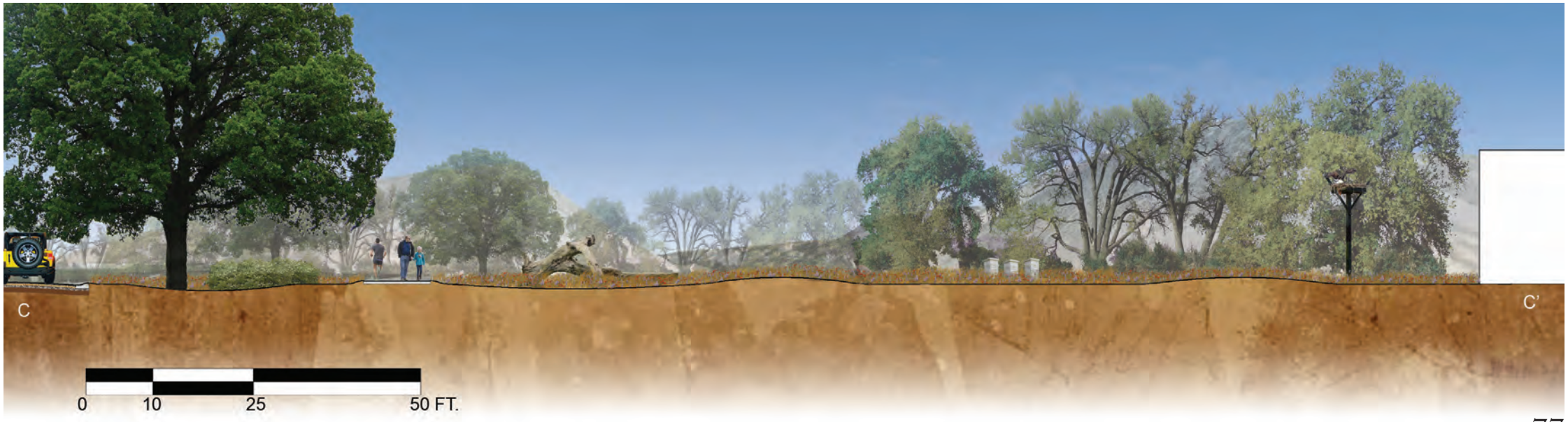
Perspective C1 demonstrates how the front entrance of the community center looks. It shows how all the paths converge and pass by the main entrance providing easy access from the pathway. Also shown is the relationship of the community center to the proximity of the parking lot out front as well as the turf area that provides outdoor space for activities from the community center. Perspective C2 illustrates a view looking down the street. This perspective helps to understand that even though the streets are narrower and the housing density is higher, the development doesn't evoke a feeling of being crowded. With the large amount of open space provided, strategic offsetting of housing, and carefully placed vegetation the site still feels open. The section C-C' illustrates the wildflower meadow. The pathway is shown where it meanders through the meadow. There are natural features within the meadow that provide opportunities for habitat for smaller non-disruptive species such as birds, rabbits, squirrels, and other wildlife. These features include fallen logs, boulder clusters, as well as platform nesting areas that provide habitat for key species such as the bald eagle and the peregrine falcon. Also located within the wildflower meadow are the bee boxes on site. These provide habitat for honey bees as well as pollination throughout the entire site. The section helps to illustrate how the bee boxes were located near the center of the meadow as to provide a comfortable distance from the main path and the users but also is still visible to draw awareness to honey bees and their ecological importance.





C1

C2



# CONCLUSION

# CONCLUSION

The overall design seemed to be successful in achieving the goals that were laid out in the early stages of research for the project. The first goal, to identify and protect key habitats for wildlife migration, was achieved through the suitability analysis locating areas where not to develop based on where wildlife movement and habitat are located, as well as the community design itself providing a large amount of open space that provides habitat for smaller non-disruptive species and connects the site to surrounding open space. The second goal, to create low-impact housing for residents of Jackson, Wyoming, was achieved through the demographic and housing analysis identifying the most in need of housing as well as the desired type of housing, it also helps to aid in the pressure of the high demand of housing needed for Jackson, and the higher density design of the site allowed for more units to be provided on site. The third goal, to reduce conflicts between humans and wildlife, was achieved by locating the site outside of areas with major wildlife movement, as well as the implementation of simple design decisions such as the plant selection being based on wildlife attraction.

The design was successful in providing a community for residents of Jackson to live without interfering with wildlife habitat and movement, but it also provided many other benefits for the residents of the site as well. Through the network of pathways on site, the large amount of community open space and the emphasis on creating a natural looking environment, the design is able to improve residents' mental, physical, and social health. The site also helps to create a connection to nature in the area as well as awareness to the importance of wildlife corridors and why protecting these habitat connections is important to maintain the health of the wildlife that is so highly valued in the area.

# LIMITATIONS

Throughout the project there are a few limitations that are beyond the control of the design that would need to be addressed if the design was taken any further to fruition. One would be that in order to make sure the wildlife corridors and areas of movement are being preserved it would need to be written into a management plan for the area. The management plan would provide policy and limitations on where future developments could be located in order to preserve these ecologically important areas. Another limitation that arises is that a housing cost analysis would need to be conducted in order to evaluate what the cost of these housing units would be upon completion and if this price point would fall within the range of affordability for the targeted residents. Lastly, a limitation is being able to find a group willing to take on the project. With the focus on the development being for lower income residents this is a lower profit for developers and currently in the area the only group that primarily serves the lower income groups is habitat for humanity.

It's also important to note that even though the design focuses on mitigating human-wildlife conflicts this doesn't prevent the possibility of an encounter in the housing development in the future. Often times deer are found in town as well as occasionally larger animals such as moose can be scared into town during thunderstorms. In instances like these further management plans by the community such as a home owners association should be put in place to be able to mitigate any further conflict. These management plans could include how trash will be collected on site as not to attract unwanted wildlife, as well as procedures on what residents should do if there is an instance where a disruptive species is found within the development.

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