

SOUTH CACHE VALLEY PROJECT

PLANNING WITH GEODESIGN



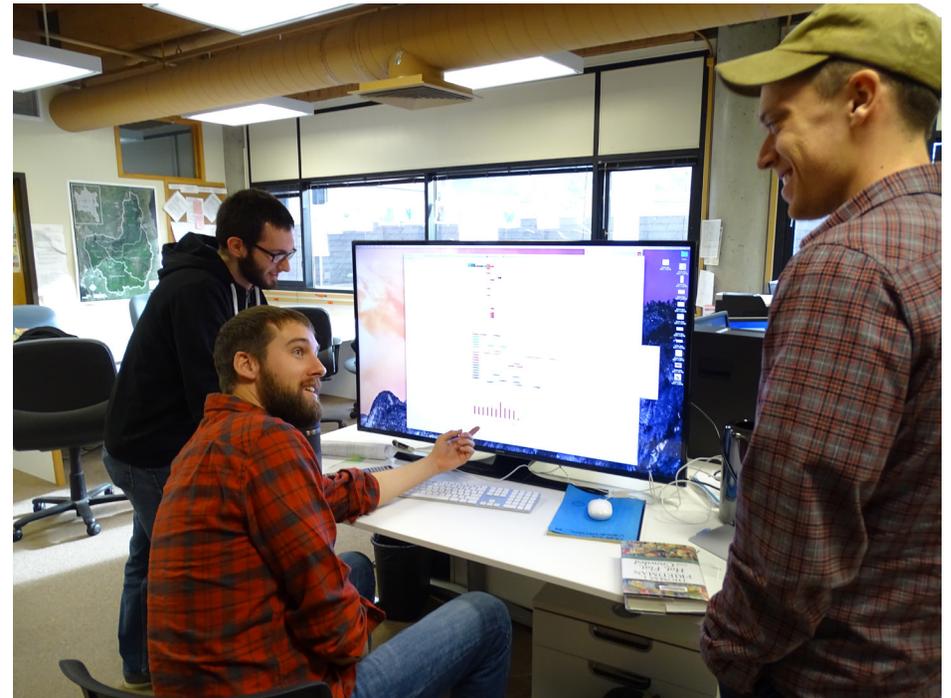
PREFACE

The South Cache Valley Geodesign project is part of a larger study of the Blacksmith Fork and Little Bear watersheds, which students in the Master of Bioregional Planning (MsBRP) program examined during the Fall 2015 and Spring 2016 semesters. The students considered alternative futures for these watersheds, which surround the southern portion of Cache Valley, specifically addressing the question of how the cultural and natural resources of the watersheds can be protected while accommodating the pressure of population growth and climate change.

The following report summarizes the experience and outcomes of the initial eight weeks of the Alternative Futures of the Blacksmith Fork and Little Bear project, in which students used a geodesign approach to collaboratively develop planning and design proposals for the future of South Cache Valley. During this time, MsBRP students and Master of Landscape Architecture (MLA) students joined forces and worked collaboratively to identify the issues facing the communities in Cache Valley. They also analyzed the opportunities and limits of the natural and human systems within the study area and participated in a one-day geodesign workshop led by Prof. Carl Steinitz in October 2015. This report, which has been prepared by the MsBRP students, summarizes the background and outcome of the workshop as well as capabilities of the Geodesignhub software to incorporate cost and implementation considerations in planning decisions.

The students have prepared this report not only as a documentation of the South Cache Valley case study, but also to explore the relationship of geodesign to the bioregional planning process. The geodesign project was the first exposure of MsBRP students to this scale of work and for many of the MLA students it was their initiation with GIS technology. As part of this educational experience, they gained expertise with technologies and methodologies as well as the art of collaboration. The students are to be commended on their openness and perseverance.

Barty Warren-Kretzschmar



ACKNOWLEDGMENTS

Firstly, we would like to thank Prof. Carl Steinitz and Hrishikesh Ballal for leading the geodesign workshop and for the opportunity to use the Geodesign Hub software.

Furthermore, our project would not have been possible without the support of Nibley City's Planner, Shari Phippen and Nibley City Manager, David Zook. Other community partners that provided invaluable information and guidance include: Brian Carver, Zac Covington and Rodger Jones from the Bear River Association of Governments (BRAG), Josh Runharr from Cache County Development Services, Ron Salvesen from Hyrum City, and Randy Stacey from Mountain Crest High School.

Similarly, we would like to thank the Utah State University (USU) faculty and staff who oversaw, enhanced and made the project possible through their technical and professional contributions. These individuals include Project Directors: Prof. Barty Warren-Kretzschmar, Prof. Carlos Licon, Prof. Richard Toth and Prof. Todd Johnson; consultants Prof. Nancy Mesner and Prof. Robert Davies and GIS experts Ellie Leydsman McGinty, Chris McGinty and

Prof. R. Douglas Ramsey, who contributed with support from an Environmental Protection Agency Environment Education Grant.

Finally, the success of the project hinged on the participation of the workshop participants. These individuals include: Brian Carver and Zac Covington from BRAG; Ron Hellstern, Shari Phippen and David Zook from Nibley City; Chris Harrild from Cache County Development Services; Jeff Gilbert from Cache County Metropolitan Planning Organization; John Hardman from USDA NRCS; Prof. Frank Howe, Prof. Shujuan Li and Prof. Peter Wilcock from USU; USU Masters of Landscape Architecture students Keni Althouse, Tanya Rice, Lynda Smith and Jennifer Weisman and USU Masters of Bioregional Planning students Tairon Kimura, Scott McComb, Lyndi Perry, Emmet Pruss, Thomas Terry, Stephanie Tomlin and Connor White.

This report was prepared by Scott McComb, Emmet Pruss, Thomas Terry and Connor White.



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INTRODUCTION

The South Cache Valley Geodesign Project

In the fall of 2015, students from Utah State University's (USU) Masters of Bioregional Planning and Masters of Landscape Architecture programs formed a joint studio to assist the communities of South Cache Valley, Utah develop alternative futures.

South Cache Valley is located in northern Utah (see Figure 1). The area is facing growing pressure from population growth, climate change, agriculture, recreation use and the nearby expanding Wasatch Front metropolitan region.

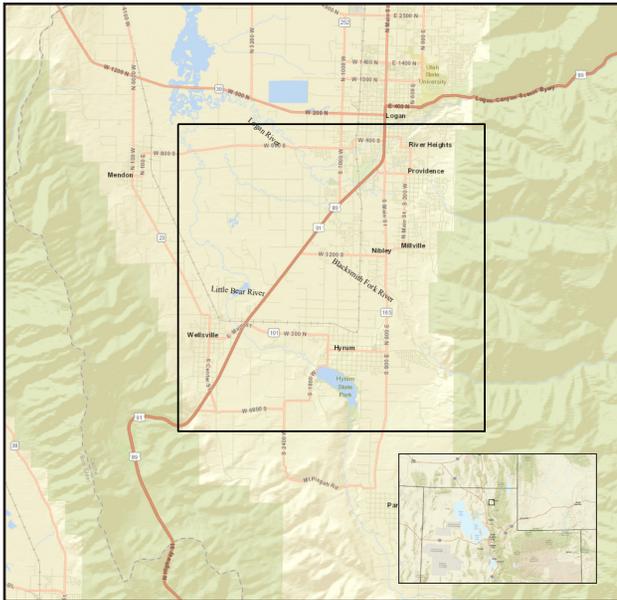


Figure 1. South Cache Valley study area and vicinity.

The students followed the geodesign process described by Dr. Carl Steintz in *A Framework for Geodesign* (2012), to develop, describe and assess alternative futures for South Cache Valley. For the first eight weeks of the project the students researched, gathered data and developed models needed to assess the area. A model being a representations of the landscape in the form of a map. This was followed by a one-day workshop with community members to develop and assess the alternative futures.

The geodesign process allowed students to learn a method for addressing landscape level issues, collaborate with other students and community stakeholders, and to provide South Cache Valley residents with alternative ways to plan for their future.

Geodesign

Geodesign is an iterative design method that uses stakeholder input, geospatial modeling, impact simulations, and real-time feedback to facilitate holistic designs and smart decisions”
 –McElvaney and Walker, 2013

Prof. Steintz developed the geodesign framework as a way to organize the process for mapping, analyzing, evaluating, visualizing, and negotiating alternative futures across different scales and disciplines. It was developed around six guiding questions and corresponding models as seen in Figure 2.

The geodesign framework - by Carl Steintz

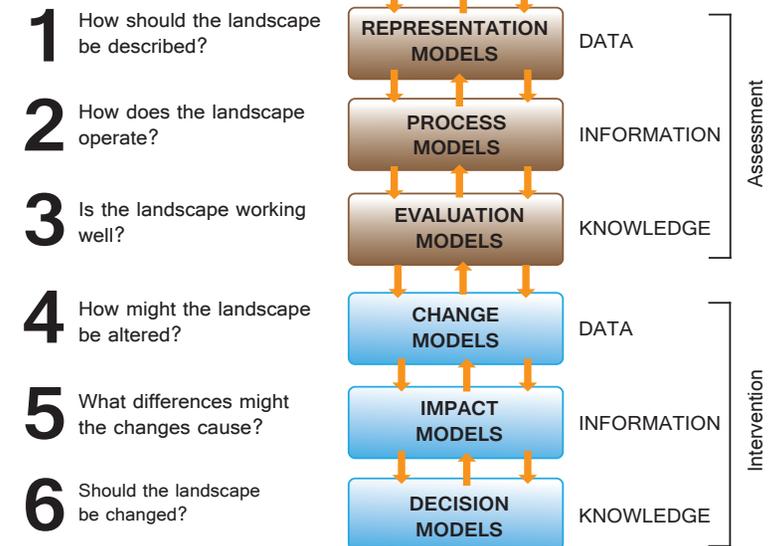


Figure 2. The geodesign framework.

Geodesign & Bioregional Planning

Landscape level assessment and planning can be achieved with geodesign and bioregional planning processes. Both methods provide a structured approach to analyze and develop solutions for landscape issues but use slightly different steps and terminology for achieving results.

The following diagram displays the bioregional planning process as it fits within the context of the geodesign process. This report focuses on the implementation of Prof. Steintz's geodesign process to address the landscape issues facing South Cache Valley.

Representation Models

How should the study area be described?

The representation models are used to understand what the appropriate study area should be for the project. This includes identifying system boundaries, the area's physical, economic, and social geography and history, and reviewing any prior plans and data.

Process Models

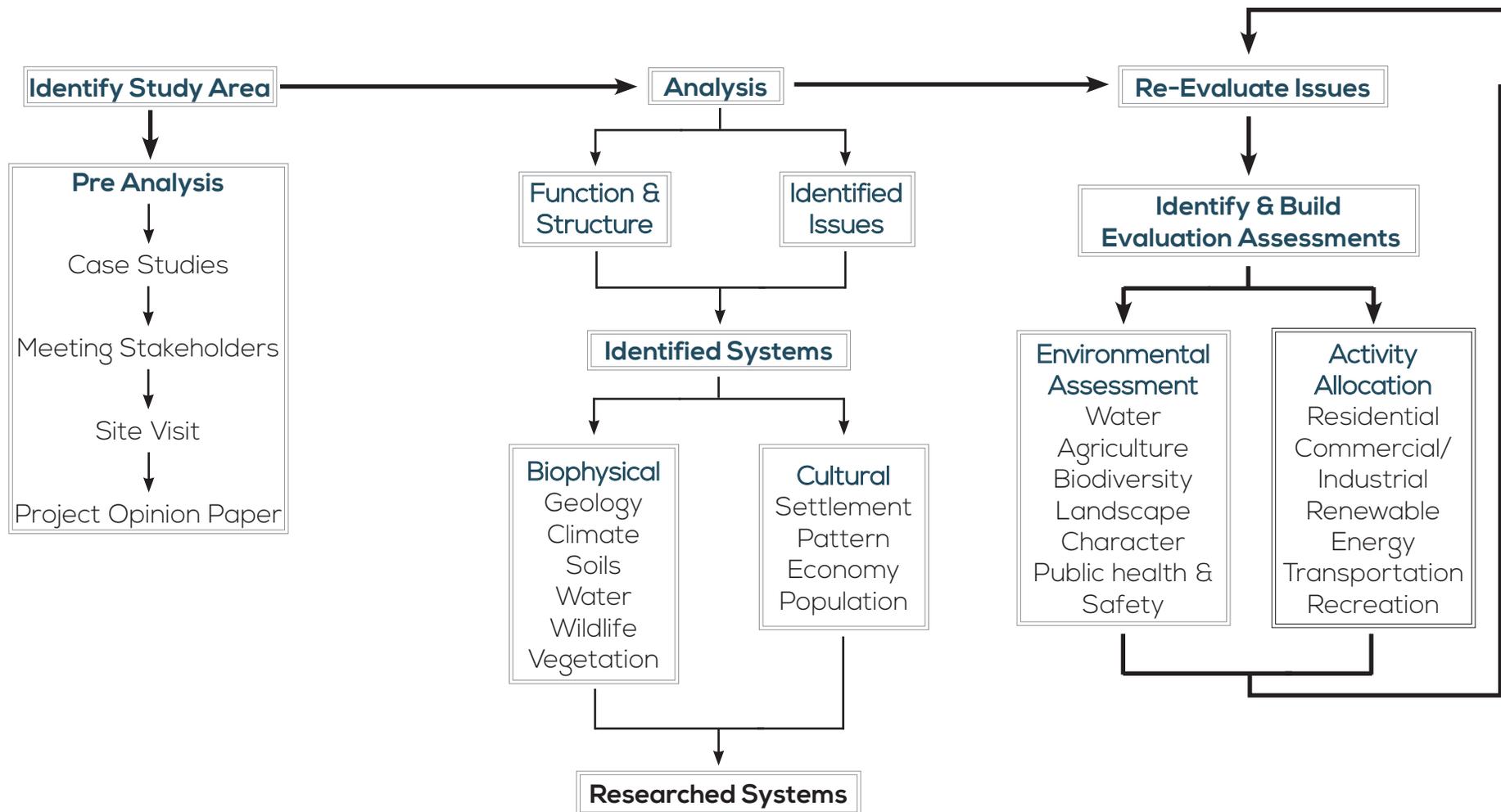
How does the study area operate?

The process models are used to define and understand the process relevant to the study area and to develop a scope of what should be include or not in the analysis. This might include the area's major physical, ecological and human processes—the structure and function of the landscape.

Evaluation Models

Is the study area working well?

The evaluation models are used to assess the social and spatial aspects of the study area. This might include determining where areas are attractive, working well, vulnerable, or where conflict is occurring.



Change Models

How might the study area be altered?

The change models are used to describe how the study area might be altered. This requires understanding how the people of the place regard future change and identifying what changes would fix, improve or address issues the area is experience now and in the future. This might involve deciding where conservation is needed to protect a species or where growth could best occur.

Impact Models

What differences might the changes cause?

The impact models are used to assess the consequences, benefits, and costs of proposals. This might include reviewing which future changes are beneficial or harmful.

Decision Models

Should the study are be changed?

The decision models are used to negotiate a final proposal or alternative future that meets the objectives of the stakeholders. This might include understanding peoples' "positions," and which consequences of change are considered most important.

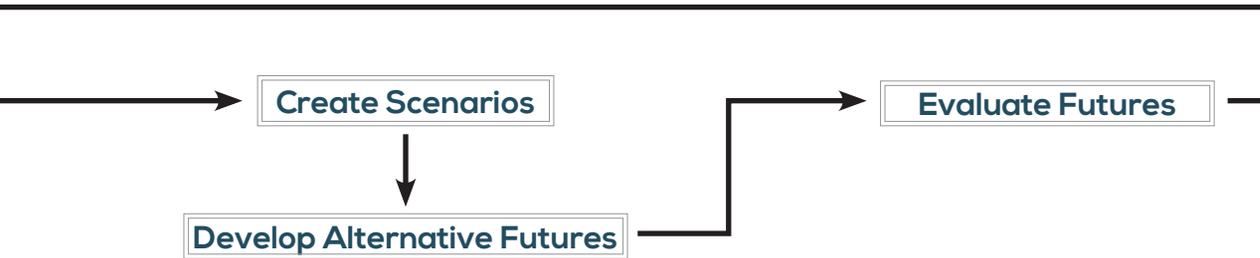


Figure 3. View of Nibley and the Bear River Mountains during an aerial visit of South Cache Valley.



Figure 4. Graduates meeting with the Nibley City Manager at one of the City owned springs.

1 | REPRESENTATION MODELS

South Cache Valley

South Cache Valley is a nine square miles area located in Northern Utah. The area is geographically unique with the Wellsville Mountains to the west and the Bear River Mountains to the east forming a bowl-like shape around the larger Cache Valley. In between is a bustling area of intertwined farmlands, industries and growing communities as seen in the distribution of land uses in Figure 5.

Three rivers, the Blacksmith Fork, Logan, and Little Bear, flow westward across South Cache Valley before converging in a massive wetland reservoir bordering the northwest portion of the study area. These rivers and wetland support recreation, wildlife habitat and supply water for area farming and municipalities.

Development History

Once the hunting grounds for Native Americans, South Cache Valley became a fur trapping destination by the mid-19th century. Soon after Mormon pioneers led by Brigham Young settled the area. The Mormons built their communities around the “Plat of Zion”—a grid town system—and agriculture.

South Cache Valley continued to grow as an agricultural community and by the end of WWII the population had tripled. Population growth and the automobile began pushing low-density development outward from the historical grid towns into the agricultural lands.

Despite the declining amount of farmlands, South Cache Valley remains one of the top producing regions in Utah for dairy products, cattle and crops. In addition to the dairyland legacy, South Cache Valley is known for Utah State University and the nearby National Forests and Wilderness areas.

South Cache Valley has a thriving population of approximately 52,000 residents of which 50% are under the age of 25 (U.S. Census, 2014). Population in Cache Valley has exploded since 2000, with one community experiencing a 175% growth rate (Nibley City, 2016). This can be attributed to profitable conditions for developers including flat, low costing land and pro-development towns.

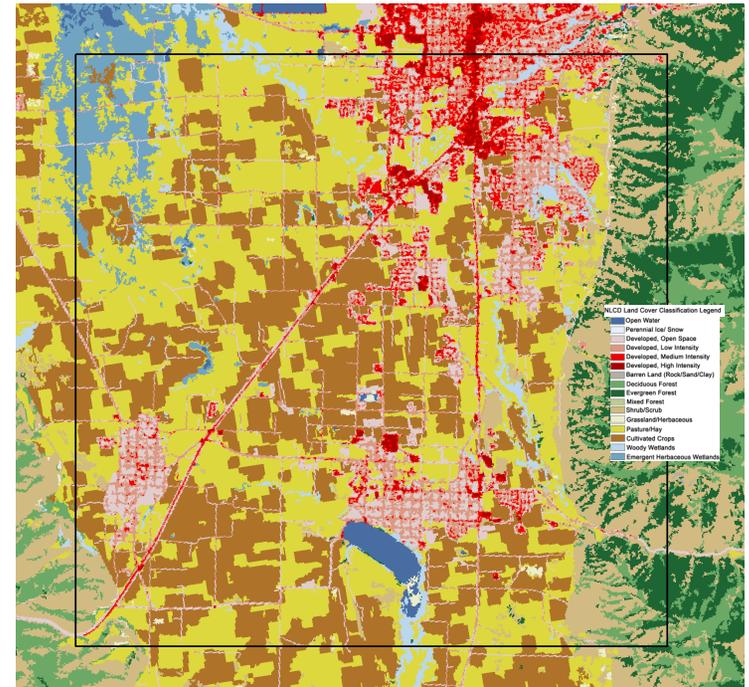


Figure 5. Land use map of the study area.



Figure 6. Hyrum Reservoir and the Bear River Mountains located at the southern end of the study area.

2 | PROCESS MODELS

Biophysical & Cultural Systems

The function and structure of South Cache Valley were broken into two categories: biophysical and cultural. The biophysical systems included geology and soils, climate, water, vegetation and wildlife, and the cultural systems included settlement history, population, and economy.

Structure and Function

Structure and function are landscape ecology terms used to describe the spatial patterns and process of the landscape. Structures are the spatial relationships among landscape elements and influence the conditions and resources that determine the diversity, distribution, and abundance of living organisms (Coulson & Tchakerian, 2010). Functions are the interactions between these structural elements and deal with the flux of energy, materials, and information within and among the elements forming the landscape (Coulson & Tchakerian, 2010).

Water

Water is the lifeline of the Intermountain West. With Utah being the second most arid state in the nation with an average precipitation of 15 inches per year and 18 inches locally, water is a contentious and precious

resource (“Annual Rainfall,” n.d.; Osborn, 2016).

Spring precipitation and winter snowpack fuel the wetlands, reservoirs, rivers and aquifers of South Cache Valley. However, municipal and agriculture uses put stress on the system to the point that rivers and streams, including the Blacksmith Fork, run dry during late summer and fall months.

Water shortages not only affect farms and towns but also the environment and recreation. Low flows in the river prevent kayaking, canoing, fishing, and other water sports. They also make the rivers unsuitable for iconic fish like the Bonneville cutthroat trout. With fishing contributing to \$293 million per year to the State economy, low or no flowing rivers put stress on the wildlife and the local economy (Prettyman, 2013).



Figure 7. Fisherman and a moose taking advantage of the Blacksmith Fork River. Later in the year stretches of the river run dry due to diversions.



Figure 8. Irrigated alfalfa fields along the northern extent of South Cache Valley.

Conversely, too much water can also be a problem. When large snowmelt occur quickly, the rivers and streams in the area swell and inundate the floodplain. Many of the floodplains have been developed over the years and have lost their natural ability to absorb 50- and 100-year flood-events. The result is major property damage, like in 2011, where \$12.7 million in infrastructure damages occurred in Logan and Providence (“FEMA Inspects,” 2011).

Development also impairs aquifer recharge along the foothills of the Bear River and Wellsville Mountains. The addition of impervious surfaces and gray stormwater infrastructure reduce the amount of water seeping into South Cache Valley’s primary aquifer.

Geology & Soils

South Cache Valley is part of a transitional zone between the Basin and Range province, an area

characterized by flat deserts and elongated mountain ranges, and the Middle Rocky Mountain province, an area defined by folded mountains (Spangler & Constance, 1999). Over thousands of years, tectonic activity along the East and West Cache Fault Zones formed the Wellsville Mountains to the east of the study and the Bear River Mountain to the west.

Today, tectonic activity continues to periodically occur along these fault zones posing earthquake and landslide risks. Additionally, the high water table in the valley, combined with this seismic activity, poses a liquefaction risk. Liquefaction is a phenomenon that occurs when shallow water-saturated sandy soils are subjected to ground shaking causing the soil to lose strength and behave like a liquid similar to quicksand.

During the last ice age between 30,000 and 15,000 years ago, the Bear River and Wellsville Mountains experienced significant glaciation (Eldredge & Biek, 2010). When this period ended, the glaciers began to recede, and the historic Lake Bonneville was formed. Lake Bonneville was a massive freshwater lake occupying parts of Idaho, Nevada, and Utah, including Cache Valley (see Figure 9). Approximately 18,000 years ago, the lake reached its peak level and breached its elevated boundaries at the nearby Red Rock Pass in Southern Idaho (Hintze, 2005). Lake Bonneville then receded depositing nutrient rich alluvial soils into the region and helped form terraces along the foothills of the mountains.

The rich valley soils are finely textured and poorly drained, creating ideal conditions for agriculture including water intensive practice of flood irrigation (BioWest, 1990). The foothill and canyon soils, however, tend to be well drained.

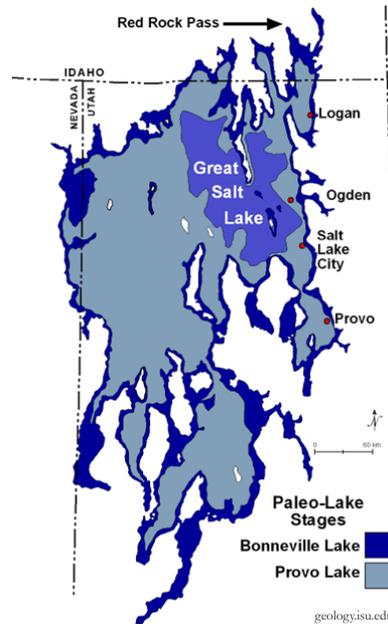


Figure 9. Historic Lake Bonneville.

Climate

South Cache Valley experiences a humid continental climate with warm dry summers and cold winters. The surrounding mountain ranges receive approximately 50 inches of snow a year, feeding the rivers and reservoirs throughout the valley. However,

over the next century, climate change will continue to diminish the snowpack and decrease the amount of usable water in South Cache Valley (R. Davies, personal communication, September 22, 2015).

The nearby Wellsville and Bear Mountains form a unique bowl shape around South Cache Valley inviting winter inversions to the area. The winter inversions are formed when cold air is trapped below warm air sealing in toxic chemicals from furnaces, cows and automobiles. Inversions have occurred regularly and in high enough concentrations for the area to be designated by the U.S. Environmental Protection Agency as a nonattainment zone for particulate matter 2.5 (Idaho Department of Environmental Quality, n.d.). Long exposure to PM 2.5 is known to cause significant health risks including asthma and heart disease (World Health Organization, 2013).

Vegetation & Wildlife

South Cache Valley contains eleven distinct lifezones (Donaldson and Raming, 1979). These zones contain considerable biodiversity, although some species, such as the bison and grizzly bear, were extirpated in the 19th and 20th centuries. Other iconic species, like the elk, mule deer, and mountain lion, remain in the area, and are popular species for hunting.

Cutler Reservoir, a shallow wetland reservoir at the convergence of the Little Bear, Blacksmith Fork and Logan Rivers, provides critical habitat for migratory and local birds along the northwest portion of South Cache Valley.

Historically grasses and riparian vegetation in lower elevations, and juniper, shrubs and coniferous trees at higher elevations would have dominated South Cache Valley. Bison herds helped maintain this cover via their migratory grazing until they were hunted to extirpation in the 1930s (Cache Valley Visitors Bureau, 2010). Additionally, by 1910, the area contained over 300,000 sheep and 16,000 dairy cows (Cache County, n.d.). This new, fixed grazing depleted the natural vegetation and invited nonnative species such as sagebrush and cheatgrass to the area (see figure 10) (Hull & Hull, 1974). Cheatgrass, an invasive plant, dies off during summer and contributes to the area's wildfire hazards.



Figure 10. Uncontrolled sheep grazing degrading the natural land cover.

Settlement History

Before the introduction of horses in the 18th century, Fremont Indians used the area for seasonal hunting grounds, but had not established permanent populations (Cache Valley Visitors Bureau, 2010). After the introduction of horses, however, native tribes, including the Shoshone, began to burn land covers in the region in order to increase grazing area for their herds, prolonging their presence in the area.

The first non-native presence in South Cache Valley were the “mountain-men” of the mid-19th century. These fur traders found ample resource in the rivers and mountains of the Cache Valley region. Jim Bridger, for example, was said to have stashed nearly 50,000 beaver pelts within the borders of what is today Hyrum Township (Cache Valley Visitors Bureau, 2010).

The second wave of non-natives to establish a presence in the area were the Mormon pioneers of Brigham Young. The Mormons built the first settlements according to their Plat of Zion, a system of gridded streets with half-acre lots that encouraged sustenance farming (see Figure 11). They also constructed elaborate irrigation canals to move mountain water across the valley to feed the growing agriculture practices.



Figure 11. Hyrum City plat map exemplifying the Plat of Zion. (USU, n.d.)



Figure 12. Plowing Old Main Hill at Utah State University, 1918.

Population

Population of South Cache Valley remained relatively small, as well as agriculturally based, until WWII. Post WWII, the agricultural industries in the area began to slowly decline, while the population more than doubled. The growing population and the rising popularity of the automobile pushed large, single family housing into the farmlands.

Today, South Cache Valley continues to see rapid growth with the population expected to double again by 2040 (see Figure 13) (Envision Utah, 2009).

Economy

The economic structures of the first settlements were dominated by agriculture including, ranching, woolen mills, dairies, irrigated crops, dry crops, and timber harvesting. Throughout the early to mid-20th century, Cache Valley was also a prominent citrus-crop producer.

Currently, agriculture still accounts for about 26% of the overall economy through the production of ranching, dairies and irrigated and dry crops, especially

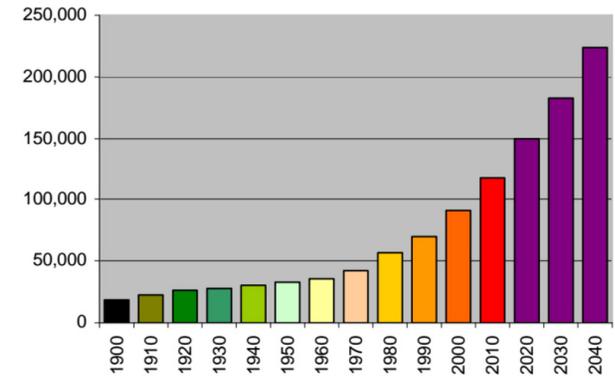


Figure 13. Past and future projected populations of Cache County, Utah.

alfalfa and corn (AG source; USU Extension, 2006). However, sprawling residential patterns threaten the availability of agricultural land used for future generations. This, combined with a workforce transitioning to technological, consulting and other industries, leaves the land that is currently in use for agricultural purposes at risk for development for other uses.

Many of the employment opportunities for people living in the study area are located to the north in Logan. Many of the communities, e.g. Nibley, are bedroom communities—a suburban town where many commuters live but not work. This places strain on local governments to maintain the current infrastructure with a deficient tax base.

Recreation and tourism also constitute a large component to the current economy. The nearby Naomi and Wellsville Mountain Wilderness Areas attract people from around the west for hiking, fishing, rock climbing, backpacking, and backcountry skiing. Cache National Forest, which surrounds the wilderness areas, serves for more active forms of recreation, including ATV use and shooting. These activities bring tourism and retail opportunities to South Cache Valley.

3 | EVALUATION MODELS

Issues Facing South Cache Valley

South Cache Valley's agrarian legacy is being challenged by a growing urban population. It is projected that by 2040 the population will double (Envision Utah, 2009). As the population continues to grow, communities will need to accommodate the growth while addressing the following issues important to residents: maintaining agriculture lands, reducing air pollution, providing enough clean water, maintaining rural character and biodiversity, and providing areas to recreate (Envision Utah, 2009).

Water Quality & Quantity

Warming winter temperature and drought threaten the amount of snowpack available to support agriculture, municipal and environmental needs. An increasing amount of impervious surfaces due to development is reducing the amount of groundwater recharge zones along the foothills of the mountains. This along with increased runoff and nonpoint source pollution in rivers are threatening the quality of water for municipal and environmental use.

Air Pollution

Due to its unique topography, pollutants from cars, businesses and livestock can remain in Cache Valley due to inversion conditions (see Figure 14). This occurs mainly during the winter and can have serious health implications (Pope & Dockery, 1995).

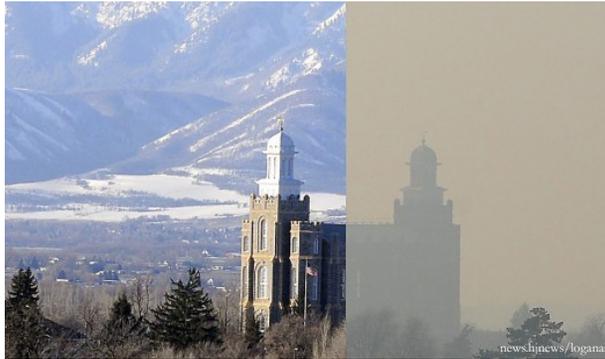


Figure 14. Logan Temple on a clean and dirty air day.

Loss of Agriculture & Rural Character

Agriculture makes up 26% of Cache County's economy, making it one of the highest contributors to agricultural production in the state (UACD, 2011). The current rate of development is consuming nearly 600 acres of farmland each year in the study area (UACD, 2011).

Rural character as identified by South Cache Valley residents includes farmland, undisturbed mountains and rivers, and distinct, separate communities (Envision Utah, 2009). The advancement of subdivisions and strip development threaten the agriculture and natural lands that contribute to the economic vitality and visual quality of the region (see Figure 15).

Access to Recreation

82% of land in the study area is privately owned, and

more than 90% of the rivers run through private land. This situation makes it difficult for residents and tourists to fish, hike, bird watch or canoe in the valley.

Loss of Biodiversity

The expansion of agriculture, residential development and roads are fragmenting the natural landscape and distributing the existing natural habitat areas. Water diversions cause rivers, such as the Blacksmith Fork, to run dry for part of the year. These degradations continue to diminish what little nature areas are left for biodiversity in South Cache Valley.



Figure 15. Expanding subdivision like this one in Nibley, Utah threaten the rural character and agricultural production of the region.

Developing the System Models

Building on the issues identified in the study area, ten systems that represent the most important natural and

human systems to South Cache Valley were identified and modeled, they include:

1. Water
2. Biodiversity
3. Physical Health & Safety
4. Landscape Character
5. Agriculture
6. Residential Development
7. Commercial/Industrial Development
8. Recreation
9. Transportation
10. Renewable Energy

Each systems was built in ArcGIS using data collected during the representation model phase (see appendix B).

Classification

Each system model was classified into three categories—red, yellow and green—to evaluate its performance on the landscape.

Red signifies areas that are most important for the health of that system and should not be altered, otherwise that system would be significantly degraded. Green represents areas that are not significant for the health of that system, and are thus the most suitable for change, according to that system. Lastly, yellow represents areas that have non-critical importance to the system's health. If change occurred in these areas, the system would still function but it would see some impact to its overall health. The following evaluation models provide examples of how these classifications were used to assess the different systems in South Cache Valley.

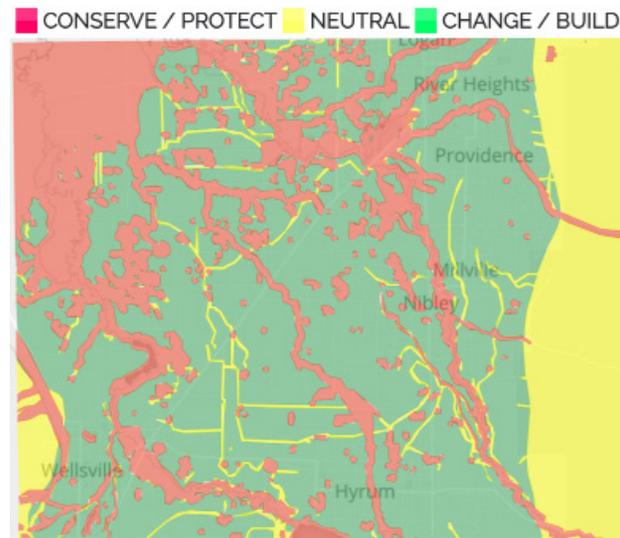


Figure 16. Water evaluation model.

Water

The water model identifies the critical areas for water in South Cache Valley (see Figure 16). The red areas signify streams, rivers, lakes, riparian areas and springs as the most important areas to conserve for the overall health of water in the area. If change occurs within these areas, it would significantly impact the quantity and quality of water in the area. Changes might include water being contaminated or the area being built on. Yellow areas represent aquifer recharge zones and canals. Changes in these areas would not significantly impact the overall health of water in the area but still could potentially have impact on the water quality of the aquifer. The green areas represent areas where most changes will not have a significant impact on the health of water in the area.

The water model shows the importance of Culter Reservoir and wetland in the northwest corner of the area, and that the several streams and rivers that cross the valley are important for maintaining a healthy water system for people and the environment of South Cache Valley.

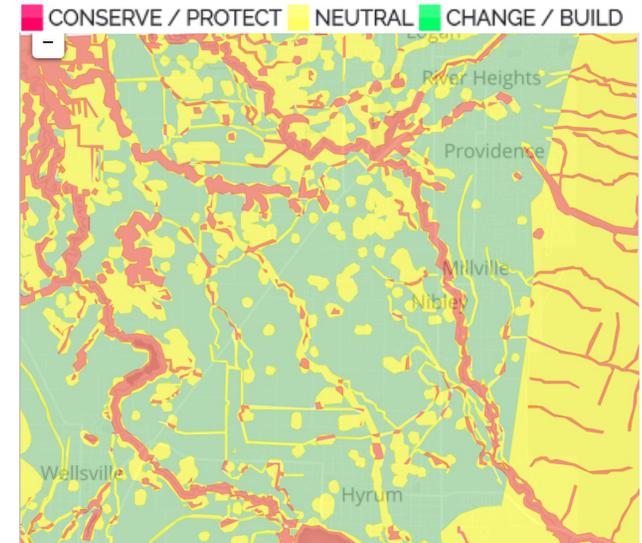


Figure 17. Biodiversity evaluation model.

Biodiversity

The biodiversity model identifies areas of aquatic and terrestrial habitat, and areas with the greatest species richness (see Figure 17). The red areas represent portions of the study area with the highest biodiversity. Yellow areas represent moderate levels of biodiversity and green areas have minimum biodiversity.

Areas with the highest levels of biodiversity (red) are located along the rivers, streams and reservoirs and are important for conserving biodiversity in the study area. Other areas that are moderately important for maintaining biodiversity are the canals, springs and mountains surrounding the study area.

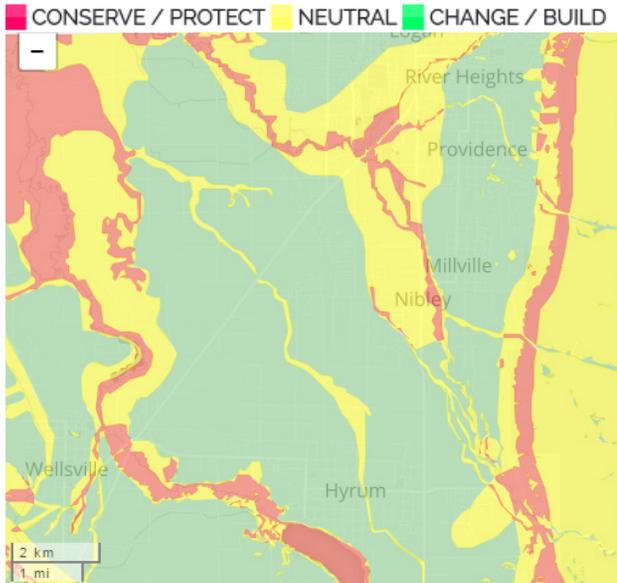


Figure 18. Physical health & safety evaluation model.

Physical Health & Safety

The physical health and safety model shows areas susceptible to natural hazards, such as landslides and rock falls (see Figure 18).

Areas with the highest risk for natural hazards are represented by red. Green represents areas with no hazards, and yellow represents areas with some natural hazards. The highest risk areas for natural hazards are located along the East Cache Fault Line, and within the 100 year river floodplains.

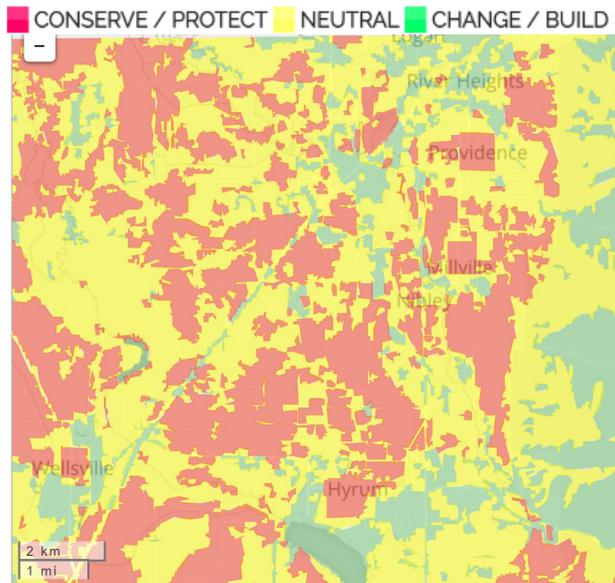


Figure 19. Landscape character evaluation model.

Landscape Character

The landscape character identifies important areas for rural character. Rural character is described as the “open space,” e.g., parks, farms, natural areas and scenic views of the mountains and valley (see Figure 19).

Red areas contribute heavily to the rural character of South Cache Valley. These areas are highly visible and contain some form of “open space.” These areas are scattered throughout the study area. Areas that are ideal for change (green) because they do not contribute to the rural character included roadways and the portions of the landscape that are not completely visible as one moves through the study area, e.g., the backside of the Bear River Mountains.

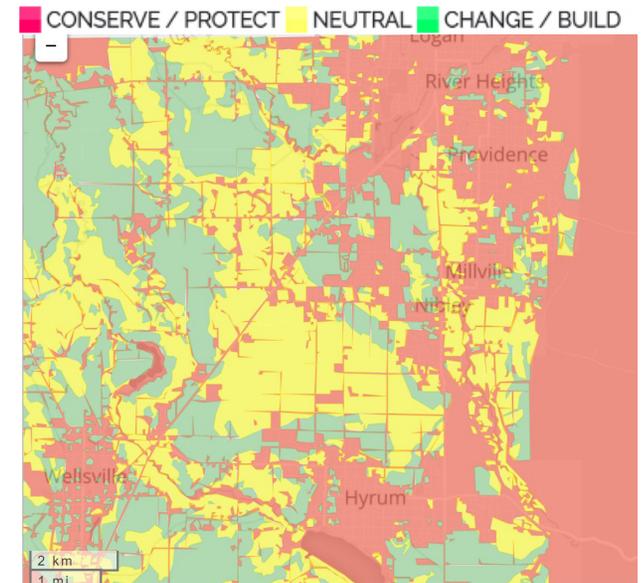


Figure 20. Agriculture evaluation model.

Agriculture

The agriculture model identifies valuable agricultural lands based on soil and existing agricultural land uses (see Figure 20). This model did not take into consideration current development because farming can occur in urban areas as well. The best areas to protect (red) are located throughout the study area where soil is rated as good for agriculture. The best areas to change (green) can be found along the Bear River Mountains to the east and other steep or poorly drained areas throughout the valley.

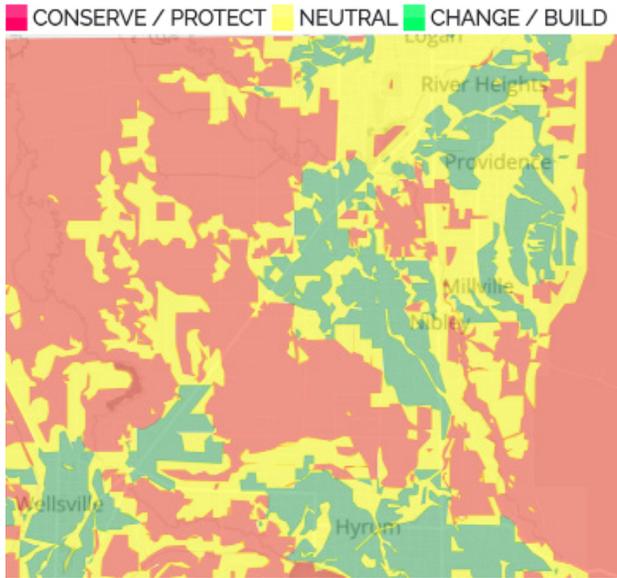


Figure 21. Residential evaluation model.

Residential Development

The residential development model displays the most suitable areas for residential development (see Figure 21). Areas in green are the best areas for future residential development. These areas have good soil to build on, are close to roads, and are within existing municipalities. Yellow areas contain two of these characteristics and are found adjacent to municipalities and areas with good soil for housing. Poor areas for residential development (red) are the steep mountain slopes, existing developments, and floodplains.

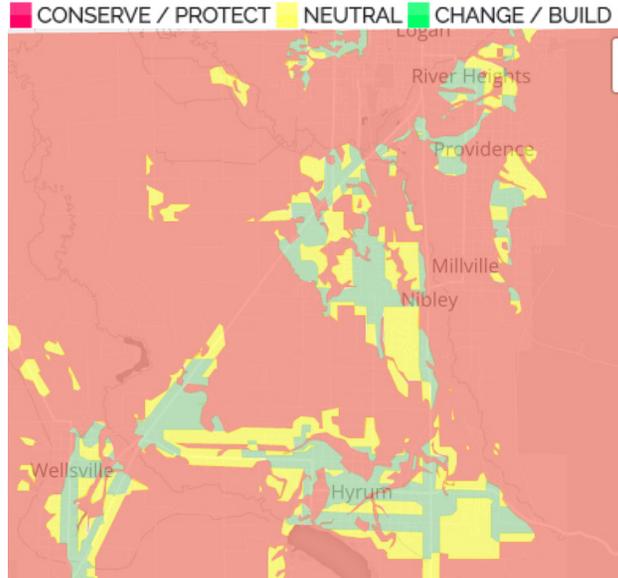


Figure 22. Commercial evaluation model.

Commercial/Industrial Development

The commercial/industrial development model identifies suitable locations for commercial and industrial development (see Figure 22). The best suited areas (green) are located within municipalities and are close to roads and/or railroads. The model shows few areas as ideal (green) for expanding commercial/industrial developments.

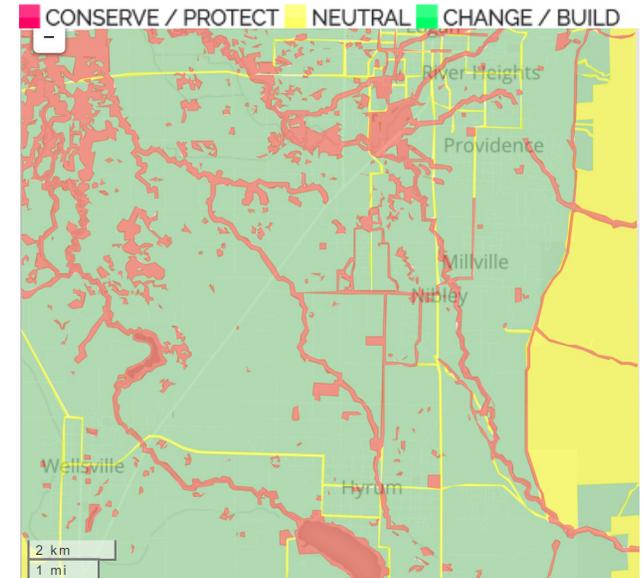


Figure 23. Recreation evaluation model.

Recreation

The recreation model considers outdoor leisure or activities that occur in public spaces (see Figure 23). This include: activities along streams and trails, parks, golf course and bodies of water. The red (no change) areas already contain outdoor activities. Yellow areas provide some opportunity for recreation and can be found along key road connections and the Bear River Mountains to the east.

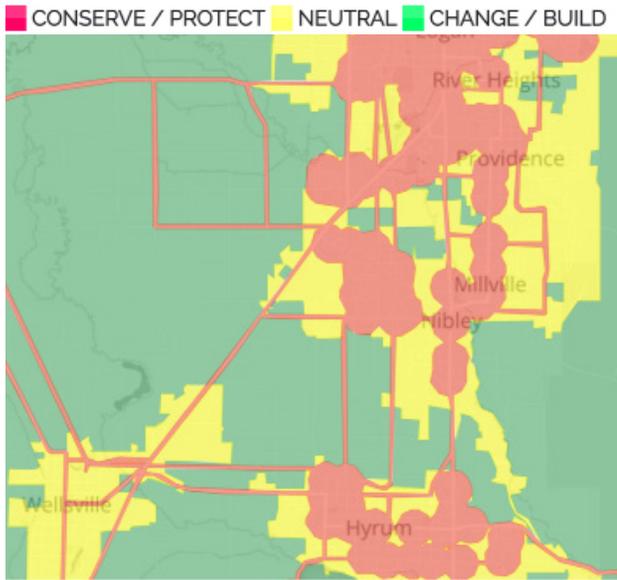


Figure 24. Transportation evaluation model.

Transportation

The transportation model shows multi-modal transportation, including bus stops, bus routes, bicycle routes, park & ride lots and railroads (see Figure 24). Red (no change) are areas already containing one or more of those land uses and no improvements are needed. These areas tend to be inside municipalities and along major roadways. Areas ideal for change (green) are located outside municipal boundaries where no type of multi-modal transportation occurs. This constitutes a large portion of the study area.

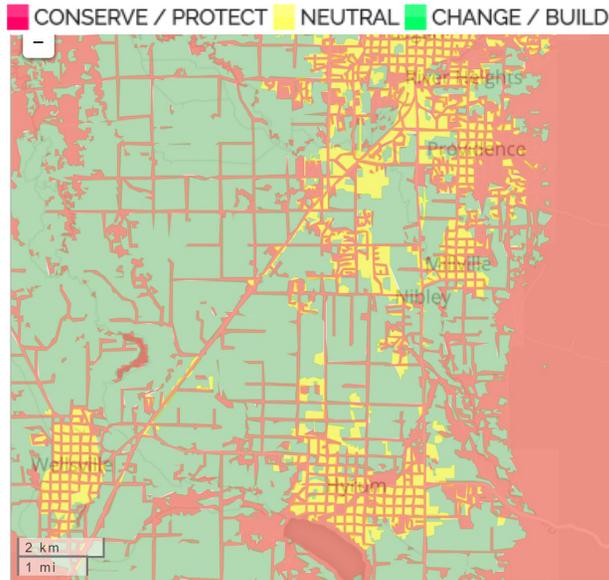


Figure 25. Renewable energy evaluation model.

Renewable Energy

The renewable energy model identifies areas suitable for the installation of large-scale photovoltaic solar-power facilities i.e. solar “farms” (see Figure 25). Areas with sufficient annual solar radiation, a developable slope and open land cover are the most suitable (green) for large-scale solar and are located mostly in the undeveloped portions of the study area. Areas with sufficient annual solar radiation and a developable slope were considered moderately suitable (yellow areas) for solar. These areas are found in currently developed areas. Areas not suitable for solar (red) are located on transportation routes, mountains and water.

4 | CHANGE MODELS

The Workshop

The South Cache Valley project culminated in a one-day workshop that brought together community stakeholders in various fields and occupations to work with the students and faculty to develop alternative futures using the Geodesign Hub online software (www.geodesignhub.com). The software was developed by Prof. Steinitz and Ballal. It allows users to create, share and collaborate on alternative futures in a rapid, interactive website. The software was designed to facilitate collaborative planning efficiently and effectively, as well as bridging the gap between experts and non-experts.

Change Models Part I & II

The change models occurred in two phases, the first phases involved creating future projects and policies that would improve the ten systems. The second phase involved building alternative futures with those projects and policies that respond to the expected changes in South Cache Valley.

Creating Projects & Policies

Teams were formed for each of the ten systems with the goal of creating future projects and policies that would improve that system. Teams were formed with

students, community stakeholders and experts. The participants were placed in teams that aligned with their expertise and graduate students acted as team leaders. Collaboratively, the team members created projects and policies in the Geodesign Hub that reflected information in the respective evaluation models.

Projects

Projects consist of proposals that are built or have a physical impact on the study area, e.g., the creation of a highway by-pass.

In the workshop, the biodiversity team created the Hyrum Slough re-naturalization project (see Figure 26). The intent of the project was to daylight a fragmented riparian corridor and restore it by removing invasive species and planting additional vegetation. The re-naturalization would bring additional habitat and vegetation to the area.

The team identified this project based on local knowledge and the biodiversity evaluation model. The model showed fragmented red (no change) and yellow (non-critical) patches that if improved could become an uninterrupted corridor for wildlife and plant habitat.

Policies

Policies consisted of proposals to change activity patterns in their affected area, e.g., maximizing

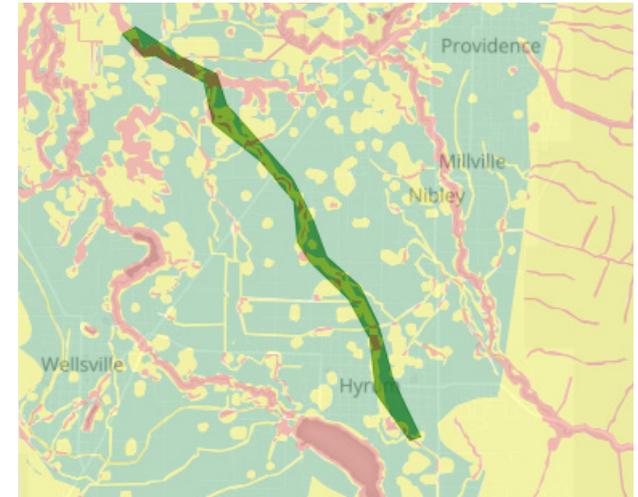


Figure 26. Hyrum Slough re-naturalization project (green dark green).

irrigation efficiency in an agricultural area. In the workshop, the residential team created an “infill” priority policy (see Figure 27). The goal of the policy was to focus residential development in the vacant areas of municipalities before considering areas outside of communities. The residential team developed the policy by determining that the best land for homes is located inside municipalities, because infrastructure was already in place and there is closer proximity to schools and stores.

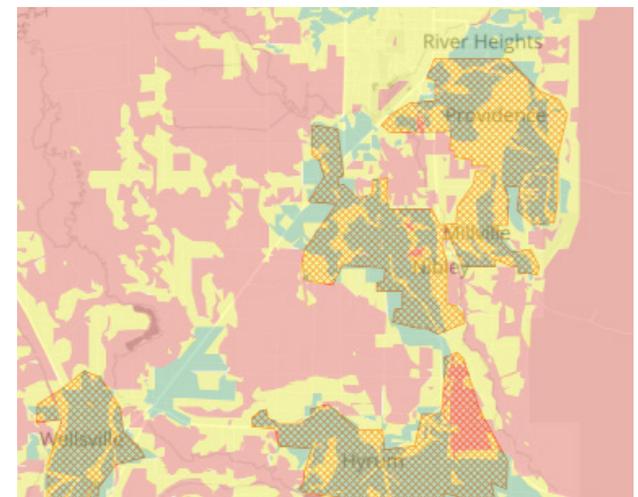


Figure 27. “Infill” priority policy (orange cross-hatching) would encourage development inside existing municipalities instead of outward.

Creating Proposals for Alternative Futures

After creating numerous projects and policies across South Cache Valley, six stakeholder groups were formed. The six stakeholder groups were:

1. Developers (DEV)
2. Regional Planners (RPL)
3. Farmers (FRM)
4. Environmentalist (ENV)
5. Old Folks (OLD)
6. Young Folks (YNG)

Within the stakeholder groups, participants would combine projects and policies to build alternative futures for South Cache Valley. The participants in each group took on the role of their group's interest. For example, Old Folks were to develop a future that would be ideal for an older population. For them this included having many hospitals, multiple transportation options and natural areas. Farmers were to develop a future focused on maintaining the agriculture legacy of the area. Developers focused on building residential and commercial developments. Young Folks concentrated on families, schools and parks. Environmentalist were to build a future aimed at preserving and expanding natural systems. Finally, Regional Planners focused on a holistic future where a functional balance of these priorities could be achieved.

System Priorities

Each stakeholder group started by deciding on the importance of the ten different natural and human systems for their objective (see Figure 28). By prioritizing the systems, they emphasized their interests when building their proposal. For example,

the farmers set systems like water and agriculture as high priority for their future and systems like commercial development and renewable energy as low priorities. Setting priorities allowed the team to form a strategy for how they would build their different futures.



Figure 28. The system priorities for the farmer. Larger values like 10 represent a high priority. For farmers, water and agriculture were the most important priorities.

Future Objectives

Each stakeholder team was requested to develop proposals based on a program of change which included the following requirements:

- Provide access to outdoor recreation
- Preserve wildlife habitat
- Locate two of the following five institutions:
 - State prison
 - General hospital
 - Sewage treatment plant
 - Regional technical high school
 - Major commercial center
- Double the housing and commercial space
- Provide public or multi-modal transportation to all municipalities
- Protect water quantity and quality
- Preserve as much agricultural land as possible
- Provide 1,000 acres of solar panels (distributed and/or utility scale)

Proposals for Futures

The first future proposal was the most difficult for all the groups to produce due to all the considerations needed. Once the first future proposal was created,

teams could then build off of their first proposal. All teams were encouraged to make as many proposal as possible, improving on the previous versions.

In creating the futures, some of the groups focused on the systems that were most important to them, as was evident in the Developer's design (see Figure 30). For example, it largely consisting of commercial (orange) and transportation (black) projects and policies. Other groups focused on a more diverse array of systems, like the Regional Planners.

Impacts

After creating each proposal, teams ran a detailed impact analysis of their future in the Geodesign Hub. This is covered in greater detail in the following chapter. The analysis displayed where each system had positive, neutral, and negative impacts within that system and against other systems, as well as costs for implementing their future. This allowed teams to identify how their proposals would affect the landscape and where changes in their design could be made to improve their design.



Figure 29. The renewable energy system team working to create projects and policies that would later be used to build proposals.

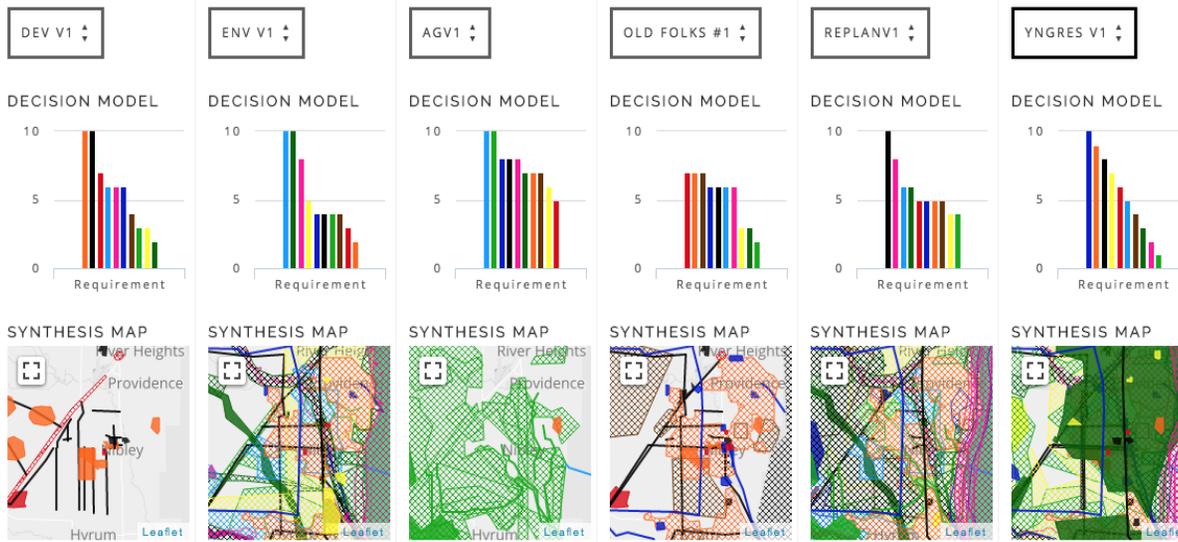


Figure 30. The first proposal for each stakeholder group. The bar graph represents the stakeholder groups' priorities and the synthesis map were the proposals. The environmentalist, regional planners and the young folks proposals focused on meeting all the goals in the first proposal. While the developers, farmers and the old folks created simpler proposals focused on a few systems.

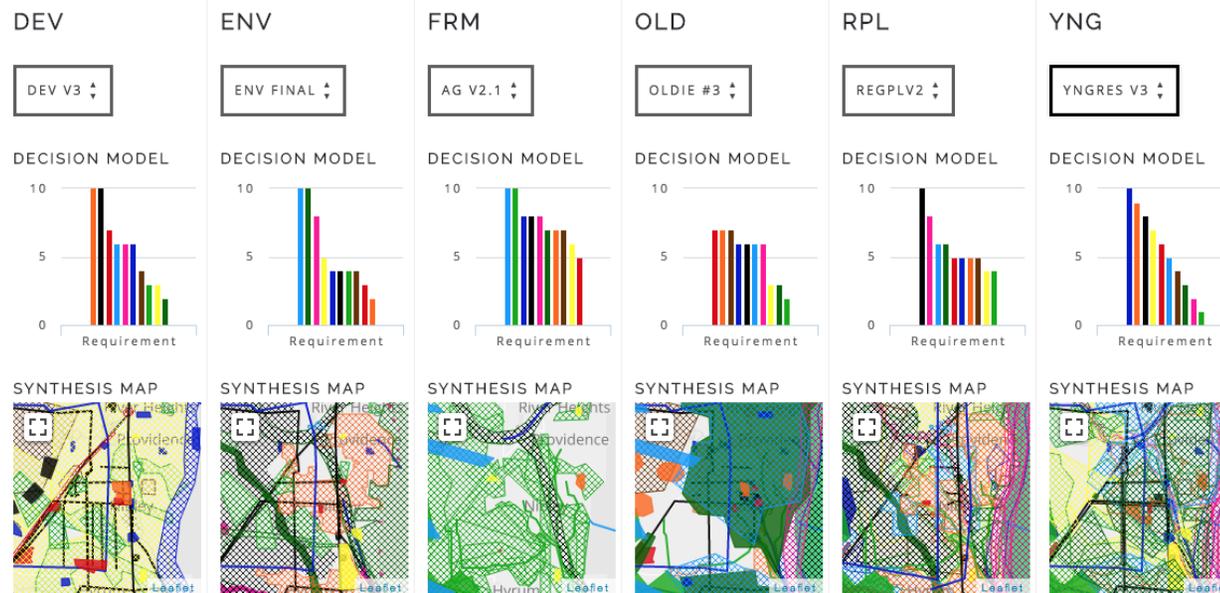


Figure 31. The final proposals used by the stakeholder groups for the decision model process. Most groups built their final proposal by focusing on project and policies that were most important to them then added the objectives around their top priority projects and policies.

Final Proposals

After creating and analyzing impacts for their proposals, the teams selected their best future proposal. Due to time constraints of the workshop, each stakeholder group did not accomplish every design objective. However, the designs produced did address a number of significant issues for the study area, and were essential for the negotiation process that occurred for the decision models (Chapter 7).



Figure 32. The developer stakeholder group discussing which projects and policies to include in their proposal.

5 | IMPACT MODELS

For each future proposal created, the Geodesign Hub software computed a detailed impact analysis of the proposal on the ten different systems and estimated the cost of the projects. This allowed teams to quantitatively evaluate their proposal and identify where their proposal was improving the current condition and where it was not (see Figure 33).



Figure 33. The detailed impact analysis for all ten systems.

System Impacts

The system impacts analysis assessed the effects of a proposal on a system by system basis. By selecting one system or model, the Geodesign Hub would calculate the impacts of the proposal on that system (see Figure 33). For example, if water was selected, the Geodesign Hub would calculate the impacts of all of the water projects involved with the proposal on the water system (see Figure 34).

These impacts were displayed in a purple, yellow, orange classification system, in which purple signified a positive impact, yellow a neutral impact, and orange a negative impact.

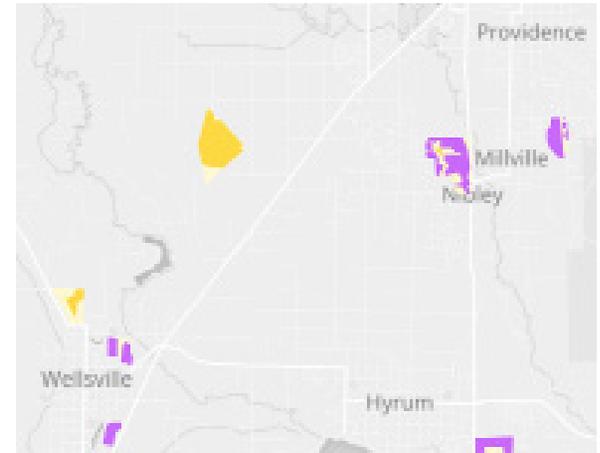


Figure 34. Water impact model showing both positive (purple) and negative (orange) impacts of water for this proposal.

Cross System Impacts

The cross system impact analysis allowed the participants to view the impacts of selected projects on all systems, simultaneously. For example, Figure 35 demonstrates how the residential development proposals impacted the wildlife system or public health and safety. This type of information was crucial for understanding the area as an

interrelated functioning system and for evaluating the overall effects of a proposal.

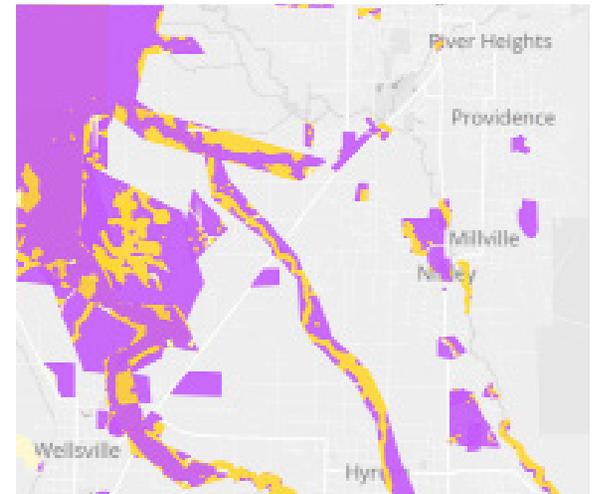


Figure 35. Cross system impact model for a residential development proposal.

6 | DECISION MODELS

Once each stakeholder group completed its final proposal, the groups moved onto negotiating one final design. Due to time constraints, the “final negotiation model,” i.e. the final South Cache Valley decision model, was completed by the stakeholder group leaders after the workshop ended. However, Prof. Stienitz initiated the negotiations by demonstrating his “sociogram” process (see Figure 36).



Figure 36. Prof. Stienitz figuring out which stakeholder groups would work well together using a sociogram.

The purpose of a sociogram is to identify which groups will work best with one another. To do this, each stakeholder group presented their proposals and the other groups determined which one was most compatible to their own. This process was done on a scale of four, ranging from “partner” (++) to “never partner” (-).

When the sociogram was completed, it was used to determine the sequence of negotiation between stakeholder groups.

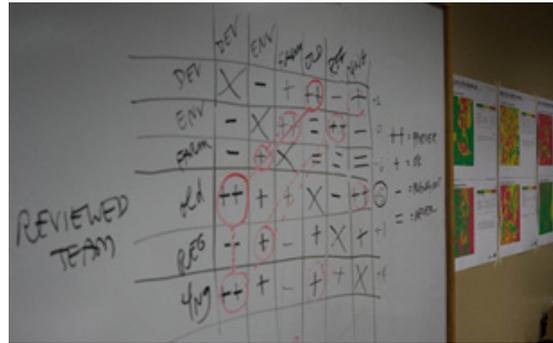


Figure 37. The result of the sociogram showing the connections between the stakeholder groups.

The Negotiation

In the final negotiations (which occurred after the workshop), the stakeholder team leaders that represented the group served as a representative for each of the stakeholder groups (see chapter 7). The largest overlap of interests identified by the sociogram was between the old folks, developers, and young folks. These groups formed a coalition to develop one future design in the first round of negotiations. Similarly, the environmentalists, farmers, and regional planners exhibited an interest in working with each other, although somewhat weaker. Thus, they worked together in the first round to develop one future.

In the second and final round of negotiations, representatives from the two coalitions met to agree on one design. The software allow the negotiators to discuss and compare the proposed projects and policies of each of the ten systems individually. In this way they were able to identify areas of agreement as well as prioritize projects and policies for compromise.

This design was the final negotiation model. It combined the most salient interests from the various stakeholder groups, given their diverse objectives.

The proceeding figures in this chapter compare some of the stakeholder groups’ alternative futures by detailing the various projects and policies of which they were composed. Identifying commonalities in these projects/proposals was crucial for the negotiations process.

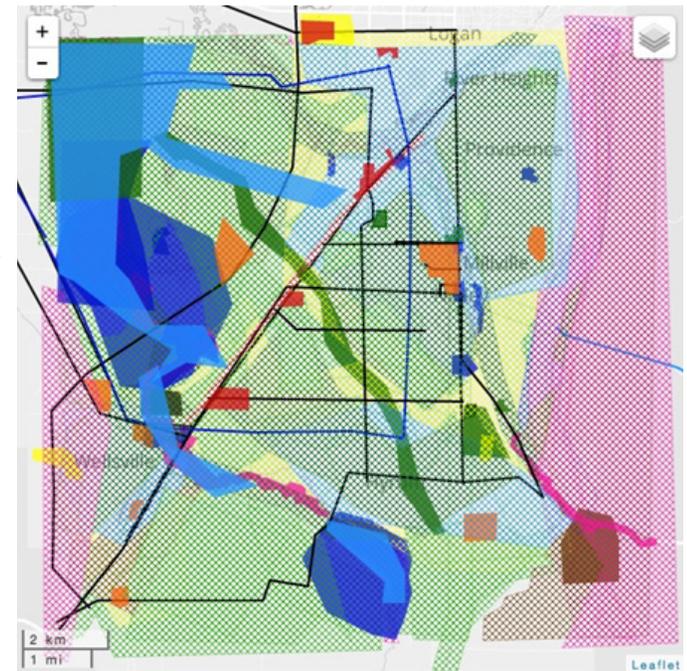
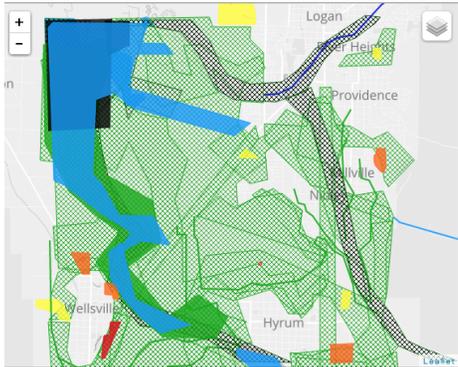


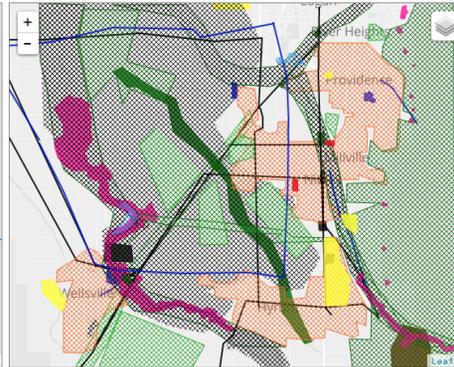
Figure 38. The decision model (final negotiated plan) negotiated between the environmentalist and the developers.

Farmers



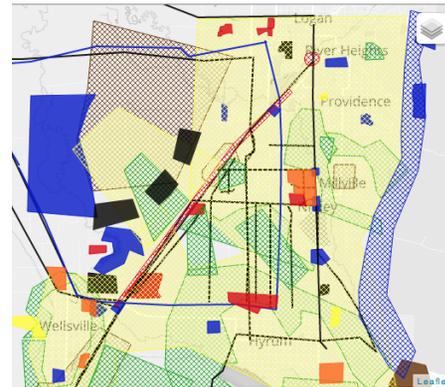
	WTR	BIOD	PHS	LAND	AGR	RES	COMI	REC	TRAN	RENE
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2				2	2					
3				3	3					
4	4			4	4					
5				5	5					
6	6			6	6					
7				7	7					
8				8	8					8
9				9	9					9
10				10	10	10				
11				11	11					11
12	12			12	12	12				
13				13	13					13
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35										35

Environmentalist



	WTR	BIOD	PHS	LAND	AGR	RES	COMI	REC	TRAN	RENE
1			1							
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3		3						3		
4			4	4					4	
5		5								
6		6								
7		7	7			7				
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29										

Developer/Old Folks



	WTR	BIOD	PHS	LAND	AGR	RES	COMI	REC	TRAN	RENE
1			1		1					
2					2			2	2	
3		3	3							
4		4			4			4		
5					5			5		
6		6			6					6
7	7	7	7			7		7		
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Environmentalist/Farmers



	WTR	BIOD	PHS	LAND	AGR	RES	COMI	REC	TRAN	RENE
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2				2				2	2	2
3			3		3			3		
4				4						
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6	6	6						6	6	6
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Figure 40. A side by side comparison of the developers/old folks (left) and environmentalists/farmers (right) negotiation models.

Figure 39. A side by side comparison of the farmers (left) and the environmentalists (right) negotiation models.

7 | CONCLUSION

The Final Negotiated Proposal

The final negotiated proposal (Figure 41) focused growth within existing communities through infill priority and growth boundaries policies. New growth was focused along the new bypass highway (see letter A) and Wellsville. New transportation projects crisscross the study area providing alternative modes of transportation for residents, including light rail, bus rapid transit connecting Wellsville to Logan and Logan to Hyrum, and bike lanes connecting Hyrum to Logan.

The proposal also included several environmental restoration (e.g. daylighting the Hyrum Slough (see letter B) and floodplain restoration) and protection projects (e.g. no building in floodplains) as well as water improvement projects for Cutler Marsh and Hyrum Reservoir. The proposal also provided groundwater recharge protection along the foothills (east portion of the study area) and source water protection for springs.

Another emphasis of the proposal was the agriculture zone protection between communities and along major state routes. These policies would ensure farming practices remain in the valley and the rural landscape character is protected.

The Geodesign Experience

Previous workshops that used the Geodesign Hub

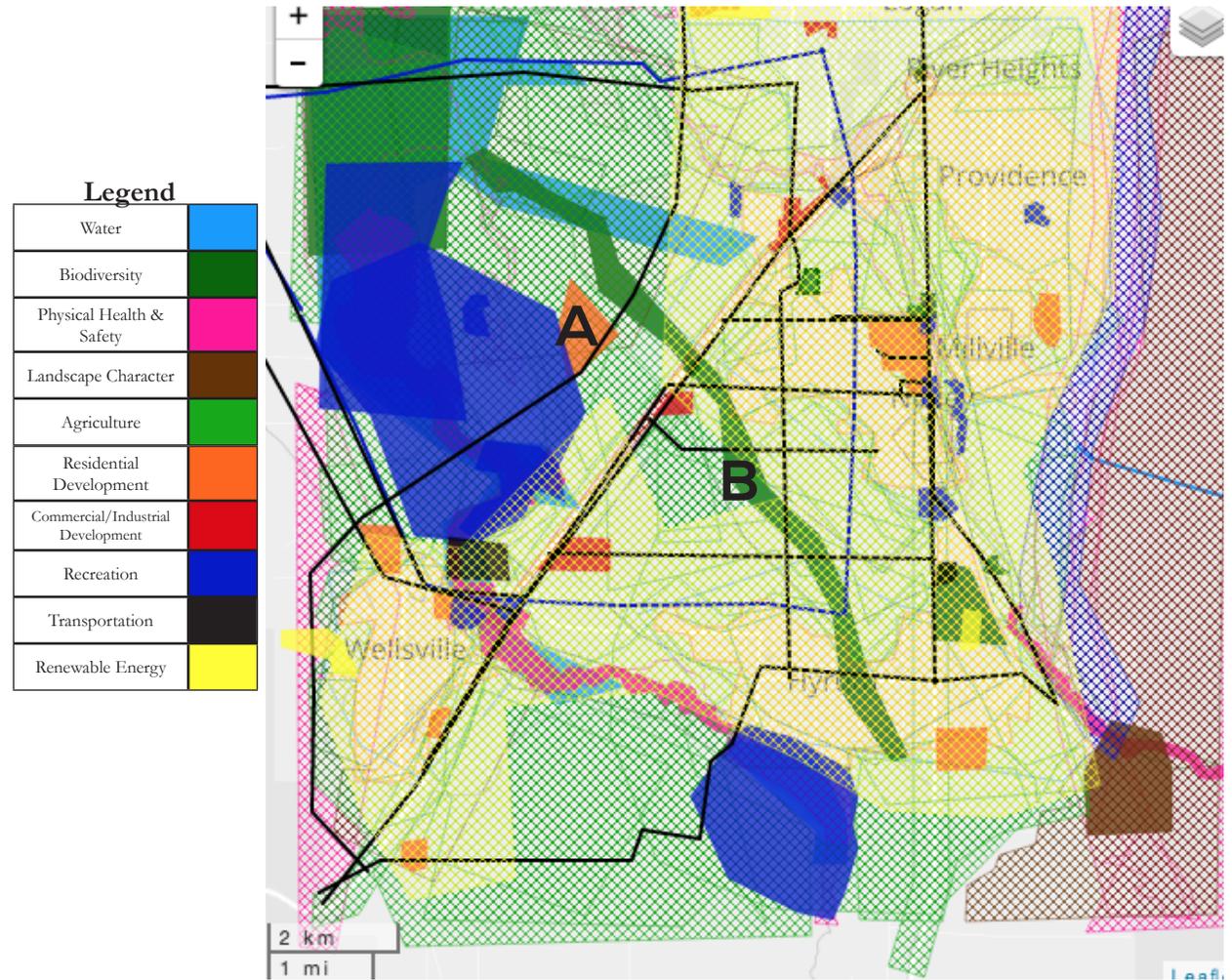


Figure 41. The decision model (final negotiated plan) for South Cache Valley.

took place over the course of a three-day period. The South Cache Valley project was unique in that the bulk of it occurred during one 8-hour session. The one-day

workshop afforded diverse opportunities to explore the geodesign process in an interactive, virtual and analytic capacity. However, it concluded before the participants developed the final negotiation model,

established a timeline or performed a thorough cost and impacts analysis. Prof. Warren-Kretzschmar and her M.S. BRP students later performed these procedures.

For these efforts, each one of the stakeholder groups was assigned to a M.S. BRP student. Negotiations then followed Prof. Steinitz's sociogram associations. Eventually, the environmentalists (also representing the farmers and regional planners) and the developers (also representing the young and old folks) developed the final model. This was completed through a back-and-forth negotiation process. The environmentalist's group was concerned primarily with minimizing the impacts of further development, and also desired some restoration. The developer's group was mostly concerned with additional infrastructure and developable land. The new highway bypass and large residential development adjacent to the Cutler Reservoir were especially contentious. These projects were included after a series of agreements that reduced their proportions and include compensatory arrangements, such as water conservation projects (blue) and policies (green), and smaller, higher density residential and commercial projects in other areas. The negotiation process lacked the input of the non-M.S. BRP workshop participants. Ideally, in a community planning setting, the negotiations process would have included more diverse, permanent or long-term stakeholders of the study area. Other drawbacks of the one-day workshop included not having enough time to thoroughly complete the costs, impacts analysis, or project timeline. The cost analysis and project timeline are tools in the Geodesign Hub that allow communities and planners to develop these projects for the implementation phase of their project.

The time-crunch diminished the overall usefulness for the analyses performed in the workshop to be applied to real projects and policies in the study

area. However, the South Cache Valley project was still very useful as an educational and training tool for its participants. Throughout the project, i.e., the workshop, the research and modeling that led up to it and the analyses that were performed after it. The participants gained a functional familiarity with the geodesign process and practiced collaboration across disciplines in a dynamic community with multiple, and sometimes conflicting, priorities. Additionally, the community interactions that took place throughout the project and workshop resulted in a sharing of

ideas and information between partners that were unlikely to occur in standard classroom and office settings. The geodesign process enhanced the ability of the students and community partners to perform as regional planners, and the Geodesign Hub proved to be a useful tool. While not all of the Geodesign Hub's functions were utilized fully during the workshop, the organizers later explored these tools and are now confident in their ability to use the software in the geodesign process to develop effective regional design.



Figure 42. Wellsville Mountains behind an alfalfa field in South Cache Valley.

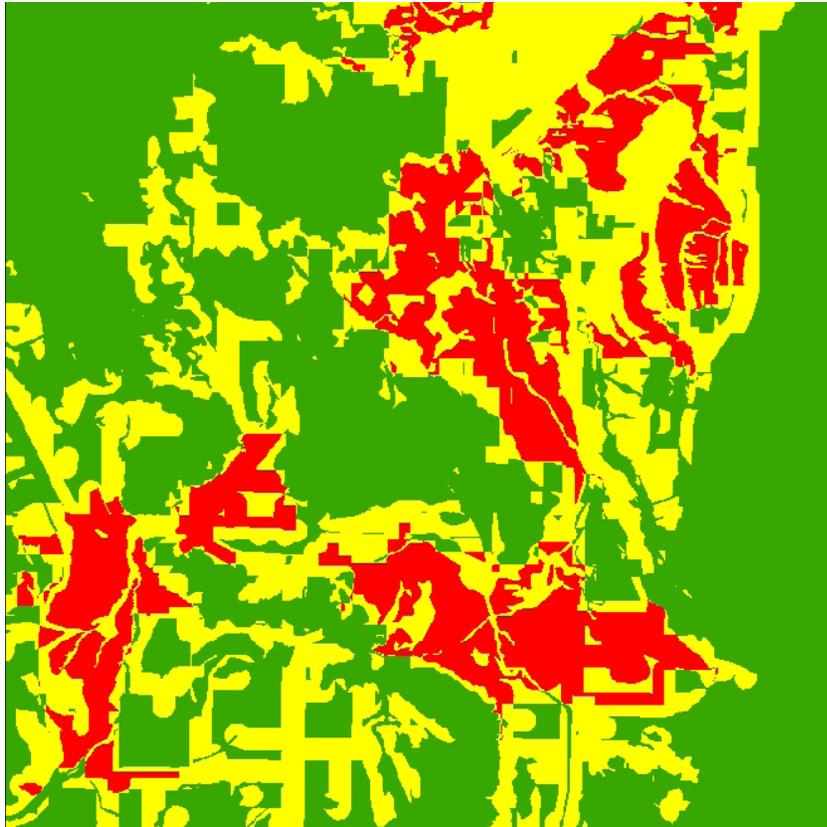
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APPENDIX A | REFERENCES

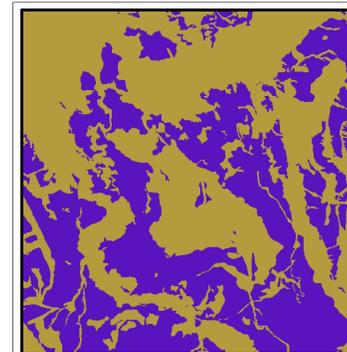
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APPENDIX B | DETAILED EVALUATION MODEL

Residential Model

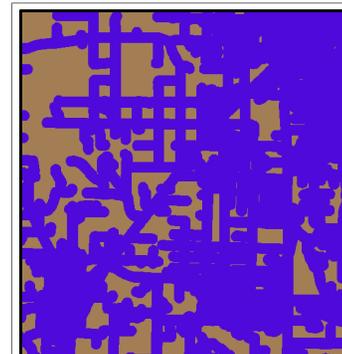


Most Attractive Ideal for Change	Neutral	Least Attractive Ideal for Protection
Areas that have the best soil for construction, are within a 1/4 mile of existing roads and within municipal boundaries	Contains two of the three criteria	Contains one or none of the criteria for suit-able residential development



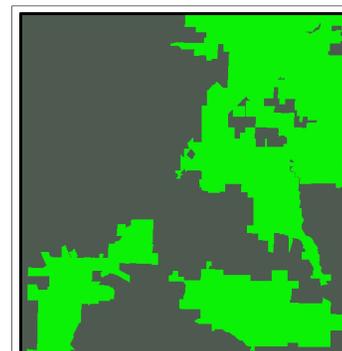
Soils
 Purple = Good Suitability
 Brown = Poor Suitability

+



Roads
 Blue = Within 100m of a road
 Brown = Not within 100m of a road

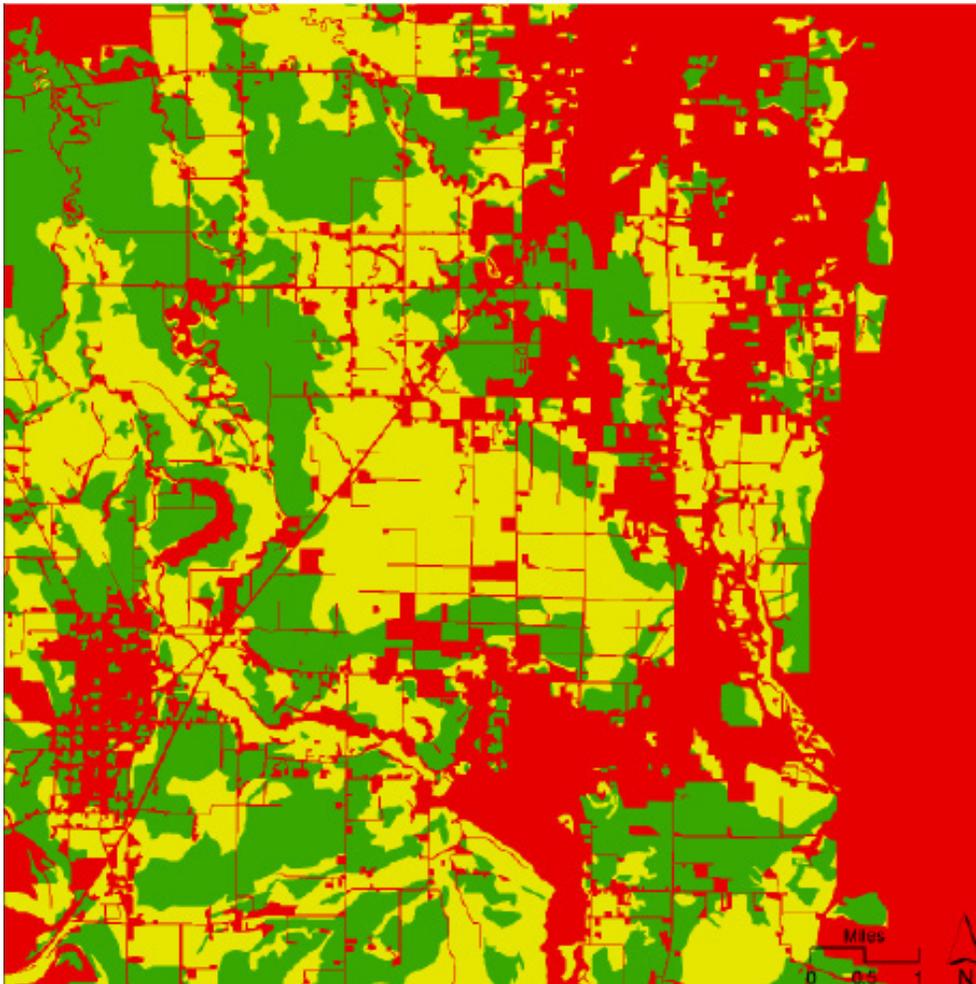
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Municipalities
 Green = Within Boundaries
 Grey = Outside Boundaries

Soil data from SSURGO and all other from Utah AGRC

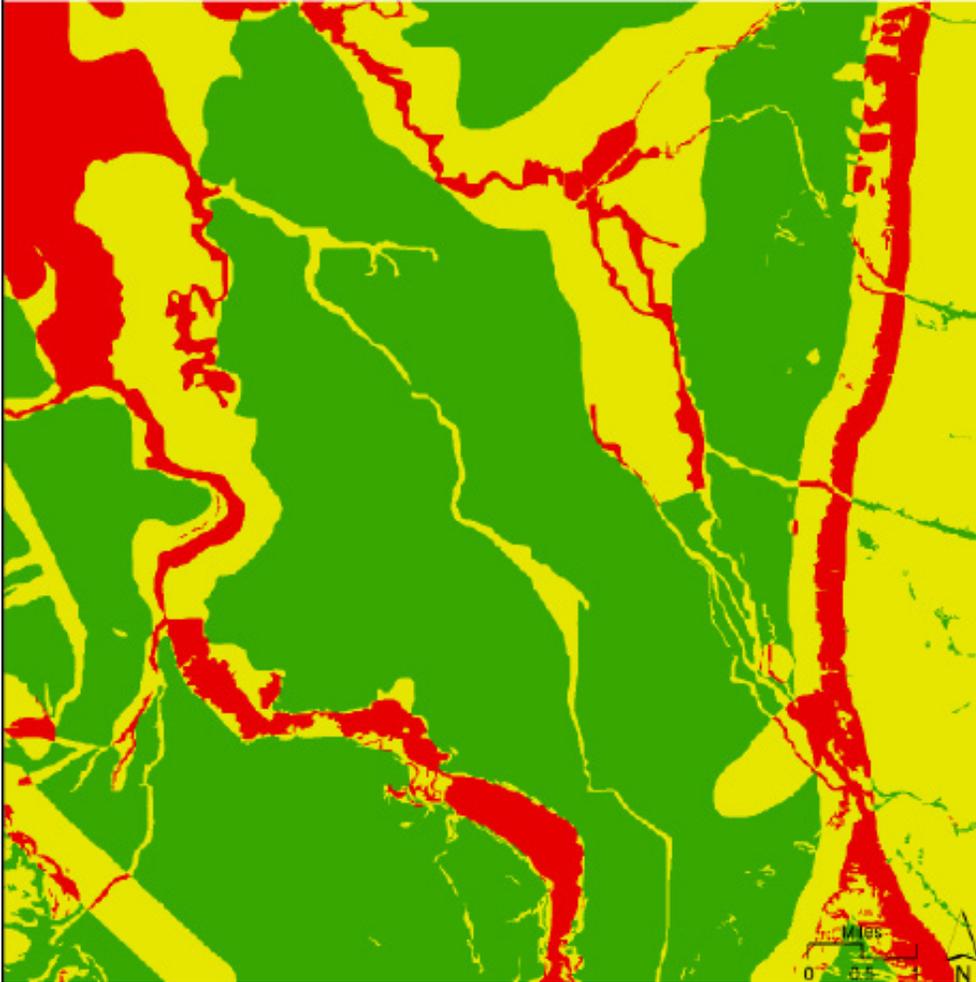
AGRICULTURE MODEL



Model Legend		
Most Attractive	Ideal for Change	Areas that do not have any agricultural significance. These areas are not presently used for agriculture, do not have prime soils for agriculture, and are not being irrigated
Neutral		Areas of less significance; these lands are presently used for agriculture but do not have prime soils, and/or efficient watering systems (flood irrigation)
Least Attractive	Ideal for Protection	Areas to protect; these lands are currently being farmed, have prime soil for agriculture and are using efficient irrigation systems (sprinkler and/or subsurface)

Model Data		
Data	Modification	Source
Soil	Insignificant or prime for agriculture	Utah AGRC
Land Use	Existing Agriculture	Utah AGRC
Water Related Land Use	Irrigation: None, flood or sprinkler	Utah AGRC

PUBLIC HEALTH & SAFETY MODEL



Model Legend		
Most Attractive	Ideal for Change	Areas with no risk from natural hazards
Neutral		Areas at risk from one type of natural hazards
Least Attractive	Ideal for Protection	Areas at risk from as many as four types of natural hazards

Model Data		
Data	Modification	Source
Floodplain	100 year	Utah AGRC
Fault Line	1/4 mile buffer	Utah AGRC
Natural Hazards	Areas susceptible to geological formation and historic landslides	Utah AGRC
Landslides and Rock Falls	Areas susceptible based on slope	Utah AGRC

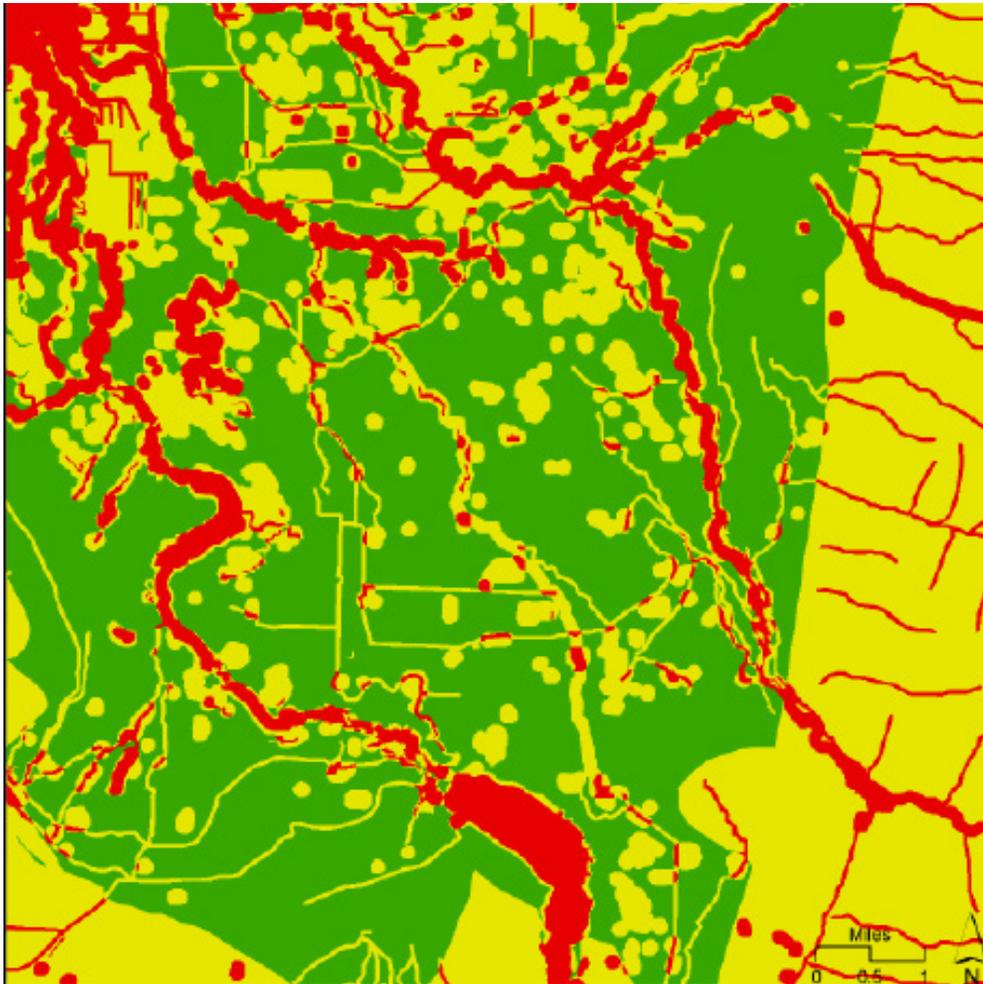
WATER MODEL



Model Legend		
Most Attractive	Ideal for Change	Areas with little or no risk to water quality and the hydrological system
Neutral		Areas with moderate risk to water quality and the hydrological system. These areas consist of 500-year flood zones, canals and intermittent streams (30 m buffer), primary recharge zones (outside of significant drainages), and riparian areas (not covered by inputs listed in the maximum risk
Least Attractive	Ideal for Protection	Areas at high risk/vulnerability of water quality degradation and impacts to the hydrological system. These areas consist of rivers and major streams (75 m buffer), lakes/reservoirs (45 m buffer), springs (30 m buffer), wetlands (50 m buffer), and 100-year flood zones

Model Data		
Data	Modification	Source
Rivers	Buffered 75 m	USFS
Small & Intermittent Streams	Buffered 30 m	USFS
Canals/Connectors/Pipelines	Buffered 30 m	USFS
Landslides and Rock Falls	Areas susceptible based on slope	Utah AGRC
Lakes/Reservoirs	Buffered 45 m	Utah AGRC
Springs	Buffered 30 m	Utah AGRC
Wetlands	Buffered 50 m	Utah AGRC
Riparian Areas	Extracted data	Utah AGRC
Floodplains	Extracted A, AE and 0.2% annual	Utah AGRC
Aquifer/Groundwater Recharge Zones	Extracted primary recharge zones	Utah AGRC

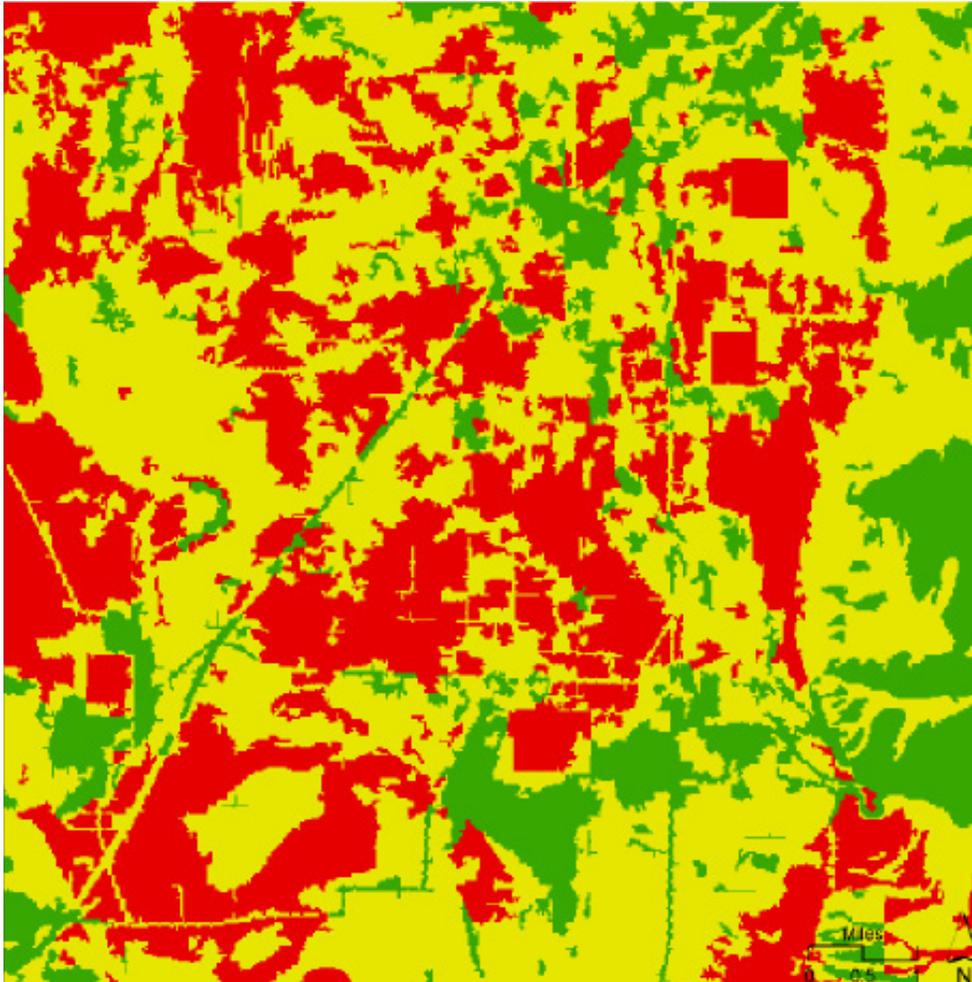
BIODIVERSITY MODEL



Model Legend		
Most Attractive	Ideal for Change	Areas with little or no biodiversity
Neutral		Areas with moderate levels of biodiversity
Least Attractive	Ideal for Protection	Areas with the highest biodiversity

Model Data		
Data	Modification	Source
Wildlife Habitat (11 species)		Utah AGRC
Rivers	Buffered 90 meters	Utah AGRC
Canals	Buffered 30 meters	Utah AGRC
Lakes & Reservoirs	Buffered 60 meters	Utah AGRC

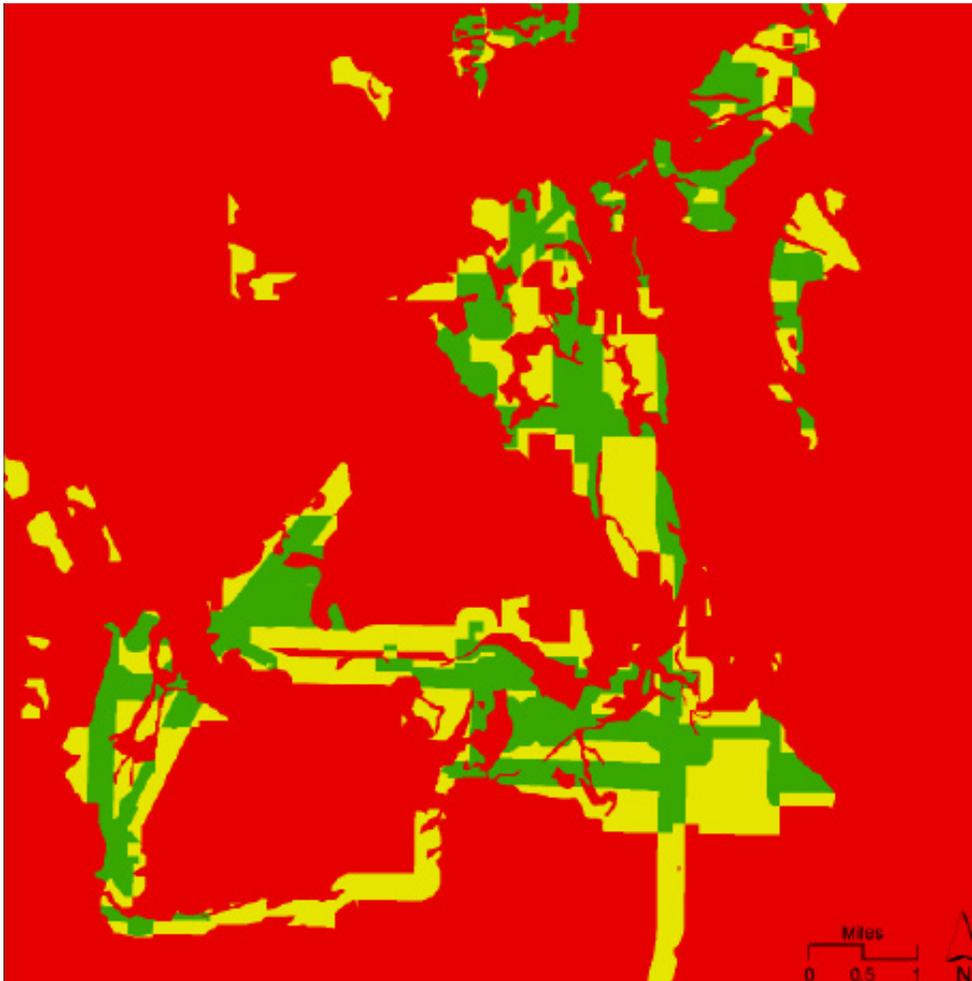
LANDSCAPE CHARACTER MODEL



Model Legend		
Most Attractive	Ideal for Change	Lowest risk areas are areas that do not contribute to the landscape character of the valley. This is an area where change can occur with out much impact on the character of the valley
Neutral		Medium risk areas are areas that contribute a little to the landscape character of the valley. Some changes can occur in these areas without impacting the character of the valley
Least Attractive	Ideal for Protection	Maximum risk areas are areas that con-tribute heavily to the landscape character of the valley. Change in these areas would greatly impact the character of the valley

Model Data		
Data	Modification	Source
Parks		USFS
Agricultural Lands	Prime	Utah AGRC
Wildland Areas		USFS
Riparian Areas		Utah AGRC
Viewshed	Several points along U.S. Route 89/91	

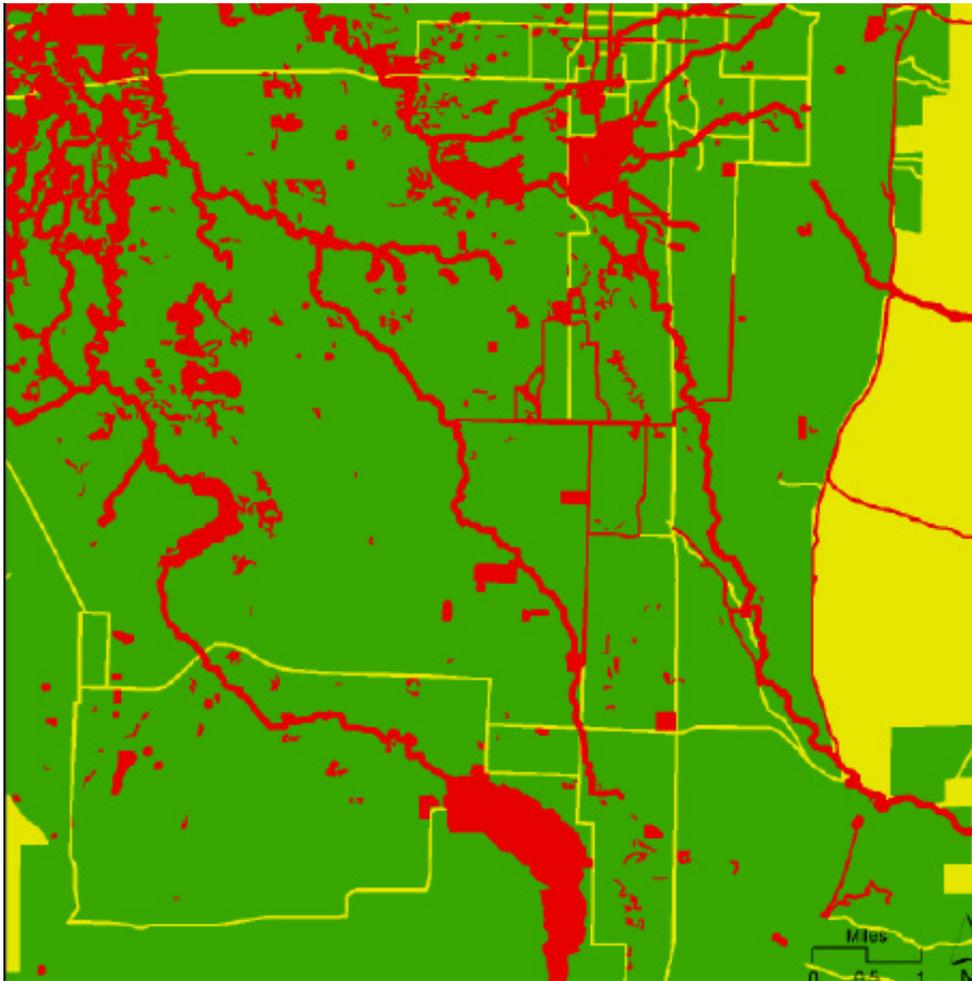
COMMERCIAL/INDUSTRIAL MODEL



Model Legend		
Most Attractive	Ideal for Change	Areas with suitable soils for small commercial development within municipalities that are also within 1/4 mile (400 m) of roads, 1/4 mile (400 m) of railroads, and within or adjacent to existing commercial/industrial districts
Neutral		Areas with suitable soils for small commercial development within 1/4 mile (400 m) of roads and 1/4 mile (400 m) of railroads. Also includes areas with suitable soils within municipalities (but not limited by proximity to roads, railroads, or commercial/industrial districts)
Least Attractive	Ideal for Protection	Maximum risk areas are areas that contribute heavily to the landscape character of the valley. Change in these areas would greatly impact the character of the valley

Model Data		
Data	Modification	Source
Soils	Not limited for small commercial development	NRCS SSURGO
Major Roads	Buffered 400 m	Utah AGRC
Railroads	Buffered 400 m	Utah AGRC
Zoning	Commercial zones and 200 m from existing commercial zoning	Cache County
Municipal Boundaries	Boundary lines	Utah AGRC

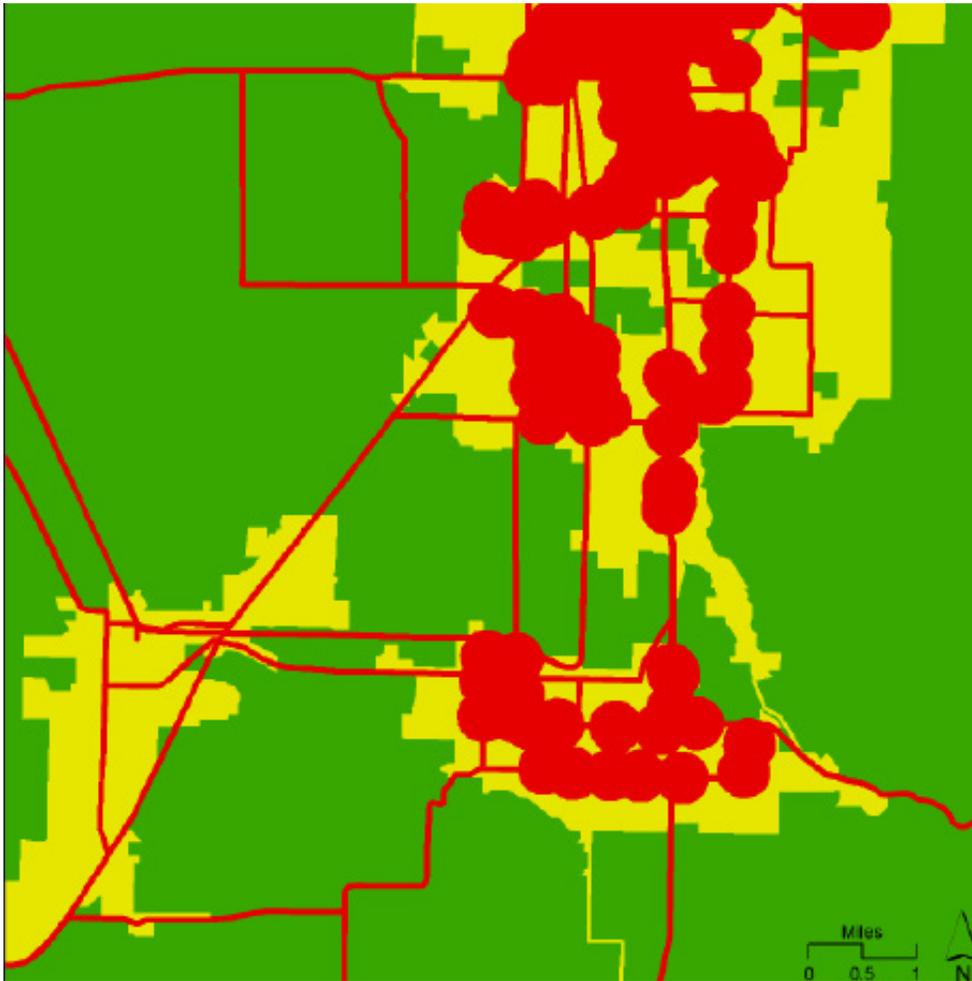
RECREATION MODEL



Model Legend		
Most Attractive	Ideal for Change	Areas that provide little existing opportunity for recreation and can be improved into a recreational use, e.g. playing fields, trails
Neutral		Areas that provide some opportunity for recreation (streams, lakes, parks, golf courses, and trails)
Least Attractive	Ideal for Protection	Areas that provide good opportunities for recreation (e.g. streams, lakes, parks, golf courses, and trails) and should be protected

Model Data		
Data	Modification	Source
River/Streams	Buffered 50 m	Utah AGRC
Trails	Buffered 50 m	Utah AGRC
Parks	Extract shape	Utah AGRC
Golf Courses	Extract shape	Utah AGRC
Lakes/Reservoirs	Extract shape	Utah AGRC

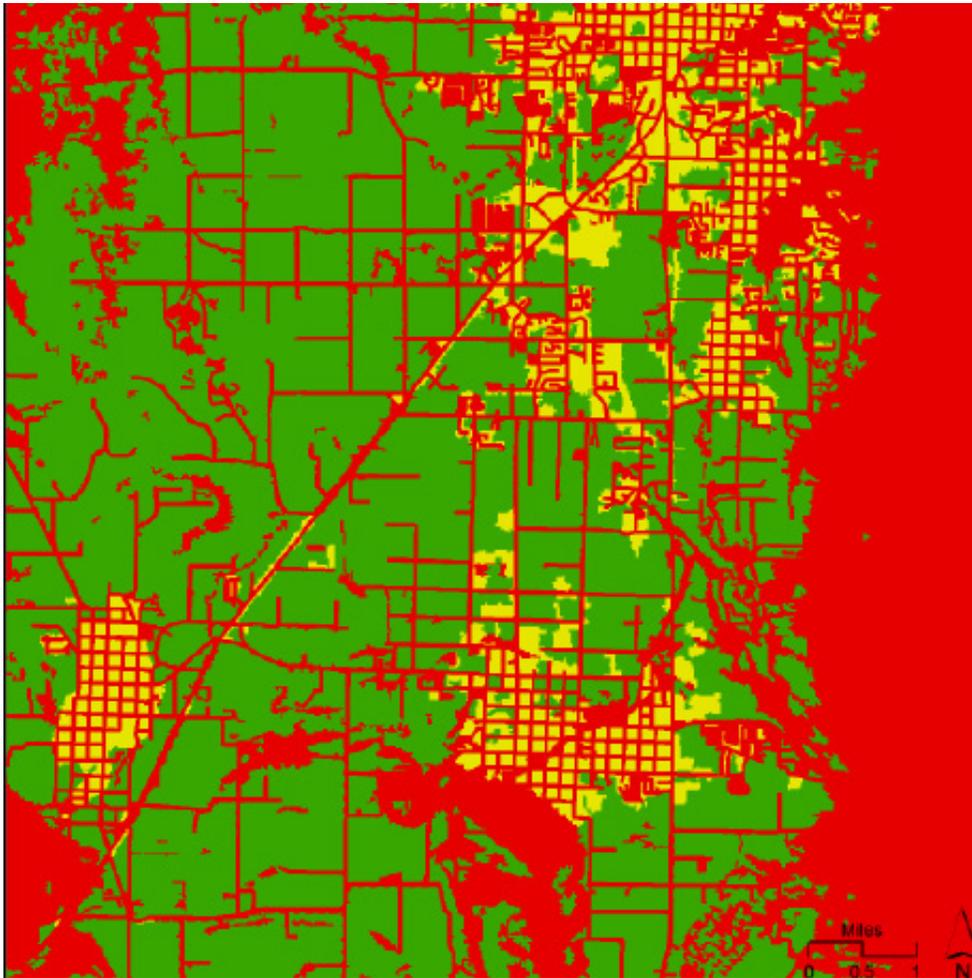
TRANSPORTATION MODEL



Model Legend		
Most Attractive	Ideal for Change	Fewest modes of transportation available in this area. Improvement of multi-modal transportation is needed
Neutral		Mid-range of availability of transportation
Least Attractive	Ideal for Protection	Many modes of transportation available in these areas. Improvement or change of the transportation system is not required

Model Data		
Data	Modification	Source
Bus Stops	100 year	Utah AGRC
Bus Routes	Buffered 400 m	Utah AGRC
Major Roads		Utah AGRC
Municipalities		Utah AGRC
Bicycle Routes		Utah AGRC
Park and Ride Lots		Utah AGRC
Railroads	Buffered 400 m	Utah AGRC

RENEWABLE ENERGY MODEL



Model Legend		
Most Attractive	Ideal for Change	Areas with sufficient annual solar radiation, a developable slope, and open land cover
Neutral		Areas with sufficient annual solar radiation and a developable slope, but not ideal land cover
Least Attractive	Ideal for Protection	Areas with sufficient solar radiation, not developable slope, and/or prohibitive land cover

Model Data		
Data	Modification	Source
Slope	< 30%	Utah AGRC
Solar Radiation	Above mean for the study area (1,385 kw/m ²)	Utah AGRC
Land Cover	Sparsely developed and undeveloped land	NLCD 2011