2007

Alternative Futures Study Little Bear River Watershed

Richard E. Toth
Z Covington
E C Curtis
A J Luce

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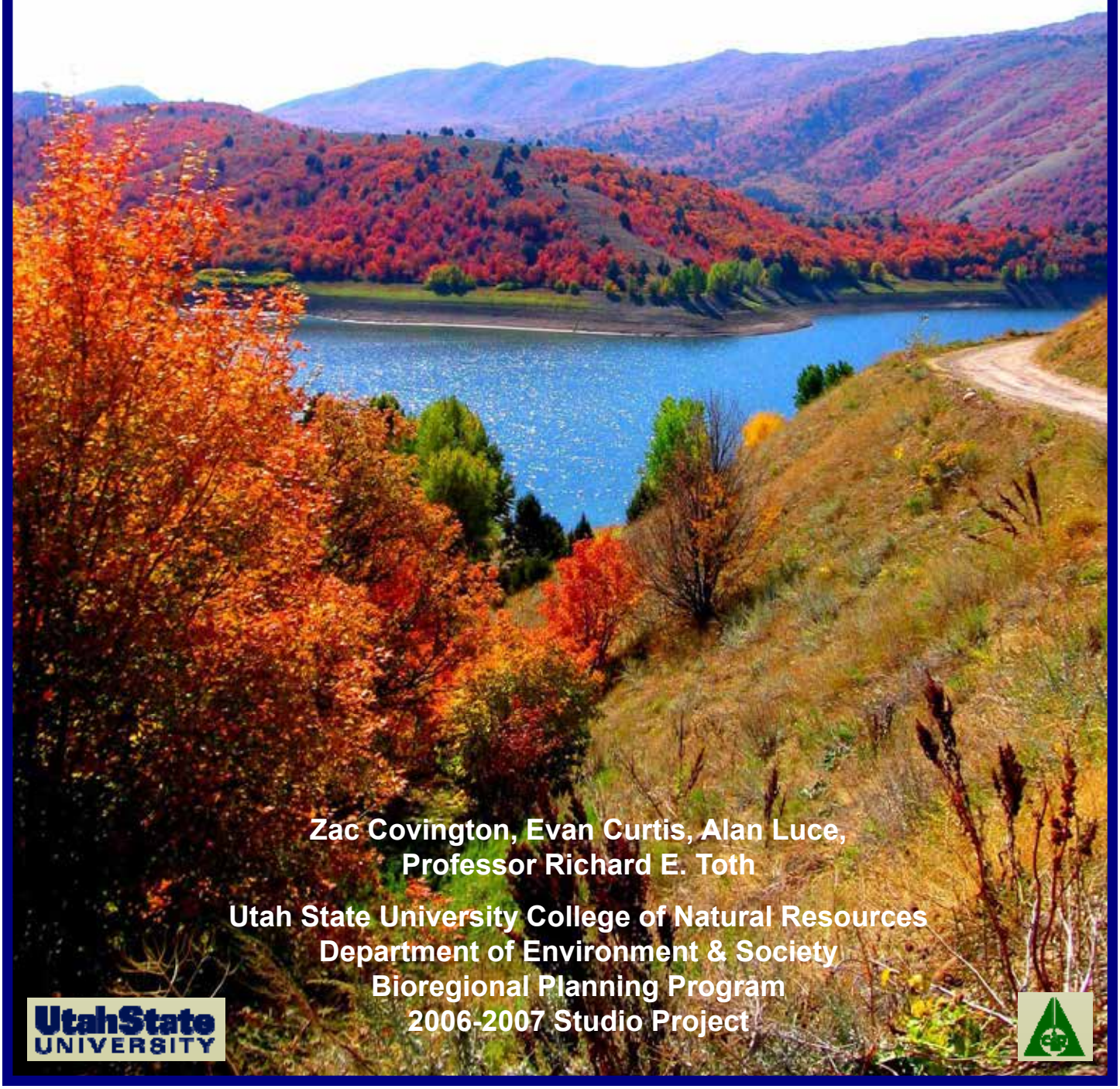

Zac Covington, Evan Curtis, Alan Luce,
Professor Richard E. Toth

Utah State University College of Natural Resources
Department of Environment & Society
Bioregional Planning Program
2006-2007 Studio Project

Little Bear River Watershed

College of Natural Resources
Department of Environment & Society -
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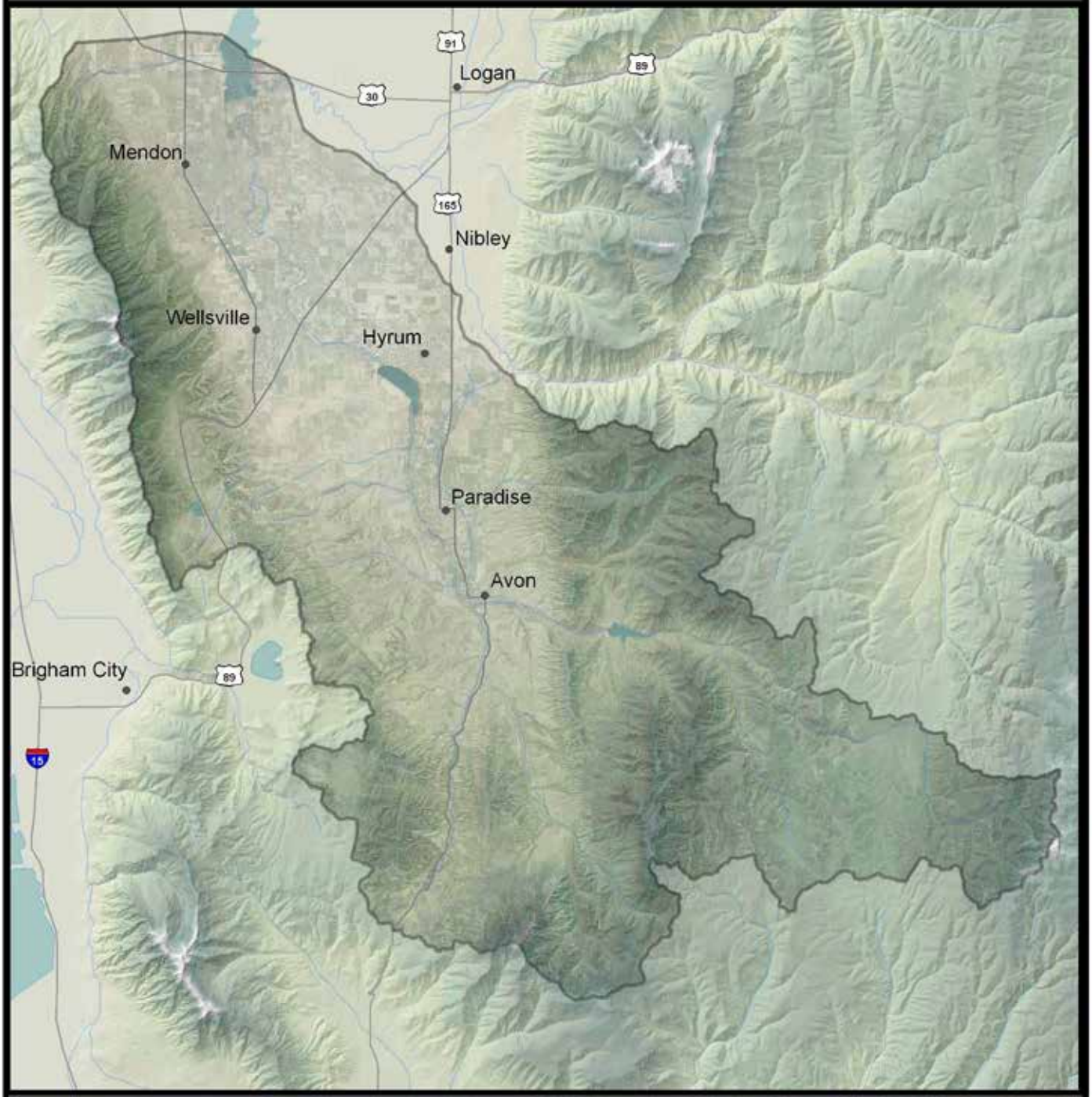

Image generated from 10 meter Digital Elevation Model (DEM) and 1 meter imagery from the National Agriculture Imagery Program (NAIP).

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All vector data provided by the Utah Automated Geographic Reference Center (AGRC).

Alternative Futures Study
Little Bear River Watershed

Bioregional Planning Studio 2006-2007

Study Team:
Zac Covington
B.L.A. - Landscape Architecture
Utah State University

Evan Curtis
B.A. Political Science
Utah State University

Alan Luce
B.S. Geography
Utah State University

Director:
Richard E. Toth, APA, ASLA
Professor, Environment and Society
Utah State University

Utah State University
College of Natural Resources
Department of Environment and Society
Bioregional Planning Program
May 2007

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Cover Photo: Porcupine Reservoir © Evan Curtis

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We also acknowledge with gratitude the many planning students and professionals whose hard work has laid the foundation upon which we build in planning for a better quality of life in the Little Bear River Watershed.

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Study Team, left to right: Alan Luce, Evan Curtis, Professor Richard Toth, and Zac Covington.

Table of Contents

Foreword

Over the past five years, a series of landscape-level studies have been carried out within the Great Salt Lake Basin by graduate students in the Bioregional Planning program in the Department of Environment & Society (see www.cachevalley2030.info).

One of the pedagogical objectives of these studies has been to test both the quality of data at different scales of planning, and the accuracy of planning alternatives as the spatial scale changes from regional to community-level applications.

The Little Bear River study presented here is the most recent in this detailed analysis of landscape planning and management recommendations.

Cache Valley's unique history, culture, climate, and natural resources have provided a foundation for the future growth and development of the region. The Cache Vision 2020+ Subcommittee on Growth, Land Use, Public Lands, and Open Space developed a number of goals and objectives for addressing growth and land preservation issues in the valley. Several of these objectives are advanced in this work: 1) future development should be looked at from a regional or valley-wide perspective including portions of southeastern Idaho, 2) growth should be directed to proper locations by respecting critical lands composed of environmental, agricultural, and cultural features of the region, 3) more compact development should be encouraged and, 4) new tools for managing growth should be instituted including shared tax revenues, transfer of development rights, and urban growth boundaries.

In addition to these four objectives, the study team devised a "tiering" approach in their modeling which will allow the various stakeholders in the region to "buy into" a planning recommendation in a more measured and incremental way. As future issues surface, the study team believes that this will be a major contribution to management policy in that it scales decisions to various planning objectives and issues, as opposed to a blanket approach. Lastly, this report also contains several community-level analyses which are nested within the overall study area of the Little Bear River (See Appendices D and E). It is recommended that similar community-level studies be initiated in order to assist unincorporated towns with their future growth and development. Since the community-level studies are set within the context of the Little Bear River Watershed, both the data and computer models can be utilized in their future planning and design.

RET/bh August, 2007

Pre-Analysis Methodology

When addressing complex regional planning issues for areas that have specific development pressures or concerns, the methods used should be connected and reciprocating. While the order in which this project was researched and analyzed was quite structured, the overall planning strategy was intentionally fluid and connected. In this project there was taken an approach that is used by many land planners and designers, consisting of site inventory, site analysis, data analysis, mapping, and final future development scenarios (Toth, 1974). However, the modeling and final future scenario sections of this project were done in a unique and intriguing manner.

While participating in site inventory and analysis, site visits on the ground and in the air were utilized for their various advantages to attain a perspective on current land uses and development patterns. While on these site visits, obvious issues and potential problems with the land use in the Little Bear River Watershed were recorded and discussed. These visits were then supplemented by project opinion papers that formally summarized our findings. Case studies which were applicable to the situations in the Little Bear River Watershed were studied and analyzed to give the students a better understanding of potential problems and/or the solutions to those problems.

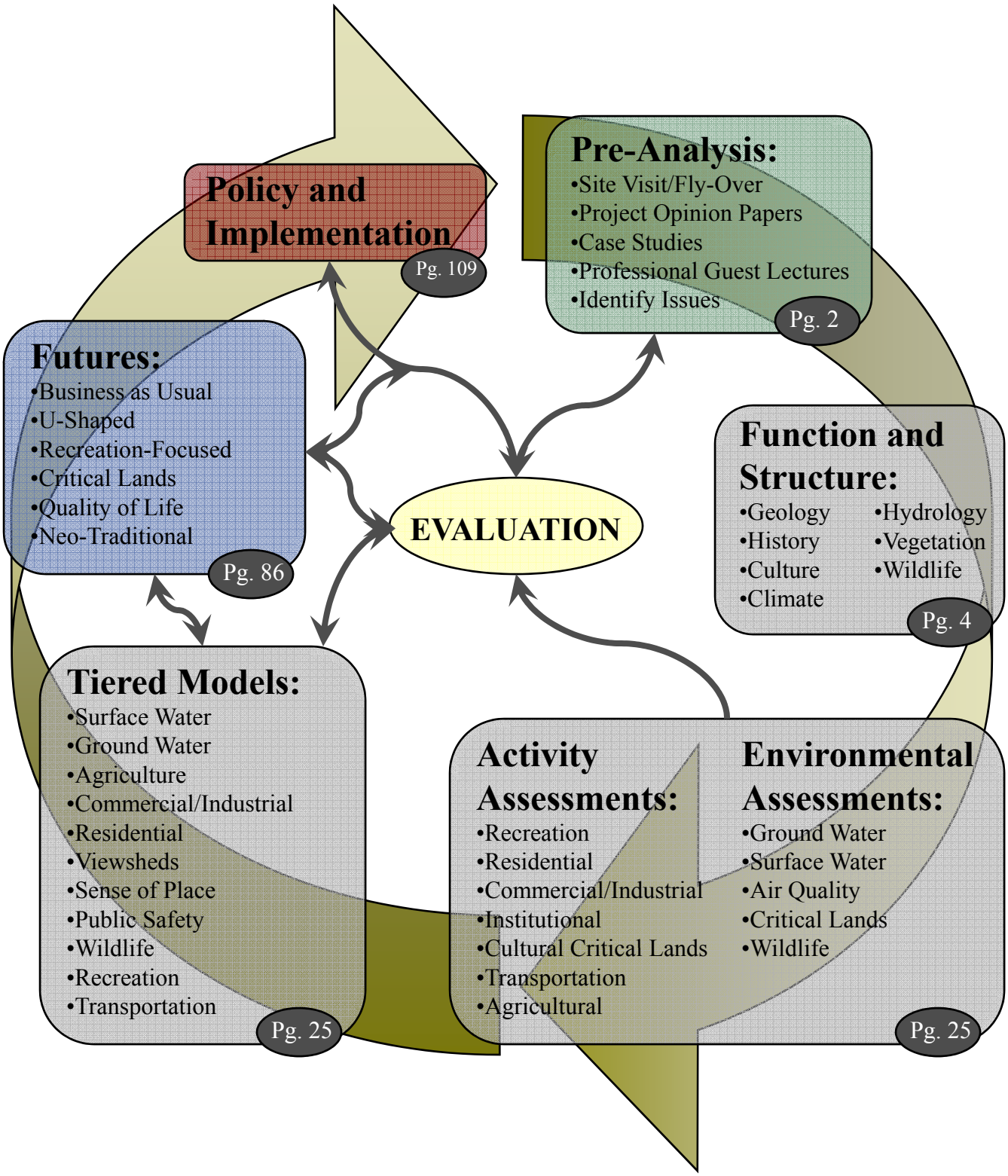
The region's natural, historical, and cultural assets were studied in-depth in order to give the students a more educated understanding of the functional and structural aspects in the region. Fourteen environmental and activity assessments were analyzed to provide a detailed view of what land uses were currently taking place on the landscape. These assessments were eventually used to create working models of the various uses and to create maps of those uses.

While the research was taking place, and models were being created and modified, many professionals were consulted in order to give the students exposure to real life issues and for the utilization of expertise. Many university professors and working professionals were interviewed, and some gave presentations on topics such as ground and surface water, wildlife, transportation, sociology, residential development, geology, recreation, recent regional planning projects and others.

At the suggestion of Professor Richard E. Toth and Teaching Assistant Ellie Leydsman McGinty, a tiered approach to modeling was applied to give flexibility and creativity to the futures. This tiering structure consisted of an average of three tiers per model, which progressed from the most basic land use to more complicated. For example, Tier 1 Public Safety consists of very basic land types that could compromise public safety, while Tier 3 Public Safety consists of more complexity and a larger amount of land. These tiers were then used in combination with one another to create five futures that could realistically be applied to the Little Bear River Watershed.

Arguably the most important aspect of this methodology is the eventual implementation and policy changes in the communities and/or county for which it is intended. While there is a great amount of land in the Little Bear River Watershed that has not been developed, current and potential development pressure is evident. As community, county, and regional residents and planners see how development pressure may affect the health, safety, and welfare of the people in the region, care should be taken to develop and preserve land in an intentional manner that compliments the concerns of its residents.

Pre-Analysis Methodology



Analysis Function and Structure

Before one can begin creating future growth options for a region or community, there must be an adequate understanding of the natural systems in that region or community. For example, if one of the crucial aspects of an area is the winter range of Mule Deer, one must study about the Mule Deer and understand why winter range is important and what land attributes combine to make winter range for that animal.

In the learning and understanding of the existing systems in the Little Bear River Watershed, natural, historical, and cultural subjects were studied to give an adequate background for the land uses being addressed in the study.

These systems were comprised of geology, history, culture, climate, hydrology, vegetation, and wildlife. Each was studied with the intention of acquiring enough general knowledge to give an adequate base for the environmental and activity assessment models, and eventually for alternative future development scenarios.

The Little Bear River Watershed is rich with the above-mentioned amenities. Without a basic understanding of these systems, major errors could be made in the mapping and eventual suggested uses of these amenities. The studies engaged in were also supplemented with several professional lectures and presentations by USU faculty and visiting planning professionals.

Photos by Zac Covington

History and Culture

The towns, people, landmarks, and culture of the area surrounding the Little Bear River reflect the rich history of the Cache Valley. To ignore the history and culture of this area in the planning process would be especially dissolute considering the enormous influence the past has had in shaping this region and those who reside here. The names that identify towns and landscape features remind current residents of the expansive history that contributes to the region. One can hardly pass through the many towns and surrounding areas without noticing the many historical sites, cultural and religious buildings, and the agricultural feel that permeate the landscape. This feel ties the present with the past and should surely influence the future of the Cache Valley.

Cache Valley's Natives

While little is known about the original inhabitants of the area, it can be assumed that hunters and gatherers used the area as early as 10,000 years ago, with more sure evidence of the Fremont culture between 700 to 2,000 years ago. Due to the frigid temperatures and large amounts of snow that define the winters in Cache Valley, it is believed that early inhabitants vacated the area on a seasonal basis, preferring the rich foodstuffs of the region during the summer months. Few artifacts remain of the valley's earliest inhabitants, demonstrating the impetus the natural environment has had on human use of the area (Peterson, 1997).

By the time the first white explorers arrived, the Shoshone Indians were the primary inhabitants of the area. These Native Americans profited from the many deer, elk, buffalo, and antelope that occupied the area. Additionally, the many rivers that flow from the surrounding mountains provided these natives with an ample supply of fish, perhaps explaining why the Shoshoni referred to themselves as the Pangwaduka, or "Fish-eaters" (Peterson, 5).

As white explorers began to encroach upon the west, tribal competition became fiercer, and Blackfeet, Crow, and Ute tribes were also seen in the area (Peterson, 1997). By 1880, as permanent white settlements became common and the United States government began to relocate the natives to reservations, the Native Americans' collective issue in the area was effectively nullified (Peterson, 1997).

Trappers

Shortly after the Lewis and Clark expeditions, fur trappers and explorers began to comb the mountain west in search of beaver, and in 1818 a 21-year-old French Canadian fur trapper by the name of Michel Bourdon entered the Cache Valley. It is believed that he was the first white man to set foot in the area and is given credit for naming the Bear River for the many grizzlies he encountered in the area. In subsequent years, many other trappers such as John Weber, Ephraim Logan, Jim Bridger, Jedediah Smith, and Peter Skene Ogden poured into the valley (Peterson, 1997). These trappers and explorers left their mark in the histories they left, the landscape features they named, and the impact they had on the inhabitants of the area.

Not only did the early trappers leave many of the first written descriptions of the area, they also took the liberty of naming many of the identifying features. The name "Cache Valley" originates from these early trappers, a cache being a hiding place for their surplus supplies. Jedediah Smith first recorded the use of the name as

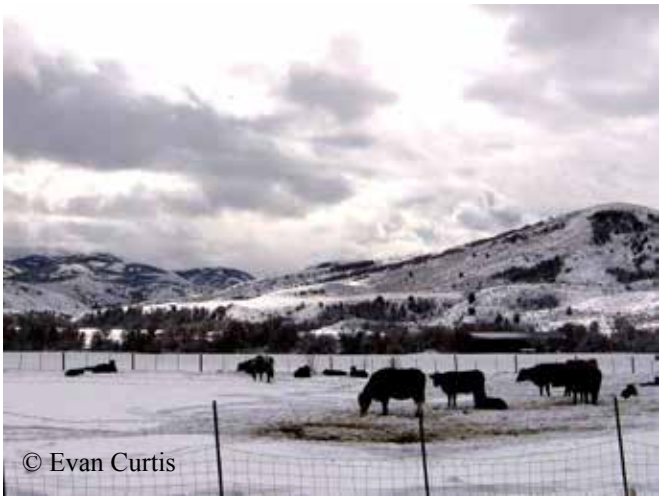
identifying a rendezvous site in the valley in 1826 (Peterson, 1997); however, James Beckwourth takes credit for first using the name Cache Valley to replace the previous appellation of Willow Valley (Peterson, 1997). The names of other surrounding areas also reflect the effect that trappers had on the area: Logan, Bridgerland, Ogden, and Weber are a few local names that immortalize these early trappers.

Settlement

Prior to 1850, Cache Valley had not had any permanent year-round settlements (Peterson, 1997). However, as Mormon pioneers flooded into Utah after 1847, it seemed inevitable that settlers would make use of the Valley's ample water supply and comparatively lush vegetation. And indeed, by 1900, the population of the Utah side of Cache Valley was over 18,000 (Peterson, 1997).

Prior to any intention of settling the area, Brigham Young, the Mormon prophet and Utah's territorial governor, sought the area as a possible summer feeding ground for his own, and the LDS church's numerous cattle (Peterson, 1997). In July of 1855, ten men arrived in Cache Valley to prepare the

area for the more than 3,000 cattle that would arrive. In spite of the 200 tons of wild grass hay that the men stored, the winter proved too difficult, and the ranchers endeavored to relocate the cattle back to the greater Salt Lake



Valley. Only 420 of the church's 2,000 cattle survived the winter, and the ranchers who remained in the valley were completely snowbound until spring (Peterson, 1997).

The experience dissuaded Young from using the valley as a herding ground but did not deter him from eyeing the area as a possible location for settlement as new converts to the church continued to pour into the Salt Lake Valley. As drought plagued most of Utah throughout the 1950s, Peter Maughan of Tooele County sought Young's permission to select a place in Cache Valley for settlement in order to alleviate some of the pains associated with the drought (Peterson, 1997). With permission granted, Maughan set up camp on the 15th of September, 1856 and established Maughan's fort, or present day Wellsville. With permanent white settlers now established in the valley, Cache Valley was considered by whites to be open for settlement (Peterson, 30). Unlike many other Mormon settlements throughout the west, the Cache Valley grew, not because they were called and sent, but because they wanted to be there. Despite Maughan's admonition to remain in the south end of the valley, settlements burgeoned north along the numerous streams. Mendon, Logan, Smithfield, and Richmond were each established in 1859 (Peterson, 35).

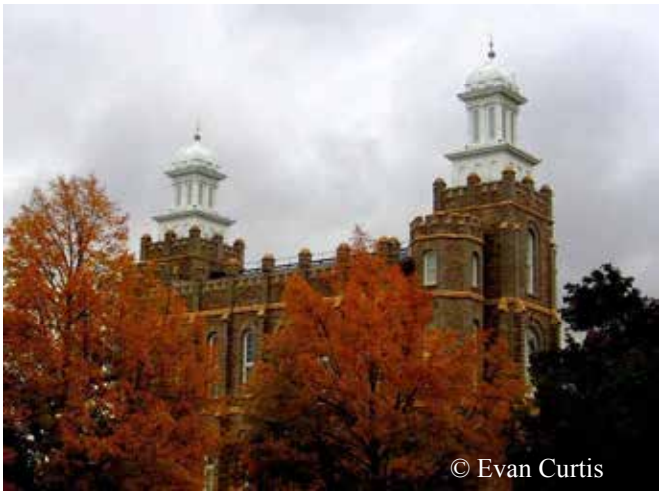
Mormon Settlement Patterns

City planning in the Little Bear River watershed began with the earliest Mormon settlers who entered the valley. For this reason, to understand the history of this development from a planning perspective, it is imperative to understand Mormon settlement patterns and the plans these early pioneers implemented.

The basic concept for Mormon cities originated from the plat for the City Zion, drawn by church founder, Joseph Smith, in 1832. The basic pattern of a Mormon village placed homes in a separate location from the farm. The city streets ran due north/south and east/west, intersecting at right angles (Nelson, 1952).

The plan contained significant planning innovations that, had they been followed, may have mitigated many of the problems being faced in the mountain west today (Moser, 2006).

Though the plats of the cities in the Little Bear River watershed differ somewhat from the original plat for the City Zion, the basic structure of these Mormon villages remains largely intact with the exception of recent subdivisions and developments. The square blocks, wide streets and regulated lot sizes give a unique character to the older sections of these towns and reflect the planning heritage that exists in the area. In a Journal of the American Institute of Planners, Charles E. Sellers praised these Mormon village as emulating the idea that "public interest [comes] before the personal aggrandization. [The Mormons] believed that a high standard of personal living was equally as important as a high standard of individual living. Their cities and towns are evidence of this belief. Many of them are still models of orderliness" (Moser, 2006).



The influence of the Church of Jesus Christ of Latter Day Saints

Since the early days of white settlement in the valley, the history, politics, and culture of the Cache Valley, as with much of Utah, have been largely influenced by the predominant religion: the Church of Jesus Christ of Latter Day Saints (the Mormons). As previously mentioned, the church oversaw the settlement and early governance of the area, and even defined the pattern of the settlements. Once the early settlements were established, the leaders of the church had a predominant role in naming towns, setting up economic and civic systems, and overseeing educational institutions (Peterson, 104). Today such historic sites as the Logan Temple and the Logan and Wellsville Tabernacles, along with several historic churches, dot Cache Valley as vestiges of the early settlers' dedication to their religion. These reflections of the past are joined today by dozens of other LDS churches in the area (www.mormon.org), with several still being constructed, demonstrating the continued presence and growth of the church in the valley.

History's influence on the present

Ever since the original natives came to this valley to make use of the abundant foodstuffs, this area has been a special place for those who use the land for a living or for recreation. Like the Shoshoni, "fish-eaters" who sought the fish that populate the many rivers in the area, modern-day anglers spend countless hours on the valley's streams. In the

tradition of the early trappers and pioneers, hunting is an extremely popular activity in this area. The early recognition that this valley's soil had a tremendous potential for agricultural purposes has not been forgotten. The Cache Valley is still considered to be the "bread basket" of Utah. Even the history itself has created a passion for many in the area. Cemeteries, museums, and historical sites such as the Heritage Center all point to the critical function that history plays in the structure of this area.

The mountain man spirit still has an influence in the valley, however. Studies (Cordell, 1995) indicate that a higher percentage of residents in the Rocky Mountain states camp, especially in primitive areas, than those in other regions of the country. The Rocky Mountain region also has a much higher percentage of big-game hunters (274), hikers, horseback riders, and freshwater fishers (276) than most of the other five areas.

Agriculture remains a defining feature in the Cache Valley. In fact, it is one of the primary agricultural producers of the state, leading the state in barley production and closely following in winter wheat, spring wheat, dry beans, corn for silage, apples, and hay. Aside from crops, Cache County also has the second largest inventory of cattle and cows, and the largest number of milk cows (Godfrey et al.). Throughout the county there are 1189 farms covering 267,924 acres (Utahreach.org). The agricultural feel prevails throughout the south end of the valley as well, with many private dairies and farms visible, as well as the industrial giant Miller's Blue Ribbon Beef, headquartered in Hyrum, with over 1000 employees (www.eamiller.com).

History remains a part of the area's culture and identity, underscoring the pivotal role that the region's history plays in the current culture of Cache Valley. The feel of the towns in the Little Bear Watershed reflect the prevailing pioneer spirit of the past. The allure that emanates from the well-planned cities and towns deserves preservation for the future. In the words of Charles E. Sellers, "Let us hope the distinctive charm and personality of these splendid communities will not be sacrificed" (Moser, 2006).

Geology and Soils

The Little Bear River Watershed covers a large land area with a variety of soils and geological features. These geological features serve many beneficial purposes for agriculture, development, and recreation, yet can also be hazardous if misunderstood. It is critical to incorporate geology into the planning process by considering the function of the geological history, soil types, fault lines, and liquefaction possibilities.

Geological History

The geological history of the region plays an interesting role in Cache Valley's settlement and development and must be incorporated in any analysis of future development of the region. Northern Utah, containing a wide variety of sedimentary, metamorphic, and igneous rocks from every era, has been referred to as a "geologist's paradise" (Liddell and Ohlhorst, 2005). The Little Bear River Watershed is part of the Middle Rocky Mountain physiographic province, comprised of Precambrian rocks, altered by multiple cycles of mountain building and burial. (Milligan, 2000). The geologic cycles that formed the mountainous region have been happening for hundreds of millions of years, combined with more "recent" glaciation some 14,000 years ago and the prehistoric deposits from Lake Bonneville (Liddell and Ohlhorst, 2005). These geological processes formed very evident landscape features throughout the Cache Valley, such as the Bear River Mountain Range, the Wellsville Mountains, and the "benches" of the valley.

The Bear River Range to the east is comprised of marine sedimentary rocks of the Paleozoic age which were buried, lithified, and deformed during the Mesozoic Age. These "deformations" included "thrusting" the underlying rocks of the area (part of the Willard Thrust Sheet) some 50 km west to east, and "folding" the rocks in the bear river range into a large "U" shaped structure, referred to as the Logan Syncline. Normal faulting has lifted these mountains while the valley has dropped down; the East Cache Fault separates the mountain front from the valley (Liddell and Ohlhorst).

The Wellsville Mountains, west of the valley, are reportedly listed by Guinness Book of World Records as the "steepest" (or more accurately, narrowest) mountain range in the world and are bounded by normal fault lines. The highest peak and valleys were sculpted by glacial ice during the Pleistocene Epoch, while running water cut the lower valleys. Unlike the Bear River range, no folding occurred; instead, the rocks dip

steeply into the Cache Valley and, consequently, large landslides have occurred in the past (Liddell and Ohlhorst).

Prehistoric Lake Bonneville

The deposits from a historic lake, Lake Bonneville, formed the "benches" upon which many homes are currently built (Liddell and Ohlhorst, 2005). In prehistoric times, this freshwater lake covered western Utah and a strip of Nevada and would have inundated many of the present day towns in Cache Valley, such as Logan, Hyrum, Clarkston, and Mendon.

Bonneville Shoreline © Evan Curtis

Soils

The soils in the Cache Valley have been a significant factor in determining the success of the region's agricultural endeavors. Three major soil orders make up the Cache Valley: alfisols, inceptisols, and mollisols (Toth et al., 2006).

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Alfisols

Alfisols, described as "moderately leached forest soils" that are well developed, contain a subsurface of clay and have high native fertility (http://soils.ag.uidaho.edu) Alfisols comprise only a small portion of the Little Bear River watershed, occurring mainly in the mountain regions to the south where clay has moved from the surface to the subsurface. A thin layer of dark, organic matter that covers the light-colored surface of the soil identifies alfisol. Since alfisols are highly alkaline in nature, they are predominately vegetated by salt-tolerant shrubs and grasses (Toth et al. 2006).

Inceptisols

Inceptisols display a wide range of characteristics and occur in semi-arid to humid environments. Inceptisols are typically found on fairly steep slopes, young geomorphic surfaces, and on resistant parent materials. Due to their primary location in mountainous areas, they are mainly used in forestry and recreation. Inceptisols are

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limited in the Bear River Watershed, the majority being in the area northwest of Mendon (Toth et al. 2006).

Mollisols

Mollisols are the predominant soils in the Little Bear Watershed and are distributed throughout the region (Toth et al., 2006). These dark, fertile soils are typically associated with grasslands and are among the most productive agricultural soils in the world due to their granule structure. They are comprised of abundant organic materials that give the soils a dark surface. Mollisols are moderately alkaline at lower elevations and moderately acidic at the higher elevations. They are typically found in areas that receive greater than 12 to 40 inches of annual precipitation and in areas at an elevation greater than 4,500 feet. Mollisols dominate the mountains, high plateaus, foothills, and the benches of this region (Toth et al., 2006).

Seismology

As with most mountainous regions, the Little Bear River watershed is prone to seismic activity that must be considered in development. The Cache Valley is bounded on both sides by two primary normal fault zones- the East Cache fault zone and West Cache fault zone (Toth et al., 2006). An earthquake is basically a rupture or slip of rock along a fault caused by excessive forces within the earth's crust. This ground shaking, especially the horizontal forces, can be very destructive, especially to older structures. Considering the fact that Cache Valley falls in a high threat area for earthquakes relative to other areas in Utah, according to the Uniform Building Code seismic zone map, necessary precautions must be taken into consideration (Christenson, 1994).

Liquefaction

Combining water-saturated soils such as those along river bottoms with earthquake ground shaking results in liquefaction. Liquefaction makes once solid soils lose their strength and behave like a viscous liquid. Basically, it turns into quicksand.

The implications of this process to developed areas are of course drastic, as liquefaction can cause buried objects to surface, buildings to sink or tilt, slope failures, and lateral shifting of ground several feet, to name a few. For liquefaction to occur, an area must have loose or sandy water-saturated soils and sufficient ground shaking to cause these susceptible soils to liquefy. As previously mentioned, Cache Valley is bounded by two major faults and, furthermore, has susceptible soils which, as a 1962 earthquake proved, leads to liquefaction (Anderson et al., 1996).

Function of geology

The geology and soils of this region provide stunning variety, visual quality, recreational opportunities, and functional areas for development and agriculture. However, they also pose serious threats that must be considered in the future of development of the region.

Climate

The southern portion of Cache Valley has a distinct beauty. Towering mountains surround the lower benches and valley bottom. The topographic variability of the area, along with other factors such as latitude, elevation, and continental location, contribute to the distinctive four-season climate of the Little Bear River Watershed. The climate is instrumental in carving out the definite physiographic and cultural characteristics of the area.

Classification

The Modified Köppen Classification System is used to classify climatic types according to the vegetation responses to precipitation and temperature (Pope and Brough, 1996). This classification system delimits the Great Basin and Range region as mainly Desert and Steppe climate types. However, the majority of the Little Bear River Watershed is classified as a Humid Continental-Warm Summer Climate simply because of the relatively high amounts of precipitation received (Pope and Brough, 1996). Within the Humid Continental –Warm Summer type, the winter temperatures are cold and the average temperature is below 32°F. Also, the summers are warm and are characterized by 4 months of average temperatures above 50°F (Oliver and Hidore, 2002). The Wellsville Mountains and southern portion of the Bear River Range, which encircle the southern end of Cache Valley, are classified as Mid-Latitude Highland. The Highland climates are characterized by annual mean temperatures below 72°F.

Temperature

The Little Bear River Watershed is known for its harsh long winters, warm pleasant summers, and large diurnal temperature ranges.

The Little Bear River Watershed is located at approximately 41° north latitude, and the elevation ranges from 4,200 ft. in the valley floor to over 9,000 ft. in the mountains. The large range in seasonal temperature is due to the tilt of the earth's axis, along with the distance of the watershed from the equator where there is little seasonal variation (Pope and Brough, 1996). During summer months, when the solar declination angle is lowest, the average temperatures are near 70°F. However, during winter months, when the sun's direct rays are over the southern hemisphere, there are approximately 35 to 40 days in Cache Valley where the temperature does not rise above freezing, and the average temperature in January is 25°F (Cache County Comprehensive Plan, 1998).

The wide diurnal temperature range is due to the high elevation of the watershed above sea level. Similarly, the area experiences a wide range of annual temperatures due to the lack of oceanic influence which serves to moderate temperatures of coastal regions (Oliver and Hidore, 2002).

Precipitation

The majority of the precipitation in the region arrives in the form of snow during the long winter months. The mountains surrounding the lower watershed maintain cooler temperatures throughout the year along with extremely cold winters (Pope and Brough, 1996). With the extremely cold winter temperatures comes the abundance of snow during the winter months. The highlands can receive over 500 inches of "the greatest snow on earth" in a given year, while the valley bottoms generally receive around 17 inches per year.

As the prevailing westerlies carry moisture from the ocean towards Utah, a great deal of low level moisture is lost in the Sierra Nevadas (Pope and Brough, 1996). As the dry air reaches the Wellsville Mountains, along with the south end of the Bear River Range, the air is forced to lift upward. Temperatures tend to cool with elevation, so as the dry air from the west is lifted into higher elevations, it begins to condense and form clouds which precipitate the excess moisture on the mountains and surrounding areas. Thus, the amount of precipitation in the Little Bear River Watershed is higher than the surrounding areas due to the outlying topography of the region. The amount of precipitation in the region may also increase as evaporation from the Great Salt Lake adds to the amount of moisture in the air traveling east towards the Wellsville Mountains. This increase in moisture is commonly known as the "Lake Effect."

Climatic Influences

Cultural patterns in the Little Bear River Watershed tend to respond to local climatic factors such as temperature, wind patterns, and levels of precipitation. The majority of the population in Utah is located around 4,500 ft. elevation (Pope and Brough, 1996). Southern Cache Valley is no exception to this settlement trend. The 4,500 ft. level tends to have less of a diurnal temperature change than the valley floors and the higher mountain slopes. This is due to the energy exchanges which take place between the sun and the earth's surface throughout the duration of the day. The Cache Valley floor is heated during the day. This heated air begins to rise up the sides of the surrounding mountains during the afternoon. In the evening the air begins to cool rapidly in the mountains because of the thin atmosphere. High pressure forms, and the colder, more dense air descends to the valley floor (Oliver and Hidore, 2002). The local cold dense air descending down the mountains, along with occasional large high-pressure systems which form in southwest Wyoming create strong winds. These winds are then channeled down the canyons similar to a funnel. The canyon winds in the Little Bear River Watershed can reach hurricane speeds of over 100 mph.

The cool air that descends down the mountain and settles in the valley floor can also contribute to early frost. The early frost reduces the amount of growing degree days, which are the days in which crops are able to grow and mature (Oliver and Hidore, 2002). The growing degree days in the region follow this pattern. There are approximately 80-120 frost-free days in the course of a year for the valley floor in southern Cache Valley. On the other hand, the benches, around 4,500 ft. elevation, average between 120-160 frost-free days (Ashcroft et al., 1992). In the Little Bear River Watershed, agriculture is a key economic and cultural factor. The farmers understand the frost patterns, and they develop and cultivate their lands accordingly.

Annual temperature variations not only affect the humans of the area but also the wildlife. During the winter months the snow increases in the highland elevations which forces wildlife to migrate to lower elevations in search of food. The wildlife then run into conflicts with the human population residing in the benches and lower areas of the valley.


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The seasonal trends of the Little Bear River Watershed also influence the recreational activities of the area. The summer months provide many days in which people enjoy activities such as boating, fishing, canoeing, hiking, camping, and horseback riding, while the fall and winter months provide amenities such as hunting, skiing, snowmobiling, and ice-fishing. The climate tends to influence not only the locations in which people live in southern Cache Valley, but it also influences the way people live their daily lives.


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Future Issues

The residents of the Little Bear River Watershed are also influenced by the periodic winter inversions. The inversion is caused by the topography and high pressure systems of the region, which hold cool air along the lower areas of the valley and prevents the mixture of upper and lower atmospheric air. The inversion acts as a lid, trapping pollutants from automobiles and livestock waste near the surface, creating very serious health threats for the residents of the Little Bear River Watershed.

The climate of the Little Bear River watershed plays a significant role in the day-to-day lives of each of the residents. Similarly, the way in which the people live their lives can have potential effects on certain aspects of the existing, and future air quality. In order to maintain a healthy climate for the entire valley, the people living in the watershed need to be mindful and aware of the ways in which they can aid in limiting harmful pollutants and ensure a healthy climate for each of the residents today and those to come.

Hydrology

Water is known as the great integrator (Mesner, 2007). It is incorporated in so many factors of life. However, water is also affected by many features, and the Little Bear River is a highly dynamic, integral component of the south end of Cache Valley. The river defines the area and gives it shape. It is the driving central force behind historical and modern-day living practices. Coincidentally, the modern day living practices are also highly influential on the current quantity and quality of the water in the little Bear River.

System Drainage

The Little Bear River Watershed encompasses approximately 196,000 acres and includes a variety of land uses (Division of Water Quality, 2002). The watershed includes 122 miles of perennial streams and 228 miles of intermittent streams (Hardman and Allred, 1995). The upper portions of the watershed are dominated by two main river drainages. The East Canyon drainage stores most of the water from the Bear River Range in Porcupine Reservoir.

The South Fork River drainage is made up of multiple creeks throughout the south end of Cache County. These smaller creeks create the smaller canyons and distinct landscape of the upper portion of the watershed. The two river drainages converge near the town of Avon and continue to flow north towards Hyrum Reservoir (Division of Water Quality, 2002). The majority of the land surrounding these two drainages is undeveloped and supports seasonal grazing practices during the warmer months of the year.

Below the confluence of the two smaller drainages, the primary land usage is 40 percent agricultural (Division of Water Quality, 2002). The river continues to flow through the small towns of Avon and Paradise until it reaches Hyrum Reservoir. Below the dam the land use is mainly agricultural, including large feed lots, dairy farms, and meat packing plants. A large portion of the runoff of the Hyrum area is captured in the Spring Creek drainage. This drainage includes approximately 14,600 acres and is almost entirely dominated by agricultural practices (Division of Water Quality, 2002). The Little Bear River continues to meander through the valley bottom, past the towns of Wellsville and Mendon, until it reaches Cutler Reservoir. The Logan and Spring Creek drainages also converge with the Little Bear River near the top of Cutler Reservoir. This lower portion of the river is dominated by wetlands.

Surface Flow

The Little Bear River Watershed is influenced by the high amount of spring runoff and overland flow from the surrounding mountain ranges which may contain several hundred inches of snow. The average annual discharge of the Little Bear River is approximately 65 (kac-ft). However, during the year 2005, the annual discharge recorded 86 (kac-ft). The discharge during flooding was 6 ft. above normal river heights. This flooding caused severe damage to homes, along with extensive amounts of property damage (USGS, 2006).

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Water Resource Management

There is an old saying in the west, "You can steal my wife, but not my water." Southern Cache Valley water usage is highly variable and difficult to monitor due to rural management practices. There are a high number of canals for irrigation, along with a number of wells. It is estimated that over 50% of drinking water in Cache Valley comes from private wells (Sanderson and Lowe, 2002). The amount of wells most likely increases in the Little Bear River Watershed, especially in the towns of Paradise and Avon.

© Alan Luce

The watershed contains two reservoirs. Porcupine Reservoir, which is located in the East Fork drainage, is an earth-fill dam that was built in 1964. The reservoir can hold up to 12,500 acre-ft of water. The dam aids agricultural practices by providing regulated, constant flow of the canals which diverge from the main flow below the dam. The dam and shoreline are privately owned; however, there are no restrictions to public access. The reservoir is located in a highly scenic area and is a highly valued recreational area and fishery (Lake Reports, 1996). Hyrum Dam was built in 1935 and is one of the most popular recreational areas in the Little Bear River Watershed. The reservoir can hold up to 16,290 acre-ft. of water and provides recreational activities such as boating, canoeing, fishing, and camping. The reservoir also was built to provide water for the agricultural practices in the south end of Cache Valley.

The two reservoirs in the Little Bear River Watershed have many beneficial uses. However, the construction of dams has certain effects on the pollution of the Little Bear River. Dams act as sediment traps and alter the natural high level of seasonal runoff. Additionally, these reservoirs contain large amounts of nutrient runoff from surrounding agricultural lands which can lead to eutrophication (Lake Reports, 1996). Reservoirs also contribute to the thermal pollution of the water by altering the natural annual water temperature ranges. This temperature alteration can have drastic effects on the associated aquatic life.

Pollution Concerns

The Little Bear River has been determined to be impaired by the Utah Division of Water Quality. There are many factors leading to the impairment of the river. Historically, most of the efforts were centered around point sources such as fish hatcheries and meat packing industries. However, the key factors of pollution are non-point sources. The main sources of pollution include large amounts of sediment and phosphorus runoff from agricultural practices (Division of Water Quality, 2002). High sediment amounts in the Little Bear River are due to overgrazing of riverbanks, which causes erosion. The Little Bear River Watershed also contains more than 50 dairies with an average size of 120-milk cows (Hardman and Allred, 1995). These feedlots and dairies are often located near open water sources. The majority of the phosphorus comes from agricultural runoff and poor manure management practices. The phosphorus is then tied to the sediment in the river (Division of Water Quality, 2002).

In order to help reduce pollution and further impairment of the Little Bear River, Best Management Practices have been implemented, the first of which surrounds the management of manure. This was done on a voluntary basis as farmers attempted to address water quality concerns (Hardman and Allred, 1995).

Manure bunkers and liquid storage structures were created where animal waste could be stored up to 120 days (Hardman and Allred, 1995). Riparian corridor management practices were implemented to reduce erosion caused by overgrazing. The riparian buffers around the streams reduced the bank erosion and also served to filter out sediment. The last management practice surrounded grazing. The grazing management practices included prescribed grazing areas along with alternative watering sources for animals (Hardman and Allred, 1995).

Future Concerns

As population continues to increase in the southern end of the valley, the potential for future impairment of the Little Bear River will also increase. The major issues related to population increase surround the hardening of surfaces along river corridors due to intense urbanization. Similarly, the increased urbanization will significantly affect the already limited amount of culinary water supplies, along with the limited capacity of existing wastewater treatment facilities. Certain measures, similar to the Best Management Practices (BMP), will need to be implemented in order to address the future needs and concerns surrounding the hydrology of the Little Bear River Watershed.

Vegetation

Historical Vegetation

In looking at the history of vegetation, it can be difficult to find records that accurately describe the regions before the initial settlement of the areas. In the case of the southern portion of Cache Valley, the records are somewhat generalized to the whole of Cache Valley (north into Idaho as well), and general notes concerning vegetation in the western U.S. is often referenced. However, there are a few specific notes relating to the area in the early 1800's that illustrate the overall patterns of the valley.

© Zac Covington Possible Historic Vegetation Types

Pre-L.D.S. Settlement

One of the earliest descriptions of the valley on record is Peter Skene Ogden's Hudson Bay trapping party, that described the valley as being full of bison and large grassland stands of vegetation (Hull and Hull, 1974). Also, mention of this grass-filled area was made by the 1841 Bartleson wagon train and by John C. Fremont as he passed through. There is little-to-no mention made of sagebrush in the valley, and then only in sparse groupings along the higher foothills. In 1832, a man by the name of Warren Angus Ferris wrote that Cache Valley was, "one of the most extensive and beautiful vales of the Rocky Mountain range…, producing everywhere most excellent grass….(Hull and Hull, 1974)."

Post-L.D.S Settlement

As time went on, the U.S. Forest Service did some land surveys, the earliest being from 1855 to 1878 when the land was described as being a perfect cattle grazing valley, with the potential to graze as many cattle for as long as one could want.

This valley was seen as a grazing wonderland and, by the years 1888 to 1900, much of the valley had already been overgrazed. Stands of sagebrush began to take over the valley floor, although some native stands of grasses are still believed to exist where accessibility for cattle grazing was difficult. While the vegetation has obviously changed from these historical records, it could be argued that the Little Bear River Watershed and the adjacent lands are some of the closest remnants of the historical vegetation types of Cache Valley. These vegetation types, as investigated by Hull and Hull, were the following:

•Beardless Bluebunch Wheatgrass
•Streambank Wheatgrass
•Basin Wildrye
•Junegrass
•Sandberg Bluegrass
•Western Wheatgrass
•Indian Ricegrass
•Needle and Thread
•Sand Dropseed

Current Vegetation

The vegetation in Cache Valley has changed significantly from what it was in the pre-settlement and even early-settlement era. There are generally five different eco-regional sub-categories (Level IV Ecoregion) in the south end of Cache Valley as determined by the Ecoregions of Utah map produced by the Western Ecology Division of the Environmental Protection Agency. They are listed as the following with general vegetation types included:

Wasatch Montane Zone

Douglas fir, ponderosa pine, aspen, big sagebrush, snowberry, elderberry, mountain grasses, sub-alpine fir, engelmann spruce, willows, and birch.

Mountain Valleys

Great Basin sagebrush, juniper, pinyon pine, grasses, and cottonwoods.

Semiarid Foothills

Gambel oak, maples, juniper, sagebrush, pinyon, service-berry, mountain mahogany, snowberry, and associated grasses.

Wetlands

Baltic rushes, cattails, burreed, common reed grass, sedges, and/or bulrushes.

Malad and Cache Valleys

Bluebunch wheatgrass, western wheatgrass, bluegrass, great basin wildrye, cheatgrass, big sagebrush, reeds, sedges, foxtail, saltgrass, wiregrass, saltgrass, and greasewood.

Many situations exist across Cache Valley where there have been general vegetation changes due to farming and irrigation practices. Figures 1 and 2 show some basic examples of southern Cache Valley's vegetation/land use relationships. As shown in Figure 1, connections exist in these upper, middle, and lower elevations. Different species of organisms live in these varying habitats and are dependent on these levels of vegetation, depending on their needs.

Figure 2 shows an example of a basic earthen dam, seen frequently in the western United States. These dams can be great recreational boosts for communities and are used for irrigation and culinary water reserves. When these reservoirs are placed in an ecosystem, changes in the vegetation can occur, and species can be lost or others can move in to the newly changed landscape.

Stresses to Vegetation

Stresses to the vegetation that exist today are complex and vary greatly depending on the area. In Cache Valley, the uses that most prevalently affect the vegetation are farming, urbanism, waste management, roadways, reservoirs, mining, canal systems, and others. While there are many ways these uses effect the vegetation in the south end of the valley, some of the changes that have occurred or could occur are:

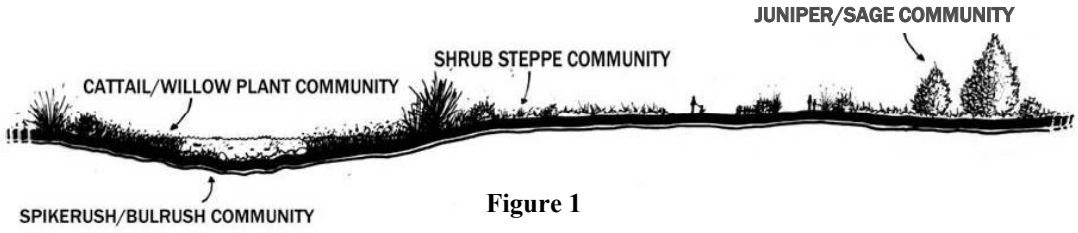


Figure 1

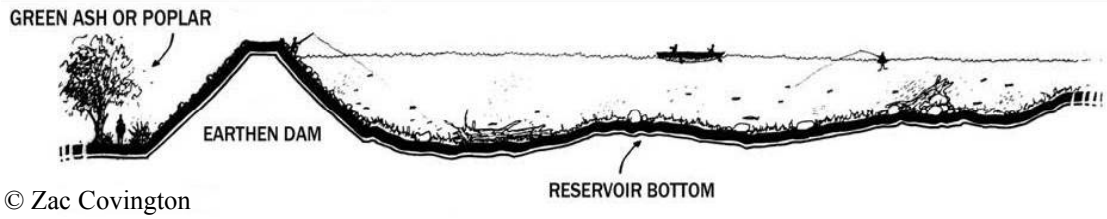


Figure 2

•Vegetation species changes by increased or decreased water availability in the water tables due to reservoirs, irrigation, and other water uses.

•Removal of wetlands as natural filtration systems, compromising water quality (Stokes and Watson, 1989).

•Vegetation removal causing under-story vegetation species changes, resulting from elevated ground temperatures and increased direct sunlight.

•Clear cut or excavated areas from subdividing vegetated land which decreases the aesthetic value of a community, and the viewshed quality of the area as seen by surrounding communities.

•Loss or decrease of native vegetation and ecosystems caused by overgrazing, invasive weeds, erosion, flooding, etc (Stokes and Watson, 1989).

Notice in this aerial photo of Hyrum Reservoir the variety of land uses in what was once a grassland valley. While these uses have many positive attributes, without constraints, the natural vegetation of an area that provides crucial functions for the surrounding communities is depleted and sometimes eliminated.

Critical Uses For Vegetation

In determining critical uses and values for the healthy stands of native or non-native species of any wildlife, it is important to keep in mind the benefits of this vegetation to the residents of the area. While reasons for determining value of preserving or reclaiming vegetation can be infinite, several topics have been discussed with regularity. Some of these topics are quality of life, ethics and morality, recreation, economics, and to avoid legal problems such as with the federal or state government environmental laws (APA, 1997). The following are a few crucial additional uses for healthy stands of wild vegetation in and around our communities:

Water Quality

The vegetation surrounding lakes, rivers, and streams is often overlooked in relation to the quality of the water. This vegetation provides a natural filtration system for pollutants that may enter the water body and is critical to the stability of the banks, preventing erosion. Several problems occur with erosion including high sediment loads and release of various pollutants into the water. These pollutants and sediments can harm or be fatal to wildlife and to the residents of the communities downstream that use the water for culinary purposes.

Wildlife Habitat and Food
The vegetation in Cache Valley is crucial to the survival and health of the animals that inhabit the area. Not only do these animals need the nutritional benefits of the vegetation, but it is also used for cover, bedding, shade, etc. Various stands of vegetation provide places for the wildlife to live during all seasons. Most of the wildlife in this region migrate seasonally and take advantage of the various ranges.

Temperature
Increased temperature has been associated with loss of vegetation in many places and situations. This has particularly been associated with urban areas where urban hot spots have been detected using satellite imagery (Scott, 2006). This can also happen in a range situation where the soils are exposed to the sun and become warmer as the day progresses. This temperature flux can potentially change vegetation type because plants more suited to the hotter temperature may be more adept to grow.

Aesthetics
Not many people can dispute the benefits of aesthetically pleasing views to the beauty outside. Most of us live in the areas we do because of the way the surrounding landscape looks. This is especially true in the south end of Cache Valley because of the undeveloped land that surrounds the various communities.

Erosion Control
In the year 1923, there was a problem for the people in Willard, Utah because of the amount of grazing that had been allowed on the east bench of the community. This elimination of much of the vegetation on the slope caused massive mudslides when much of the Wasatch Front was plagued by severe flooding. Boulders the size of cars were carried into town and many people had damage to their belongings. Whether by this or other unwise practices, land erosion can be detrimental to individuals and to whole communities.

Future Vegetation
If measures are taken to prevent damage that communities outside of the Little Bear River Watershed area have already experienced, there can remain the beauty and amenity that currently exists. Farming and ranching are currently major uses of the discussed lands and, if maintained properly, these functional, aesthetic, and cultural practices can continue to give it the character it has been historically known for. As other land uses begin to threaten existing vegetation, such as urban sprawl and industry, land designation legislation should be implemented with the importance of the vegetative qualities that reside in mind. If done properly, and with community resident support, this can ensure that the area retains its rich cultural, historical, and scenic heritage.

Wildlife

Historical

While accounts of wildlife in Cache Valley are limited, there are a few historical records that can lead to fair assumptions. One of the earliest records regarding the animals of Cache Valley is told by an old Shoshone Indian Chief named Sagwich. He tells of the winter of 1780, when the snowfall for the region was extreme, and the Indians had to move out of the valley. The valley was previously filled with elk, deer and bison, but when the Indians returned there were only seven bison left, most of which they tried to hunt for food. After that storm, the Indians apparently did not live in the valley as often or as long. This story was somewhat verified, because the early settlers found the remains of deer, elk, and bison in the late 1700's (Sorenson). Also, the fact that bison were in the valley has been written about in other early settlement accounts by Peter Skene Ogden (Hull and Hull, 1974). Other obvious species that were recorded to be in the valley included beaver, wolves, cutthroat trout, and grizzly bears. This is an excerpt from a U.S. Forest Service history of the intermountain region:

Grizzly Bear

http://bowhunting.net/bearhunting.net/beargrsm.JPGQuality

Beaver

http://www.bcadventure.com/adventure/wilderness/animals/beaver.htm

At the time of the Euro-American penetration, a rich diversity of lush foothill and mountain meadows, tall timber and sagebrush covered or peppered the mountains and valleys of the Intermountain Region. Early diaries indicate that wildlife was also unevenly spread over the eastern and northeastern portions of the region. Peter Skene Ogden reported numerous herds of buffalo and elk and a great many beaver. In the Cache Valley, he found buffalo scarce but reported grizzly bear in abundance. As early as 1825, Ogden's journal indicates that areas formally rich in beaver had become entirely destitute. By 1835, other mountain men and trappers were having similar experiences. Other species had disappeared from areas where they had previously abounded. Cache Valley was found entirely destitute of game and trapping parties were forced to live chiefly upon roots (U.S. Forest Service).

©Zac Covington

Cutthroat Trout

Current

The current wildlife in the Little Bear River Watershed may still be similar to what it was in the pre-settlement history of the valley, with the exceptions of the wolf, the grizzly bear and the bison. Wildlife in the Little Bear River Watershed includes, but is not limited to the following species: mule deer, elk, moose, beaver, black bear, mountain lion, raccoon, red fox, coyote, frogs and toads, rattle and other snakes, bats, various owls, many waterfowl including geese and ducks, numerous wetland dwelling bird species such as the Great Blue heron, grouse and other game bird species, red-tailed hawk and other raptors, meadowlark and many valley bird species, bonneville cutthroat trout and other cold and warm water fish species, and many more, too numerous to name.

Wildlife Value

Much of the land in the state of Utah, and more specifically in the Little Bear River Watershed, is owned and maintained by private parties. Most of the people who live in or close to these rural and wildland areas value the amenities that such a place can bring to the people and wildlife

A Western Toad, Burrowing Owls, and a Townsends Big-eared Bat (DWR Website Photos)

©Zac Covington

Spawning Kokanee Salmon Near Porcupine Reservoir

associated with them (Stokes and Watson, 1989). These amenities include stunning views, hiking, hunting, fishing, camping, mountain-biking, canoeing, snowshoeing, riding ATV's, or general enjoyment of the place and the natural inhabitants. There are also economic benefits that can be associated with having these critical lands near towns. Real-estate prices often increase in nearby municipalities because of the beauty and amenities surrounding them, and people moving to the areas are more likely to have an interest in the continued preservation of those lands.

Landowners will often improve or preserve stands of vegetation around sensitive habitat areas and water bodies. They see this as a stewardship obligation and a business investment because of decreased erosion and increased water and vegetation quality. Government agencies such as the Natural Resources Conservation Service provide education and incentives for owners of land that is habitat for wildlife. Also, there are many other groups that support and initiate critical habitat land improvement or preservation. These groups in Cache Valley include Ducks Unlimited, Cache Land Trust Alliance, Rocky Mountain Elk Foundation, Trout Unlimited, Bridgerland Audubon Society, and others.

Future

The future of the natural qualities of the Little Bear River Watershed could be threatened if the land is allowed to be developed in unchecked urban sprawl patterns. With this unfocused development may come devastating results for communities and the wildlands that surround them. While much of the current private land is used for farming and ranching, which is usually considered quality habitat for many of the species discussed above, if the land uses are changed and urbanism is allowed to creep onto critical lands, many of the problems larger communities have faced in the past (erosion, decreased water quality, vegetation and wildlife loss, visual degradation, economic losses and others) could happen.

With these and other tools, the residents and communities of the Little Bear River Watershed can work to collectively maintain and improve their communities by enhancing the natural lands used by them and the accompanying wildlife. Following good management practices and increasing these lands can only benefit communities.

photos.phr.edu/gallery/wwc/moose

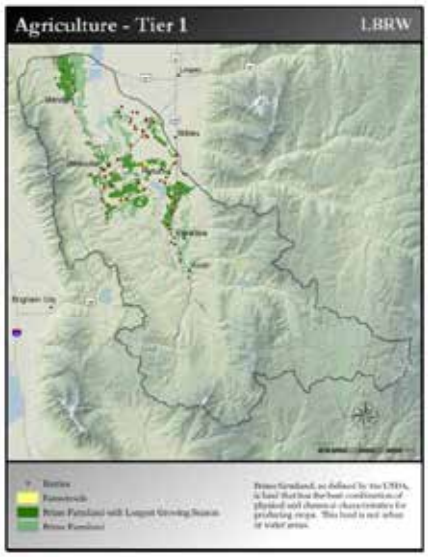
Analysis Modeling and Tier Process

Conventional modeling and the combination of those models into alternative future growth scenarios is critical to addressing the needs and values of a region regarding the landscape and its use. While these modeling processes are adequate in addressing specific needs for a region, the amount of choices in modeling and creating future growth scenarios is limited. The modeling process in this project is comprised of the creation of several tiers or levels in each model.

This model tiering strategy creates many options in the planning process. It could be utilized by city, county, and regional planners to tailor futures to their areas of interest or concern. This approach could also be used by local leaders in city or town meetings to have the respective residents compile a list of the models that they feel is most representative of the areas values respective to land use.

After the models were listed, they could be combined to show the residents and planners what these futures would look like under the criteria that they chose. For example, one could take a Tier 2 Public Safety, Tier 3 Ground Water, Tier 2 Agriculture, Tier 1 Viewsheds, and a Tier 2 Recreational Wildlife and come up with a future. This approach gives a large amount of possibilities for a region and allows planners to choose their models carefully and in line with what they feel is a realistic representation of their region or town's concerns and priorities.

An example of a tiered model is below:



Agriculture – Tier 1

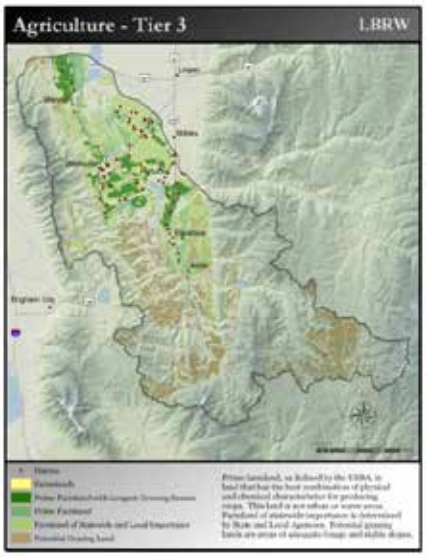
ESSENTIAL

This model contains the highest priority attributes of agricultural land in the Little Bear River Watershed according to the research conducted.

Agriculture – Tier 2

MODERATE

This tier includes everything in Tier 1, along with an additional level of significant attributes of agricultural land.



Agriculture – Tier 3

EXTENSIVE

This tier includes all of the attributes of Tier 1 and Tier 2 and also includes other valuable attributes that are important to agriculture in the Little Bear River Watershed.

Surface Water

The Little Bear River Watershed consists of various water resources which are an important factor in the overall quality of life. These water sources include the streams, rivers, tributaries, and wetlands that make up the Little Bear River. The river itself contains multiple reservoirs which provide for local recreational activities such as boating, swimming, and fishing. These reservoirs are also important factors of the agricultural practices which exist along the course of the river and throughout the valley. Over time, certain agricultural practices, along with rapid urban growth have contributed to the impairment of the river.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The Little Bear River and its tributaries have been designated as a Cold Water Fishery by the Utah Department of Environmental Quality (DEQ). The Little Bear River is currently protected for secondary contact recreation such as boating, wading, or similar uses. It is also protected for cold water species of game fish, waterfowl, and shorebirds, including the necessary aquatic organisms in their food chain (DEQ). The entire river is protected for agricultural uses including irrigation of crops and stock watering (DEQ). However, both the upper segment above Hyrum Reservoir and the segment below the dam have been listed as impaired in respect to its use as a cold water game fish habitat (DEQ).


© Evan Curtis

The specific pollutants or stressors to the Little Bear River have been determined to be total phosphorus and hydrologic modification (DEQ). Phosphorus stimulates algal growth and production. Over time, the algal decay contributes to a decrease in dissolved oxygen. The limited amounts of available oxygen lead to a decrease in fish populations along with a decrease of invertebrate biodiversity (Mason, 2003).

Spring Creek, which enters the Little Bear River just above Cutler Reservoir, has been listed as impaired in respect to its use as a cold water game fish habitat (DEQ). However, this tributary to the Little Bear River has also been listed as impaired in regard to its use as a secondary recreation site. Specific pollutants and stressors include fecal coliform, ammonia, dissolved oxygen, thermal pollution, and total phosphorus. The pollutants and stressors along Spring Creek and the Little Bear River are consequences of high effluents from multiple point and non-point sources (DEQ).

Pollutants along the Little Bear River and its tributaries result from a variety of agricultural and industrial uses.

Poor agricultural practices along with effluents from large feed operations, various industrial practices, urban runoff, and wastewater treatment plants have contributed to the impairment of the river. The U.S. Department of Agriculture, along with several other agencies, support groups, and volunteers, has begun implementing Best Management Practices (BMP) along the course of the river in order to reduce the amounts of pollutants in the stream. The focus of the management practices has been centered on the reduction of phosphorus and sediment loading which result from agricultural runoff and erosion. These management practices include: stream bank restoration, manure management, riparian corridor restoration, buffers around streams and wetlands, fencing practices, alternative watering solutions, grazing management, and public education and involvement (Hardman and Allred, 1995).

The riparian areas and wetlands along the course of the Little Bear River act as filters for the sediment, phosphorus, and other pollutants. The lower areas of the watershed, where aquifer levels are near the surface, act as recharge zones for the groundwater of the valley. These areas become vital to the quality of the surface water and future health and safety of the groundwater. The implementation of the Best Management Practices, along with the cooperation of major stake holders will ensure the future quality of the Little Bear River.

Mitigation Zone

One of the ways to reduce the amount of pollutants entering the stream is through the implementation of a mitigation zone along stream banks and wetlands. This mitigation zone, which is simply a linear buffer from the center of the stream or wetland, limits certain agricultural and urban activities within the zone. However, the ownership of land within the mitigation zone remains unchanged (Kiemstedt, 1990).

Tier 1

Tier 1 illustrates the areas that are most likely to contribute to the existing pollutants along the Little Bear River and the associated tributaries. These areas include steep slopes and soils of limited permeability within a 15 meter mitigation zone.

Tier 2

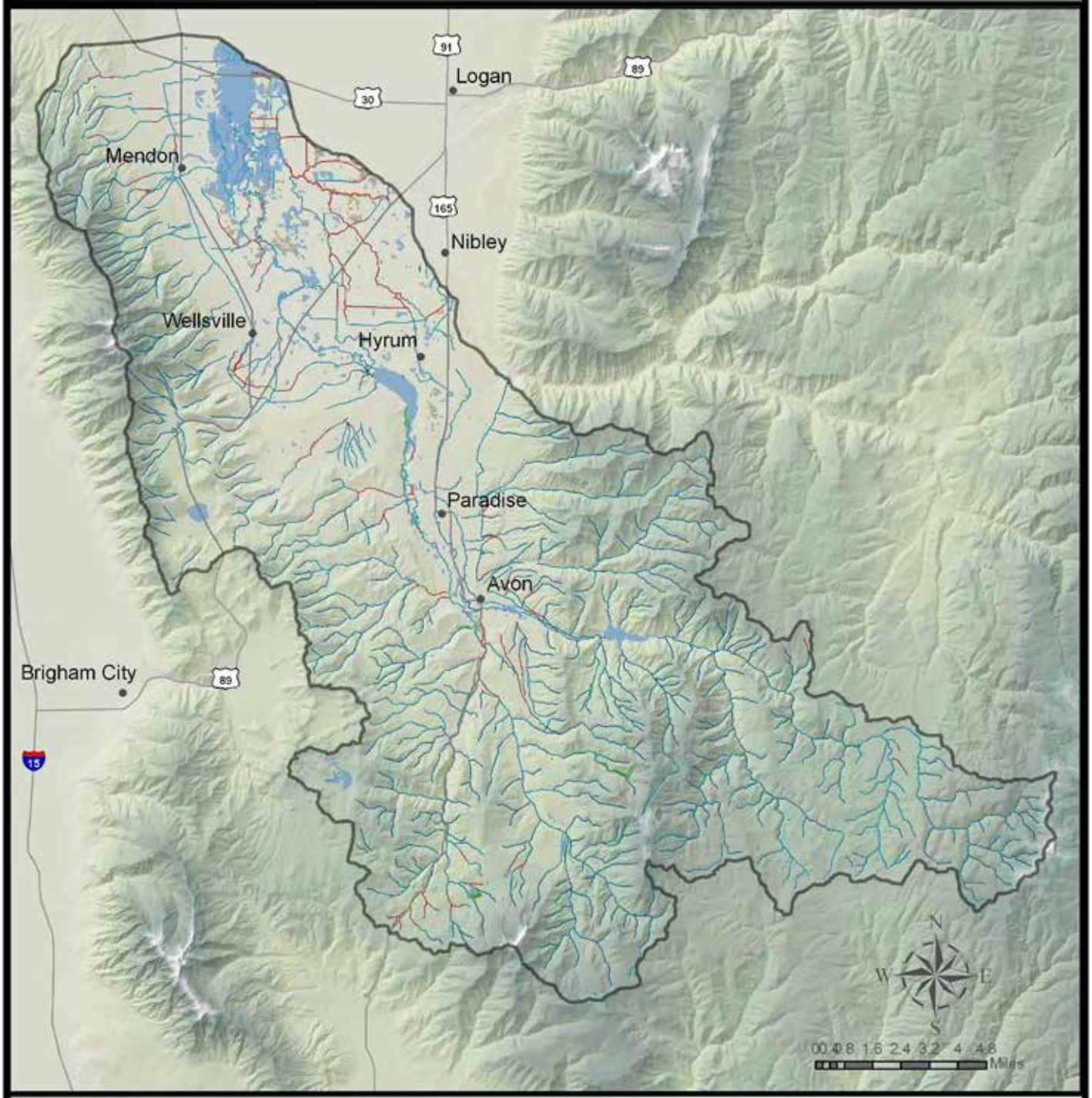
Tier 2 contains the same attributes as Tier 1; however, the 15 meter mitigation zone has been increased to 25 meters to provide further filtration of sediments and phosphorus. Also, this tier illustrates 1st order watersheds which are vital to the overall quality of water.

Tier 3

Tier 3 contains the same attributes as Tier 2; however the 25 meter mitigation zone has been increased to 50 meters. The increased mitigation zone ensures the limitation of harmful pollutants that have led to the impairment of the river.

Surface Water - Tier 1

LBRW

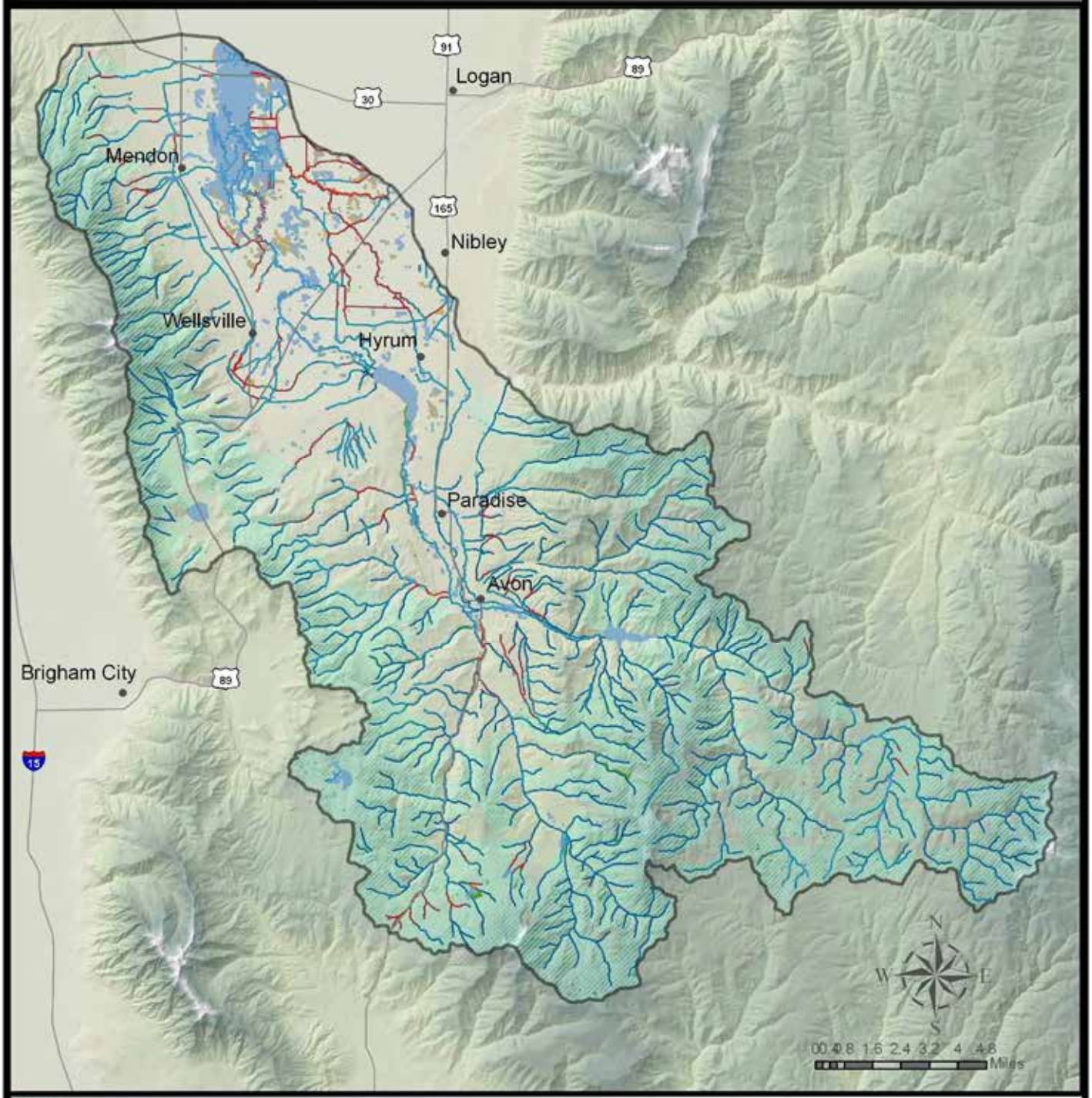


- Streams With a 15m Mitigation Zone
- Wetlands With a 15m Mitigation Zone
- Soils of Low Permeability Within 15m Stream Mitigation Zone
- Soils of Low Permeability Within 15m Wetland Mitigation Zone
- Slopes>15% Within the 15m Stream Mitigation Zone
- Slopes>15% Within the 15m Wetland Mitigation Zone

The Streams Layer includes both perennial and intermittent drainage channels.
The Mitigation Zone is derived using linear buffers from the centerline of the streams and wetlands.

Surface Water - Tier 2

LBRW

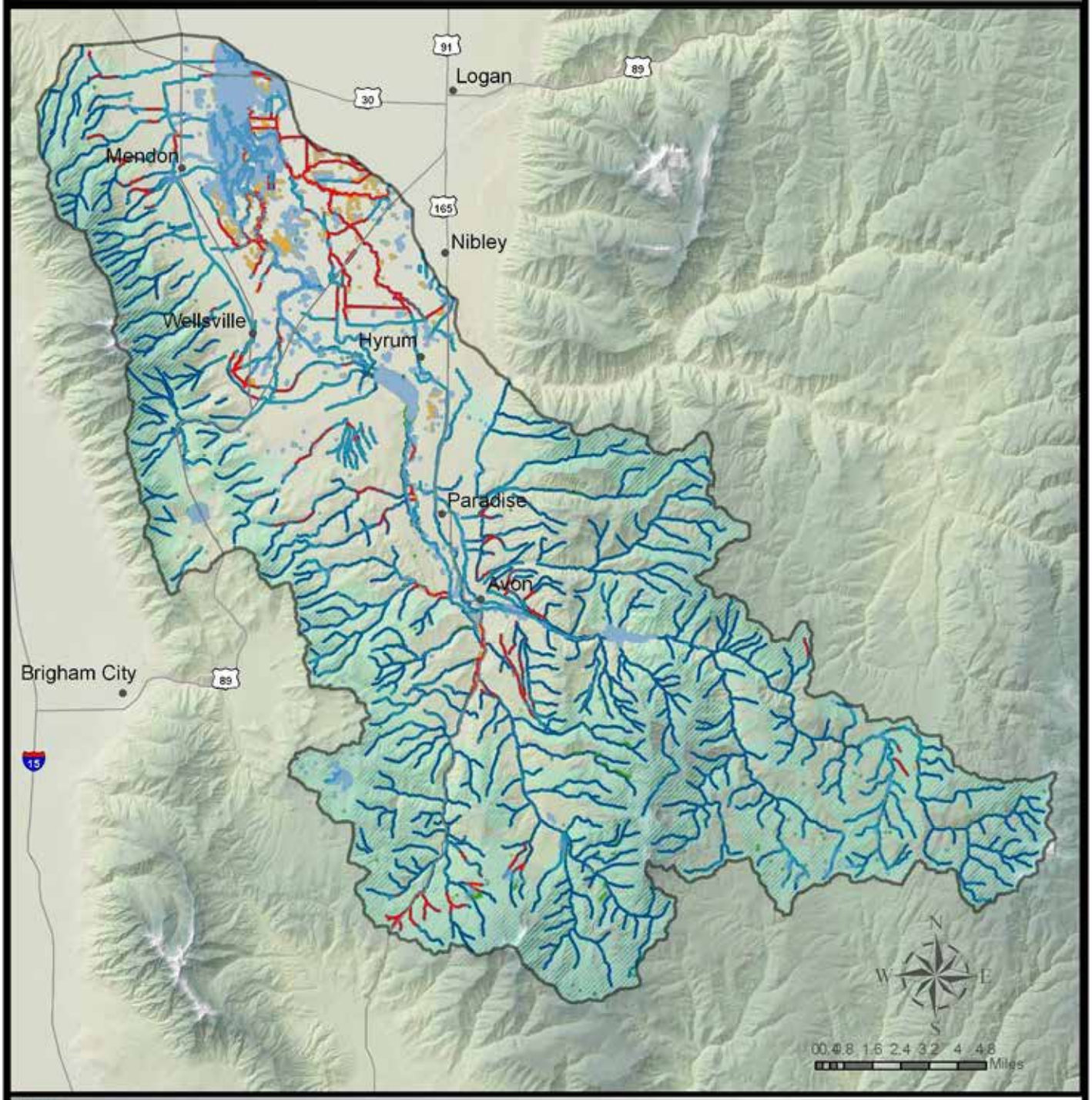


- First Order Watersheds
- Streams With a 25m Mitigation Zone
- Wetlands With a 25m Mitigation Zone
- Soils of Low Permeability Within 25m Stream Mitigation Zone
- Soils of Low Permeability Within 25m Wetland Mitigation Zone
- Slopes>15% Within 25m Stream Mitigation Zone
- Slopes>15% Within 25m Wetland Mitigation Zone

The Streams Layer includes both perennial and intermittent drainage channels.
The Mitigation Zone is derived using linear buffers from the centerline of the streams and wetlands.

Surface Water - Tier 3

LBRW



- First Order Watersheds
- Streams With a 50m Mitigation Zone
- Wetlands With a 50m Mitigation Zone
- Soils of Low Permeability Within 50m Stream Mitigation Zone
- Soils of Low Permeability Within 50m Wetland Mitigation Zone
- Slopes>15% Within 50m Stream Mitigation Zone
- Slopes>15% Within 50m Wetland Mitigation Zone

The Streams Layer includes both perennial and intermittent drainage channels.
The Mitigation Zone is derived using linear buffers from the centerline of the streams and wetlands.

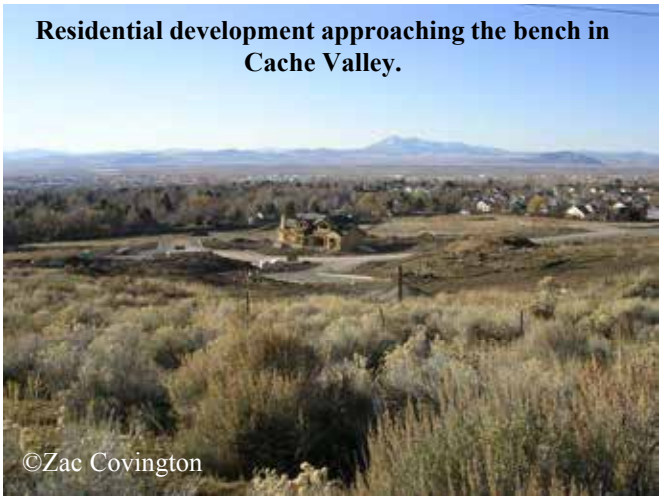
Groundwater

Groundwater and water quality can often be overlooked in planning and growth oriented decision-making. These are both critical biophysical components of a landscape and can greatly affect the general health, safety, and welfare of the communities that utilize them. There are also socio-cultural impacts that can be expected from the decline of the value of each of these components. These impacts also effect the quality of life of the area residents and need to be understood and protected to maintain that quality throughout.

In order to understand the effects that disturbed groundwater can have on an area, the basic physical processes of the water cycle and water aquifer recharge need to be understood. After precipitation falls onto a landscape, there are several processes that affect the dispersal of that precipitation, which are the following:

•Infiltration into the soils
•Percolation into the water aquifer at different levels
•Surface runoff
•Water body storage (lakes, rivers, wetlands etc.)
•Evaporation
•Vegetation, streams, soils, water bodies and general transpiration

Possible Ground Water infiltration area in Hyrum City.



Residential development approaching the bench in Cache Valley.

After the water is collected into the aquifer(s), then there are several groundwater layers that the water can be stored in. These include confined aquifers, unconfined aquifers, and perched water tables and aquifers. Several important water body types rely on the continual recharge of the aquifers including streams or rivers, lakes, and wetlands. Probably the most realized need for this aquifer recharge is in the form of wells and springs (Baker, 2006). Depending on the depth of the wells that are drilled in the aquifer, wells can become exhausted as the water is used past the capacity of the aquifer in that particular area.

The overuse of water in an aquifer from urban development can deplete groundwater resources. Not only can this decrease the amount of available water for residents and croplands, but it can also cause financial burdens to residents and municipalities. This increased burden can come by way of increased pumping distance to groundwater resources and lowered amounts of water in wells (McGuire, 2004).

Water Quality

In conjunction with groundwater and the changes that can come about through the increased urbanization of a watershed, water quality can be affected tremendously as well. Water quality can be of concern in small watersheds such as the Little Bear River and can include increased

Agricultural and bench areas near Paradise.

sedimentation, nutrient loading, and thermal pollution (EPA) (Wurtsbaugh). Sedimentation can be problematic in water quality because it can cloud the water with not only excess soil, but any nutrient that may be in the sediment. Sedimentation is usually a result of erosion and runoff events. This runoff can often contain higher amounts of nutrients, including nitrogen and phosphorus. These nutrients eventually deposit into standing water bodies such as lakes, reservoirs, and wetlands and can contribute to eutrophication (loss of oxygen in a water body which creates uninhabitable water for various organisms).

Groundwater recharge is large in scale but precise in the effects the upper portions of the watershed can have on the water table quality and quantity. The activities in the upper catchments of a watershed are the most crucial to the recharge ability and the water quality of the watershed (Baker, Mesner). The protection and reclamation of riparian and wetland areas are key in the utilization of the natural, and least expensive, filtration system in the south end of Cache Valley.

Suggested Mitigation

•No urban development in upper catchments
•No urban development in aquifer recharge areas
•Designation of upper catchments as managed grazing and wildlife habitat areas
•Allow development in accordance with natural aquifer capacity
•Allow managed water use of irrigation type farming in lower catchments
•Discourage industrial and commercial development in crucial aquifer recharge areas
•Preserve all riparian and wetland areas (percolation, aquifer recharge) (Mesner, 2007)

Tier 1

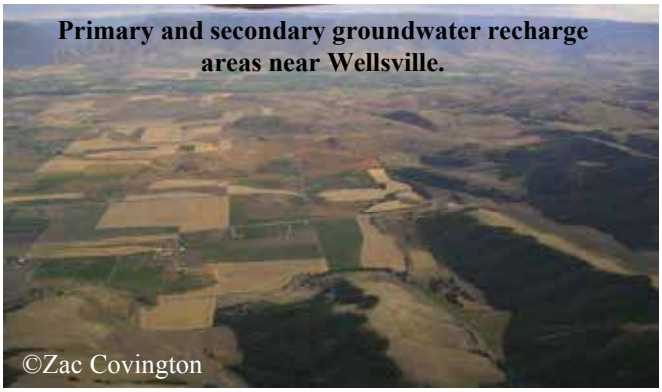
Tier 1 for the groundwater model places the highest value for land to be protected for groundwater quality and includes the primary recharge areas for the valley. The estimated Cache Valley Principal Aquifer (see GIS References, page 119) is also shown on each of the tiers, to give a sense of where there would be a higher capacity to build based off of groundwater quantity.

Tier 2

Tier 2 shows the principal recharge areas as well as the secondary recharge areas, with a reference to the estimated Cache Valley Principal Aquifer location.

Tier 3

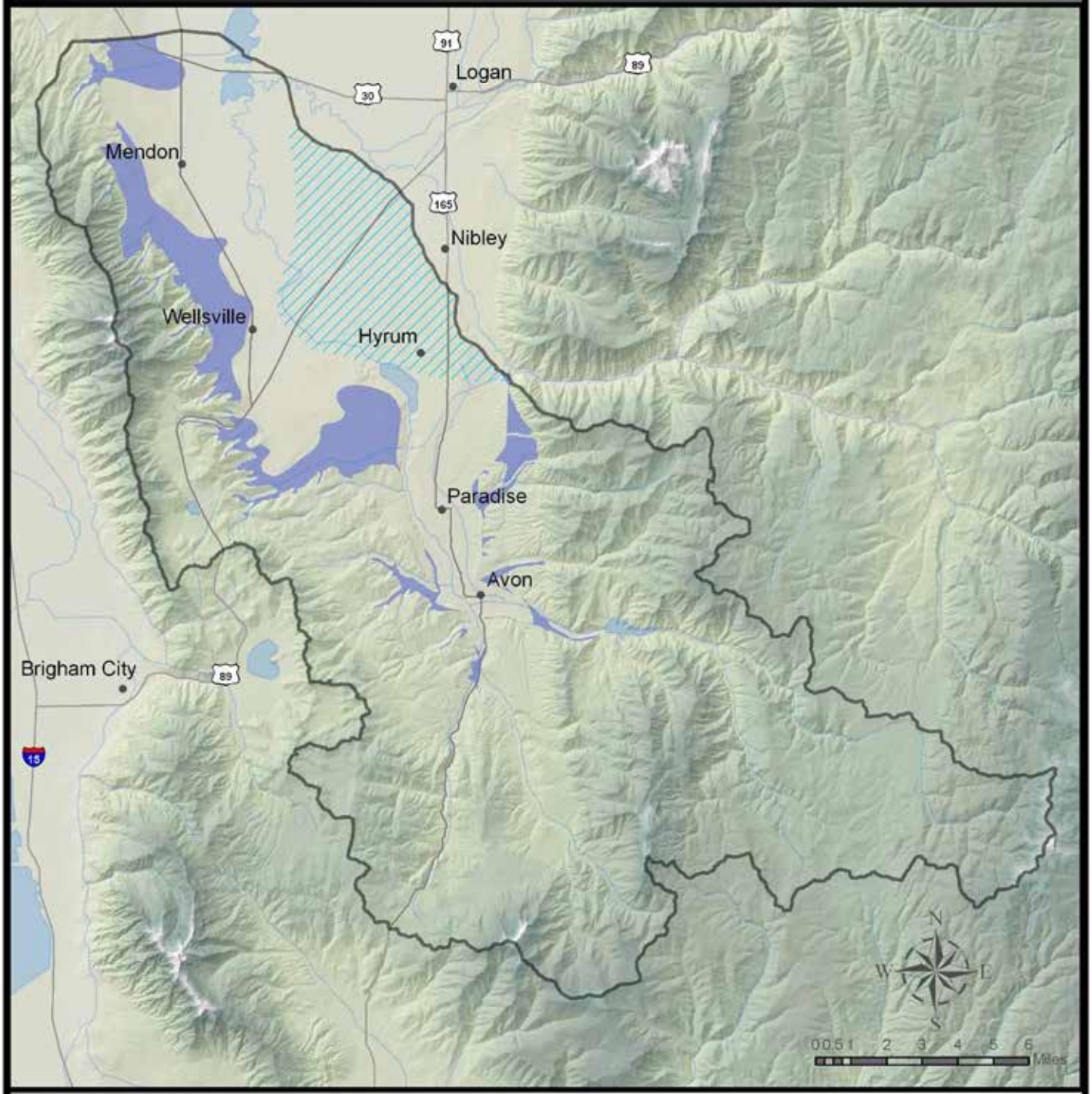
Tier 3 shows the information from the previous two tiers and adds wetlands as crucial areas to protect for water quality. All the area in the watershed that is not above the estimated Cache Valley Principal Aquifer is dotted to indicate that if there is building in these areas, there should be investigation into the implications of building based off of septic tank densities, water availability, and well water quality.



Primary and secondary groundwater recharge areas near Wellsville.

Groundwater - Tier 1

LBRW

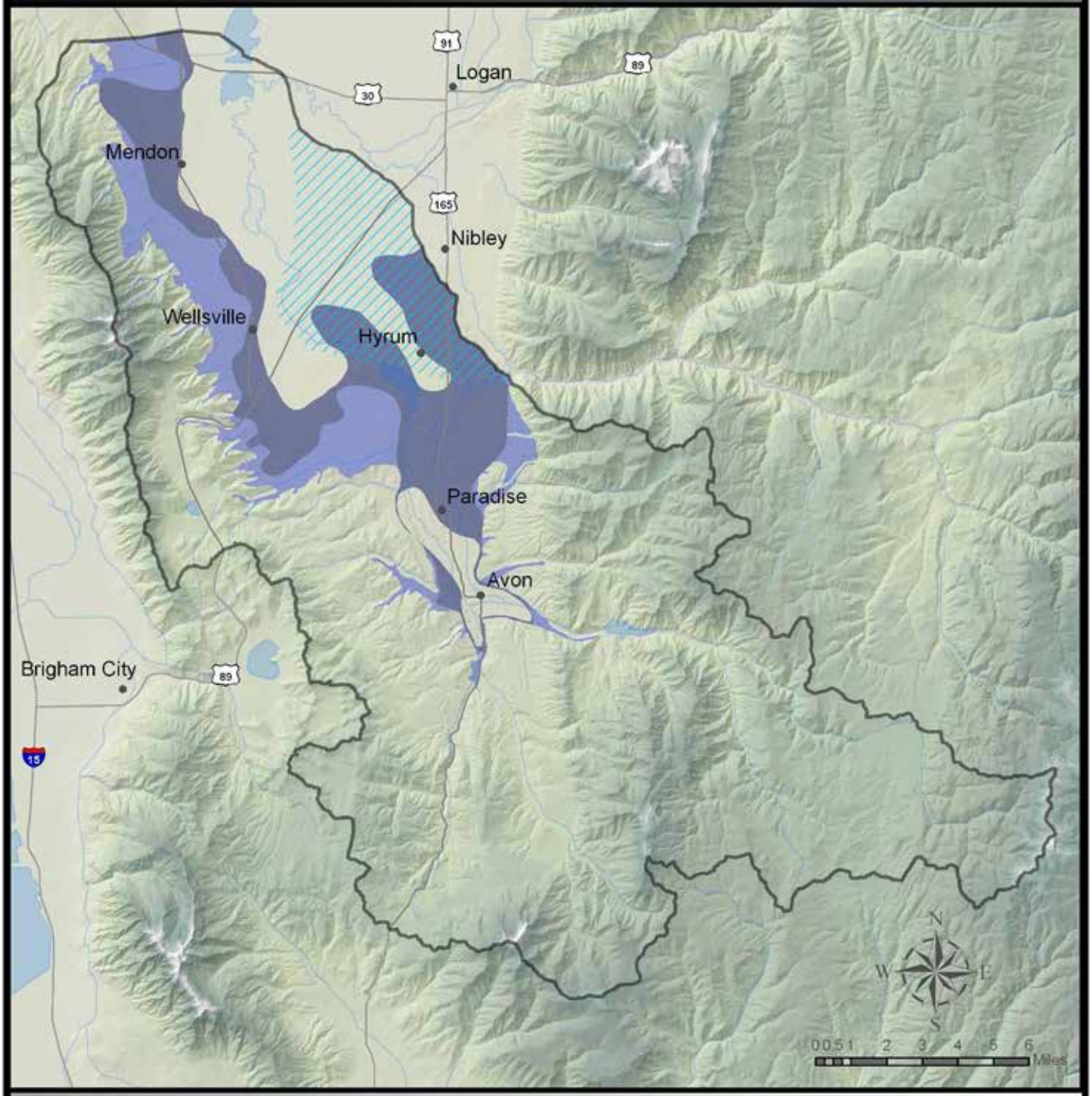


Estimated Cache Valley Principal Aquifer Location

Primary Groundwater Recharge Areas

Groundwater - Tier 2

LBRW



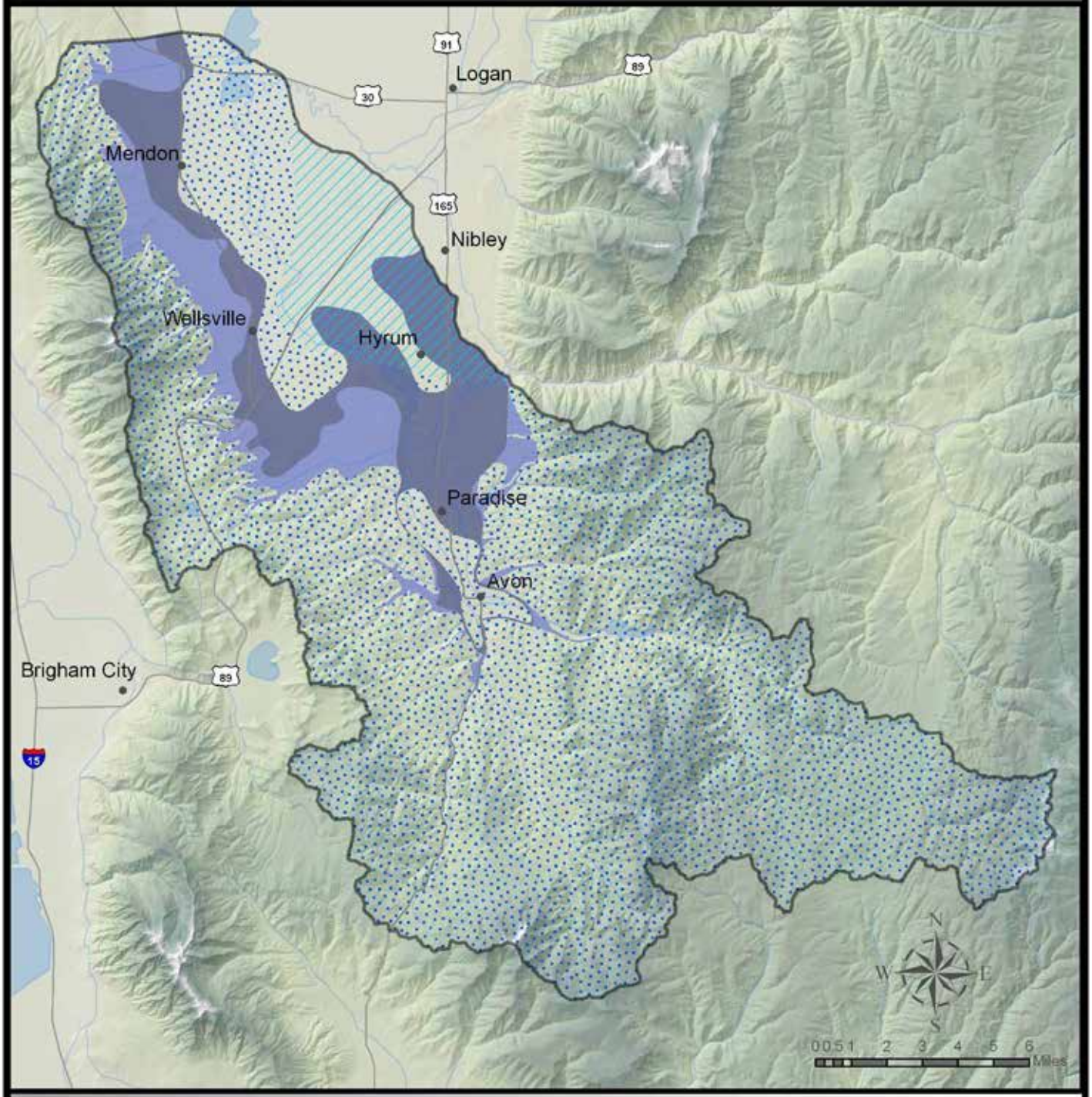
Estimated Cache Valley Principal Aquifer Location

Primary Groundwater Recharge Areas

Secondary Groundwater Recharge Areas

Groundwater - Tier 3

LBRW



Groundwater Caution Areas

Estimated Cache Valley Principal Aquifer Location

Primary Groundwater Recharge Areas

Secondary Groundwater Recharge Areas

Groundwater Caution Areas are those areas that are outside of primary and secondary recharge boundaries that may not have access to as much groundwater as development above the aquifer.

Commercial/Industrial

Industrial and commercial land use in Cache Valley has been both controversial and beneficial for the surrounding communities. There is a constant tension about the zoning designations and standards and the location of these economic areas in proximity to residential areas. The economic land uses can be of great value to communities and are a vital and integral part of their growth and sustainability. Jobs are created, goods are manufactured or sold, and residential communities increase in size and diversity. While the buildings that comprise commercial and industrial zones are as different as the types of businesses that inhabit them, there are basic site demands for them. General building site requirements are as follows:

Site Requirements
Less than 20-25% slope (Marsh, 1992)
Outside the 50-year floodplain
Well drained and adequate agricultural soils
Good water aquifer recharge
Good groundwater quality
Outside seismic fault zones
Outside landslide or liquefaction areas
Outside of wetlands, riparian areas, or critical habitat
Water rights ownership
Accommodating climate (precipitation)

Service and Access Requirements
Within ¼ mile of power and phone lines
Access to sewer and city water

Public Service and Improvements
Proper emergency and snow/ice removal access via maintained roads
Water use access for fire crews

Support Activities Required
Recreational facilities/parks
Hospitals

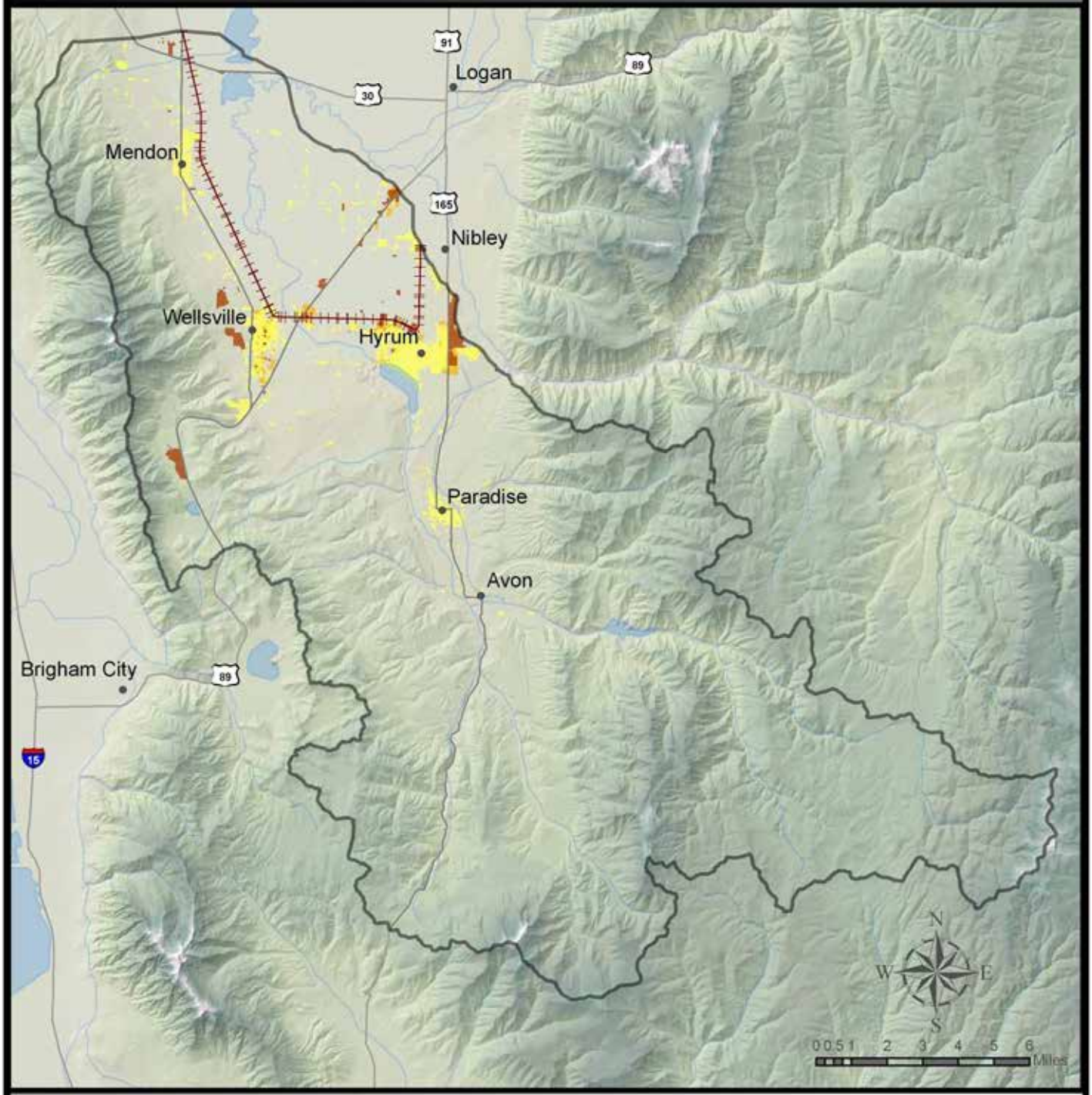
In accordance with the basic site requirements and the assistance of other academic and professional resources, the following are the tiers for the commercial and industrial model (see Commercial/Industrial references):

Tier 1
Tier 1 Commercial/Industrial is the most restrictive on the amount of land that can be utilized as commercial or industrial land use. This land is close to existing infrastructure and major roads, close to existing residential development, is within currently sewered areas, and is built in the safest areas.

Tier 2
Tier 2 is moderately restrictive on commercial and industrial growth. It is in moderately safe areas to build, close to existing infrastructure and major roads, and is close to existing residential development.

Tier 3
Tier 3 is the least restrictive tier on commercial and industrial growth. It largely follows the major roads, emphasizing the need for these businesses to have access to roadways. The lands for this tier are also located within the lands that are essentially safe to build on.

Commercial/Industrial - Tier 1 LBRW

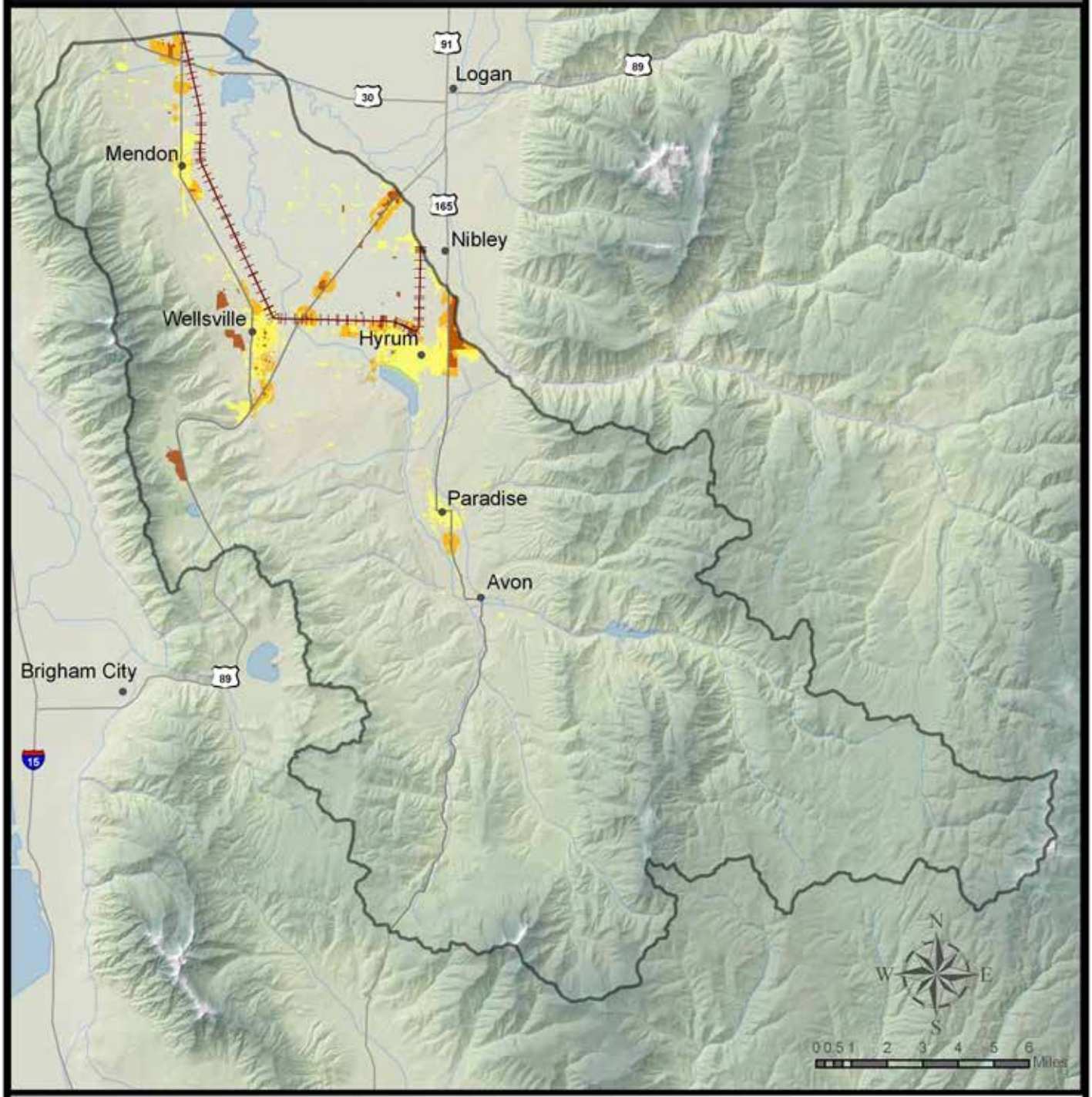


Potential Land for Commercial Development
Existing Commercial/Industrial Land
Existing Residential Land
Railroads

Potential Comm./Ind. Land Criteria:
1/4 Mile State Highway Proximity +
1/4 Mile Commercial Proximity +
1 Mile Residential Proximity +
Within Sewered Areas -
Public Safety Tier 3

Commercial/Industrial - Tier 2

LBRW



Potential Land for Commercial Development

Existing Commercial/Industrial Land

Existing Residential Land

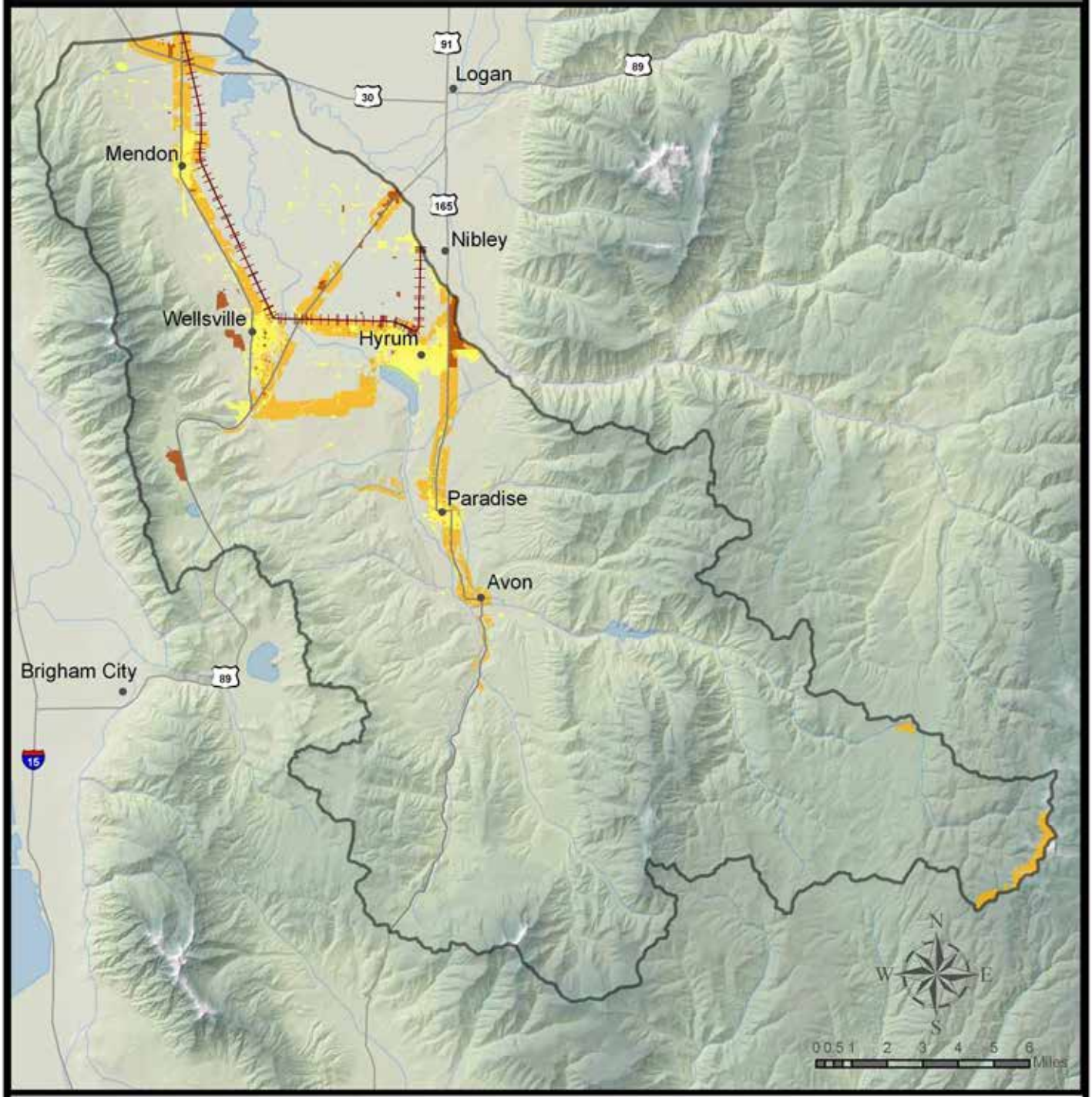
Railroads

Potential Comm./Ind. Land Criteria:

1/4 Mile State Highway Proximity +
1/4 Mile Commercial Proximity +
1 Mile Residential Proximity -
Public Safety Tier 2

Commercial/Industrial - Tier 3

LBRW



Potential Land for Commercial Development

Existing Commercial/Industrial Land

Existing Residential Land

Railroads

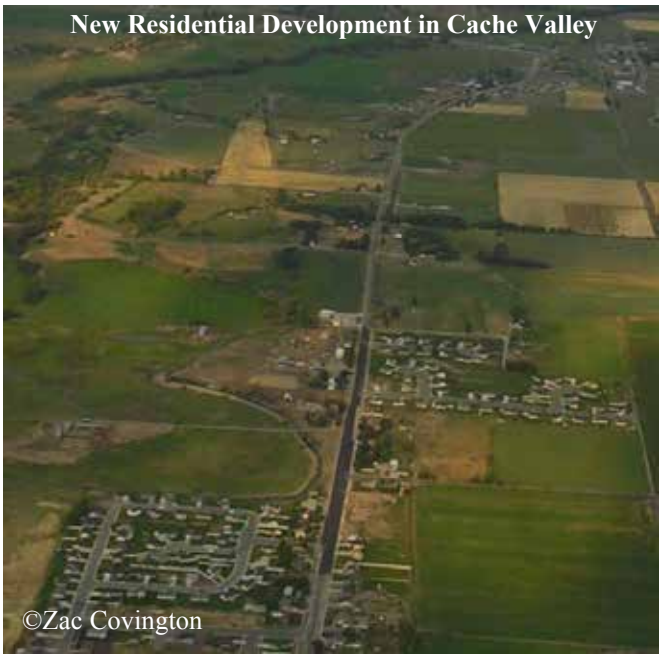
Potential Comm./Ind. Land Criteria:
1/4 Mile State Highway Proximity -
Public Safety Tier 1

Residential

Cache Valley is growing at a rapid rate in many of the areas that were used historically for agricultural land. For example, communities such as Providence, North Logan, Smithfield, and others have progressively become more and more dense in development, and the empty spaces in between have also begun to fill in.

There are many ways that residential land can be designated. According to average Cache Valley residential designations, they include Agricultural Residential at 1 unit/10 acres, Single Family Low Density Residential at 1 unit/1-5 acres, Single Family Traditional Residential at 1-7 units/acre, Multi-family Medium/High Density at 1-14 units/acre, Multi-family Very High Density at 1-32 units/acre, Commercial Neighborhood/Mixed Use located at areas of highest intensity adjacent to existing residential development, and Mobile Homes at 1-8 units/acre.

The standards for potential residential land use in Cache Valley used in this model were taken from interviews of Cache Valley realtors and developers, University staff, and the report "Cache Valley 2030."



New Residential Development in Cache Valley

General activity information for all types of residential development is given below. Particular differences in each of the above-mentioned densities are noted following the general activity information and contains information for the potential site disturbances, visual quality, complimentary activities, and conflicting activities of each density.

Site Requirements
Less than 20-25% Slope (Marsh, 1992)
Outside the 50-year flood plane
Well-drained and adequate agricultural soils
Away from industrial and commercial areas
Good views outside the property
Good water aquifer recharge
Good groundwater quality
Outside seismic fault zones
Outside landslide or liquefaction areas
Water rights ownership
Close to wetlands, riparian zones, and critical habitat
Accommodating climate (precipitation)

Service and Access Requirements
Within ¼ mile of power and phone lines
Access to sewer and city water good

Public Service and Improvements
Proper emergency and snow/ice removal access via maintained roads
Water use access for fire crews

Support Activities Required
Schools
Recreational facilities/parks
Religious facilities
Cultural activities
Shopping (food, clothing, etc.)
Hospitals

In analyzing land that was most cost-effective for developers to build on, the before mentioned attributes were taken into consideration and several others are noted in the following explanations:

Tier 1
Tier 1 Residential is the most restrictive tier on growth for the watershed. This model has the least amount of land that can be utilized for residential development. This tier is close to existing residential and commercial land, close to existing roads, within areas that are currently sewered, the safest areas to build on, and above the estimated location of the Cache Valley Principal Aquifer (see Groundwater reference section).

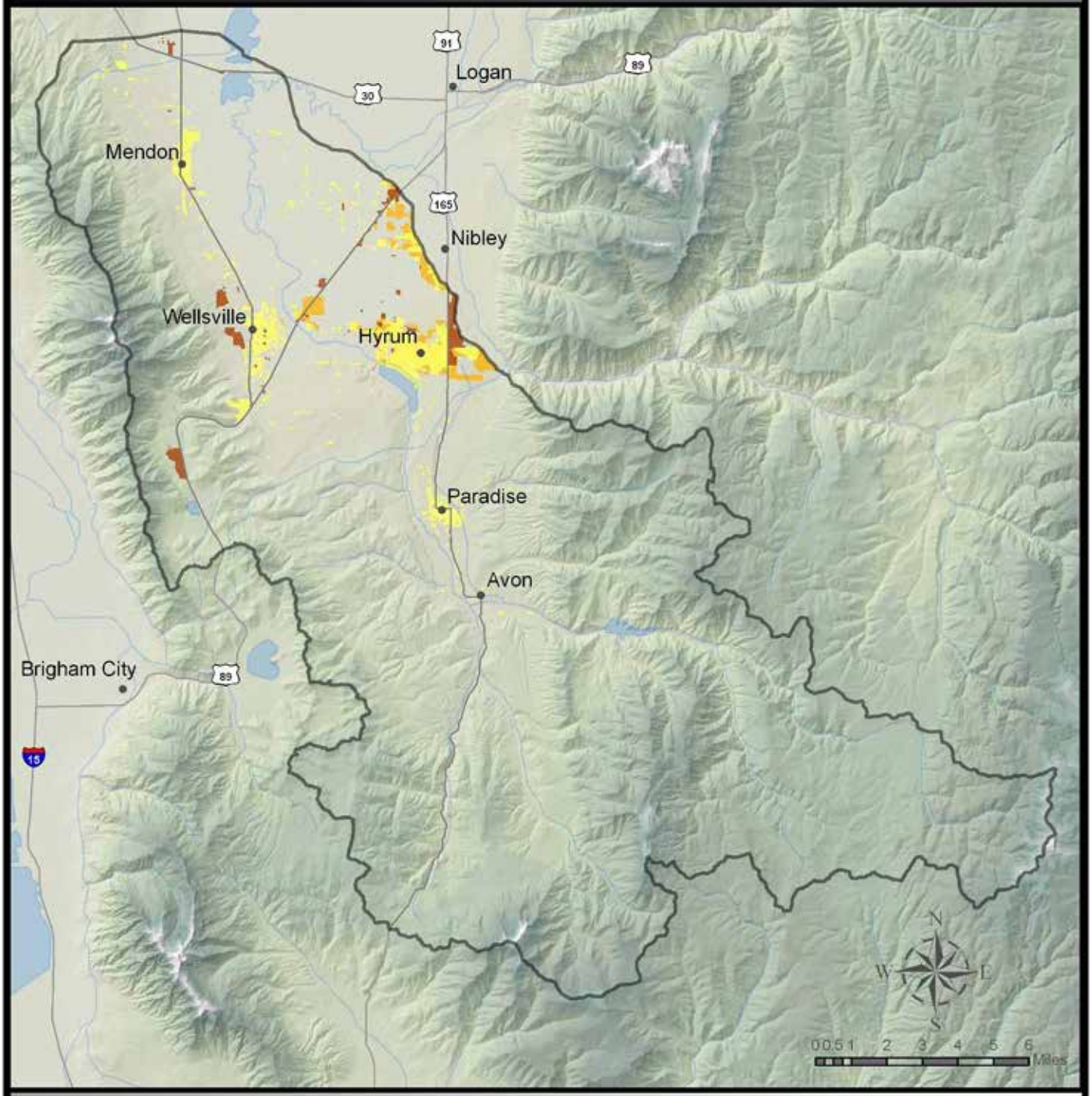
Tier 2
Tier 2 Residential is less restrictive on development and is moderately safe, close to existing infrastructure, and above the aquifer.

Tier 3
Tier 3 Residential is the least restrictive on development, has essential public safety attributes, and is close to existing infrastructure.

©Zac Covington **Aerial photo looking North towards Avon and Paradise in Cache Valley, Utah**

Residential - Tier 1

LBRW



Potential Land for Residential Development

Existing Commercial Land

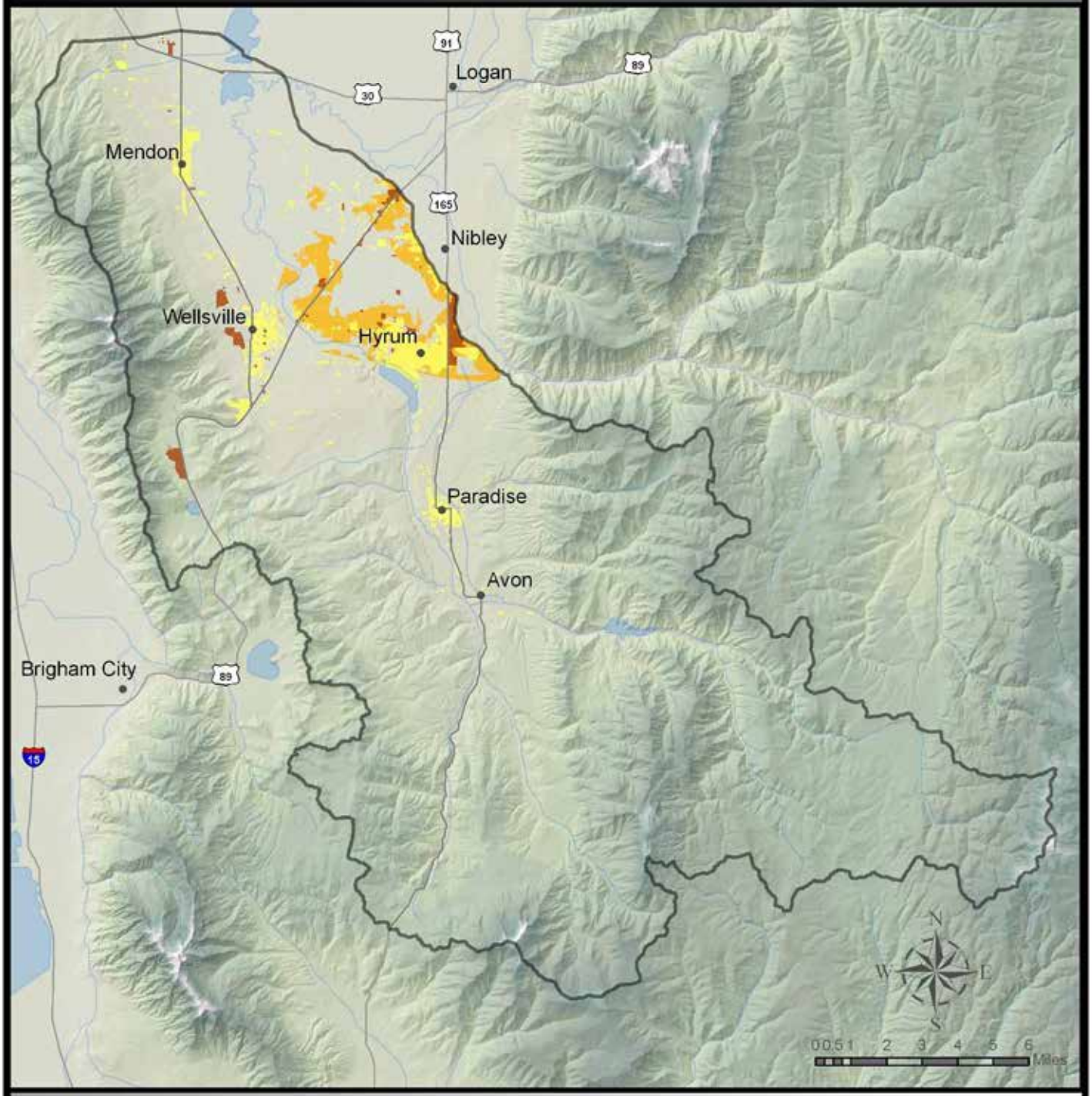
Existing Residential Land

Potential Residential Land Criteria:

1/4 Mile Road Proximity +
1 Mile Commercial Land Proximity +
Within the Cache Valley Principal Aquifer +
Within Sewered Areas -
Public Safety Tier 3

Residential - Tier 2

LBRW



Potential Land for Residential Development

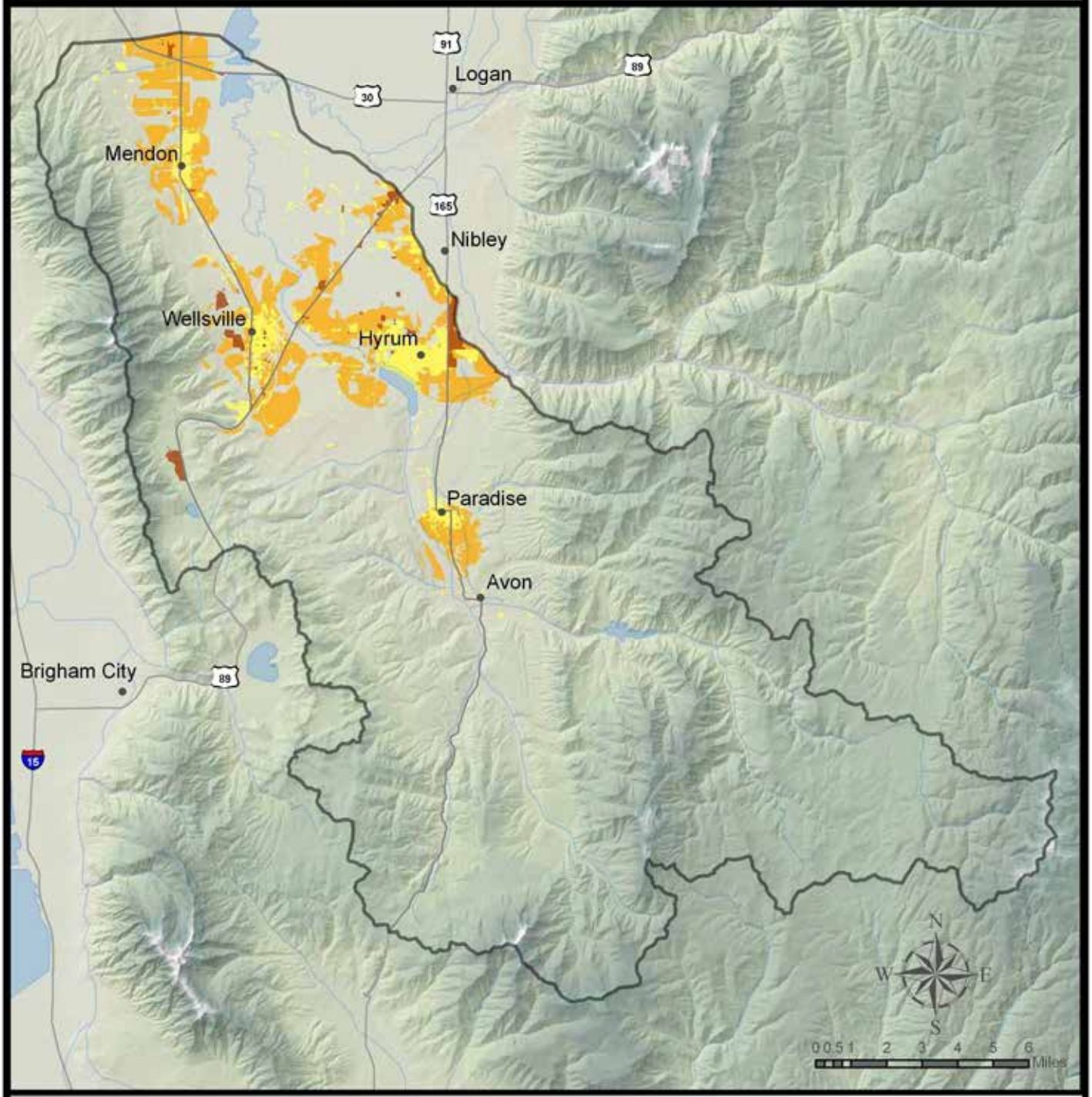
Existing Commercial Land

Existing Residential Land

Potential Residential Land Criteria:
1/4 Mile Road Proximity +
1 Mile Commercial Land Proximity +
Within the Cache Valley Principal Aquifer -
Public Safety Tier 2

Residential - Tier 3

LBRW



Potential Land for Residential Development

Existing Commercial Land

Existing Residential Land

Potential Residential Land Criteria:
1/4 Mile Road Proximity +
1 Mile Commercial Land Proximity -
Public Safety Tier 1

Transportation

The population of the Little Bear River Watershed is growing at a rapid rate. Along with this growth comes the need for a widely comprehensive transportation plan. The transportation model takes into consideration several planning reports prepared by local and state government agencies such as the Cache Metropolitan Planning Organization (CMPO). In addition, this model incorporates several other criteria based on current and projected growth within the valley, current transit demands, areas of congestion, and existing and projected population access within the Little Bear River Watershed. The transportation model also takes into account areas restricted by conservation easements and pollution concerns.

Components

Principal Arterial: These highways serve traffic volumes in excess of 40,000 vehicles per day at a speed of 45 mph or greater. Driveway access to these roads is limited along with a limited number of traffic lights (CMPO, 2005).

Minor Arterial: The Minor Arterials serve as connector streets between the principal arterial highways. These connecting streets generally have speed limits of approximately 45 mph and under. These streets also tend to have two lanes traveling in opposite directions (CMPO, 2005).

Tier 1

Tier 1 includes an illustration of existing roads along with existing state and local transportation projects. Many of the projects focus around the areas of rapid growth in the city of Nibley. One of the main additions to the current transportation network is the proposed Principal Arterial, stretching along the south end of the valley from Hyrum to Wellsville, then continuing north to Mendon until it connects with State Route 30.

Tier 2

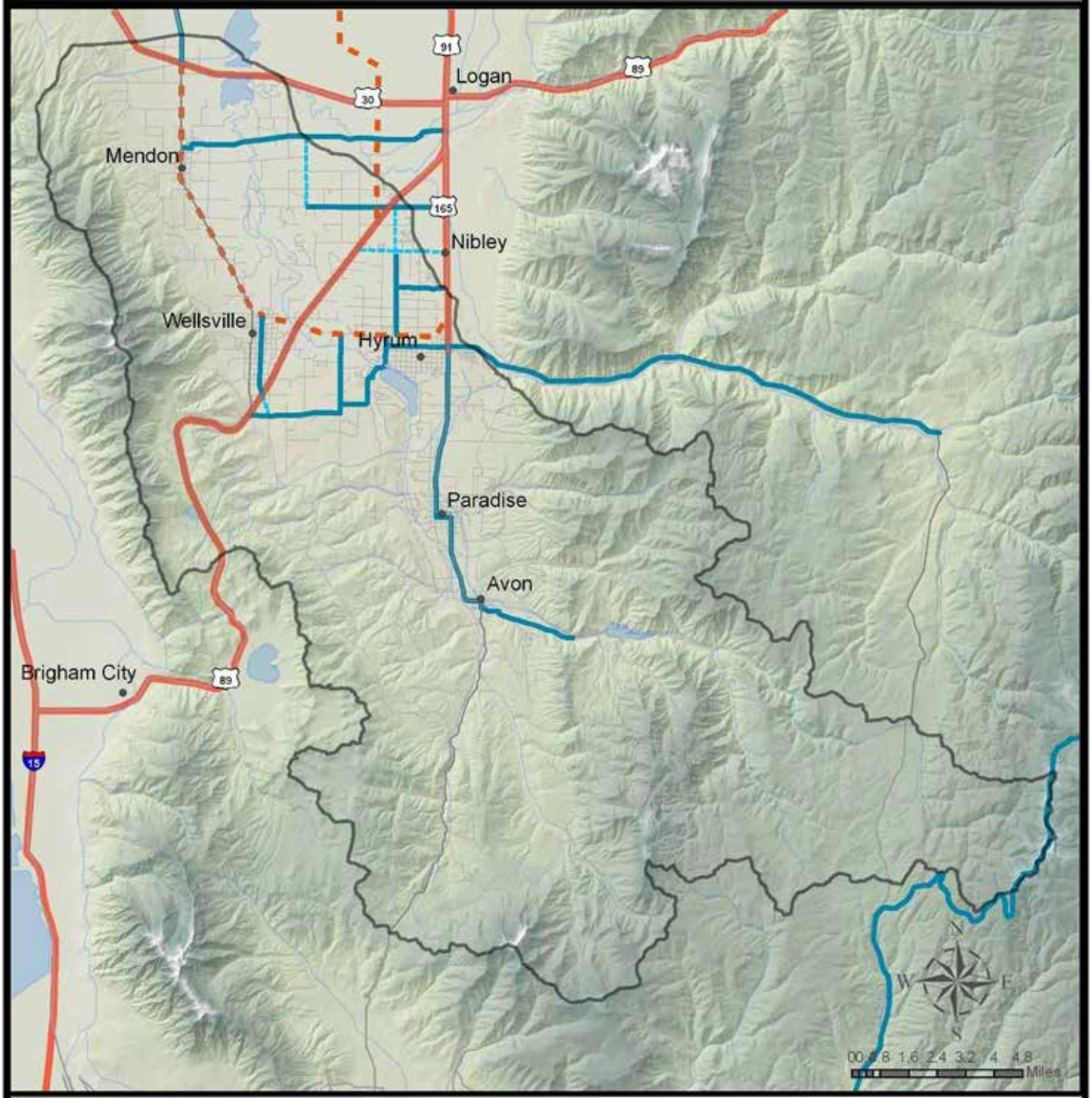
Tier 2 includes many of the additions of Tier 1. However, this tier focuses on accommodating the current and future growth of the south end of the Little Bear River Watershed. Also, a minor arterial, connecting Cache Valley to Ogden Valley, has been proposed.

Tier 3

Tier 3 is the most aggressive in design. This tier provides access to the projected growth along the south end of Cache Valley along with the numerous recreation destinations throughout the Little Bear River Watershed. This tier also alleviates a large amount of the congestion existing along the existing Principal Arterials.

Transportation - Tier 1

LBRW

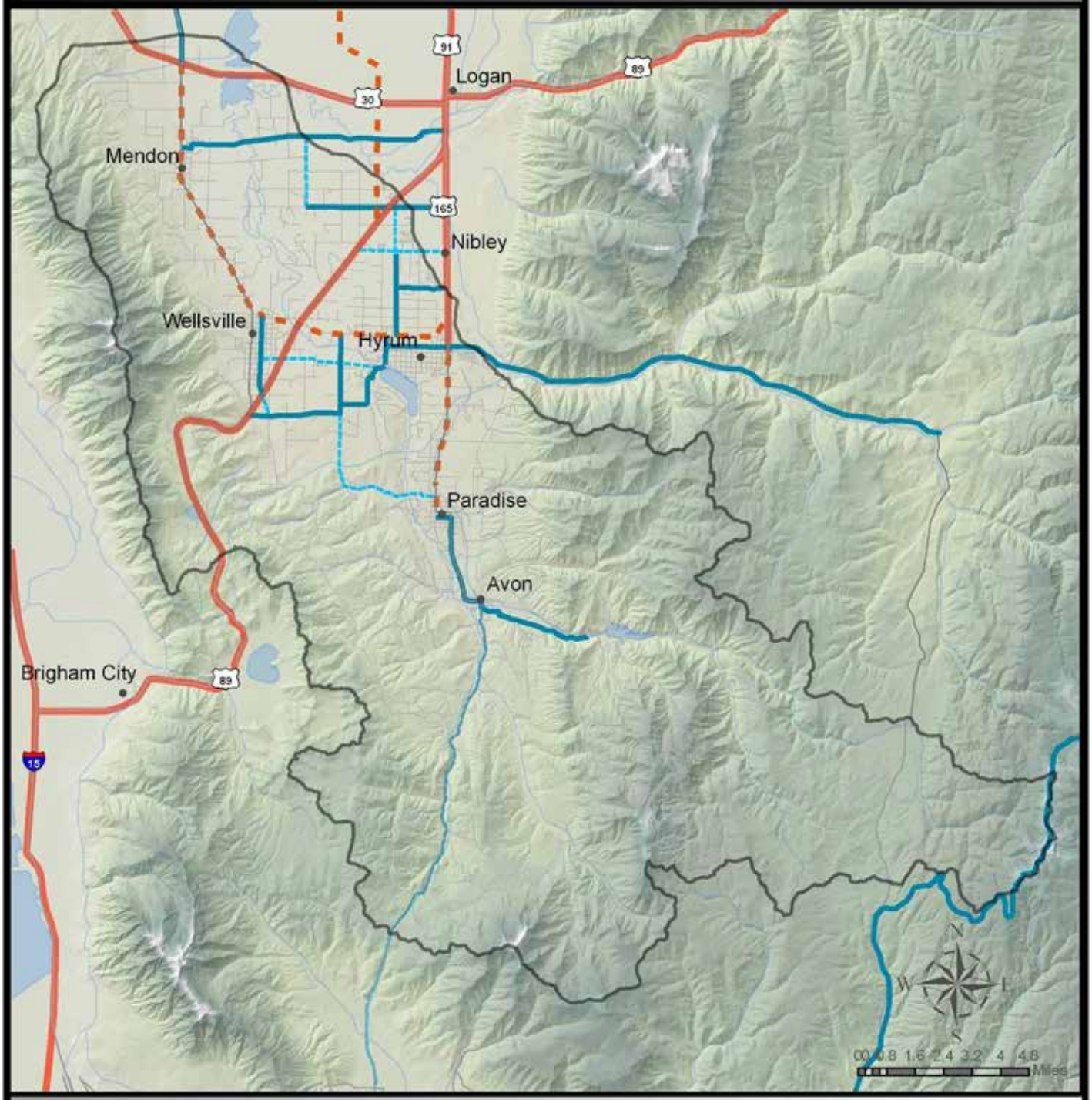


- Existing Principal Arterial
- Proposed Principal Arterial
- Existing Minor Arterial
- Proposed Minor Arterial

Principle Arterial streets are state highways with travel speeds exceeding 45 mph. Minor Arterial traffic travels at moderate speeds with multiple access points. Arterial streets may function as collector streets as well as state highways.

Transportation - Tier 2

LBRW



Existing Principal Arterial

Proposed Principal Arterial

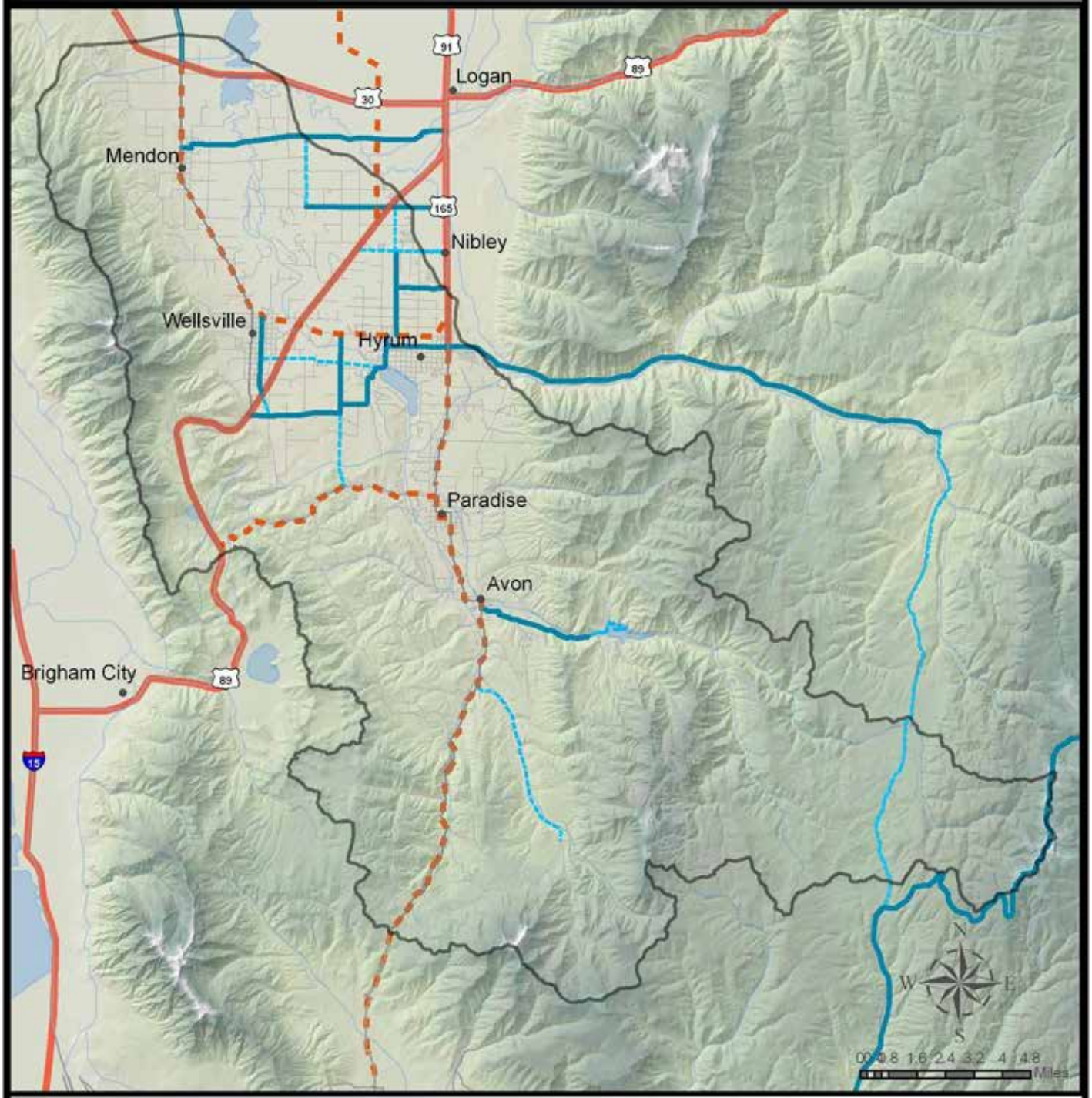
Existing Minor Arterial

Proposed Minor Arterial

Principle Arterial streets are state highways with travel speeds exceeding 45 mph. Minor Arterial traffic travels at moderate speeds with multiple access points. Arterial streets may function as collector streets as well as state highways.

Transportation - Tier 3

LBRW



- Existing Principal Arterial
- Proposed Principal Arterial
- Existing Minor Arterial
- Proposed Minor Arterial

Principle Arterial streets are state highways with travel speeds exceeding 45 mph. Minor Arterial traffic travels at moderate speeds with multiple access points. Arterial streets may function as collector streets as well as state highways.

Public Transportation

The Public Transportation model takes into account numerous factors dealing with both public access and overall public health. The already existing public transportation system gives access to numerous places of employment in the urbanized areas of the valley, along with various recreation trails and byways (CVTD). In addition, the current and proposed public transportation is essential in limiting air pollution, which increases significantly during periods of inversion.

Air Quality Concerns

The periods of winter inversion in the watershed are due to topography and high-pressure systems of the region which hold cool air along the lower areas of the valley and prevents the mixture of upper and lower atmospheric air. The inversion acts as a lid, trapping pollutants near the surface and creating very serious health threats for the residents of the watershed. The pollutants that are trapped near the surface consist of very fine particles known as Particulate Matter 2.5 (PM 2.5). These fine particles are capable of entering into the lungs of individuals. Once in the lungs, the fine particles not only cause an increase in asthma attacks, but they can cause serious health effects to both the cardiovascular and respiratory systems (Stewart, 2004). Those most severely affected by PM 2.5 matter are little children, the elderly, and individuals who spend long hours involved in outdoor activities (Stewart, 2004).

Particulate Matter is created by reactions between carbon dioxide and ammonia (Stewart, 2004). The main contributors to the high concentration of carbon dioxide are automobiles, wood burning stoves, and local power plants. Ammonia is a byproduct of animal waste from various agricultural practices. The number of vehicles on the road has greatly increased over the past 20 years. This increase has lead to an increase in carbon dioxide and PM 2.5 levels which has resulted in the violation of EPA's air quality standards on many occasions (Stewart, 2004).

Future violations of federal standards will result in federal restrictions which will have negative financial impacts on the residents of the Little Bear River Watershed. In order to prevent future occurrences of non-compliance with air quality regulations, Cache Valley has begun promoting the usage of the already existing mass transportation services provided by the Logan Transit District (LTD) and the Cache Valley Transit District (CVTD). These routes spread throughout the urbanized centers of Cache Valley and even provide access to residents of Preston, ID. However, there are only a few existing routes that give access to the residents of the Little Bear River Watershed. These routes mainly provide limited access to the people living in the cities of Hyrum and Nibley.

Route Designation

Proximity to the following criteria are used in determining public transportation routes:

•Existing public transportation (CVTD, CMPO)
•Proposed public transportation (CVTD, CMPO)
•Homes with limited vehicle access
•Major employers
•Education centers
•Trails
•Bike and pedestrian access
•Growth trend projections
•Homes with individuals younger than 17
•Homes with individuals older than 60
•Parks and recreation sites
•Lower income housing
•Persons with disabilities
•Institutions and public service facilities

Tier 1

Tier 1 includes the existing bus routes that extend to the towns of Nibley and Hyrum. These routes are then expanded to include the growing populations in the towns of Paradise, Wellsville, and Mendon. This will alleviate the congestion along Highway 165 and provide access to numerous recreation sites and trails throughout the south end of Cache Valley. This tier also proposes that the existing bus rapid transit route (BRT) from Logan to Preston be extended to Brigham City in order to alleviate congestion

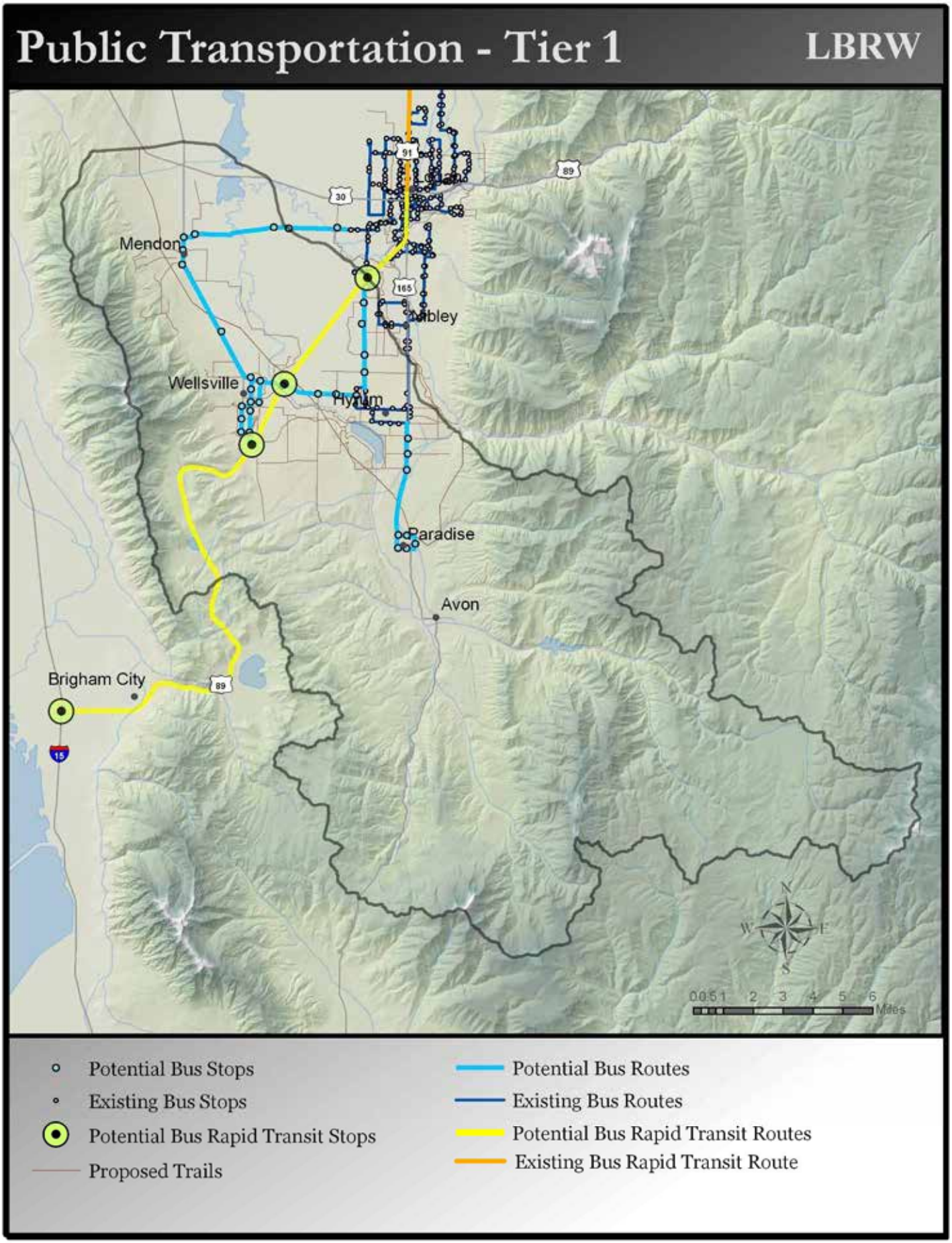
along Highway 89/91 and provide access to the proposed commuter rail line extending from Payson to Brigham City.

Tier 2

Tier 2 includes all of the existing and proposed routes of Tier 1. In addition, Tier 2 provides more access to the towns of Nibley, Hyrum, and Wellsville in areas that are experiencing rapid growth. Also, a proposed bus rapid transit route extending along State Highway 30 has been proposed. This proposed route will provide access to the residents of Box Elder County and help reduce traffic volumes and carbon dioxide emissions along the center of Cache Valley.

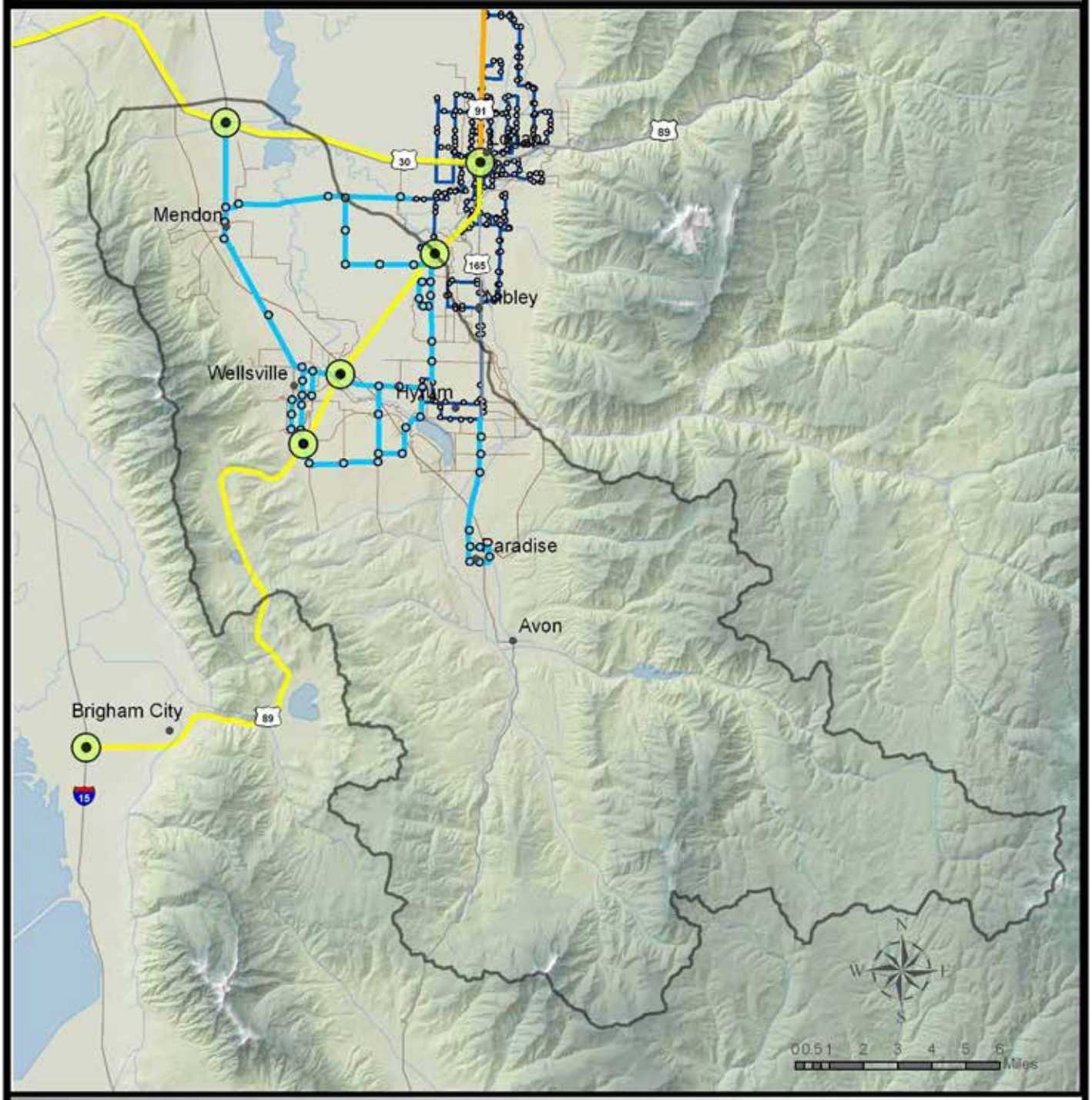
Tier 3

Tier 3 includes all of the existing and proposed routes of Tiers 1 and 2 with minor additions throughout the watershed. However, this tier includes a commuter rail line, utilizing existing rail lines which service the Little Bear River watershed and connect to the commuter rail stretching along the Wasatch Front. Additionally, this tier includes a bus rapid transit line connecting Cache Valley to Ogden Valley and Powder Mountain ski resort.


Public Transportation - Tier 1
LBRW
Mendon
Wellsville
Hyrum
Paradise
Avon
Brigham City
91
89
30
165
15
N
W
E
S
0 0.5 1 2 3 4 5 6
Miles
Potential Bus Stops
Existing Bus Stops
Potential Bus Rapid Transit Stops
Proposed Trails
Potential Bus Routes
Existing Bus Routes
Potential Bus Rapid Transit Routes
Existing Bus Rapid Transit Route

Public Transportation - Tier 2

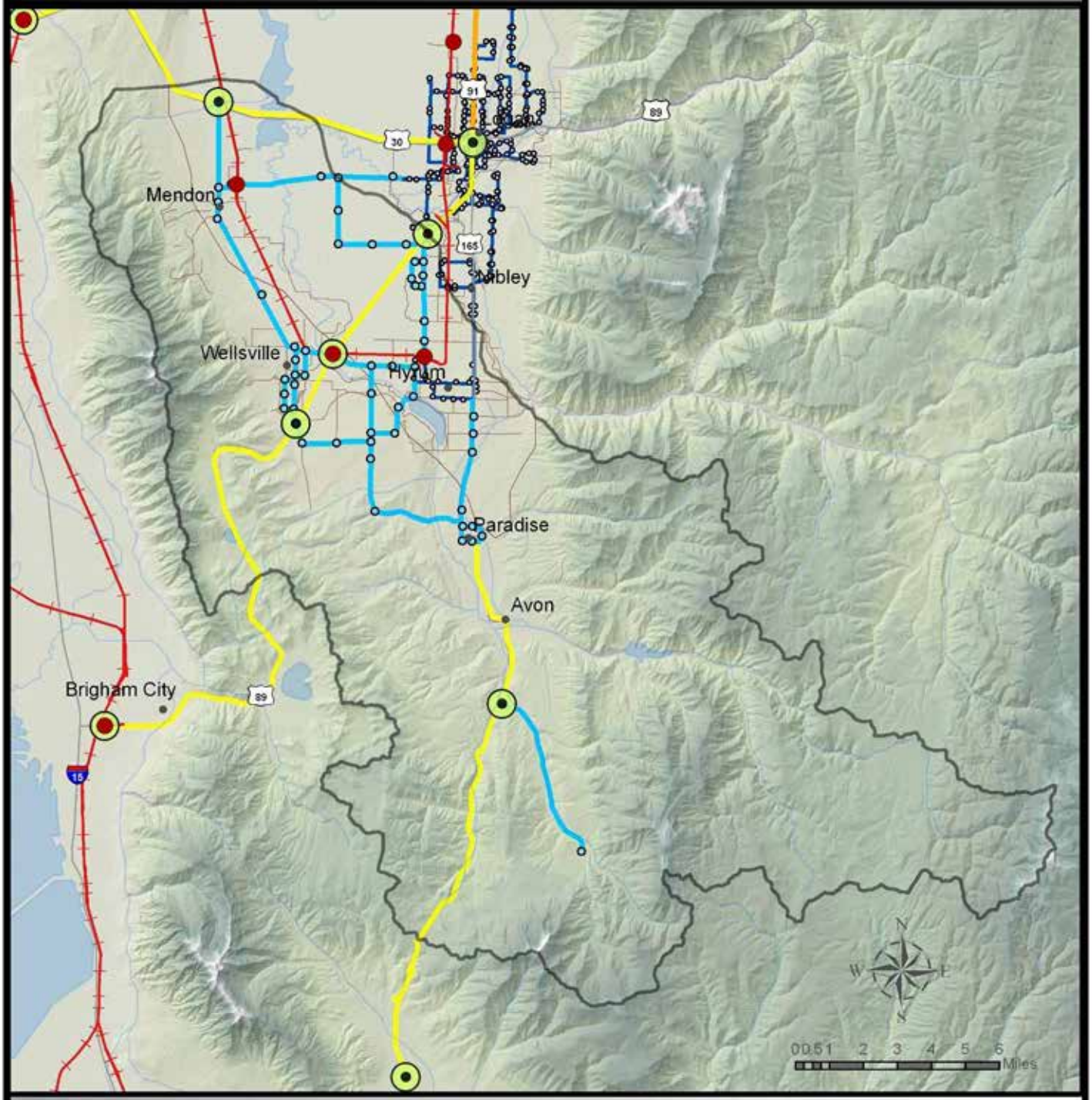
LBRW



- Potential Bus Stops
- Existing Bus Stops
- Potential Bus Rapid Transit Stops
- Proposed Trails
- Potential Bus Routes
- Existing Bus Routes
- Potential Bus Rapid Transit Routes
- Existing Bus Rapid Transit Route

Public Transportation - Tier 3

LBRW



- Potential Rail Stops
- Potential Bus Stops
- Existing Bus Stops
- Potential Bus Rapid Transit Stops
- Proposed Trails
- Potential Rail Transit
- Potential Bus Routes
- Existing Bus Routes
- Potential Bus Rapid Transit Routes
- Existing Bus Rapid Transit Route

Viewsheds

Possibly one of the first impressions that visitors get about Cache Valley comes from their entrance into the valley from Wellsville (commonly called Sardine) Canyon. In the orientation of current residents, these views that open up from the gateways (unique openings or entrances) into and out of the valley, and views that people most often see and individually cherish, are priceless and must be preserved. Generally, these views are determined by site visits, previous research, surveys, etc. and should be an integral part of planning for the south end of the valley. There are many threats to these views, including residential, commercial, and industrial development, pit mining, overgrazing of hillsides, invasive weeds, abuse of lakes, ponds, and rivers, signage along roadways, and the removal of historical buildings and agricultural land use. Included in these views and gateways are the following:

From the base of Wellsville (Sardine) Canyon [Wellsville City]

- •Looking north toward Logan (Agriculture, wetlands, rivers, barns, etc.)
- •Looking east toward Hyrum (same as above, and Bear River Range)
- •Looking west toward Mendon, Wellsville, and the Wellsville Mountains (majestic, natural)
- •Looking south into the canyon and at the south benches (natural)

From Hyrum

- •Looking south towards Paradise/Avon (mountains, hills, and farmland)
- •Looking east to Blacksmith Fork Canyon (unobstructed views of Bear River Range)
- •Looking west toward Wellsville, Mendon and Wellsville Mountains (agriculture, wetlands, rivers, barns, mountains)

From Mendon

- •Looking west towards Wellsville Mountains
- •Looking south towards Logan/Petersburg (agriculture, wetlands, rivers, barns)
- •Looking east towards Nibley/Hyrum (agriculture, wetlands, rivers, barns, Bear River Range)

From Paradise/Avon

- •Looking north, east, south and west (agriculture, mountains, benches, rangeland, wetlands, rivers, Hyrum reservoir, etc.)

From Nibley

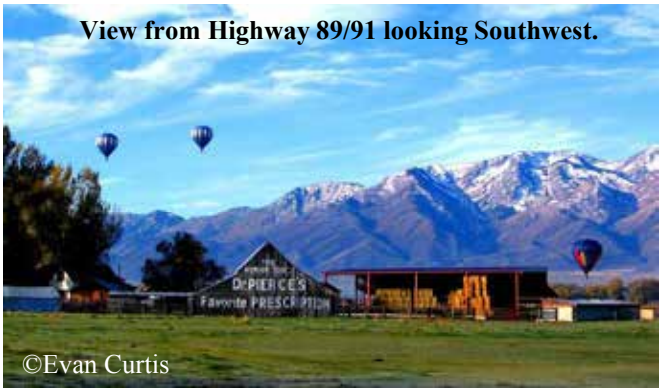
- •Looking south towards Hyrum (Hyrum reservoir, mountains, rivers, agriculture)
- •Looking west towards Wellsville (agriculture, mountains, rivers, wetlands, benches)

Tier 1

Viewsheds Tier 1 is derived from the Tier 2 town points and also includes five points along Highway 89/91 between Wellsville and Nibley. These points were used to represent the area most often viewed by the many people entering into the valley via the highway. A viewshed analysis was done from each of these points at a height of 2 Meters (6 feet).

Tier 2

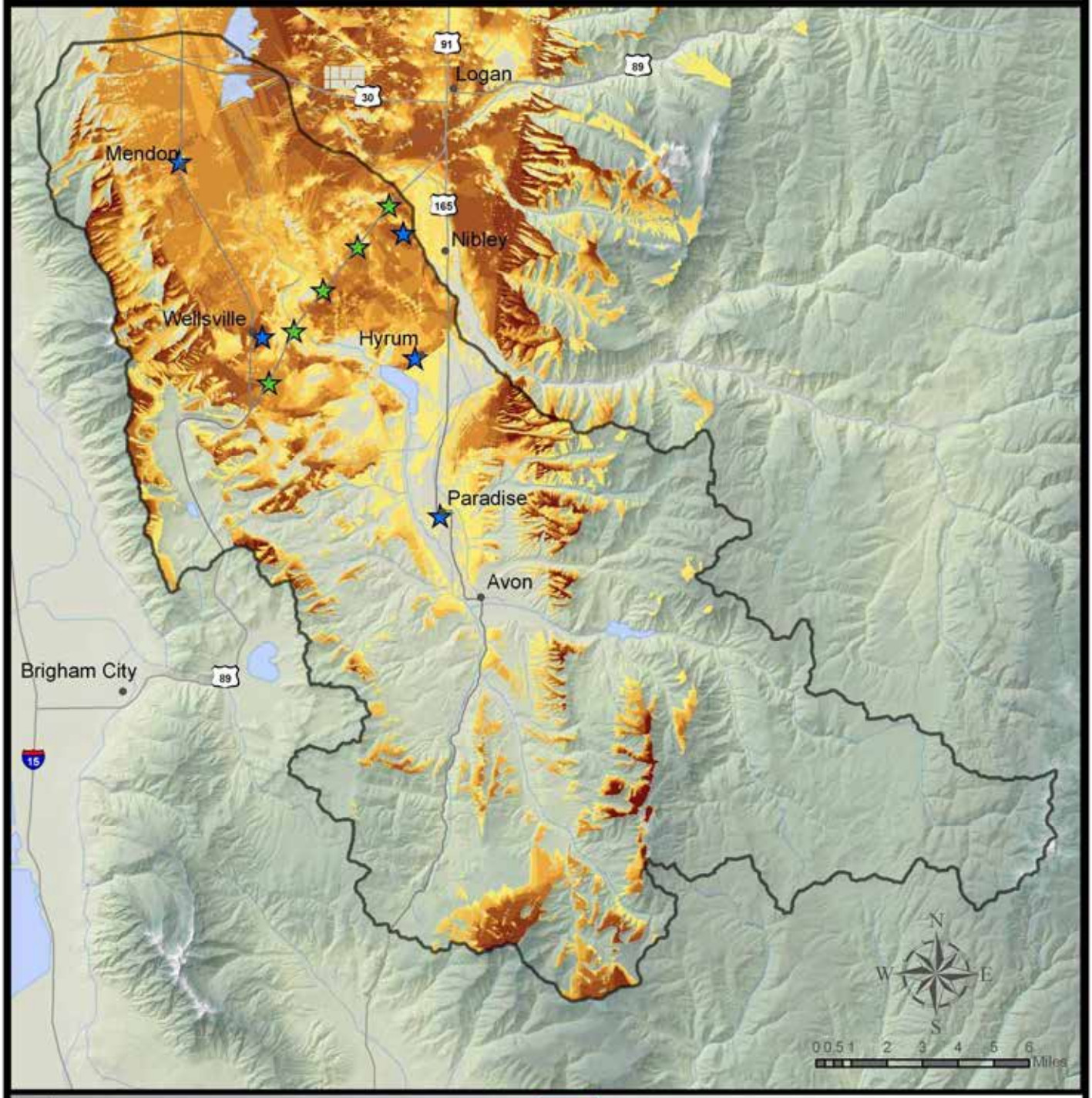
In Tier 2, a point was placed in each of the five town areas in the watershed which included Wellsville, Mendon, Nibley, Hyrum, and Paradise/Avon.



View from Highway 89/91 looking Southwest.

Viewsheds - Tier 1

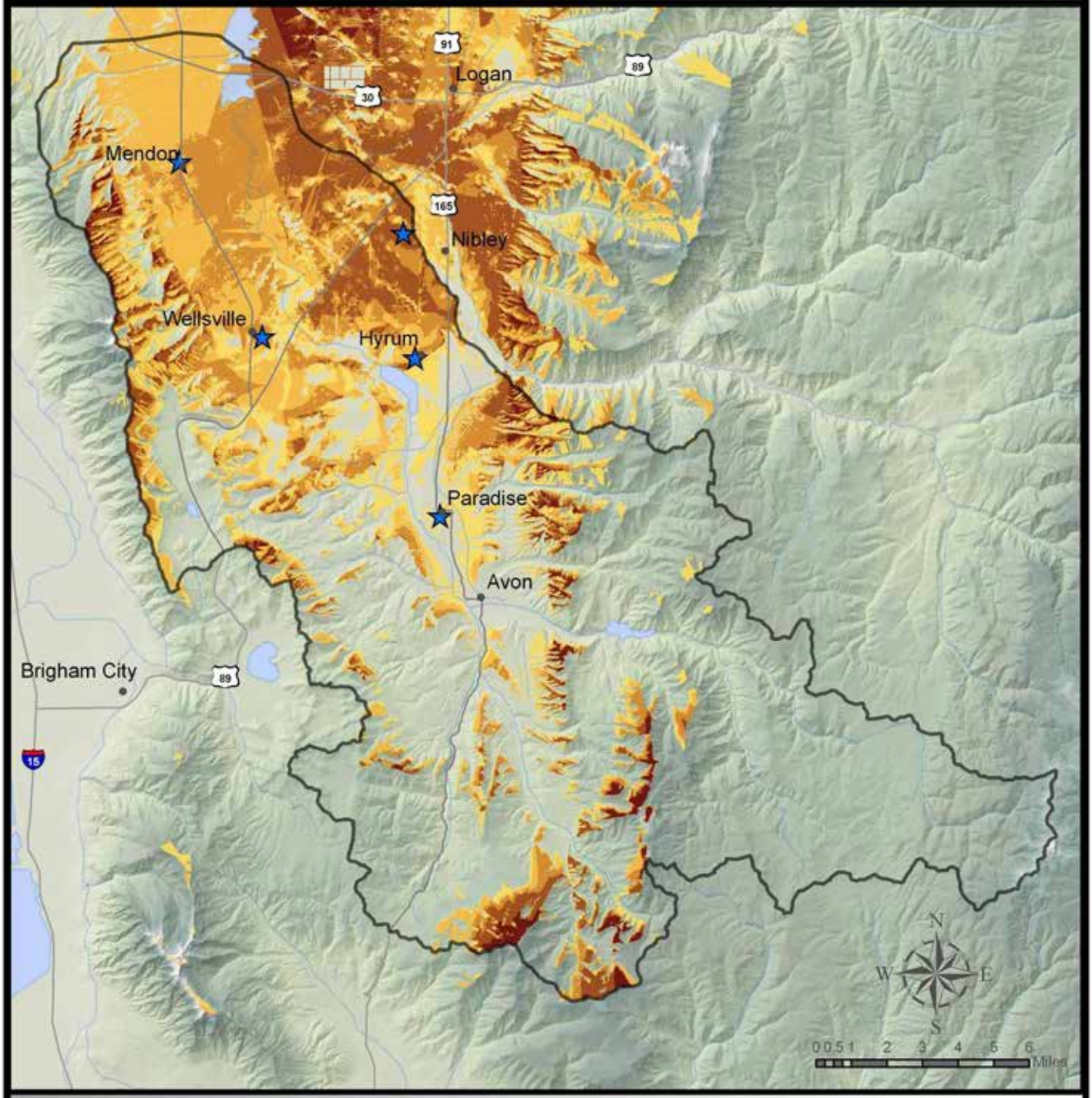
LBRW



- Town View Points
- Highway 89/91 View Points
- Visible From 10% of Town and Hwy Points
- Visible From 20% of Town and Hwy Points
- Visible From 30% of Town and Hwy Points
- Visible From 40% of Town and Hwy Points
- Visible From 50% of Town and Hwy Points
- Visible From 60% of Town and Hwy Points
- Visible From 70% of Town and Hwy Points
- Visible From 80% of Town and Hwy Points
- Visible From 90% of Town and Hwy Points
- Visible From 100% of Town and Hwy Points

Viewsheds - Tier 2

LBRW



Visible From 20% of LBRW Towns

Visible From 40% of LBRW Towns

Visible From 60% of LBRW Towns

Visible From 80% of LBRW Towns

Visible From 100% of LBRW Towns

Town View Points

Sense of Place

In defining a sense of place for any region, there are many variables considered by many different types of people, that describe the places that people consider valuable. The reasons for these lands being considered valuable also vary and should be treated with respect. In the modeling of these lands, several resources held a wealth of information: these were the quality growth and city standards survey's of Cache County and Hyrum City.

Views of agricultural land in Cache Valley.

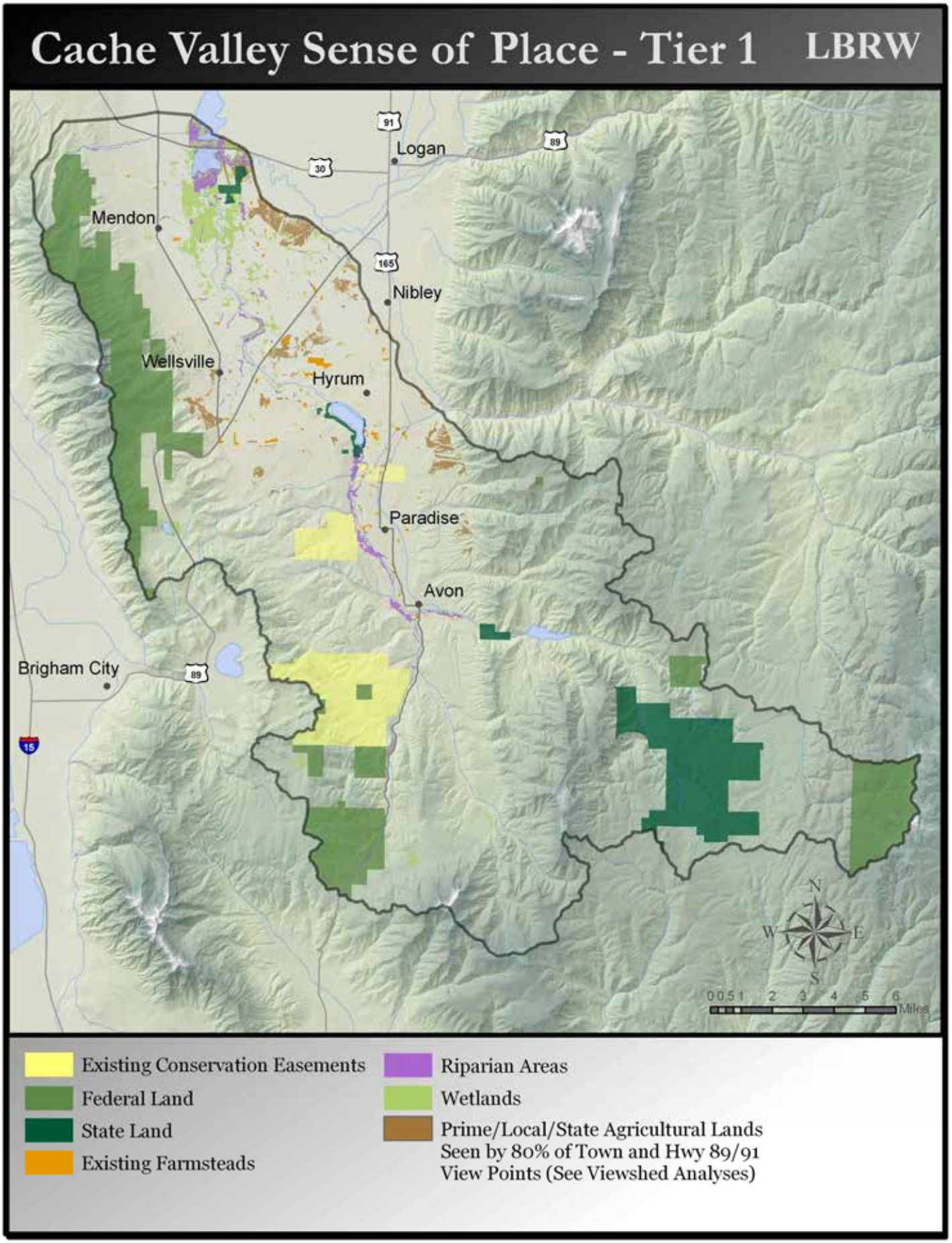
While diverse ideas concerning sense of place attributes exist in the minds of the residents in the Little Bear River Watershed, these surveys were invaluable resources used for reference regarding some of the land values of the people. These sense of place lands create spatial orientation and identity for residents. There are four main attributes that are crucial to the residents of the south end of Cache Valley. They are historical and religious icons, physical land attributes and uses, views and gateways and urban development patterns. These lands must be preserved as much as possible in order for the south end of Cache Valley to preserve its beauty and splendor.

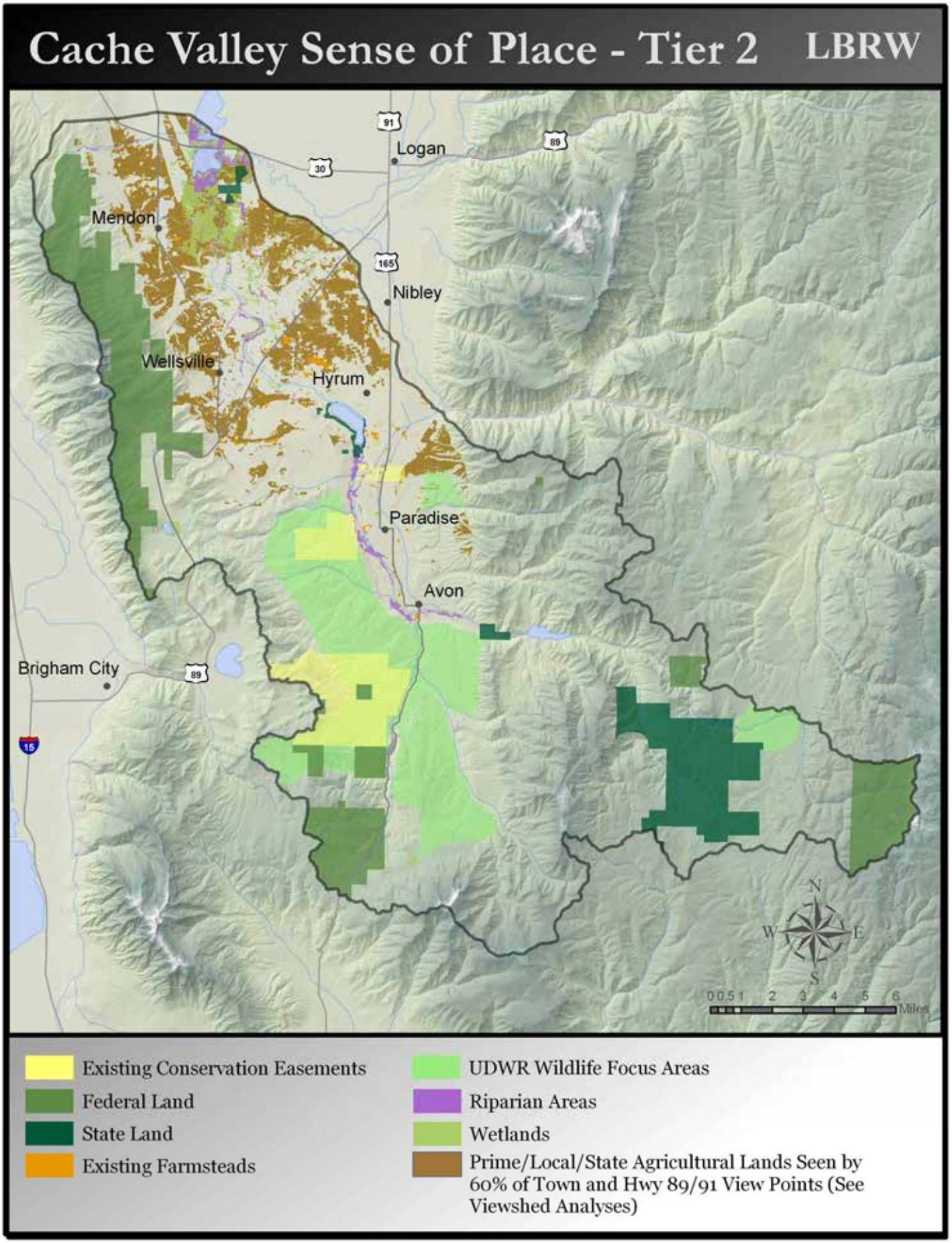
Tier 1
The attributes in this tier represent some of the most basic needs for the watershed socially, culturally, and visually, relating to land use and geographical area. They include the most basic views of agricultural land in the watershed (seen by 80% of the points in Viewshed Tier 2), wetland and riparian areas, existing farmsteads, existing conservation easements (wildlife habitat), and state and federal lands (wildlife, recreation, usable resources).

Tier 2
This tier includes all of the basic needs listed in Tier 1, but increases the views of agricultural lands (seen by 60% of the points in Viewsheds Tier 2). It also adds the Utah Division of Wildlife Resources (UDWR) High Priority Wildlife Areas, which have been designated by the UDWR as being important areas to manage for wildlife more strictly.

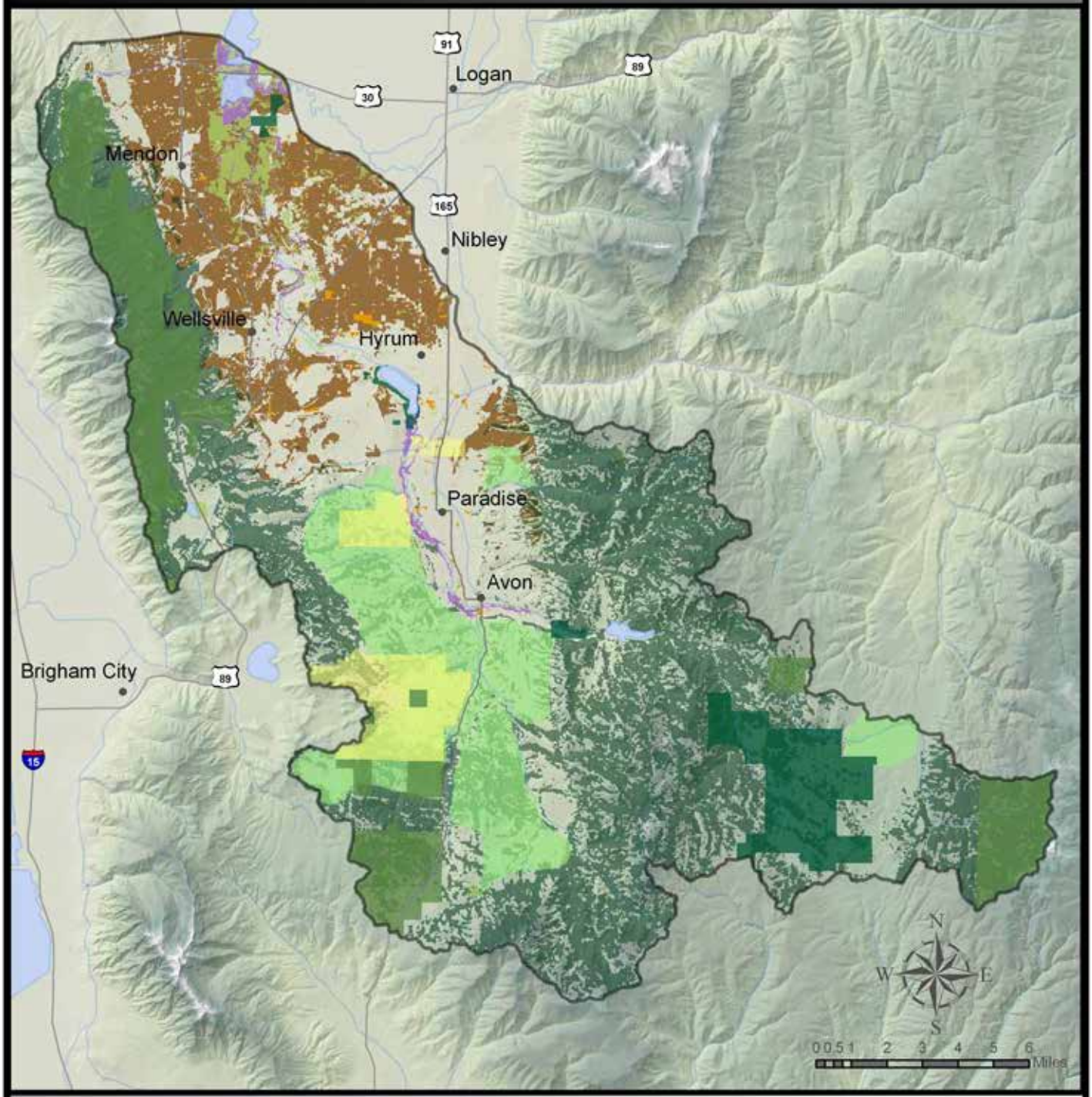
Tier 3
Tier 3 includes all of the aspects in Tier 2 but adds even more views of agricultural lands (seen by 40% of the points in Viewshed Tier 2). It also adds areas with large vegetative cover types (trees), which are not only suitable for recreational purposes but are important habitat areas for many types of wildlife (nice areas for birding or having wilderness experiences).

Large vegetation stand near Cache Valley.


Cache Valley Sense of Place - Tier 1
LBRW
Logan
Mendon
Nibley
Wellsville
Hyrum
Paradise
Avon
Brigham City
91
89
30
165
15
N
W
E
S
0 0.5 1 2 3 4 5 6
Miles
Existing Conservation Easements
Federal Land
State Land
Existing Farmsteads
Riparian Areas
Wetlands
Prime/Local/State Agricultural Lands
Seen by 80% of Town and Hwy 89/91
View Points (See Viewshed Analyses)


Cache Valley Sense of Place - Tier 2
LBRW
Logan
Mendon
Nibley
Wellsville
Hyrum
Paradise
Avon
Brigham City
91
89
30
165
15
N
W
E
S
0 0.5 1 2 3 4 5 6
Miles
Existing Conservation Easements
Federal Land
State Land
Existing Farmsteads
UDWR Wildlife Focus Areas
Riparian Areas
Wetlands
Prime/Local/State Agricultural Lands Seen by 60% of Town and Hwy 89/91 View Points (See Viewshed Analyses)

Cache Valley Sense of Place - Tier 3 LBRW



- Forested Areas
- Existing Conservation Easements
- Federal Land
- State Land
- Existing Farmsteads
- UDWR Wildlife Focus Areas
- Riparian Areas
- Wetlands
- Prime/Local/State Agricultural Lands Seen by 40% of Town and Hwy 89/91 View Points (See Viewshed Analyses)

Agriculture

The Little Bear River Watershed was originally chosen as one of the early Mormon settlement sights because of the vast abundance of grasses for grazing (Peterson, 1997). Since the mid 1850's agriculture has remained as the dominant feature of the Little Bear River Watershed. The large amount of agricultural practices such as grazing, cropland, and dairies not only provide economic viability for a significant number of residents of the area, but these practices also contribute to the overall high quality of life for the population of the Little Bear River Watershed.

Tier 1

Tier 1 consists of areas of major importance in meeting the "nations short- and long-range needs for food and fiber." One of these areas is labeled as "prime farmland," which is land that has the "best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses" (NRCS). Prime farmland that exists along the benches has been highlighted in Tier 1 due to the relatively long growing season. Tier 1 also contains the existing dairies and farmsteads within the Little Bear River Watershed.

Tier 2

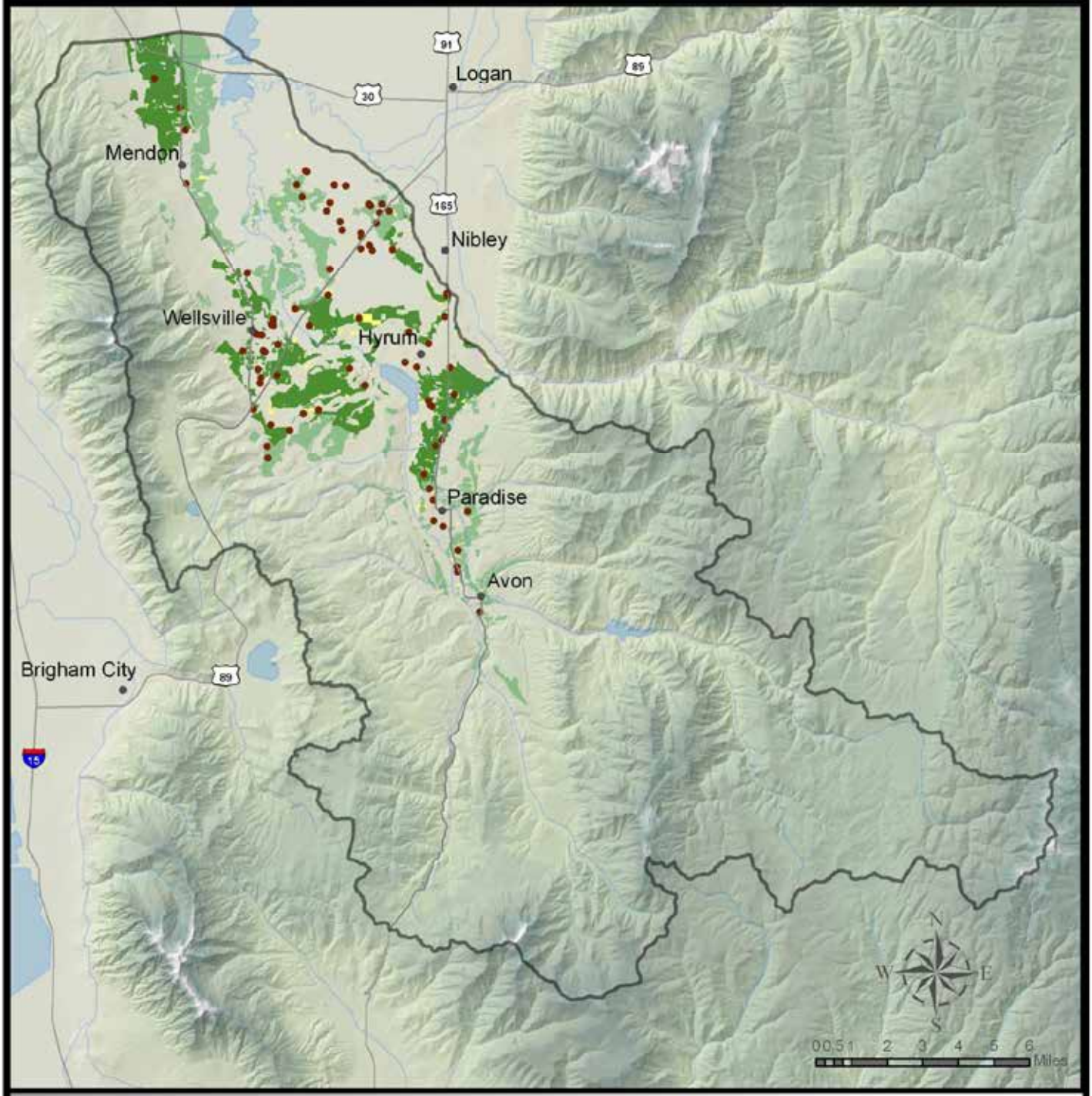
Tier 2 contains all of the components of Tier 1, along with other areas of agricultural significance. One of the areas that has been added to Tier 2 is "farmland of statewide importance," which consists of land that "nearly meets the requirements for prime farmland and that economically produces high yields of crops when treated and managed according to acceptable farming methods" (NRCS). Tier 2 also consists of "potential grazing land" which is prevalent along the upper benches of the Little Bear River Watershed. The potential grazing land consists of areas of adequate forage along slopes maintaining acceptable levels of stability.

Tier 3

Tier 3 contains all of the components of Tiers 1 and 2. This tier also contains areas which are labeled as "farmland of local importance," which is land that "is identified by the appropriate local agencies. Farmland of local importance may include tracts of land that have been designated for agriculture by local ordinance" (NRCS). This tier includes many areas that have traditionally been used as farmland within the Little Bear River Watershed, along with areas of potential agricultural significance along the benches and upper reaches of the watershed.

Agriculture - Tier 1

LBRW

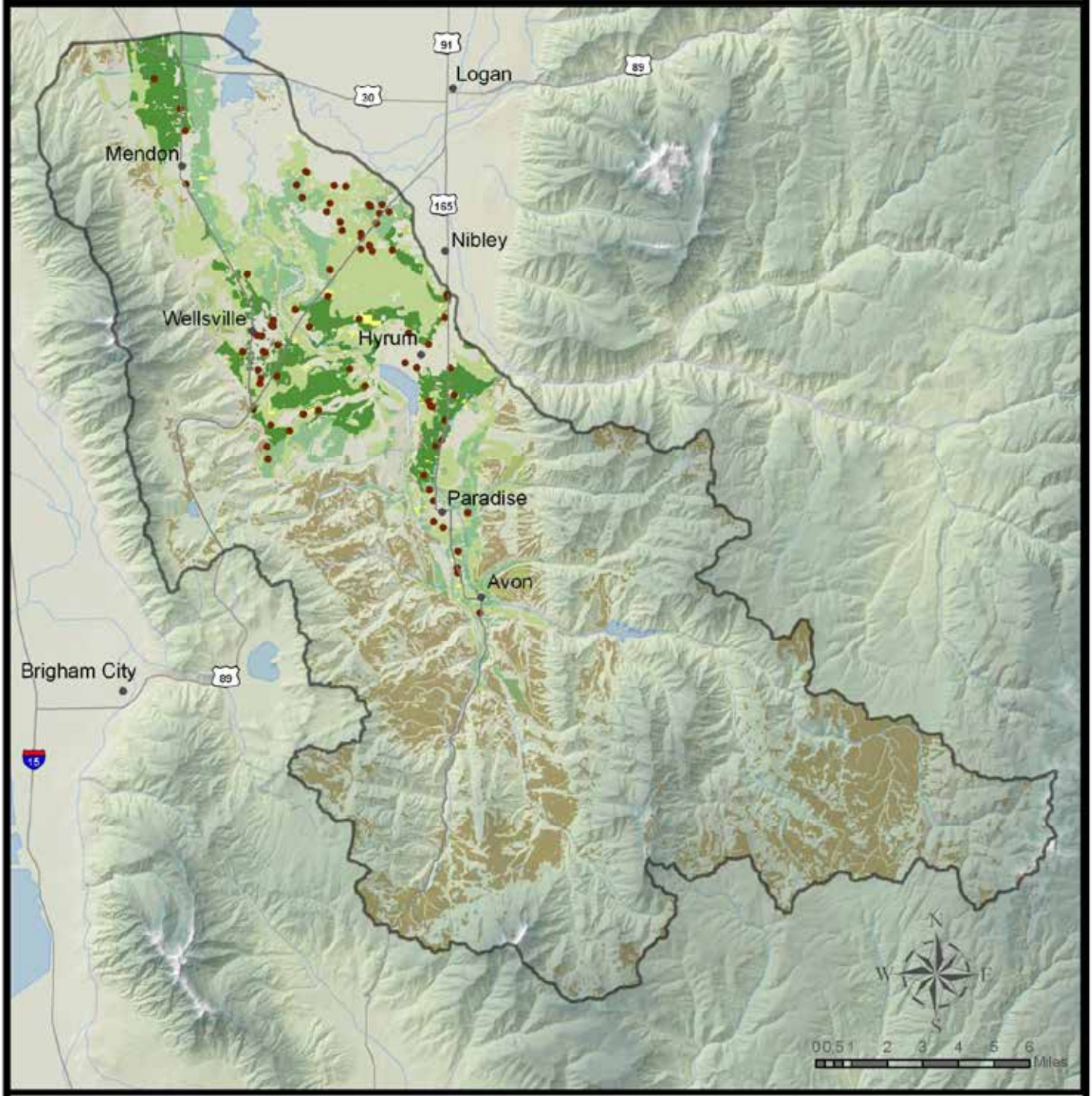


- Dairies
- Farmsteads
- Prime Farmland with Longest Growing Season
- Prime Farmland

Prime farmland, as defined by the USDA, is land that has the best combination of physical and chemical characteristics for producing crops. This land is not urban or water areas.

Agriculture - Tier 2

LBRW

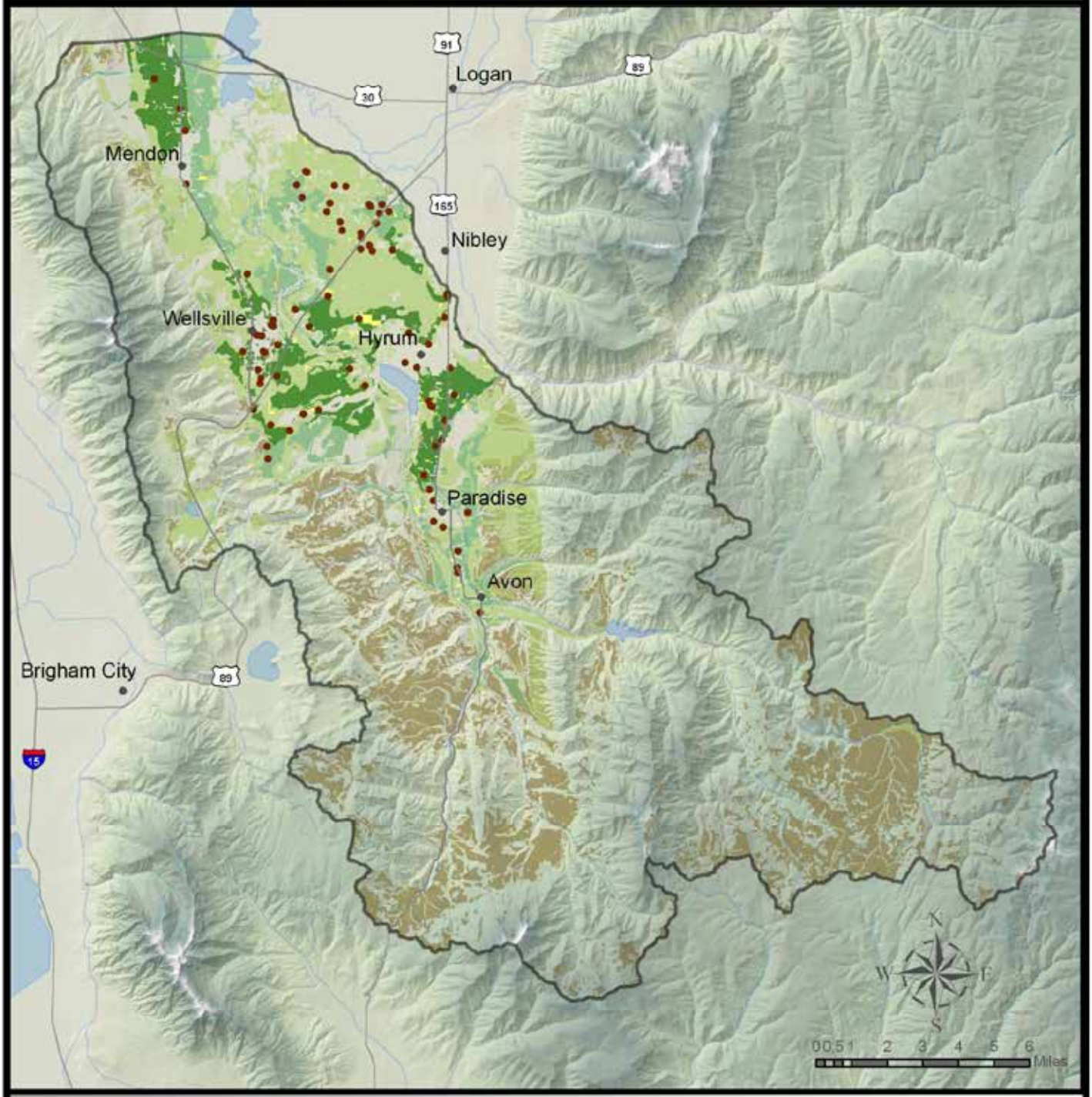


- Dairies
- Farmsteads
- Prime Farmland with Longest Growing Season
- Prime Farmland
- Farmland of Statewide Importance
- Potential Grazing Land

Prime farmland, as defined by the USDA, is land that has the best combination of physical and chemical characteristics for producing crops. This land is not urban or water areas. Farmland of statewide importance is determined by State Agencies. Potential grazing lands are areas of adequate forage and stable slopes.

Agriculture - Tier 3

LBRW



- Dairies
- Farmsteads
- Prime Farmland with Longest Growing Season
- Prime Farmland
- Farmland of Statewide and Local Importance
- Potential Grazing Land

Prime farmland, as defined by the USDA, is land that has the best combination of physical and chemical characteristics for producing crops. This land is not urban or water areas. Farmland of statewide importance is determined by State and Local Agencies. Potential grazing lands are areas of adequate forage and stable slopes.

Public Safety

Arguably the most important landscape features to regulate for public safety are those with potential natural hazards. Natural hazards can pose a risk to public health, safety, and welfare through the possibility of destruction to property and even human life. Some potential natural hazards in the Little Bear River watershed are geological hazards in the form of steep slopes, fault lines, and loose soils prone to liquefaction. Flooding hazards can exist anywhere in the flood plain and is also a risk in areas with shallow water tables. Wildfires are potential hazards anywhere urban development encroaches upon undeveloped mountains and hillsides, although certain types of vegetation may increase the risk. By avoiding development in these areas, harm to human life and property can be greatly reduced.

Earthquake Damage, Logan 1962, USU Special Collections

Geological Hazards

The Cache Valley is bounded on both sides by fault lines. This normal faulting has lifted mountains and lowered the valley, resulting in unique natural beauty as well as potential risks to development (Liddell and Ohlhorst, 2005). In the event of a major earthquake, besides the initial effect of shaking on development, loose soils could also result in landslides or structures sinking due to liquefaction. Furthermore, the steep slopes inherent to mountainous regions impose a certain degree of risk of landslides or avalanche potential.

Earthquakes and Fault Zones

An earthquake is basically a rupture or slip of rock along a fault caused by excessive forces within the earth's crust. This ground shaking, especially the horizontal forces, can be very destructive, particularly to older structures (Christenson, 1994). Earthquakes may also cause flooding, which will be discussed later (BRAG, 2004). Considering the fact that Cache Valley falls in a high threat area for earthquakes relative to other areas in Utah, according to the Uniform Building Code seismic zone map, necessary precautions must be taken into consideration (Christenson, 1994). Cache County only permits building in earthquake zones after careful review and approval of an engineering geotechnical report (County Code 17.18.020).

For the purposes of the model, only the quaternary (recent or active) faults were used (Evans, 2007b). Since subsidiary faults can sometimes break loose, a set-back ordinance precludes development within fault zones. Growth within these zones would require further study prior to actual development (Evans, 2007a). Since determining specific distances for set-backs is uncertain, Tier 1 uses a 15m (roughly 50ft) buffer around fault lines, while Tiers 2 and 3 employ a 30m (roughly 100ft) buffer zone.

Steep Slopes

The Little Bear River Watershed covers extremely steep terrain. The Wellsville Mountains, for instance, are touted as the steepest in the world (Liddell and Ohlhorst). The Governor's Office of Planning and Budget (2005) defines steep slopes as "land with a slope angle of 20% or greater for a minimum of 30 feet horizontally." Areas with these steep slopes require great expense to develop and maintain, and involve significant risk in the form of landslides, slope failure, avalanches, and erosion. In addition to the individual risk and expense involved, steep slopes also strain public funds through road maintenance and other services (GOPB, 2005). In Utah, slopes over 30% are restricted, and in Cache County, slopes over 20% must be legally approved prior to any development being permitted (Envision Utah, 2002; Cache County Code 17.18.060).

Since the percentage of slope upon which development is acceptable varies among ordinances and guidelines (e.g. see Toth et al, 2005; GOPB, 2005; Envision Utah, 2002), Tier one restricts development on any slope greater than 30%, Tier 3 restricts growth on any slope greater than 20%, and Tier 2 takes the middle ground, restricting slopes greater than 25%.

Flooding Potential

Flooding is a temporary overflow of water into areas that are not normally inundated with water. This inundation causes considerable property damage and may also disrupt communications, transportation, electric service, and other community damage (BRAG, 2004). Most flood damage occurs in the floodplain, the low-lying areas adjacent to a river (GOPB, 2005). In Utah, the whole floodplain is usually restricted due to the extreme damage that can be caused to property, and in some cases human life, as homes become inundated with flood water (Envision Utah, 2002; GOPB, 2005). Cache County code states that any structures built in a floodplain "shall provide an elevation certificate from a state certified surveyor and be approved by the county floodplain manager" (Cache County Code 17.18.060).

In addition to property damage that may occur as a result of flooding, ecological problems may result which also affect the public health, welfare, and safety. Sewage and septic systems may overflow or rupture, carrying contaminants into streams, lakes, and groundwater (GOPB, 2005).

Since flooding poses a legitimate risk every spring, as well as during various other times throughout the year, the FEMA floodplain was included in all tiers in this model. Due to the geological hazards that also exist in the watershed, it is important to note the areas that could be flooded during an earthquake due to dam breeches, ruptured pipelines or aqueducts, disrupted canals or streams, and damaged water tanks in planning any developments on or near the floodplain (BRAG, 2004).

Liquefaction Potential

When water-saturated sand soils that lack cohesion are subject to ground shaking, liquefaction occurs. Liquefaction causes these soils to lose strength and bearing capacity and behave more like a viscous liquid. This gives the soil properties similar to quicksand, causing buildings to settle or tip and subterranean structures that are light or buoyant, such as buried storage tanks, to float upward. Liquefaction occurs when soils that are susceptible to liquefaction experience strong shaking, such as during earthquakes of magnitude 5.0 or greater (BRAG, 2004). This obviously involves significant potential damage to life, property, and public health. However, due to relatively rare occurrences, only moderately high liquefaction potential is listed in Tier 2, and the less likely medium liquefaction potential is added to Tier 3.

Wildfire Potential

Wildfires are uncontrolled fires that spread through relatively undeveloped, and often public, lands (GOPB, 2005). Wildfires often begin unnoticed, and as they quickly spread through vegetative fuel, they can expose or consume structures (BRAG, 2004). With a trend of residential developments expanding into wildland environments throughout the west, structures are increasingly being placed near large amounts of burnable vegetations. Structures in these areas are prone to destruction from either the fire itself, or from the landslides, mudflows, and flooding that often follows fires (GOPB, 2005).

Wildfires can be expensive to fight; in 1996 alone the cost to fight fires in Utah was $22 million (USU Extension). In addition to being costly, fighting wildfires can be risky as well. The best strategy is mitigation by avoiding the development of areas adjacent to thick stands of trees and undergrowth (GOPB, 2005).

Using the Bureau of Land Management's (BLM) Statewide Fire Risk Assessment Data (1998), fire risk data was extracted for the Little Bear River Watershed. Using the BLM's risk categories, Tier 1 shows areas of "extreme" fire potential, Tier 2 shows both "high" and "extreme" fire potential, and Tier 3 includes all medium to extreme fire potential. Areas covered by both steep slopes and fire potential appear with a "hatch" pattern, since these areas may also be prone to landslides and flooding, or be difficult for emergency vehicles to access.

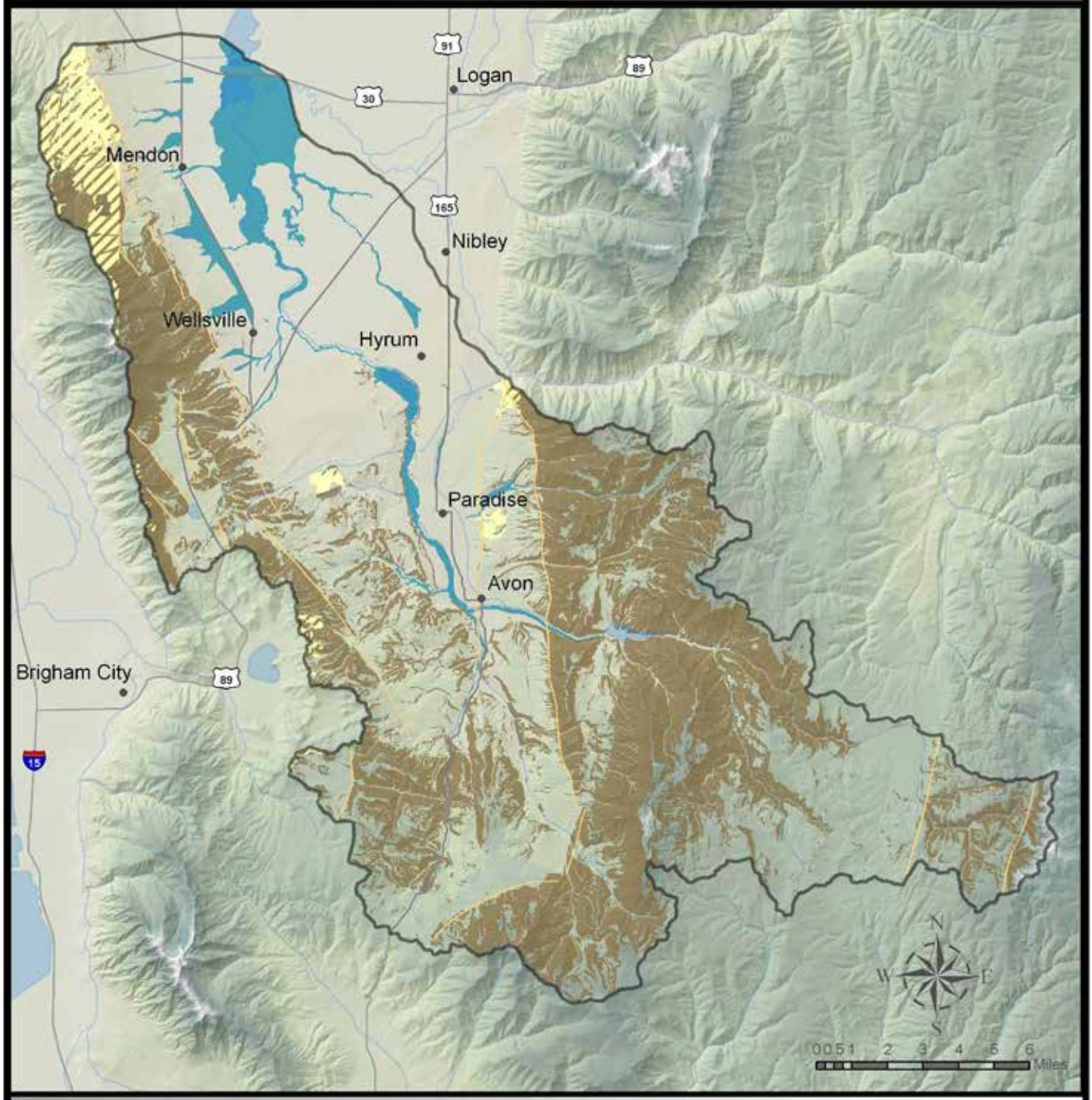
www.ffsl.utah.gov/Graphics/fire/NewHarmony.jpg

Soil Suitability

Because soil properties can affect the development of building sites, it is necessary to also analyze soil conditions of the watershed when planning growth. Because many of these limiting risks can be mitigated or overcome through design and installation techniques, only Tier 3 reflects the soils that may be unsuitable for development. For the soils layer, only soils deemed "very limited" for dwellings with basements by the Natural Resources Conservation Service (NRCS) were included in the model. "Very limited" indicates the area contains one or more features that are unfavorable for the specified use. These limitations generally require major soil reclamation, special design, or expensive installation procedures to mitigate consequences such as flooding, shrink-swell, and unstable slopes (NRCS, 2005).

Public Safety - Tier 1

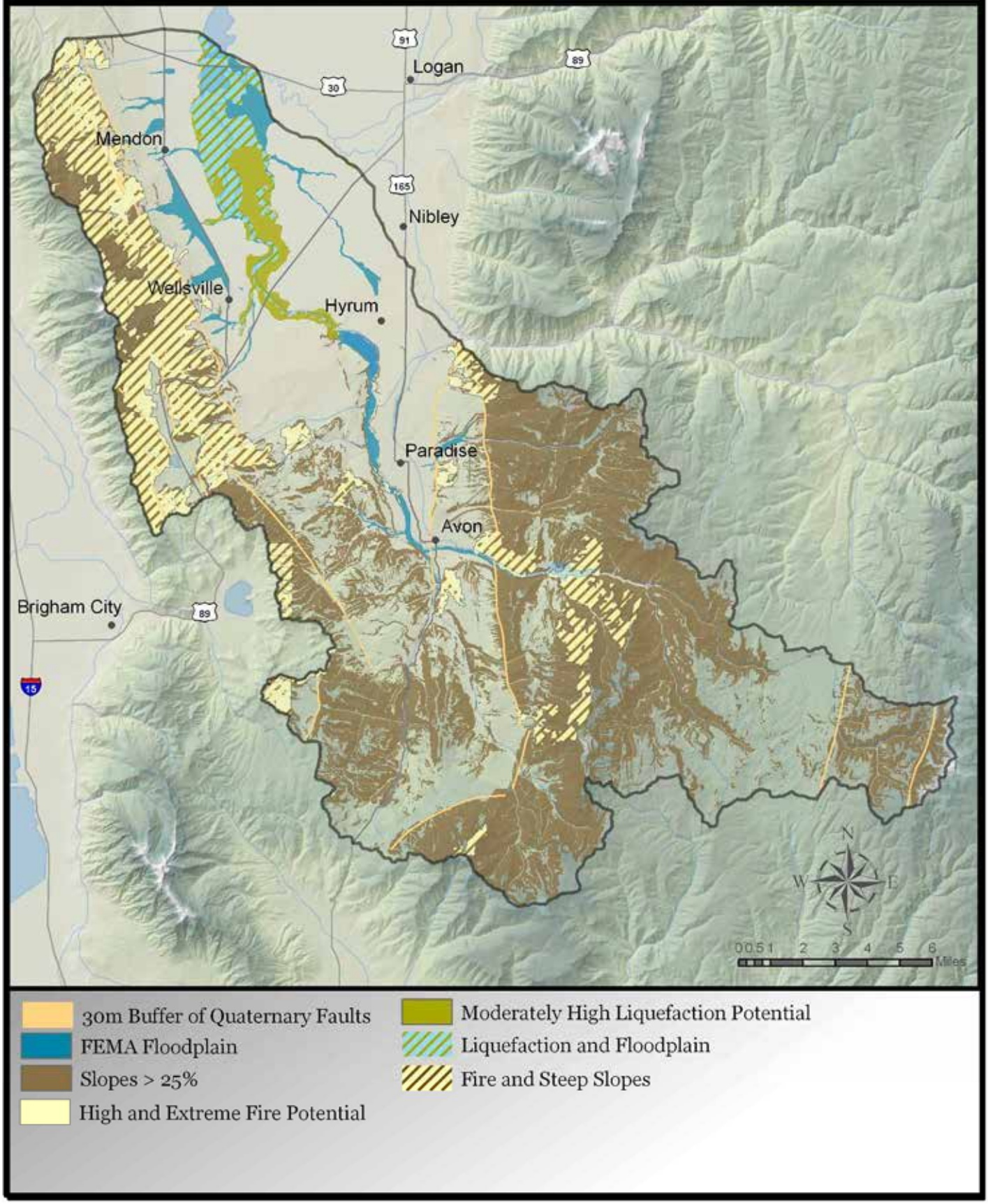
LBRW



15m Buffer of Quaternary Faults
Slopes > 30%
FEMA Flood Plain
Extreme Fire Potential
Fire and Steep Slopes

Public Safety - Tier 2

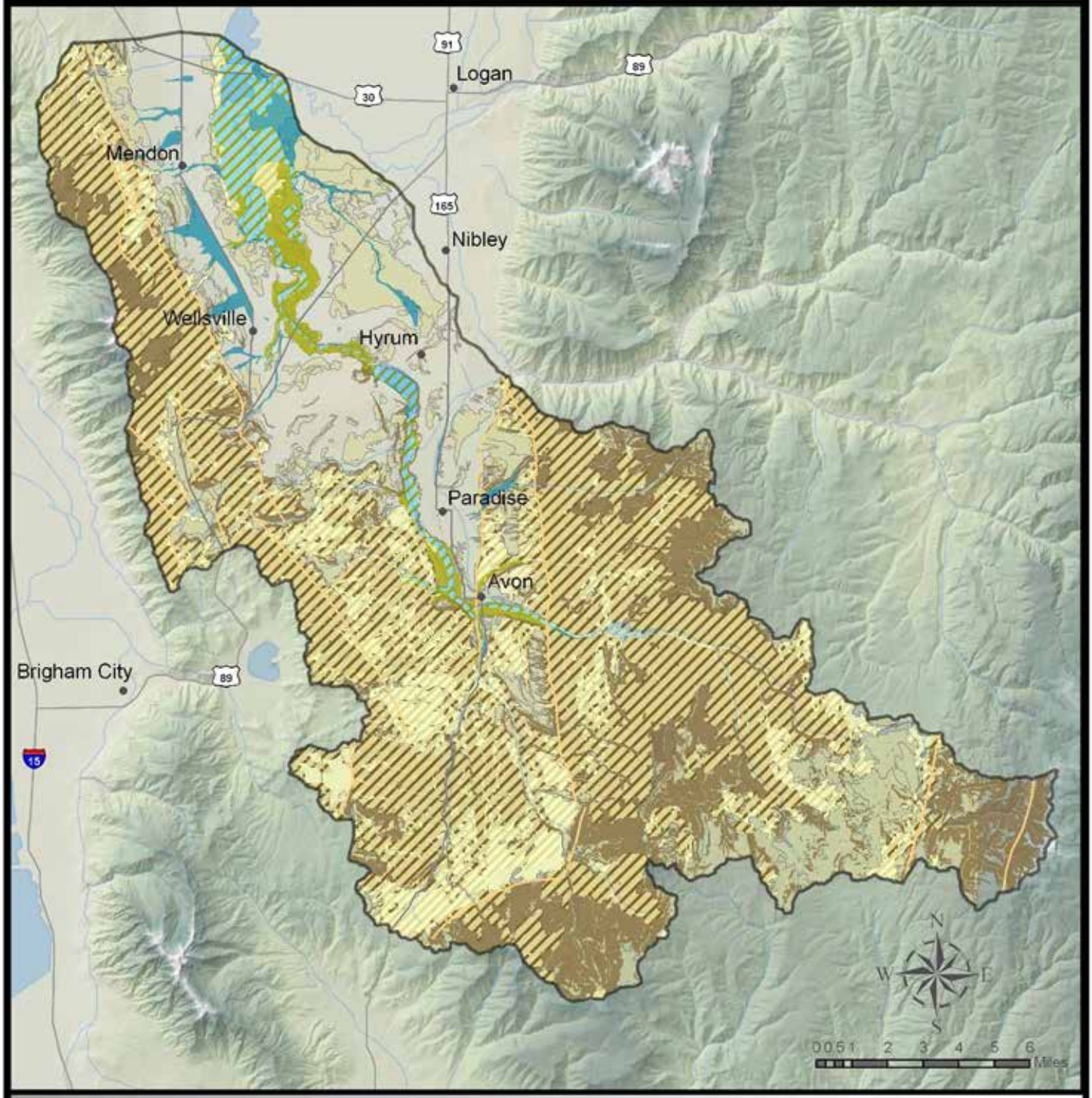
LBRW



30m Buffer of Quaternary Faults
FEMA Floodplain
Slopes > 25%
High and Extreme Fire Potential
Moderately High Liquefaction Potential
Liquefaction and Floodplain
Fire and Steep Slopes

Public Safety - Tier 3

LBRW



- 30m Buffer of Quaternary Faults
- FEMA Floodplain
- Slopes > 20%
- Medium to Extreme Fire Risk
- Very Limited Soils
- Medium to High Liquefaction
- Liquefaction and Floodplain
- Fire and Steep Slopes
- Very Limited Soils and Fire Potential

Wildlife

The Little Bear River Watershed contains a variety of wildlife that plays an important role in recreation, the area's identity, and ecological and biological systems. While habitat for every species cannot be identified, representative species from different groups of species act as surrogates and provide an umbrella of habitat necessary for a healthy ecosystem.

In modeling wildlife, it was determined that two types of wildlife models could be made. The first model focuses on the ecological health of the watershed. Habitat specialists such as voles and raptors (such as hawks or owls) act as indicators of habitat health. Their habitat represents some of the most critical areas of vegetation in the watershed (MacMahon, 2007).

The other model deals with those species that stand out for their recreational value. Native species such as grouse, mule deer, and rocky mountain elk, along with introduced species such as the ring-necked pheasant and chukar partridge offer hunters and wildlife enthusiasts a variety of opportunities for interacting with wildlife in many different settings within the watershed.

Some habitat features, such as the availability of water and the lack of development are critical for a majority of species. For this reason, riparian zones are included in both models to provide corridor systems to facilitate species movement and to protect life-sustaining aquatic systems (Beard, 2006; Baird, 2006).

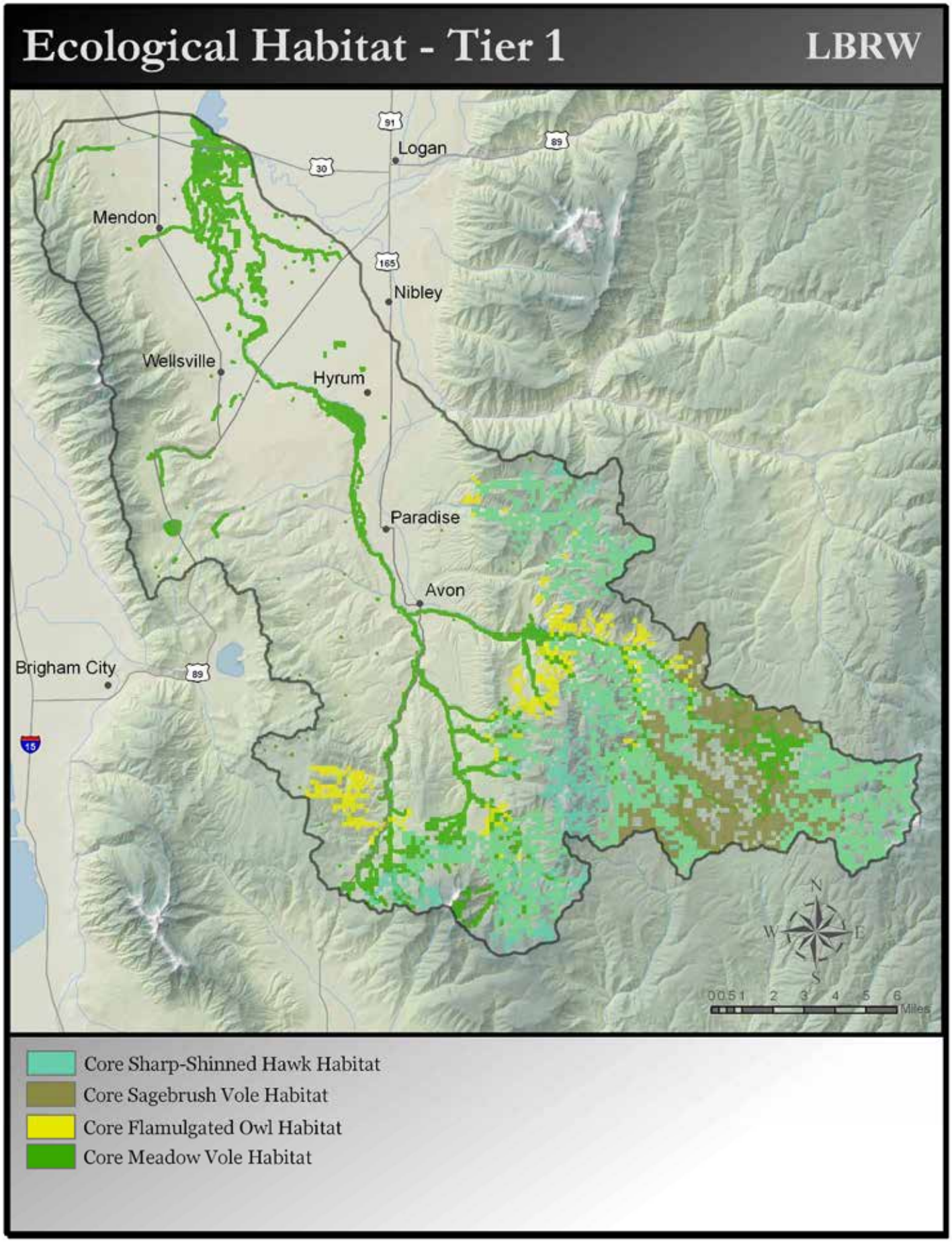
Ecological Habitat

To determine the ecologically significant habitat, Southwest Regional Gap Analysis (SWReGAP) data was used to determine vegetation types suitable to the sagebrush vole, meadow vole, sharp shinned hawk, and flamulgated owl. Since many small, isolated habitat patches were found throughout the watershed, these habitat areas were tiered by the area of contiguous habitat that existed (MacMahon, 2007). Tier one represents only the largest patches of contiguous, or core, habitat. Tiers two and three include increasingly smaller patches of contiguous habitat.

Recreational Species

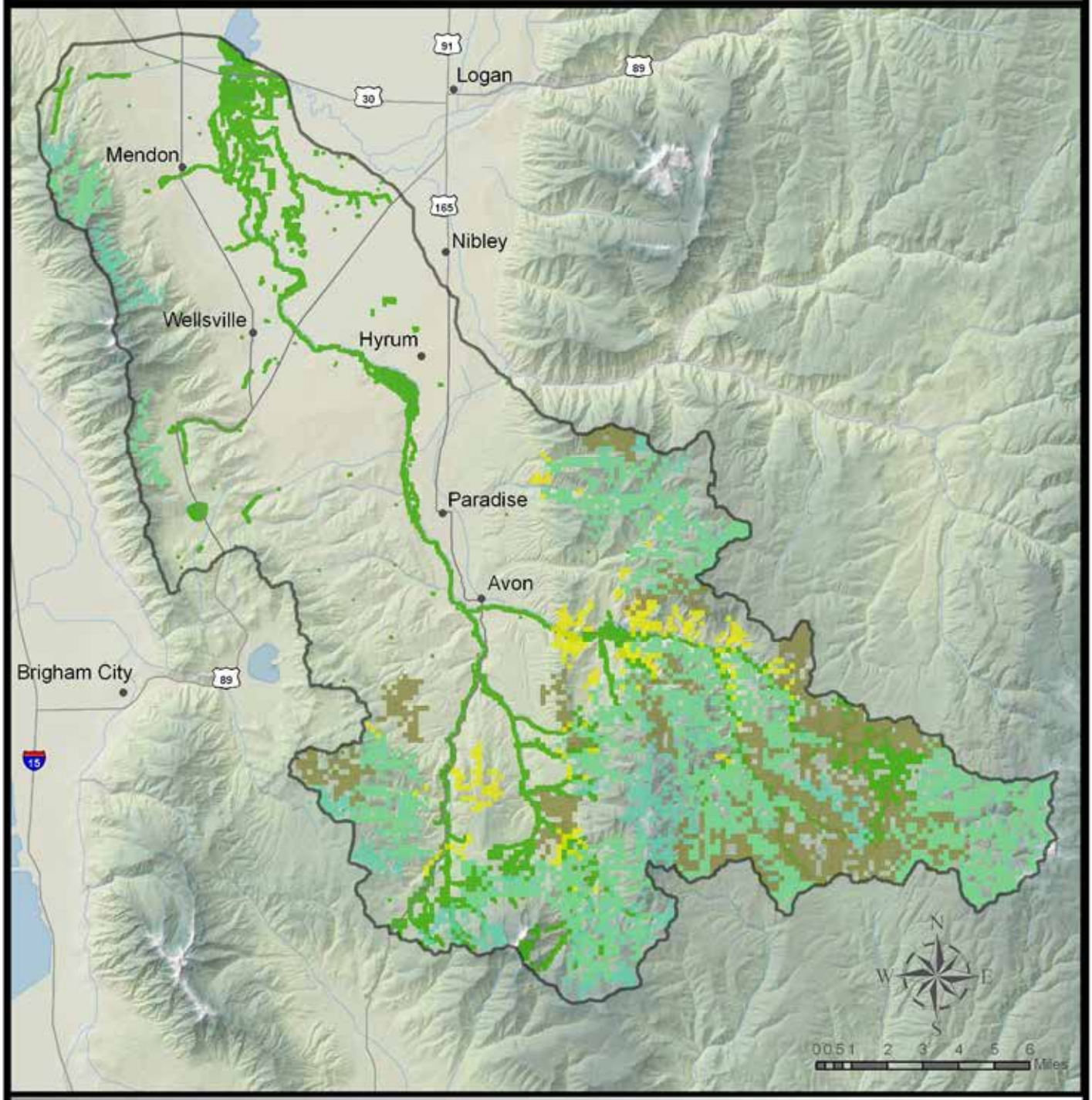
While the ecological habitat model covers much of the critical wildlife habitat in the watershed, it is not specific to the recreationally significant species that are prized by residents within the watershed and throughout the state. While protecting this entire habitat range would require more acreage, it is an investment that could pay large dividends through tourism dollars and recreation-based retail.

The model was created by overlaying the individual ranges of the following species: mule deer, rocky mountain elk, moose, sagebrush grouse, blue grouse, ruffed grouse, sharp-tailed grouse, chukar partridge, ring-necked pheasant, and riparian areas to represent fish and waterfowl species. Tier 1 represents habitat that is used by at least five of the listed species. Tier 2 represents habitat that is used by at least four of the listed species. Tier 3 also includes prime farmland since pheasant, the most popular game bird among Utah hunters, are limited to agricultural lands (Rawley et al., 1996).


Ecological Habitat - Tier 1
LBRW
Logan
Mendon
Nibley
Wellsville
Hyrum
Paradise
Avon
Brigham City
91
89
30
165
15
N
W
E
S
0 0.5 1 2 3 4 5 6
Miles
Core Sharp-Shinned Hawk Habitat
Core Sagebrush Vole Habitat
Core Flamulgated Owl Habitat
Core Meadow Vole Habitat

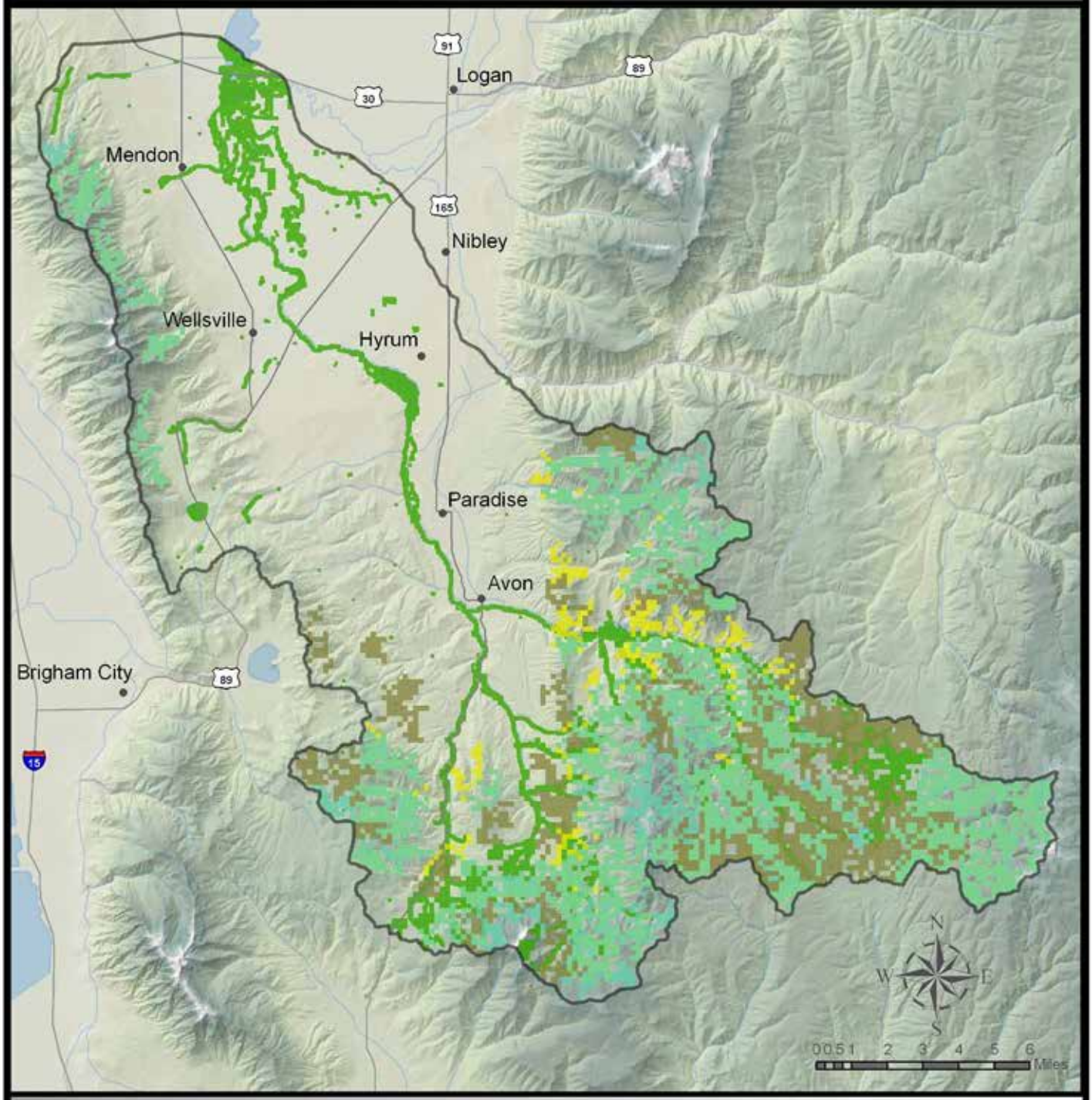
Ecological Habitat - Tier 2

LBRW



- Core Sharp-Shinned Hawk Habitat
- Core Sagebrush Vole Habitat
- Core Flamulgated Owl Habitat
- Core Meadow Vole Habitat

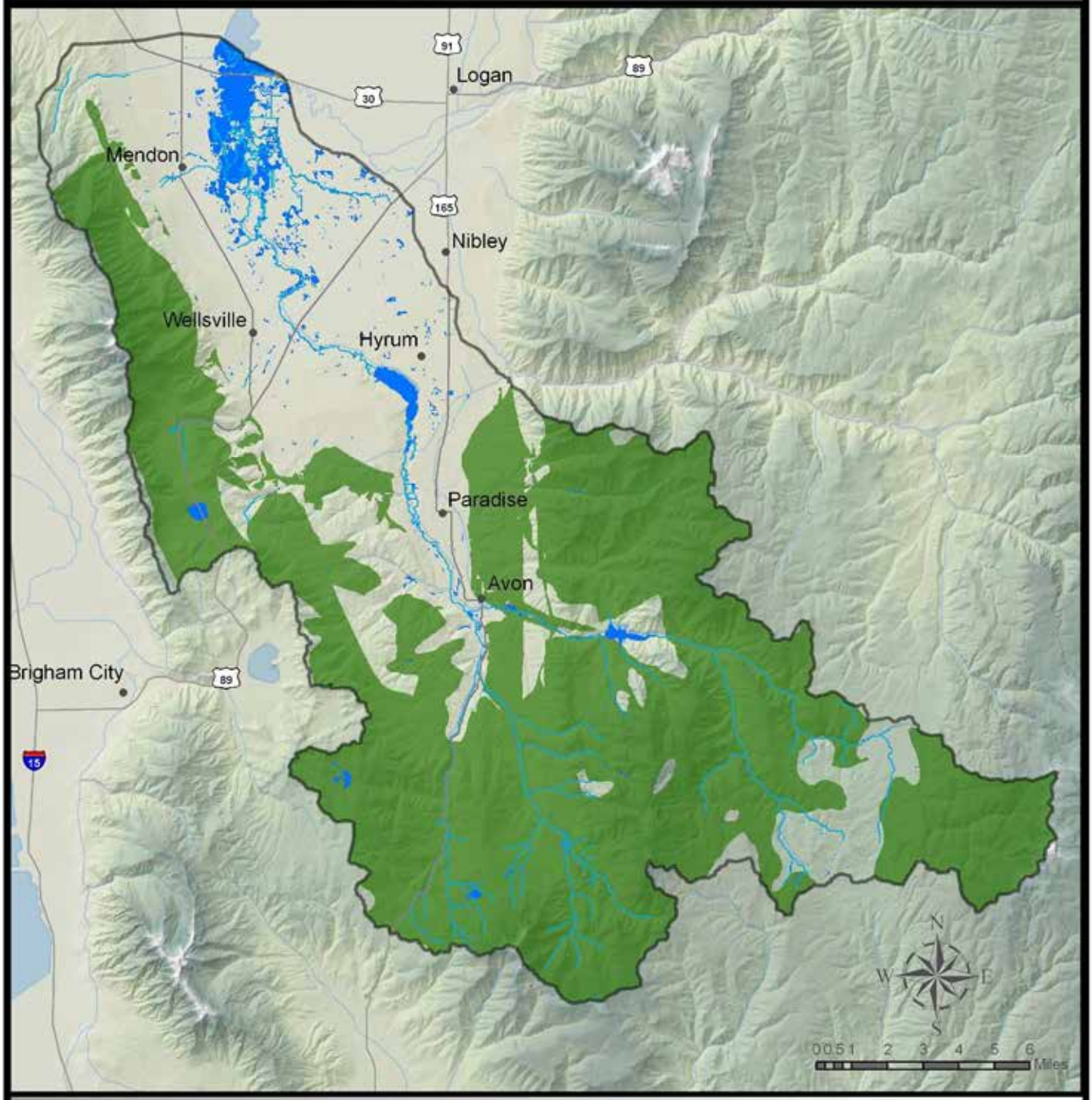
Ecological Habitat - Tier 3 LBRW



Core Sharp-Shinned Hawk Habitat
Core Sagebrush Vole Habitat
Core Flamulgated Owl Habitat
Core Meadow Vole Habitat

Recreational Wildlife - Tier 1

LBRW



30m Buffer of Streams

Water Bodies; Lakes and Wetlands

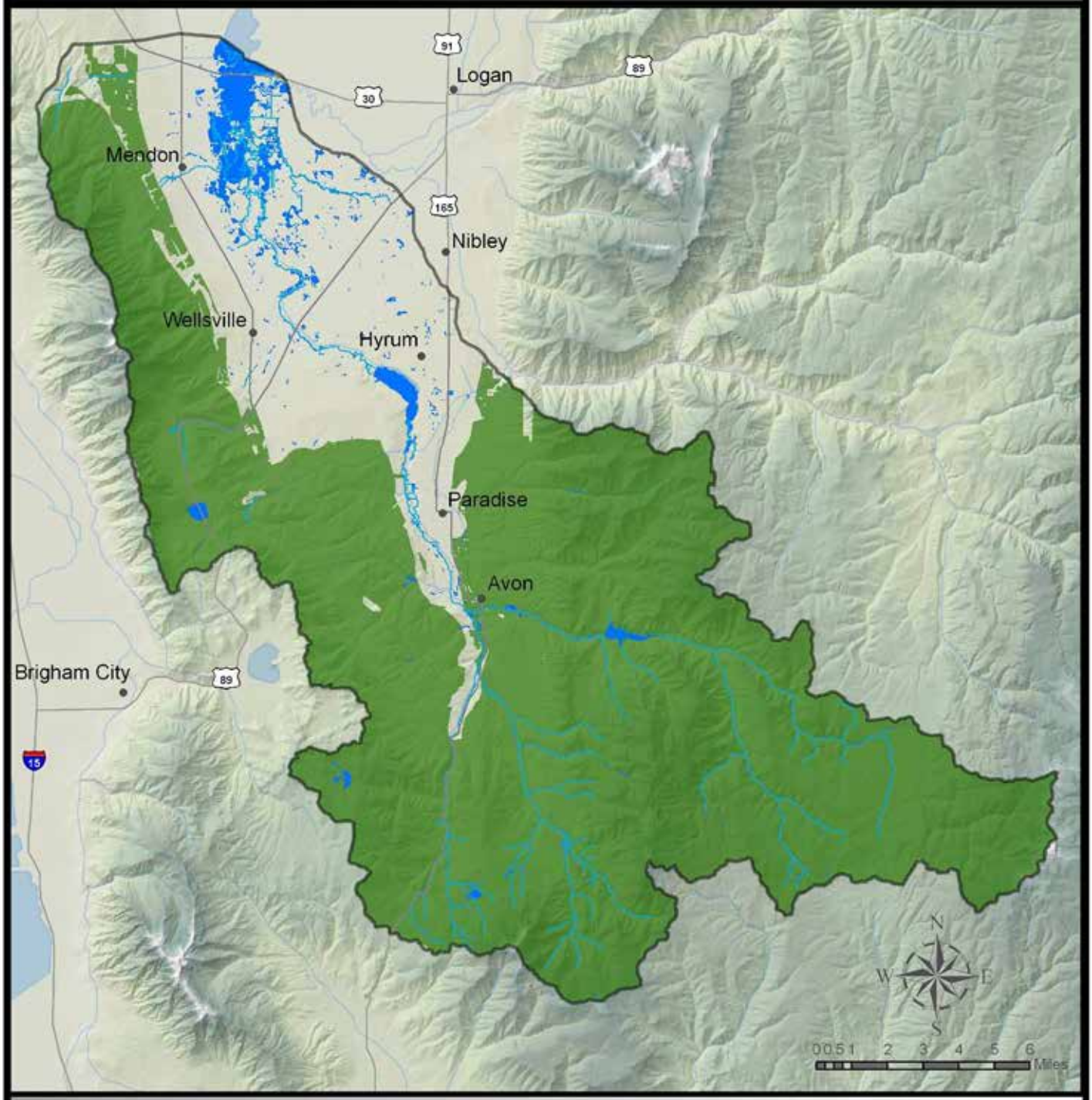
Habitat of More than 5 Recreational Species

Species Used:

Blue Grouse, Chukar, Elk, Moose, Mule Deer, Pheasant (prime ag land), Ruffed Grouse, Sharp-Tailed Grouse; Wetlands and Streams represent fish and water-fowl habitat

Recreational Wildlife - Tier 2

LBRW



30m Buffer of Streams

Water Bodies; Lakes and Wetlands

Habitat of More than 4 Recreational Species

Species Used:

Blue Grouse, Chukar, Elk, Moose, Mule Deer, Pheasant (prime ag land), Roughed Grouse, Sharp-Tailed Grouse; Wetlands and Streams represent fish and water-fowl habitat

Recreational Wildlife - Tier 3

LBRW

30m Buffer of Streams

Water Bodies; Lakes and Wetlands

Habitat of More than 4 Recreational Species Plus Agriculture Tier 1

Species Used:

Blue Grouse, Chukar, Elk, Moose, Mule Deer, Pheasant (prime ag land), Roughed Grouse, Sharp-Tailed Grouse; Wetlands and Streams represent fish and water-fowl habitat

Recreation

With so many impressive landscape features in the Little Bear River Watershed, year-round recreational opportunities abound. From the pristine peaks of the Naomi Wilderness area to the wetlands of the lower Little Bear River, the watershed offers a myriad of diverse opportunities for enjoying the outdoors. Nearly every undeveloped acre in the watershed holds at least a degree of potential for recreational use. In selecting areas of potential recreation, however, criteria were used to determine the areas that would be the most suitable for designation as recreation areas.

Tier One

The model was created by first analyzing prime land for recreation. While even the most challenging terrains and diverse vegetation types can be amenable to recreation, for the purposes of this model, prime recreation only included slopes less than 15% and areas with trees (Steinitz and Allen, 1979). For camping, flat (less than 3%) slopes with trees were considered most prime. Both were modeled only for areas within 400m (1/4 miles) from the road.

Due to their general popularity, rivers and streams were included with a 30m buffer, to include riparian habitat and areas for trails and camping. Lakes and wetlands were included for their potential as fishing, wildlife watching, and other water sport areas. Cache County's proposed Bonneville Shoreline Trail was included as a primary route for non-vehicular travel. Other areas that offer good potential for trails and camping are the many canyons surrounding the valley. Entrances to these canyons could be ideal areas for trailheads or small parks. Only those canyons with slopes primarily less than 20% were included.

Since floodplains are considered problematic for development, floodplains were included as possible candidates for parks or other recreation areas. Lastly, the Naomi Wilderness area and state and federal public lands were included due to their general accessibility and openness.

Recreation Nodes

Since many of these recreational landscape features overlapped, these recreational "nodes" were mapped to show areas with multiple uses. In most instances these nodes occur in canyons with flowing water. For Tier 1, only areas with more than four overlapping features are considered.

Tier 2

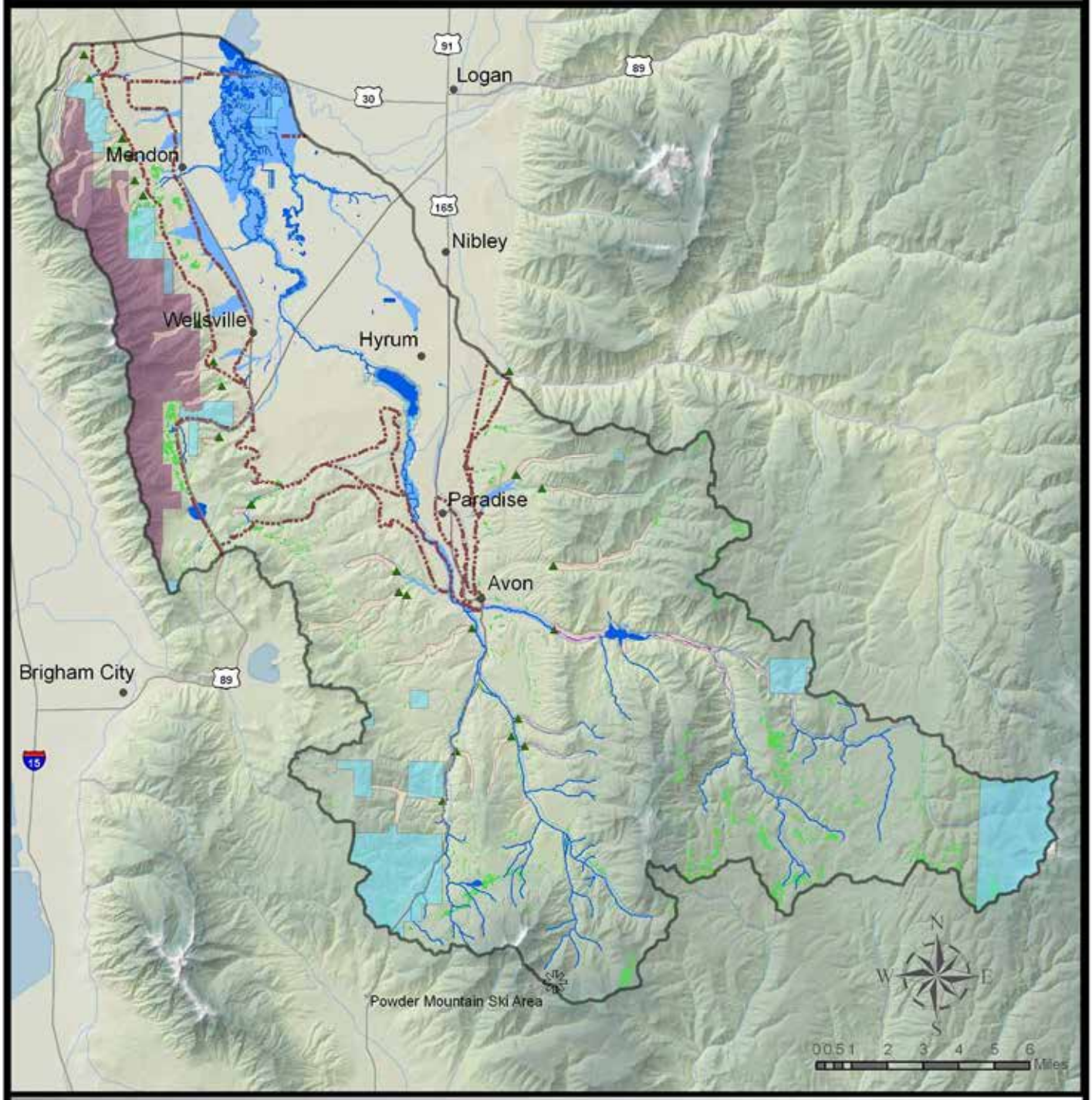
Tier 2 follows many of the same guidelines as Tier 1. However, Tier 2 also includes all flat (less than 3%) areas within 400m (1/4 mile) of roads as areas for camping if they are not currently used for agriculture, development, or water.

Tier 2 also includes Cache County's proposed city trails as areas along which recreation could be ideal. For the recreational nodes, areas with three or more overlapping features were mapped.

Tier 2 also recognizes the significance of recreationally important wildlife species. To accomplish this, Tier 1 of the Recreational Wildlife model was used. The species included are blue grouse, ruffed grouse, sharp-tailed grouse, ring-necked pheasant, chukar, mule deer, rocky mountain elk, and moose.

Recreation - Tier 1

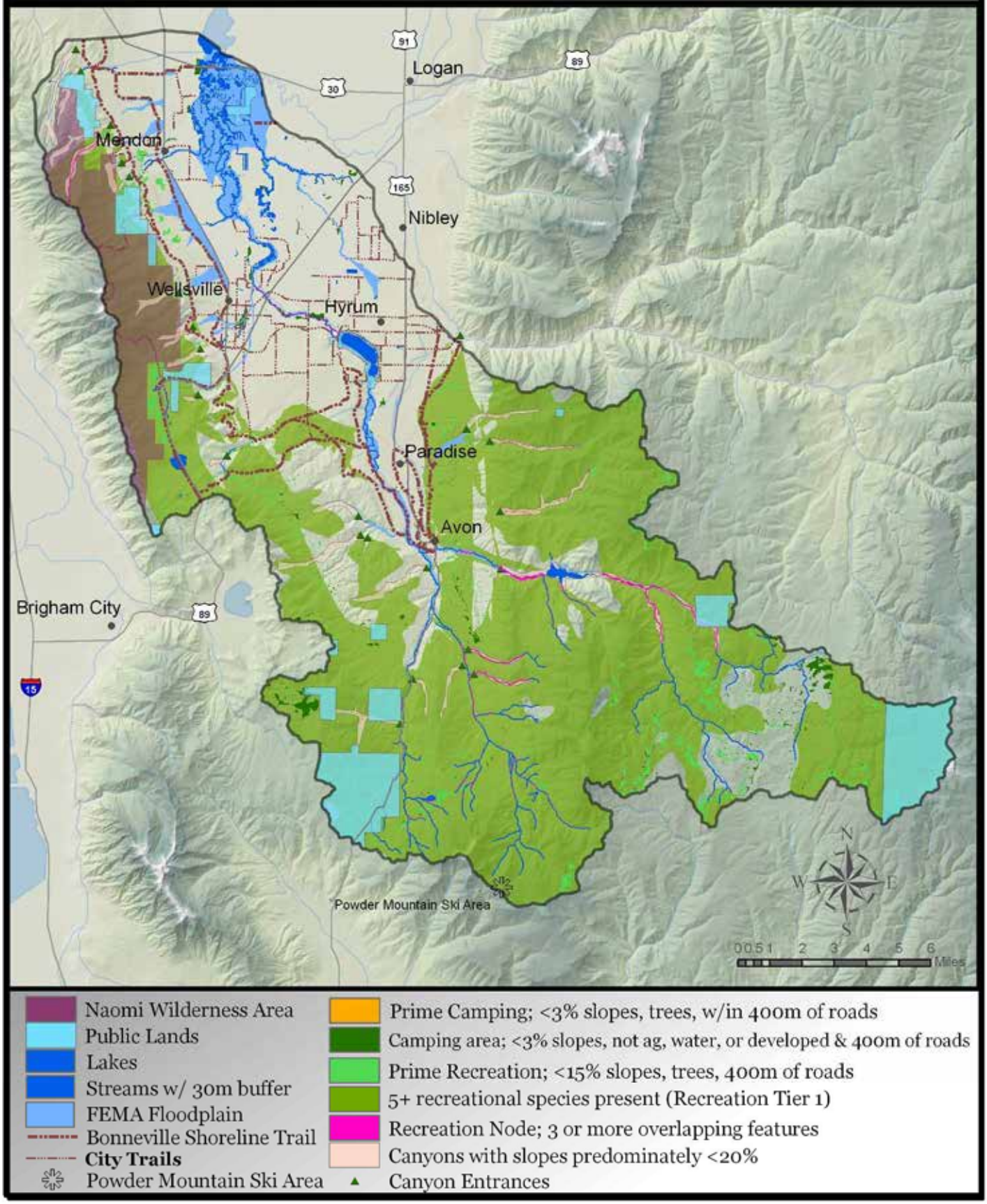
LBRW



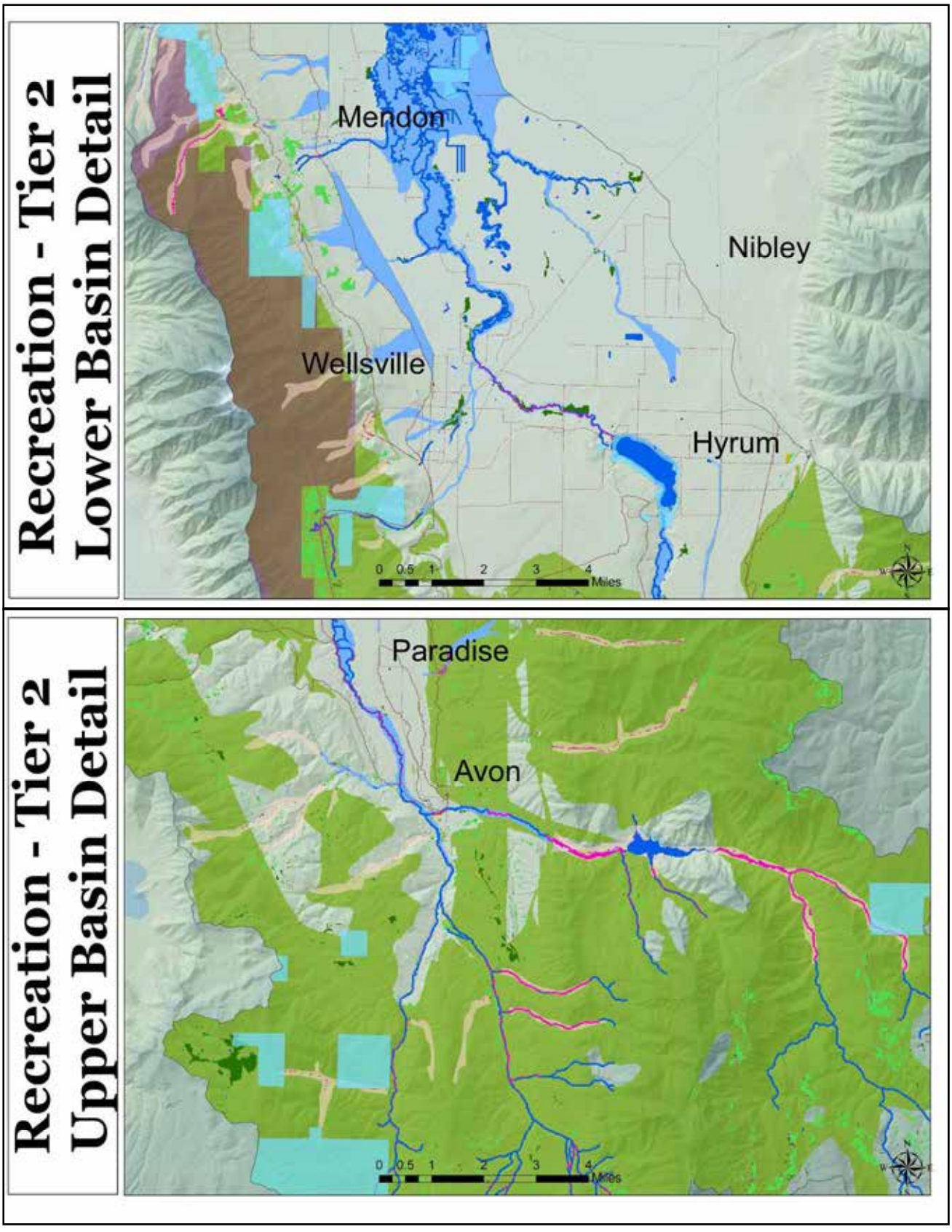
- Naomi Wilderness Area
- Public Lands
- Lakes
- Streams w/ 30m buffer
- Bonneville Shoreline Trail
- Powder Mountain Ski Area
- FEMA Floodplain
- Good Camping; <3% slopes, trees, w/in 400m of roads
- Prime Recreation; <15% slopes, trees, 400m of roads
- Canyon Entrances
- Canyons with slopes predominately <20%
- Recreation Node; 4 or more overlapping features

Recreation - Tier 2

LBRW



- Naomi Wilderness Area
- Public Lands
- Lakes
- Streams w/ 30m buffer
- FEMA Floodplain
- Bonneville Shoreline Trail
- **City Trails**
- Powder Mountain Ski Area
- Prime Camping; <3% slopes, trees, w/in 400m of roads
- Camping area; <3% slopes, not ag, water, or developed & 400m of roads
- Prime Recreation; <15% slopes, trees, 400m of roads
- 5+ recreational species present (Recreation Tier 1)
- Recreation Node; 3 or more overlapping features
- Canyons with slopes predominately <20%
- Canyon Entrances



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Winter Recreation

With the long winters that epitomize Northern Utah, it is necessary to also consider opportunities for winter recreation. While many forms of winter. recreation surely exist, snowmobiling and cross-country skiing are the focus of this model. However, several other activities such as winter camping, dog sledding, and snowshoeing could also occur in these areas. Also, Powder Mountain is marked as the primary area for downhill skiing and snowboarding for the area

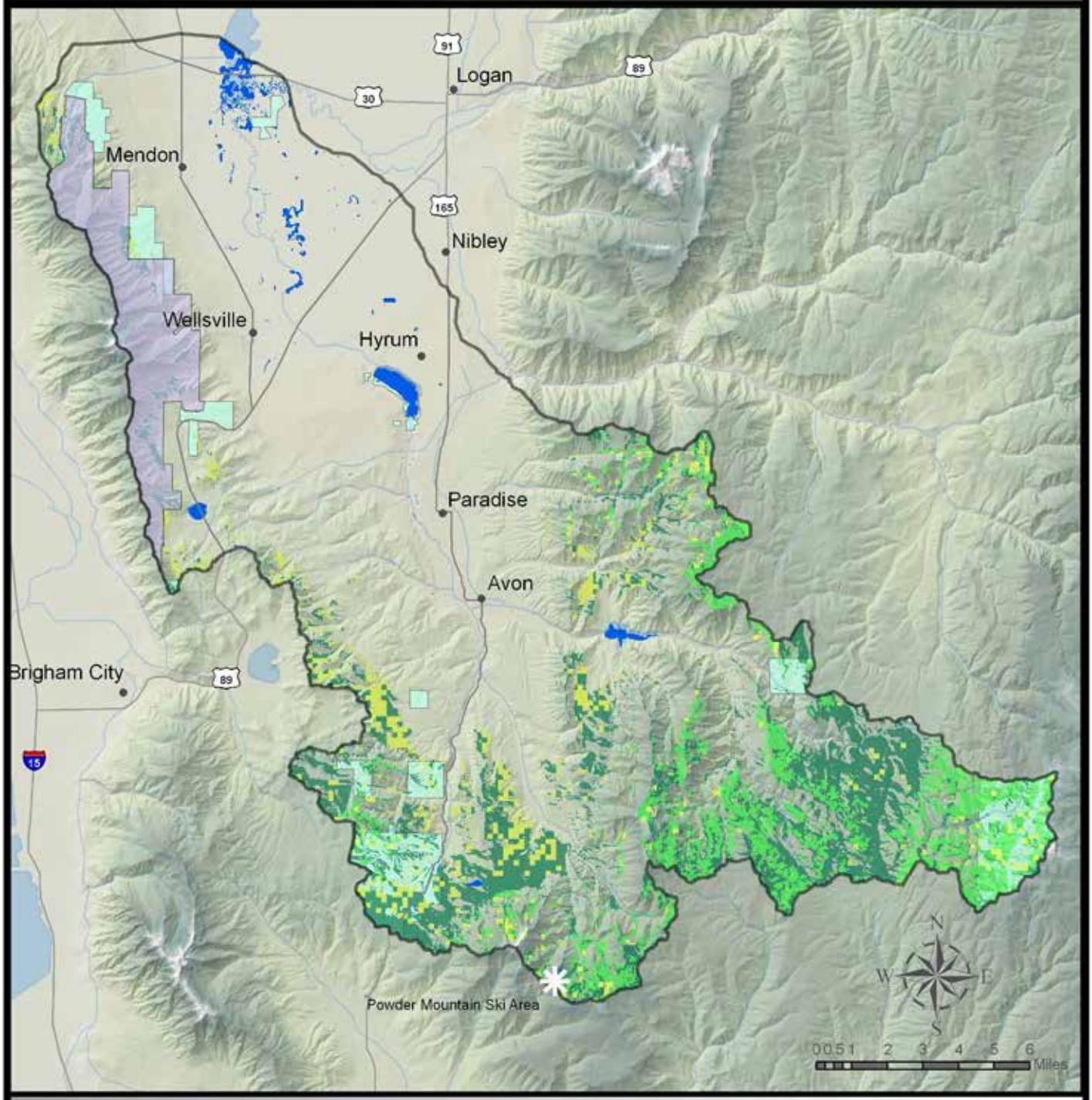
With help from Utah State's Kevin Kobe and Wally McFarlane of Nortic United, criteria were developed to determine the most likely areas for winter recreation. Since prolonged cold temperatures are necessary, the model uses elevations above 7000 feet or else north-facing slopes or canyons above 6000 feet. To ensure an aesthetically pleasing experience and protection

from the wind, elevations above 7000 feet also must be treed in order to be included. Lastly, only terrain less than 20 degrees in slope was included.

To determine suitability for snowmobiling, only areas above 7000 feet and not overlapping ecologically sensitive habitat (Ecological Habitat Tier 3) were included.

Winter Recreation

LBRW



Powder Mountain Ski Area
Lakes
Wilderness
>6000 ft elevation, north-facing slope or canyon < 20 degree slopes
Snowmobile Recommended, Not Ecological Habitat
>7000 ft elevation, < 20 degree slopes, trees
Public Lands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Alternative Futures

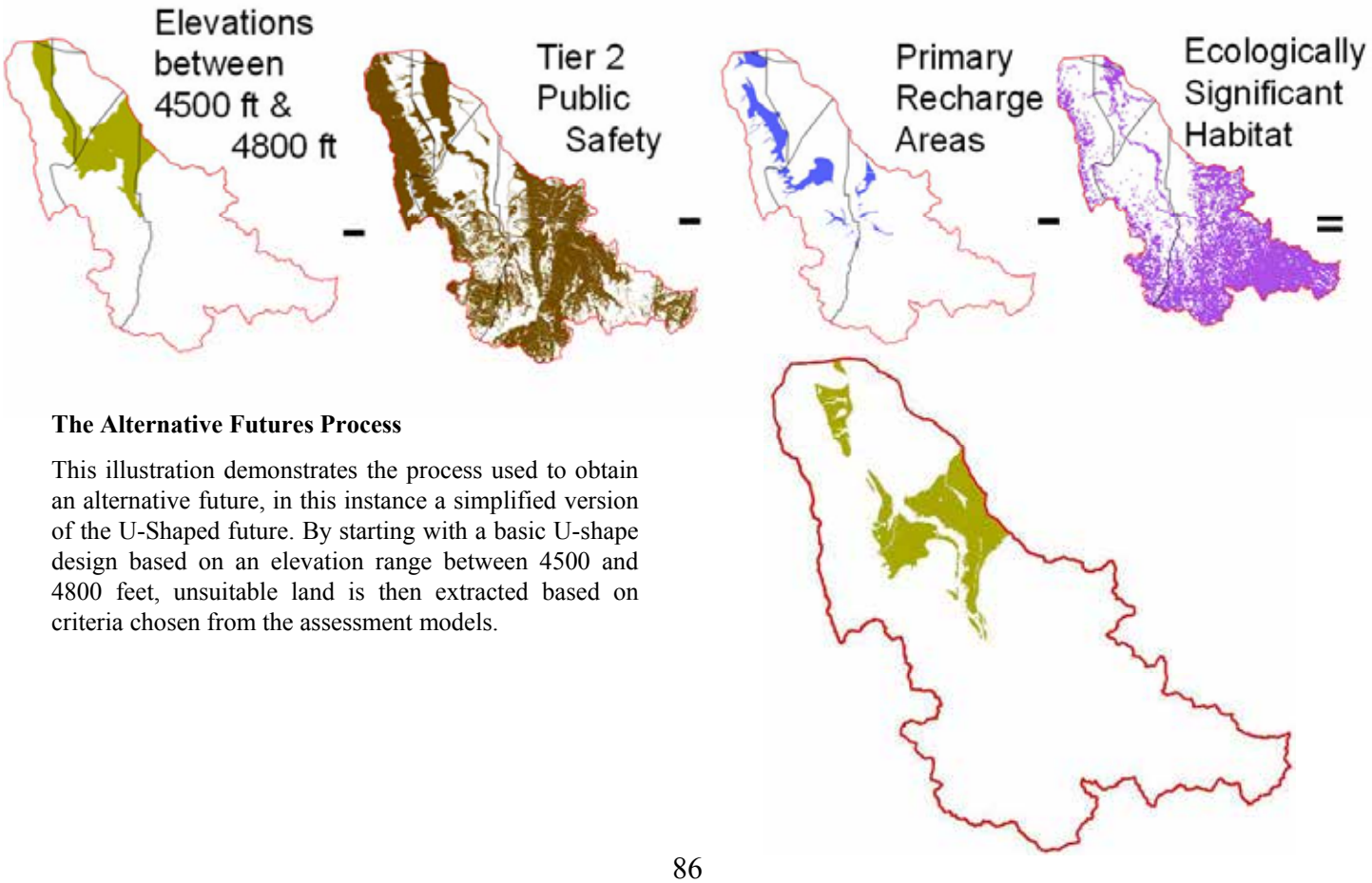
Once the assessment models have been created, it is then possible to determine how various growth patterns could affect, or be affected by, the biophysical or cultural factors. Using the assessment models, it becomes possible to ascertain which lands meet desired development criteria and which lands would be better suited for other uses.

By employing a combination of assessment models and creative design, alternative locations for development emerge depending on the criteria selected. By selecting more stringent criteria, such as in Tier 3 models, only prime areas for development surface. By selecting criteria that represent the values of the community, it is possible to model what the future of development would look like.

While the possible alternatives that could be created are virtually limitless, only six alternative futures are discussed here. These alternative futures are:

- Plan Trend: Business as Usual
- U-Shaped
- Recreation Focused
- Critical Lands
- Quality of Life
- Neo-Traditional

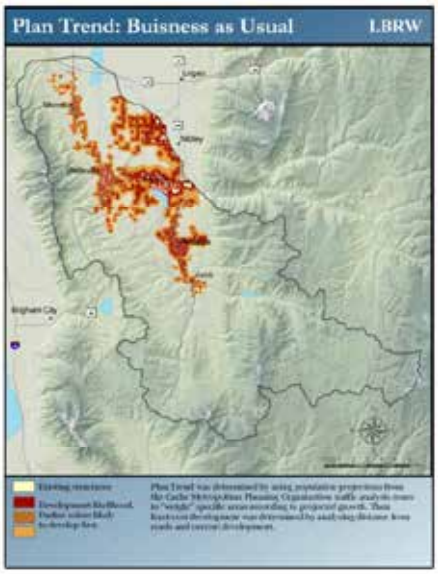
As their names imply, each alternative future focuses on different values. These values shape the criteria used, which results in vastly different outcomes. These alternative futures depict how very different the Little Bear River Watershed could appear depending on the choices made by citizens, planners, and commissioners.



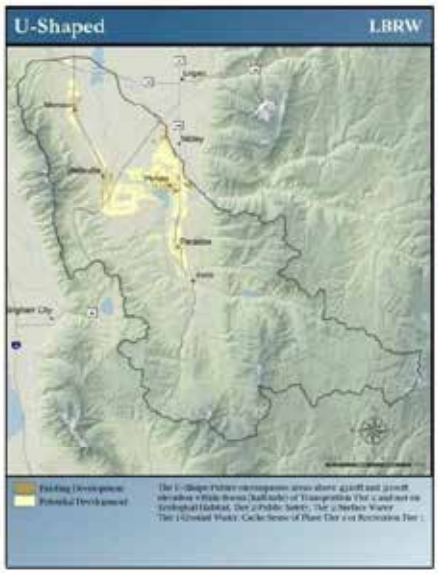
The Alternative Futures Process

This illustration demonstrates the process used to obtain an alternative future, in this instance a simplified version of the U-Shaped future. By starting with a basic U-shape design based on an elevation range between 4500 and 4800 feet, unsuitable land is then extracted based on criteria chosen from the assessment models.

Alternative Futures



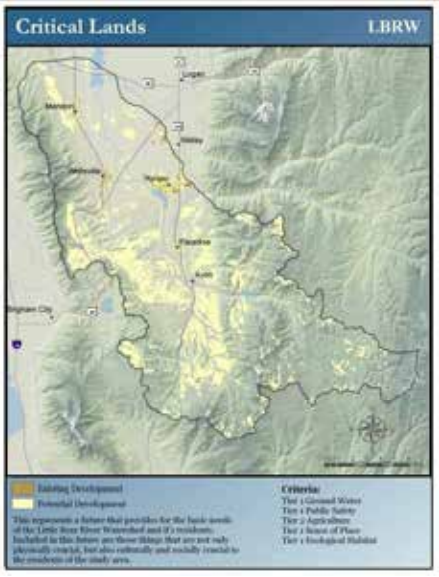
Plan Trend
Page 88



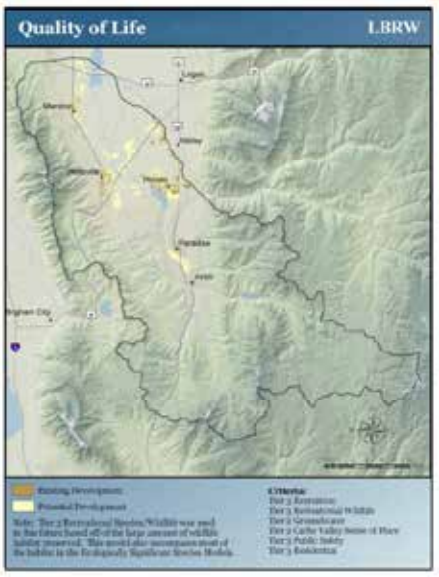
U-Shaped
Page 93

Recreation-Focused
Page 97

Neo-Traditional
Page 100



Critical Lands
Page 103



Quality of Life
Page 106

Without direction, it can be assumed that the development pattern will continue much as it has in the past. The Plan Trend: Business as Usual future shows what the Little Bear River Watershed development pattern may look like in thirty years barring any changes and without any planning steps taking place.

Plan Trend was determined by dividing the watershed into four population zones, using population projections from the Cache Metropolitan Planning Organization traffic analysis zones to "weight" specific areas according to projected growth. Then it was assumed that development would occur in areas of lowest economic net cost. The least-cost development was determined by analyzing distance from roads and current development.

While many other factors such as landowners' willingness to sell, surely influence growth and development, and any change in the status quo could greatly alter what the future would look like, the Plan Trend future depicts a good idea of what the Little Bear River Watershed could look like in 2030 according to the best available data.

Advantages:
This future offers relatively few advantages. It could, however, result in short-term economic gain, especially to landowners on the fringe of current development.

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Disadvantages:
As can be seen in many urban areas around the country, there are many disadvantages to unplanned sprawl. It consumes land and resources, especially farmland. Goods and services are scattered throughout the region, requiring elaborate road systems and almost complete reliance on the automobile. Lacking centers, this future produces excess congestion and waste. Even if the population remains sparse, nearly all of the landscape is developed. Without logical centers and mixed uses, mass transit would not be efficient or effective (Nelessen, 1994).


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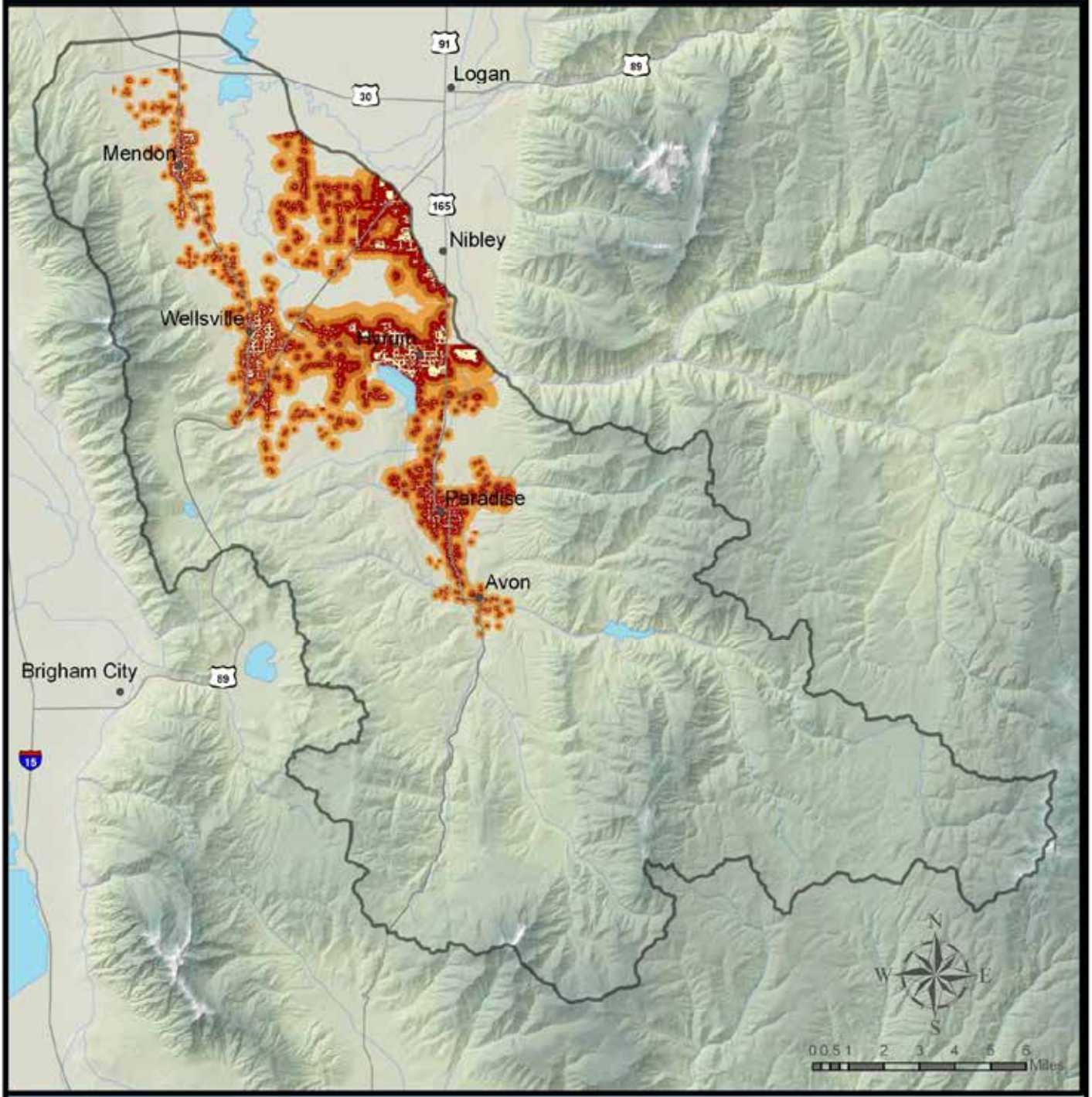
Plan Trend: Buisness as Usual

LBRW

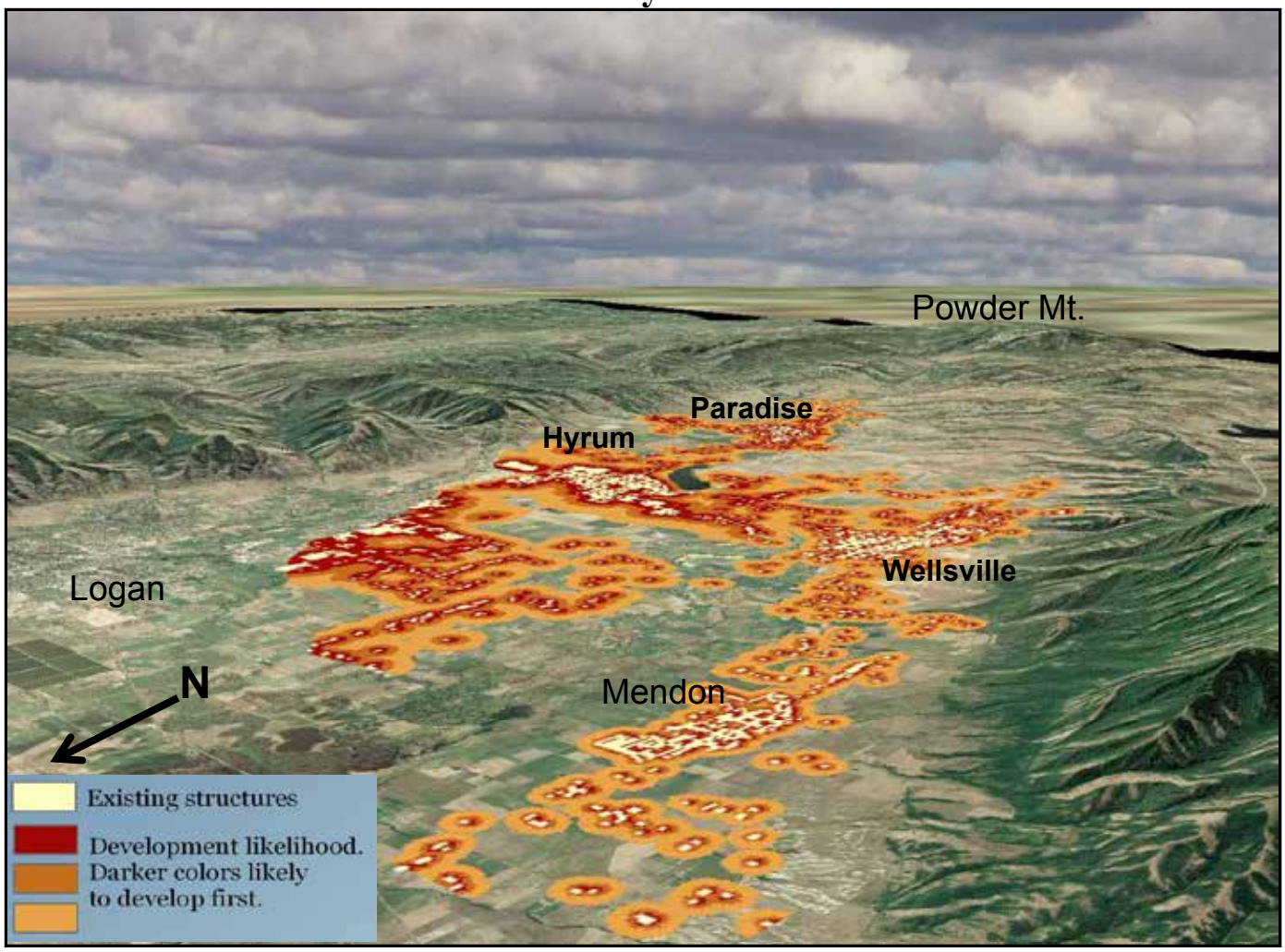


Existing structures

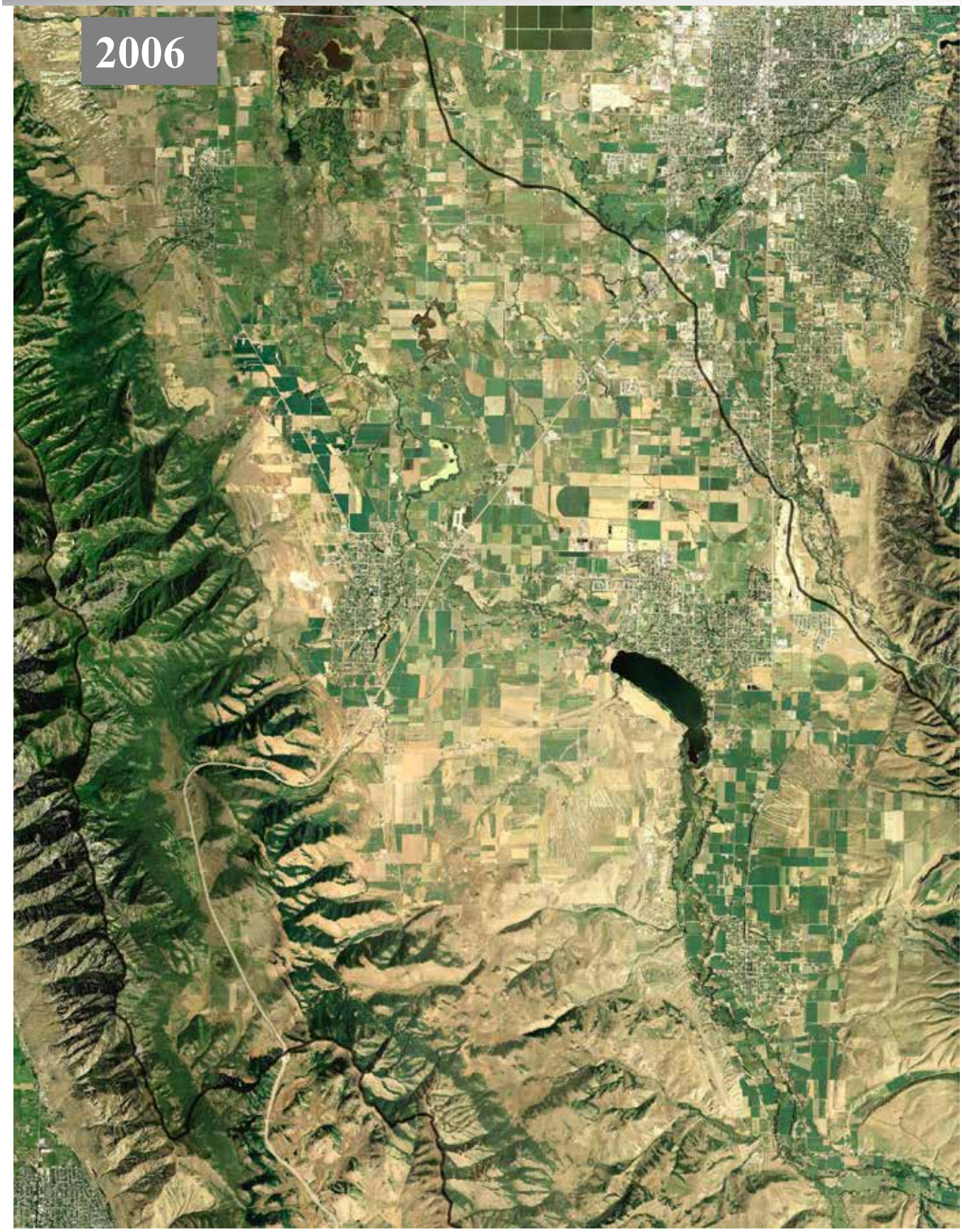
Development likelihood. Darker colors likely to develop first.

Plan Trend was determined by using population projections from the Cache Metropolitan Planning Organization traffic analysis zones to "weight" specific areas according to projected growth. Then least-cost development was determined by analyzing distance from roads and current development.

Bird's-Eye View



As the population continues to increase in the Little Bear River Watershed, demand for housing developments will also increase. Without preventative measures, uncontrolled urban sprawl is likely to occur throughout the watershed. This development pressure is most likely to occur near existing municipalities, infrastructure, and major transportation routes. However, as development continues to burgeon throughout the watershed, infrastructure and public services become increasingly costly.


2006


2030?

The U-shaped future began as a conceptual idea for directing sprawl within an elevation range. By directing sprawl in a linear fashion, the hope was to facilitate mass transit or highway planning and reduce the need for additional infrastructure. Along with transit lines and other infrastructure, a main fiber-optic cable line could be laid for easy access to developments.

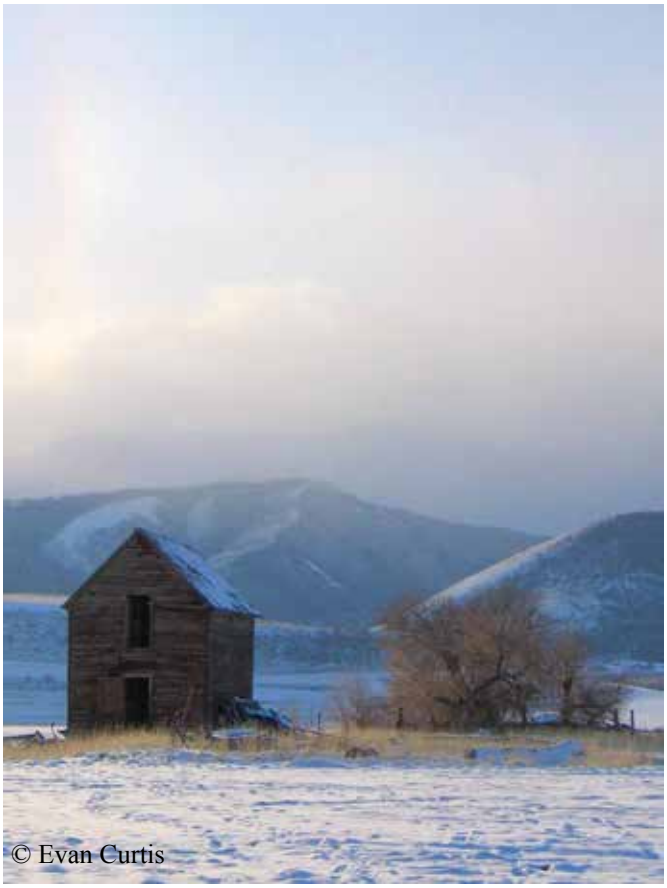
Furthermore, the thin development would put every resident within walking distance of the "core" urban strip on one side, or open space and recreation opportunities on the other side. This would facilitate commercial "hubs" in the center of development and a series of trails along the perimeter connecting to the Bonneville Shoreline Trail. Taking this conceptual U-shape pattern and modeling it using GIS and several of the assessment models resulted in a slightly different pattern; however, it still meets the basic objective of its conceptual beginnings.

The final U-shaped future included only elevations above 4510 ft, and below 5000. There were many reasons for this. First off, most of the existing towns fell between these elevations. Second, this elevation range has the longest growing seasons making it ideal for planting lawns, gardens, and fruit trees, and (theoretically) would keep the amount of days that windows must be scraped to a minimum. Third, this elevation range preserved the views of the mountains above it and the wetlands and agricultural areas below it. This protected area also included the areas adjacent to Highway 89, which would maintain the agricultural ambiance that the valley entrance has become known for. It also kept development out of river bottoms and most of the floodplains.

Next, only areas that were in this elevation range and within a half mile of the transportation routes delineated in the Tier 2 Transportation model were kept. This kept the need for highways to a minimum and slimmed down the pattern to be only a mile wide in most places. From this, Groundwater Tier 1, Surface Water Tier 2, Ecological Habitat Tier 3, Public Safety Tier 2 and Cache Valley Sense of Place Tier 1 were removed.

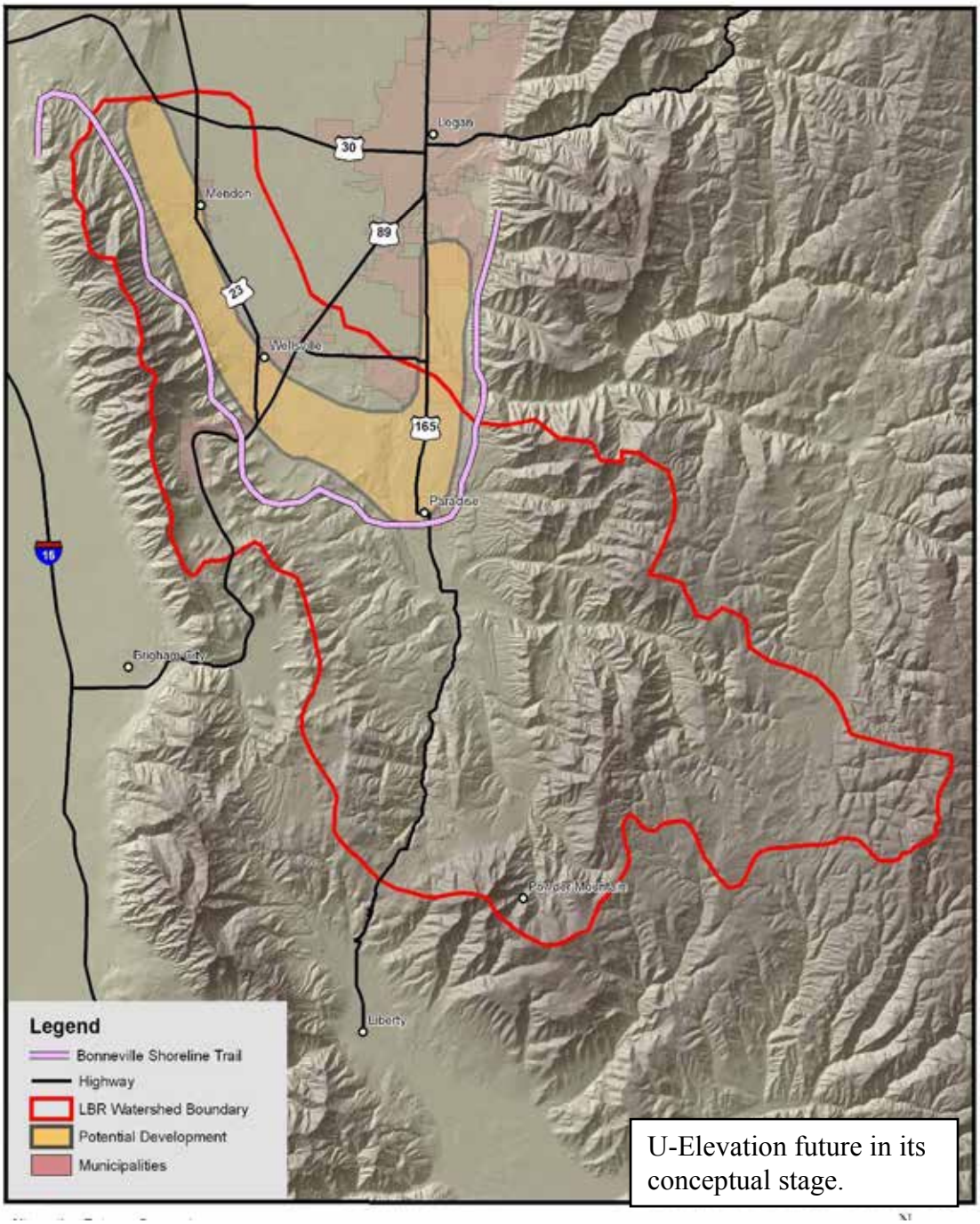
Advantages:

Directing development in this U-shaped pattern offers several advantages. First off, it follows the existing development pattern and would not require a large adjustment. It facilitates all modes of transportation, including mass transit, and reduces infrastructure costs. It avoids critical lands such as first order watersheds, wetlands, wildlife habitat, and geological hazards. Furthermore, it preserves the visual quality of the mountainsides and of the wetlands and agriculture in the valley bottom. It also promotes a high quality of life by placing each resident within proximity of open space and creates opportunities to expand trail ways.



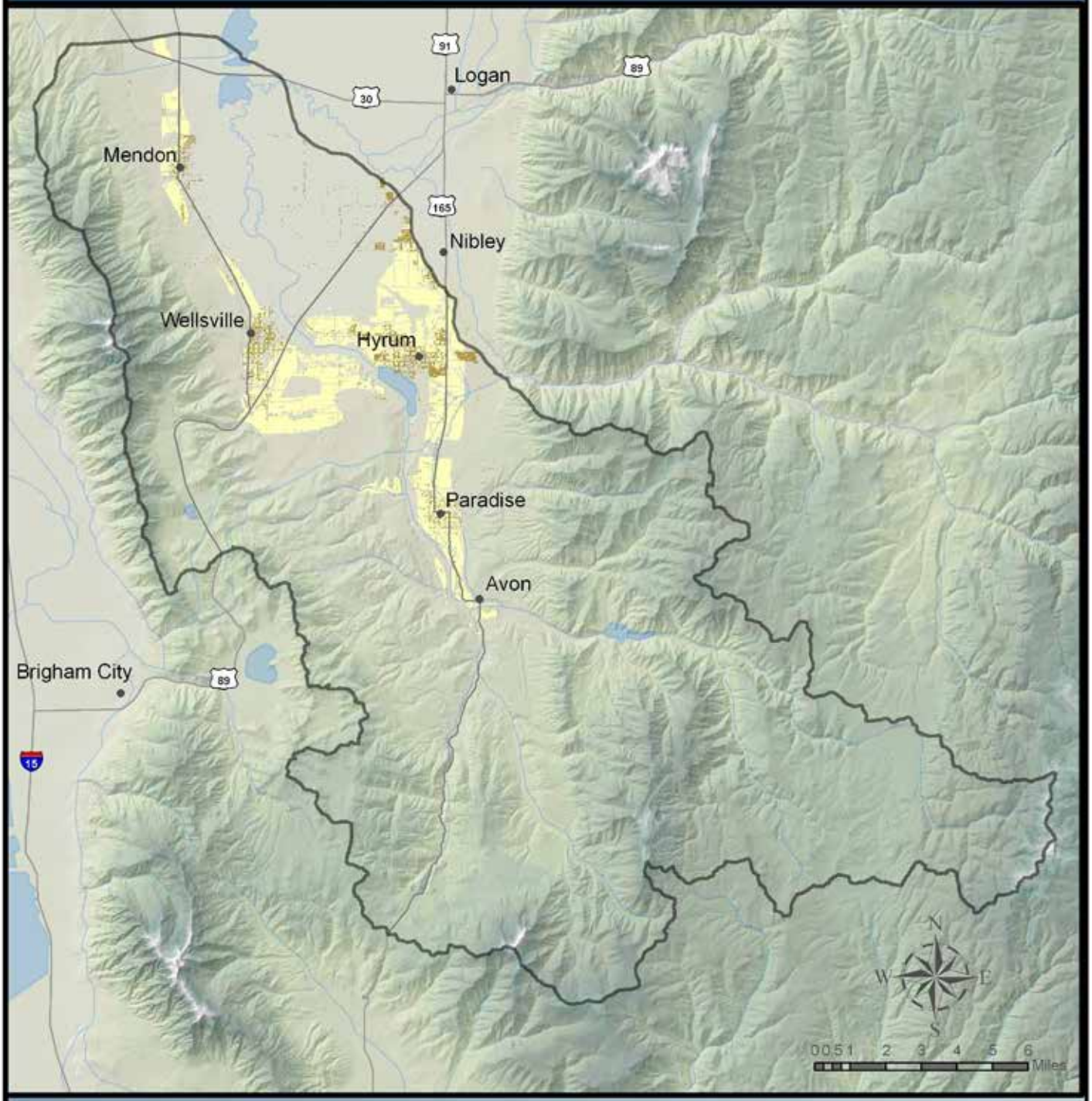
Disadvantages:
In spite of the many advantages this plan offers, it could potentially decrease the identity of individual towns. This may also result in jurisdictional conflicts or require new thinking regarding law enforcement and other public safety jurisdictional boundaries. Its proximity to primary recharge areas and development in secondary recharge areas would also raise questions regarding environmental issues. Lastly, it would fragment the natural landscape, dividing the valley bottom from the mountains.

U-Elevation



U-Elevation future in its conceptual stage.

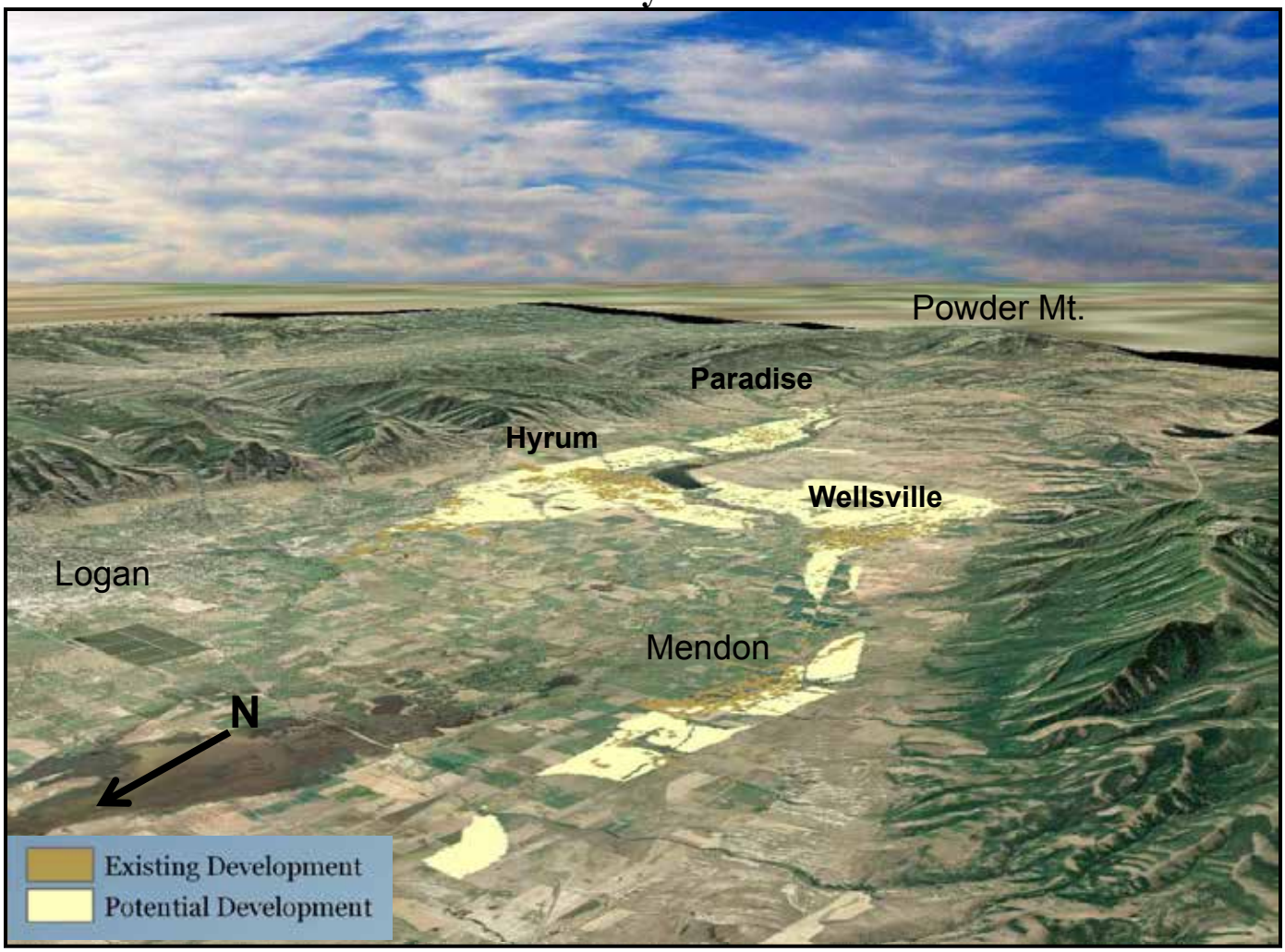
U-Shaped LBRW



Existing Development
Potential Development

The U-Shape Future encompasses areas above 4510ft and 5000ft elevation within 800m (half mile) of Transportion Tier 2 and not on Ecological Habitat, Tier 2 Public Safety, Tier 2 Surface Water, Tier 1 Groundwater, Cache Sense of Place Tier 1, or Recreation Tier 1

Bird's-Eye View



Focusing current development patterns along major transportation routes and within a specified elevation range preserves a large quantity of wild lands, prime agriculture areas, mountain sides, and riparian areas. Furthermore, by centering development in a linear pattern, each resident is placed within easy access of the development center on one side, and to open space and trails on the other. This linear development pattern also facilitates the creation and operation of a public transportation and trails system.

Futures Recreation-Focused

The question was posed, "what would the Little Bear River Watershed look like if development centered around recreational opportunities?" The answer, of course, is that it may end up resembling a resort area such as Park City, Utah; Jackson, Wyoming; or Aspen, Colorado. Using the Tier 1 Recreation assessment model, a 400 meter (¼ mile) buffer was placed around all recreation features. The idea was that every residence in this future would be within ¼ mile, or easy walking distance, of trails, canyon entrances, riversides, reservoirs, or potential open space. Also, this future reveals potential sites for cabins, recreation resorts, or second homes in higher elevations. With Powder Mountain Ski Resort located within the watershed boundaries, the potential for such a future could be a real possibility. Great care was taken to preserve the visual quality of the watershed as well.

The future consists of a ¼ mile (400m) buffer of the recreation features in Tier 1 Recreation. From that, only land that is within 400 meters of an existing road was included. Tier 1 Sense of Place, Tier 1 Groundwater, Tier 2 Ecological Habitat, Tier 2 Surface Water, and Tier 1 Visual Quality were removed from the future.

The idea of implementing a future may be met with controversy. While the future offers many advantages, those advantages come at a potentially high cost.

Advantages:

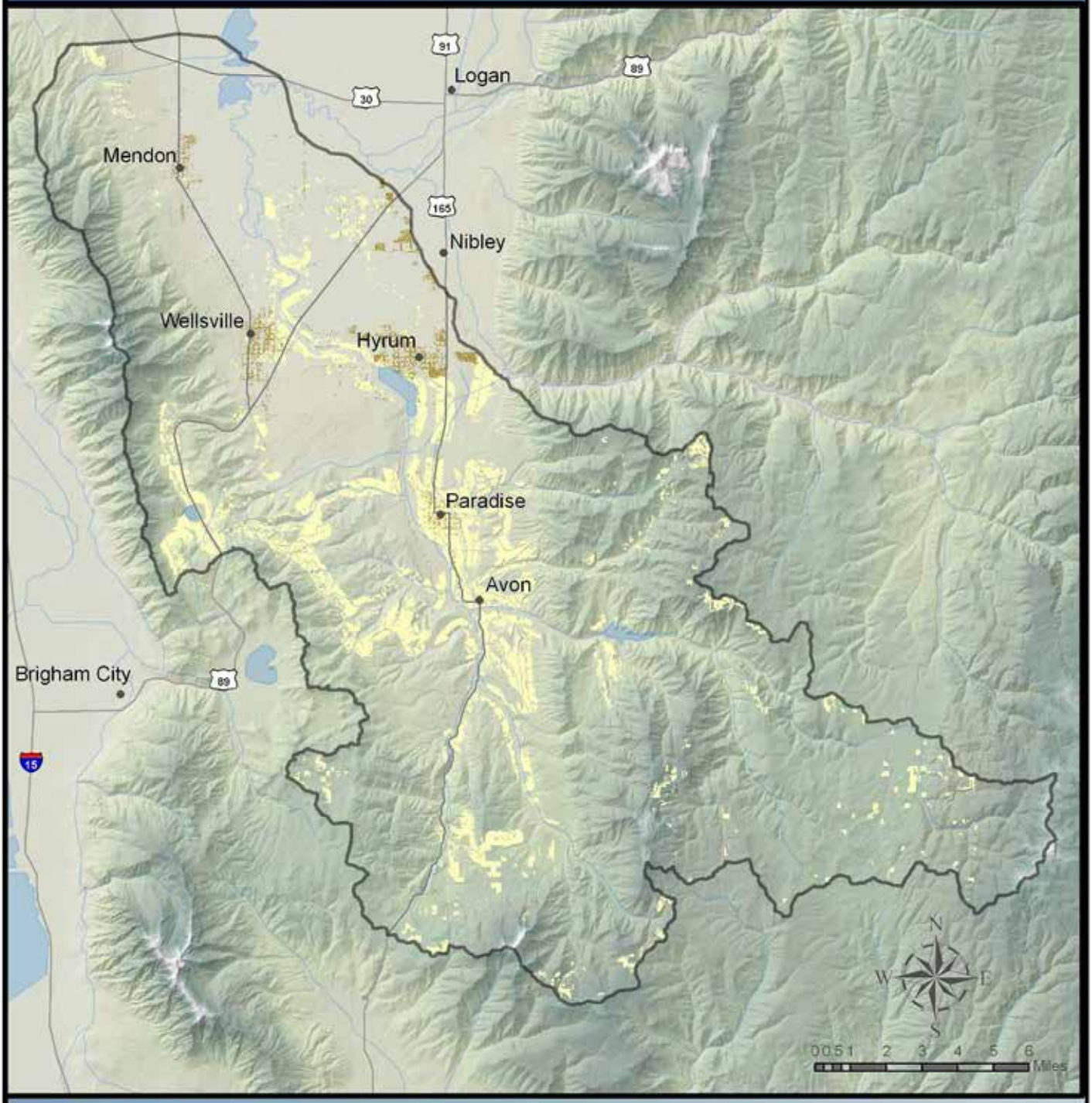
The first advantage of this future is that it recognizes and preserves important recreation areas within the watershed as a priority. Focusing development around these recreational opportunities could potentially improve the quality of life to an enormous extent. Putting people within easy distance of trails, for instance, would promote physical activity and increase time spent out of doors. Furthermore, placing more people on trails could potentially increase their sense of place. In the long-term, such a plan would likely stimulate the economy as businesses search out areas with a high quality of life and tourists come to enjoy the atmosphere.

Disadvantages:

While the long-term may see an economy stimulated by growth, the short-term may require public funding to improve roads and deliver public services such as emergency services and waste management to outlying areas. This would especially be a difficult pattern for the implementation of mass transit, including school busses. With development being spread out in this manner, vehicle miles driven per person may also increase. Also, with an increase in vacation homes, the sense of place is diminished by transient residents who may only reside in the area for short periods of time. Seasonal residents may also diminish the tax base by contributing less to the economy than they require for public services. Such development may also diminish the rural character of the area and increase traffic to once-tranquil towns. Lastly, by focusing the development along the borders of prime recreation areas, more people are adjacent to flood plains and riparian areas. This could be a potential threat to the public safety in the event of a major flood and could also pose a threat to the environment by putting more and more development near ecologically significant habitat.

Recreation-Focused

LBRW



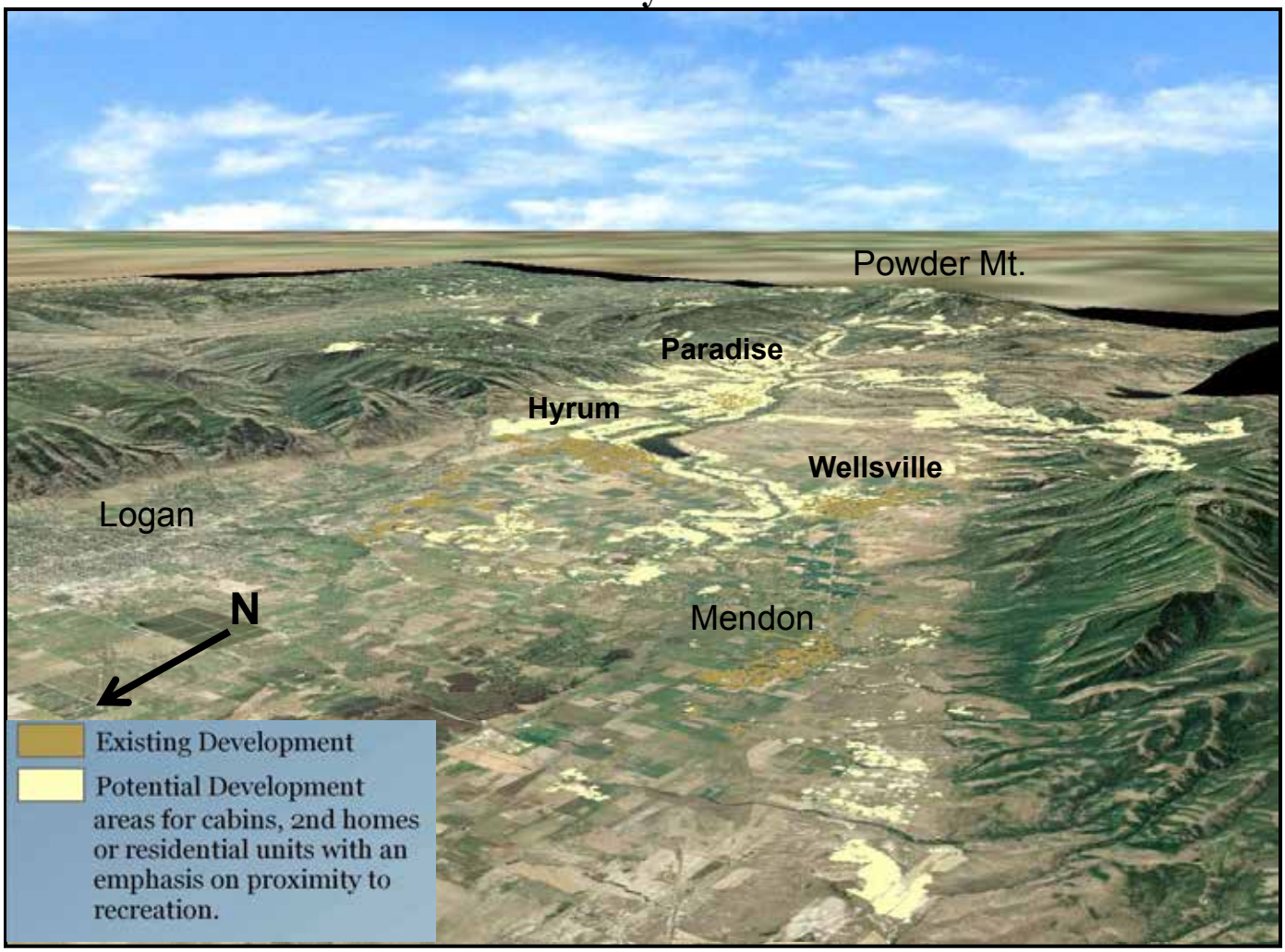
Existing Development

Potential Development areas for cabins, 2nd homes or residential units with an emphasis on proximity to recreation.

Criteria:

Within 400m (1/4 Mile) of Tier 1 Recreation Features, Within 400m (1/4 mile) of roads, Tier 1 Sense of Place, Tier 1 Groundwater, Tier 2 Visual Quality (4 or more Views), Tier 2 Ecological Habitat, Tier 2 Surface Water, Tier 1 Public Safety

Bird's-Eye View



A future planned around recreation areas places residents in very aesthetically pleasing areas and encourages outdoor activity and exercise. However, great care would need to be taken to minimize the visual impacts on the stunning scenery that is found in the Little Bear River watershed. Furthermore, due to the large area that would need to be serviced by public infrastructure and emergency services, planning would be required to ensure that the development occurred in an economically viable manner.

Neo-Traditional

In the mid 1860's, the early Mormon settlers of the Little Bear River Watershed began platting out each individual village using the "Plat of Zion" layout. This layout consisted of 10 acre blocks which contained 8 individual lots within each block. The inner city blocks were surrounded by farmland and pasture. The farms that surrounded the villages were ten to twenty acres in size (Peterson, 1997). The primary villages were located approximately 4 to 6 miles apart and each town maintained the same traditionally planned layout, which concentrated growth within the city blocks and utilized the surrounding areas for agricultural production. As growth continued, new towns or villages were appropriately designated in a "planned and directed" manner and agricultural and water resources were administered by local leaders (Peterson, 1997).

The majority of the early settlements of the Little Bear River Watershed maintain the same urban center characterized by wide streets, 10 acre blocks, and agricultural production in the area surrounding the individual villages (Peterson, 1997). However, as growth has increased exponentially throughout the area, urban sprawl has replaced the traditional settlement pattern, and the once individual towns have begun to merge into one large urban area.

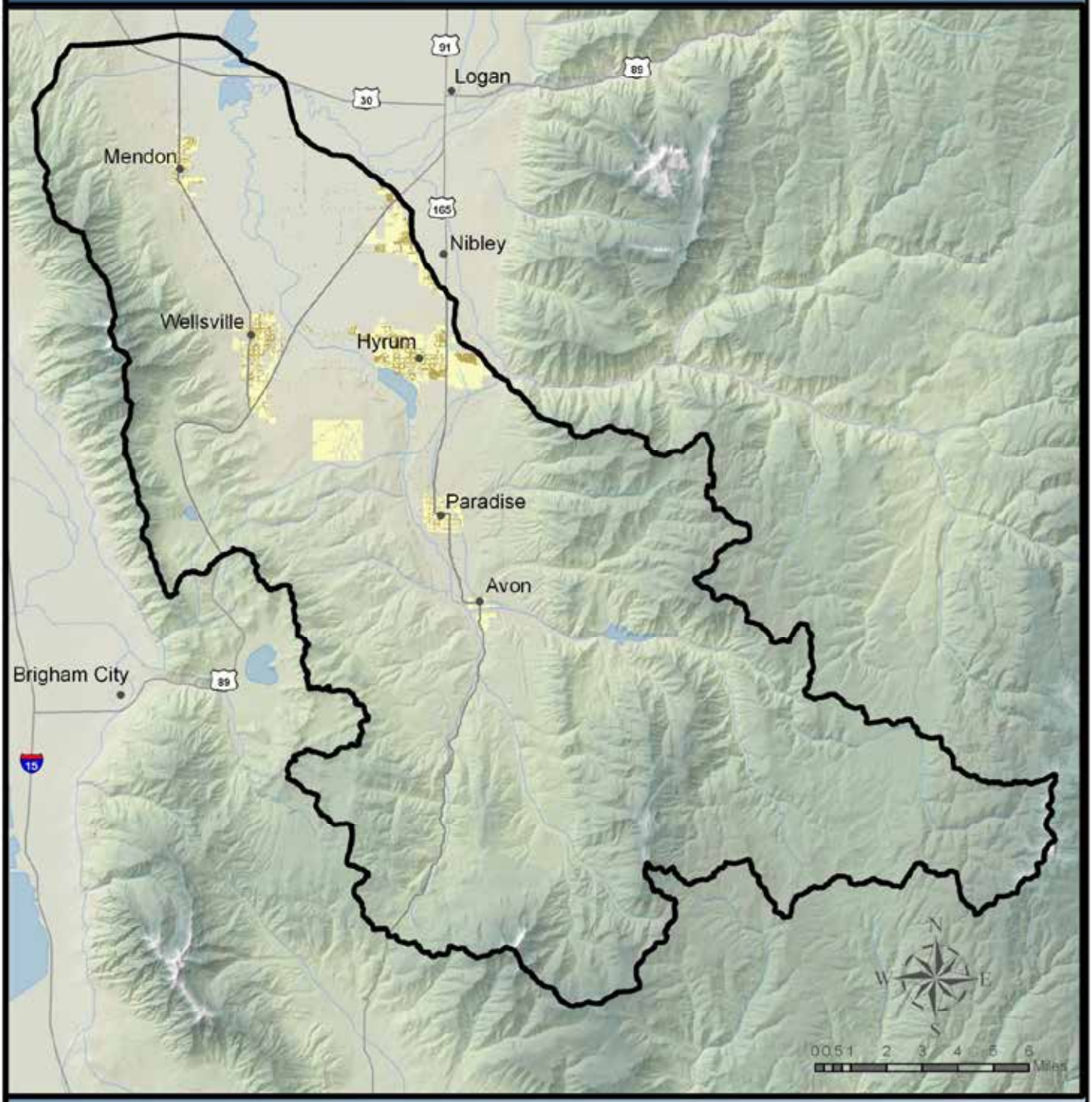
The Neo-Traditional development pattern concentrates development within defined municipal boundaries while preserving the open areas between towns as agriculture. New towns or traditionally planned communities may be designated in order to accommodate long-term growth.

Advantages:
Some of the main advantages to the Neo-Traditional development pattern surround the reduced costs to local residents by simply lowering the demand for wide-ranging increases in infrastructure. Future costs to local residents would also be reduced by maintaining growth within designated municipal boundaries which avoid areas that compromise public health, welfare, and safety. Additionally, the traditional towns maintain a sense of place and preserve the historic and agricultural identity of the Little Bear River Watershed.

Disadvantages:
Some of the disadvantages surround the already complex issues regarding air quality. With the increased distance between towns and major employers, the amount of carbon dioxide will only increase as traffic volumes along existing roads between towns increases. However, the traffic demands may be reduced through public transportation efforts.

Neo-Traditional

LBRW



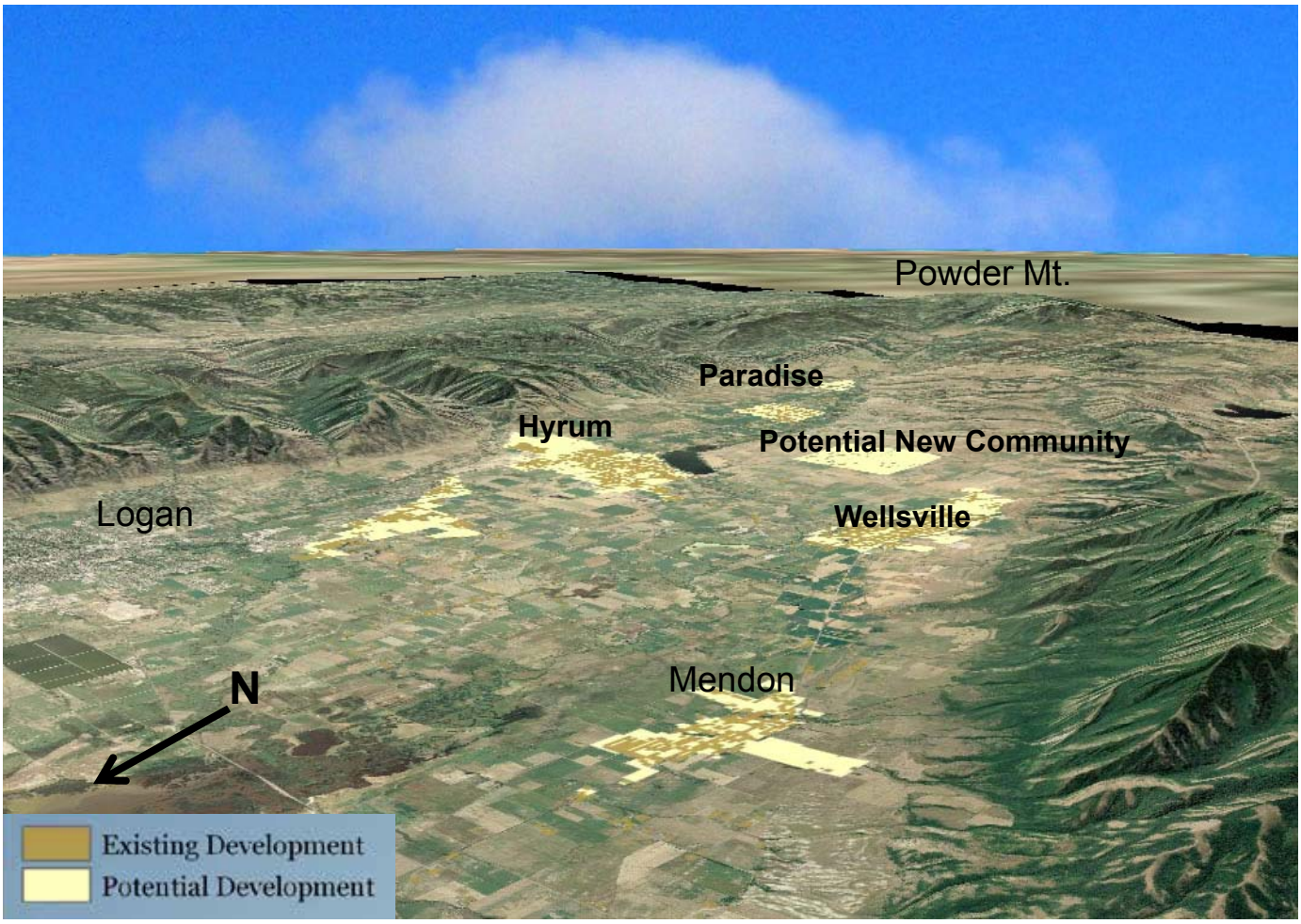
Existing Development

Potential Development

The Neo-Traditional Future consists of existing municipal boundaries along with a proposed new community. Tier 2 Public Safety, Tier 2 Surface Water, Tier 2 Ecologically Significant Habitat, and Tier 1 Recreation have all been extracted from the areas of potential development.

6,954 acres @ 2 units/acre @ 3 people/household = 41724 residents

Bird's-Eye View



The Neo-Traditional Town emphasizes a sense of community and sense of place, encouraging connection within the city itself. One of the main attractions of these smaller communities is the reduced dependency on the automobile. The majority of the recreation, community institutions, and public transportation can be easily accessed by foot. The tightly knit, compact Neo-Traditional town utilizes mixed-use planning and significantly reduces the occurrence of suburban sprawl. Thus, the Neo-Traditional town is very cost effective in terms of infrastructure expansion, while at the same time preserving the rich cultural identity of Cache Valley and the Little Bear River Watershed.

Critical Lands

The term "Critical Lands" is one that has only recently been used to define the attributes of a landscape that a town, city, county, or region considers "critical" to maintaining the character of the area and protecting its citizens. The Little Bear River Watershed not only has threats to the health, safety, and welfare of its residents, but also threats to its water quality, wildlife, vegetation, and its sense of place as a historically agricultural valley. With this in mind, measures should be taken from local planners and planning commissions to prevent the problems that can be associated with ignoring the threats to these components.

The models used for the Critical Lands future were derived from tiers of the Groundwater, Public Safety, Agriculture, Sense of Place, and Ecological Wildlife Species models. This future places emphasis on cultural, historical, and public safety issues. While much of the land available for development under this future is removed from the valley floor, there is space for the expected population growth with room to spare. Ideally, this future would serve as a pattern for creating county and city land use codes and would emphasize smart growth planning in the valley.

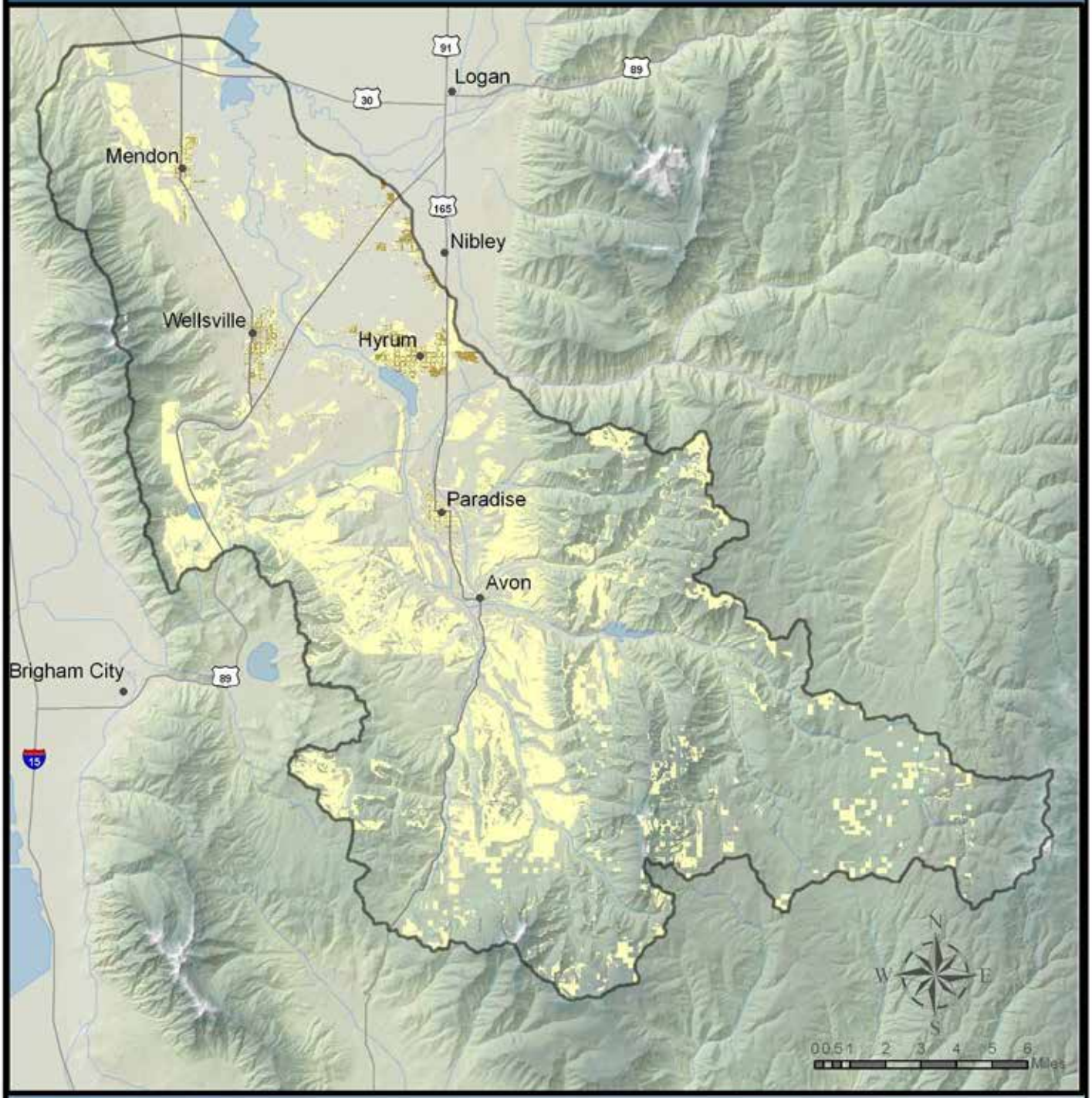
Porcupine Reservoir looking East

Advantages:
The main advantage to the Critical Lands future is found in its simplicity. The future takes into account the most crucial components of regional planning in an area, utilizing the land for peoples' most basic needs. These needs include public health, safety, and welfare. While people may disagree on the definition of critical lands, this future uses very basic ideas that capture the idea of critical lands.

Disadvantages:
The main disadvantage to this future is the amount of land that is available for development. This spread-out growth is expensive for communities and the region as a whole to pay for, relating to infrastructure costs and transportation issues. Cache Valley sense of place is also compromised, and the views and vistas of the valley are disturbed.

Critical Lands

LBRW



Existing Development

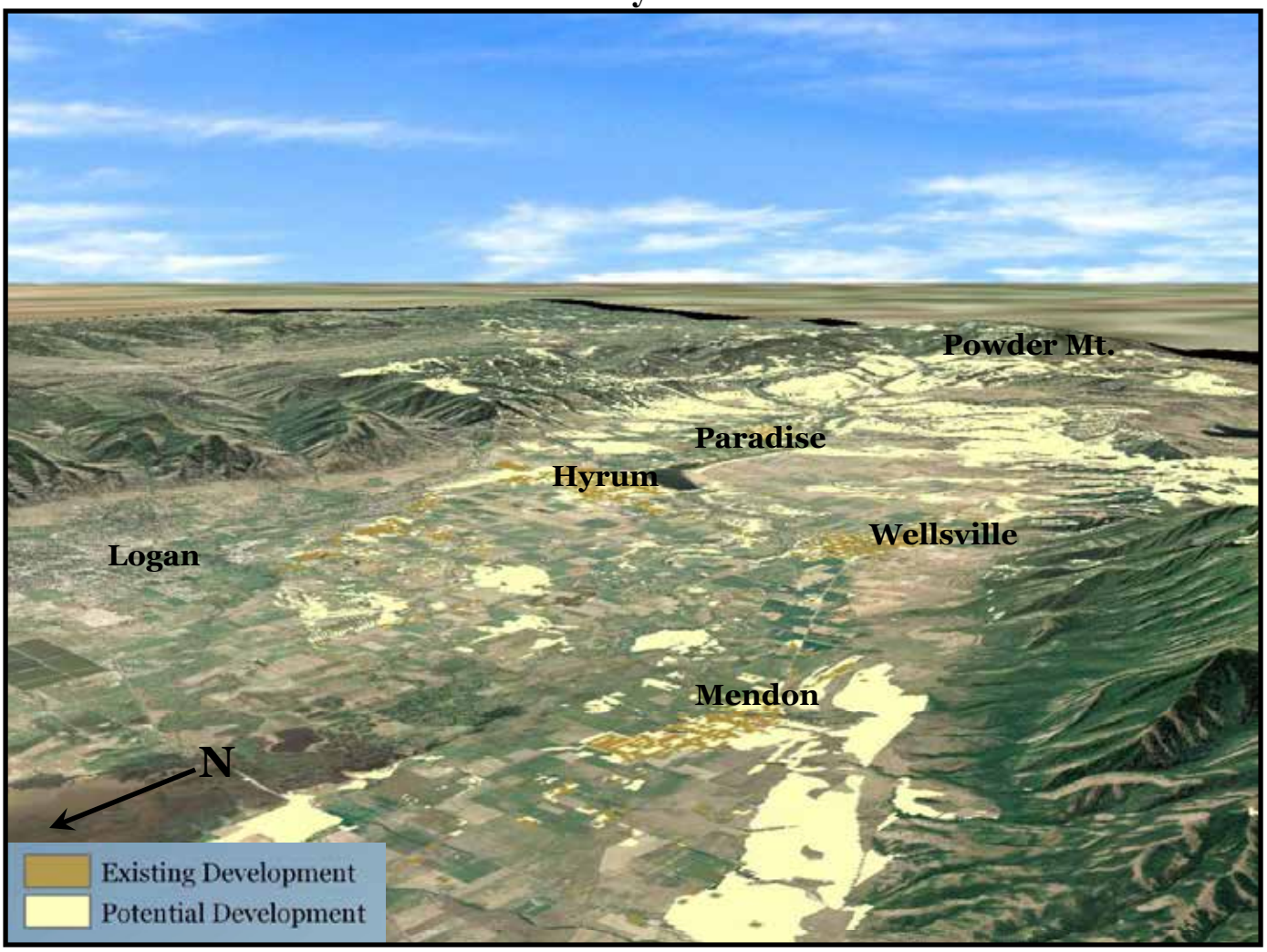
Potential Development

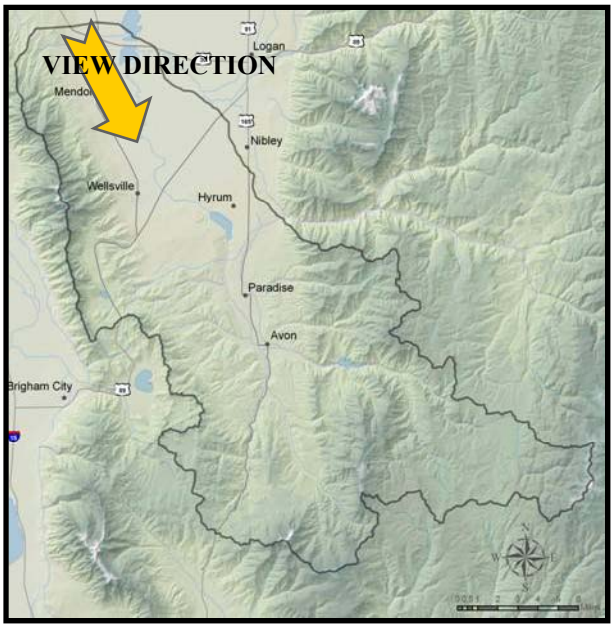
This represents a future that provides for the basic needs of the Little Bear River Watershed and its residents. Included in this future are those things that are not only physically crucial, but also culturally and socially crucial to the residents of the study area.

Criteria:

Tier 1 Groundwater
Tier 1 Public Safety
Tier 2 Agriculture
Tier 1 Sense of Place
Tier 1 Ecological Habitat

Bird's-Eye View





The importance of critical land planning for a region is essential to protecting the "bare minimum" needs of society. In the Little Bear River Watershed, this is even more crucial because of the large land areas that are relatively untouched by development thus far. In larger communities, such as the development found along the Wasatch Front in Utah, critical lands are largely developed. While this future represents only the bare minimum in land use planning, much of what is vital to the region could be preserved for the good of the residents in the watershed. Resources such as groundwater, agriculture, and public safety would be minimally preserved and could prevent many problems in the future.

When considering the effects that urban sprawl and suburbia can have on a region, there should be efforts to create land planning solutions that protect public welfare and maintain a quality of life for residents. In this particular model, growth patterns follow principles that relate specifically to the economic, health, safety, welfare and quality of life needs of the Little Bear River Watershed.

Urban Sprawl in Salt Lake City, Utah

Many rural communities in America, particularly in the west, have found that problems are eminent regarding the growth patterns of their town or city. These problems often relate to what is referred to as the property rights or landowner rights of the individual. These rights can often be abused and surface contentiously in a community. Some towns have even placed a development moratorium, which prevents any development in an area from happening for a period of time, while a planning commission makes decisions relative to desired growth patterns in an area.

This Quality of Life future is comprised of Recreation, Recreational Wildlife Species, Groundwater, Sense of Place, Public Safety, and Residential model tiers. These models and tiers were chosen to include those lands that should be preserved in order to most closely maintain the valleys current characteristics. *If utilized, this future would have enough land to add approximately 27,000 new residents at three units per acre.*

Cutthroat Trout

Advantages:

Main advantages to the Quality of Life future consist of decreased infrastructure costs due to smaller tracts of land being developed. Although this future is an extreme example of what could be, it has important implications in reference to increased density in and near existing municipal boundaries, leaving plenty of land for ground and surface water quality and wildlife habitat.

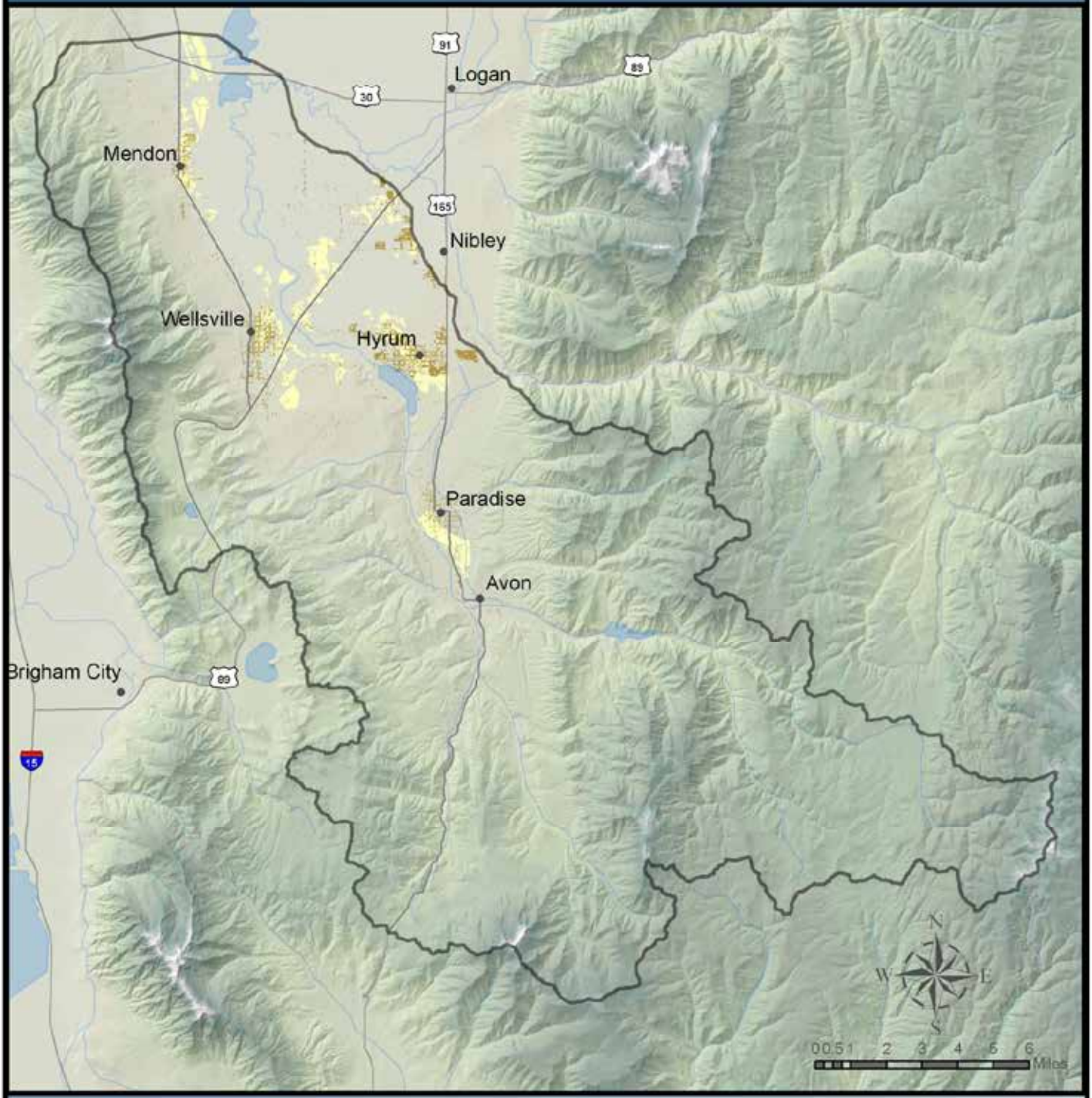
Wetlands in Cache Valley, Utah

Disadvantages:

Disadvantages to the Quality of Life future are due to strict land use policy and/or conservation methods. This type of future may be harder to adopt by multiple municipalities because of property right issues, etc. However, the future does show a great example of how higher density and regulated land planning can create a virtually unchanged Little Bear River Watershed within the next 25 years.

Quality of Life

LBRW



Existing Development

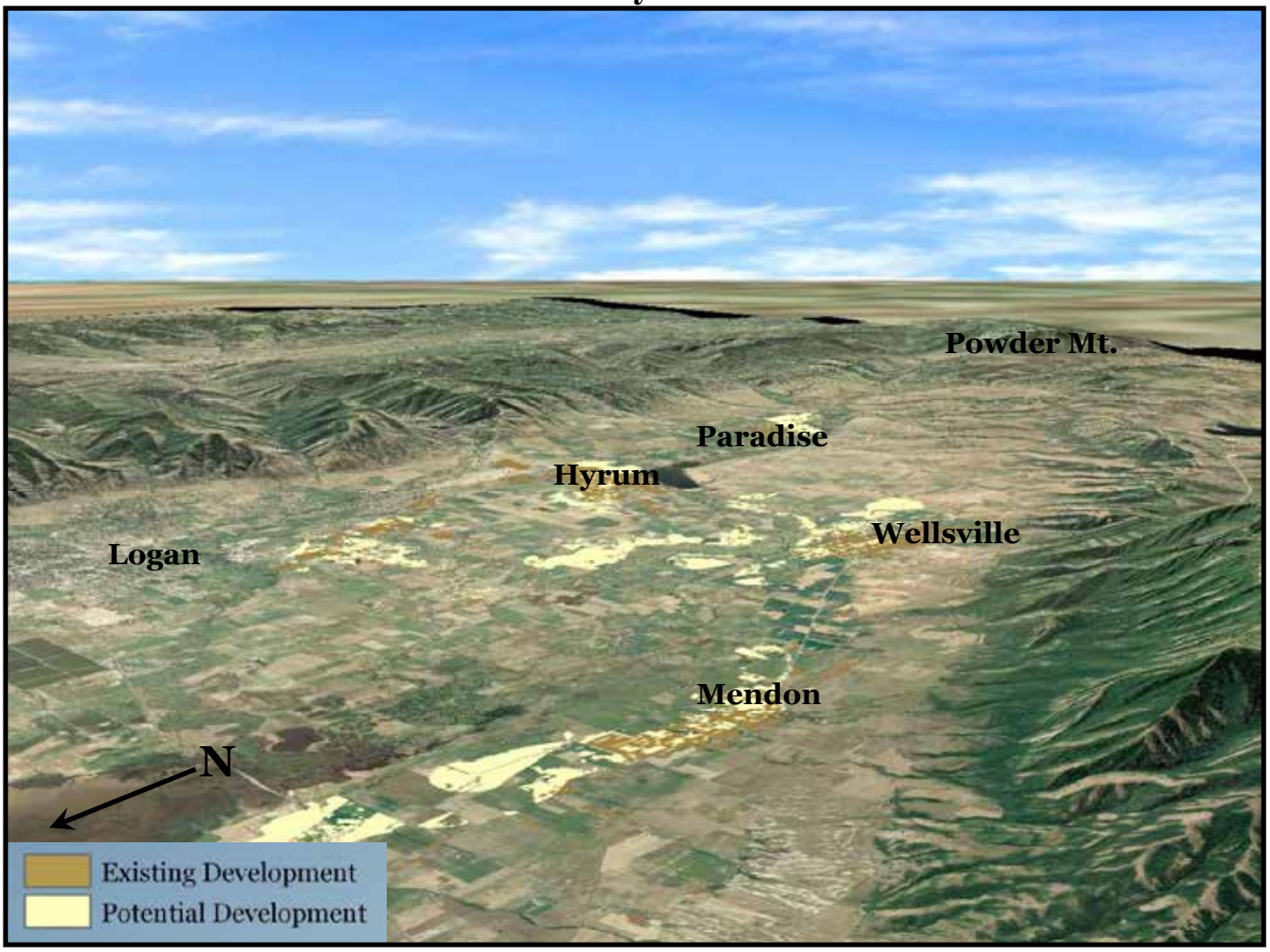
Potential Development

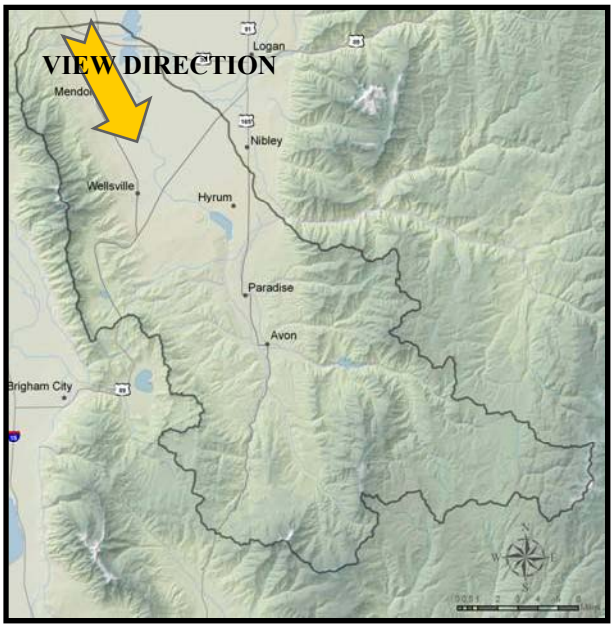
Note: Tier 3 Recreational Species/Wildlife was used in this future based off of the large amount of wildlife habitat preserved. This model also encompases most of the habitat in the Ecologically Significant Species Models.

Criteria:

Tier 3 Recreation
Tier 3 Recreational Wildlife
Tier 2 Groundwater
Tier 2 Cache Valley Sense of Place
Tier 3 Public Safety
Tier 3 Residential

Bird's-Eye View





While the Little Bear River Watershed is largely agricultural and undeveloped, there are increasing pressures to build in the watershed (Bill Bertolio, Cache Valley Realty). These pressures stem from the valley's proximity to nearby cities that provide for residents a rural lifestyle that is relatively close to their place of work. There are also increasing pressures to develop areas along Highway 89/91 from Nibley to Wellsville, which is also where the gateway views into the valley from Sardine Canyon (Wellsville Canyon) and historical agricultural lands are quite concentrated. With a simple and refined "quality of life" planning strategy, housing is still plentiful and natural, cultural, and historical amenities are preserved for many years to come.

Conclusions

Policy and Implementation

The Little Bear River Watershed offers a magnificent quality of life for residents and astonishing beauty and adventure to visitors. It is an area where the past mingles with the present, and wild lands converge with the tame. Such a remarkable area will surely continue to attract growth as individuals seek a better quality of life for themselves and for their children. With the inevitable growth already occurring in the region, and the promise of continued growth, it would be irresponsible not to plan and direct development in a manner that maintains the high quality of life that current residents have come to expect and to ensure the general health, welfare, or safety of future residents.

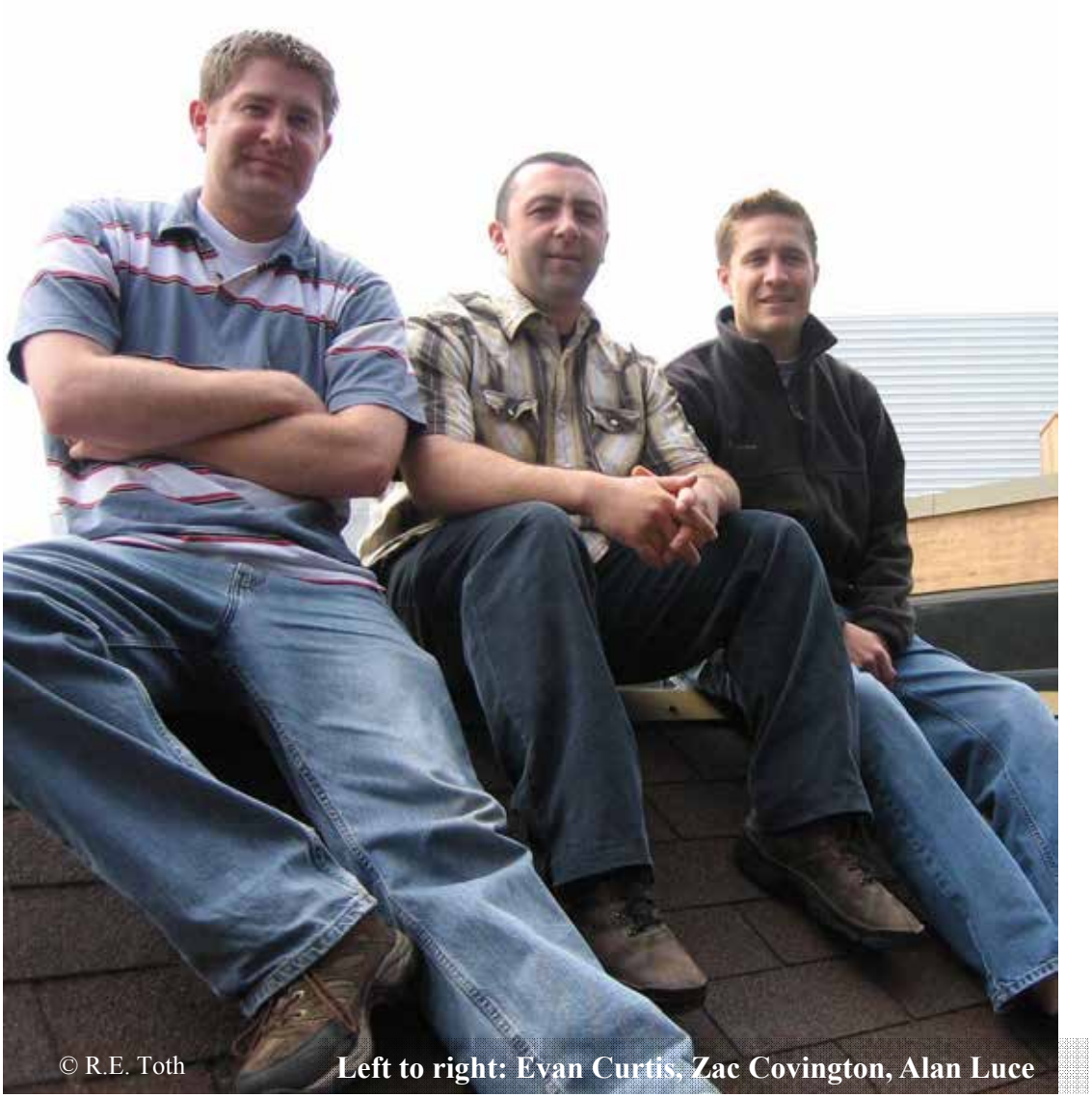
Through continued study, much can be learned about the land; however, it is not enough to merely learn about the land, but steps must be taken to implement the acquired knowledge into policy.

Through the use of current planning and zoning tools and, where needed, the creation of new tools, it is hoped that development in the Little Bear River Watershed will add to the unique character of the region in a manner that does not detract from, but instead adds to, the general health, welfare, and safety of those living in the Little Bear River Watershed.

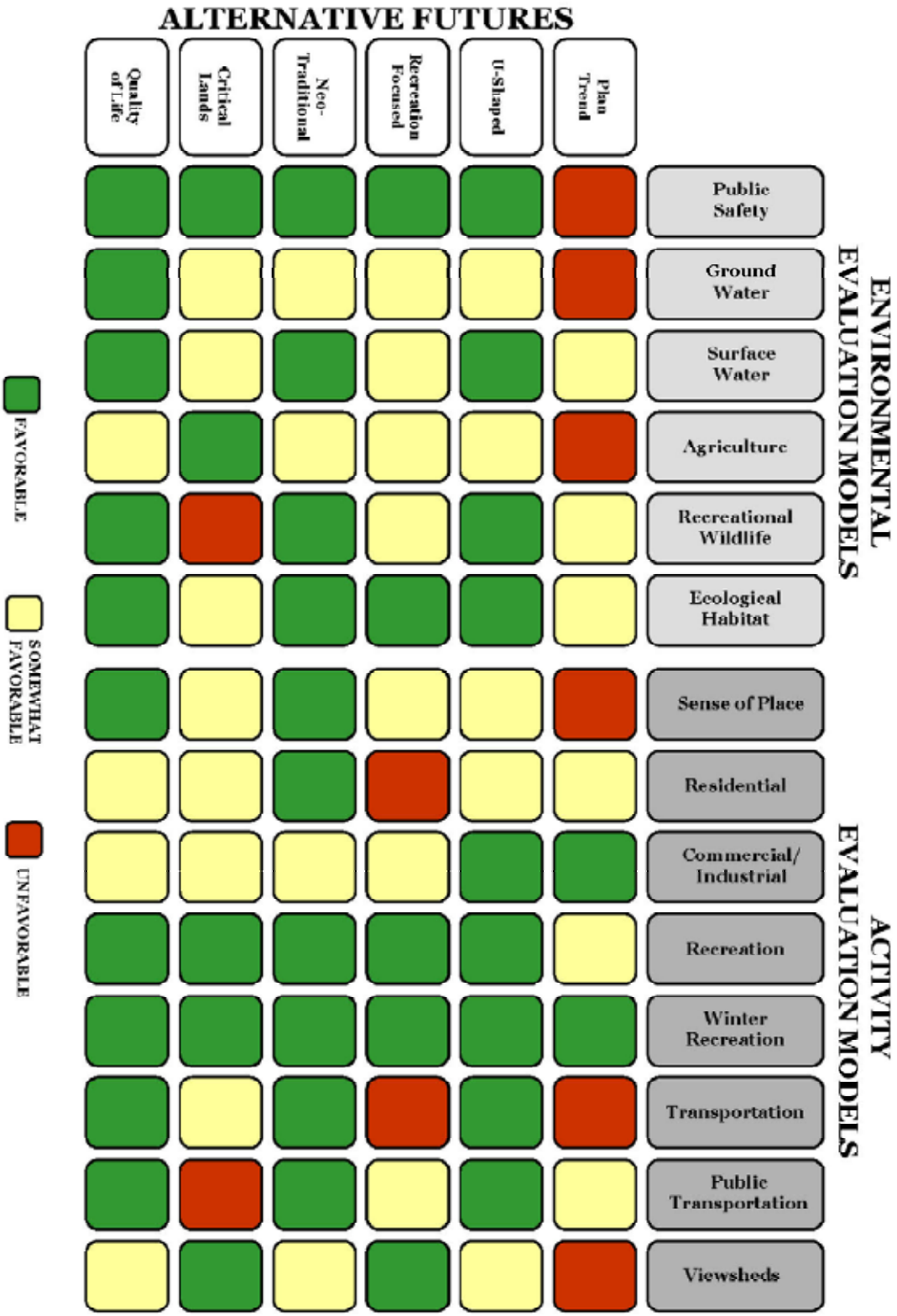
Conclusion

Many regions of the country are scrambling to recover from the mistakes of the past. As sprawl continues to stretch infrastructure costs to a maximum and depletes the natural and agricultural lands that create such a high quality of life, many planners, government officials, and private organizations are trying desperately to salvage those lands that are critical for the public health, welfare, and safety.

Unlike so many other regions in the state and around the country, the Little Bear River has the unique advantage of time to prepare for the growth that will inevitably happen. As the communities and unincorporated areas of the Little Bear River Watershed continue to face this persistent pressure to develop, it is hoped that tools such as those outlined in this report will aid in the decision-making process and keep the Little Bear River Watershed a magnificent place to live and work for generations to come.



Left to right: Evan Curtis, Zac Covington, Alan Luce



Analyzing the Alternative Futures

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Fire Data from Bureau of Land Management (BLM)

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Various views of Prime Agricultural lands and agricultural lands of local and state importance (data extracted from the SSURGO soils data available at the following citation: USDA NRCS SSURGO Metadata reports in the MS Access SSURGO template database, or from the Soil Data Mart website at: http://soildatamart.nrcs.usda.gov/ssurgometadata.aspx
U.S. Department of Agriculture, Natural Resources Conservation Service
Publication_Date: 20051129

Tree vegetation coverage used to represent areas of priority for recreational activities and wildlife viewing and biodiversity (data extracted from utlandcovv.zip file from the USGS GAP data website at http://gapanalysis.nbii.gov/portal/server.pt?open=512&objID=202&PageID=222&cached=true&mode=2&userID=2).

Survey's and Other Information:
-Cache Chamber of Commerce has a vision of "Vistas and Surface Access" which is described as the following: "*Cache Valley needs timely access to key transportation corridors along which agricultural lands are protected and breathtaking views are preserved*."

"Cache County Citizen Survey Results: Views on Decision-Making in the County Survey conducted Summer 2004." By the Institute for Social Science Research on Natural Resources, given to us by Peggy Petrzelka.

GIS References

Key Points for Cache Valley Identity Issues:

-The majority of people value a rural lifestyle and the natural beauty of the area.
-The majority of people do not like the growth and urban sprawl that is taking place.
-The majority of people see growth and urban sprawl as the single most important issue facing Cache County.
-The majority of people consider Cache County a less desirable place to live during the past five years.
-The majority of people list growth as their number one reason for the county being a less desirable place to live.
-If people said that the county was a more desirable place to live, it was primarily for an increase in stores and new services.

"Cache County Quality Growth Survey" from 1999, done by Dave Rogers, Stan Guy and Mark Tuescher. Sponsored by the Cache County Commissioners, the Cache County Planning Office, and Utah State University Extension. Key Points for Cache Valley Identity Issues:

-84% valued open public spaces
-Ranked "where existing infrastructure is located" as most important for new growth.
-69% said that "existing open agricultural spaces between communities in Cache Valley" should be preserved as open space.
-66% said that having working farms or ranches in Cache Valley was very important
-In order of priority, the following natural spaces as open space sites were place at high value:
    75% Rivers and streams
    54% Hillsides
    49% Wetlands
    49% Entrances to valley

Viewsheds were done in ArcGIS 9 using the viewshed analysis tool, with a vertical height of 2 meters (six feet, the average size of a human). Views were taken into account from the 5 existing municipalities in the Little Bear River Watershed, namely Hyrum, Wellsville, Mendon, Nibley and Paradise. Also included was Highway 89-91, by placing 5 points evenly spread along the stretch of road in the valley bottom.

Residential and Commercial Lands: Information for least cost residential land criteria was derived from "Cache Valley 2030" and professionals involved in land planning, development and real estate. Such professionals included Professor Richard Toth, Tom Singleton MAI, Curt Webb, Kent Dunkley (Real Estate Broker), and Bill Bertolio of Cache Valley Realty. Comments included the following:

-A lot of people are moving into the valley.
-Many work outside the valley and commute.
-There is more commercial development coming into the south end of the valley, and people are moving towards that development to avoid Logan City.
-Cache Valley has reached the "Magic" number of 100,000+ people, which indicates growth stability.

-Developers are building, and people are coming.
-The south end of the valley tends to be selling for $30,000+ per acre, with 2-5 acre lots in high demand in the Paradise/Avon area.
-A 9 acre parcel in Providence is up for sale for $55,000 per acre and is close to streets, water, sewer and power.

Trails Data (Cache County), Tim Watkins

Cache Valley Transit District. http://www.cvtdbus.org/

Extra's:

Cache County Population Projection for 2030 = 183,989
http://library.loganutah.org/local/cache/almanac/chapter4.cfm#CACHE%20COUNTY%20POPULATIONpro

LBRW rough estimates for 2030 = apr. 22,750
(Cache Metropolitan Planning Organization, Jeff Gilbert, 2004-2030 Population Added figure)
2004 Cache County population estimates were 100,182 according to UDWS, John Matthews, 2005 fact sheet.

Appendix A

1,500 Acres in Cache Valley Preserved (UT)

Contact:
Alina Bokde, TPL (801) 870-4335
Paradise, Utah, 9/20/03 –

Mark E. Rey, U.S. Department of Agriculture Under Secretary for Natural Resources and the Environment, today joined the Trust for Public Land (TPL), a national non-profit land conservation organization, at a celebration marking the preservation of more than 1,500 acres of ranchland in historic Cache Valley.

The celebration marked the conveyance of a conservation easement on Brooke Ranch to the Utah Department of Agriculture and Food for protection in perpetuity.

Keynote speaker Under Secretary Rey was followed by speakers representing the Utah Department of Agriculture and Food; Shauna Kerr, vice chair of the Utah Quality Growth Commission; Skip Nelson, state conservationist of the U.S. Natural Resources Conservation Service (NRCS); Bill Christensen, Utah regional director of the Rocky Mountain Elk Foundation; John Hansen, Cache County Council; Landowners Jon and Vickie White; and Alan Front, Senior Vice President of the Trust for Public Land. Alina Bokde, the TPL Project Manager, said, "This project exemplifies the kind of multi-agency effort that makes the preservation of working lands a success. My colleagues and I are very grateful for the support of our partners, Jon and Vickie White, our funders and the community. Not only is Brooke Ranch protected, but the Cache Valley agricultural community has a vivid example of how the purchase of development rights can protect working lands and of the local, regional and national support that such efforts attract." TPL Utah, in partnership with the landowner, the U.S.DA NRCS, Utah Quality Growth Commission, Utah Division of Wildlife Resources, and the Rocky Mountain Elk Foundation has secured funding to purchase development and other rights to Brooke Ranch, which was settled by the White family in 1906. Funds for the purchase of the easement came from the USDA Farm and Ranch Land Protection Program, the LeRay McAllister Critical Lands Conservation Program, the George S. and Dolores Dore Eccles Foundation, the Utah Division of Wildlife Resources, the Rocky Mountain Elk Foundation, and other donors.
The development rights were conveyed to the Utah State Department of Agriculture and Food in the form of a conservation easement, which will contain permanent restrictions on the use and development of the land, and permit only certain agricultural uses.

"Protecting Utah agriculture protects our food supply, our environment and our heritage," said Cary G. Peterson, Utah Commissioner of Agriculture and Food. "Protecting these acres in Cache County sends a positive message to other land owners who are considering what to do with their land for the future," he added.

Shauna Kerr, vice-chair of the Quality Growth Commission said, "The Quality Growth Commission must carefully evaluate proposed projects and select those that we determine are truly 'critical lands' and those that have significant partners to leverage our investment. This project met both of these tests and could not have been accomplished by any one of the partners or funding mechanisms, however; together we have preserved this beautiful agricultural land. Together we have assured that this land continues to grow crops

and livestock instead of little houses in a row. I grew up in this Valley and I have watched as one field after another has been subdivided and fewer and fewer acres are in production. Efforts like this will assure that our children and grandchildren will know and appreciate Cache Valley as the agricultural heart of Utah."
In protecting Brooke Ranch, TPL also preserves a significant piece of the the historic agricultural character of the community established by early Mormon settlers, including the property owner's great-grandfather.
The protection of Brooke Ranch also supports important wildlife habitat lands and natural resource values. Bill Christensen, Utah regional director of The Rocky Mountain Elk Foundation, said "Elk, deer and moose all winter here and are dependent on this important habitat. Sharp-tail grouse are also found on this important piece of ground. This generous gift from the White family will continue to protect key wildlife habitat."
The Trust for Public Land is a national non-profit land conservation organization. TPL's mission is to conserve land for people to enjoy as parks, gardens, and natural areas, and ensuring livable communities for generations to come. Since its founding in 1972, TPL has helped protect more than 1.45 million acres. TPL depends on the support of individuations, foundations and corporations. For more information, visit TPL on the web at www.tpl.org. In Utah, TPL has helped preserve more than 33,000 acres. Aside from Cache Valley, TPL is active throughout the state, preserving forest wilderness, protecting public access to the 100-mile long Bonneville Shoreline Trail, and working with willing sellers to return culturally significant lands to Native Americans.

http://www.tpl.org/tier3_cd.cfm?content_item_id=12604&folder_id=675

Appendix B

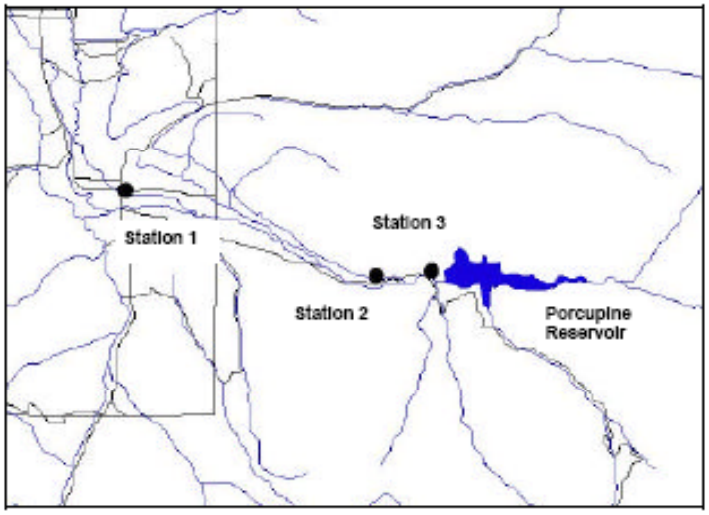
The Ichthyogram

December 2000 Volume 11 Issue 4

East Fork Little Bear River: 2000 Population Estimates

The parasite *Myxobolus cerebralis* was discovered in 1993 in the East Fork Little Bear River drainage. Its impacts on the salmonid populations are of interest, as well as impacts of recent construction at Porcupine Dam and low flows during this especially dry year. In addition, cutthroat trout of three different strains (Bear Lake, southern Bonneville, and Yellowstone) had been stocked in May in an attempt to determine any differences in prevalence in a field setting. Population estimates in this stream have been conducted for several years, permitting some long term perspectives on impacts. In September 2000, additional sampling was conducted to monitor possible changes.

Two-pass electrofishing was used to capture all fish possible in a 100 m reach. The three reaches sampled in 1997 and 1998 were sampled again on 19 September 2000. Station 1 was the reach furthest downstream, just above the Liberty Road bridge in Avon. The middle reach (Station 2) was in the area that the Division of Wildlife reconstructed to return the stream to a normal meander, and the uppermost reach (Station 3) was between the reconstructed area and Porcupine Dam.



Map of Little Bear River, showing sampling sites.

As in past years, the catch consisted primarily of brown

(Continued on page 2)

inside...

Appendix B

(Continued from page 1)

trout, data for which are summarized in Figures 1 and 2. Cutthroat were found in low numbers, primarily in the two upstream reaches. These were four survivors of the 2000 stocking (2 Bear Lake and 2 southern Bonneville, identified by fin clips) plus other cutthroat trout with no fin clips that were presumably of natural origin. These averaged 241 to 260 mm in total length. Sloped head deformities seen in 1998 were found only in a single cutthroat trout. Blacktail, another clinical sign of whirling disease, was found in one brown trout young-of-the-year.

Cutthroat trout showing classic slopehead deformity

Editor:
Chris Wilson (nrdwr.cwilson@state.ut.us)
Contributors:
Eric Wagner (nrdwr.ewagner@state.ut.us)
Ronnie Arndt (nrdwr.rarndt@state.ut.us)

Send comments or change of address to:
EDITOR, The Ichthyogram
1465 West 200 North, Logan, UT 84321

STATE OF UTAH
NATURAL RESOURCES
Wildlife Resources

Appendix C

Governor Huntsman & The Nature Conservancy Announce
Landmark Conservation Effort

Partnership Effort is the Largest Conservation Initiative in Utah History

Salt Lake City, Utah—18 July 2006—

Today, at a meeting of The Rotary Club of Salt Lake City, Governor Jon Huntsman Jr. and The Nature Conservancy announced the launch of The *Living Lands & Waters Campaign*—the largest conservation effort in Utah's history. Over the next four years, the Conservancy's statewide effort will raise $43 million in public and private funds for conservation projects to save Utah's most at-risk lands and waters. To date, the Conservancy has raised $24.9 million in public and private funds, leaving $18.1 million still to raise by July 2009.

"We're thrilled to have Governor Huntsman help us launch this effort because I think his presence reminds all of us that at its core, this conservation campaign is really about helping people, said Livermore. "Our lands and waters are not only critical to our quality of life, and our health, but they are also the backbone of our agriculture, tourism and recreation industries."

The Conservancy's Living Lands & Waters Campaign is an ambitious vision. Based on years of scientific analysis, the campaign will implement a suite of conservation projects in Utah's most important and at-risk areas – protecting lands, watersheds and species in eight massive priority regions throughout the state.

"This campaign is unique for two main reasons," said Dave Livermore, the Conservancy's Utah State Director. "First, after an intensive statewide study we have identified Utah's most ecologically significant lands and waters—and developed an innovative plan to protect them. Second, with Utah's tremendous growth, we have reached a new level of urgency. The Conservancy believes we must act quickly and decisively to save Utah's natural heritage."

A new report released this week from the Oquirrh Institute reveals disturbing trends for Utah's lands and waters, including:
--Utah loses more than 15,000 acres of agricultural land and open space to development each year.
--Utah ranks fifth in the nation for the highest number of species at risk of extinction. (Source: NatureServe)
--If current trends continue, 308 square miles—an area the size of New York City—will be developed along the Wasatch Front by 2030.

"There is no question that Utah is changing more quickly than any of us could have even dreamed possible thirty years ago," said Norma Matheson, Former First Lady and Co-Chair of the *Living Lands & Waters* Campaign. "We still have a chance, right now, to ensure that Utah remains one of the best places to live in the United States. If we destroy our open spaces, family farms and watersheds, we will have failed ourselves and Utah's future generations."

Appendix C

To coincide with the launch of the Living Lands & Waters Campaign, the Conservancy is announcing the **purchase of a conservation easement on the 6,700-acre Selman Ranch near Logan**. Nestled in the Little Bear drainage, this ranch harbors breeding ground for the Columbian sharp-tailed grouse—a bird that has already lost more than 96 percent of its historic habitat in Utah and is in danger of being federally listed as an endangered species.

"My grandfather's purchase of this land marked the beginning of a family tradition—not just of living off the landscape—but of nurturing it and enhancing its value for native animals," said rancher Bret Selman. "We are excited about working with the Conservancy on this easement because we feel like somewhere, sometime, someone needs to save a place for Utah's wildlife."

The terms of the agreement will allow the Selmans, third-generation sheep and cattle ranchers, to keep working the land and passing on their careful tradition of stewardship to future generations. The Conservancy will also work with the Selmans and other partners, including the Utah Division of Wildlife Resources (DWR) and the Utah Department of Agriculture to develop a long-term management plan that will address habitat improvements, invasive species and sustainable logging on the ranch.

"Saving places like Selman Ranch is becoming increasingly difficult in burgeoning Cache County," said Joan Degiorgio, the Conservancy's Northern Mountains Regional Director. "As the City of Logan grows, its impacts on traditional agricultural lands and open spaces are real. Residential developments and ski lifts have recently been proposed for the undeveloped South Fork of the Little Bear River drainage—just 5 miles from Selman Ranch."

The Selman Ranch is just one example of the tangible, on-the-ground results that are possible through the *Living Lands & Waters* Campaign. Thanks to support from private contributors, the LeRay McAllister Fund, DWR and the federal Landowner Incentive Program, the Conservancy has **already raised $1, 480,000 for this easement, but still has $2,295,000 left to raise.**

"The protection of Selman Ranch is a major conservation success story and a perfect example of the importance of the *Living Lands & Waters* Campaign," said Livermore. "Over the next four years, we will work to save more places like Selman Ranch—areas that harbor critical wildlife habitat and are important to local communities, and places that are under increasing pressure from human impacts."

A few other key projects of the *Living Lands & Waters* Campaign include:

Virgin River Headwaters: a conservation collaboration among 17 ranchers on 11,000 acres near Zion National Park, supporting critical habitat and a key watershed.
Boulder Creek Canyon Ranch: the protection of prime ranchland in the heart of Boulder, creating a wildlife corridor between natural protected areas.
Great Salt Lake: the *Wings & Water* Wetlands Education Program offers 4th grade students and teachers a new way to use the Great Salt Lake as an unforgettable outdoor classroom.
White Dome: a new 800-acre preserve in Washington County will create a community resource and save some of the world's last remaining populations of endangered wildflowers.

Appendix C

"The *Living Lands & Waters* Campaign marks a new era for conservation in Utah," said Former US Senator Jake Garn. "Just as our ancestors had the foresight to plan our cities, protect key watersheds and carefully steward Utah's natural resources, we must have the wisdom to do the same. *Living Lands & Waters* will make a tremendous contribution to the future of our state."

The mission of The Nature Conservancy is to preserve the plants, animals and natural communities that represent the diversity of life on earth by protecting the lands and waters they need to survive. To date, the Conservancy and its more than one million members have protected more than 12 million acres in the United States and helped protect more than 80 million acres in the Americas, Asia and the Pacific. www.nature.org

<http://www.nature.org/wherewework/northamerica/states/utah/press/press2555.html>

Appendix D

Hyrum City GIS Land Planning Atlas

An Analysis Discussing Geographic
City Planning Safety Issues

By: Zac Covington

Final Student Project for WATS 6920
Geographic Information Systems
Professor Matthew Baker
Utah State University
Fall 2006

Appendix D

Table of Contents

List of Figures

Appendix D

1-1 Abstract

In land planning for rural areas or growing urban areas surrounded by large amounts of open land, it is important for city councils and planning commissions to designate land uses carefully. The public and the adjacent municipalities in these areas could be vulnerable to many different types of natural or man-made disasters, if proper residential development planning principles are not addressed. Developers and land owners can also be of assistance to potential clients by becoming knowledgeable and responsible concerning the various local physical threats that exist around developing communities.

The purpose of this project was to examine and analyze various bio-physical components of the landscape surrounding Hyrum City, a growing town in Northern Utah. Through the use of Geographic Information Systems (GIS), these landscape components were compiled and analyzed to give visual mapping of the geographical areas where development and growth could safely occur, and where it should not occur. It was intended to provide a tool for community planners to utilize for the safe and responsible planning of their city.

1-2 Introduction

This project considers the land adjacent to Hyrum City, which is located in the southern end of Cache County, Utah. Hyrum City is a growing city that has acquired recent development demands from various sources. The following is an excerpt from the Hyrum City Website: "For many years, Hyrum's population remained stable at 1,700 people. Then, following a growth spurt in the early 1970's, Hyrum leveled off at 3,900. Over the next decade-and-a half, the population inched upward until a flurry of building in the mid-1990's, caused by an influx of people from outside the valley, boosted the present population to approximately 6,300 as reflected in the 2000 census (Hyrum City)."

This growth has been planned for by the current community leaders, and has offered the city some challenges. This report shows briefly and visually what geographical areas in the area could be responsibly developed, and which areas should be avoided for the safety of future Hyrum City residents.

There has been extensive use of GIS in the past to incorporate similar and more detailed analysis processes as this project locally, nationally and internationally. Some of the more recent and local examples include planning involving the Wasatch Front and Cache Valley, both in the State of Utah. Both of these projects researched public health, safety and welfare issues surrounding various growing communities. Mapping was then applied that showed areas of high and low concern for safety, and provided communities and planners with crucial information for their areas.

Appendix D

2-1 Methods

The methods used for this project encompassed the gathering of data, importing the data into a GIS program (ArcGIS 9), extracting relevant data, adjusting colors and the organizational order of the relevant data, analyzing the data and creating maps that were useful for community planners. The data was obtained from several sources including the Utah Automated Geographic Reference Center (AGRC) and the Natural Resource Conservation Service (NRCS). The data acquired for this project was the following:

- Cache Valley 10 Meter Digital Elevation Model (used to determine slopes, view-sheds and to create a hillshade)

- Data Shapefiles including liquefaction potential, SURGO soils, fault zones, FEMA floodplain, landslide potential, wetlands, roads, lakes and streams

- Cache Valley National Agriculture Imagery Program (NAIP) 2004 (10 Meter)

The data that was required for analysis was first refined for the proper usage of the included components of the landscape. Data layers that were analyzed for areas designated as un-safe for developing were 30% and greater slope, moderate to high liquefaction potential, landslide areas, limited soils for residential development, fault zones, floodplain, and wetlands. These components were all merged into one layer that was designated as lands that were not safe for residential development. The layers that were labeled as un-safe to develop were intentionally categorized as a single value, given the importance of each of these components, discussed in later sections.

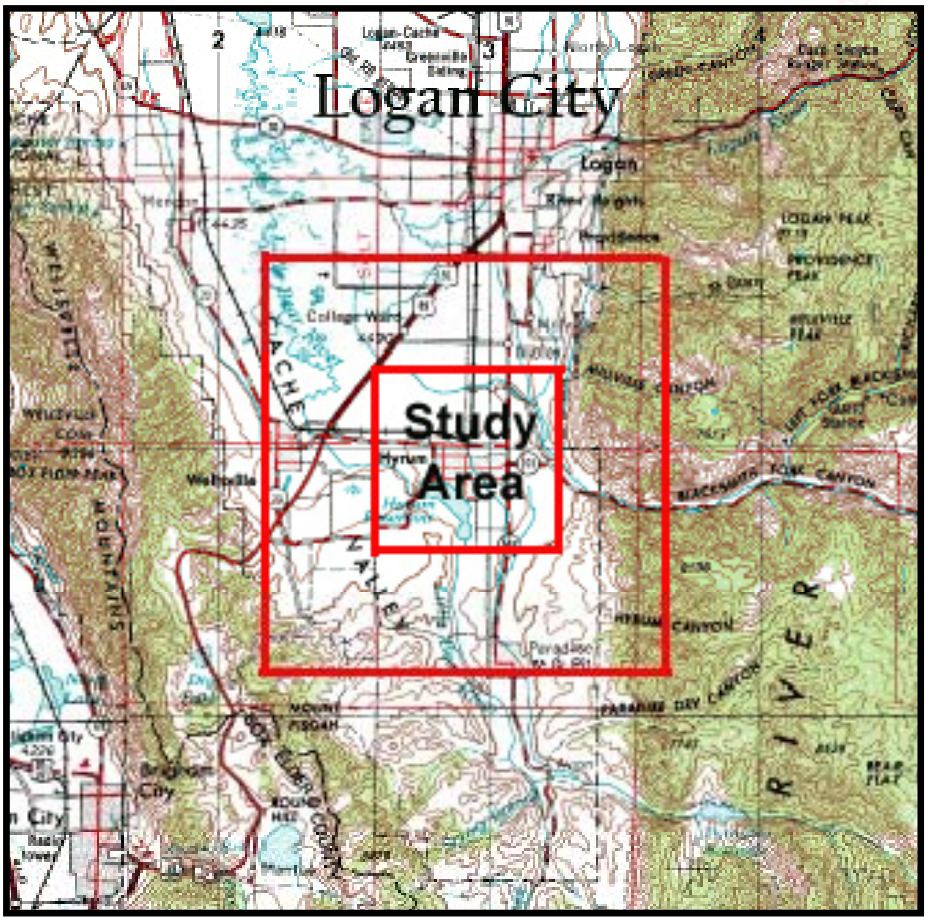
The data was also used in an analysis to determine what areas may have greater potential for residential developers to build on based off of three main components. These include slopes 5-15% (easy to develop and maintain), non-limited soils (safe to build on), and within a ¼ mile buffer of roads (close to existing infrastructure, which is less expensive to develop). Three views of the city were also taken into account, and were each from prominent city gateway areas that are frequently used by residents and visitors. These view-shed analyses are intended to give community planners assistance in determining which areas are viewed most prominently from their cities and whether or not those views should be changed with growing development.

2-2 Results

In the analysis and merging of each of the components listed above, the visual clarity and geographical importance of each component is essential. The following pages are designated for individual and combined layers of the analyses and contain general summaries and results of the accompanying maps.

Appendix D

Hyrum City is Located in beautiful Cache Valley, Utah. With new demands involving residential and commercial growth, the city has new pressures for finding land that is suitable for development, and safe for family housing. It is located on Highway 165, which runs from Logan City to Paradise, Utah. Hyrum reservoir compliments the city with recreational opportunities, as does the nearby Forest Service lands.



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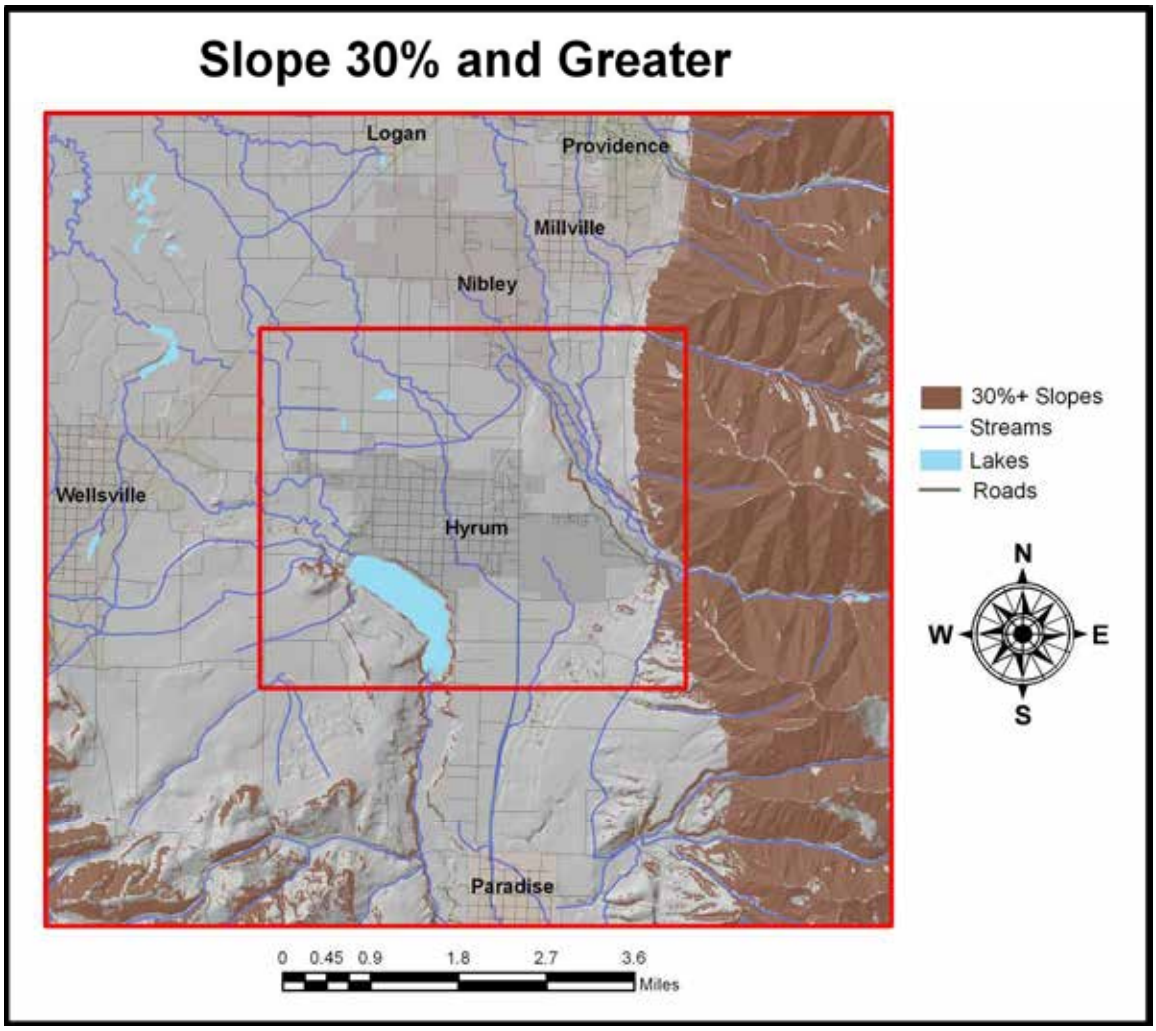

One important geological factor affecting and in many ways determining areas that suitable for development is slope. There are various ranges of slope that are acceptable for building on, ranging from 0 to 35% and greater. However, professionals that design and build residential lots and subdivisions are cautious about building on any slope over 30%. In the Hyrum area, high slopes are not really a problem in most areas, but there are some steeper areas that could prove to be problems in the future.

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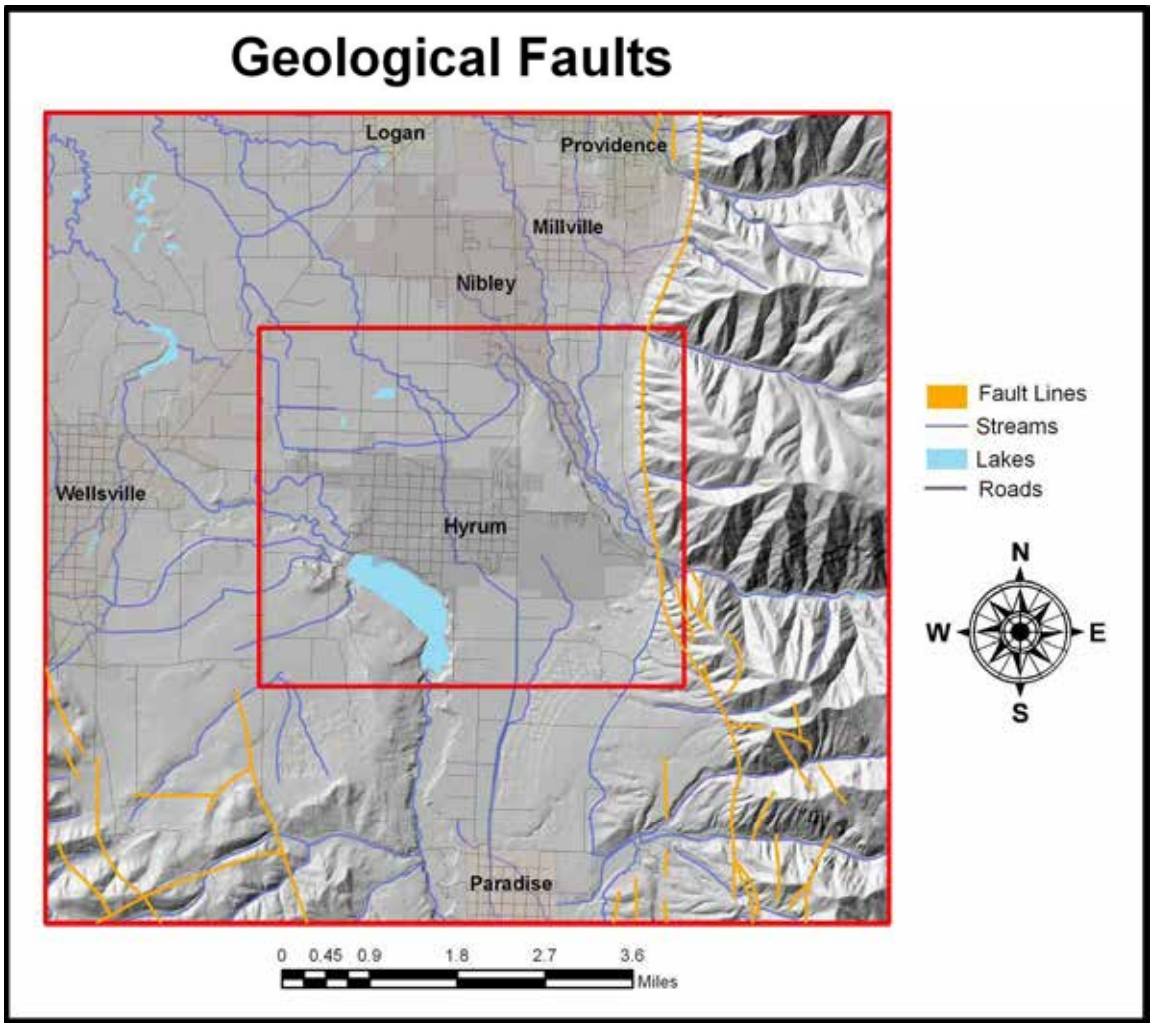

Earthquakes are expected to affect much of northern Utah in the future. Geologists have been warning Utah residents for many years that we are due for earthquakes that could be sizable. While earthquake magnitude and arrival can not be fully predicted, there always remains the chance that Hyrum City could be affected. The east bench is where the main faults are located, as seen above, and should be avoided when deciding on building location or zoning designation.

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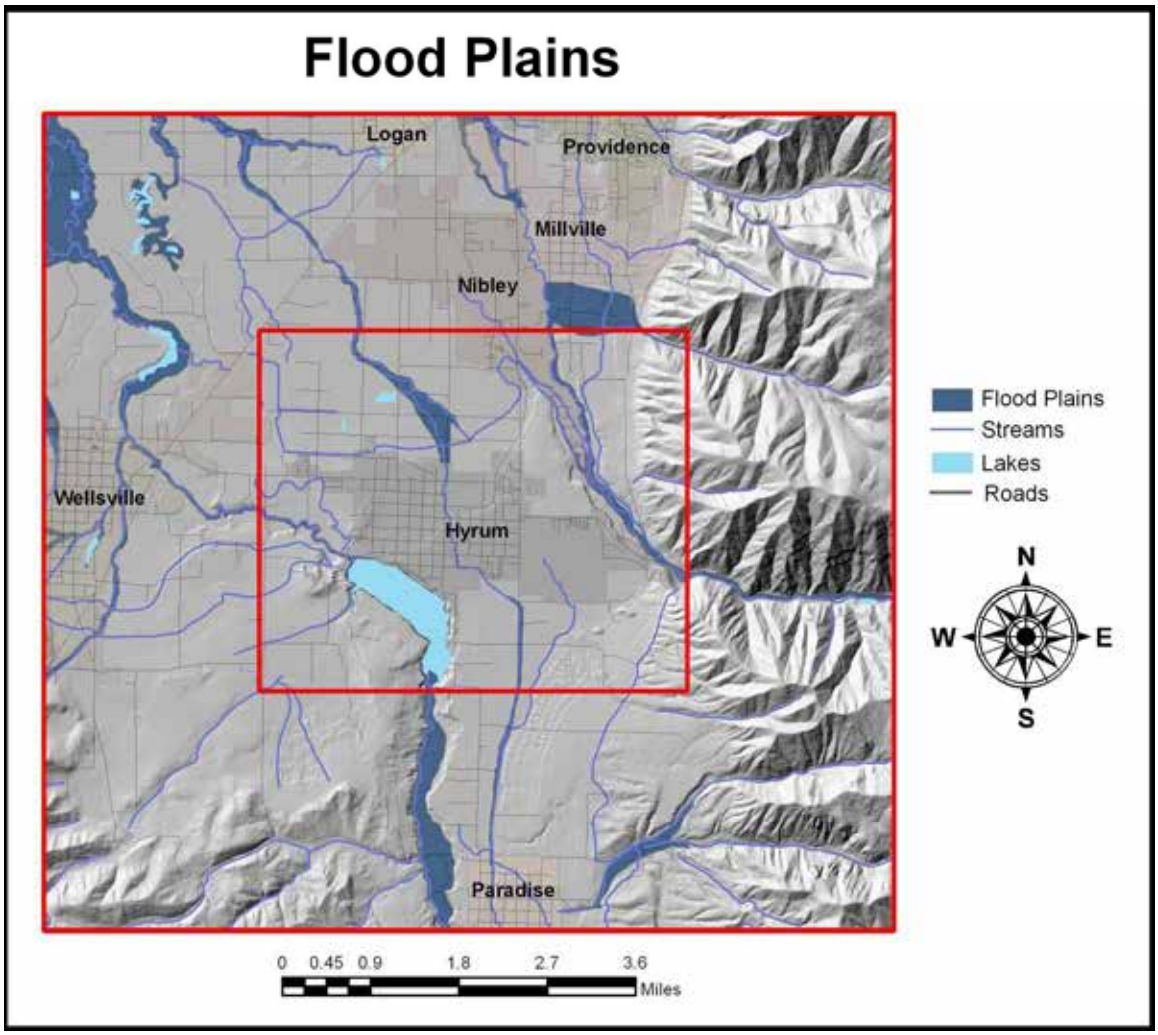

Although there are existing structures in the path of the flood plains in Cache Valley, such as dams and reservoirs, flood danger has historically been a problem in some areas. Millville, Nibley and other towns near Hyrum suffered from flooding several years ago, which damaged fields, houses and other types of personal property. Natural drainage of the surrounding watersheds has been dramatically altered with increased urban development in the valley, and Hyrum is no exception. There is always a chance of flooding in the western U.S., and municipalities and individuals can be financially protected by developing away from these areas.

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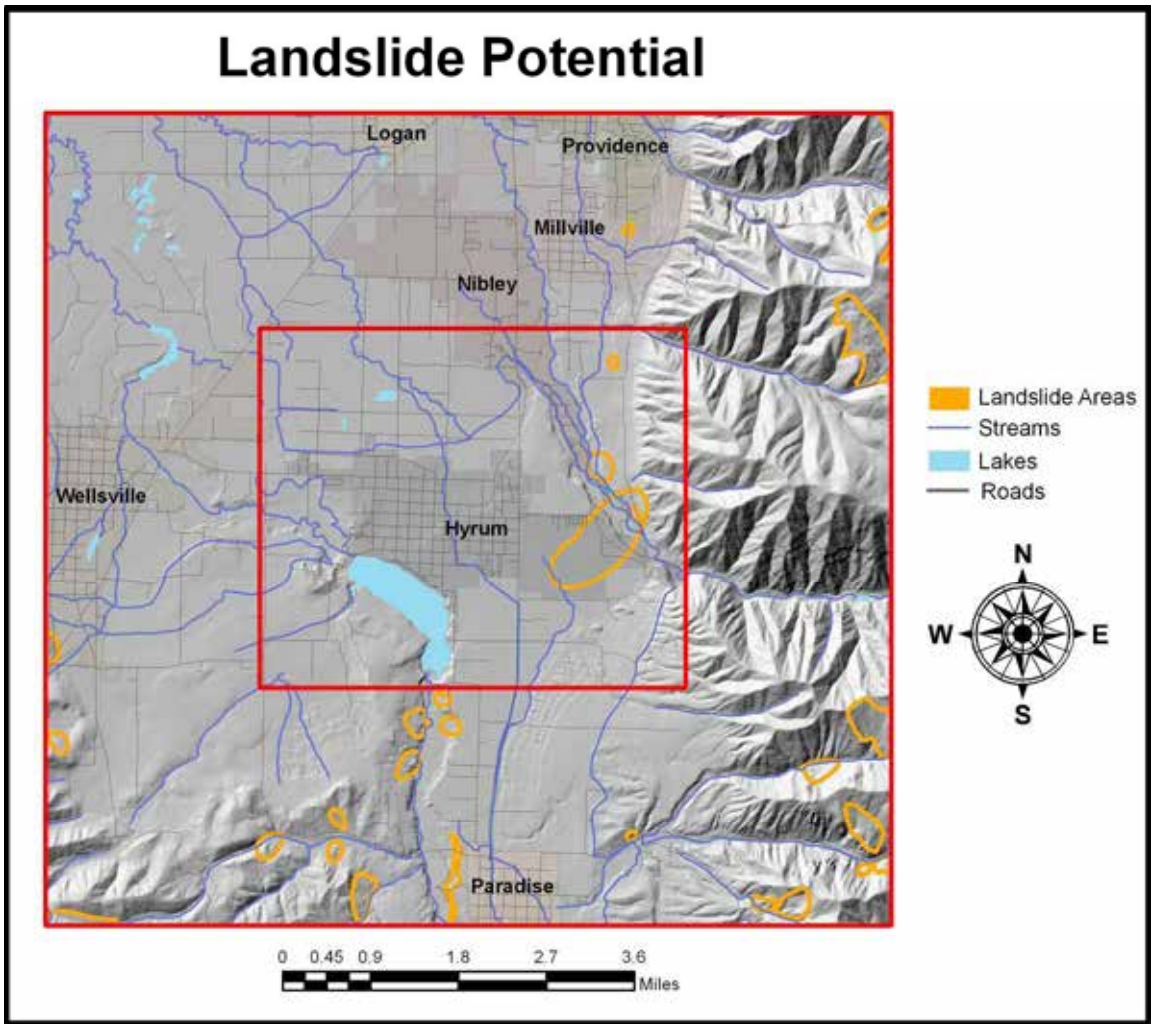

When building on and around a historical lake and its shoreline, including the historical Lake Bonneville and its shoreline, ground stability can be of great concern. Since it is near impossible to predict exactly how, where and when these events can occur, using available data can help in preventing disaster. These landslide potential maps from the AGRC show those areas most prone to landslides and can aide in those decisions.

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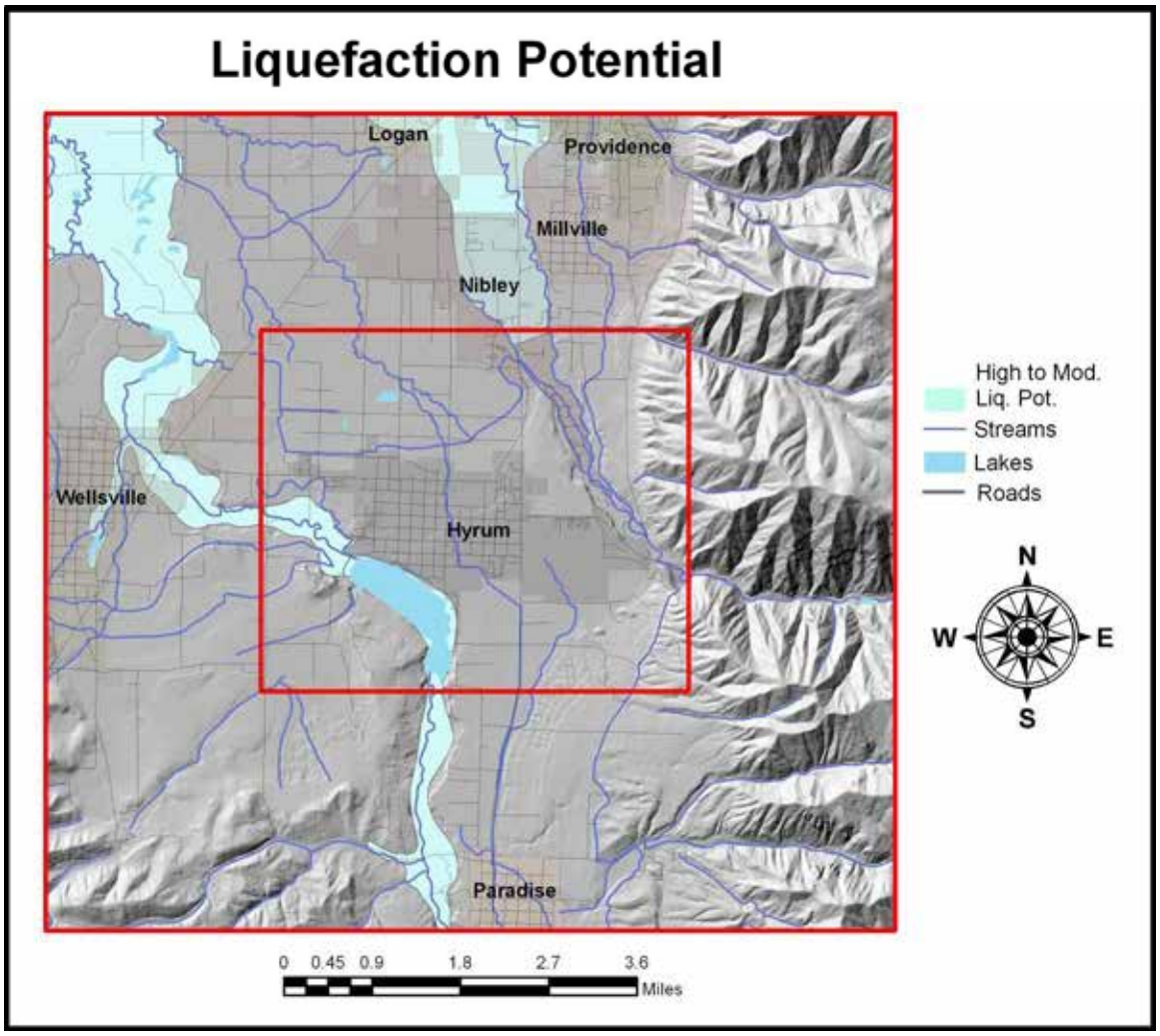

Liquefaction is a problem that can occur during an earthquake, where saturated soils become unstable and liquid-like, moving and destroying houses, roads, sewer and anything else in its path. Problems with liquefaction have occurred in areas such as Anchorage, Alaska where structures were torn from their foundations and people were injured. Since liquefaction is a variable that includes soil type and saturation, areas with a high water table and specific soil types combine to create serious problems.

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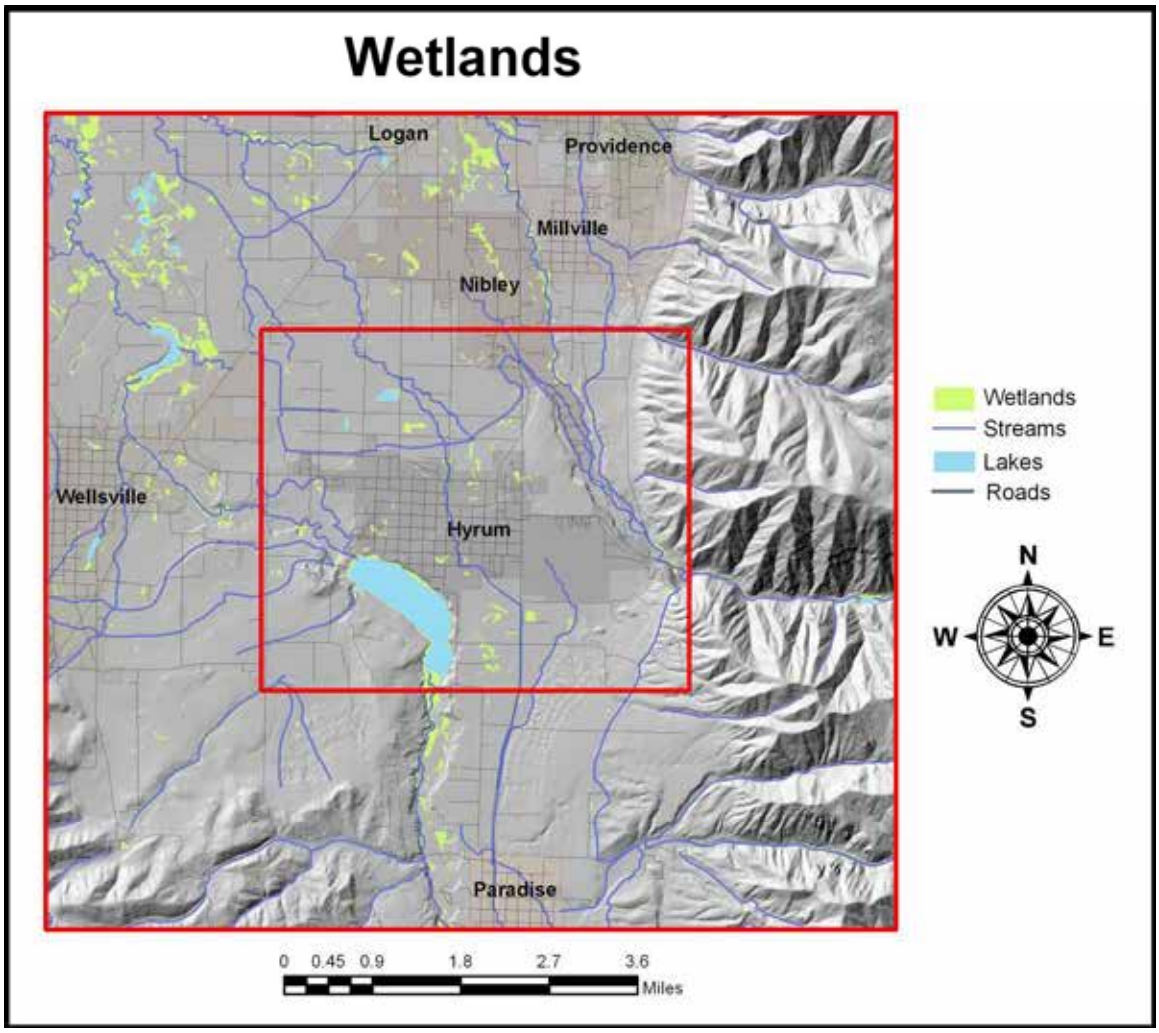
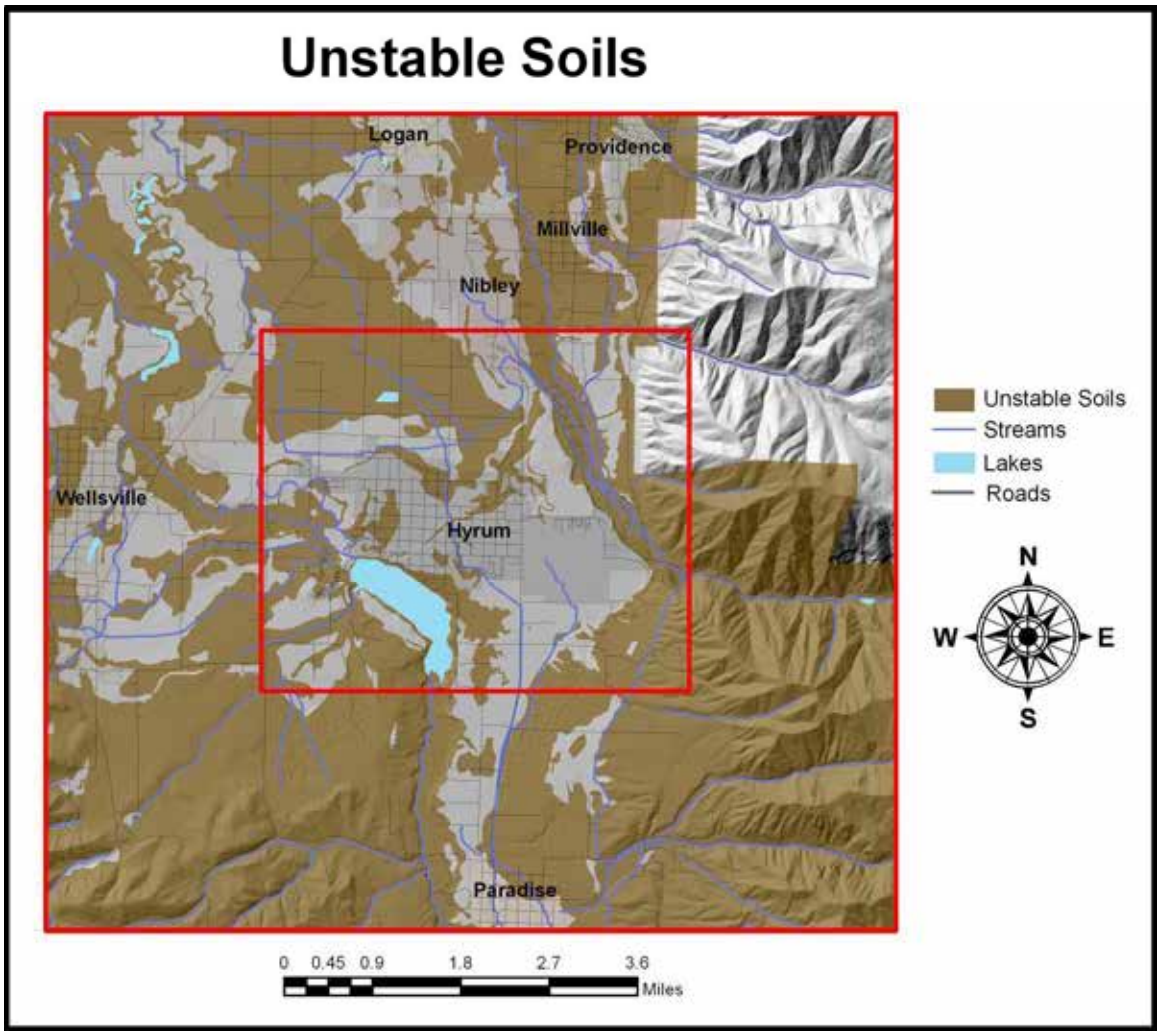


While there are many aspects concerning ground water quality, wetlands is one of the most critical affecting the natural filtration of a lower watershed system. Wetlands also have been designated as some of the most valuable lands in the U.S., housing wildlife and providing enjoyable and economically rewarding aesthetics for an area. Besides the general quality that wetlands bring to a city, the soils are not suitable for building, and should be avoided when concerned with development.

Appendix D



Soil stability can an important factor in t he structural integrity of building foundations. If the ground underneath a structure is not solid, there can be problems, not only regarding a freeze/thaw scenario, but during an earthquake as well. Bad soil conditions in the valley are most generally tied to high clay content, and are made even more unstable with added water saturation. This soil data is taken from the United States Department of Agriculture (USDA) Natural Resource Conservation Service SSURGO database.

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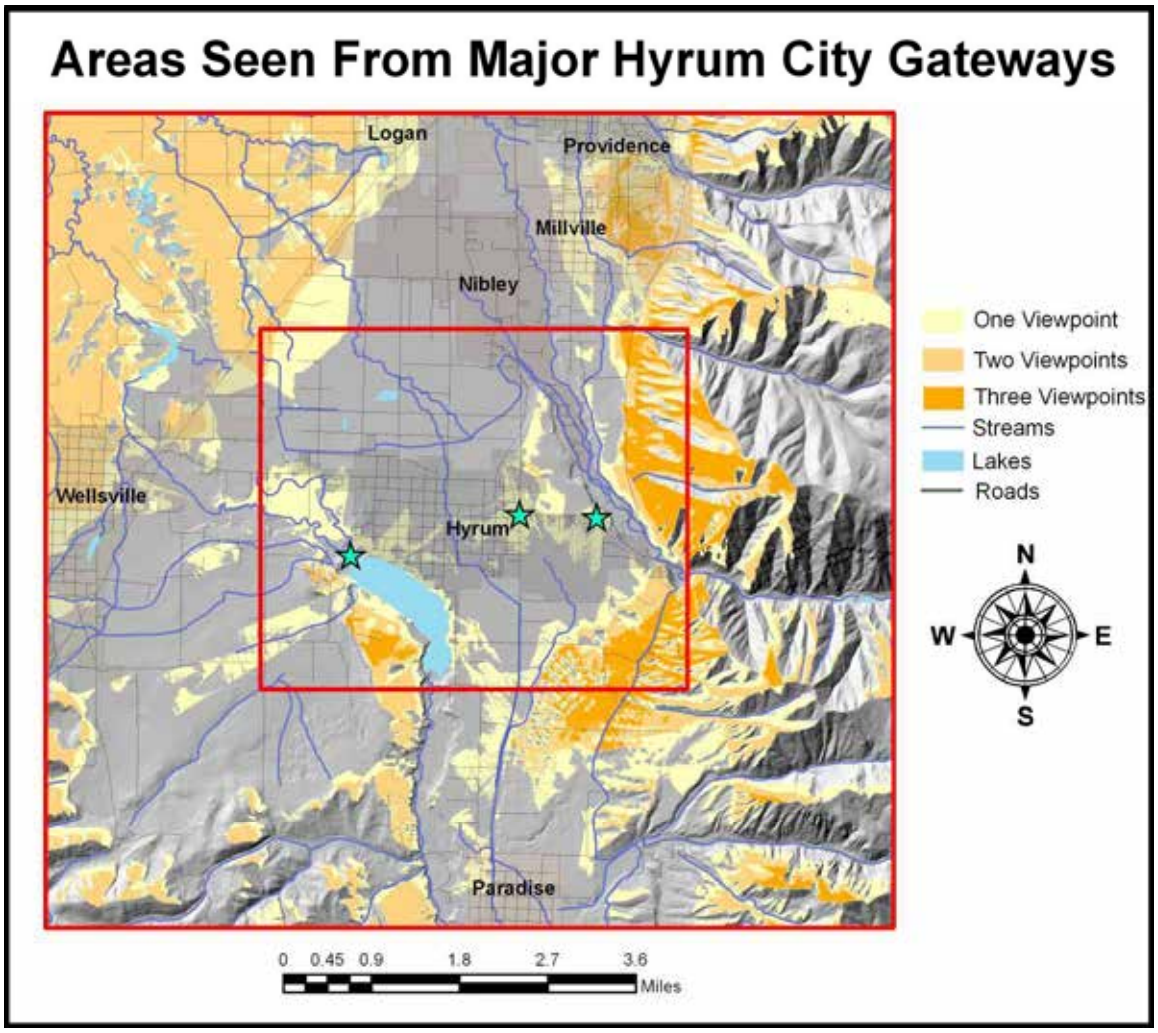

Hyrum City is a beautiful place to live for its residents, and those that drive through or visit. There are many good areas for views of the city, but several are more memorable than others. In this analysis, I chose three of the best "gateway views" that I enjoyed, going into the city and out. These are areas where one is generally at the same elevation as the main part of the city, and the analysis was done at a height of about 6 feet. As seen in the map above, the darker the orange, the more visible the site is from the three sites combined. Hyrum City has several critically viewable areas surrounding it, and this should be taken into consideration as well when zoning and development recommendations or approvals are made.

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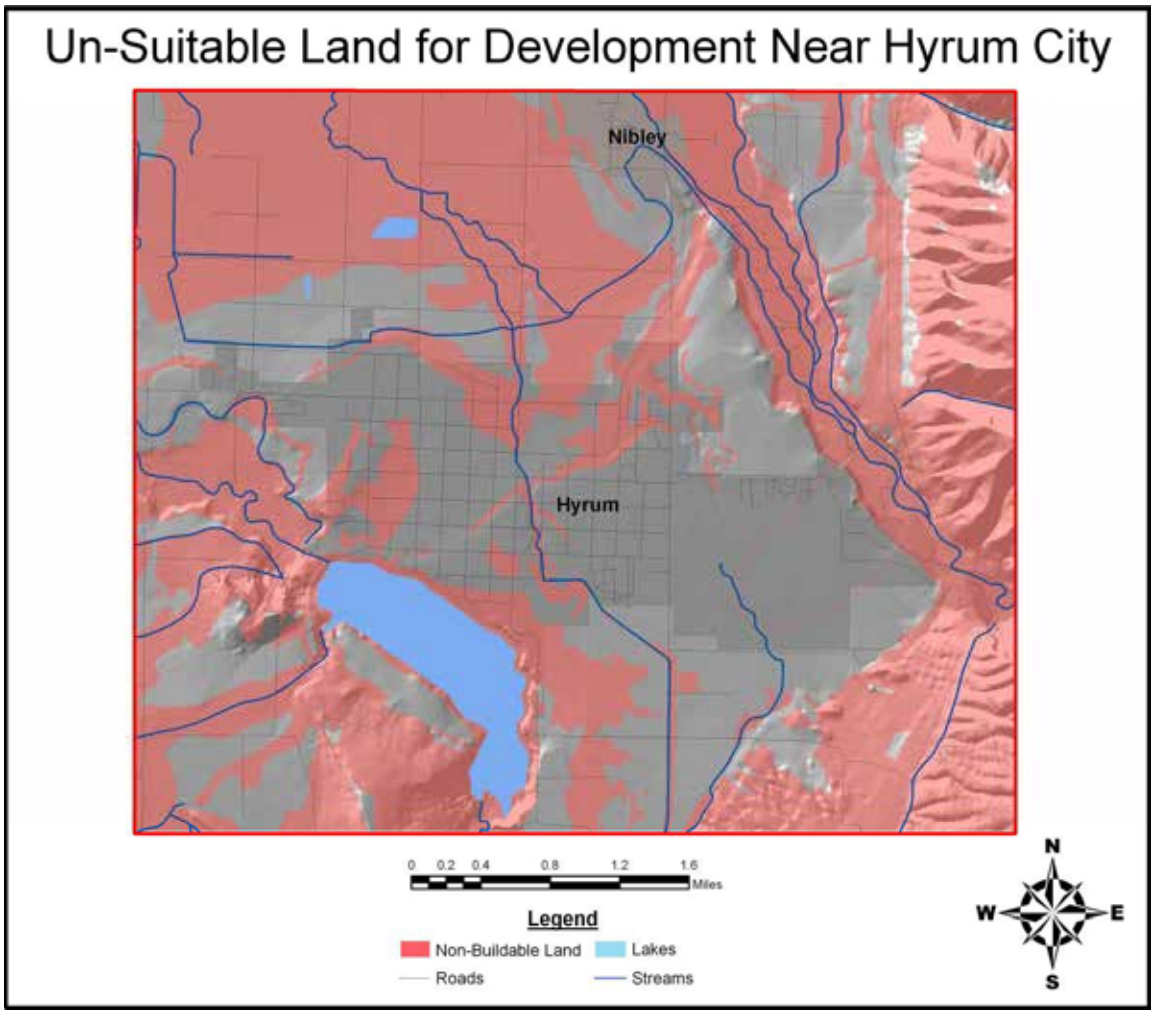
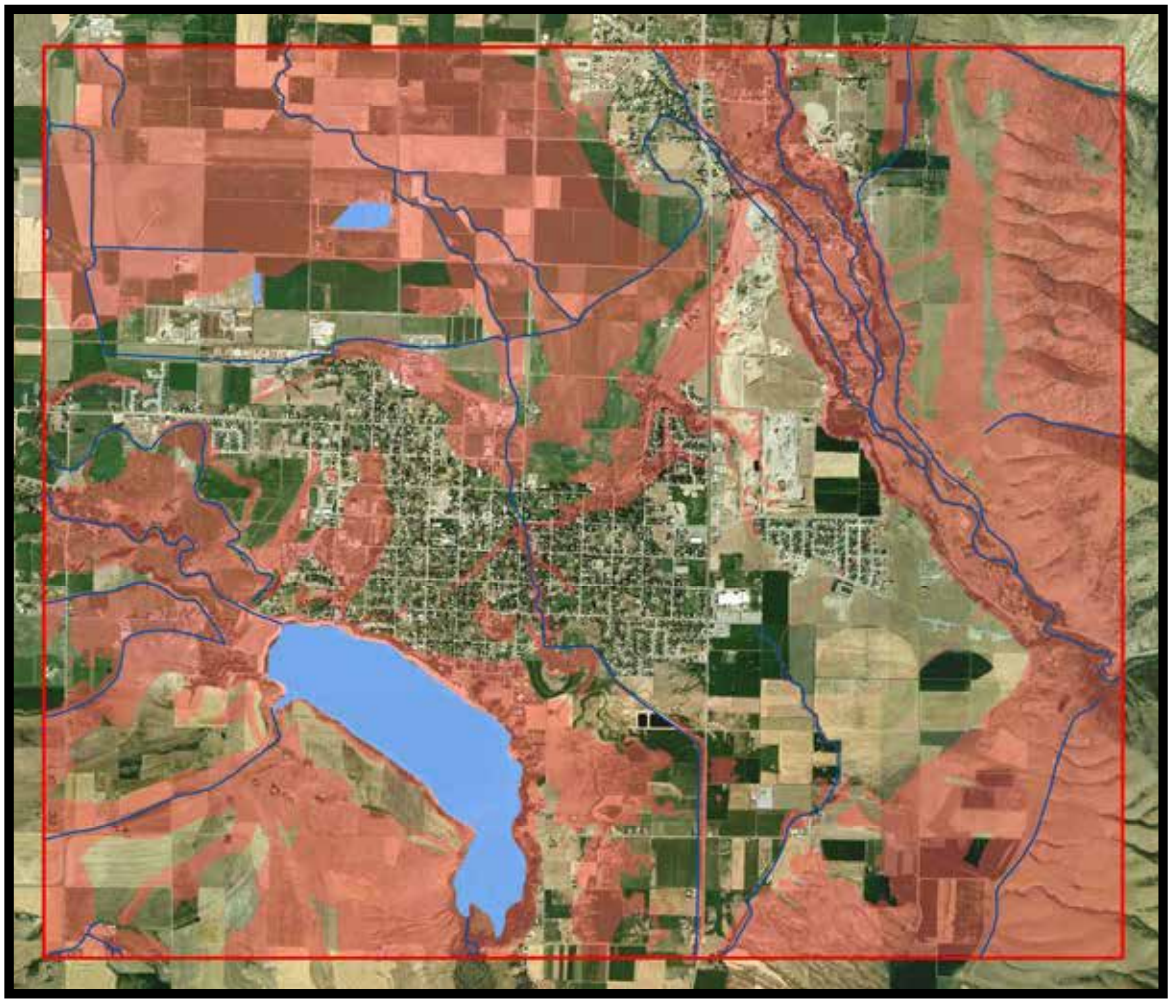


After the previously presented layers are all added together in a composite, areas that have any one of the elements described are shown in red. Since one of these is not necessarily more important than the other, each is left to remain as a critical area that should be avoided when developing an area. While Hyrum City is generally building in safe and economically viable areas, certain un-suitable building locations could be discussed in order to prevent safety issues from arising.

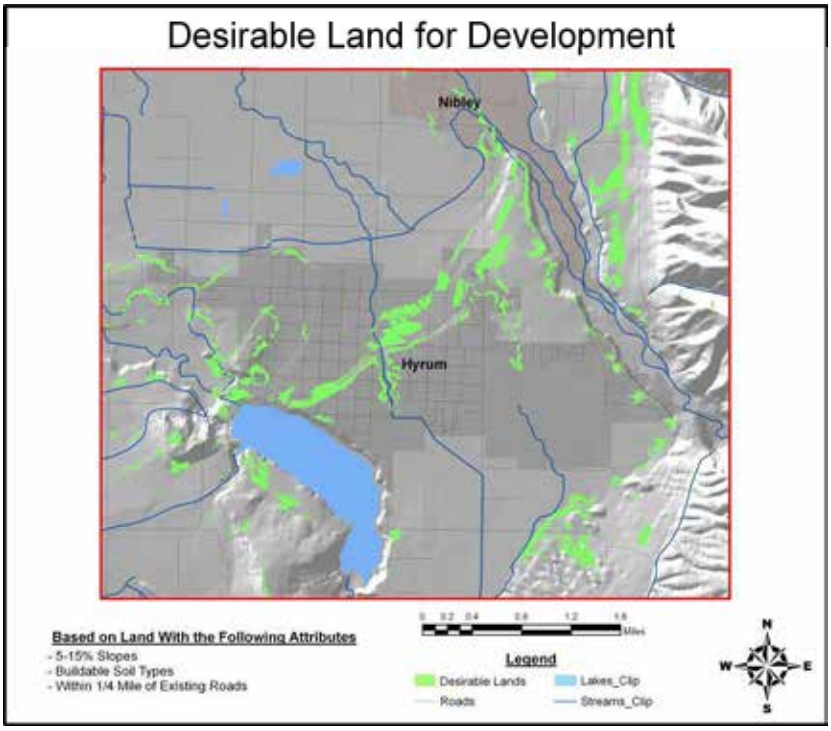
Appendix D



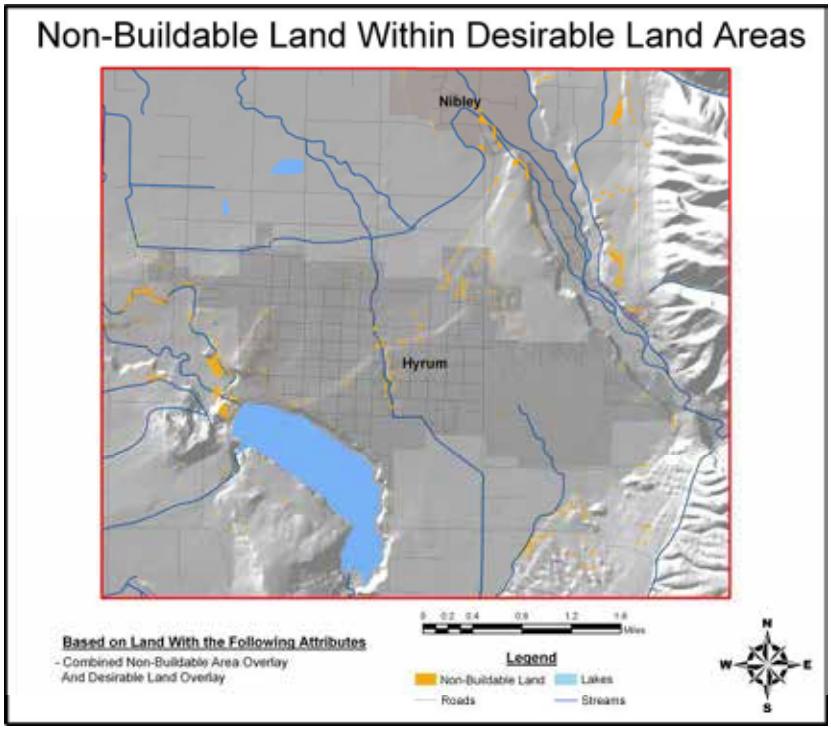
This is the same layer of land that should be avoided in the development of Hyrum City. It has been placed over a NAIP aerial image from 2004, to give officials a better idea of where the critical land areas are. When looking at this photo, one can see where there is room for safe development, and where the city can zone for development in the future. By analyzing and making decisions based on critical lands in these specific areas, community leaders can plan safer, more aesthetically and economically viable communities. The remaining critical lands not only serve as municipal safety cushions and various types of working lands, but they can also serve as future park sites or other amenities that can add value to a community.

Appendix D

These maps were created using several of the previous layers including suitable soils, slopes from 5% to 15%, and are within ¼ mile of existing roads. Each of these elements is crucial for developers in having an area that is easy to build on and that has proper water drainage.



The lower map shows the areas desirable for residential development that was over-laid with the lands that are un-developable from a safety standpoint. Though not many of these areas exist, they are places that should be avoided when building in these desirable areas.



Appendix D

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Flood Zone Information From Metadata Text: Description Abstract: Flood Zones as determined by FEMA and FIRM between 1978 and 1981 Purpose: digitized by BRAG for the purpose of hazard analysis and mitigation plan).

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Liquefaction Problems in Anchorage Alaska:
http://nisee.berkeley.edu/bertero/html/damage_due_to liquefaction.html

Soils Layers and Designations: USDA NRCS SSURGO Metadata reports in the MS Access SSURGO template database, or from the Soil Data Mart website at:
http://soildatamart.nrcs.usda.gov/ssurgometadata.aspx

Citation_Information:
Originator:
U.S. Department of Agriculture, Natural Resources
Conservation Service
Publication_Date: 20051129
Title:
Soil Survey Geographic (SSURGO) database for Cache Valley
Area, Parts of Cache and Box Elder Counties, Utah
Publication_Information:
Publication_Place: Fort Worth, Texas
Publisher:
U.S. Department of Agriculture, Natural Resources
Conservation Service
Other_Citation_Details: ut603
Online_Linkage: URL:http://SoilDataMart.nrcs.usda.gov/

Utah AGRC Website: http://agrc.its.state.ut.us/

Appendix D

3-2 GIS Analysis Notes

•Added all layers
•Created two new view polygon shapefiles (one for Hyrum close-up and one for the region (to adjacent towns)
•Clipped all features with largest boundary as clip feature
•Changed symbolism and organized
•Created slope map – ArcToolbox, spatial analyst, surface, slope
•Reclassified slope – 30% and less = 1, all others = 0
•Selected and Extracted Moderate to High Liquefaction Potential
•Selected and Extracted "non-limited" for residential development SSURGO soils (SSURGO Metadata reports in the MS Access SSURGO template
•Selected inverse (limited soils) for unsuitable soils layer
•Researched Earthquake buffers in California and found recommendations to be from 50 ft to 1000 feet both sides. Decided to use the 50 ft minimum regulatory buffer in State of California Code (C:\temp\Zac\gis\california geo survey code earthq.htm)
•Converted unsuitable soils, moderate to high liquefaction potential, lakes, streams, landslide potential, wetlands, and floodplain to rasters
•Created three view points from Hyrum City and did Viewshed analysis at 2 meter height (6 ft.)
•Reclassified Slope – 5-15% slope for most desirable building areas
•Buffer Roads with ¼ mile buffer and clipped from study area
•Multiplied the three previous layers together to get a "most desirable lands" map
•Multiplied "most desirable lands" x "non-buildable lands" to get potentially unsafe areas within the most desirable building lands
•Also did overlay of Non-Buildable Land over a 2004 NAIP aerial photo (from AGRC) to give realistic orientation
•Made Utah and Cache County orientation maps

Appendix E

A Geographic Information Systems (GIS) Assessment of Critical Lands Surrounding Paradise Utah

Evan Curtis

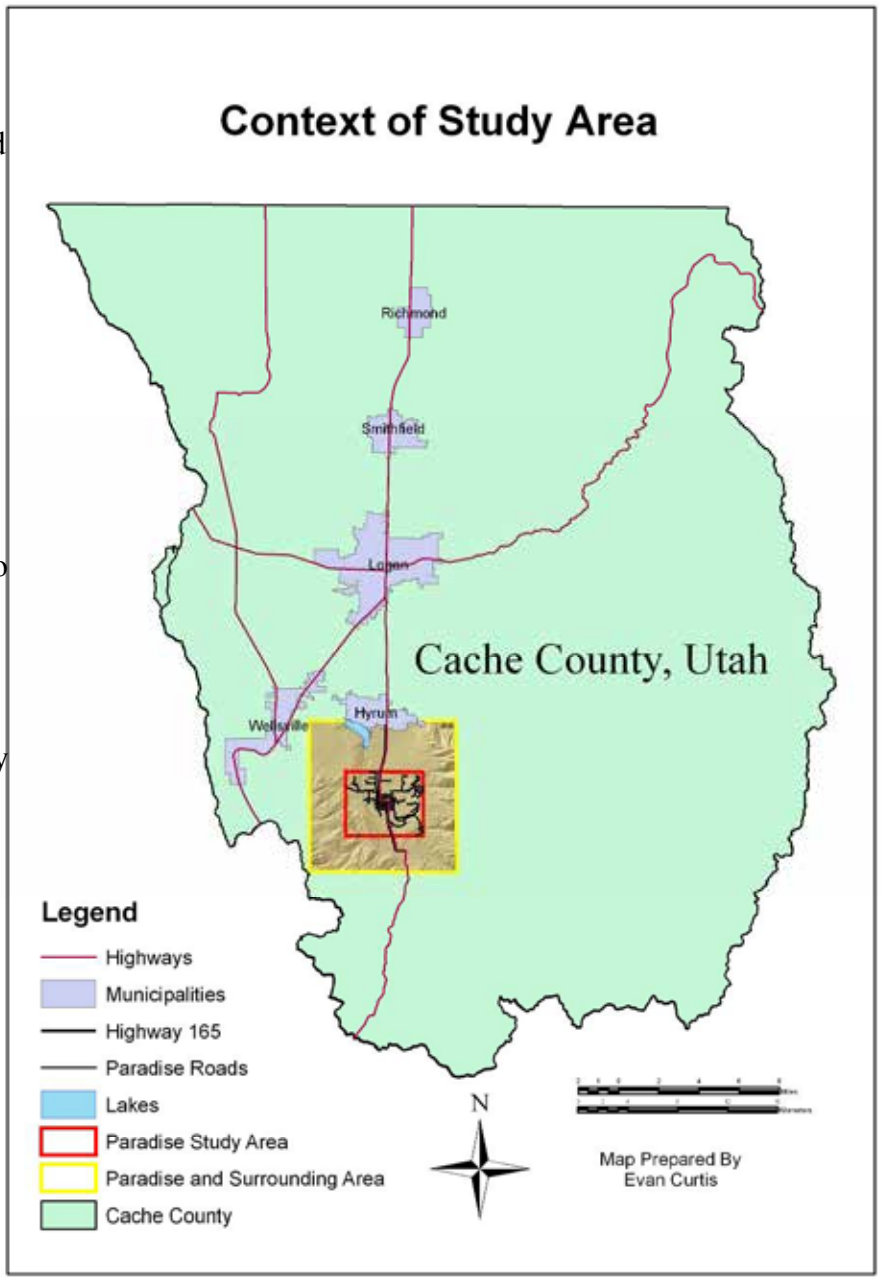
Appendix E

Abstract

With rapid growth occurring in Cache County Utah, there is an increasing demand for developable land. However, many areas are better for development than others, and some are simply unsuitable for development due to natural hazards or environmentally sensitive areas. These lands are critical for the health, welfare, and safety of residents in the area. This study looks at which lands in the Paradise, Utah area are unsuitable for development, and then of the remaining lands, which lands are best suited, or most desirable for future development. In order to accomplish this, a Geographic Information System (GIS) approach was used, which uses computer data and models to generate maps based on selected criteria.

Introduction

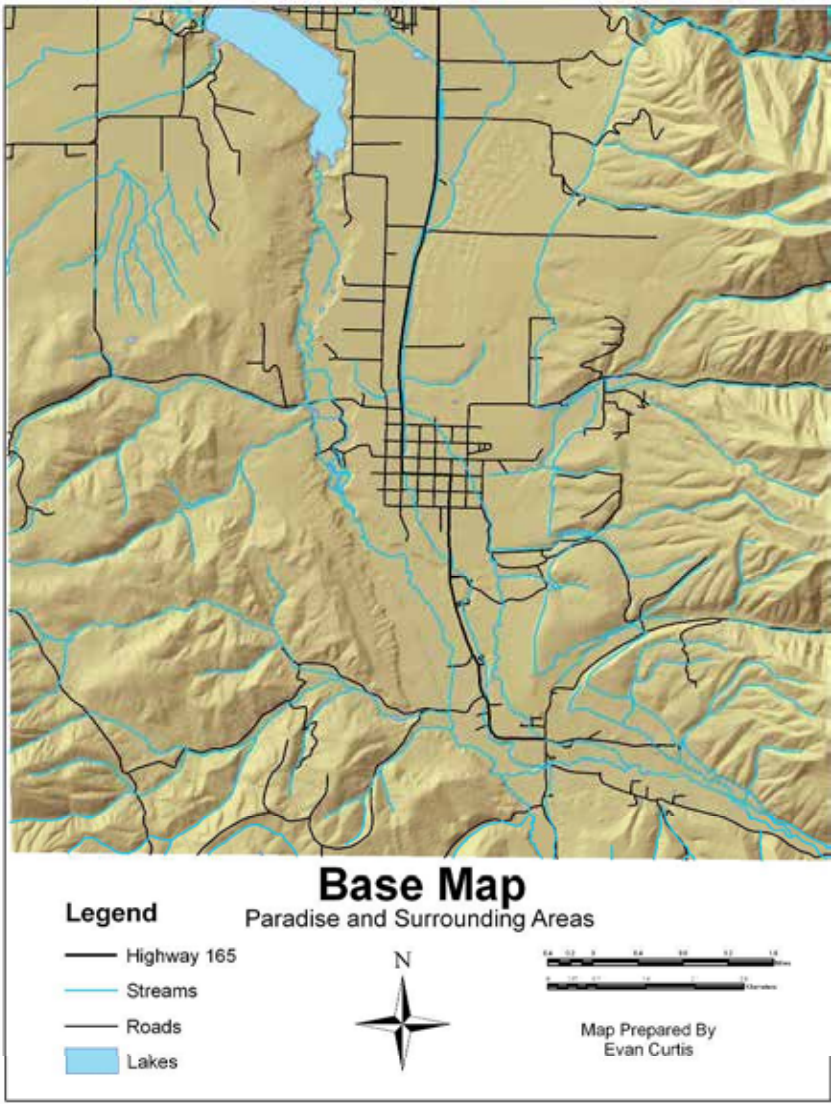
As a bioregional planning student, I posed the question, what lands are best suited for development in the south end of the valley based on natural hazards and environmentally sensitive areas? To answer this question, I used a geographic information system (GIS) approach to map the critical lands, and find areas where these lands overlapped. To understand critical lands it was necessary to compile a base map, and maps of the different elements of critical lands. While many more features could have been added to an assessment of critical lands, such as riparian areas, a buffer of streams, and wildlife habitat, I included only what I feel, after a careful study on the subject, those critical lands that directly influence the public health welfare and safety of the human populations who will be living in these areas. While every effort was exerted to assure the accuracy of the data and the models which were derived from these data, the maps are not guaranteed to be accurate. Inherent in any GIS model is a certain level of error and uncertainty. These models should therefore only be used as a general guide in funneling development to the most appropriate areas.



Appendix E

The Base Map

The creation of base maps gives a point o reference from which to work. This base map of Paradise and the surrounding area includes roads, streams and lakes data from the Utah Automated Geographic Reference Center (AGRC), a GIS data site for the state of Utah. It also includes a hillshade derived from a 10 m digital elevation model (DEM) that was also obtained from the AGRC.



Critical Lands

In order to evaluate the critical lands in the area, it is necessary to define what a critical land is. The Governor's Office of Planning and Budget defines critical lands as "lands which are essential to the health safety, and welfare of Utah and its residents" (Governor's Office of Planning and Budget, 2005). Critical lands are divided into three categories by Envision Utah: Natural Hazards, Environmentally Sensitive Areas, Open Space and Agricultural Lands (Envision Utah, 2002). Due to time. constraints, this model will only concentrate on risk posed to public safety through natural hazard areas and environmentally sensitive areas

Arguably the most important landscape features to regulate for public safety are those with potential natural hazards. Natural hazards can pose a risk to public health, safety, and welfare through the possibility of destruction to property and even human life. Some potential natural hazards in the Little Bear River watershed are geological hazards in the form of steep slopes, fault lines, and loose soils prone to liquefaction. Flooding hazards can exist anywhere there in the flood plain, and is also a risk in areas with shallow water tables. By avoiding development in these areas, harm to human life and property can be greatly reduced. be living in these areas.

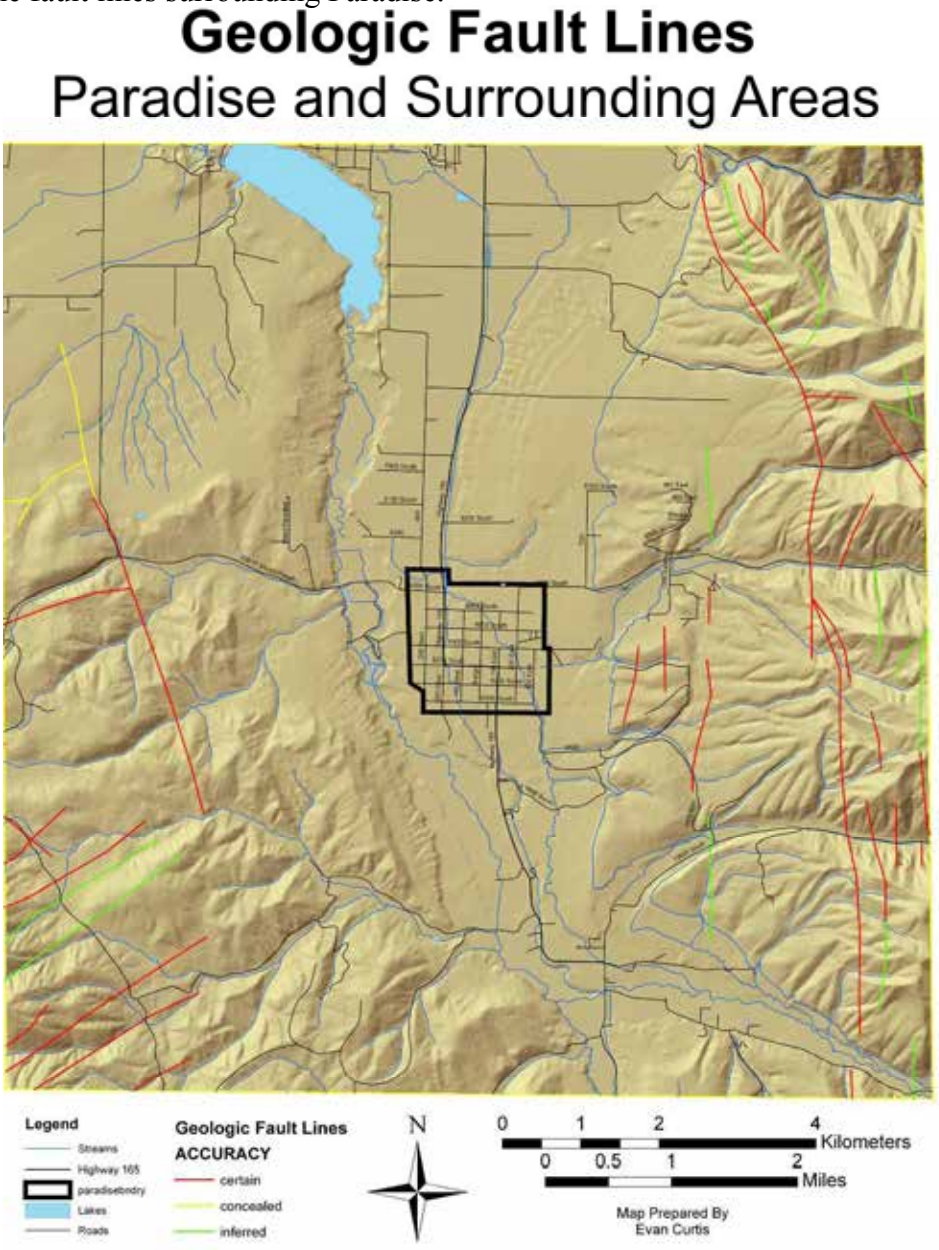
Geological Hazards-

The Cache Valley is bounded on both sides by fault lines. This normal faulting has lifted mountains and lowered the valley, resulting in unique natural beauty, as well as potential risks to development (Liddell and Ohlhorst, 2005). In the event of a major earthquake, besides the initial effect of shaking on development, loose soils could also result in landslides or structures sinking due to liquefaction.

Appendix E

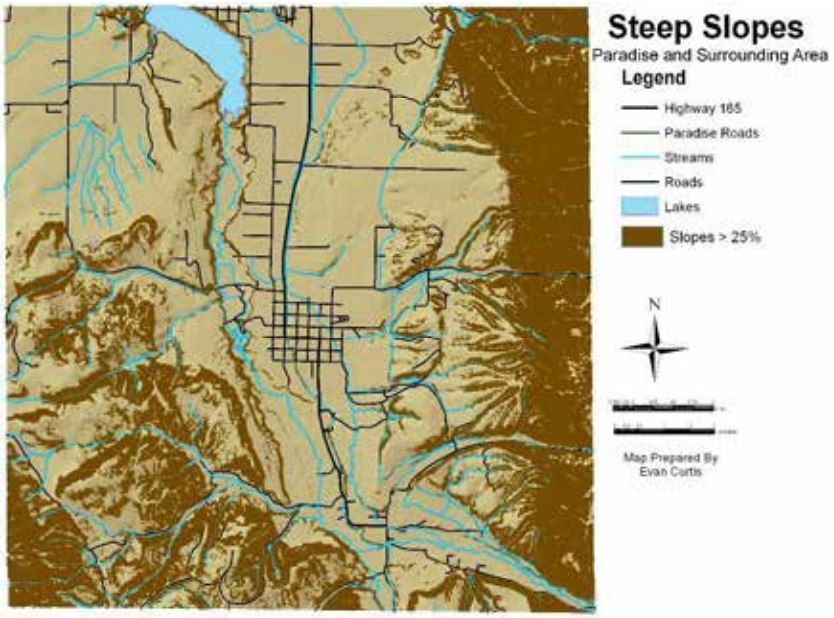
Earthquakes and Fault Zones

An earthquake is basically a rupture or slip of rock along a fault caused by excessive forces within the earth's crust. This ground shaking, especially the horizontal forces, can be very destructive, especially to older structures (Christenson, 1994). Earthquakes may also cause flooding, which will be discussed later (BRAG, 2004). Considering the fact that Cache Valley falls in a high threat area for earthquakes relative to other areas in Utah, according to the Uniform Building Code seismic zone map, necessary precautions must be taken into consideration (Christenson, 1994). Cache County only permits building in earthquake zones after careful "review and approval of an engineering geotechnical report (County Code 17.18.020). For the purposes of this model, fault lines will be considered a critical land not suited for development. A buffer of 25 meters will be added on each side of the fault line to allow for some of the error in fault lines. Figure 3 shows the fault lines surrounding Paradise.

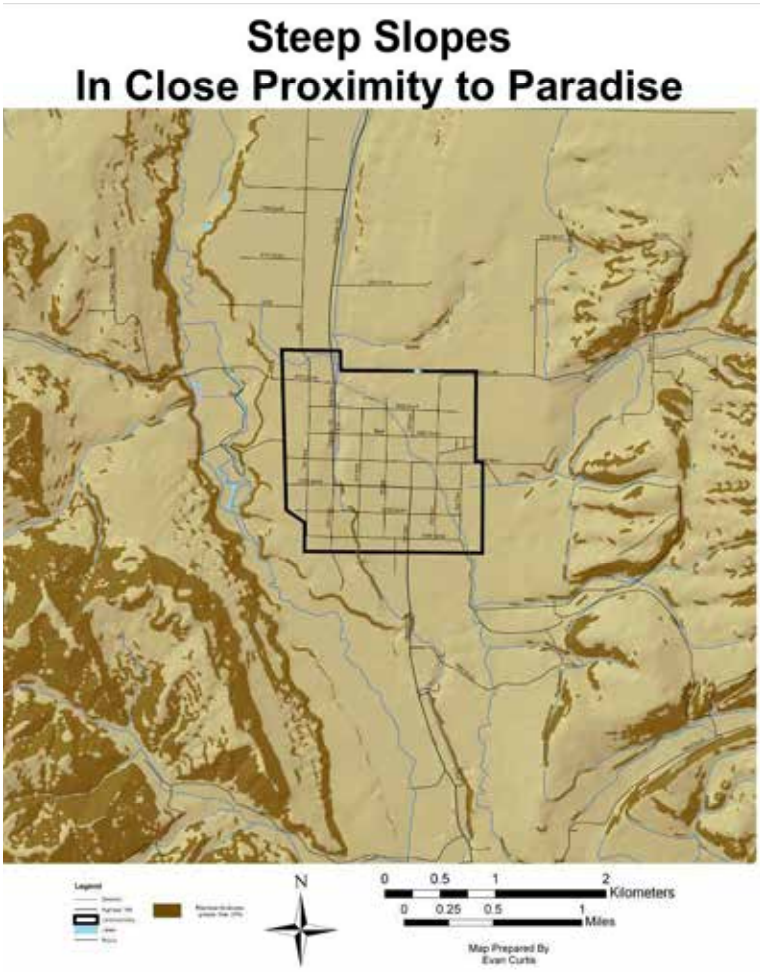


Appendix E

Steep Slopes



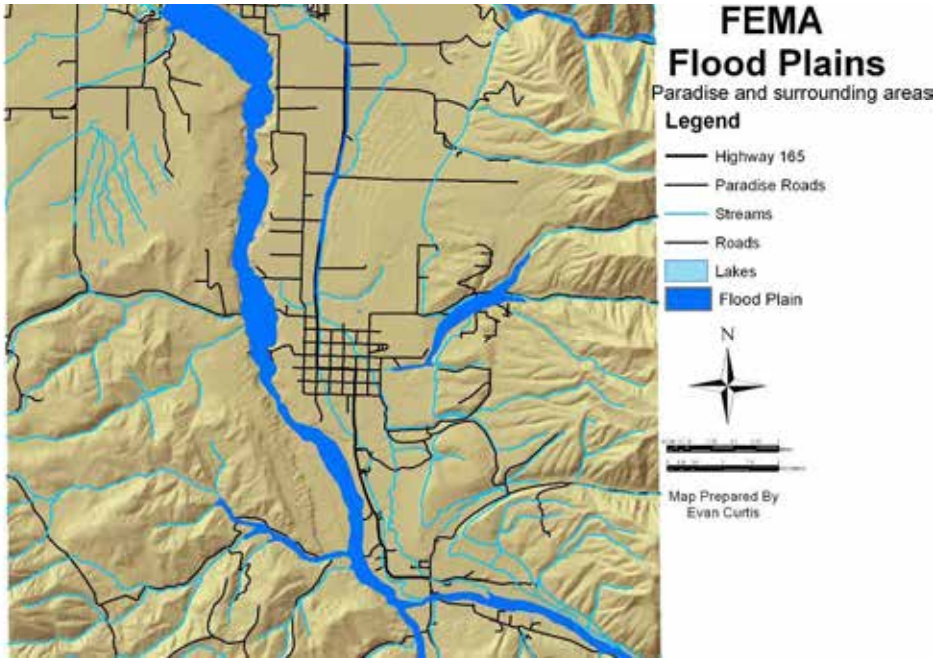
The Little Bear River Watershed covers extremely steep terrain. The Wellsville Mountains, for instance, are touted as the steepest in the world (Liddell and Ohlhorst). The Governs Office of Planning and Budget (2005) defines steep slopes as "land with a slope angle of 20% or greater for a minimum of 30 feet horizontally." Areas with these steep slopes require great expense to develop and maintain, and involve significant risk in the form of landslides, slope failure, avalanches and erosion. In addition to the individual risk and expense involved, steep slopes also strain public funds through road maintenance and other services (GOPB, 2005). In Utah, slopes over 30% are restricted, and in Cache County slopes over 20% must be legally approved prior to any development being permitted (Envision Utah, 2002; Cache Code 17.18.060). For the purposes of this model, a slope of 25% was considered the breaking point above which development would be considered impaired. Figure 4 shows the slopes above 25% in the surrounding areas, and Figure 4a shows those steep slopes in close proximity to Paradise.



Flooding Potential-

Flooding is a temporary overflow of water into areas that is not normally inundated with water. This inundation causes considerable property damage and may also disrupt communications, transportation, electric service and other community damage (BRAG, 2004). Most flood damage occurs in the floodplain, the low-lying areas adjacent to a river (GOPB, 2005). In Utah the whole floodplain is usually restricted due to the extreme damage that can be caused to property, and some cases human life as homes become inundated with flood water (Envision Utah, 2002 and GOPB, 2005). Cache County code states that any structures built in a floodplain "shall provide an elevation

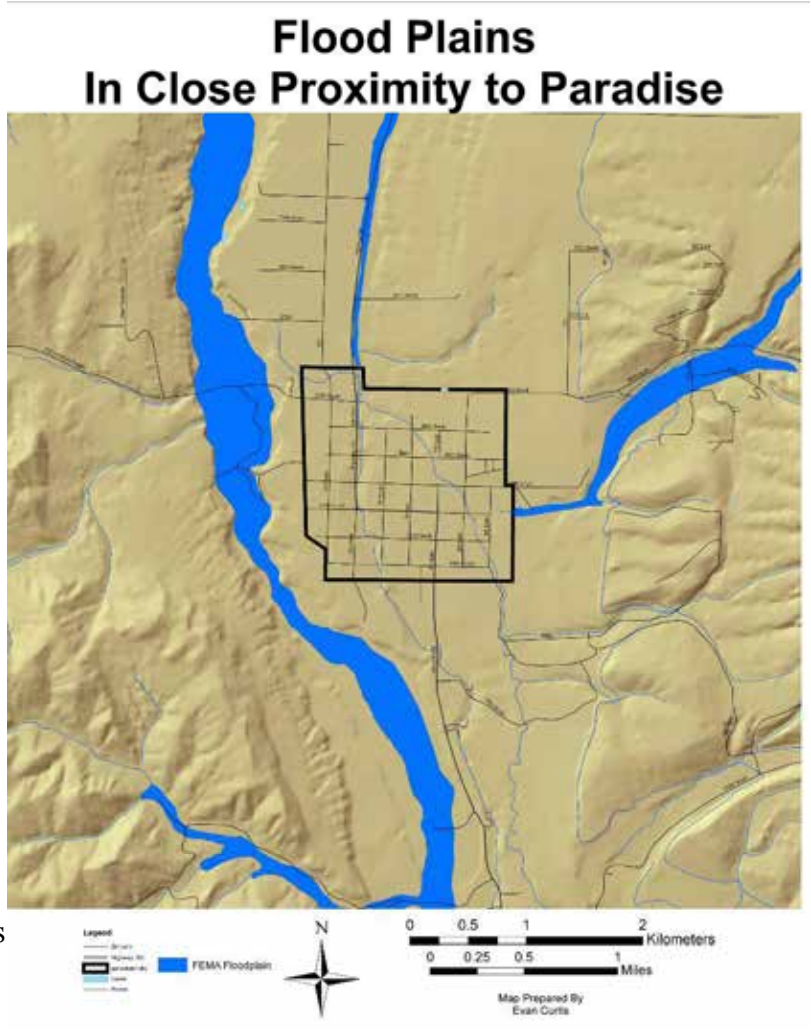
Appendix E



certificate from a state certified surveyor and be approved by the county floodplain manager" (Cache County Code 17.18.060).

In addition to property damage that may occur as a result of flooding, ecological problems may result which also affect the public health welfare and safety. Sewage and septic systems may overflow or rupture, carrying contaminants into streams, lakes and groundwater (GOPB, 2005).

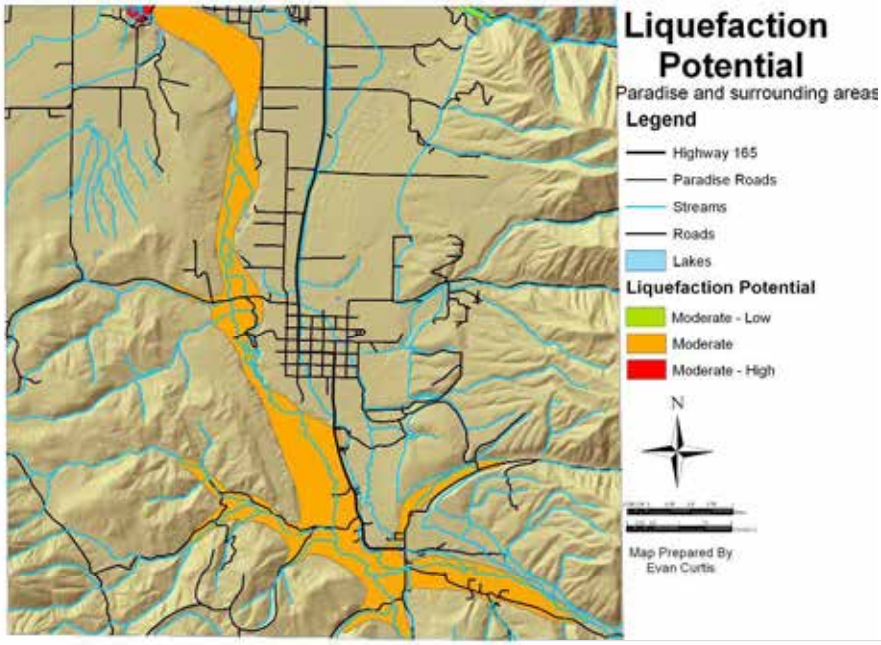
For this model, the floodplain was determined by using the FEMA floodplain layer from the AGRC. Figure 5 shows the context of floodplains around Paradise, and Figure 5a shows a closer view Paradise.

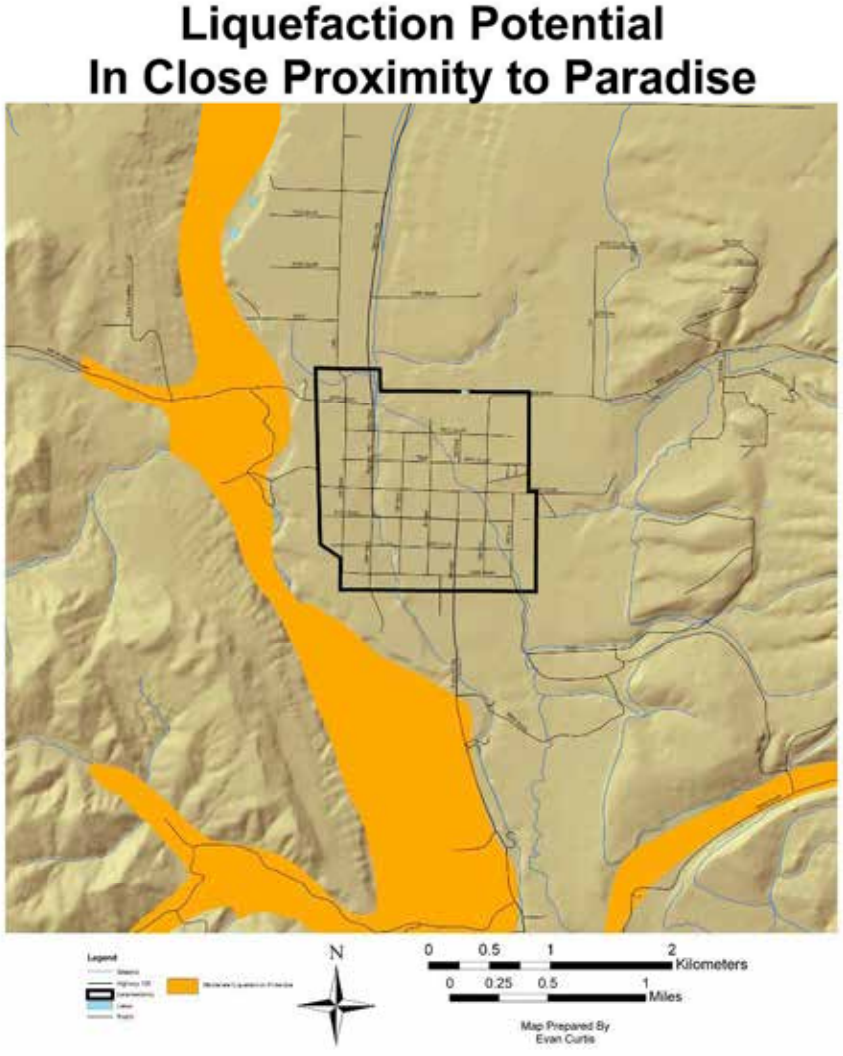


Liquefaction Potential-

When water-saturated sand soils that lack cohesion are subject to ground shaking, liquefaction occurs. Liquefaction causes these soils to lose strength and bearing capacity and behave more like a viscous liquid. This gives the soil properties similar to quicksand, causing buildings to settle or tip, and subterranean structures that are light or buoyant, such as buried storage tanks, to float upward. Liquefaction occurs when soils that are susceptible to liquefaction experience strong shaking, such as during earthquakes of magnitude 5.0 or greater (BRAG, 2004). This obviously involves significant potential damage to life, property, and public health. The maps on the following page show the liquefaction potential for the surrounding areas and the liquefaction potential nearest to Paradise.

Appendix E

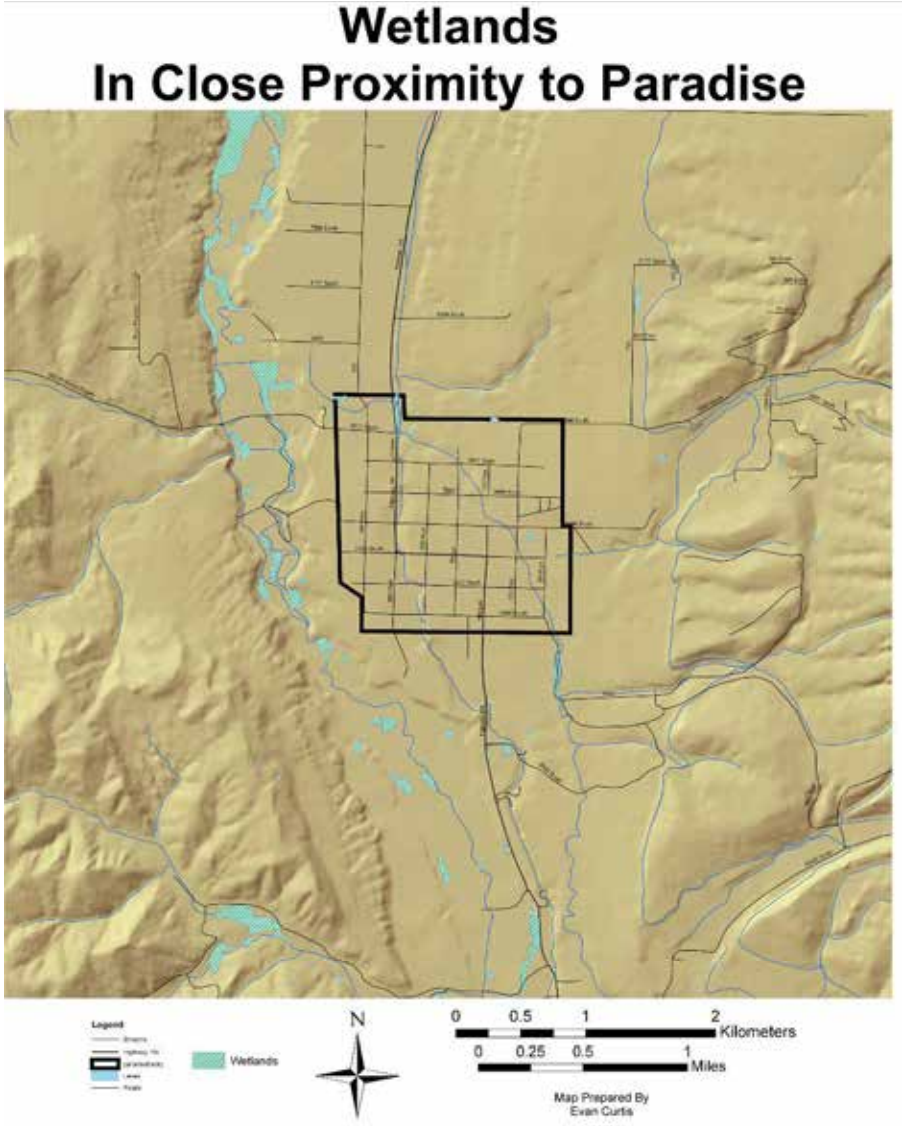

Liquefaction Potential
Paradise and surrounding areas
Legend
Highway 165
Paradise Roads
Streams
Roads
Lakes
Liquefaction Potential
Moderate - Low
Moderate
Moderate - High
N
Map Prepared By
Evan Curtis


Liquefaction Potential
In Close Proximity to Paradise
Legend
N
0 0.5 1 2
Kilometers
0 0.25 0.5 1
Miles
Map Prepared By
Evan Curtis

Appendix E

Wetlands

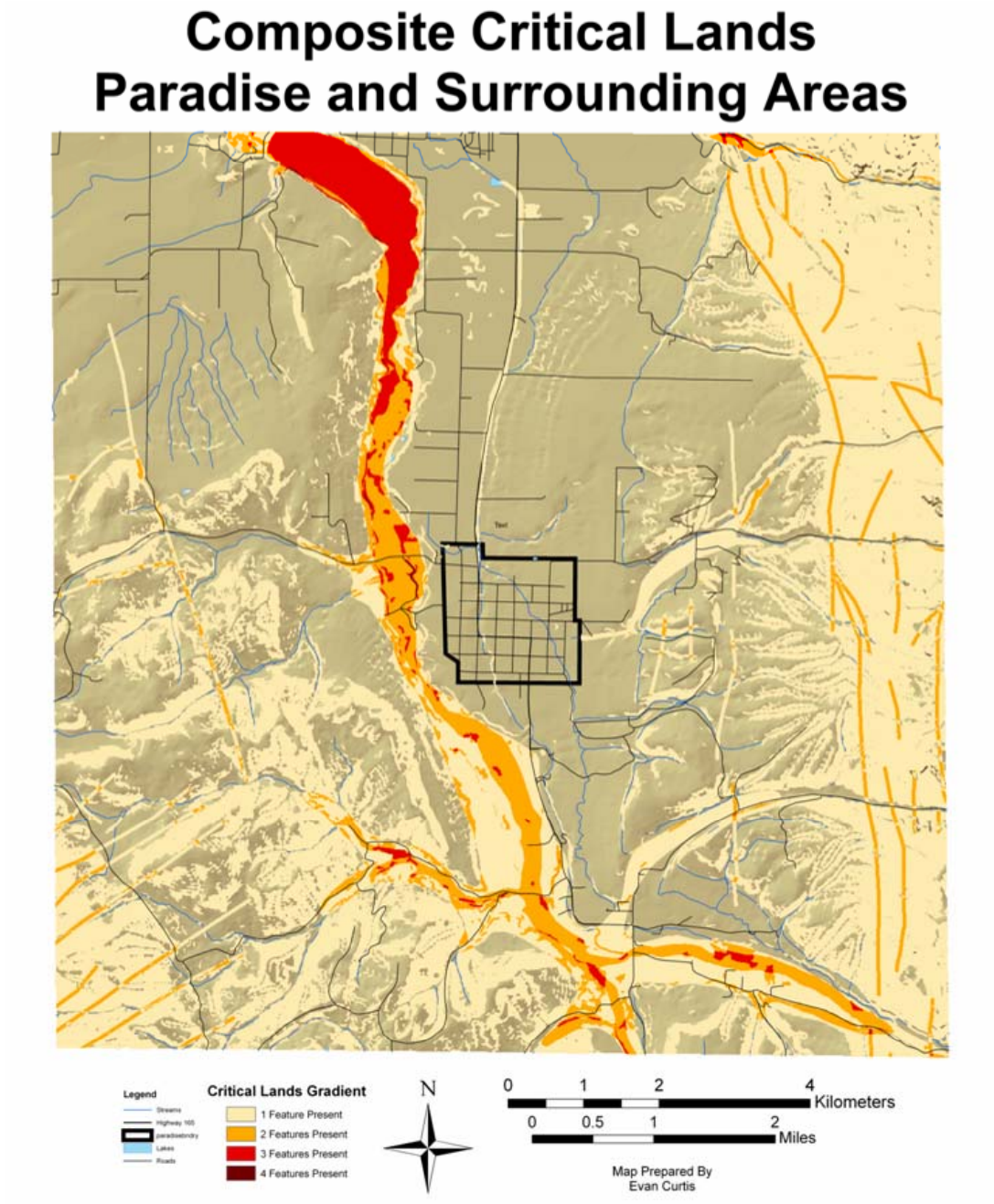
Riparian zones, lakes and wetlands are critical components of a watershed. Wetland and riparian areas are not only critical as wildlife habitat (Envision Utah, 2002) and as recreation areas, these landscape features are also critical in providing irrigation water for crops, ecological functions and as flood control. Riparian zones are those areas of vegetation found along streams, lakes and wetlands. They provide essential functions, such as filtering runoff, preventing erosion, and slowing the velocity of floodwaters. Streams and Lakes hold water that is essential to wildlife, and a large aspect of human recreation and irrigation. Wetlands are the transition areas between dry land and open water, where the water table is usually at or very near the surface. Wetlands are sometimes or always covered with water, have poorly drained soils, and contain plants hydrophytes, or "water-lovers" that survive with little or no oxygen. Wetlands are vital to a healthy ecosystem for their role in flood control, floodwater storage, key wildlife habitat and recreation opportunities (GOPB, 2005). Protecting these areas will provide critical wildlife habitat and corridors, recreation possibilities, flood mitigation, and groundwater filtration. Since most riparian areas fall within the floodplain, which has already been discussed, this map only looks at wetland areas.



Appendix E

Composite Critical Lands

Once the critical land layers have been determined and mapped, it is possible to overlay them in a GIS application to determine those areas which are the most critical based on the amount of critical land that occupies an area. The critical land layers can be weighted based on their relative importance to public health safety and welfare, however, for the purposes of this model, each critical land type is equally weighted. This composite map will then show the areas that do not pose a threat to development, and those that pose a greater risk for putting people in harms way. Figures 8 and 8a show an overlay of all of the critical lands, with fault lines buffered by 25 meters. The darker the area, the more critical landscape features are present in that area.



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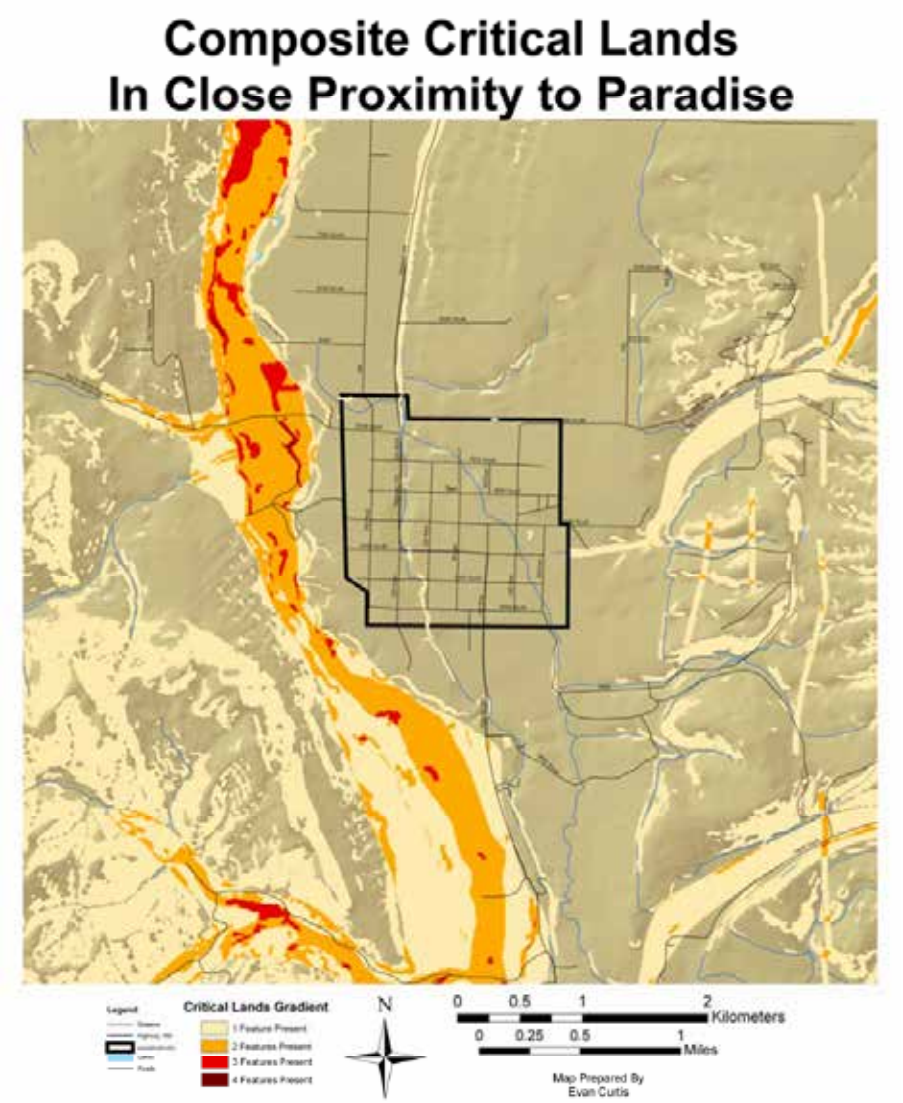
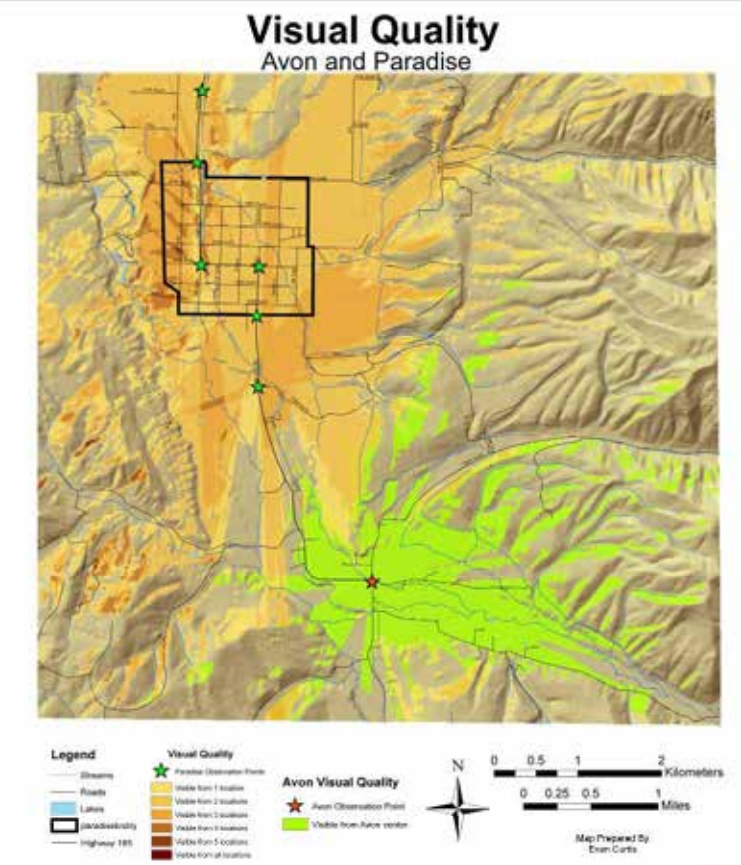


Cultural Critical Lands

Using landscape features in planning may be the most basic, and vital means of directing future development for the health, welfare and especially safety of those residing in an area. However, these biophysical landscape features are not all that make up a place. Included in any community is a historical or cultural context, unique societal characteristics, and economic factors that give the community a "sense of place." These "cultural critical lands" should also be included in any planning scenario
In Paradise and the surrounding area, a rural and agrarian ambiance permeates the landscape, providing visitors and residents with stunning vistas and a rural feel. This rural feel may be upset by new development if careful planning is not implemented. For this reason, it can be beneficial to use a GIS application to determine which areas are highly visible. These highly visible areas can then be planned with scrutiny to determine their most appropriate and beneficial use.

Appendix E

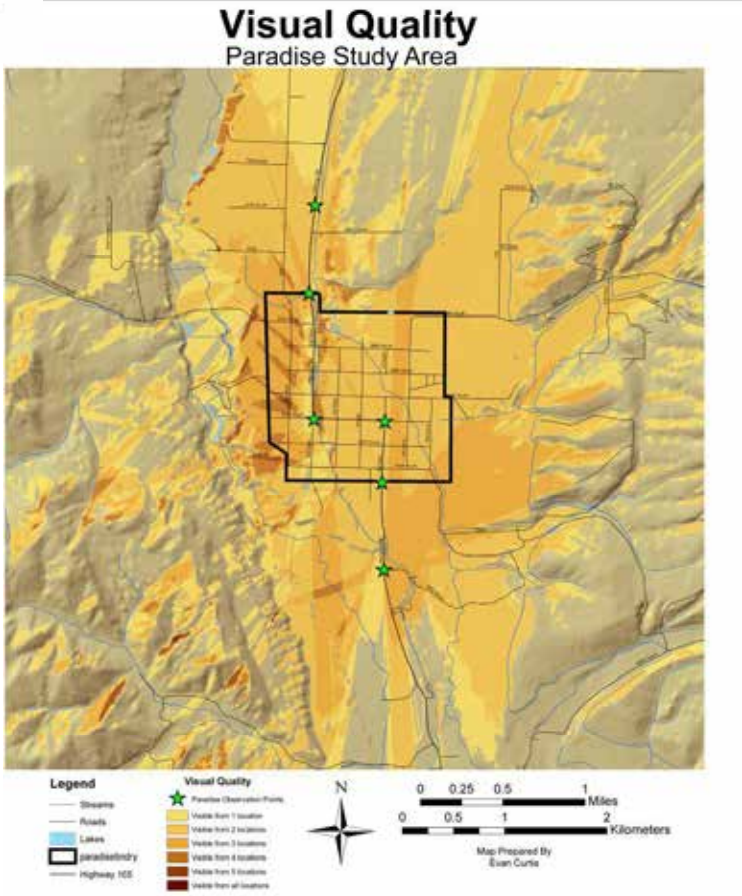


Using a Spatial Analyst tool known as "viewshed" it can be determined which areas are visible from observation points with certain parameters. For Paradise, observation points were set at both city entries, at the bends in Highway 165, and at roughly one kilometer from both ends of town on Highway 165. The observation points were set at 2 meters from the ground (roughly the height of a full grown man or someone elevated in a pickup truck) and the observable landscape was set to 8 meters off of the ground (roughly the height of an average building) to show where a building would be seen if development took place. One observation point was also placed in Avon.

The map at right shows viewsheds from an observation point in "central" Avon, as well as the viewable areas surrounding Paradise. The map shows only those areas in and around Paradise that can be seen from the observation points in Paradise.

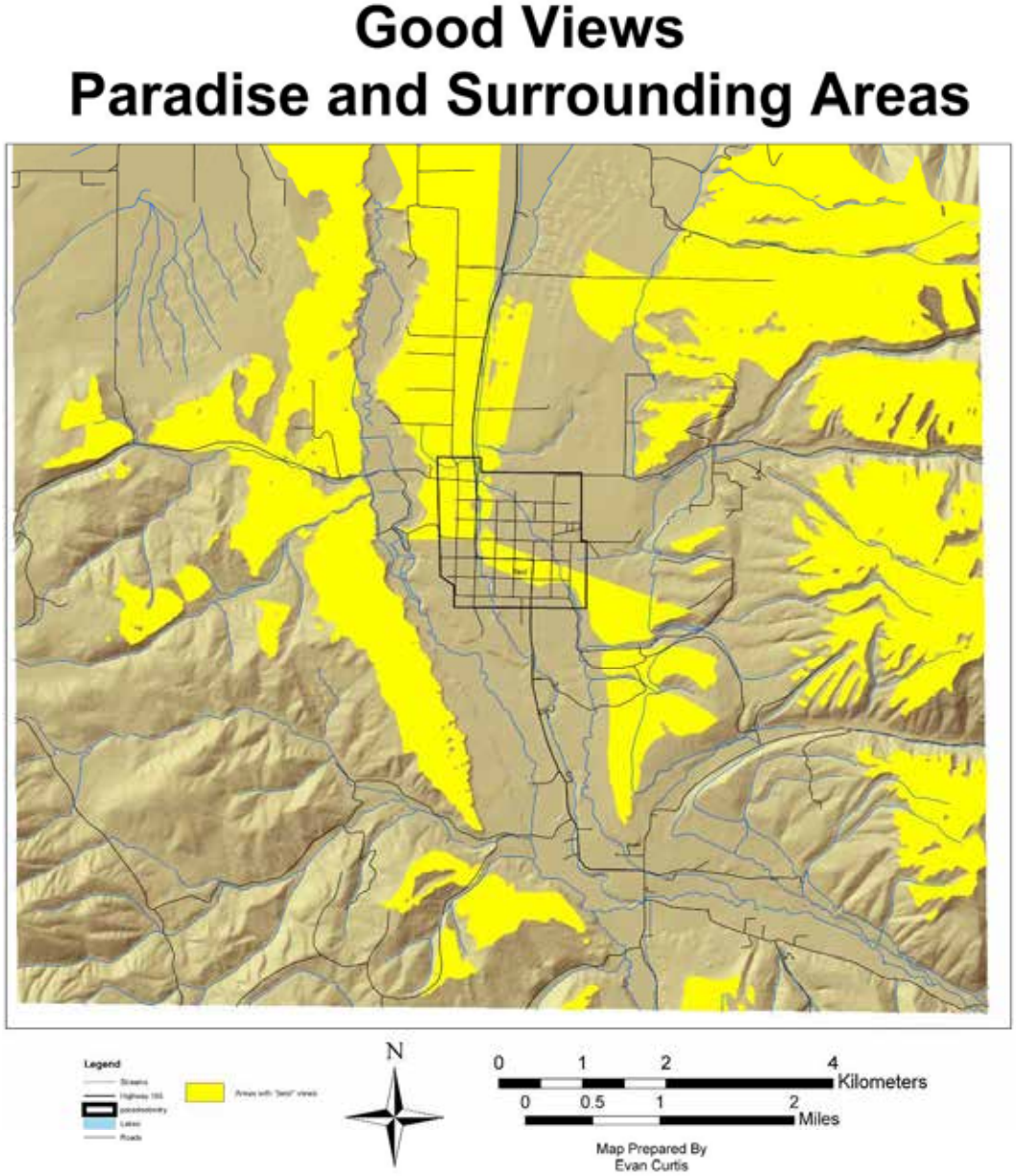
Looking Ahead….

Once a critical lands assessment had been completed, revealing the areas that are not suitable for development, and those that were, the question was raised "what next?" With so much land left for development, where would the most likely spots for development be? A discussion with real estate agent Alan Barker revealed some interesting criteria that people use for determining where to build their dream home. According to Barker (2006), houses on the north side of the street are better due to the sun exposure during the winter, and the shade for back yards in the summer. Barker also added that people like to build their house on a hill with a view. Along with Barker's assessment, it is also logical to assume that developers will want to build in an area in which costs can be kept to a minimum. This means building close to existing or planned infrastructure.



Appendix E

Consumers will also want to keep costs down, one way of doing this is by building on south-facing slopes, to take advantage of the sun's rays in winter time. Another way is by building within an incorporated city's boundary, thus enabling the homeowner to benefit from city services.

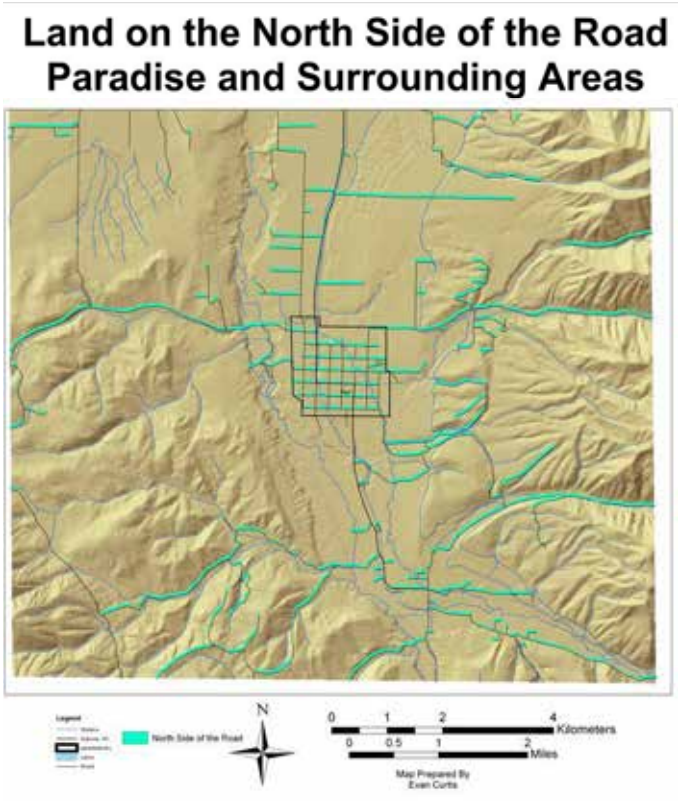


Good Views

A cursory look around Cache County reveals that a strong majority of the new houses, especially larger houses, are being perched on hillsides with views of the valley. For this reason, a viewshed analysis was used to reveal which areas had view of attractive landscape features such as the Logan Temple, Tim's Peak, James Peak, Hyrum Reservoir, the Wellsville Mountains, and some of the higher peaks along the Bear River Mountain Range.

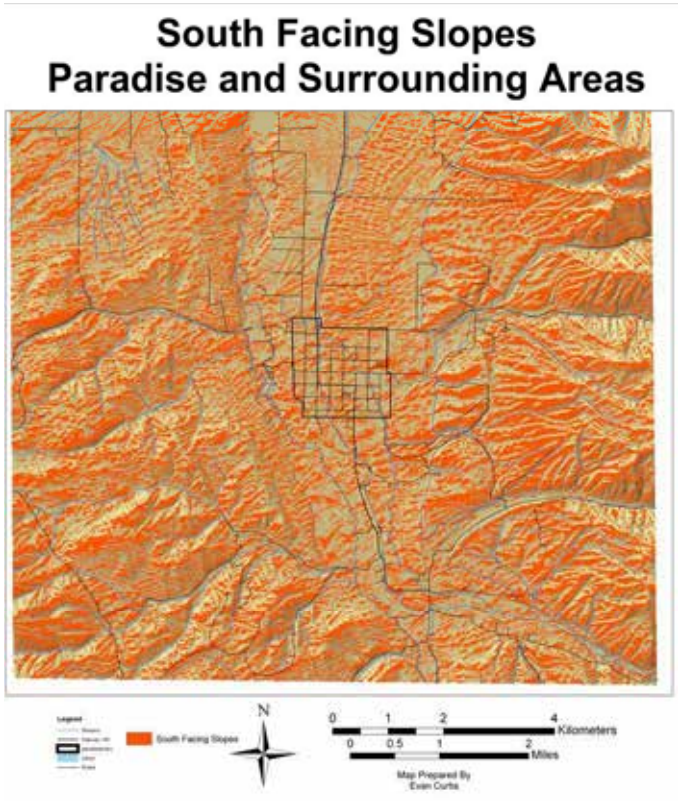
The above Map shows the areas with a view of these landscape features if an observer is elevated 12 feet off of the ground, where a typical deck might be located.

Appendix E



South-Facing Slopes

For energy efficiency, it makes sense for home-owners to try and locate themselves on a south to southeast-facing slope to take advantage of the suns rays in winter. The map at left shows these south-facing slopes.

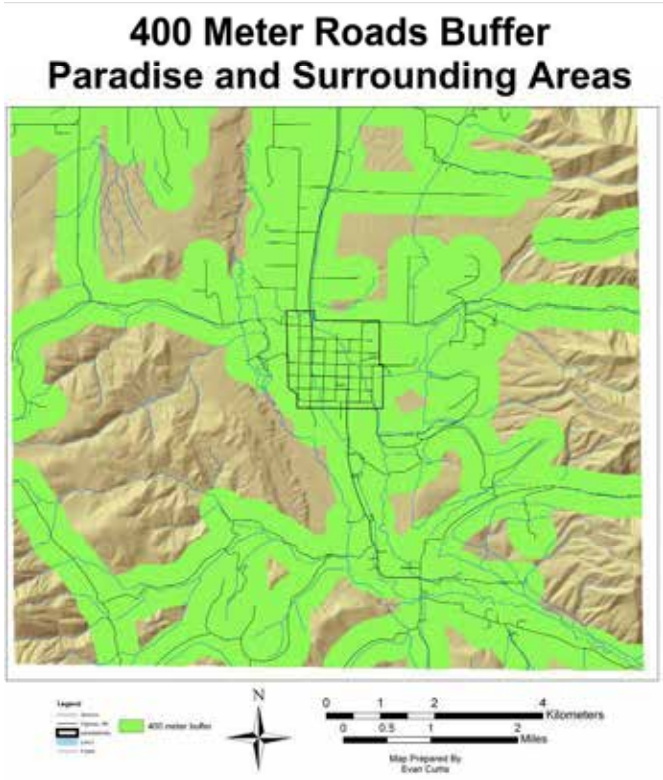


South Facing

With south-facing homes being more popular, the map at left demonstrates those lots that would be located on the north-side of the road, and with the houses therefore pointing south.

Proximity to Infrastructure

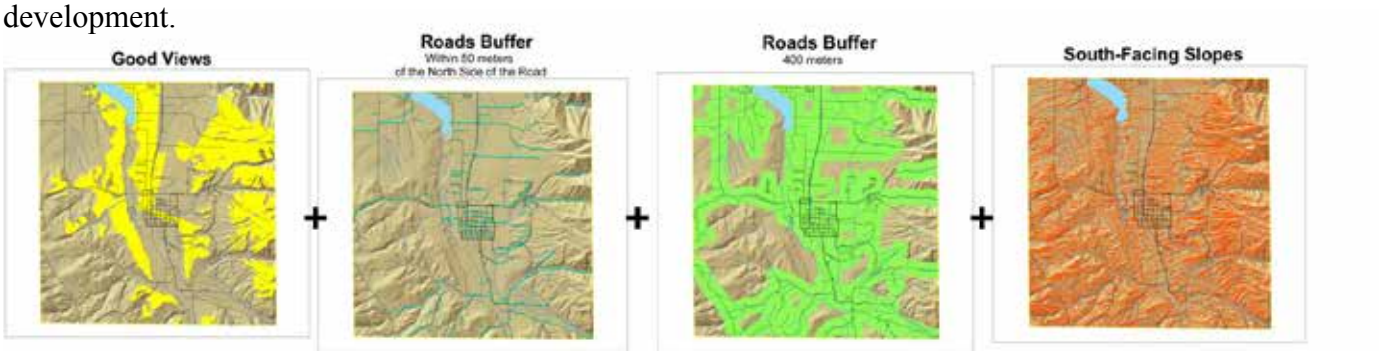
One key aspect that determines a parcel's value to a developer is its distance from a major road (Toth, 2006). According to Utah State University Professor Richard Toth (2006), development will usually occur within a quarter mile of a major road. For this reason, a distance tool was used to identify the 10 meter cells that were within 400 meters, or a quarter of a mile from a road in the roads layer. The map below shows a 400 meter buffer of existing roads.

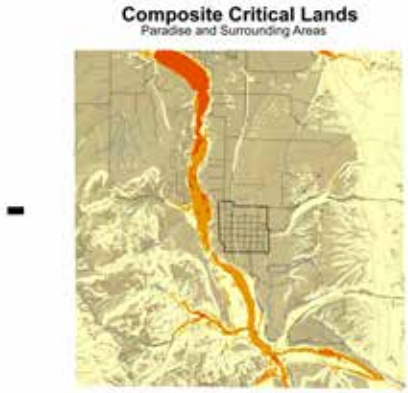


Appendix E

Development Pressure

Combining the above layers gives us the lands that should theoretically undergo the most pressure for development.





Then we can subtract those areas that would be unsafe for development: the critical lands. The end result would be the areas that would be most sought after for development that do not compromise the public health welfare and safety. Darker areas in Figure 14 show areas with a theoretically greater value.

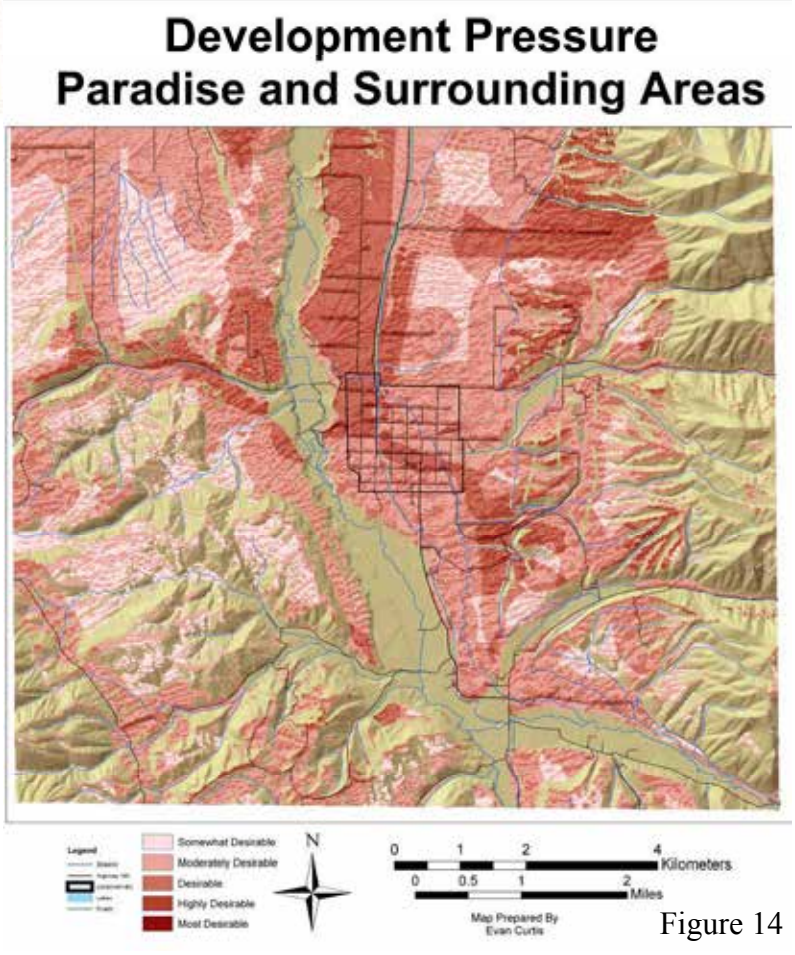


Figure 14

Appendix E

Actual Development Patterns

Of course, reality often differs from the ideal or theoretical. For instance, as valuable as a piece of land may be, the actual development of the land depends on willing sellers and buyers, as well as approval from planning commissions etc. For this reason, an analysis of current development patterns provides an interesting look at actual development pressure versus the theoretical "best" places to build. Figure 15 shows points of actual development that were digitized from a satellite image. These points were then run through a kernel density analysis, which shows patterns in density. While some structures were inevitably missed, and some barns or sheds may have been counted as houses, the analysis will nonetheless demonstrate the general patterns as they relate to the development pressures outlined on the previous page.

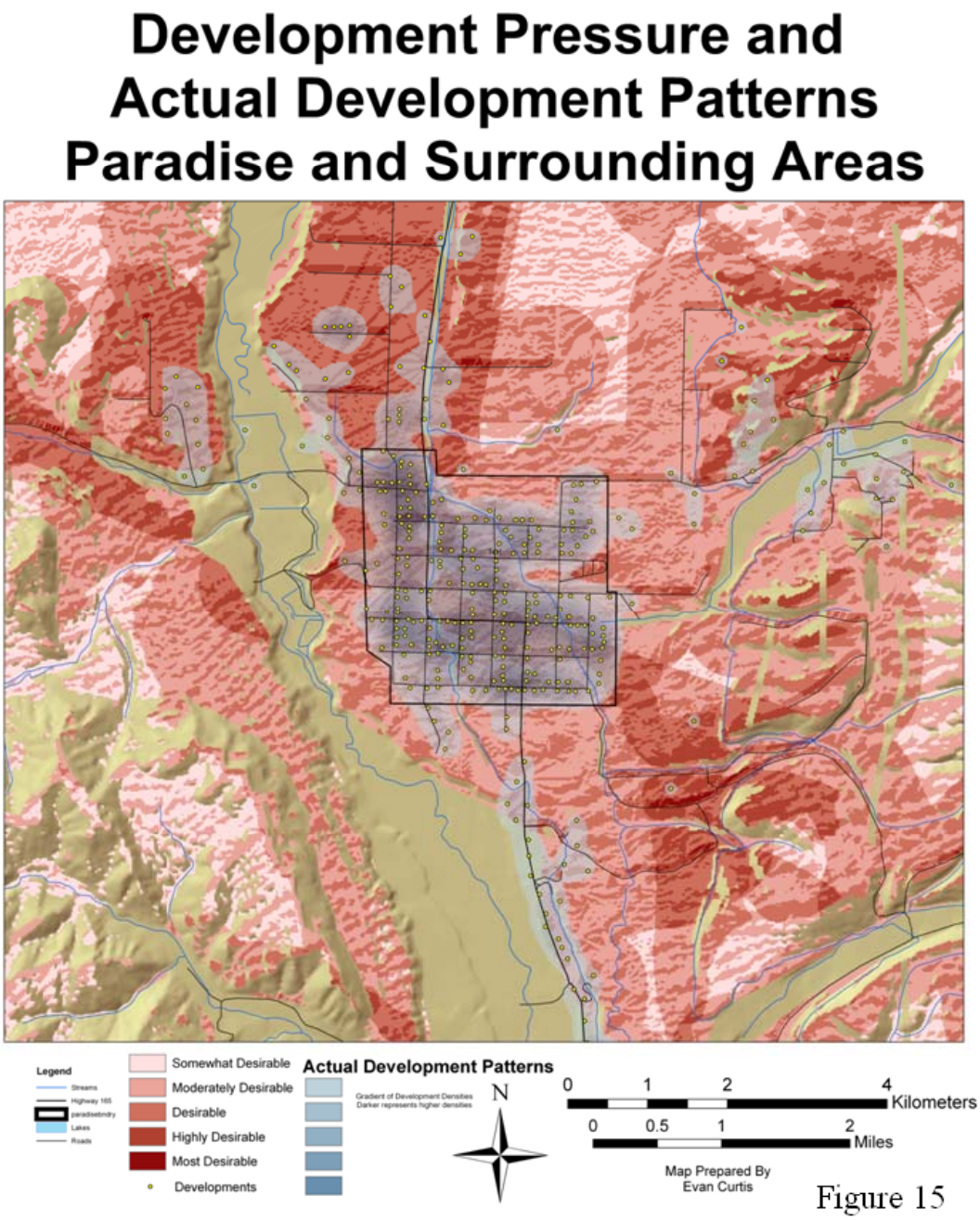


Figure 15

Appendix E

Lessons Learned….

A casual glance at Figure 14 reveals that many of the development densities do overlap with highly valued land, as expected. However, many prime areas are lacking in development. The study also reveals that some of the actual developments were in areas that were deemed as “critical” by some of the primary analysis. Actual “on the ground” field work would be needed to ascertain the extent of danger these structures find themselves in. For instance, some of the structures in the floodplain may merely be recreational facilities owned by hunting or fishing clubs, and are not primary residences. However, where this is not the case, this data shows areas that deserve particular attention from planning officials in both Paradise and Cache County.

The study is particularly useful as a means of directing future growth. For instance, both Figure 14 and Figure 15 show a trend toward development between Hyrum and Paradise, a trend that could lead to sprawl and a loss of the cultural identity and sense of place that defines these two rural towns. Understanding this trend may enable planners to direct growth in a more socially salient direction. Furthermore, Figure 15 shows the development patterns shifting toward Avon in areas that are not necessarily the most valuable lands. A comparison of Figures 9a, 14, and 15 show that certain areas that are extremely valuable, and have low impact on visual quality, are underdeveloped.

Certain problems are inherent in these analysis, however. For instance, precise land-ownership information, prime agricultural lands, aquifer recharge areas and wildlife corridors, to name a few, were not included due to the lack of availability or because they were beyond the scope of this study. Adding such information could reveal other factors that should be taken into account, prior to any concrete planning efforts being made.
Methods and Data Sources

All data came from the Utah Automated Geographic Reference Center (AGRC), a clearinghouse for GIS data in Utah. Each map was prepared using ArcMap software from ESRI. All vector data used in analysis was converted to 10 meter raster form to match the 10 meter Digital Elevation Model (DEM) that was used in creating the base map. Converting vector data to raster does introduce some error into the analysis by giving each 10 meter cell only one value, however, the 10 meter cell size was deemed ideal for this type and scale of analysis. Individual analysis tools used in each analysis are mentioned in descriptions of individual analysis.

This form of analysis is based off of similar case studies in the planning field, and especially in this region, specifically the Cache Valley 2030 report produced by the Utah State University Bioregional Planning program in 2006 (see Toth et al., 2006)..

Appendix E

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Appendix E

Addendum:
A Possible Use of the Study…

Appendix E

Applications of GIS……

Following the initial study "A Geographic Information System (GIS) Assessment of Developable Lands Surrounding Paradise Utah," the idea of using the information in creative ways to inform, educate and excite the public became apparent. The author therefore used the information to show some alternative futures developed using the National Agricultural Imagery Program's (NAIP) satellite imagery and aerial photographs manipulated using Photoshop. The idea is to take the digital map and put it into a more relatable media. The following images are examples of how taking GIS models one step further can create realistic glimpses of what future development in the area may look like, and what the author is planning on doing with the GIS information obtained. Paradise, 2004

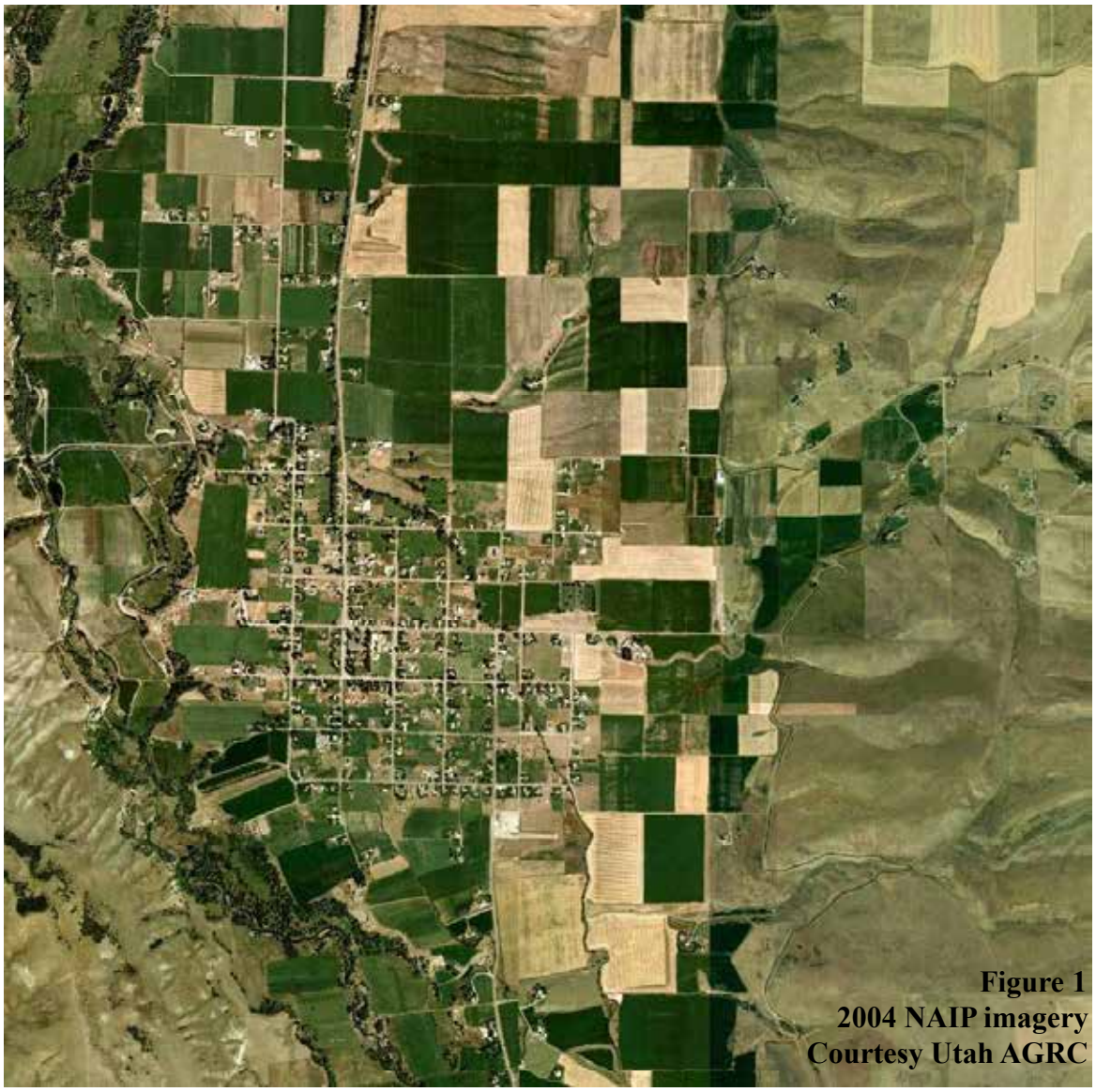


Figure 1
2004 NAIP imagery
Courtesy Utah AGRC

Figure 1 shows the 2004 NAIP satellite image of Paradise, Utah. Figure 2 shows what Paradise could look like in around 30 years, using the "Development Pressure Map" .

Appendix E

(Figure 13) in the study. The image is not an exact match of the GIS assessment, since it is assumed that not all land owners will be willing sellers, and some development will be random, and not follow the criteria of the map. Furthermore, this map assumes that current housing densities and zoning policies will continue as a general rule.

Figure 2
2004 NAIP imagery
Courtesy Utah AGRC
Image manipulated by
Evan Curtis

Appendix E

Hyrum, 2006

Although Hyrum was not in the study area, using a similar aerial photo of Paradise could be manipulated to show an even more realistic picture of what the future of development could be, assuming that the GIS models hold true and that no changes in current zoning policy are implemented.

Hyrum, 2030?

Appendix F

Evan Curtis
Case Study Review
September 19, 2006

Alternative Futures for Utah's Wasatch Front:
bioregional planning for the maintenance
and conservation of open space
Toth, et al., 2002

Abstract

In the Fall of 2000, a conglomeration of graduate students and professors at Utah State University began a land-use study for the entire Bear River Watershed and was later joined by state and local planning and government professionals and agencies. Their multi-faceted goal was to create a GIS database of the various characteristics of the study area, gather and review public opinion surveys to ascertain public sentiments toward open space, assess likely growth patterns and their affect on open space, and to research possible strategies for protecting these open spaces. The pre-Analysis of the project began by surveying the biophysical aspects of the study area from both a plane and ground, and the socio-demographic aspects through a review of public surveys. Next the group analyzed the structure and function of the various landscape components, relevant case studies, and held meetings with diverse stakeholders in the region. These steps revealed some of the issues in the area, as well as desirable objectives.
From this point the researchers assembled and analyzed GIS data to form base maps of the assortment of land uses and characteristics. These base maps were then analyzed and assembled to project the alternative futures for the Wasatch Front based on maximum conservation; health, welfare, and safety; and Planned Development.

A. Client and Background of Study

The study area, encompasses a vast area of northern Utah, including nearly 10,000 square miles (nearly size of Maryland), 5 counties (Davis, Morgan, Salt Lake, Tooele, and Weber), 53 cities and contains 64% (about 1.4 Million) of Utah's population. (7)

The study area was divided into three sub-regions
Eastern Mountain Valley Sub-Region
Central/Urban Sub-Region
Western Desert Sub-Region

Figure 1

Appendix F

B. Major Problems/Issues of Concern

Through site visits, research, and public interaction the researchers were able to identify some of the key issues in this area as:

- Urban Sprawl
- Quality of Life
- Water quality and quantity
- Agricultural preservation and interface with urban and natural environments
- Loss of local “character”
- Connective corridors are needed between mountains and valleys, possibly along waterways
- Landscape fragmentation (checkerboard ownership)
- Wild land/urban interface- habitat loss, fire etc
- Cultural needs of three different “regions”

With the continued urbanization and loss of agricultural and wild lands, open space has become an increasingly important issue for residents in the study are. Population analysis of the study are found that residents placed a high priority on the outdoors and wanted open space, wildlife, and trail systems to be part of their surroundings. It is a high enough priority, according to the surveys, that residents were even willing to forgo mutually exclusive activities and were even supportive of some tax increases to preserve open space (36-38).

C. Type of Staff, Consultants and Project Duration

The study began in the fall of 2000, and was published on July 11, 2002. It was truly a combined effort with staff and consultants from the U.S. Geological Survey, Biological Resources, Utah Cooperative Fish and Wildlife Research Unit, Utah State University, College of Natural Resources, Wasatch Front Regional Council, Swaner Design, Utah Division of Wildlife Resources, Marriner S. Eccles Foundation, as well as public opinion and stakeholders taken into account as well.

The key staff for the project were the following:

- Richard E. Toth, Project Director
- Thomas C. Edwards, Jr., Principal Investigator
- Robert J. Lilieholm, Principal Investigator
- David L. Bell, Principal Investigator
- Erin R. Buteau, Graduate Research Associate.

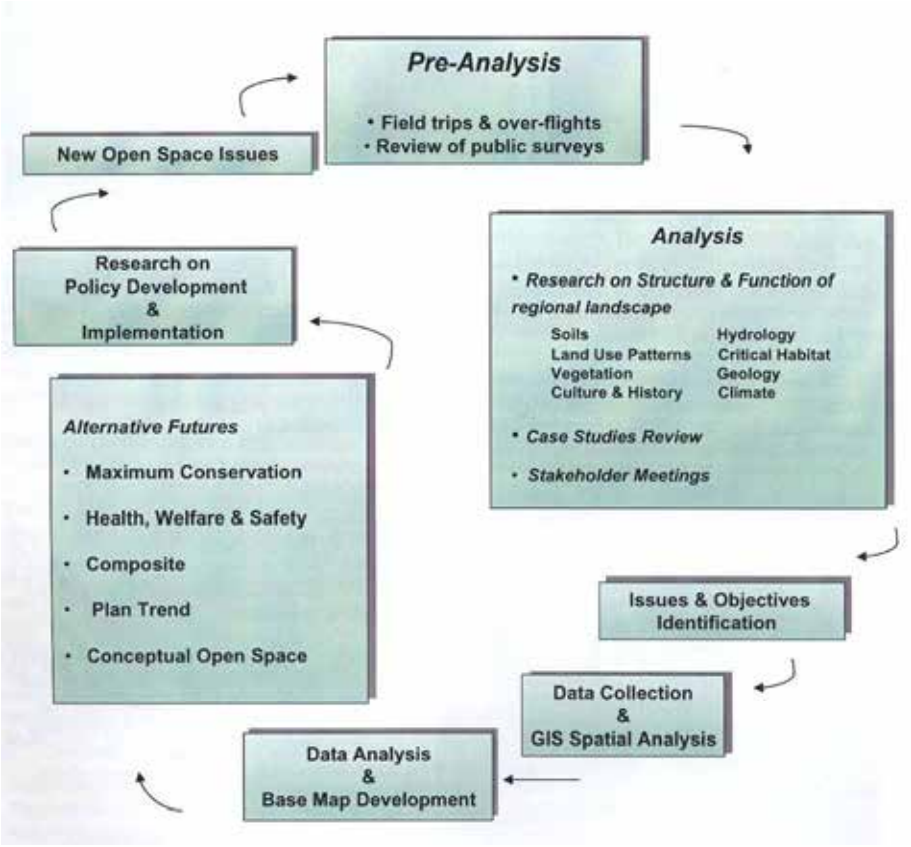
Appendix F

D. Key Terms:

Open Space: broadly defined as “any piece of land left in a somewhat natural state, including protected/preserved lands, riparian corridors, agricultural or working lands, developed parks, wetlands, and wildlife corridors.” (36)

Geographic Information System (GIS): “database that is an inventory of the biophysical, socio-demographic, and economic attributes of the region” (41).

E. Block Line Diagram



F. Source and Scale of Data

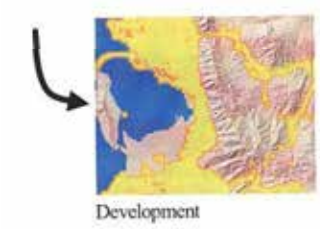
Because of the immensity of the study area, large scale data of 1:100,000 map units was primarily used. For more precise planning on a smaller scale, the scale of 1:24,000 was used, which produces a 30 meter pixel size. Geographic data was received from government agencies and the Utah Automated Geographic Reference Center (41).

Appendix F

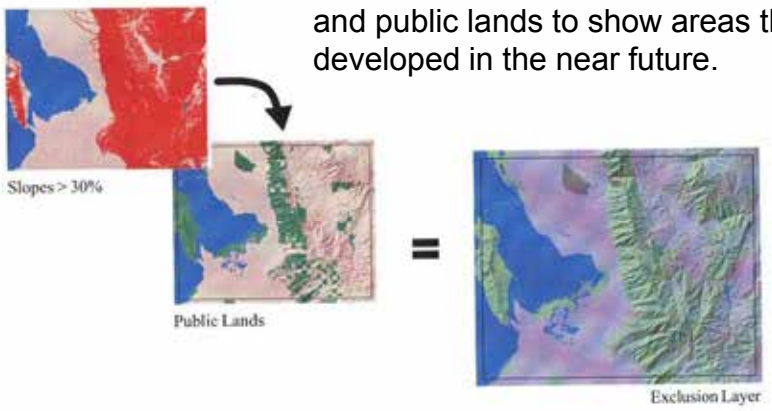
G. Criteria used in plan

One of the primary foci of the project was to develop a plan for open space in the Wasatch Front. To be considered open space, an area had to meet three of the following criteria:
Contribute to the unique character of the region
Lose ecological functionality if fragmented
Function as a connective element between other areas of open space
Function as a destination to which people would visit
Open space that crosses jurisdictional lines, and is of multi-jurisdictional interest

To achieve its goals, the project relied heavily on computer models. One of the critical models used in deriving a plan for this study area was the Plan Trend Model, which looked at the areas most likely to be developed. The criteria used to determine future growth were partially based on a growth model developed by Camp Williams National Guard Base. Camp Williams determined that major roads, water availability, slope, an urban hubs were variables in predicting good building sites. Plan Trend for the Wasatch study is similar in that it uses developmental costs and proximity to existing infrastructure to determine likelihood of future development. Plan trend uses the following criteria:



- Slope: slopes less than 25% grade are most cost-efficient
- Municipal Boundaries: these areas already have necessary infrastructure that people seek
- Proximity to existing roads: Roads increase access and likelihood of development
- Proximity to existing development: these lands have a greater potential for development
- Exclusion layer: This dataset combines steep slopes (>30%) and public lands to show areas that are not likely to be developed in the near future.



Appendix F

H. Proposed program and/or plan (conclusions reached)

After the many hours of research and database inventories were completed, the Wasatch study group was able to assemble a Conceptual Open Space Model. This model combined both the composite open space databases and plan trend to prioritize land use. This enables land use planners to see where conflicts are likely to occur, and where conservation or development can be easily implemented (72).

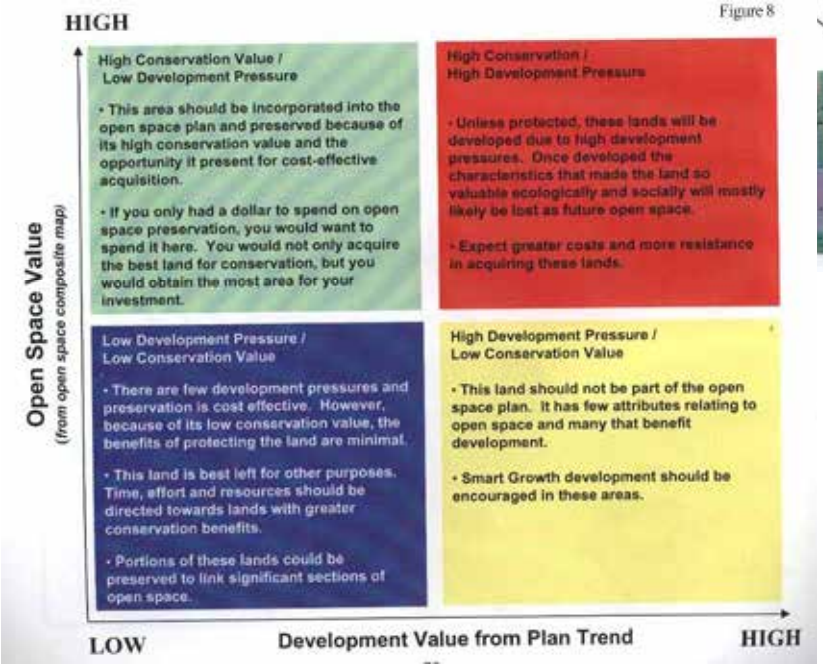
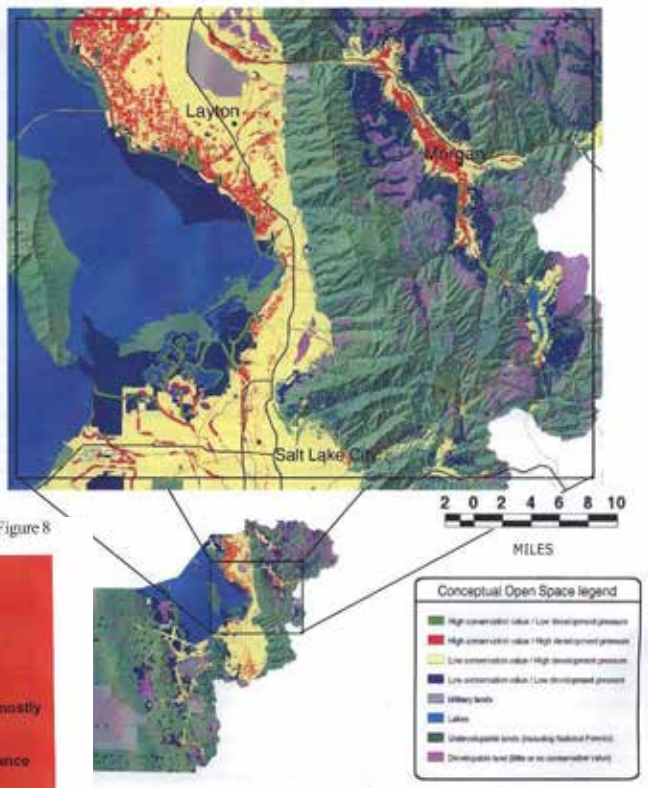


Figure 8



I. Implementation strategies for program.

The researchers in this study recognized the necessity of a good implementation strategy. To implement the models designed in the study, a toolbox of programs was provided which included Federal Programs, State and Municipal Programs, and Private Organizations that facilitate the protection of high-priority conservation lands (74-75). The toolbox also outlines several suggestions for Smart Growth and the preservation of Agricultural lands, trails, and greenways (76-77).

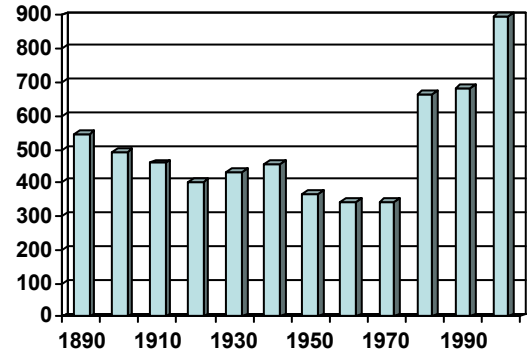
Appendix F

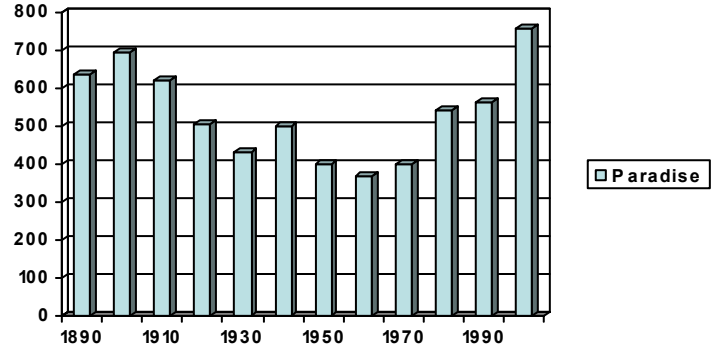
Citation of Wasatch Front Study

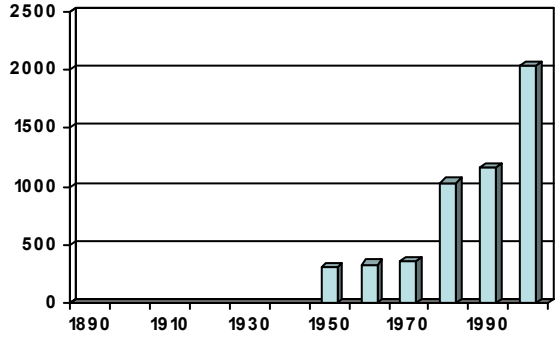
Toth, T.E., T.C. Edwards, Jr., R.J. Lilieholm, D.L. Bell, and E.R. Buteau. 2002. Alternative Futures for Utah's Wasatch Front: bioregional planning for the maintenance and conservation of open space. Final Project Report No. 2002-2, Utah Cooperative Fish and Wildlife Research Unit, Utah State University, Logan UT 84322-5290 USA

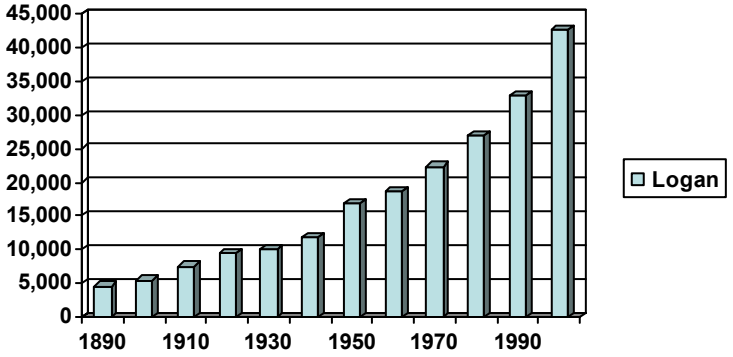
Appendix G

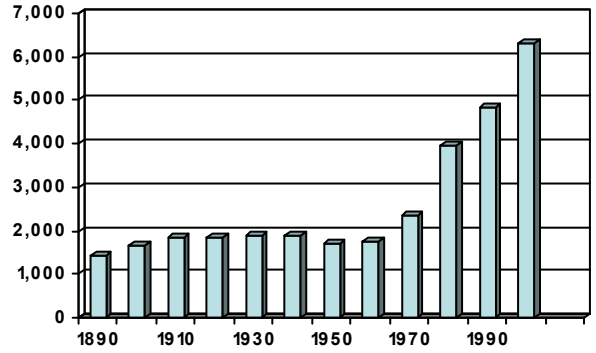
Growth Patterns in the Little Bear River Watershed and Cache County
US Census Bureau

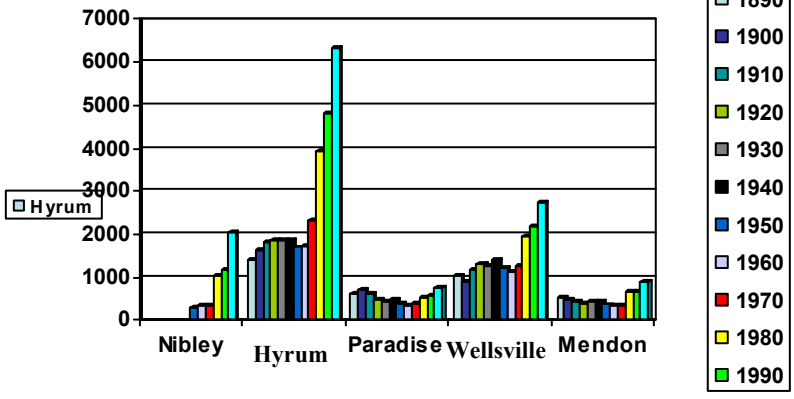


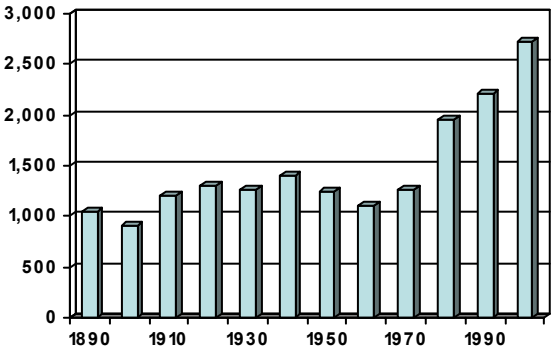


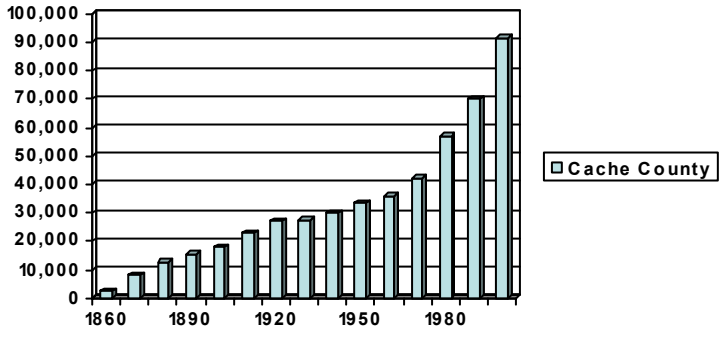






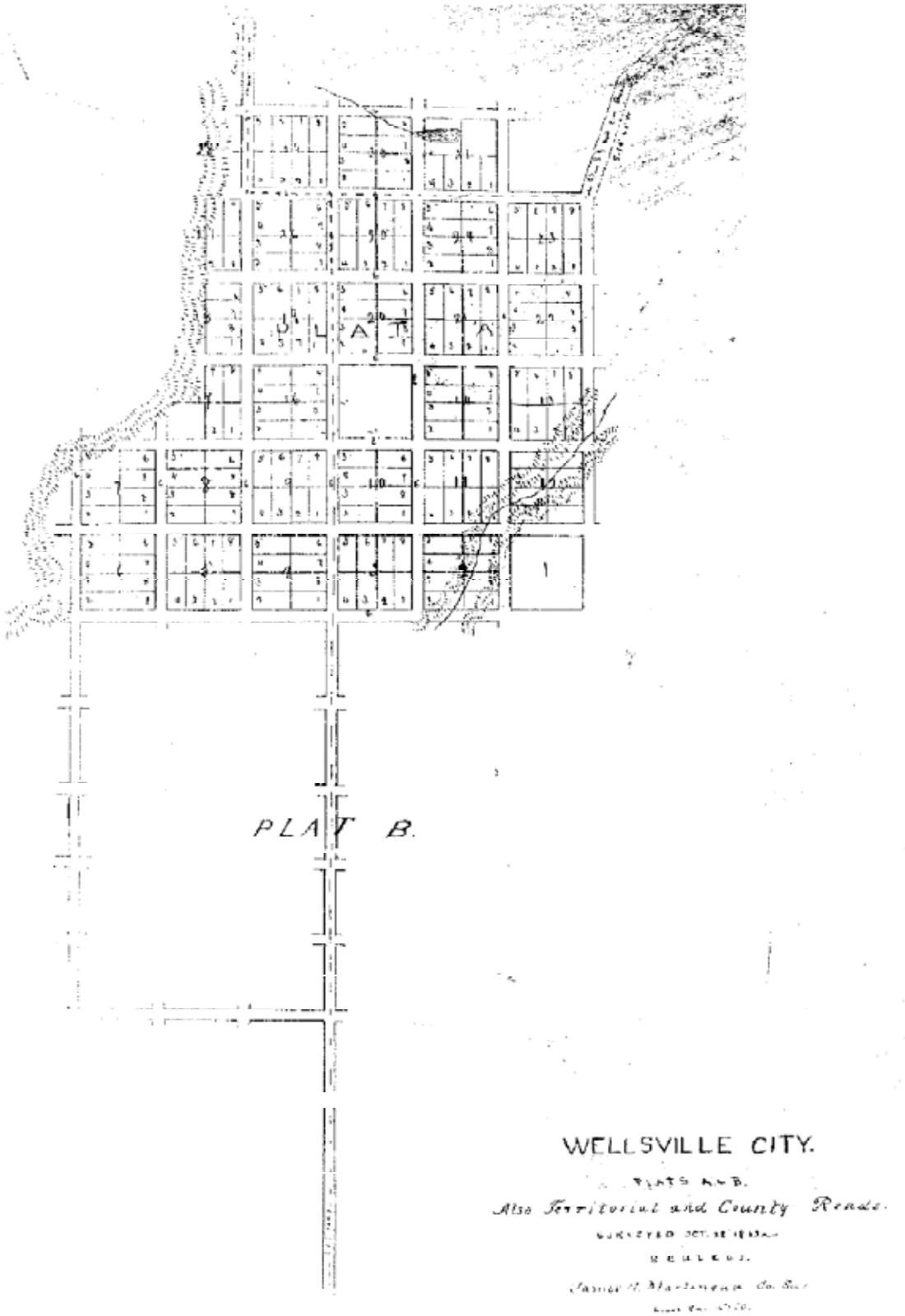






Appendix G

This 1863 Plat of Wellsville City demonstrates how an original Mormon settlement in the watershed placed a great deal of importance on following the planning techniques outlined by Joseph Smith Jr. in the Plat for City Zion.



Appendix G

This image overlays the 1863 Wellsville plat (see previous page) with satellite imagery from 2004. For the most part, the town is laid out in precisely the same manner as it was in 1863, with new developments expanding the city's boundaries, especially to the south.