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The River, the Residents, and the City: A Holistic Vision Study for Logan River's Upper Reach

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THE RIVER, THE RESIDENTS AND THE CITY: A HOLISTIC VISION STUDY FOR LOGAN RIVER'S UPPER REACH

By

Lisa J. Aedo

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

of

Master

of

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ABSTRACT

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for Logan River's Upper Reach

by

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Utah State University, 2021

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(202 pages)

PUBLIC ABSTRACT

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for Logan River's Upper Reach

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The three-mile Upper Reach of the Logan River starting at the USU Water Lab to the 100 East bridge has been negatively impacted by residential development and diversion for agriculture and industry. A task force comprised of faculty at USU, professionals, government and city officials, and concerned residents has developed a Conservation Action Plan focused on twenty-two baseline indicators which, if improved, can help rehabilitate the river. This thesis looks at the factors that created the current challenges and seeks to provide a holistic vision with design solutions to address said challenges in alignment with that Plan. A literature review focused on Stephenson's Cultural Values Model (2012) serves to understand the different perspectives applicable to the river. The Urban Stream Renovation (USR) model proposed by Smith et al (2016) helps clarify the interplay between social and ecological interests. The review also includes elements of Utah's water laws and governmental practices that have contributed to water issues that affect the Logan River. Public consultations via community meetings and surveys between 2016 and 2019 consider the current interests and concerns of the residents. By looking at the Upper Reach from a social, policy, and environmental perspective, the project proposal designs aim to provide holistic and sustainable solutions that include the voices of the river, the residents, and the city.

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This page would not be complete without an expression of deep gratitude to my family for their constant encouragement and unwavering faith in me and this endeavor.

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CHAPTER I

INTRODUCTION

Background

When catastrophic events occur, they often reflect our lack of awareness of or willingness to consider how nature works. Several events related to the Logan River in Cache County, Utah, in the past decades have raised concerns about how we plan, design, and interact with our water sources. Such events are related to canal-building on unstable slopes, diversions of water for agricultural, industrial, and social purposes, and the development of infrastructure in, along and across the river. Figure 1 illustrates three events that caused public outcry about those interventions. In response to those events, a group of Utah State University faculty and concerned citizens came together in 2014 to create the Logan River Task Force (Appendix I). The mission of the Logan River Task Force is to "make the Logan River system a showcase of ecologically viable, socially beneficial river restoration", as expressed in their Conservation Action Plan published in 2016 (CAP, 2016). Currently, twenty-two baseline characteristics with accompanying indicators have been identified in the Conservation Action Plan to help guide actions to be undertaken along the river. These focus primarily on the ecological health of the river, but also address the social benefit of the river through the potential for recreation and a healthy river system. The Task Force has also contributed to the publication of a planting guide for riverfront owners and stakeholders interested in protecting the riparian areas (Dettenmaier and Howe, 2015), and the formal adoption in 2020 of a Blue Trail proposal by the Logan Municipal Council to expand possibilities for recreation on the river (Pace, 2020).

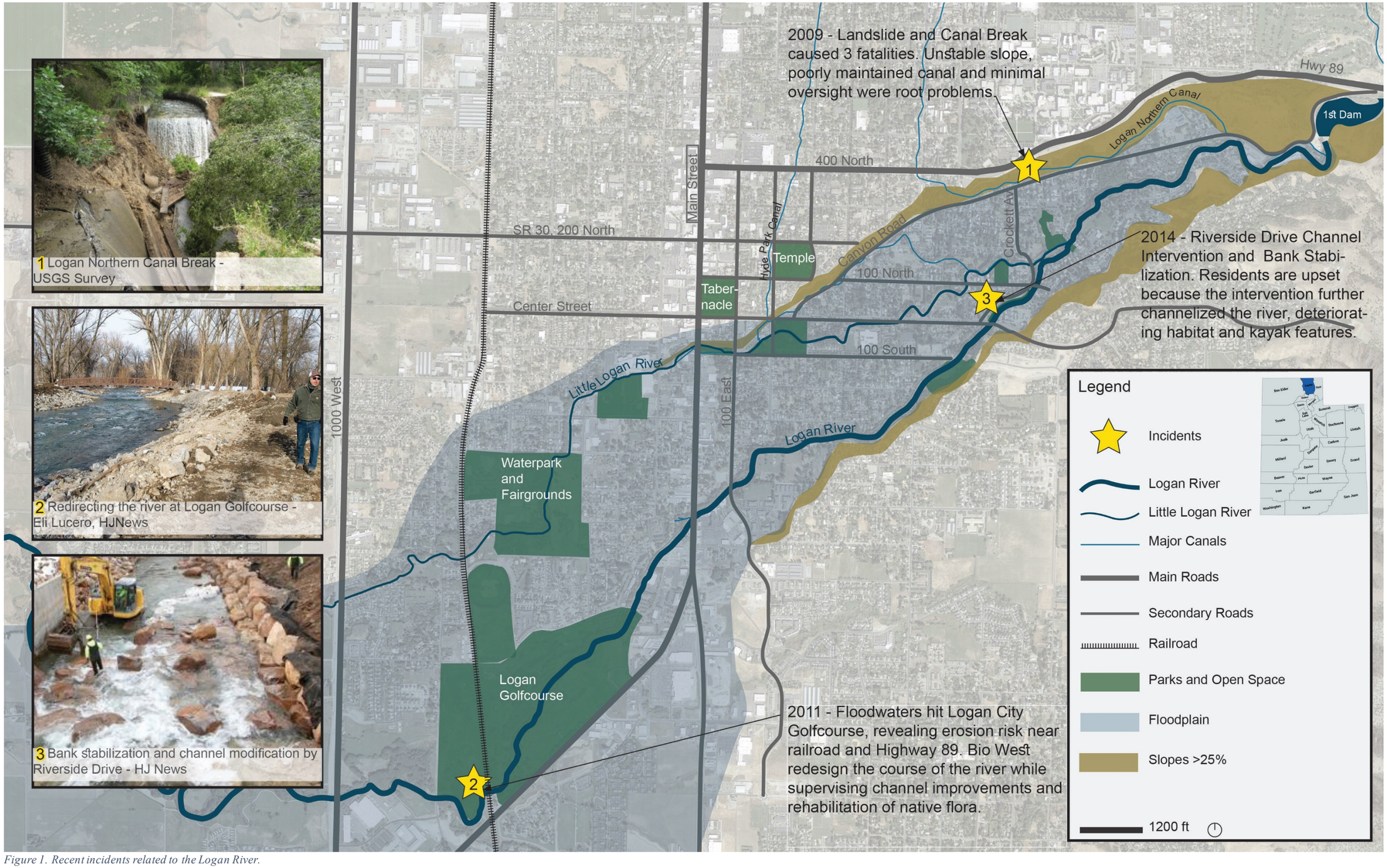


Figure 1. Recent incidents related to the Logan River.

The guidelines provided by the Conservation Action Plan are general in nature and do not specify locations for application beyond dividing the Logan River into three reaches based on land use characteristics (Figure 2) and outlining the potential for a blue

Figure 2. Three reaches of the Logan River highlighting the Upper Reach.

trail. Because the Upper Reach (Figure 3) is the area most impacted by development and infrastructure, with plans to renew infrastructure in ways that could affect the river negatively or positively, I am interested in developing a holistic, sustainable vision for it. This involves understanding its history, discovering its conflicts and possibilities, and creating design proposals in alignment with the twenty-two Conservation Action Plan objectives. 'Holistic' in this case means considering the whole of the stakeholders, including the river and related ecology, together with the concerns of the residents and the city. 'Sustainable' is to be understood as creating opportunities or projects that serve the present stakeholders without compromising opportunities for future stakeholders to adapt to their needs (Brundtland, 1987).

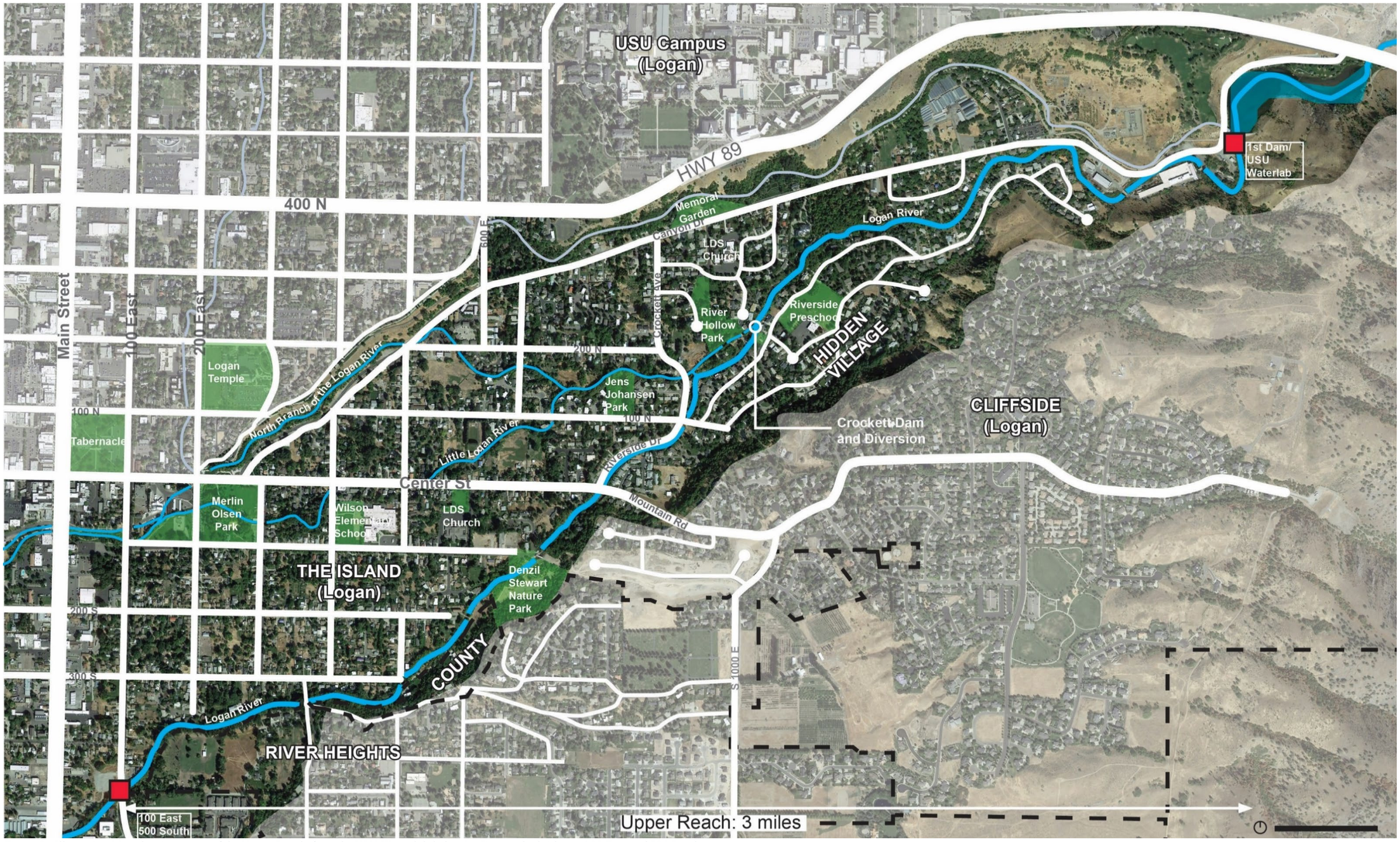


Figure 3. Illustration Map showing extent of the Upper Reach, from the USU Water lab below 1st Dam to the bridge at 100 East and 500 South.

Purpose of this Thesis

The CAP describes goals related to river health, ecology, and recreational benefit, but does not map specific areas where such goals could be applied, nor does it address future developments planned by the municipalities. There is also a historical and cultural component to the reach that is hard to qualify, but that is nevertheless present in the landscape and should be considered. The hope is that the conclusions obtained from this research and the design proposals they inspire can be of use to those who have a stake in the river's future.

Definitions:

Stakeholder	-	"a person with an interest or concern in something, especially a business" (https://www.lexico.com/definition/stakeholder)
Holistic	-	derives from the concept of "holism," where "parts of a whole are in intimate interconnection, such that they cannot exist independently of the whole, or cannot be understood without reference to the whole, which is thus regarded as greater than the sum of its parts" (https://www.lexico.com/en/definition/holism).
LRTF	-	Logan River Task Force
CAP	-	Conservation Action Plan; the 22-point baseline evaluations highlighted by the LRTF.
CVM	-	Cultural Values Model; the theoretical framework proposed by Janet Stephenson (2008) which forms the backbone of the conceptual frameworks and designs proposed in the thesis.
USU	-	Utah State University
UR	-	Upper Reach of the Logan River; referring to the 3-mile stretch between the USU Water Lab and the bridge at 100 East 500 South by Riverwoods and Riverwalk.
USR	-	Urban Stream Renovation; "a flexible stream improvement framework in which short-term ecological and societal outcomes are leveraged to achieve long-term ecological objectives" (Smith et al., 2016).
cfs	-	Cubic Feet per Second, a common measure of water flow in the river.

River conservation: "a careful preservation and protection of something, i.e., the management of a natural resource to prevent exploitation, destruction, or neglect" (Merriam-webster.com/dictionary).

River rehabilitation/ to rehabilitate: "the action or process of restoring the river to a former state," such as for ecological services, efficient stream flow, or an aesthetic

feature (Merriam-webster.com/dictionary).

River restoration: “to put or bring back into existence or use; to bring back to or put back into a former or original state” (Merriam-webster.com/dictionary).

Figure 4. Pedestrian Bridge over Crockett Diversion

CHAPTER II

FRAMEWORK AND METHODOLOGY

Approach

To organize my approach to obtain a holistic vision, I decided to base my theoretical framework on Janet Stephenson's Cultural Values Model (CVM) which focuses on Relationships, Practices, and Forms (Stephenson, 2008). Most of this approach is discussed in the literature review, though the analysis and design also attempt to further interpret the Upper Reach along these lines of understanding. This method makes it possible to include the tangible as well as the intangible and historical aspects of the landscape into the evaluation to develop a conceptual framework for the design. It also gives context to the land use overlaps observed in the analysis of the reach. For the analysis and application of ecological and social stream renovation proposals in the Upper Reach, I chose the Smith et al. (2016) model for Urban Stream Renovation. This model provides a metric, albeit subjective in this case, for assessing projects.

Literature Review

The literature review explains the principles laid out in the CVM that help to evaluate a landscape holistically in time and space, followed by literature relevant to applying that framework. This includes historical literature and photos to understand how water and land use in the Upper Reach evolved, based on policies that affect the river and surrounding areas. Another framework, Urban Stream Renovation (Smith et al., 2016), relates to the development and evaluation of proposals based on social or ecological priorities. These and other issues relevant to the development of a holistic, sustainable

vision for the Upper Reach are reviewed and discussed.

Analysis

In order to begin to understand the evolution behind the Upper Reach, the analysis section focuses on place-specific information obtained through a traditional physical, biological, and cultural analysis performed in landscape evaluations, as well as from information obtained in the literature review. The CVM and USR frameworks are embedded in this analysis and not treated as the basis of the analysis The USR is, however, summarized in the final project matrix (Table 2, p. 103) as a way to qualify each proposal.

Inclusion of Stakeholder Views

The Logan River is the main performer in this interplay between nature and human society. As such, it is a stakeholder with its voice expressed through the Conservation Action Plan (CAP) as put forth by the Logan River Task Force (LRTF). Other stakeholders include residents, recreationists, engaged citizens and the governmental authorities with jurisdiction or dominion over some aspect of the Upper Reach. These voices are obtained via surveys from 2016 and 2019 and unstructured interviews realized between 2018 and 2020, resulting in an interpretation of how they view the past and envision future improvements to the current situation. Voices of the past are also obtained from historical research to understand the embedded values that have contributed to the current situation.

Case Studies

Case studies serve as references for proposed projects and are included to illustrate how a preceding project or intervention achieved a goal sought for in the proposed actions. Included are:

- Portneuf Vision Study
- Jordan River Parkway
- Hoosic River Revival
- Truckee River Whitewater

Integration

The design chapter (Chapter VI) presents the voices of the river, the residents, and the city of the past and present as a confluence of ideas that help inform a holistic vision for the future. The design proposals are based on the information derived from the literature review, case studies and analysis and emerge from the following:

1. A SWOT analysis that reflects the voices of the river, the residents, and the city, which in turn gives rise to the goals, principles, and scope of design proposals.
2. A matrix that evaluates how well the proposals align with the USR and CAP.
3. A location map illustrating project areas referenced in the matrix.
4. Explanations and details relevant to each project area.

CHAPTER III

BALANCING SOCIAL AND ECOLOGICAL NEEDS

The goal of this review is to discover and reference literature that relates to and elucidates the path to obtaining a holistic, sustainable vision for the Upper Reach. I searched diverse topics, including visioning, the history of Logan and Cache Valley, river classification, river restoration, approaches to obtaining stakeholder feedback, and a cultural approach to evaluating landscape. Even though every landscape is unique in context, natural patterns and their repetition in nature make it possible to obtain guidelines that can serve as founding principles for project proposals within the current socio-economic context.

Does the Upper Reach of Logan River Suffer from Triplopia?

Triplopia is a term used to describe the medical condition known as triple vision or seeing three images of the same thing. In developing a vision for potential projects along the Upper Reach, it is appropriate to ask whose vision they should represent- the river's, the residents', the city's, or perhaps a little of all three? The CAP vision is to "make the Logan River system a showcase of ecologically viable, socially beneficial river restoration" (CAP, 2016). For the Upper Reach, this goal is complicated by the fact that most of the riparian edge is owned privately and thereby all decisions must be made in deference to the interests of the resident-owners. However, the "city" (i.e., Logan) provides those residents with the infrastructure they need, both for access across the river and for protection against flooding from runoff and storm events through a city drainage system. This added dimension to the vision of what the Upper Reach can be is important

because it is what allows the current residents to keep their vision of the river in the first place. These two anthropogenic entities together represent the 'socially beneficial' element in the CAP vision, while the river and its ecosystem make up the element which requires 'ecologically viable' solutions. When these three elements are in harmony, holistic sustainability is reached and the metaphorical triplopia would be cured.

Understanding Culture and Cultural Relationships to Landscape

The previous observation relates to the current situation, but there is an argument for a deeper perspective of the Upper Reach. Beltran-Caballero (2013) states that a built landscape needs to be understood from the perspectives and social organization of the people or entity that built it. His context for this statement arises from failed efforts to reconstruct and maintain Inca infrastructure based on 20th and 21st century paradigms: the Inca social hierarchy was based on principles of a strong work ethic, reciprocity, and service as payment to a theocratic state. Failure to restore and successfully maintain their roads, irrigation systems, and villages today is because the current government hierarchy and social values favor neither the former method of service payments or local organization which would make such restoration projects sustainable over time. The same could be said of the current relationship between the Upper Reach of the Logan River, its residents, and the city: the environment and local features that caused the Logan River to braid, meander, and flow through the Upper Reach towards the Great Salt Lake have been manipulated by people with a different 'mind-set' than the nature that formed it. Thus, returning the river to the way it was is unlikely because of its changed context. One could also say that the pioneer-era paradigm that caused these changes to happen has

been superseded by a growing society with a worldview based less on a united, theocratic effort and more on personal preferences, commercialization, and fashionable trends.

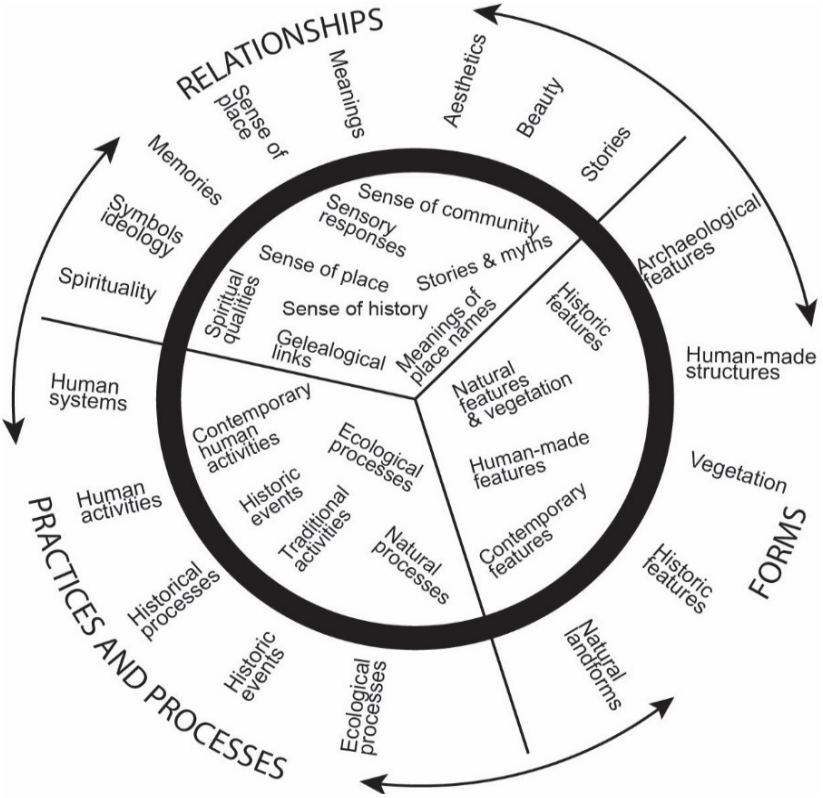


Figure 5. Three components of landscape existing within and without local knowledge.

Stephenson (2008) divides landscape valuation into three interactive categories: Forms, Relationships, and Practices (Figure 5). The outer circle represents the elements analyzed by technical and professional disciplines; the inner circle speaks for the communities and local knowledge associated with the landscape. She cites Mackinder (1887) and Leighty (1963) to illustrate the dichotomy of how landscape can shape practice versus how practice can change the landscape. Both are true in different contexts. In the case of the Upper Reach, the land forms dictate the patterns and development of infrastructure such as roads and bridges. The climate also dictates the types of plants that can grow in the area. At the same time, culturally derived agricultural practices and social preferences impose their development patterns on the landscape.

Figure 5 also illustrates the dichotomy of landscape valuation between those who live in an area (inner circle) and those who are foreign to it. As regards the Upper Reach, it can be inferred that the river's seasonal ebb and flow dictated how and when the Shoshone residents interacted with it (Parry, 2019). This changed with the arrival of permanent pioneer settlers, who diverted the river, therebychanging the landscape to derive benefits as pertaining to permanent settlement. Both interactions are now part of the conversation as we strive to 'rehabilitate' rivers to a more healthy, naturalistic state while maintaining both social benefit and safety (Booth, 2004; Speed, 2016; Espinosa et al, 2016; Wheaton, 2005.)

Our Relationships to Rivers

There are many ways we can relate to rivers. Kondolf and Pinto (2016) propose a three-dimensional approach accompanied by some interesting illustrations of scale (Figure 6). They describe our relationships to rivers as vertical, transverse, or longitudinal. A vertical relationship could be the experience of walking down a riverbank from a street to get close to the river to fish. That descent would be a 'vertical relationship' to the river. A longitudinal relationship could be characterized as an action that that follows the length of the river, such as kayaking, or floating logs downstream. Finally, a transverse relationship is related to how a river is crossed, for example by wading, or crossing a bridge, or taking a ferry. This brings in the concept of scale and river width. Figure 6 is an adaptation of these illustrations, with the red rectangles indicating applicability to the Upper Reach of the Logan River. The illustrations also relate to the design of infrastructure when considering options for spatial connection to,

along, and across the river.

The Many Faces of River Modification

The topic of river rehabilitation has existed for centuries, though perhaps not always in the sense with which we might consider it today. Capability (Lancelot) Brown modified rivers into aesthetically pleasing curves and meanders for wealthy estate-owners in England during the 18th century (Podolak, 2012). In our day, the concept of river restoration came of age in the 1980s after it became clear that the common practice of using rivers as dumping grounds for chemical and human refuse was having negative and intolerable effects on the environment (Speed, 2016). There is also a level of confusion

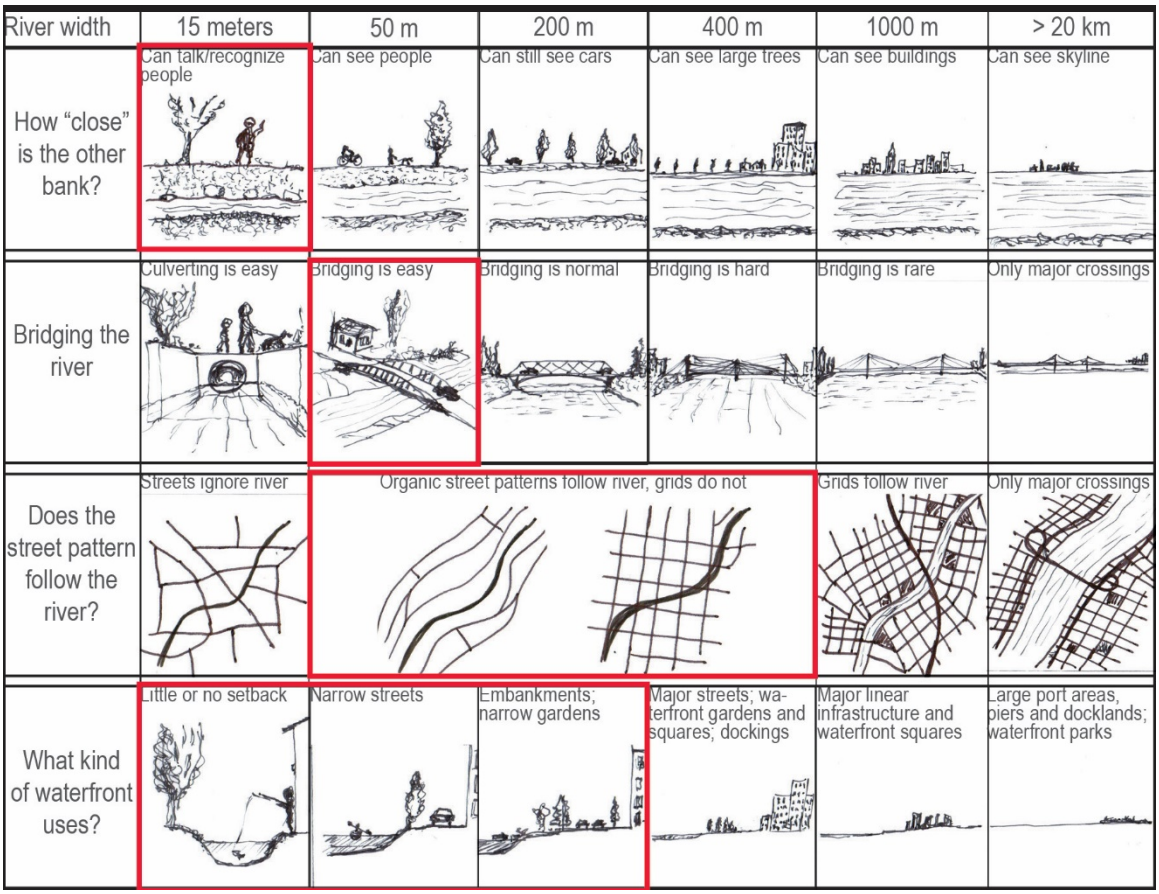


Figure 6. Illustrating the social and urban relationships with river width.

related to terminologies used for river modification, due to interchangeable terms terms such as “restoration” (an attempt to restore it to a historic state), “renovation” (improving a current condition), “rehabilitation” (change from one use/aesthetic to another), etc. Restoration is defined by Wohl et al. (2015) as “modifications [that] share the goal of improving hydrologic, geomorphic, and/or ecological processes within a degraded watershed and replacing lost, damaged, or compromised elements of the natural system”. Speed et al. (2016) concur, but specifically point out that the process of “improvement” is initiated by society and is therefore subject to societal values. The importance of societal input as impetus for change is evident in other literature (Fox & Cundill, 2018; Weber, 2019; Gregory & Brierly, 2009; Stephenson, 2008; Smith et al., 2018; Iwaniec & Wiek, 2014; Prior, 2016). The formation of the LRTF was itself based on society’s desire to increase participation in decisions related to the river and expand the level of expertise by which projects were evaluated and realized. The questions of who decides which projects should be realized and how to

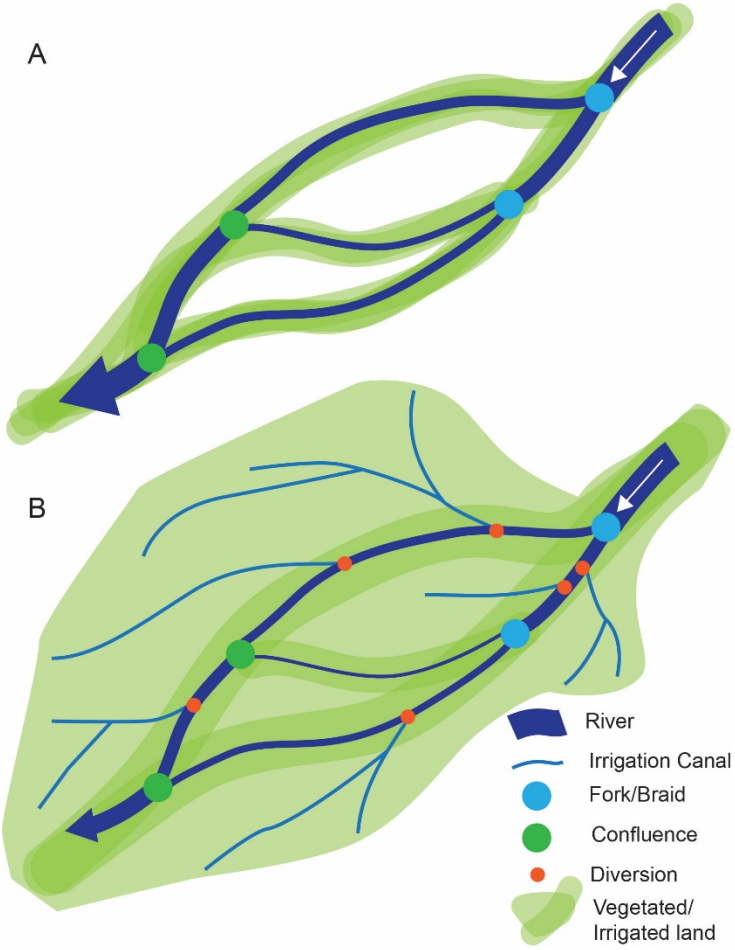


Figure 7. Effect of diversions on main river flow.

realize them are intrinsically a social problem. The degradation of river systems is in most cases caused by humans, and the Upper Reach of the Logan River is no exception. Owners of riverfront properties have shared tales of renovation woes as they hauled out old tires, cars, jammed logs, plastic objects, metal waste, and even discarded tombstones from the river (personal communication, M. Jablonski, 2020; B. Booton, 2019; C. Essig, 2019).

Society's approach to river "management" is fraught with social and ecological challenges. Historically, in order for permanent settlement to be feasible, irrigation canals had to be dug to convey water to fields that provided the crops necessary for survival. As a result, the organizing structure around water distribution was one of "prior appropriation" (Haws, 1965, p55) which persists to this day. This structure maintains that water rights holders have a legal right to use water. Such water rights holders generally consist of irrigation companies which control canals and diversion points (See "B" in Figure 7) and which distribute water to water shareholders via pump systems or flood irrigation from irrigation ditches dug from the main canals. The development of damming and diversion systems to control water flow and access to water throughout the year is an example of river degradation in favor of social benefits. While dams were created to enhance diversions and provide steady flow for irrigation systems and electric power generation (Ricks, 1965; Simmonds, 2004; Haws, 1965), they also prevent access to spawning areas of native fish. The water diverted for irrigation diminishes mainstream flow in summer (Figure 7), resulting in a negative effect on the surrounding riparian areas as well as the water temperature and quality required for maintaining a healthy fish population. Another detrimental practice is the removal of riparian vegetation in favor of

riprap for flood protection. This can have the opposite effect as it reduces friction and percolation, and channelizes the river, causing water to flow unobstructed with greater velocity. This increased energy can result in erosion and flooding downstream. Allowing development to occur on the river's floodplain confines the river channel in addition to placing people at risk. Such development does not allow the river enough room to braid, meander and expand as it would naturally. Such confinement, together with impermeable surfaces including streets, parking areas, and rooftops, all of which increase the amount of runoff, expose people to flood risk, especially during storm events or rapid meltdowns of snowpack (Dunne & Leopold, 1978).

In Logan, the issue of land ownership adjacent to the river serves as a point of contention. State laws indicate that the water flowing in the river is public property (until allocated for beneficial use), but that the land adjacent to it, if held privately, is private property which only allows for access if there is a riparian easement or if it is part of an irrigation system requiring maintenance. Due to continued residential development that has occurred along the Logan River, irrigation companies are finding it increasingly difficult to access the system for maintenance (Cache Water Summit, 2019; personal communication, D. Weber, May 25, 2020). It is also challenging for water masters to maintain the current irrigation system as it requires a level of manpower, coordination and community effort that rarely exists at the level it did 160 years ago. Another source of inefficiency with the open irrigation canals is water loss through seepage and evapotranspiration: the canals flow over permeable surface in ditches where some water percolates down to the aquifers or subterranean water conduits, some is lost by evaporation, and some is absorbed and "lost" by vegetation through transpiration. It is

estimated that about 30% of the water running in the open system is lost in these ways (personal communication, N. Daugs, 2019). Another inefficiency in the system is the irrigation method itself, which is generally accomplished by flooding. This means that much of the irrigation water ends up where it is not needed. Therefore, to increase said efficiency, a feasibility study is being proposed to evaluate the possibility of piping irrigation water and creating a secondary water or irrigation system that functions by demand with gravitational flow, probably starting below the 1st Dam above the USU Water Lab (personal communication, N. Daugs, 2020; personal communication, D. Weber, 2020). As of this writing, the funding required for such a renovation is estimated at US$90 M. The application has been approved at the State level and is moving through the appropriate Federal agencies for approval.

Figure 8. Tubing in the Little Logan River/Crockett Canal, Merlin Olsen Park, June 2020. By: Author

If approved, the possibility of piping water from the Logan River as secondary water for irrigation brings up questions of who will have access and how, whether by continuous service to water shareholders, or some other system that serves the whole community. The other question relates to who should control this system: the municipality, Cache Water District, the UTDNR or some other entity. Dan Weber is the current water master in charge of providing water from the Crockett Diversion to ten irrigation companies with water rights located between

Crockett and 300 West 300 South in Logan. These companies distribute water to over 450 shareholders spread throughout the valley. The Crockett Diversion Canal, also known as the Little Logan River, would likely suffer a reduction in flow, causing the City of Logan to lose the stream that flows through Merlin Olsen Park and the Fairgrounds further downstream (Figures 8 and 9). This would be an irreplaceable loss of a public amenity.

In my conversations with residents, I found that there is a real interest in the quality of habitat along the river, with a desire for proposals that enhance water quality, wildlife, and the quality of and access to riparian areas for recreation, contemplation, and observation of nature. (personal communication with residents, 2019 and 2020; Bio West Survey, 2016; Survey 2020).

All of the above issues were at the heart of the formation of the Logan River Task Force and its effort to create the Conservation Action Plan.

Figure 9. Swimming in the North Branch Canal by Canyon Road, June 2020.

The City Council of Logan City adopted a Blue Trails Masterplan on January 21, 2020 that will allow residents "to more fully utilize the natural amenities of Cache Valley by bringing people back to the banks of the Logan River. Through a water trail network, connecting parks across the valley starting with Rendezvous Park and Trapper Park people will once again be able to paddle or float along a significant length of the river" (Pace, 2020).

The Logan River Blue Trail masterplan (Blue Trail Masterplan, 2020) identifies locations for different activities, but the designs and more detailed information about each location is still to be developed. The Upper Reach development areas are detailed in the Design Proposal Chapter.

Motivation for River Restoration

The motivation for enacting change on a river can be manifold, but it is most often related to an anthropogenic need, rather than a sole desire for an ecological state of balance (Smith et al., 2018). As river modification cases and their descriptors have increased in the past 40 years, approaches for dealing with the problems have also proliferated worldwide (Speed, 2016; https://www.therrc.co.uk/; Wohl et al., 2015; Weber and Ringold, 2019; Fox & Cundill, 2018). Kenney et al. (2017), in questioning whether urban stream renovation is worth it based on the higher cost of restoring urban streams, suggest that the costs can be offset by social benefit, including recreational and aesthetic benefit. Smith et al. (2018) claim that urban stream proposals that focus solely on ecological improvements, with little societal engagement, result in short-lived success. For this reason, a balance between societal engagement and ecological objectives is a better formula for long-term success (Smith et al. 2018). Several authors also note the importance of the depth of local understanding and community involvement for any

aspiration of long-term success in each of the proposed interventions (Fox & Cundill, 2018; Stephenson, 2008; Weber & Ringold, 2019).

Based on this realization, a multi-disciplinary, international working group attending the Symposium on Urbanization and Stream Ecology (SUSE3) developed a conceptual framework for flexible long and short-term urban stream renovations (Smith et al. 2018). Figure 10 synthesizes the basic elements of this idea, with the stated objective "to develop a flexible alternative to ecologically focused restoration that [will] provide options for short- and long-term improvements to urban streams that may be pervasively impaired by human actions".

In this illustration, the "Renovation" segment to the left shows one action with a large "E" and a small "s", indicating the predominance of the ecological objective, but working through the societal interest. The "Renovation" segment illustrates the process of obtaining long-range ecological results by realizing several short-term projects with

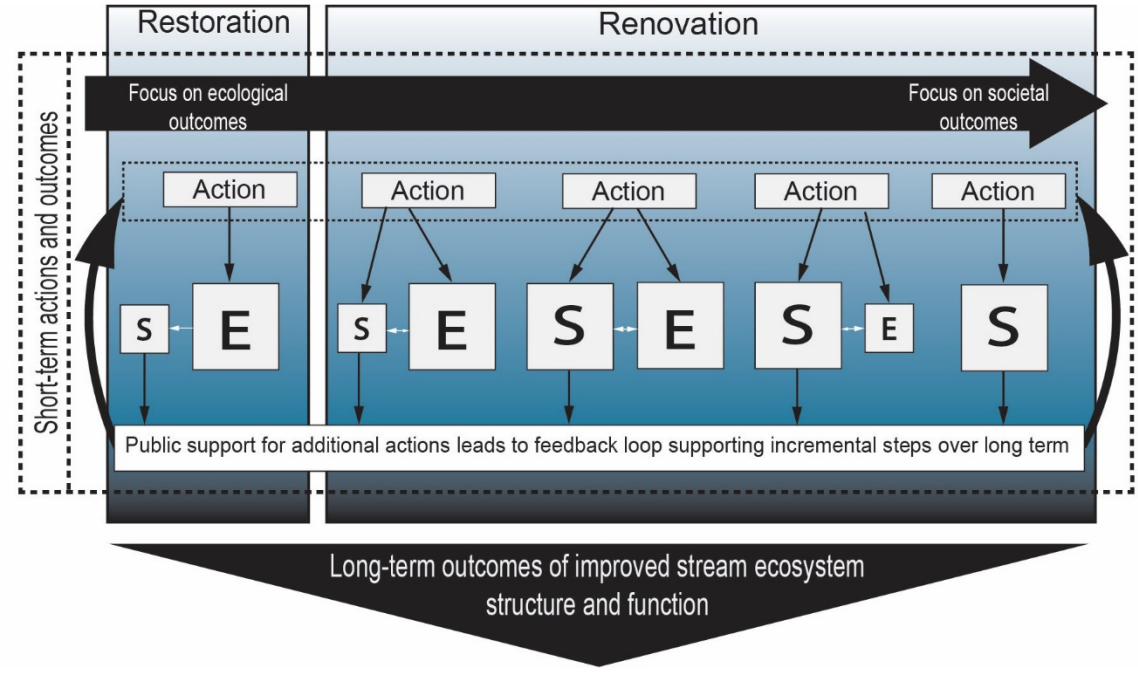


Figure 10. Illustration of the Urban Stream Renovation (USR) Conceptual Framework (Smith et al. (2018).

potentially multiple foci, all working through the societal realm (Smith et al., 2018). Thus, reversing human-initiated ecological decay requires the societal engagement in order to realize ecological benefit.

How the Urban Stream Renovation Framework Can Apply to the Logan River

This framework can be adapted and quantified in different ways. With regards to the Logan River, an option would be an attempt to remedy the over-allocation of river water and the detrimental ecological effects associated with current laws regarding "beneficial use", "prior appropriation" and "use it or lose it" clauses (Haws, 1965, CAP, 2016; Cache Water Master Plan, 2013). Figure 7 illustrates a situation where diversions remove water from the stream for irrigating crops and landscaping, thereby decreasing stream flow, which negatively affects the river's natural ecological functions. Based on the Urban Stream Renovation (USR) framework, a sole focus on restoring ecological health without societal consideration would make this situation difficult to accomplish. In the case of the Logan River, possible solutions are being discussed at the local and state level, including water banking to allocate water more efficiently or piping water from the Crockett Diversion to reduce evapotranspiration (personal conversation with N. Daugs, 2020; Pace, 2019; Cache Summit, 2019; LRTF meeting 6 Aug. 2020). The potential impact of these solutions could be significant, both in terms of social impact, should the piping result in the loss of canal water flowing through public parks, as well as environmental impact, should the hypothetical water banking system present unforeseen technical or administrative challenges. In 2020, the Utah legislature ratified Senate Bill 26, which:

> "provides for the creation of voluntary water banks organized by local water users to administer market transactions for the temporary use of water rights. SB 26 establishes an application process for becoming a water bank under the Act, directs how water rights are to be deposited into and distributed within the approved bank service area, and provides for reporting and state oversight." (Democrats, U.S., 2020).

The exact form the water banking is to take and how it will be operated is still in the development stage (LRTF meeting, 6 Aug. 2020). This is also the case for the proposal to pipe water to the shareholders and other end users, though the main outcome hoped for in this case is that more water will be left instream for ecological improvements. If the result is as expected and leaves the river with greater stream flow, the river would not only reflect both the societal and ecological objectives of the USR framework, but would also meet some of the twenty-two CAP goals to realize the vision of the LRTF, including the improvement of conditions for recreation on the river, such as kayaking or tubing, creating better habitats for fish, and promoting greater river health overall.

Meaning of a Vision for Logan River's Upper Reach

The LRTF's vision to "make the Logan River system a showcase of ecologically viable, socially beneficial river restoration" (CAP, 2016) relies on a combination of both social and ecological improvement, as outlined in the USR framework, but how does it reflect the historical or cultural heritage of the river? And should it? Stephenson (2008) highlights an evolutionary time element in her cultural values framework that is often overlooked in a typical landscape analysis. Based on her original observation about the

relationships, practices, and forms that influence our interaction with the landscape, she adds a time element with the notion of embedded values that contribute to shaping the surface values of current society. In the case of the Upper Reach of the Logan River, this is not a linear continuum, but a process that has been punctuated by clashes of different values from different cultures at different points in history (Figure 11). It shows how each historical era carries with it its own "wheel" of relationships, practices, and forms, which become embedded into the present layers of how we evaluate landscapes. In the case of the Upper Reach, the Shoshone and Mormon Pioneer heritage have become the "embedded values" that provide the foundation for today's "surface values". Regarding today's surface values and the Upper Reach, due to multiple voices and interests, the question remains as to what a vision for the Upper Reach that builds on both social and ecological needs would look like.

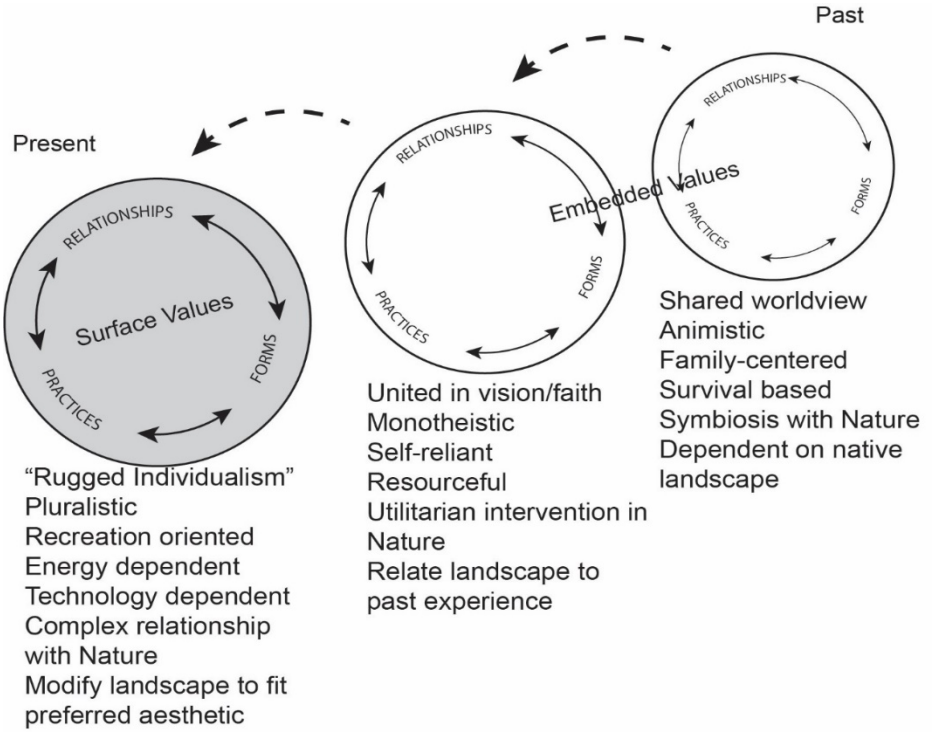


Figure 11. Interpretation of Stephenson's illustration of embedded values in the evolution of landscape that contribute to an understanding of it as a whole as applied to the Upper Reach.

What is a Vision?

Van der Helm (2009) defines a vision as "the more or less explicit claim or expression of a future that is idealized in order to mobilize present potential to move into the direction of this future." He outlines seven different vision contexts, as summarized:

1. Humanistic visions, which tend to be all-encompassing.
2. Religious or eschatological visions, which are "quintessential for understanding humans' eternal attempt to transcend the existing."
3. Political visions of the future, which are related to ideologies.
4. Business or organization-related vision statements, which exist as short slogans that attempt to capture a corporate identity or goal.
5. Community vision, which is expressed as a common aspiration for a "group or network of actors."
6. Visions derived from the melding of political, business, or community visions, described as policy or support visions, like that expressed by the Logan River Task Force.
7. The personal vision, which is related to finding a purpose or meaning to life.

In the first three contexts, argues van der Helm (2009), visions are related to a certain type of approach (or worldview) in imagining the future, whereas the other four respond to their application or field of use. To apply this to our society, we can look at two historical visions from the past: first, the Shoshone worldview and lifestyle were intimately connected to nature and its seasons; to them, nature was their past, present, and future; therefore, their impact on nature was minimal. Within this context, it could be said that their community vision or lifeway was to understand nature and watch out for each other, to share what they had to avoid starvation. Within their community and on an individual level, there was also the personal vision, or Vision Quest, whereby young men sought connection with a spirit, typically an animal, which would "bestow its powers and become a guardian for that person" (Shoshone Culture, n.d.). That vision would accompany and influence that person throughout his life, and one can imagine that it played a role in how the community interacted with the landscape: traditions included

seasonal burns to improve vegetation growth and seed yields in the following season, and the naming of places, such as the current temple site as a place of healing, the Logan River as a river of cranes, and Cache Valley as 'Willow Valley' (Ricks, 1965; Deseret News, 2007). Based on these observations, the Shoshone vision context could be classified within Van der Helm's religious, community and personal vision classifications. In a similar way, the Mormon pioneers shared a joint religious vision for the physical creation of Zion based on characteristics obtained from a vision by their leader, Joseph Smith, that resulted in the development of the Plat of Zion (Plat of the City of Zion, 1833). The settlement of Logan followed this pattern of development. Brigham Young, the leader of the Mormon pioneers, also recognized a landscape feature identified by the Shoshone as a place of healing by deciding to build the Logan Temple on it. The Mormon pioneers were not only inspired by trust in both God and Brigham Young, but also by a vision of a community where they could exercise their religion freely (Simmonds, 2004; Ricks, 1956). Thus, the pioneer vision context was akin to a blending of humanistic, religious vision with business, politics, and community in order to create individual personal visions.

Conflict of Visions: A Precursor to Triplopia

With the shared vision of settling an area to find peace and relative prosperity, the conflicting lifeways of the Shoshone and the pioneers soon revealed themselves: the pioneers laid out city blocks with plat of Zion precision and planted gardens and fields with non-native species, diverting river water to sustain these fields. The Shoshone's nomadic, precarious lifestyle of hunting and foraging with nature's seasonal cycles was

therefore upset by the displacement of native flora and fauna that for centuries had sustained them. In the words of Darren Parry (2019):

> "As more and more saints arrived in Shoshone lands, this would become an impossible situation for my people. The Pioneers had the ability and knowledge to plant and raise crops anywhere and at any time, technology unknown to Sagwitch and his people. They only knew one way to live, and in the end, it wasn't enough." (p.19)

Addressing the pioneer settlements in Cache County in 1860, Brigham Young expressed:

> "It is highly interesting to see people from so many nations joining hearts and hands to build cities, gather the poor, preach the gospel, cultivate the earth, and do whatsoever is necessary to be done to accomplish what the Lord designed in the beginning of this creation… Keep your valley pure; keep your towns as pure as you possibly can… Be faithful to your religion. Be full of love and kindness toward each other."
>
> (Ricks, 1956; *Deseret News*, 08/08/1860).

While the process of joining hearts and hands could have included the Shoshone as part of that vision, most often it did not (Ricks, 1965). Within their own community vision framework, the pioneers applied their previous knowledge to the development of this "new" land, using techniques and labor to create a society that in its physical appearance, while adhering to urban development principles envisioned by Joseph Smith (Dolan, 2017), reflected the gardens and aesthetics of their countries of origin. Lombardy poplars and crack willows were planted as windbreaks and property boundaries. Irrigation ditches

were dug according to European engineering techniques that flooded thirsty fields and fed the settlement (Simmonds, 2004). Small brick cottages and wood-frame houses are evidence of the pioneers' predominant British, Scandinavian, and North European cultural heritage. It was the vision of a Mormon community and new opportunities that brought them together to seek a better way to live. Based on the logic of manifest destiny in the 1800s, the displacement of another community to realize their own vision seemed justified. With the administrative changes that took place after statehood, and the further land and technical developments that continued after WWII, a third vision was added to the previous Shoshone and Mormon pioneer-based visions: one based on economics, growth, and car dependence. These varying visions of the Logan River are visible in the Upper Reach and are further explained in the analysis chapter.

Water for Ecology or Water for Society?

What made it possible for the pioneers to succeed was their management of water. As Logan was organized, simultaneous plans were made and executed to dig ditches and canals to direct water to fields for agricultural and domestic use. The North Branch of the Little Logan River was closest to the Logan settlement and became the main source of water for that first settlement (Haws, 1965; Ricks, 1965). The first canal diverted from the Logan River began operation in 1860, and by the end of that year, over 2000 acres were irrigated. This increased to six canals irrigating 7,379 acres in 1865 (Haws, 1965).

Samuel Fortier, a professor at the Utah Agricultural College, performed research for the Utah Agricultural Experiment Station "to define the needs for water of irrigated agriculture and to inventory the available water resources in some of the western

watersheds" (Haws 1965). He produced the first hydrograph of the Logan River, which revealed that Logan River's base flow was partially fed by seepage through the lithic mantle of the Bear River Range. This meant that flow continued well after the snowpack had melted. In Haws's words, "while realizing the economic potential of this phenomenon, he also predicted the future challenges of managing it" (Haws, 1965). Fortier (1890) stated:

> "…the wisest course to pursue is to collect and record all the physical data possible pertaining to the capacities of the irrigating ditches, the areas watered by each, and the general behavior of all sources of supply. To put off the collection of such data until litigation has begun and then attempt to render court decisions upon the conflicting testimony of interested witnesses without full knowledge of the physical facts would be unwise." (p.2)

Such litigation did occur in late 1959, when it was discovered that Logan City had been taking more than 20 cfs, or double its share of water for over a decade (Haws, 1965), resulting in the various decrees that have governed water distribution until now. It is interesting to note that even now, we are still struggling to understand the full picture of how much water flows into and out of the Logan River via its karst structure (Neilson, 2018). With climate change looming, it is anticipated that higher temperatures will produce less snowpack and more rain. How this will affect populations downstream is uncertain.

From the establishment of Cache County and Logan in 1859 to statehood in 1896, the Logan River water was managed according to the rule of prior appropriations by community leaders, who, by the nature of the community, were also ecclesiastical leaders

(Haws, 1965; Ricks, 1953; Simmonds, 2004). In 1897, the second state legislature enforced the rule of prior appropriations by enacting a state water rights law that stated: "The rights to the use of …waters of the State may be acquired by appropriation" (Haws, 1965). This was followed in 1903 by the first comprehensive water law, in which all water administration was placed under the office of the State Engineer, including the responsibility for developing hydrographic surveys of each river, stream, and water course in the state, developing a procedure for obtaining new water rights, and establishing a time-limit by which current owners of water rights needed to present proof and affidavits of those rights. In this context, it is important to note the difference between a water right and a water share (Figure 5): a water right relates to the person or entity that has a right (granted by the State Engineer) to use water. A water share refers to a user that has an agreement to use a share or portion of a water right, as per agreement with the water rights holder and in coordination with the State Engineer. The law of prior appropriations is based on the following points (Haws, 1965):

1. Water in its natural source is the property of the public and is not subject to private ownership.
2. Rights to its use may be acquired only by appropriation and beneficial use.
3. The first in time is the first in right (to use water).
4. Beneficial use shall be the basis, the measure, and the limit of the right.

Keeping water in the river for ecological support is not considered beneficial use under this legal framework, which, in some cases, has caused over-allocation of water to the point that a river dries out, as in the case of the Blacksmith Fork River during dry seasons (personal communication, D. Zook, 2019 and P. Kelly, 2019). Also, those who enjoy an older claim for beneficial use of water retain that right, even if their property is not adjacent to the river. Problems related to more recent water rights and access to water in

years of drought were solved by schedules (decrees) that were based on portions or percentages of current flow, so that everyone received a portion in drought years, but not necessarily the full amount stipulated in a "normal" year (Haws, 1965; personal communication, N. Daugs, 2020). The Logan River still operates under the Kimball Decree of 1922 (Haws, 1965; UTDWR, 2016), though the current (2020) legislature just passed bills that would enable the use of water banking as a measure to temporarily transfer water rights to uses and areas that need it. This has the potential to help increase summer flows, because it is hoped that water in the stream will now also be considered a "beneficial use" (S.B. 26; H.B. 28; H.B. 41). While such measures attempt to address the administration of the water supply, there is a lingering question regarding the current balance of water "need" and "want". With the changes in our lifestyles over the past 60 years, perhaps greater emphasis should be placed on individual control of water use?

Water Distribution and its Effects in the Upper Reach

Dan Weber is the water master for the Crockett diversion in the Upper Reach. He indicates that the Upper Reach of the Logan River has degraded since covering the Northern Canal above First Dam, probably because taking water further up the reach decreases the flow in the river sooner. Dan has noted an increase in brown moss and a decrease in the presence of beneficial stone flies. Mountain whitefish, a native fish to the region, is rarely seen. He attributes these observations to poor water quality due to lower flows, decreased amounts of oxygen in the water, and warmer water due to too much water diverted water upstream. There is not enough transparency in the way the canal systems are operated, thus, it is unclear whether or not outtakes are calibrated well

enough. There is a history of some entities taking more than their allotted shares (Haws, 1965), and since the restructuring of the Logan Hyde Park, which relocated the Smithfield Canal underground and terminated the public's access to tubing in it, Dan Weber has had difficulties obtaining clear, real-time access to the diversion amounts at that location (personal communication, D. Weber, May 2020).

Development and Water Use

As the population grows, development sprawl changes the landscape, creating other issues. Since 1959, the city of Logan has increasingly depended on well water to supply its population because the water diverted from DeWitt Springs in Logan Canyon under the Kimball Decree is insufficient (Haws, 1965). Also, with growing globalization, farming is less and less an economically viable profession due to the wage differentials between countries which make it cheaper to import food than grow it. The average age of a farmer is approaching 60, and younger generations are less interested in taking over family farms because of the hard work, international competition, and diminishing returns inherent in the endeavor. This means that more agricultural land is being sold cheaply for redevelopment into residential, commercial, or industrial use, translating into a patchwork quilt of development throughout the valley, which has sustained the population growth experienced until now (Envision Cache, 2018/2019). When agricultural land is converted to residential or commercial land, water rights associated with that property are transferred to the municipality, which then initiates culinary (piped, treated, and paid) water service to the new property owner (Cache Water Summit, 2019; Water Master Plan, 2013). It is unclear how much subterranean water is available or how

quickly it is replenished, though "the hydrostatic pressure is good," as per tests in recent years (personal communication, Lindhardt, 2020). Another effect attributable to this sprawl syndrome is an increase in impermeable roads and rooftops which produce contaminated runoff and flood potential downstream. This increase also produces a greater dependence on the automobile, resulting in longer commute times, less time for family and community building, and worsening air quality. Water waste is another issue, as development also means that more culinary water is piped longer distances to serve domestic use as well as residential irrigation of large swaths of Kentucky bluegrass, which over the last several decades has replaced many of the productive gardens that were part of the plat of Zion. Additionally, after WWII, domestic appliances such as laundry machines and dishwashers lightened the burden of housework, but also increased demands on natural resources (Haws, 1965). More bathrooms per capita, and the curse of sod-dominant, sprinkler-dependent landscaping which increases water use by up to 75% in the summer, are also indicators of [unsustainable] "modern lifestyles" (personal communication, Daugs, 2019). It was the accumulation of these effects, together with a lack of understanding or consideration of how rivers function, that initiated the causes related to the flooding woes of 2011 to the present. Therefore, understanding the relationship between social, economic, and cultural changes and their effects on our natural resources can help us find better ways to correct our mistakes and avoid making them in the future.

Which Voices Prevail: River, Resident or City?

One of the greatest challenges when it comes to human interventions of river

ecosystems is that river maintenance has been the domain of "technocrats," such as engineers and land developers, with a '"command and control" approach focused on one or two limited objectives (Gregory & Brierley 2009; Westling, 2014; Fox & Cundill, 2018; Weber, 2019). Such attempts at dominating nature typically have not considered how it would affect the whole of the associated ecology, including the society that has to live with the interventions, nor what would be required to maintain the altered state (Speed et al., 2016; Podolak et al, 2013; Beltrán-Caballero, 2013). Examples of such interventions on the Logan River include the over-allocation of water resources, resulting in unsustainable instream flow for adequate maintenance of flora and fauna at certain times of the year (Lane, 2018). The conversion of agricultural land to residential land is also an example of how developers, together with the city council and planning commission, make decisions that can affect the ecology. Once degradation has occurred, the development of a rehabilitation plan also risks undue influence by "technocrats". (Booth, 2005). Because the context has often changed within such a degraded river, restoring it back to what it once was may not be appropriate (Beltran-Caballero, 2013). The Logan River Task Force consists of a varied selection of professionals who together help formulate approaches and recommendations for best management practices (BMP). Despite this, there are still some who feel left out of the conversation who could help shed a different light on the conversation about sustainable approaches applicable to the Logan River and future use of Logan River water, including irrigation companies and farming communities that are part of the historical legacy that enabled permanent settlement in the valley (personal conversation, R. Reese, 2019).

Now, in 2020, with the influx of new residents, changing demographics, and more

eclectic points of view, issues are dealt with at the municipal, county, and state level, as prescribed by the state and federal constitutions. In our globalized, secular, pluralistic Western culture, there is no longer a singular unified community vision, even though expressed visions still provide "a powerful tool with which to frame aspirations for the future" (Van der Helm, 2009; Gregory &and Brierley, 2009). Having a vision, even if dominated by knowledgeable technocrats, does not necessarily guarantee results (Canto-Perello et al., 2016), and with a more eclectic group of people, such a vision is more difficult to put into action (Gregory and Brierley, 2010; Speed et al., 2016). This is partly due to the challenge of dealing with multiple groups of people and interests, as well as the potential bias of the person or people initiating the vision (Iwaniec & Wiek, 2014; Westling, 2014; Gregory & Brierley, 2009; Stephenson, 2008). Brundtland (1987) expresses the existential challenges of our time as we struggle to deal with societal and environmental imbalances and excesses:

> "the 'environment' is where we all live; and 'development' is what we all do in attempting to improve our lot within that abode. The two are inseparable. Further, development issues must be seen as crucial by the political leaders who feel that their countries have reached a plateau towards which other nations must strive. Many of the development paths of the industrialized nations are clearly unsustainable. And the development decisions of these countries, because of their great economic and political power, will have a profound effect upon the ability of all peoples to sustain human progress for generations to come." (p.7)

Because the world's human population is sharing the planet with all other living

creatures, we should consider our individual actions, however small, in the light of the definition of sustainability, also defined in the Brundtland (1987) report and reemphasized in the United Nation's 2015 Sustainability Goals (United Nations, 2015): "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." While one person's actions may not have a significant environmental impact in global terms, if it is multiplied eight billion times (i.e., each inhabitant on the planet does the same), it does have a significant impact. Our challenge is to change our understanding, attitudes, and behaviors to favor development that keeps our environment in balance, and why not, to the extent possible, use the Upper Reach as an example?

Approaching River Renovation on the Upper Reach

There are many ways to approach a community in order to try and understand what that community considers important relative to their environment, natural resources, recreation, etc. To secure long-term success for any restoration project, Fox & Cundill (2018) outline seven social strategies that should be included in any project:

1. Engaging in active community participation.
2. Working with local knowledge and institutions.
3. Supporting landscape dependent livelihoods.
4. Accommodating local values and needs.
5. Fostering social-ecological learning.
6. Providing educational programs that deepen local ecological understanding and value.
7. Applying systematic approaches that facilitate an understanding of local social-ecological systems.

Most of these points are being carried through, though perhaps closer coordination with local irrigation companies and more active, public communication would help the

processes that CAP addresses. I am not aware of how well the public education system at the primary and secondary levels incorporate the social-ecological learning elements relative to the Logan River, but such opportunities exist.

Let the River Speak

Podolak (2012) posed the question of whether river modifications realized almost 300 years ago by Capability (Lancelot) Brown were truly an exercise in designing with nature and discovered that they required dredging and regular maintenance to be kept as designed (Podolak et al., 2013). Other research has determined that many landscapes that we consider "natural" are still maintained to preserve a certain aesthetic appearance (Prior, 2016; Westling et al., 2014). This illustrates our historic interest in manipulating nature for our aesthetic or economic (social) benefit before considering the short and long-term consequences to ecology. In the latter half of the 20th century, this mind-set began to change with the realization that our interventions were ultimately damaging not only our environment but human existence as well. Ecological movements speaking out in favor of environmental causes appeared in Europe and elsewhere, igniting conversations about diverse topics that included river degradation, thus giving rivers a voice. In 2016, UNESCO published a manual on River Restoration (Speed et al., 2016) that gives a basic outline of river restoration approaches and experiences worldwide. The manual provides eight "golden rules for river restoration":

1. Identify, understand, and work with the catchment and riverine processes.
2. Link to socio-economic values and integrate with broader planning and development activities.
3. Restore ecosystem structure and function by working at the appropriate scale to address limiting factors to river health.
4. Set clear, achievable, and measurable goals.

5. Build resilience to future change.
6. Ensure the sustainability of restoration outcomes.
7. Involve all relevant stakeholders.
8. Monitor, evaluate, adapt, and provide evidence of restoration outcomes.

This adaptive, flexible intervention method echoes other sources and literature regarding river restoration, including the European Centre for River Restoration, a network organized in 1995 to "promote and build capacity for ecological river restoration across Europe, supporting the implementation of the EU Water Framework Directive, Floods Directive and the UN Sustainable Development Goals, the UNECE Water Convention, the Convention on Biodiversity, as well as national policies" (eccr.org). As such they are the "authoritative voice on river restoration in Europe" (eccr.org). In the UK, a group of people from the public, private and NGO sectors founded the River Restoration Centre in 1994 to "champion the view of 'better rivers' and promote the natural capital and social benefits of restoring [their] river systems for a sustainable future" (therrc.co.uk/). Their webpage is a repository of information regarding previous restoration and a resource for anyone entertaining the idea of restoring a river.

In the United States, river restoration is most often initiated and influenced by disparate voices. The federal government provides the legal structure that is carried through to the individual states and their constitutions. Federal agencies often provide oversight and assistance to the states. Based on information from the website watereducation.org, the agencies that oversee water interests are:

- The Bureau of Reclamation, which oversees federal water projects in 17 Western states; The Federal Emergency Management Agency (FEMA), which has sub-agencies in each state that help with technical and financial issues related to flood prevention and mitigation. FEMA also administers the National Flood Insurance Program (NFIP) designed to protect against flood risk and help victims of floods, though this has proved to be a thorny program that does not actually keep development out of floodplains or other risky areas but rather seems to offer a

false sense of security to those who venture into development projects in those areas (GAO, 2019).

- The National Marine Fisheries Service (NMFS), which operates under the National Oceanic and Atmospheric Administration (NOAA) and provides scientific and policy leadership.
- The U.S. Army Corps of Engineers, which operates under the Department of Defense and oversees flood control and levee construction, as well as regulating navigable waterways and wetlands.
- The U.S. Environmental Protection Agency (EPA), which exists to "protect human health and the environment". Its Region IX office "enforces federal laws that protect natural resources, including air, water and land" (watereducation.org). The Clean Water Act (US EPA, 2013) established that the Environmental Protection Agency (EPA) oversees water quality and provides federal guidelines as to acceptable water pollution levels and the quality of drinking water.
- U.S. Fish and Wildlife Service, which operates under the Department of the Interior to conserve and protect fish, wildlife, and plants with the coordination of other federal agencies.
- The U.S. Geological Survey, with a mission to provide "reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life" (usgs.gov).

With so many different agencies and unique policy frameworks, finding the right balance of stakeholders and agencies to support each initiative can be a complex process where local knowledge and a collaborative learning mindset are paramount (Fox & Cundill, 2018; Daniels & Walker, 2001). The Cities of Logan and River Heights as well as Cache County all have properties that border the Logan River in the Upper Reach, each with General Plans that provide different zoning and codes that apply to development. This can, in turn, affect the river. While the main driver of development is economic, it is up to the state and local governments, which are elected by residents, to determine to what extent they will codify and direct development that balances the social as well as the ecological use of resources.

To return to the triplopia analogy, the objective of a holistic, sustainable vision is to identify and emphasize the common threads shared by the river, the residents, and the

city. The following chapters seek to explore what those threads are and how they might be converted to a common vision.

CHAPTER IV

ANALYSIS OF THE UPPER REACH

PHYSICAL ANALYSIS

The purpose of this analysis is to understand the nature of the specified area, how it behaves, and its physical, biological, and cultural makeup and characteristics, so that proposed designs can be made in alignment with them.

The Logan River Watershed

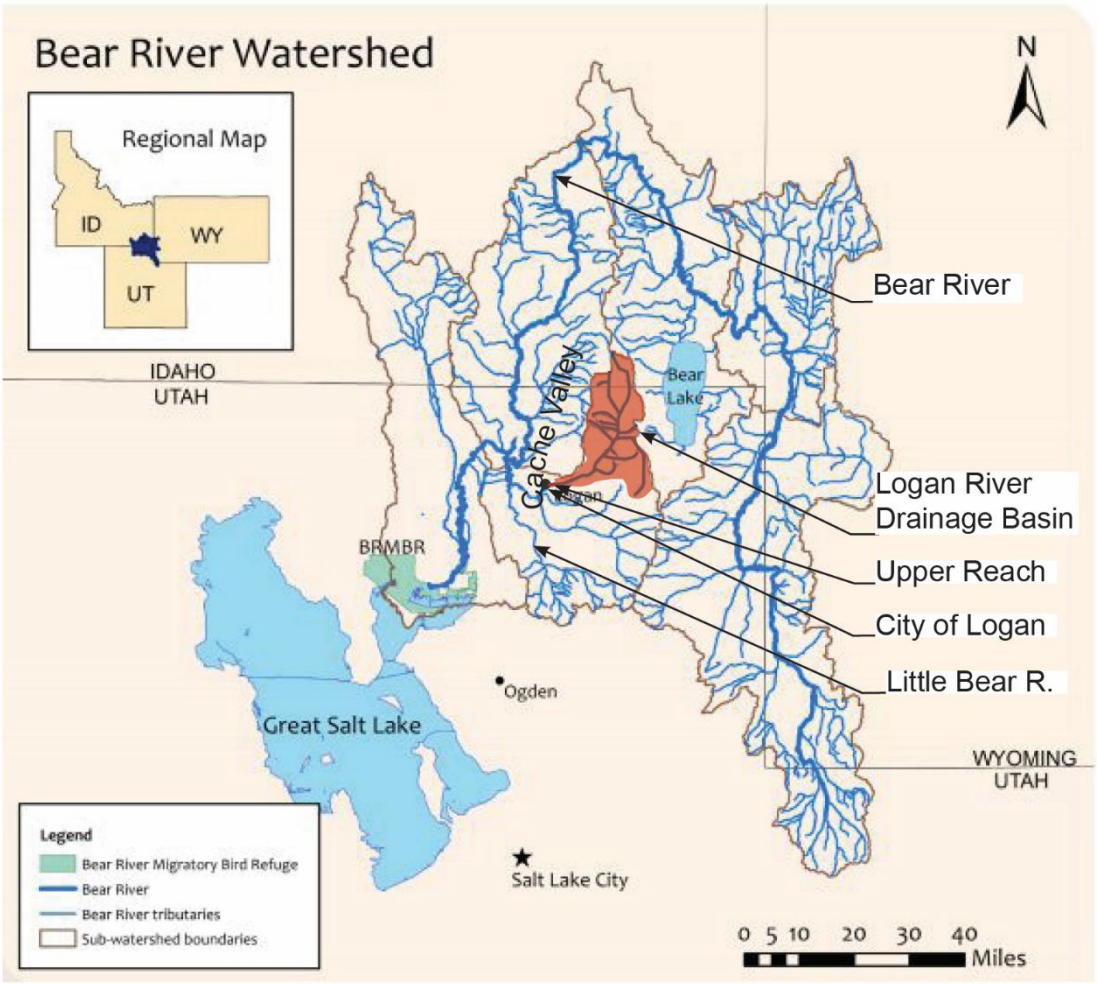


Figure 12. Bear River Watershed.

Logan River is part of the Bear River Watershed (Figure 12). The Logan River

drainage basin (in red) begins in the SE region of Idaho and flows south and southwest into Cache Valley, where it eventually joins the Little Bear River, followed by Bear River, before it flows into the terminal Great Salt Lake. It is important to understand that while the Logan River seems a small part of a large system, it is the sum of all its parts that makes it possible for any system to exist, therefore, small changes can have a cumulative effect on the system as a whole. To illustrate, it has been determined that diversions of and development around the tributaries to the Great Salt Lake are the reason for the lake's rapidly decreasing water levels (Derouin, 2017; Wurtsbaugh, 2017). While one irrigated garden may not matter, the cumulative effect of a cultural way of doing things does. Therefore, a systemic shift that starts with one is needed to change the momentum away from irreparable ecologic harm.

The Upper Reach

When the Logan River Task Force began its assessment of the Logan River within the City of Logan, it divided the river into three reaches (See Figure 2) based on the stream context in each area. The Upper Reach (Figures 13 and 14) is characterized by confinement, due to residential development.

Figure 13. Birdseye view of the Upper Reach of Logan River.

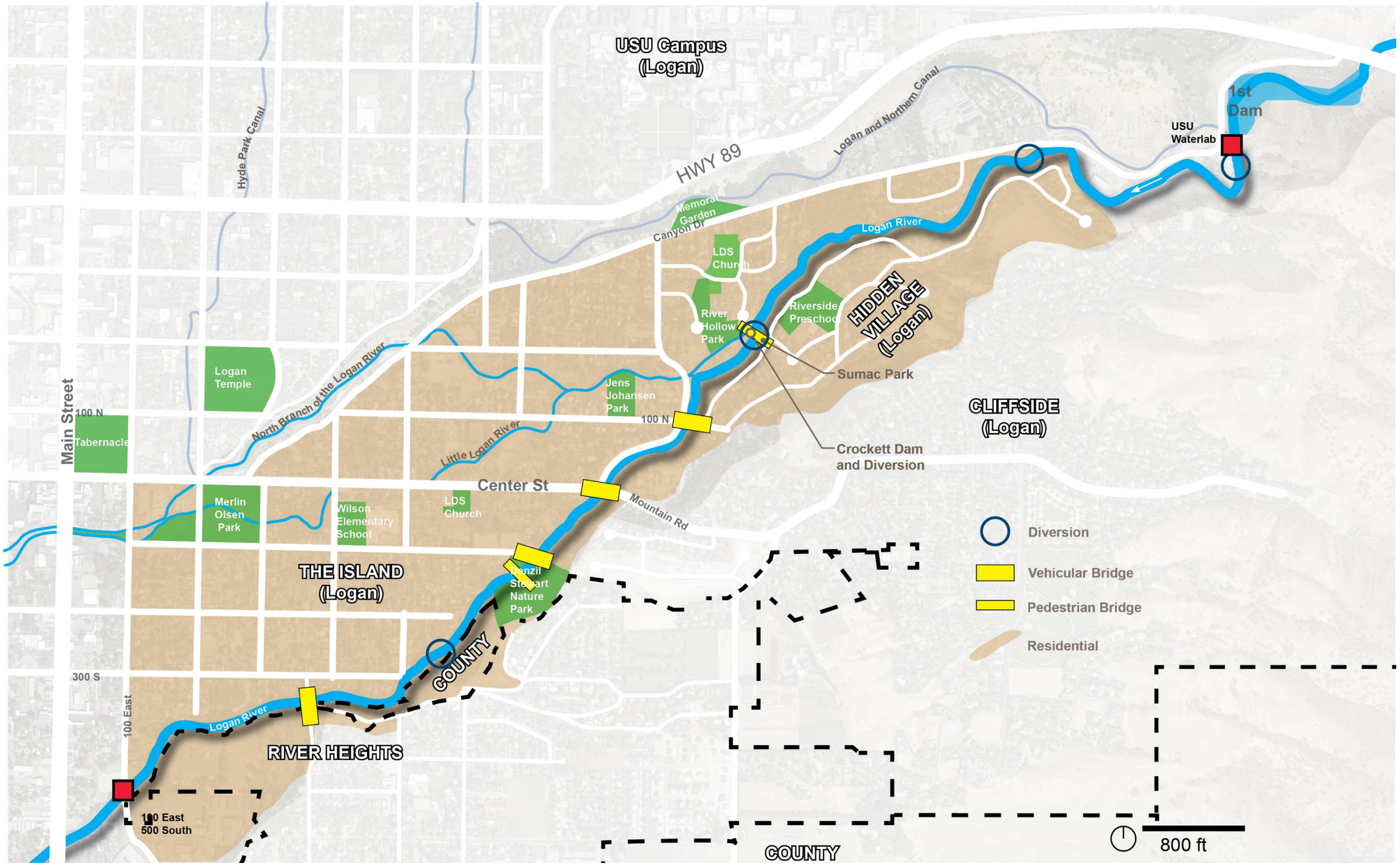


Figure 14. Main features of the Upper Reach

Geology and Topography

The form of the Upper Reach is very much related to its geologic history. The Bear River mountain range that conforms the watershed is a karst system of limestone and dolomite formed millions of years ago. Its natural porosity allows water to filtrate through it and reappear as seepage into springs and rivers (Greene, 2019). This is one of the characteristics that allows the Logan River to continue to flow into the summer months after the rainy spring season.

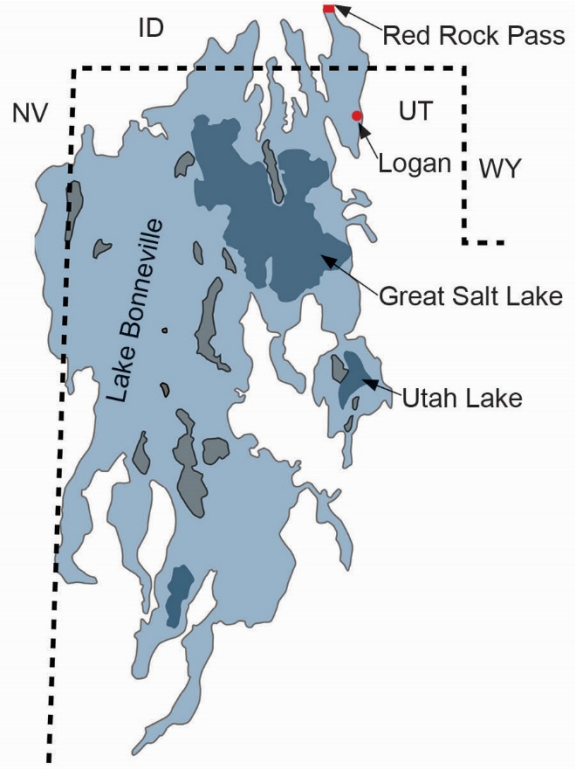


Figure 15. Lake Bonneville ca 15,000 B.C.E.

Over 15,000 years ago, Lake Bonneville extended 19,800 square miles over parts of today's Utah, Idaho, and Nevada (Wikipedia, Figure 8). When Red Rock Pass failed around 14,500 years ago, all that was left of the former shoreline in the area near Logan was a bench with accumulations of sand, fossils, and shells. Subsequent drainage periods left different shoreline levels (Figure 15). As the lake waters receded, the steep slopes of the lakebed were exposed. Water from precipitation and snowmelt collected and seeped into cracks of the karst or flowed down the mountain as rivulets that collected and slowly eroded the surface as the water moved down to the valley bottoms. Logan River became the confluence of these small canyon tributaries. With its accumulated strength, it eroded its way through lacustrine alluvial deposits to the incipient alluvial fan where it currently

flows. As the slopes grew tamer on the floodplain, it slowed, and deposited its sediment load from the mountains as it meandered freely through the valley bottom. This whole process has shaped the Upper Reach and helped create the physical characteristics as they

Figure 16. Early 1900s, Looking east over Logan Island, Logan River's floodplain, with Canyon Road going towards the mouth of Logan Canyon.

appear today. The steep slopes that frame the floodplain were part of the alluvial fan formed by thousands of years of flowing water (Figures 16 and 17). The colors increase in darkness based on how steep they are, which also serves to illustrate the different "benches" shaped by different stages in the receding water levels of Lake Bonneville. With a river altitude above sea level of 4,650ft at the USU Water Lab, and an altitude of 4,515ft at 100 East, the elevation gain for the three-mile reach is 135ft.

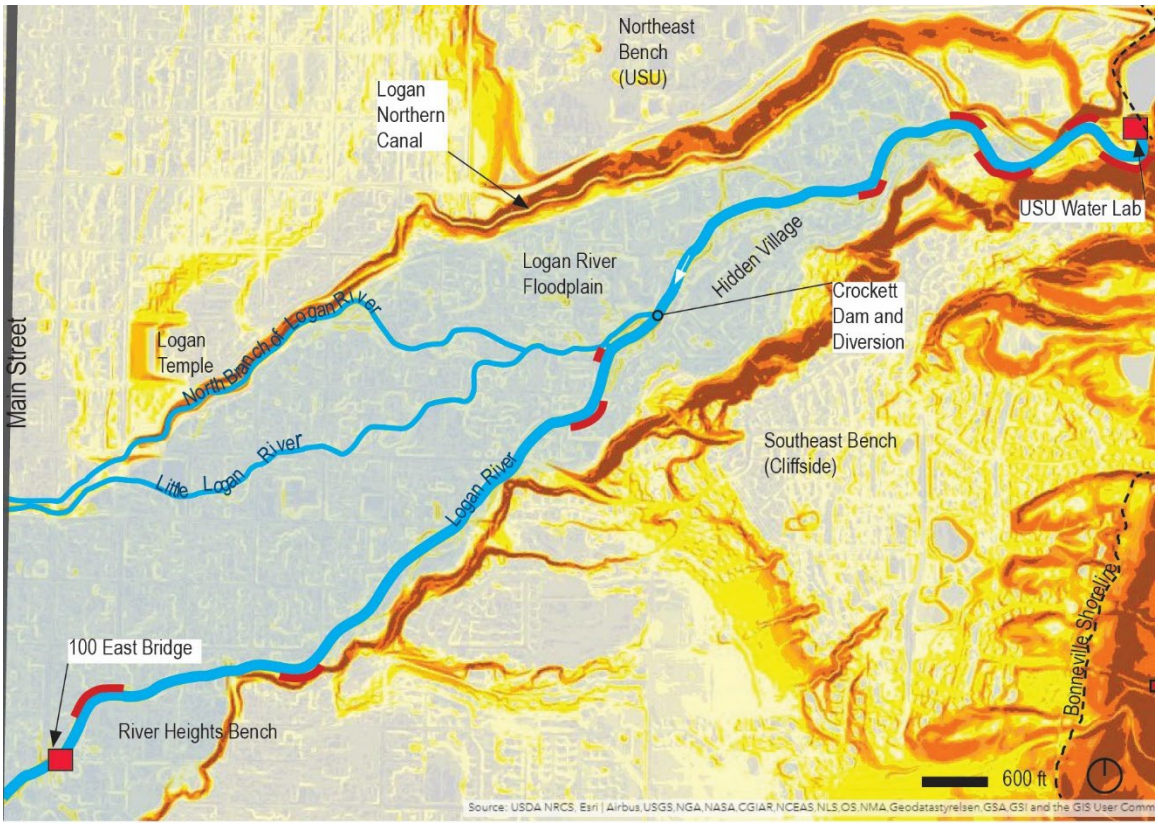


Figure 17. Upper Reach of Logan River and its floodplain (light blue-gray) showing increasing slope gradients through gray degradations (0-3% slope) to dark brown (50-100% slopes). Red markings along the river indicate erosion risk.

The Logan River floodplain unfolds as the river runs through the Bonneville Shoreline to the East. It comprises the low, level area (light blue-gray) banked by the Northeast Bench and the Southeast Bench. Several bench levels are discernable, as well as man-made features, such as the grading by the Logan Temple and the ill-fated Logan Northern Canal.

River Morphology and Changes in the Floodplain

As the river flows down through its floodplain, it creates characteristic shapes or morphological features, as illustrated in Figure 18. The shape of meanders and quantity of sediment accumulation depends on many factors, including topography, seasonal

rainfall, stormwater runoff, streambed material, river channel, vegetation cover, and level of erosion along the riverbank.

The Upper Reach evidences all these features (Figure 19). When comparing historical meanders and braids from the 1891 Logan Survey with the current location of the river channel and branches along current property lines, it becomes evident how some areas at risk of flooding and erosion are affected by the river's historic natural course. In

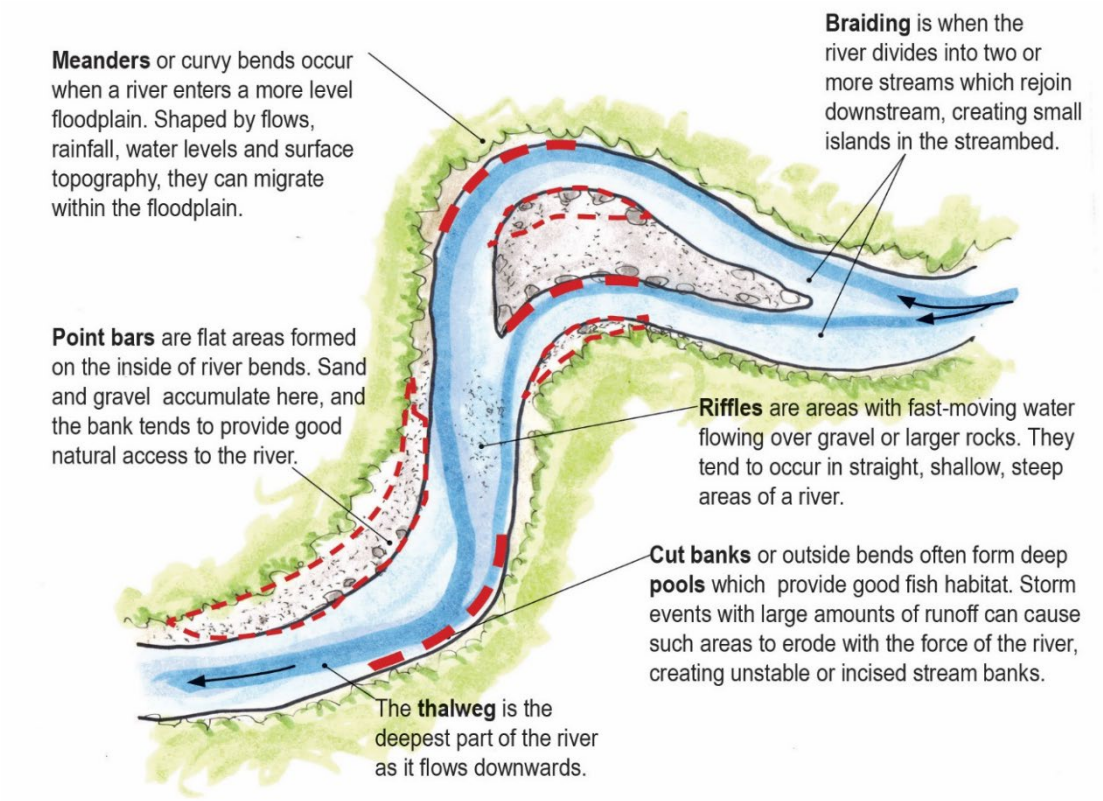


Figure 18. Typical aspects of river morphology.

most cases, when private property lines were outlined, little space for the river's natural movement within its floodplain remained. When lateral movement is reduced, the river becomes fixed in its channel and erodes downward, creating an incised channel with steeper, taller banks that make it more difficult for vegetation to grow, thereby reducing fauna habitat. When steep banks fail due to river erosion, properties are exposed, which concerns landowners about the potential for further erosion and flooding.

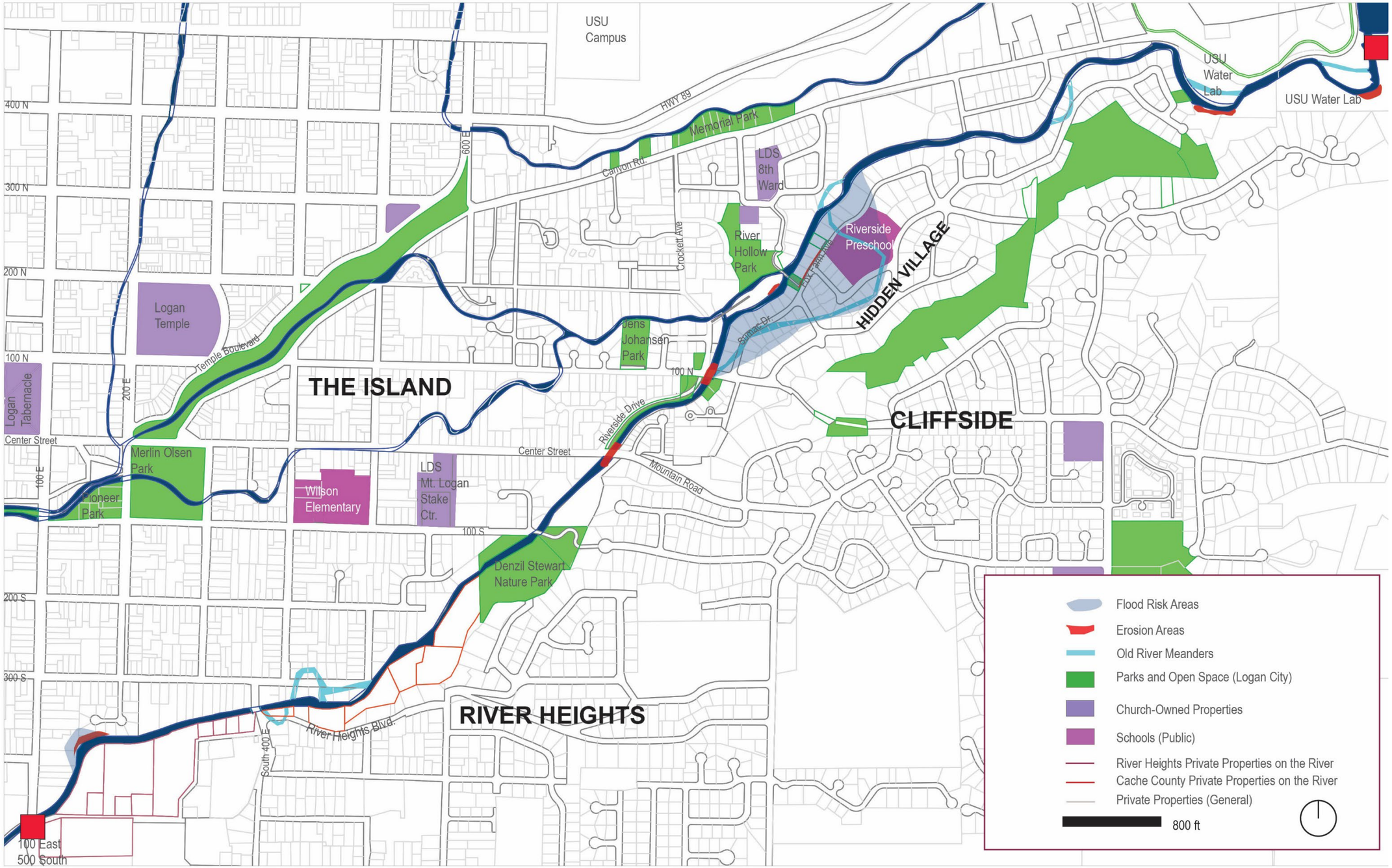


Figure 19. Comparison of Logan River course from Survey Map of 1891 and today's situation.

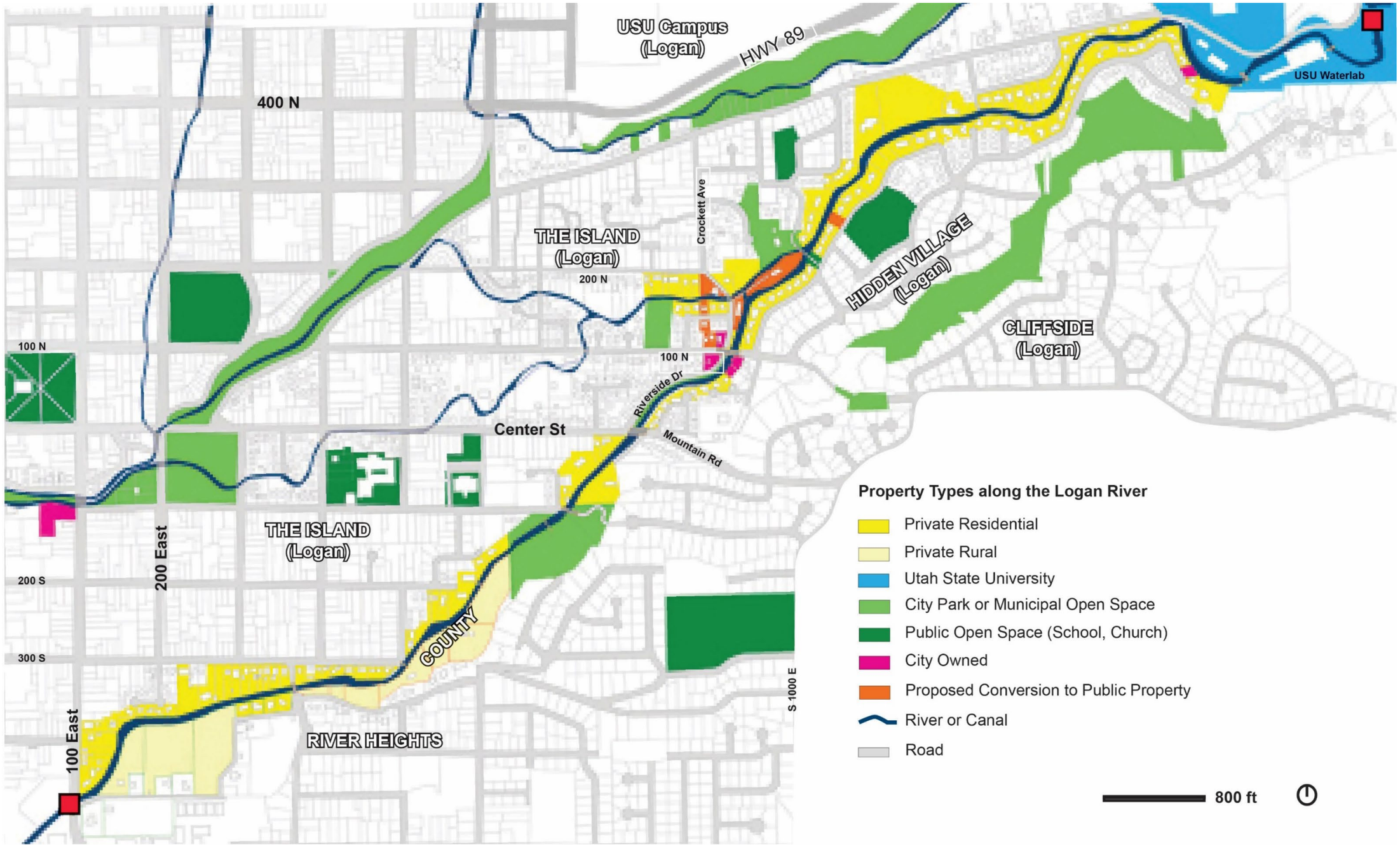


Figure 20. Map showing property types along the Logan River .

Additionally, river erosion causes more sediment and debris to be carried downstream, creating silt deposition and other potential obstructions downstream. One approach to preventing this historically has been to use concrete or hard-surface channels that move water quickly out of an area. This, however, produces its own ecological problems. Hard, impervious surfaces tend to speed the flow and do not allow water to

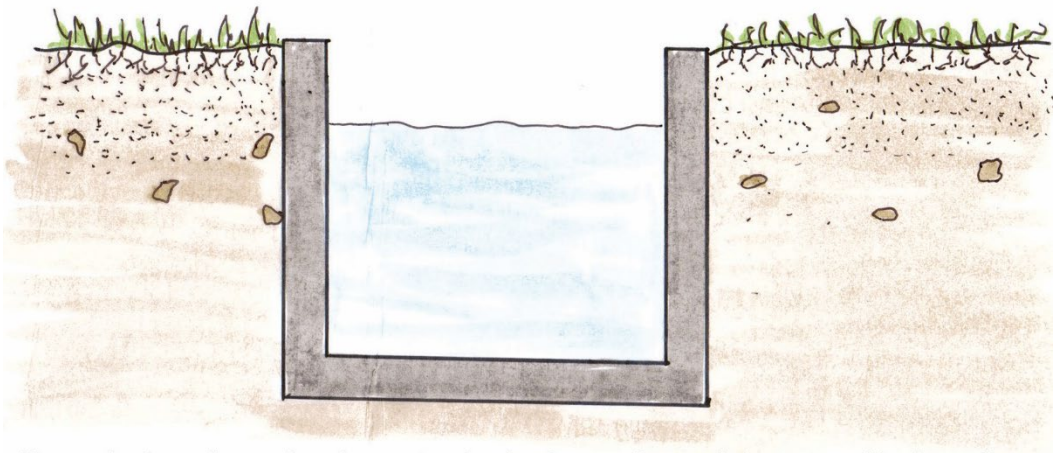


Figure 21. Concrete Channel for rapid water conveyance.

percolate into the soil for vegetation growth or habitat diversity (Figure 21). While water conveyance is efficient, it can lead to increased accumulation of water and flooding downstream. The uniform, hard surface does not allow for the propagation of normal riparian ecosystem development, and often promotes increases in water temperature conducive to algal blooms and increased acidity (low pH). In contrast, vegetated and irregular-surfaced riverbanks create friction that helps dissipate the energy of the flow, allowing water to percolate deeper into the soil as well as unload sediment (Figure 22). This, in turn, provides substrates upon which vegetation can grow and offers habitat for more diverse life forms. These healthy streambanks generally have varied topography with sloping edges covered with live organic matter and diverse surface materials, allowing multitudinous species to thrive. Shrubs and trees provide shade, which keep

water cool and decrease evaporation. In such streams, there is also a natural thalweg (the deepest part of the river) moving longitudinally down the river which creates a more natural downward flow and serves as a "highway" for paddlers heading downstream.

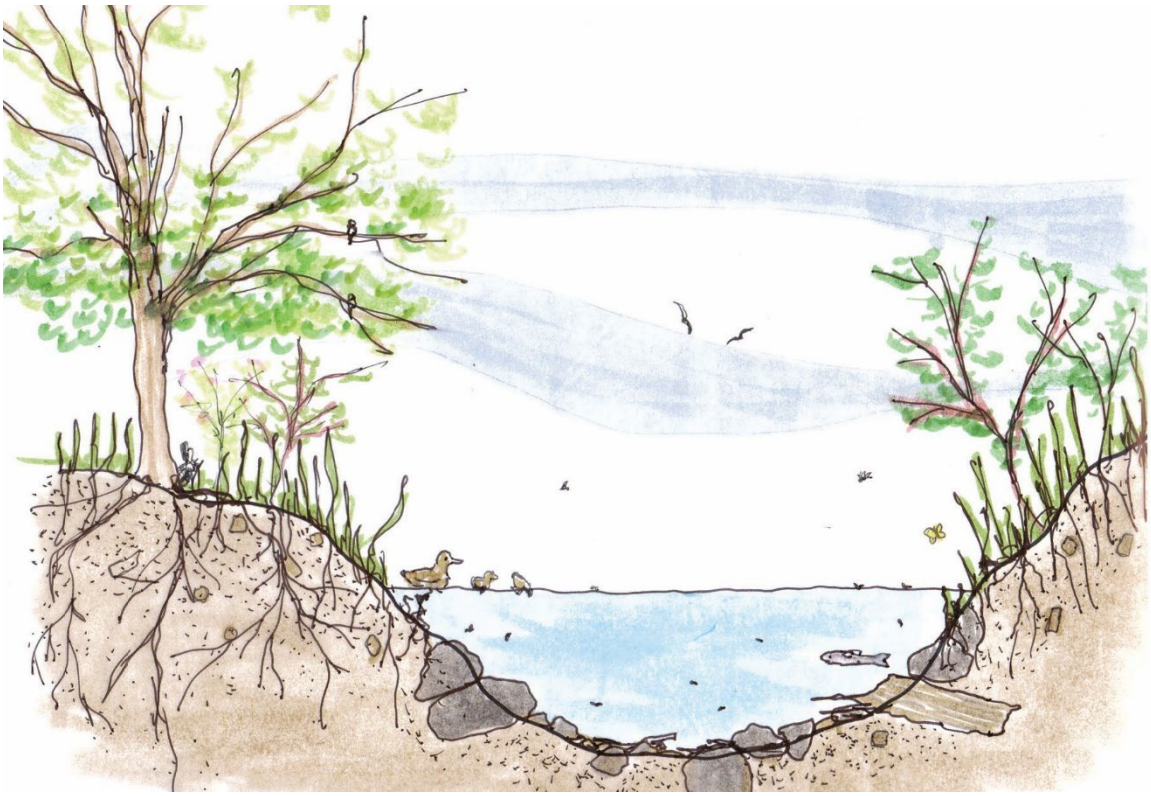


Figure 22. Healthy streambank.

The Soil

The Natural Resources Conservation Service (NRCS) under the U.S. Department of Agriculture (USDA) provides coded, detailed soil information and land use suitability on their website. This was used to obtain information about the soil typologies present in the Upper Reach (Figure 23). The NRCS map corroborates the slope map, indicating eroded, steep banks on either side of the floodplain (SwF2, Rt and RCG2). The level floodplain contains soils which are suitable for farming (SvA and Pu). One area to note is the steep bank near the USU Water Lab (RCG2) with slopes over 50%.

In the context of development strategies, the floodplain (SvA and Pu) with its easily accessible water, would best serve the community as agricultural land for future resilience. This, however, has not been the mind-set of the governing municipality.

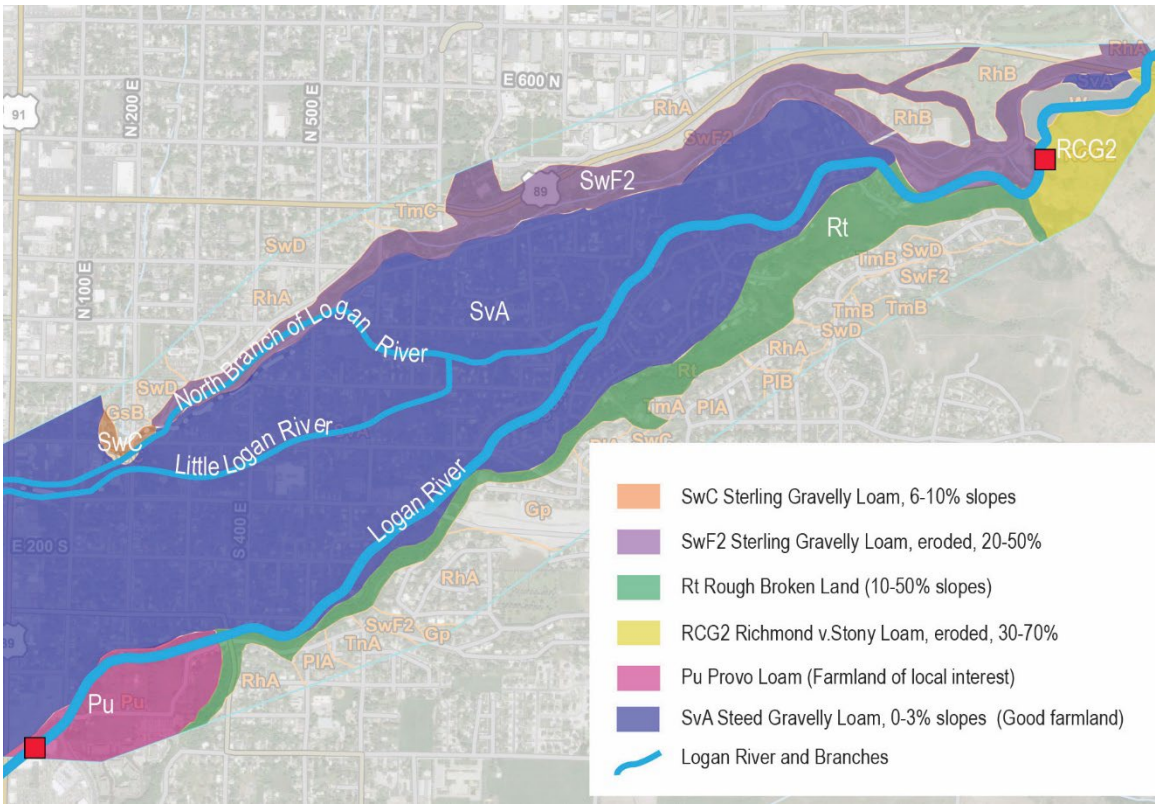


Figure 23. Illustration of soils present in the UR based on NRCS classification (Map not to scale) .

Hazards Related to the Land

While earthquakes are rare occurrences, there is a fault line along the Eastern Bench which could affect infrastructure built upon it (Figure 24). It is unclear whether the builders of the first dam were aware of the fault when the dam was built, though it is of concern what the consequences might be should it fail. The map also shows the areas where liquefaction is a hazard, covering most of the western section of the floodplain. As has been noted earlier, the steep slopes on the north and south sides of the floodplain are eroded and unstable; therefore, the slopes and the land immediately below them are

unsuitable for much beyond being kept as open space.

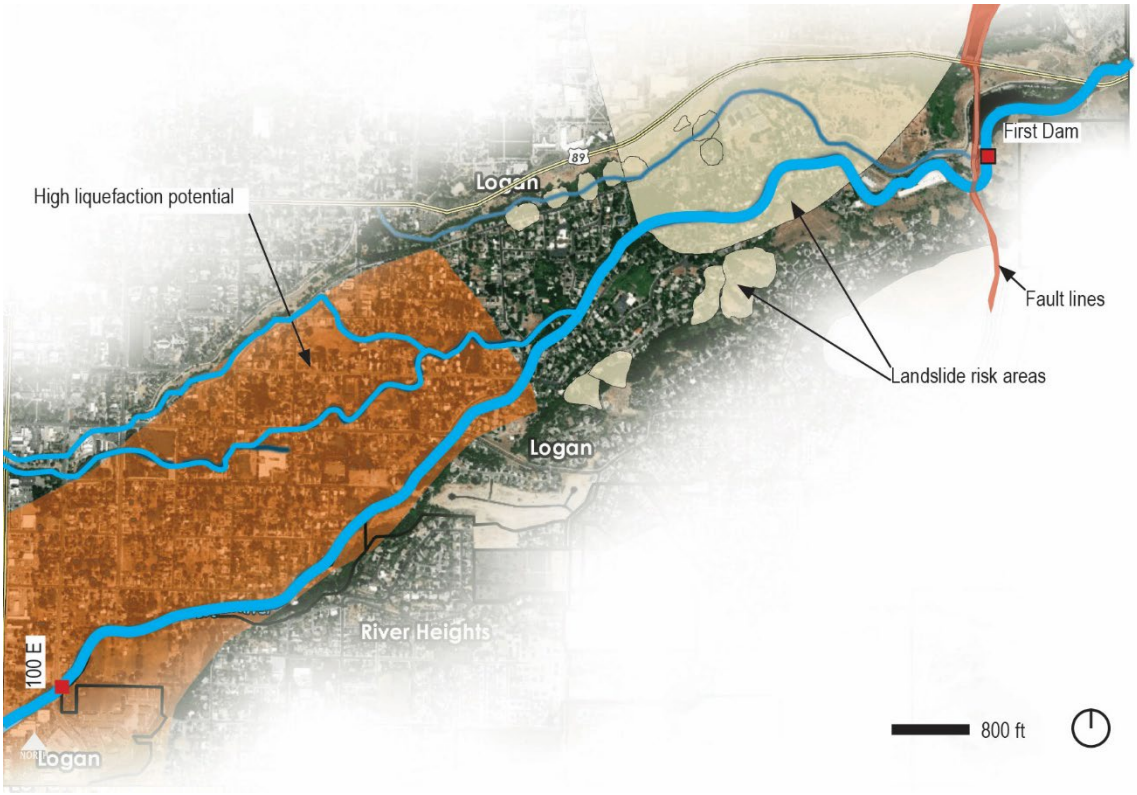


Figure 24. Hazard areas in and around the LR floodplain. Source: Cache County Online GIS.

The Water Cycle and the River

For millennia, winds have blown over the Bear River Mountains, bringing moisture from oceans, lakes, and rivers to parched land. As part of the water cycle (Figure 25), water evaporates from moist surfaces warmed by sun and air. As water molecules rise into the atmosphere, they collect as mist and clouds, moving through the sky where the winds direct. They accumulate and cool with the diurnal and seasonal changes in temperature, condensing and precipitating as rain, hail, sleet, or snow. As

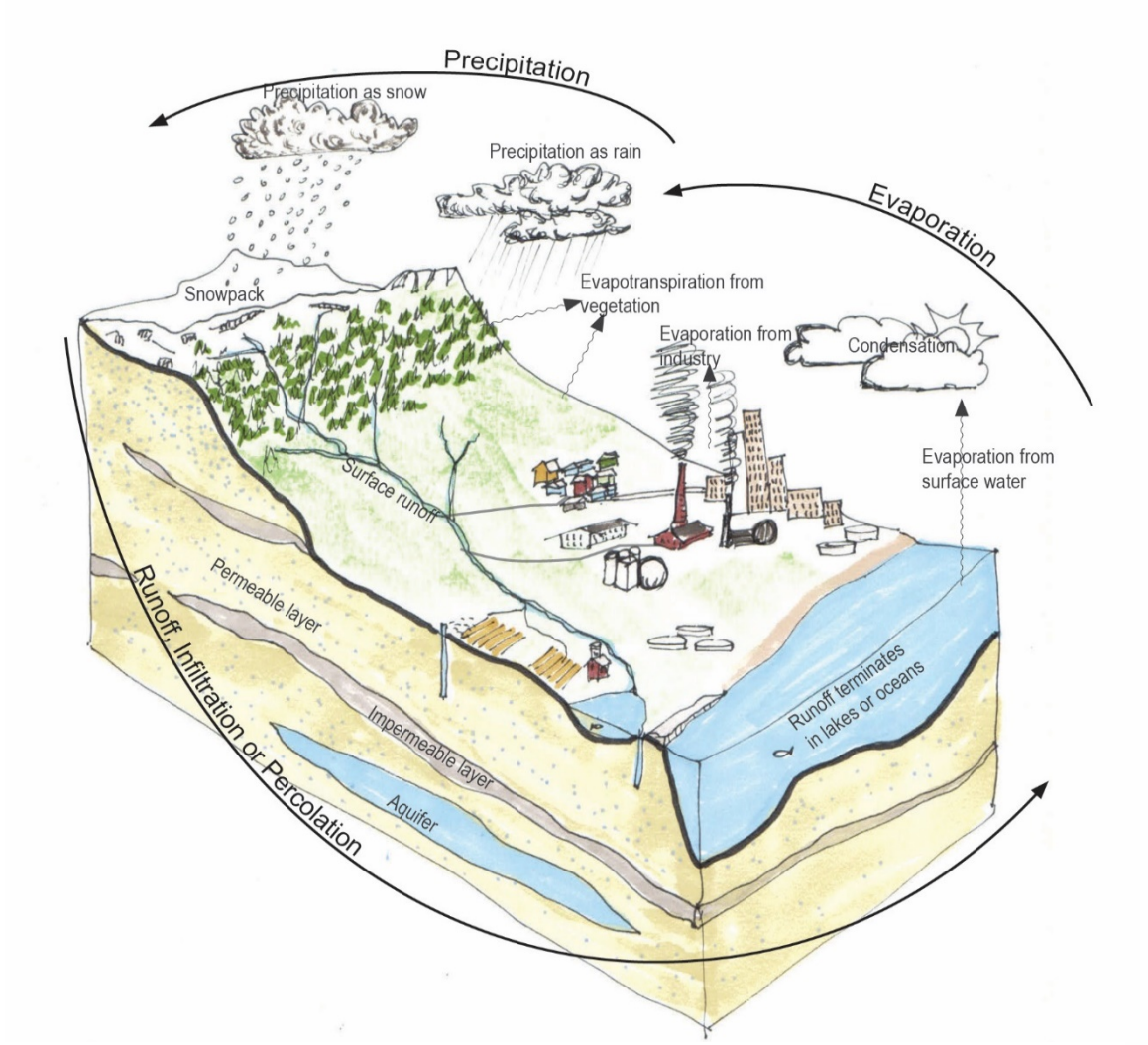


Figure 25. The water cycle.

snow, molecules remain on the land surface until the temperatures rise to the melting point, then they collect and flow downwards with gravitational pull. Some are absorbed into leaves and roots of plants, some infiltrate the soil and lithic fissures, and some percolate into deep aquifers further downriver. The rest collect into streams, rivers, lakes, and oceans before the cycle starts all over again. This water cycle has enabled life as we know it to develop into the relatively arid Bear River Watershed, as the water helps break down lithic particles that become soil and creates the ecological base for flora and fauna to flourish. Watersheds provide unique ecosystems and habitats that function as a

recycling system of water in all its forms.

Human action can modify and interrupt the cycle by collecting and storing water in dams and reservoirs, diverting it for irrigation, piping it for conveyance and delivery to other destinations, diminishing absorption by creating impermeable surfaces, and digging wells to extract the water in aquifers.

Climate

Logan is categorized as a Dfa/Dfb climate in the Köppen-Geiger system, meaning it has a warm to temperate continental climate, where the greatest precipitation occurs in the spring. Its USDA plant hardiness zone is 5b, indicating that the minimum temperature ranges between -15˚F and -10˚F. While this information is not as relevant to current

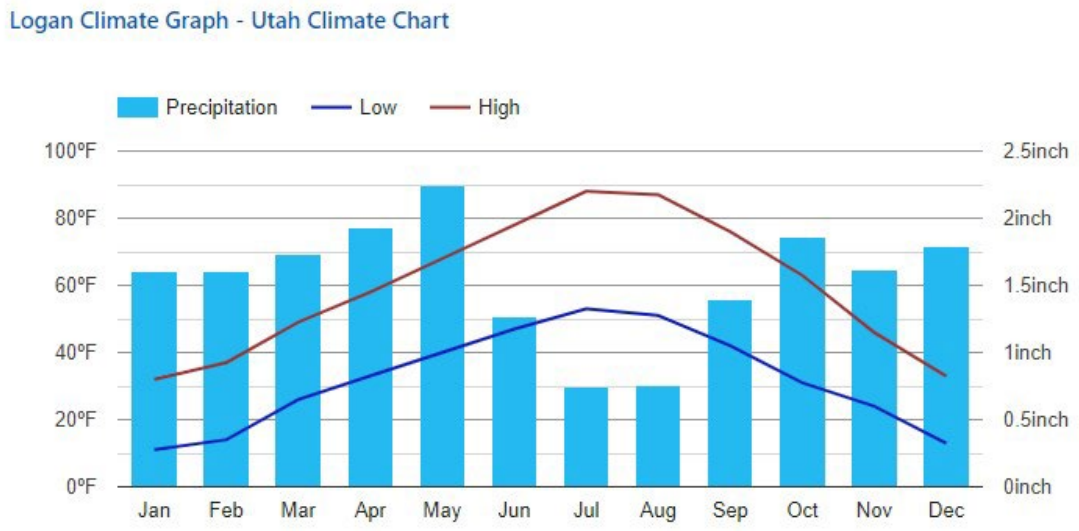


Figure 26. Logan Climate Graph Adapted from: https://www.usclimatedata.com/climate/logan/utah/united-states/usut0147

residents as it was to Logan's first pioneer settlers, agriculturists and environmentalists are concerned with how climate change will affect the seasonal temperatures and precipitation levels, and thereby influence either drought or flooding. The climate graphs above confirm that the Upper Reach receives most of its rainfall in the spring, with the

warm summer months receiving the least. Total average annual precipitation is around 18 inches, which includes 55 inches of snowfall. This amount of snowfall equals one to two inches of rainwater (https://www.nssl.noaa.gov/education/svrwx101/winter/).

Hydrology

Hydrology is "the study of the movement, distribution and management of water" (Wikipedia). It is of special importance to the health of the Logan River. Figures 27 and

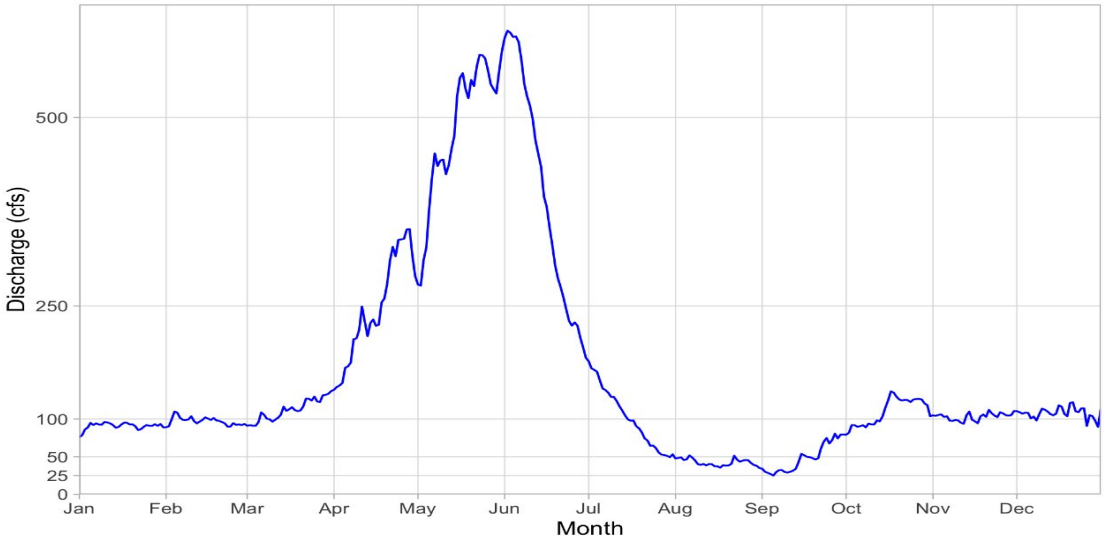


Figure 27. Crockett Reach Hydrograph showing the estimated 6-year median of mean daily discharge.

28 show hydrographs that illustrate a six-year median of mean daily flow of water in cubic foot per second (cfs) discharged through the Logan River at the Crockett diversion. Peak flow tends to occur in late May or early June and reflects the effect of spring snowmelt. Melting snow delays the runoff by several days or weeks, based on temperatures at higher elevations in the watershed. The karst system allows water to infiltrate into the rocky subbase, further delaying water flow to its terminus as it percolates through the system.

Based on conversations with Frank Howe, president of the Logan River Task

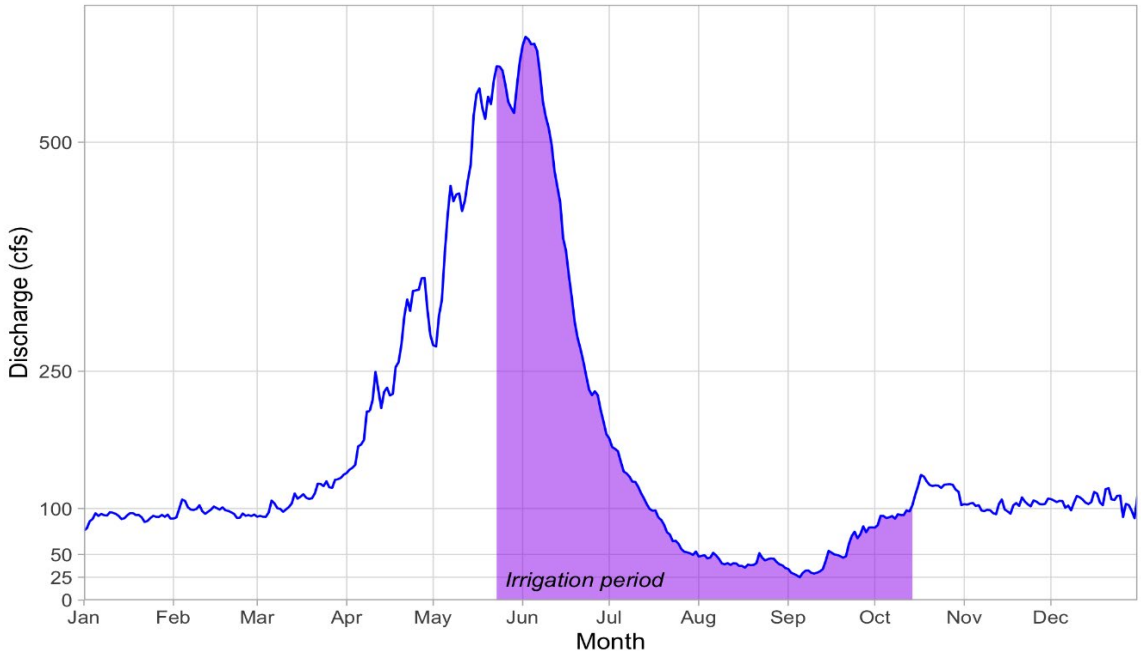


Figure 28. Crockett Reach Hydrograph highlighting the annual Irrigation Period.

Force and associate professor of wildland resources at USU (2019), there is a need to keep a minimum of 60 cfs to maintain a healthy river. As illustrated in the hydrograph, July, August, and September trend short of this, which causes challenges for the river ecosystem as well as farmers dependent on more water for irrigation in that period. As mentioned previously, at this time, "beneficial use" does not include keeping water instream. The only exception so far is for improving habitat for native fish, as described in 2008 H.B.117, where interested parties such as Trout Unlimited (generally non-profits) can lease water rights from water right owners to protect such habitat. Based on current law, there is still risk that water in a river will be over-allocated, causing it to run dry in periods of drought.

BIOLOGICAL ANALYSIS

Over 170 years of" Western" or "European-influenced" civilization has completely transformed the landscape and ecology of the Upper Reach. There is growing concern over the dwindling population of pollinators such as native bees, butterflies, moths, and birds due to the continuing use of pesticides and reduction in native habitat caused by development in the form of residential, commercial, and industrial enterprise (Sánchez-Bayo & Wyckhuys. 2019). Wildlife such as beaver, bear, bison, elk, sandhill cranes, and native trout have disappeared from the Upper Reach. Non-native vegetation abounds in parks and gardens, and the large mammal population in the Upper Reach consists mainly of mule deer and domestic pets.

Flora

The native vegetation found in the riparian overbanks and uplands of the Upper Reach is described in Dettenmaier & Howe's (2015) pamphlet "Taking Care of Streams and Rivers in Cache Valley." This serves as a practical guide to plant selections for protecting riparian areas from erosion, decreasing river velocity, creating layered understories, and promoting native wildlife. The River Heights General Plan (2009) identifies eight significant plant species found in their riparian area, including:

Fremont Cottonwood (*Populus fremontii*),
Narrow-leaf Cottonwood (*Populus angustifolia*),
Water Birch (*Betula occidentalis*),
Dogwood (*Cornus sericea*),
Sandbar Willow (*Salix exigua*),
Willow species (*Salix spp.*),
Wild Rose (*Rosa woodsia*),
Choke Cherry (*Prunus virginiana var. melanocarpa*).

Parry (2019) mentions additional species used by the Shoshone for food and utensils,

including:

Yarrow (*Achillea millefolium*),
Sego Lily (*Calochortus nuttallii*),
Yampa (*Perideridia gairdneri*),
Wild Sunflower (*Helianthus annuus*),
Utah Serviceberry (*Amelanchier utahensis*),
Wild Mint (*Mentha canadensis*),
Sagebrush (*Artemisia tridentate*),
Horsetail (*Equisetum hyemalis*),
Cattail (*Typha latifolia*),
Thinleaf Alder (*Alnus tenuifolia*),
Quaking Aspen (*Populus tremuloides*).

These species provide both habitat and sustenance for micro and macro invertebrates and the fauna in the reach. They also contribute to erosion control and flood mitigation.

(Panels on pages 58 and 59).

Fremont Cottonwood - *Populus fremontii* Image: Wikipedia.com

Narrowleaf Cottonwood - *Populus angustifolia* Image: Medivetus.com

Water Birch - *Betula occidentalis* Image: Commons.wikimedia.com

Red Osier Dogwood - *Cornus sericea* Image: Mygardenlife.com

Sandbar (Coyote) WIllow - *Salix exigua* Image: Thompson-morgan.com

Wild Rose - *Rosa woodsii* Image: On the Wing Photography

Choke Cherry - *Prunus virginiana var. melanocarpa* Image: Garden.com

Yarrow - *Achillea millefolium* Image: Theoriginalgarden.com

Sego Lily - *Calochortus nuttallii* Image:SWbiodiversity.org

Yampa - *Perideridia gairdneri*
Image: Stanford.edu

Wild Sunflower - *Helianthus annuus*
Image: Edenbrothers.com

Utah Serviceberry - *Amelanchier utahensis* Image: Medivetus.com

Wild Mint - *Mentha canadensis*
Image: Commons.wikimedia.com

Sagebrush - *Artemisia tridentata*
Image: Gardenia.net

Horsetail - *Equisetum hyemalis*
Image: Thespruce.com

Cattail - *Typha latifolia*
Image: Amazon.com

Thinleaf Alder - *Alnus tenuifolia*
Image: Calflora.gov

Quaking Aspen - *Populus tremuloi-des* Image: Amazon.ca

Fauna

The large mammals present in the reach are limited to occasional visits by mule deer when forage is scarce. An occasional fox or beaver could stray from its current fragmented habitat, but such sightings are rare (personal communication with long-time resident in Hidden Village, 2019). Beaver activity in the reach would present a hazard above the Crockett Dam due to the probability of large driftwood getting lodged in the dam structure.

The Bridgerland Audubon Society organizes a Logan Christmas bird-count every year. Their findings have identified over 100 species on a given December day (http://www.utahbirds.org/cbc/cbc.html), with special mention of one park on the Upper Reach, the Denzil Stewart Nature Park. The River Heights General Plan (2009) identifies 26 avian species sighted within their municipal boundaries adjacent to the Logan River, including a pair of winter-roosting bald eagles. Efforts should be made to maintain the habitats necessary for their continued presence.

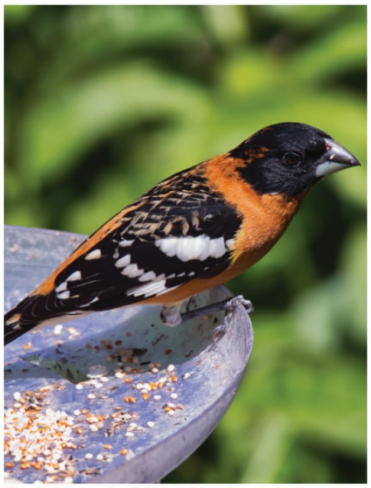
Of the fish in the reach, D. Weber (personal communication, May 25, 2020) states that he has noticed a decrease in whitefish with a parallel growth in brown moss, an indicator of riparian degradation. One of the reasons cited is the decrease in water flowing in the river, as observed after the Logan Hyde Park and Smithfield canal was piped in 2014, indicating more water was being taken from that diversion than before. The native Bonneville cutthroat disappeared with the damming of the river over 100 years ago. The river is now stocked with rainbow trout and German brown trout, which has naturalized in the Upper Reach. Pages 61 to 64 illustrate some of the fauna that can (could) be seen near the Logan River.

American Kestrel - *Falco sparverius*
Image: Wikipedia

American Dipper -*Cinclus mexicanus*
Image: Glenn Bartley

Bald Eagle - *Haliaetus leucocephalus*
Image: Wikipedia

Belted Kingfisher - *Ceryle alcyon*
Image: Terry Sohl



Black-headed Grosbeak - *Pheucticus melanocephalus* Image: Robinsrobins.blog

Cooper's Hawk - *Accipiter cooperii*
Image: eBird

Fox Sparrow - *Passerella iliaca*
Image: Wikipedia

Great Horned Owl - *Bubo virginianus*
Image: Robert Siegel

Hermit Thrush - *Catharus guttatus*
Image: allaboutbirds.org

House Wren - *Troglodytes aedon*
Image: Wikipedia

MacGillivray's Warbler - *Oporornis tolmiei* Image: allaboutbirds.org

Northern Goshawk - *Accipiter gentilis*
Image: Mark Hamblin

Red-tailed Hawk - *Buteo jamaicensis*
Image: Boreal songbird initiative

Rough-legged Hawk -*Buteo lagopus*
mage: Wikipedia

Rufous-sided Towhee - *Pipilo erythropthalmus* Image: Flickr

Sharp-shinned Hawk - *Accipiter striatus* Image: Peruaves.org

Barn Swallow - *Hirundo rustica*
Image: utahbirds.org

Townsend's Solitaire - *Myadestes townsendi* Image: utahbirds.org

Western Screech-Owl - *Otus kennicotti* Image: John C. Avise

Western Tanager - *Piranga ludoviciana* Image: National Audubon Society

White-breasted Nuthatch - *Sitta carolinensis* Image: Paul Higgins

White-crowned Sparrow - *Zonotrichia leucophrys* Image: Wikimedia

Wilson's Warbler - *Wilsonia pusilla* Image: Paul Higgins

Yellow Warbler - Setophaga (*Dendroica) petechia* Image: Wikipedia

Yellow-breasted Chat - *Flcteria virens* Image: allaboutbirds.org

Yellow-rumped Warbler - Setophaga (*Dendroica) coronata* Image: Jim Bruce

Sandhill Crane - Grus canadensis Image: UtahDWR facebook

American Beaver - *Castor canadensis* Image: Animalia.com

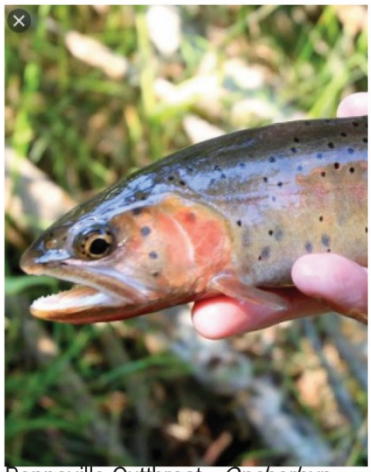
Mule Deer - *Odocoileus hemionus* Image: UTDWR.gov

Elk - *Cervus canadensis* Image: Cachevalleydaily.com

Coyote - *Canis latrans* Image: Myutahparks.com

Mountain Lion - *Puma concolor cougar* Image: Quora.com

Black Bear - *Ursus americanus* Image: Melinda Webster, UPR.org



Bonneville Cutthroat - *Onchorhynchus clarkii utah* Image: HJNews.com

Mountain Whitefish - *Prosopium williamsoni* Image: Mtpr.org

Brown Trout - *Salmo trutta* Image: Utahfishinginfo.com

Two of the biggest complaints about the river intervention performed along Riverside Drive in 2014 are related to loss of habitat. The cutting of trees and understory reduced bird habitat, and the channeling of the river made it more uniformly shallow, which reduced fish habitat. This and the fact that concrete-embedded boulders were used to reinforce the edges and placed randomly in the river's thalweg upset both fishermen and kayakers (Survey, 2019). Such interventions were at the heart of developing the Conservation Action Plan so that a more holistic and balanced approach could be applied to future projects along the reaches. These are issues that will be addressed in the design proposals.

CULTURAL ANALYSIS

The floodplain that is the Upper Reach has changed drastically with 170 years of permanent settlement. Human interventions have been influenced by paradigms, customs, traditional heritage, and policies that vary greatly from one another.

The Shoshone and Effects of First Contact with European Immigrants

The Shoshone cyclical lifeways of hunting and food-gathering with the seasons made them part of the ecological system. They were conscious of the need to harvest wisely to ensure future harvests (Parry, 2019), thereby ensuring that nature remained in balance.

With the arrival of fur trappers in the 1820s, this balance slowly shifted. Europe's demand for beaver, fox, and mink pelts took a toll on these populations countrywide. Beavers and their dams serve an important function in retaining water in the watershed by slowing it down and allowing it to percolate into the soil. From there, it is absorbed by

root systems, replenishes the aquifers, or reappears in springs further down the karst system. This natural, low tech water retention system causes water to flow longer in rivers and streams and has also been shown to protect areas from forest fires (Fairfax & Whittle, 2019) and erosion (Bailey et al., 2019).

The Shoshone traded with the trappers, and a rendezvous trading meet is recorded to have happened in 1826, but permanent settlement of the valley did not start until 1856 (Ricks 1956).

Figure 29. A Shoshone tribe posing in front of their teepees, late 1800s.

Settlement and Development

The first permanent settlement was established in 1856 when several families were directed by then Mormon prophet Brigham Young to locate suitable settlement sites in the Cache Valley. An attempt to ford the Logan River in 1859 was unsuccessful because of the dense willows and proliferation of beaver dams (Rhodes, 2001), but once

settlement began, the permanent population grew quickly. Logan City was formally established in 1866. Based on the 1891 survey (Figure 30), several features of the Logan River are evident. Meanders and branches, with extensive braiding forming small and

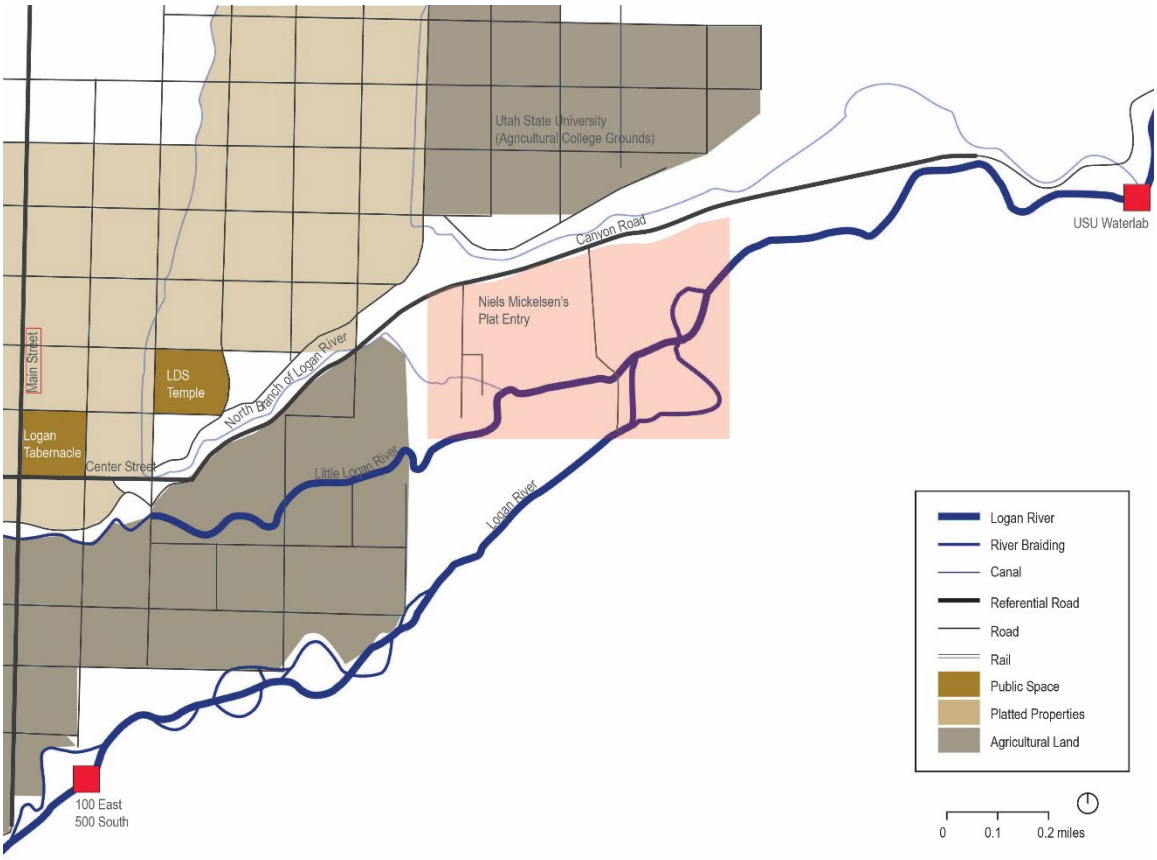


Figure 30. Illustration based on the 1891 survey of the City of Logan. Note the river braids.

large islands occur throughout the floodplain. The whole floodplain or Upper Reach was either platted (agricultural) or virgin land until the 1900s.

The plat system was based on the prophet Joseph Smith's plan for urban growth (Plat of the City of Zion, 1833), with a gridiron style layout in cardinal directions. Logan city blocks averaged a standard 660 feet in width and length for a ten-acre square block. Eight individual plots of 1.25 acres each made up each block and were intended for families to grow their own produce. Areas outside the municipal boundary were used for larger-scale farming and ranching to supply the community at large (Dolan, 2017).

Culturally, most of the settlers hailed from England, Scandinavia, and Northern Europe (Perlich, 2004). This explains both the agricultural practices and architecture used in the early development of the Upper Reach. As seen in the climate section, the average annual rainfall is 18", whereas in England and Northern Europe, the average is around 30". To make up for the difference in order to grow the crops they knew, irrigation was essential.

Water Distribution in the Upper Reach

The pioneers who settled in the valley used the Logan River as one of their main sources of water for irrigation. Canals were dug using multiple teams of horses and people to dig the trenches.

Figure 31. Digging the Logan Northern Canal.

The canal system required hard labor and coordination both in execution and in maintenance, as canal failures were frequent. Water masters oversaw the fair distribution of water rights. Because society was united around religious beliefs and respected ecclesiastical authority, it often fell on that leadership to direct the work. Trust in the system and faith in their purpose made it possible to move forward without depending solely on currency or immediate payment (Ricks, 1956; Deseret News, 08/08/1860).

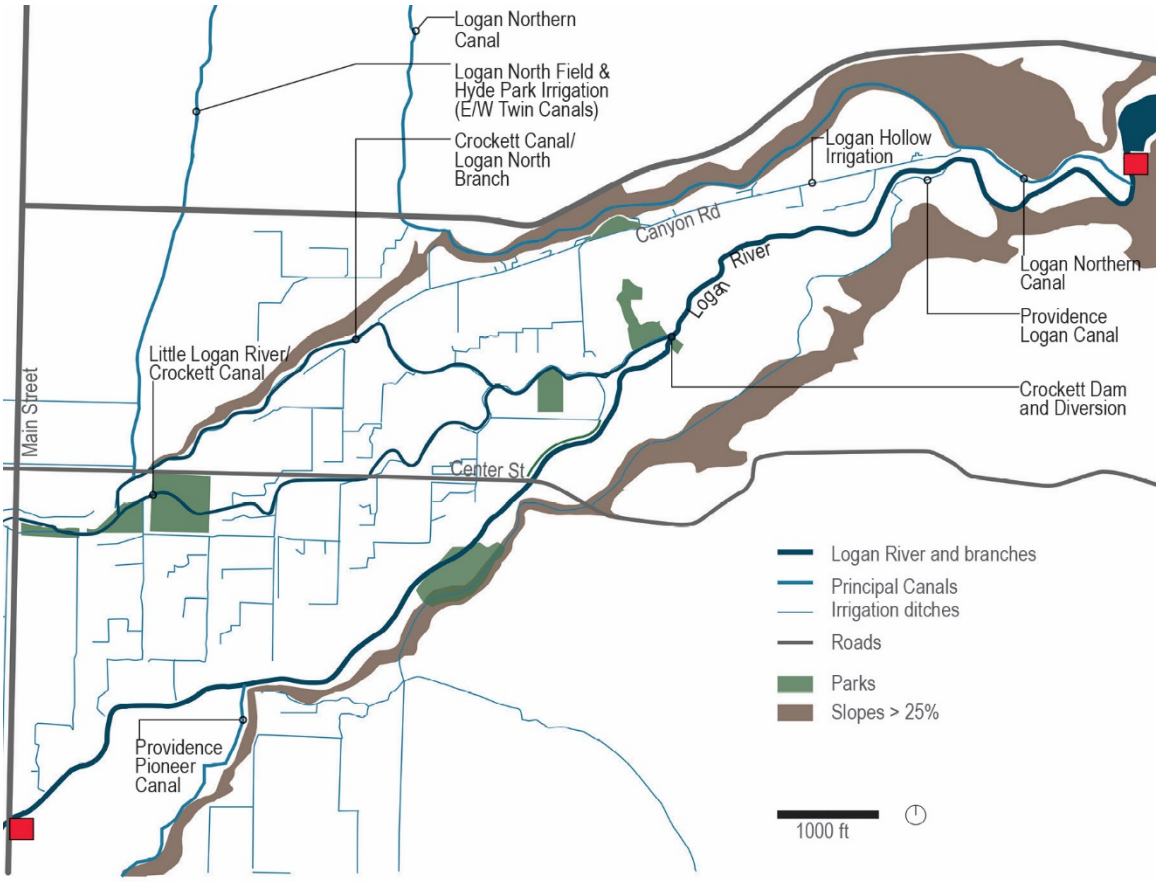


Figure 32. Diversion and irrigation ditches in the Upper Reach of the Logan River.

This united vision and strong work ethic enabled these early settlers to build the canal system that is still in operation. Figure 32 illustrates the irrigation canal and ditch system in the Upper Reach. Many of the irrigation ditches follow the original street pattern,

making access to the canals for maintenance and service easier. The irrigation channels or ditches spread out like capillaries from a main artery to serve the residents on the island and beyond. With overlapping development, service and maintenance became more difficult as new residences built over and around the pre-existing canals and ditches.

Figure 33. Providence Logan Irrigation Ditch going through newer residential properties.

Culverts are now required to keep seasonal irrigation water flowing, and current residents fear seepage or flooding, while the City and irrigation companies fear vandalism and liability for accidents. Figures 33 and 34 show parts of the Providence Logan Canal in the Hidden Village subdivision. The flood irrigation device in Figure 34 functions by placing a board or stop in the ridges shaped by the concrete or stone elements pictured, causing water to accumulate and overflow to the area needing irrigation.

Figure 34. Overflow irrigation device in the Providence Logan Irrigation Ditch.

Figures 35 and 36 show the river and canal systems as they evolved in Cache Valley.

Area of showing floodplain and boundaries with today's 100 East, 400 N (Hwy 89) leading into the Canyon, and the East Bench

Rivers and canals

This 1875 view clearly shows the braiding of the river as it emerges Logan Canyon and moves through the floodplain. The North Branch is diverted several times to accomodate mills and irrigation canals. The South Branch is the Logan River we know today. Note the absence of landmarks such as the temple and the Agricultural College (USU).

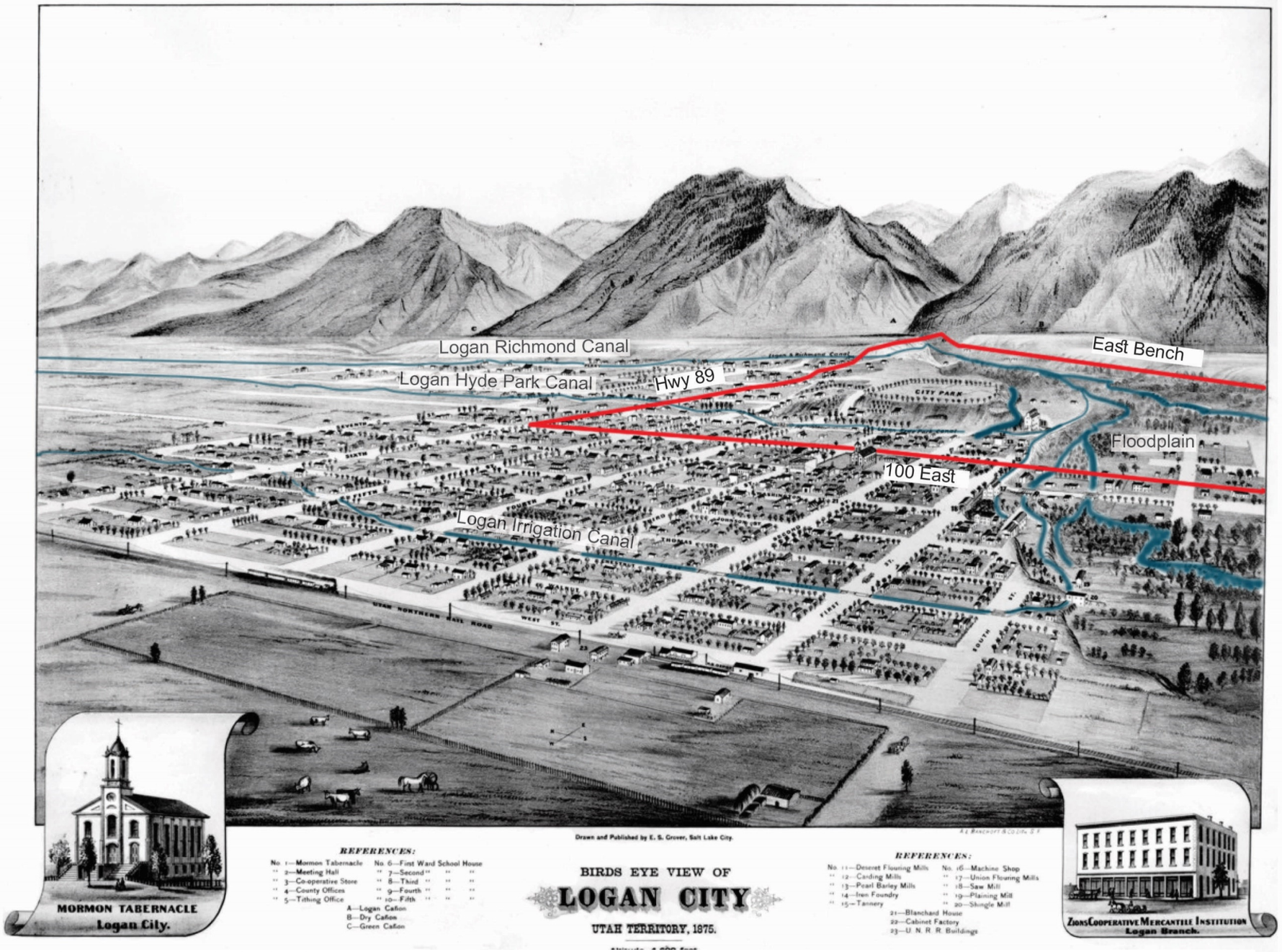
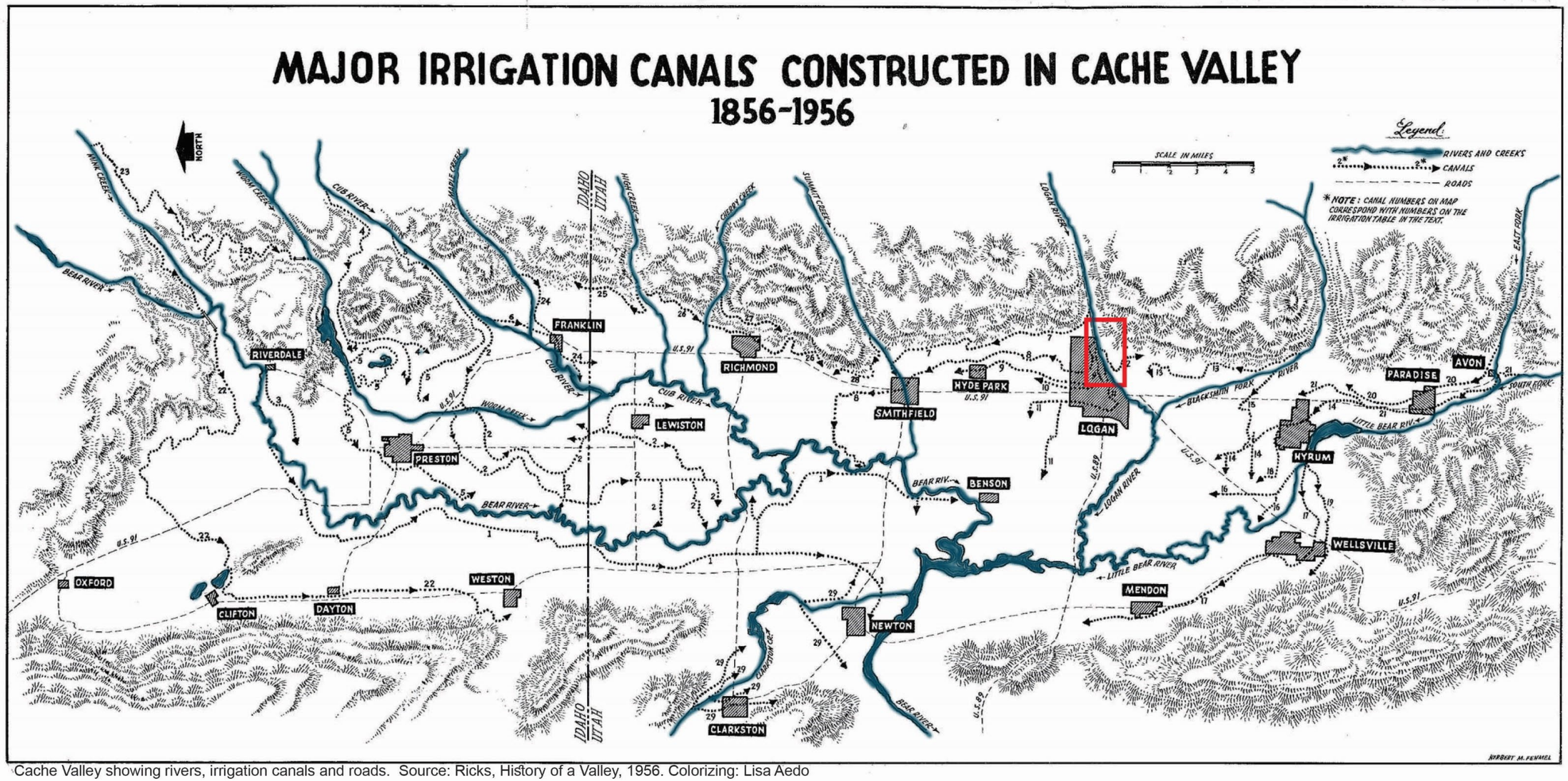


Image: 1875 Birds' Eye Map of Logan
Retrieved from: http://library.loganutah.org/archives/maps/BirdsEye.cfm
Color update: Lisa Aedo

Figure 35. Birdseye map of Logan in 1875. Grid pattern, river diversions and natural river braids in the study area are apparent.



Cache Valley showing rivers, irrigation canals and roads. Source: Ricks, History of a Valley, 1956. Colorizing: Lisa Aedo

Upper Reach; area of interest

Figure 36. River and canal system built in Cache Valley between 1856 and 1956.

Water Policy

Because Utah was a territory, territorial leadership was organized based on constitutional mandates, but as the population was predominantly religious, ecclesiastical leaders also performed those functions. This changed somewhat with statehood, as the state, county and municipal governments took over secular government functions (Simmonds, 2004; Ricks, 1965). The attitudes towards government and how the government functioned affected the river and Upper Reach indirectly, because water masters had the knowledge and experience that enabled them to control the distribution of water (Haws, 1965).

D. Weber is the current water master of the Crockett Diversion Canal and represents 10 irrigation companies with water rights who together serve over 400 water shareholders (personal communication, May 25, 2020). The surface water distribution system is based on Utah's pioneer-era law of "First in Time, First in Right," and "Use it or Lose it." Essentially this means that the person or entity that first claimed use of water for a property (no matter the distance from the water source), had the first right to its use, and if that entity did not use the water, it lost its right to use the water. Because weather and subsequent water flow could be unpredictable, the amounts taken were determined by time rather than volume. This meant that owners of water shares divided their use of water by turns to water their property, rather than by specific measures of water. In some cases, their turn to use water might occur at midnight. Every entity with a water right must respond to a water master who supervises the use of that water. In times of drought, shareholders low in the hierarchy may see very little or none of their share.

The Kimball Decree was established in 1922 to determine the water rights of the

Bear River and its tributaries (waterrights.utah.gov). New developments that have water shares associated with a property can cede those rights to the city in exchange for city water services. The accounting of how the "unused" surficial water is exchanged for city water is not very clear, as there is not yet a limit as to the amount of culinary water a user can use. The Utah Department of Natural Resources (UTDNR) publishes data on water use and determined in 2015 that Utah topped the nation in per capita use of domestic water (Milligan, 2015). With the surficial water provided for irrigation, the Kimball Decree stipulates the amount or share each shareholder is allowed, though supervising and managing that system is complicated and does not account for evapotranspiration and seepage. Until the late 1950s, the water delivery system was completely dependent upon the Logan River. As the population grew, demand for water exceeded supply, and a decision was made to obtain some of the city water from wells dug into the aquifers (Haws, 1965). This temporarily eased the supply problem, but it may have created a growing demand problem, wherein not enough consideration was given to the amount of culinary city water used for irrigating landscaping because few people were concerned as long as the hydrostatic pressure in the city wells were within acceptable levels. Daugs (personal communication, 2020) and Houser (personal communication, 2018) have stated that around 75% of city water currently used in the summer irrigates residential lawns and gardens. It is difficult, however, to gauge how much water there is and how quickly it is replenished. With continued population growth and a lack of water conservation efforts, this will become a serious issue in the future (JUB Engineers, 2013). While this problem is indirectly related to the Upper Reach, the system of which it is part is negatively affected by such use and is the cause for the diminishing water levels in the

Great Salt Lake (personal communication, P. Kelly, 2020; Wurtsbaugh, 2017).

Many farmers in Cache Valley continue to use the pioneer-age irrigation system. However, there is rising concern over insufficient water resources from the river for their irrigation needs near the end of the summer season. The water master for the Crockett Diversion, D. Weber, indicates that he can divert all but 5cfs from the Logan River into the Crockett Canal System should the need arise (personal communication, May 25, 2020). The only thing that keeps him from taking all the water is the 5cfs water right belonging to River Heights. This illustrates the predicament of the riparian ecosystem prevoiusly mentioned by F. Howe that a minimum of 60 cfs is necessary to maintain an acceptable level of ecosystem services in the Logan River. Anything lower would contribute to increased water temperatures, decreased oxygen levels, and a general degradation of habitat for the flora and fauna (personal communication, 2019). N. Daugs, manager of the Cache Water District, is promoting the possibility of replacing the current irrigation system from the Crockett Diversion with a piped system based on gravitational flow starting at the base of First Dam (personal communication, 2020). Such a system, he states, would eliminate seepage and evapotranspiration, and serve users (shareholders) with a system based on demand. For the Upper Reach of the Logan River this could mean a 30% increase in the streamflow (personal communication, N. Daugs, 2020). Residents, however, are concerned that the flora that has sprung up and flourished as a result of the historic canals and ditches will die as a result of this intervention (personal communication, H. Shugart, 2020).

Cache Water District is in the process of updating the Cache County Water Master Plan. There is concern that not enough data is available on flows, usage, seepage,

and evapotranspiration. The added effects of climate change and potential reduction in snowpack could result in increased flows or flooding in spring with subsequent summer drought. Getting to these numbers and understanding them is still an unrealized priority (Pace, 2019).

With a growing population, modifications related to water use will be needed, both in its distribution and our attitude toward its use. Historically, water use was prioritized for human consumption and irrigation; both used to sustain human life. Today most of the farmed products are not for local consumers, and the residential uses are more focused on aesthetic landscape maintenance than growing food for survival. The question is whether the system devised by the pioneers is still relevant for today's needs, or if our "needs" are only wants, and thus an expression of unsustainable attitudes promoted by consumer-centric lifeways. From a design perspective, runoff should be treated on-site and plant selections should favor native or climate-appropriate species.

Water for Residential and Recreational Uses

One of the objectives of the Conservation Action Plan is to promote river-related recreation, including opportunities for paddling. Based on consultation with members of the LRTF, the minimum discharge requirement for this activity is 250cfs. As seen on the hydrograph (Figure25), the average number of days within that threshold is only 66 days, from mid-April to mid-June. From a design standpoint, this means that launch sites should provide multiple options for enjoying and interacting with the river throughout the year, including wading, fishing, birdwatching, photography, sketching or simply nature-watching. These features need to be included in the vision plan and design proposals.

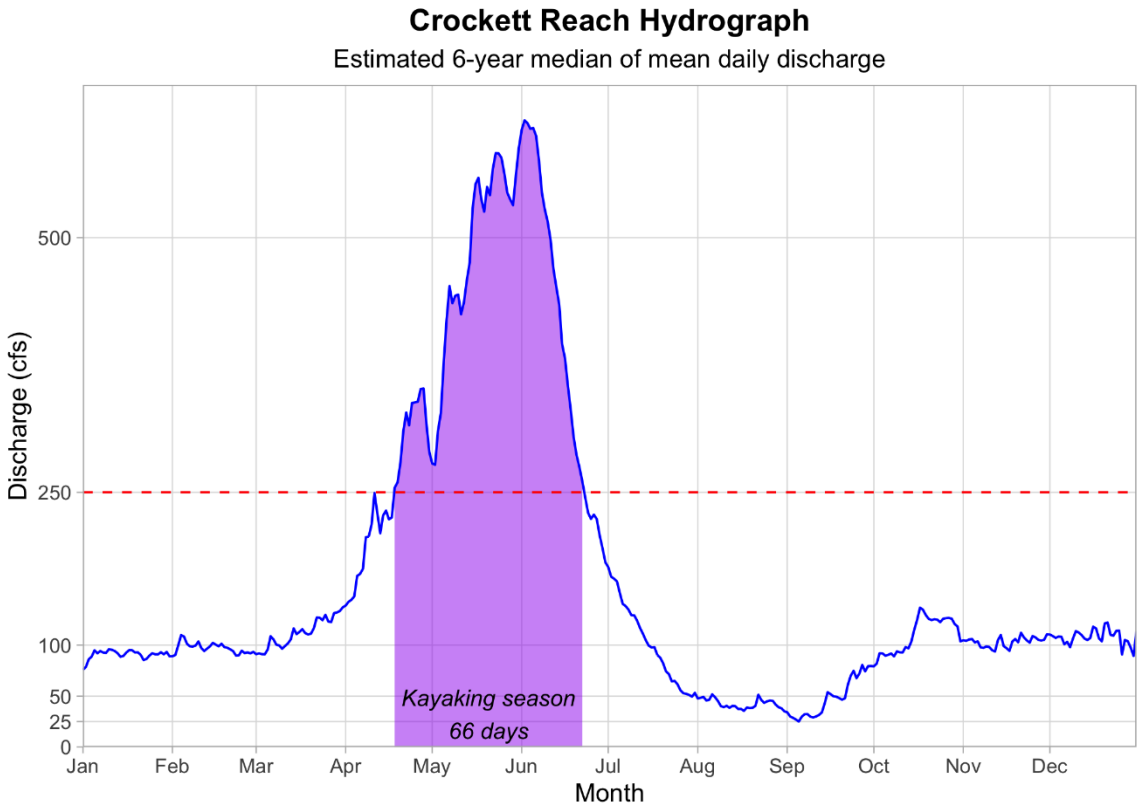


Figure 37. Hydrograph showing kayaking potential.

Growth and Development

From the time that permanent settlement took place in Cache Valley, roads and infrastructure were built to support human activities. Figure 38 outlines the gradual development of the Upper Reach. Figure 39 shows areas of specific activities realized in the Upper Reach floodplain. Fox and mink farming continued the fur trappers' legacy that gave rise to the name of Cache Valley, as indicated by C. Malouf, M. Jablonski, and D. Olsen (personal communication, October 2020). Note the bridges and diversion points, as well as the swamp area southwest in the reach. The historic braids in the river also help us understand some of the persistent challenges faced by some residents today.

Shoshone: ?-1826

Population 1826: (Seasonal) 100-500

Background:
Native tribes have lived on this land intermittently for over 10,000 years.

Lifeways:
The Shoshone foraged and hunted seasonally in Cache Valley. Transportation was on foot and by horse.

Relationship to the land:
The practice of burning was practiced to promote abundant growth of seed-bearing grasslands. For this reason, Cache Valley did not have many trees other than what grew in the riparian areas. For this reason, Cache Valley was known to them as "Willow Valley". They lived in symbiotic coexistence with nature, where resources were harvested and used only to the extent that regeneration was secured. The concept of land ownership was foreign to them, as all land was for the use of everyone (Parry, 2019).

Relationship to water:
The Northwest band was also known as "those who fish". The Logan River was known as "Crane river". Beaver were abundant and hunted for food and clothing as needed.

Trappers: 1826-1856

Population 1856: First permanent settlers

Background:
Peter Skene Ogden and Ephraim Logan were some of the early trappers who first made contact with the Shoshone.

Lifeways:
Trappers often worked for fur companies that offered compensation for beaver pelts and other fur. They would trap for beaver themselves, or trade for this with items such as guns, metal pots, beads etc. In 1826 a two-week "Rendez-vous" or trade meet between native tribes and trappers or "mountain men" was held in Cache Valley. A few years later changes in European fashion changed, causing the collapse of the fur industry.

Relationship to the land:
As pelts were collected, trappers stored them in hidden locations, or 'caches' (From the French "to hide"). This gave rise to the name of Cache County.

Relationship to water:
Neither trappers nor Shoshone were aware of the concept of extinction, though the beaver population was severely decimated by the fur industry. The beaver (we now know) helped detain runoff which protected streams from erosion and the loss of topsoil.

Pioneers: 1856-1896

Population 1900: 5,451

Background:
Directed by the Mormon prophet Brigham Young, pioneers arrived in 1856 to settle in Cache Valley.

Lifeways:
The pioneers came from various backgrounds, but were united in their faith to "build up Zion", a faith-based society with respect for leadership and adherence to religious principles. Unity and collaboration were hallmarks of their communities.

Relationship to the land:
Bringing techniques and practices from Europe, they started to organize the land into "plats of Zion" separated by wide streets. Each parcel was sufficient to provide produce to support a family. Fields for grain and grazing were developed, to the detriment of native species that previously fed native populations.

Relationship to water:
Diversion canals were dug to irrigate fields and provide water for consumption and industry. Several flour and sawmills operate in Logan. Principles of prior use and requirements for 'beneficial use' were instituted from the beginning. Logs for building were floated down the river.

Statehood & Modernism: 1896-1950

Population 1950: 16, 832

Background:
With statehood and new technologies, Utah opened up to greater influx of people and changes in lifestyles.

Lifeways:
Electric power generated from hydroelectric plants provide more energy for industry and domestic comforts.

Relationship to the land:
Farming, both individual and commercial, is the most common land use. With the GI Bill, WWII veterans receive greater access to education and home loans. Both drive population growth in Logan. Agricultural land on the Island is converted to residential bungalows.

Relationship to water:
More land is irrigated by both groundwater and canalwater. Knitting mills, sugar and molasses mills, shingle and sawmills powered by water, steam and electricity keep the economy going in Cache Valley. First Dam is built in 1911, providing Logan residents with power and electric light. With the end of WWII, the water use per capita increases, as homes increasingly have more than 1 bathroom.

Suburban Growth: 1950-2020

Population 2020: 52, 539

Background:
The baby boom and post-WWII federal programs boost growth at all levels.

Lifeways:
The industry dedicated to war is converted to the manufacture of household goods, automobiles and related infrastructure. There is a greater emphasis on consumerism, recreation and travel. Concerns about global warming and climate change increase.

Relationship to the land:
Suburban developments on cheaper agricultural land encourage growth beyond city limits. The East benches are developed. Malls and box-stores also foment an unprecedented increase in impervious surfaces. Car-dependence is a common problem. Open space is scarcer.

Relationship to water:
Canal maintenance is more difficult with growth of suburbs. Water demand increases with suburban turf aesthetic. The policy of "beneficial use" leads to over-allocation of water resources, where water quality decreases and riparian areas languish. Underground wells help ease shortage of surface water. Culinary water irrigates lawns.

Figure 38. Summary of population growth and lifeways in Logan and the Upper Reach from 1826 to 2020

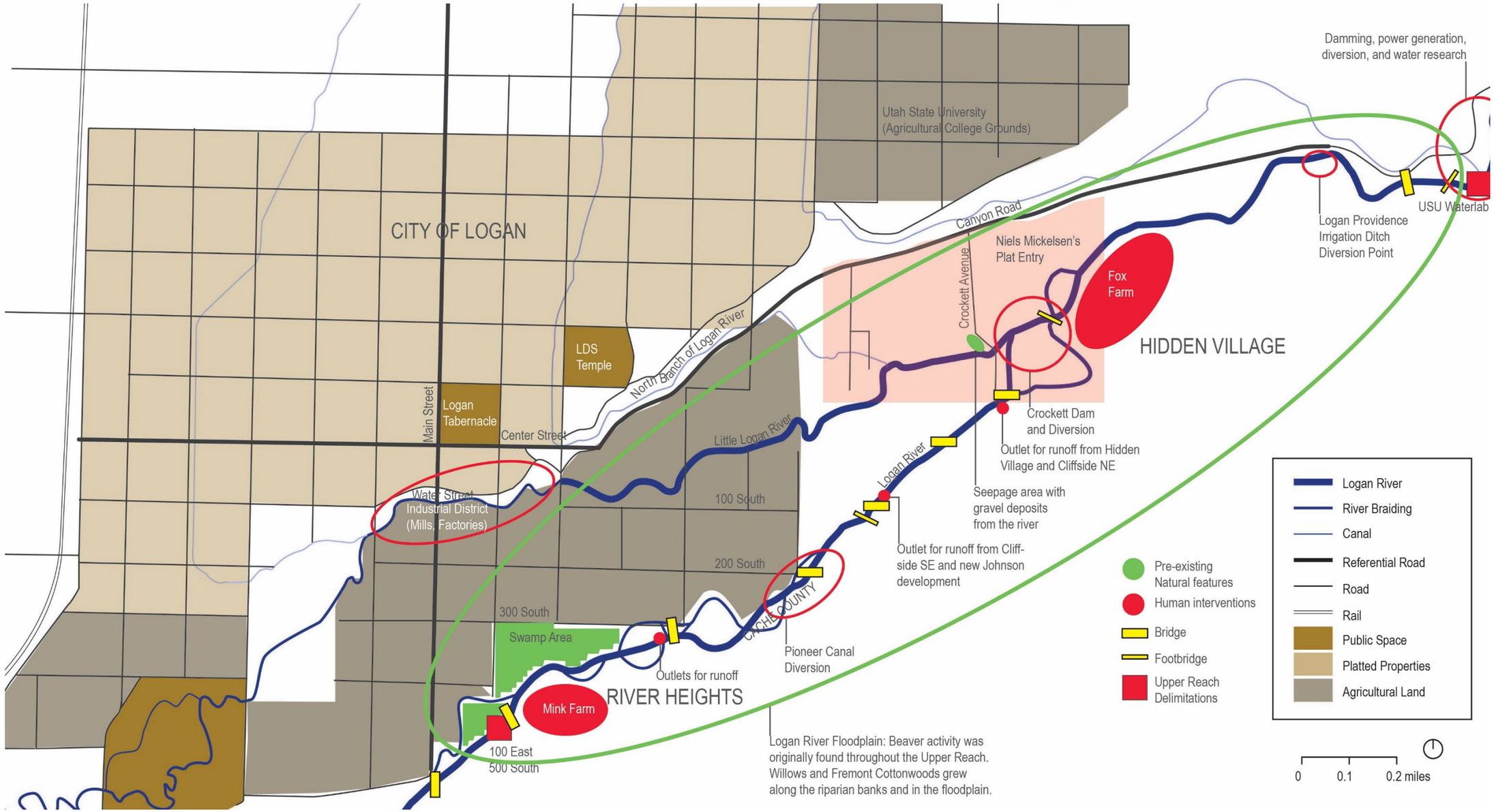


Figure 39. Different land uses and development realized in the Upper Reach floodplain.

Figure 40. Flooding of a Logan Mill, early 1900s.

As settlers arrived, structures to shelter people and industry were built with resources found in the area. Such resources included stone, lumber, and mud. The lumber was logged in Logan Canyon and floated down the river to be processed for building and manufacturing near the town center. Sawmills and flourmills used water diverted from the North Branch and Little Logan River to power the mills. Building near the river on the floodplain had its risks, as Figure 40 illustrates, with floods occurring typically in the spring as the snowmelt brought on peak flows. Between pioneer settlement, then statehood in 1896, and even up to the early 1950s, there was little urban development in the Upper Reach beyond the roadway extensions following the grid system in the plat of Zion format (Figure 41). The land east of the Logan River was not developed and only used for dry farming and pasture. As the population grew, the agricultural land in the city

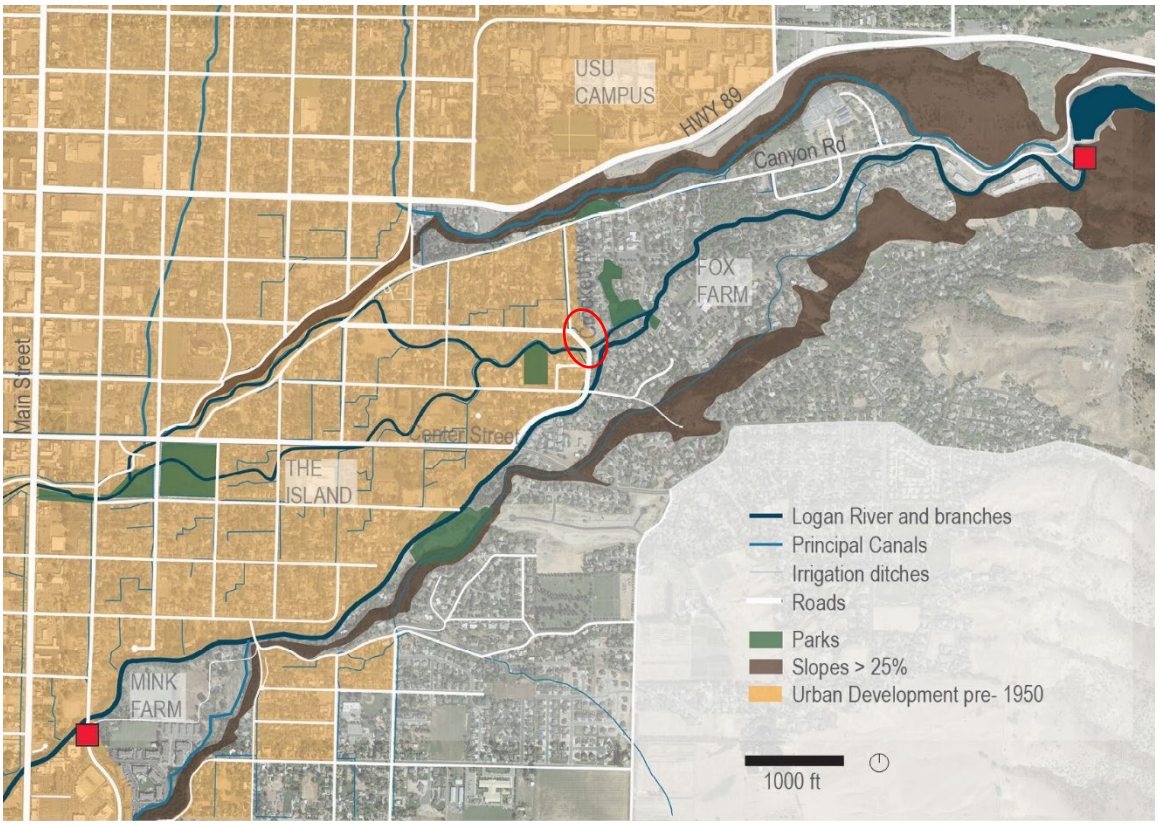


Figure 41. Logan showing Plat of Zion grid system before 1950. Note curve at Crockett Avenue (circled).

blocks gave way to small houses on properties reduced in size, but with the center block area dedicated to orchards and vegetable gardens. The grid pattern only changed when the topography changed, or a river needed to be crossed. Crockett Avenue, named after the first mayor of Logan, illustrates this. This North-South avenue veers East between 100 and 200 North to circumvent a spring and gravel deposit (Figures 41 and 42).

After World War II, there was a change in how land and roads were planned and developed. The proliferation of cars made it easier for people to live farther away from workplaces and commerce. This came with the added requirement of incorporating sufficient parking for the many activities residents engaged in, resulting in large swaths of heat-reflecting, impermeable pavement, which added to the problem of runoff and flooding. Water that would normally be absorbed into the soil now collected and gathered

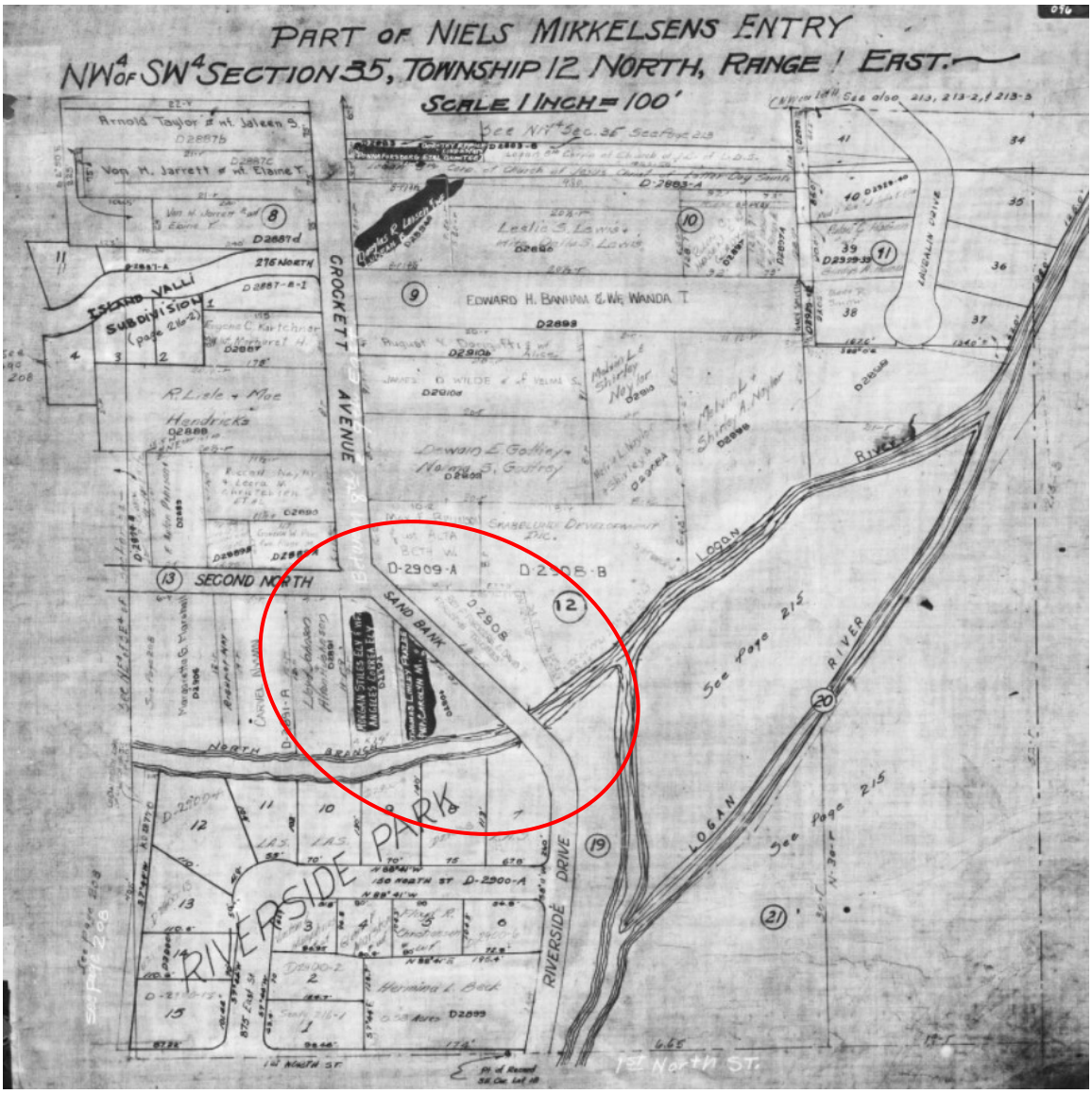


Figure 42. Showing Crockett Avenue interruption by sand bank on the North Branch of the Logan River. (Currently the Crockett Canal/Little Logan River).

in ways that could pose risks to residents and city infrastructure. Roads became more dangerous for pedestrians and bicyclists as automobiles took over the roadways. The cul-de-sac became a fixture of suburbia as part of an effort to design safer residential neighborhoods with less traffic. This also enabled developers to increase the amount of land for development rather than connect the streets. Euclidian zoning with separation of functions became the norm, isolating residences from commerce and industry, and promoting urban sprawl. As the population grew, urban and suburban areas expanded.

More technology, such as pumps to bring water up to the higher eastern benches where dry farming had been practiced, enabled their conversion to residential land. As part of this development, land was annexed into municipalities with the understanding that it would bring in greater tax revenues. The downside was that it also increased municipal maintenance costs.

Figure 43 shows this post-1950s type of development in the Upper Reach, as well

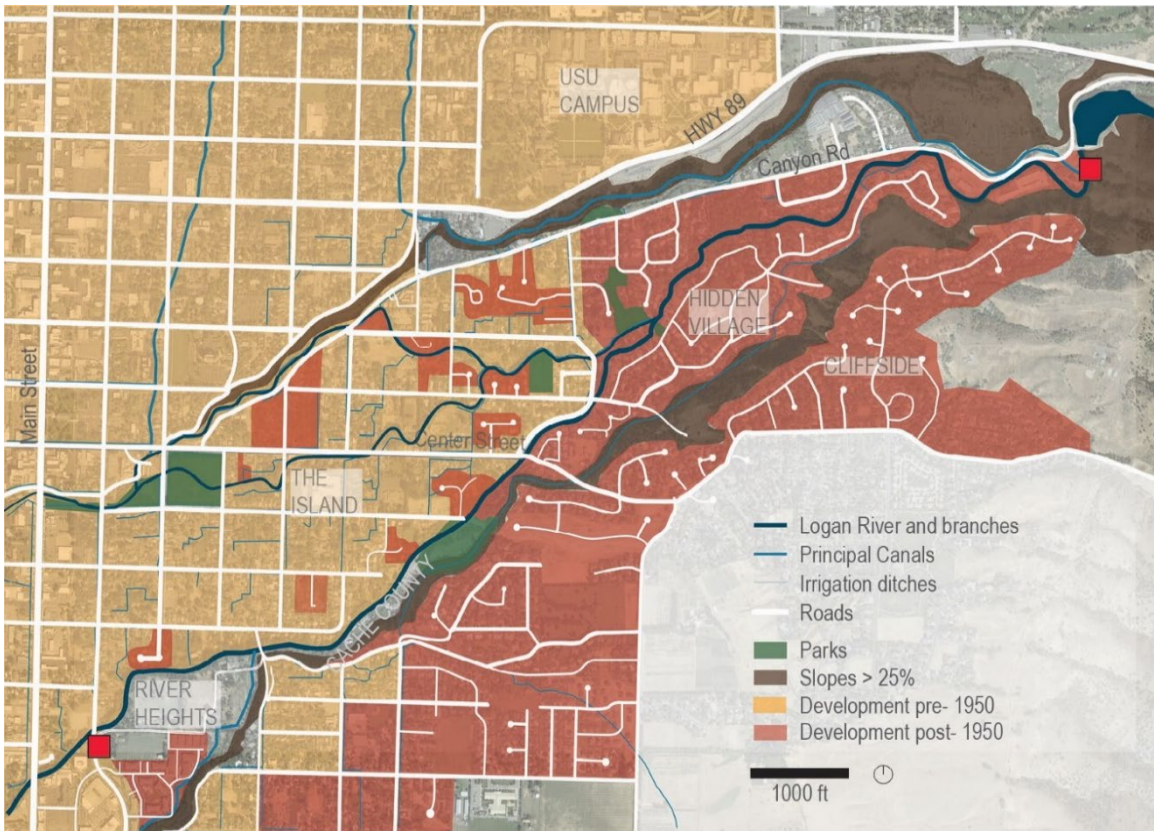


Figure 43. The red areas represent developments realized after 1950, showing a clear change in urbanization patterns with center-block infill, roads curving along contour lines and road offshoots ending in cul-de-sacs.

as the redevelopment of some of the center block areas (in red) on the former floodplain. With a more diverse job market, center block farming for sustaining families living around a center block decreased. Landowners realized it would be more lucrative to develop said land parcels and thus, small investment properties sprang up on the floodplain. More land became available to build suburbs once bridges spanned the river

at 100 North, Center Street and 300 South, with Hidden Village across from the 100 N bridge being one of the first, in 1961. The bridge across the Logan River at Center Street allowed development up the steep slopes to the historic shores of Lake Bonneville. Developments such as this often encroached upon the river, reducing public access and confining the channel to control flow and behavior. To counteract these negative effects, part of the purpose of this vision will be to find ways to give the Logan River greater relevance in the lives of its residents, as well as opportunities for the city to benefit from its ecological services.

Upper Reach in the 21st Century: The Residents

Based on surveys performed by the LRTF in 2016, and my survey (ANNEX II), residents are concerned about wildlife and nature. While walking trails close to property lines elicit fears of trash or vandalism, residents generally approve of in-stream recreation. Some residents on the left bank near the Crockett Diversion are within the 2011 FEMA flood zone and express concerns about flood risk and erosion. Bank stabilization efforts on the part of residents throughout the reach are eclectic, with some banks propped up by riprap or lined with hard edges that prevent the growth of native bank-stabilizing plants such as willows or water birch. Other edges are kept natural and adapt to the seasonal ebb and flow of the river. The variety of such interventions illustrates the diverse understanding and aesthetic preference or economy of landowners next to the river. It also indicates a lack of public policy regarding the treatment of riparian edges. With increasing concern regarding water and wildlife issues due to population growth and development, the LRTF strives to bring stakeholders together to

guide the conversation and help find solutions to both the insensitive treatment of habitat as well as Anthropocene concerns of flood conveyance, privacy, and individual aesthetics. Figure 32 illustrates current conflicts identified along the Upper Reach. My survey (ANNEX II) indicates that there is interest in keeping the river in a more natural state to preserve native flora and fauna.

The Upper Reach *is* the floodplain and has over the years of development since 1865 experienced human-induced changes that affect the ecologic and riverine performance as well as the health, safety and welfare of its residents. This is true from the perspective of the river, the residents and the city: The riparian environment and human society often seem to have conflicting goals or interests, yet society is dependent on the river and the ecosystem services it provides. This map represents the main current conflicts that exist between these voices.

1. **Erosion** at bend created by redirected river presents scouring and risk of landslide with consequent flooding downstream.
2. **Flooding** is normal in a floodplain, but development has placed residents in harm's way and requires interventions to mitigate the risk.
3. **Damming and diversion** has made it possible for permanent settlements to exist, but they also degrade the riparian environment.
4. **Gravel deposits** by the river, **seepage** and local **irrigation canals** conspire to create land formations that complicate **infrastructure** planning.
5. **Narrow bridge** is exposed to **seasonal ebb and flow.** 100 N is the only access to Hidden Village. **Runoff** from development degrades the water.
6. **Channelized river** and **riprap** deteriorate the ecology, increase the velocity and erosive force of the river presenting flood risk downstream.
7. **Cut-bank** erosion and historic low-laying wetland makes this an area prone to flooding. Residences are in a FEMA flood zone.

Figure 44. Map of Conflict areas along the Upper Reach

Upper Reach in the 21st Century: The River and the City

Much of the infrastructure put in place in the last century is aging and needing replacement or repair, as in the case of the access bridge to Hidden Village at 100 N, as well as the bridge at Center Street. The footbridge by the Crockett Diversion is also in need of updating and could be replaced by a service bridge like the one built at Denzil Stewart Nature Park. What happens to the Crockett Diversion itself is a question that goes beyond the Upper Reach, but several opportunities exist to make that area an interesting amenity that could go beyond benefiting just the local community. The Blue Trail would play an important part in making that a reality. There are also opportunities for trail connections near and along segments of the reach. Many of these possibilities depend upon the will of the residents as expressed through their participation in local government and responses to requests for public comment. The CAP will continue to be a guide and source of measurement with regards to progress made or not made. Currently, only the jurisdictions of River Heights and Cache County contain properties along the Upper Reach that could be considered rural. Of those, two properties in River Heights are currently for sale. This presents an opportunity as well as a threat. The opportunity consists of maintaining existing vegetation while providing public access and amenities that benefit the whole community. The threat is that economic motivation and municipal fear of opposition might allow development detrimental to both the ecology and community-building in the area.

With regards to water distribution and management within the Upper Reach, there is concern about water use and how the future might affect supply. As the survey (ANNEX II) indicates, piping water is not a popular proposition, and water-banking

allowing for a way around the "use it or lose it" principle in Utah water law is little understood. Educating the community about water use and providing a platform for comparison regarding secondary water use could be one option, but more options are needed. Rainwater collection and greywater irrigation could also be considered, but such irrigation methods are not currently part of best management practices (BMP) for solving secondary water demand. Multiple entities participate in the discussion. Table 1 illustrates the breadth of stakeholders and potential influencers on issues related to the Upper Reach.

The River (River Advocates)	**The Residents (Citizens of Logan and Resident Interest Groups)**	**The City (Government Authority)**
Logan River Task Force	Logan River Task Force	Logan City
Bridgerland Audubon Soc.	Bridgerland Audubon Soc.	Wilson Neighborhood Council
Trout Unlimited	Wilson Neighborhood Council	City of River Heights
Bear River Land Conservancy	Bio West	Bear River Association of Governments (BRAG)
Western Native Trout Initiative (WNTI)	JUB Engineering	Cache County
Western Association of Fish & Wildlife Agencies (WAFWA)	Cache Valley Historical Society	Cache Water District
The Nature Conservancy	Logan Canyon Hiking	Utah Division of Water Rights (State Engineer)
	Cache Hikers	Utah Division of Water Resources
	Cache Trails Alliance	UT Office of Outdoor Recreation
	Stokes Nature Center	Bureau of Land Management
	Utah Whitewater Club	National Forest Service
	American Canoe Association	Environmental Protection Agency
	American Whitewater	State Engineer

	Utah Stream Access Coalition	US Fish and Wildlife Service
	Utah Rivers Council	Army Corps of Engineers
	"Wild About Utah" (UPR radio)	Utah Division of Natural Resources (UTDNR)
	Utah State University	
	[Local Irrigation Companies]	
	[Farmers]	
	Daughters of Utah Pioneers	

Table 1. Stakeholders and Influencers

As has been observed, there are multiple issues facing the Upper Reach of the Logan River. Many of the issues are related to policy, such as the definition of "beneficial use" of water instream, including its distribution, transfer of water rights, and development policies. Addressing these is beyond the scope of this thesis. Other issues are related to physical actions in and along the river reach, including how we access the river, protect the riparian edges, treat its channels, and define its function in the floodplain. These can be addressed with planning and design. The next steps will be to review case studies with similar challenges to find inspiration and solutions to address each challenge. After this, the information acquired will be used to develop a program and develop conceptual designs to help illustrate possible solutions. It is hoped that these visualizations and designs will help illustrate what could be implemented in order to not only address the physical challenges , but also some of the social and existential challenges related to the river. Influencing either or both will require the advocacy of the Logan River Task Force and the voices of stakeholders.

CHAPTER V

CASE STUDIES

Francies (2001) defines a case study for landscape architecture as "a well-documented and systematic examination of the process, decision-making and outcomes of a project, which is undertaken for the purpose of informing future practice, policy, theory, and/or education" (p.2). For this thesis, the projects selected for case studies serve the purpose of informing research and analysis approaches with resulting projects and conceptual design proposals, illustration methods, and site selection criteria.

1. Portneuf River Vision Study (2016)

The purpose of this study is to create a "living plan…to restore the Portneuf River corridor in order to revitalize environmental, recreational, and economic opportunities while increasing community pride, connectivity and quality of life".

Project Name: Portneuf River Vision Study (https://river.pocatello.us/vision-study/)

Location: Pocatello, Idaho.

Date Designed/Planned: 2016

Size: Approximately 22 miles long, divided into four reaches (Figure 32).

Project Planning Team: The vision study was prepared by the US Army Corps of Engineers and representatives from the City of Pocatello under Section 22 of the Water Resources Development Act of 1974 (Public Law 93-251).

Consultants: The Vision Study Working Group, comprising neighborhood representatives and members of Bannock County, Idaho Department of Environmental Quality, Idaho Fish & Game, Idaho Power, ISU, Idaho Transportation Department,

adjacent Schools, Pocatello Planning & Zoning Commission, Portneuf Greenway Foundation, Portneuf Health Trust, School District 25, and non-profit organizations such as Simplot, Valley Pride, and Veteran's Memorial Building.

Figure 45. Portneuf River reach segments defined by different characteristics.

Process: Between 2015 and 2016, working groups inventoried existing conditions, assessed stakeholders, realized surveys, presentations, and Open Houses, and presented to City Council. The main topics that emerged from the community outreach were Water Quality and Ecosystem Health, and Recreation and Access. Based on these findings, the reach was segmented into four typological areas (Figure 45). These Guiding Principles were elaborated to help define the goals and recommendations for the Vision Study. Precedents and illustrations accompanied a more in-depth study of each reach, showing where projects related to specific goals could be realized. The segment most relatable to the Upper Reach of the Logan River is the Concrete Channel, which is severely confined and surrounded by older, pre-existing residences. The situation there is different in that the channel was constructed to hold 6000cfs at its maximum flow, which is double that experienced in the floods that gave rise to the Army Corps of Engineers' (USACE) intervention. Nothing so drastic has taken place in the Upper Reach, but it is the current process of how potential changes along this reach can be identified and converted into real projects that is of interest. Figures 46 and 47 express those locations.

After identification of the sites where projects that relate to the vision can occur, a hierarchy is established and selections further developed with photos, hand graphics and graphics software to illustrate the concepts.

The Portneuf River runs south to north, with the Levee Reach protecting southern farmland and downstream suburban areas from flooding. Lined by riprap and low-growing herbs, the levees offer little shade or habitat for fish and other riparian species. Corrections suggested include levee setback in areas with adjacent public lands, such as Centennial Park. Another proposal is to restore some of the historic river meanders cut

Figure 46. Levee Reach of the Portneuf River. Highlight of potential projects.

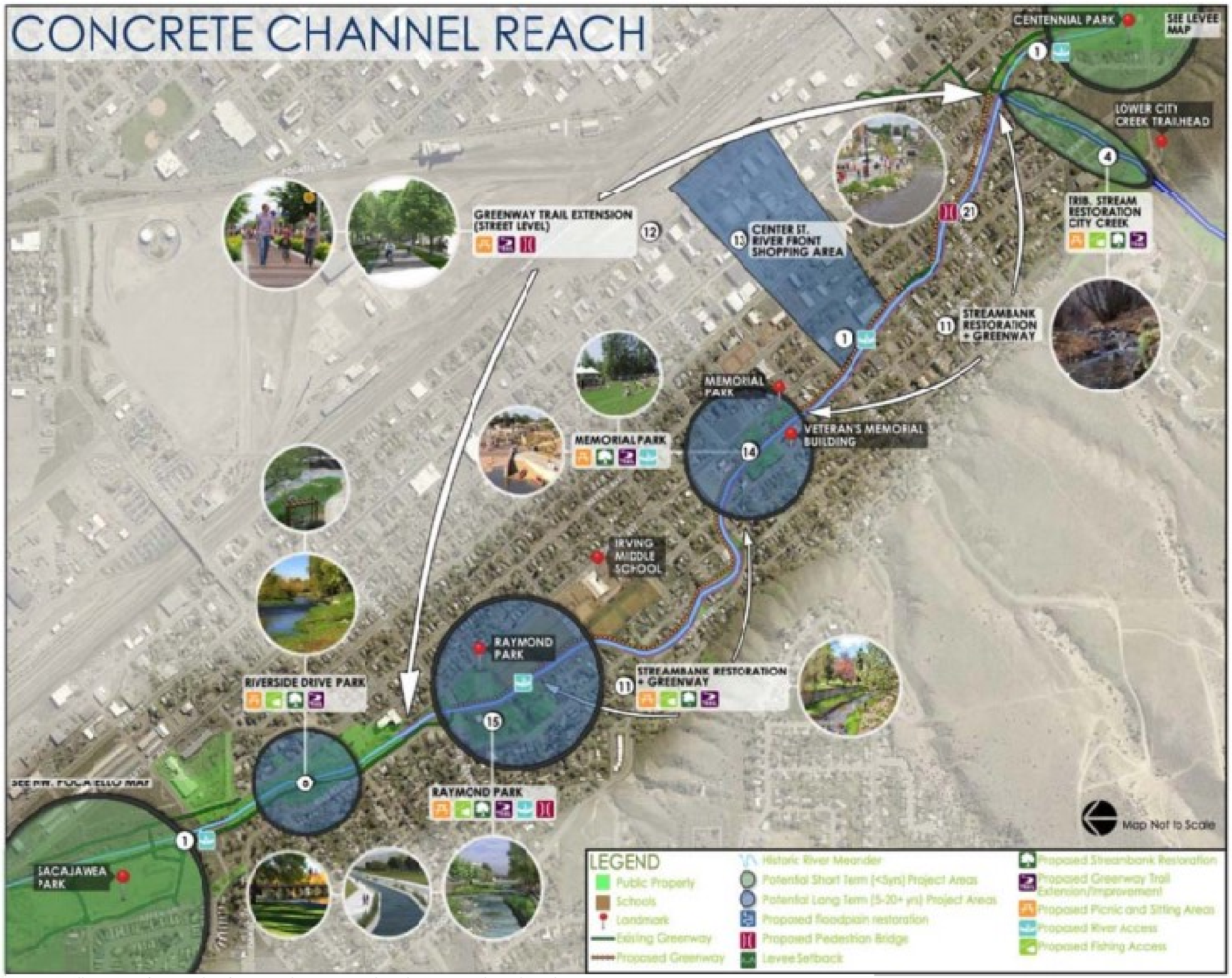


Figure 47. Illustration of project identification and connections along the Concrete Channel Reach.

off by the railroad to slow the flow and enhance habitat. Levee trails and point bar paddle access are also suggested as ways to improve social amenities along the river. The Concrete Channel completely cuts the river off from the urban center of Pocatello. Arguing that the 6,000cfs max design for a 500-year flood is excessive, the vision proposes reducing the design to 3,000cfs to allow for modifications that would improve visibility and some access points within the urban zone. One outcome of the vision study is the River Water Trail, helping people learn more about the river and highlight its tributaries and access

Figure 48. Map of Water Trail Concept.

points. This, combined with the first "Poky Paddle" event in 2019, is helping people re-connect with the river.

2. Jordan River Parkway – 2020 Jury Award, Salt Lake County Competition

Purpose: To "Re-envision a mid-valley section of the Jordan River Parkway, an urban greenway running through the heart of Salt Lake County, UT".

Project Name: Weave

Location: Jordan River, Salt Lake County, UT.

Size: 3.5 mile streatch of river divided into 5 segments

Landscape Architect(s): Loci (SLC) and Blalock & Partners (SLC) Participants: McKenna Drew, David Durfee, Michael Budge, Jennifer Lindley, Dugan Frehner, Kelly Garfield, Chad Parker, Sean Baron, Brian Backe, Kevin Blalock.

Client/Developer: Salt Lake County

The Jordan River and Logan River face similar challenges, including diversions, channelization, degraded ecology, multiple municipal jurisdictions, lack of connectivity to the river, etc. The objective of this competition was to generate design proposals that would present "an integrated, comprehensive development strategy linking residents and visitors to an ecological corridor and recreation destination, setting the stage for long-term community health and economic stability" (Figure 49).

The five main components required of the winning design were to define, restore, elevate, activate and inhabit the corridor. I was impressed by how the title of the proposal, "Weave," summarized the interrelatedness of the components and directly responded to the need for such integration, encompassing social connectedness with

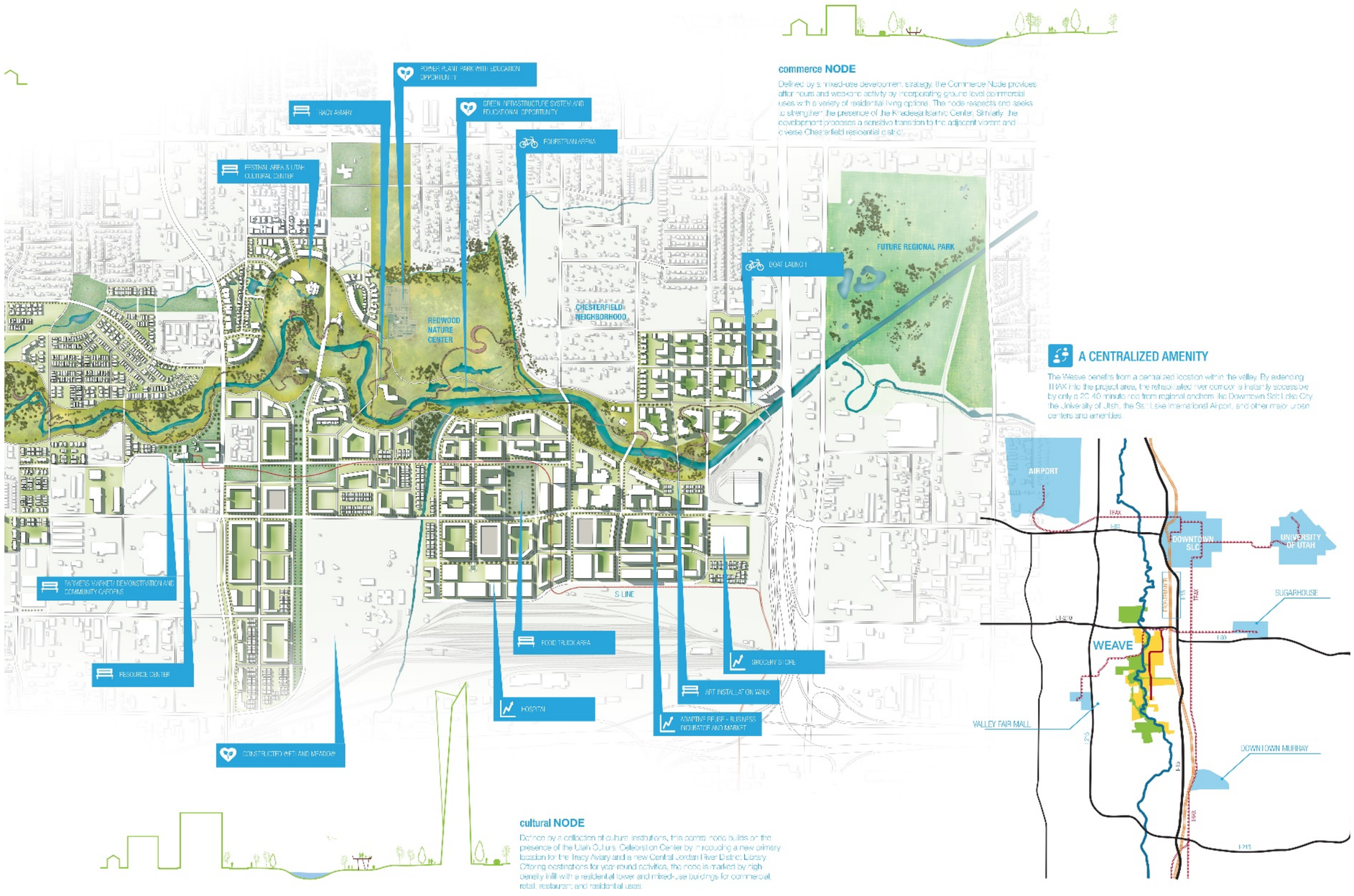


Figure 49. WEAVE proposal –Loci and Blalock & Partners, winning entry of the Jordan River Parkway competition.

ecological and economic improvement. The design clearly illustrated how the components came together. It provided suggestions for design elements and social interaction with the river along the reach, as well as clear circulation outlines to organize harmonious development.

3. Hoosic River Revival

Location: North Adams, Massachusetts

Completed: 2015

Size: South Branch: 1.2 miles of which 0.5 miles served as pilot project

Landscape Architect(s): Mark Dawson, SASAKI

This project presents conceptual (Figure 50) and diagrammatic proposals (Figure 51) to solve problems related to flood control based on channelization. It provides social and recreational amenities while ensuring connectivity to existing circulation patterns. The diagrams help explain the functionality of the proposed river modifications. While this reach is challenged with industrial-era floodways, its confinement still relates to the confinement of the Upper Reach of the Logan River. The North Adams solutions are based on best management practices (BMP) and listening to a diverse group of stakeholders, with emphasis placed on social interaction around the river, access for fishing and paddling, nearby ball fields, and connecting trail systems around and across such fields. The illustrative diagrams are very clear in showing how the interventions will solve or improve the current issues facing the river: with an expanded, vegetated river channel, floodplain function and access are improved.

Another aspect of the design is the seamless integration with existing circulation

infrastructure. This offers transportation options for people getting around the city.

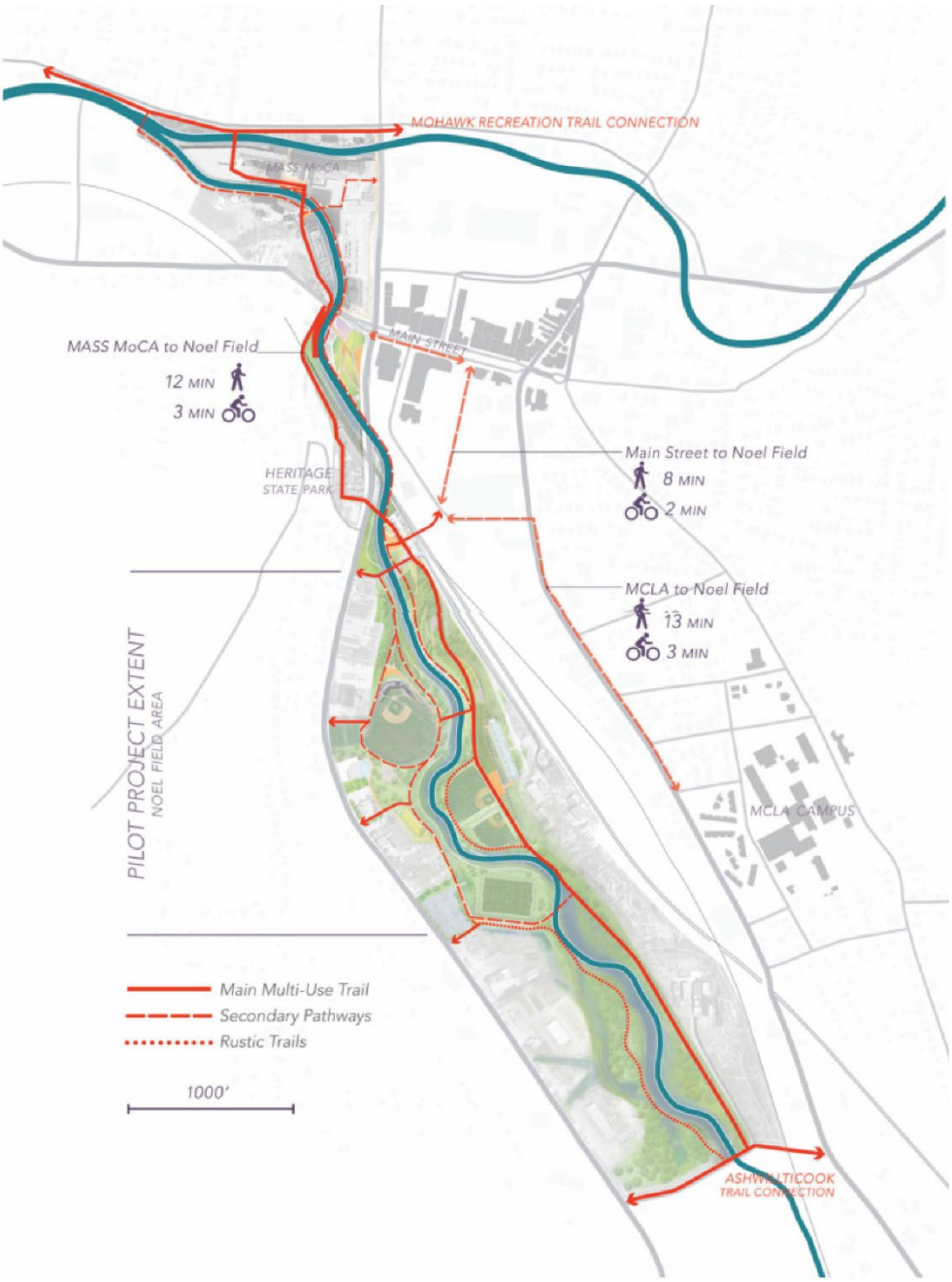


Figure 50. Schematic design proposal for the Hoosic River Revival.

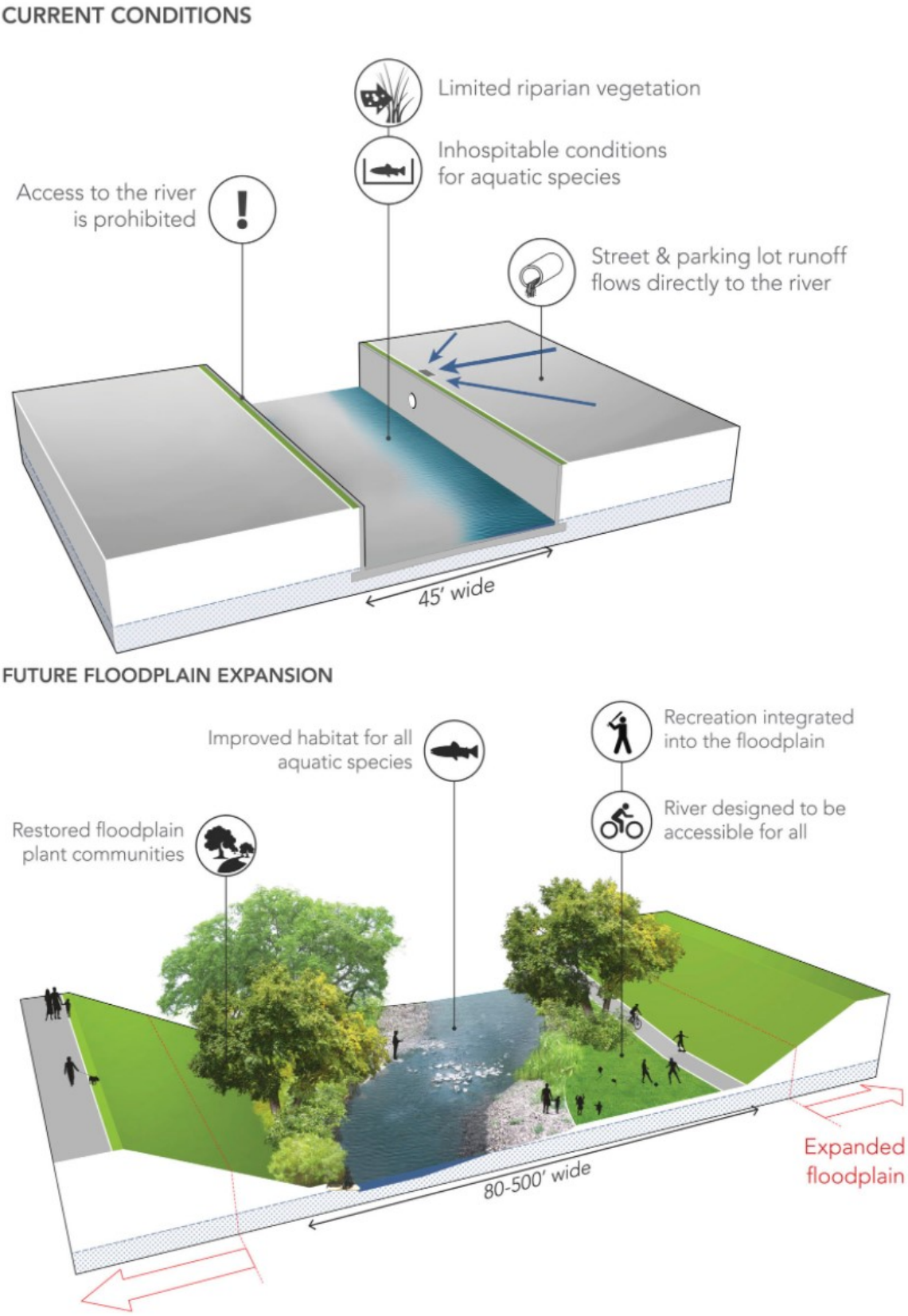


Figure 51. Current and Projected Future conditions of the river channel.

4. Truckee River Whitewater Park at Wingfield

Location: Reno, NV

Construction cost: $1.5MM

Size: 2,600 feet

Landscape Architect(s): Gary Lacy, Recreation Engineering & Planning, Boulder, CO

Design team: Kennedy Jenks Consultants

Contractor: Cruz Excavating, Inc., Incline Village

Client: City of Reno

Management of River Bottom and Banks: State of Nevada

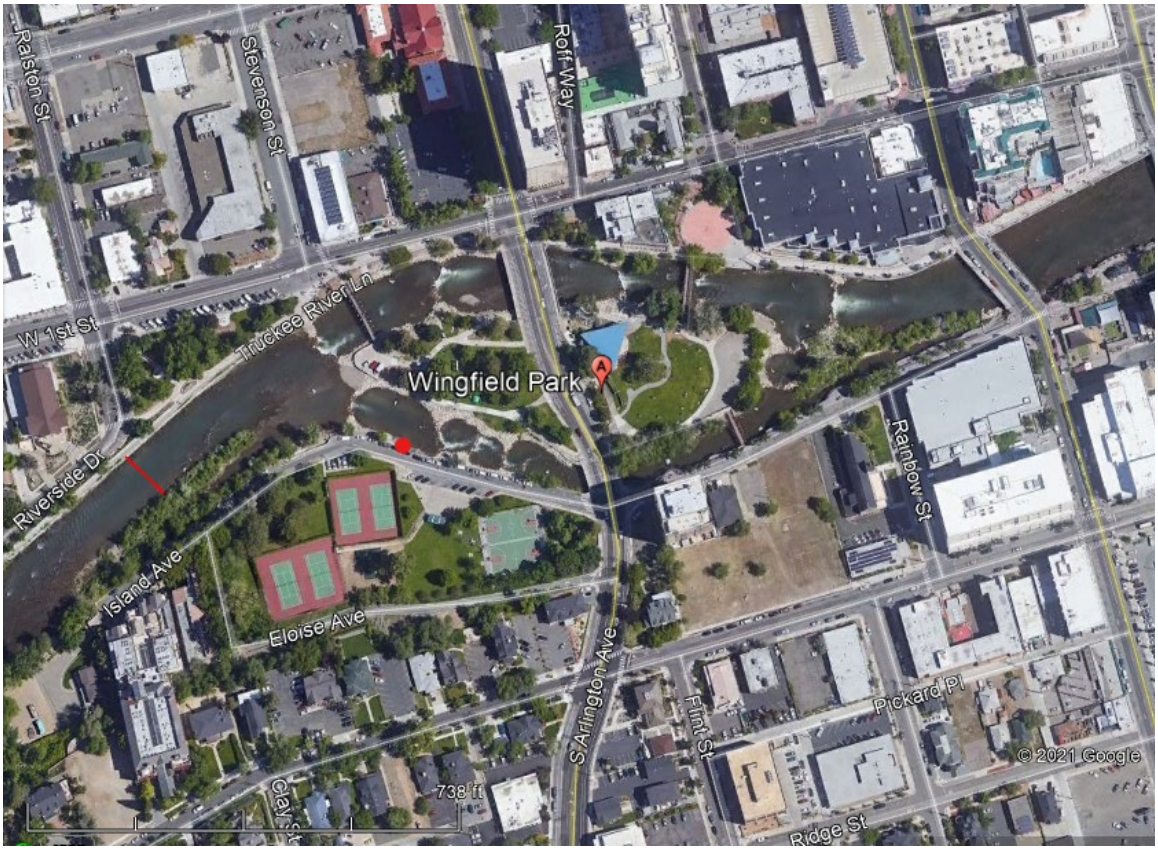


Figure 52. Location map: Wingfield Park, Reno, Nevada. Source: Google Earth Pro

This project interested me because of the recreational aspect of river renovation.

When I visited in 2018, it was obvious that this river was used and enjoyed by the community. On the August evening when I visited, people swam and waded in the river

Figure 53. Truckee River Whitewater Park By: Author

as others sat on the boulders looking out over the scenery. (Red dot on location map, Figure 52, indicates vantage point, looking downstream). There were also people walking along the riverbank and parallel sidewalk. The reconstructed area of the river consists of weirs for whitewater experiences for paddlers of all abilities, in addition to naturalized riverbanks with areas for people to wade and swim. Because the width of the river is around 90 ft (see red line on location map, Figure 52), there are more opportunities to create play features.

Case Study Commentary

In all the case studies, the rivers faced similar problems of historic floodplain interventions and riparian habitat reduction with reduced public access to the river. Some distinguishing factors related to the Logan River are its smaller width and flow when compared with the others. The prevalence of residential properties in the Upper Reach also makes it unique, illustrating the diversity of conditions facing every river. However, the ecological and social concerns are still the same: improved water quality and habitat for native flora and fauna, together with access and recreational amenities. Solutions and design approaches are dependent on local conditions and the expressed will of local stakeholders, which include the city and the residents. While ecologists are best equipped to address water quality and ecological concerns, landscape architects and planners best incorporate social concerns into land use policies. Therefore, collaboration would be the best approach to obtain the most successful results in urban river projects. The following chapter speaks to this process as it attempts to synthesize the information obtained about the Upper Reach and the expressed concerns of stakeholders and government organizations.

CHAPTER VI

SYNTHESIS AND DESIGN PROPOSALS

The Vision: A Confluence of Visions for Holistic Sustainability

From the outset, the intention of this thesis has been to gain an understanding of the interests or perspectives of the three main stakeholders of the Upper Reach: the River, the Residents, and the City, to better develop a holistic set of guiding principles applicable to the design of potential projects along the reach. Figure 19 attempts to summarize the principles most representative for each stakeholder. The River "speaks" for the ecological system to which it belongs and which it helps create; the Residents are embedded in today's human-created system of economic survival where a person's preference and financial capacity are the parameters of action upon the landscape, and the City responds to the will of Residents through elections and funding through taxation, all while conforming to statutory laws regarding its actions. The ultimate goal is to incorporate all three voices in order to achieve a holistic sustainability which satisfies the preferences of each. To what degree are human preferences naturally

Figure 54. Value Proposition for the Upper Reach.

sustainable or dictated by fashion, economic limitations, or dictums from higher up the governmental hierarchy? Where is the bottom line? What are the "givens" or assumptions upon which a holistic and sustainable design can be achieved?

The following SWOT analysis (Table 1), based on information gleaned from the analysis and literature review, attempts to distil these perspectives. Several observations can be made in relation to conflicting and harmonious relationships, for example, the river's strength when following natural laws dictated by its gravity-driven movement may represent a challenge in planning for the city and a source of concern for residents whose houses are built too close to the river's edge. In this case, understanding cause and effect with regards to variability in volume and energy flow is a requirement to avoid conflict.

Similarly, from the river's perspective, due to its human-induced weakness of separation from its floodplain and subsequent course redirection, the river can present a threat to residents when conditions that go beyond human calculations (assumptions) occur. One example exists at the sharp meander originally created east of the USU Water Lab to allow for infrastructure to be built (Project Proposal 1). In this case, the meander creates a cut bank that erodes into the steep hillside, creating ideal conditions for a landslide which would interfere with the river's flow and potentially create flooding and debris flows downstream.

Another example would apply to all and relates to whether there is water sufficient for stakeholder needs. With continuing population growth, limited supply, and an insatiable demand to satisfy standard of living expectations, there is increased risk of irrevocably depleting the resource as a whole without a better understanding of the river

system's capacity to provide for these increased demands. Connected to this is always the complication of coordinating different jurisdictions to align with a collective policy for working with the river. The opportunity exists to develop a more widespread and profound knowledge of this limited resource in order to become better stewards of it.

The following SWOT (Table 2) analysis provides the foundation for the Goals and Design Principles which in turn creates the basis for the design proposals. In terms of locating opportunities where projects can happen, these are based on existing or potential public properties adjacent to the river or properties that are strategically located and potentially available for certain types of development. Tables 3 to 6 illustrate the goals derived from the SWOT analysis and their evolution towards a scope, showing projects that could help advance the goals. This is further developed into program elements for the specific area around the Crockett Diversion. Following this is an evaluation matrix based on how well each proposal responds to the theoretical framework presented in the literature review as well as the twenty-two goals expressed in the Conservation Action Plan elaborated by the Logan River Task Force (Table 7).

SWOT ANALYSIS OF THE UPPER REACH OF THE LOGAN RIVER FOR EACH STAKEHOLDER GROUP TO OBTAIN A BASIS FOR DESIGN SYNTHESIS				
Attribute	Criteria (From https://www.wordstream.com/blog/ws/2017/12/20/swot-analysis)	FROM THE LOGAN RIVER (ECOLOGICAL) PERSPECTIVE	FROM THE RESIDENT AND USER (SOCIAL and ECONOMIC) PERSPECTIVE	FROM THE CITY (POLICY) PERSPECTIVE
Business/ Purpose relevant to		Conduct water from high point to low point while offering services for "beneficial use."	Recreation and irrigation	Represent constituents and serve as provider of statutory services to residents
Industry		Natural Resource provider	Consumer	County and Municipal Government services
Market		Environmental, Residential, Business, Municipal & Industrial services	River/Water Services	Cache County, City of Logan, River Heights City; visitors
STRENGTHS	Things it does well Qualities that set it apart Unique resources Tangible assets	• Provides water to flora and fauna in and around streambed. • Follows natural, predictable laws (gravity, path of least resistance, response to temperature and silt/debris accumulation). • Can infiltrate soil and replenish the subterranean and aquifer systems. • Seasonal expansion/contraction of flow offers unique habitats for greater diversity of flora and fauna. • Affords opportunity to study water quality, flow, and other characteristics. • Adaptability to altered streambeds.	• Provides irrigation water to shareholders. • Offers opportunities to experience and learn about riparian ecosystem up close. • Provides recreation opportunities for paddling, fishing, hiking, reflection. • Tempers extreme seasonal temperatures. • Proximity to river in the Upper Reach increases property value (Zillow.com) • Amenities around river enhance aesthetic appeal.	• Replenishes water into aquifer used by municipalities. • Enhances livability. • Provides increased tax revenue through increased property values. • Provides an outlet for runoff.
WEAKNESSES	Things it lacks Things competitors do better Resource limitations Unclear unique proposition	• Encroachment of the floodway by development and channel alterations. (LRTF). • Lack of connection between river and its floodplains (LRTF). • Lack of space for channel migration when accumulations of sand/gravel occur (LRTF). • Backwater and flooding impacts caused by Crockett Diversion (LRTF). • Materials used for bank stabilization fail and accumulate in the channel (LRTF). • Modified edges reduce flora & fauna habitat and diversity.	• The Upper Reach lacks visibility and engagement with the public. • Lack of understanding about how rivers function within natural context. • Lack of interest /opportunity to understand the Logan River and its form/function in history. • Cultural successions have broken links to the history and identity of the Upper Reach.	• Tendency of river to move around with different loads on floodplain poses difficulty in development planning. • Shared jurisdictions (River Heights, Cache County, Logan City, Cache Water District, UTDWR, UTDNR, USACE) complicate management of river issues. • Lack of precise measurements of use, need, inflow and outflow throughout the system prohibit a clear vision of priorities and future projections. • Balancing environmental requirements, residents' wishes, and policy frameworks is complicated and time-consuming. • Funding for proposals to support projects related to the Upper Reach is scarce and applying for them is time-consuming.

OPPORTUNITIES	Underserved markets for specific products Few competitors in your area Emerging need for products and services Press/media coverage of your company	• Creation of the LRTF gives it a "voice". • Collaboration can help improve the CAP indicators. • An educated and engaged task force can garner support and funding for projects that improve the river and associated habitats. • There is an opportunity to improve the measurement of water needs/use with reference to its origin (well or surface flow) so that a more constant flow can be obtained that includes system-wide environmental factors in "beneficial use." (i.e. ensuring sufficient flows to the Great Salt Lake).	• Improved facilities and infrastructure can improve access and user experience. • Appropriate treatment of river and riparian edges may improve aesthetics, safety, and value. • Opportunities to learn while using the river can foster greater appreciation and care for the river and its functions. • Greater precision in measuring flows and real need can help project available resources more precisely. • With growth and changing demands, opportunities exist to improve transparency, collaboration and problem-solving between all stakeholders.	• Logan City and Wilson Community Council are interested in improving connections to the river. • The Blue Trail proposal was approved by the City Council. • River Heights is interested in developing trail network and park adjacent to river. • Possibility to link history and heritage of the reach with local programs, including arts, education, infrastructure, growth planning, etc. • There is an active arts community that is interested in placing more meaningful art in public spaces. • Trails and outdoor experiences are promoted and funded by the UT Office of Outdoor Recreation. • Some nonprofits have goals that align with government objectives. • Opportunities exist for greater collaboration around the Upper Reach. • With growth and changing demands, opportunities exist to improve transparency, collaboration, and problem-solving between all stakeholders.
THREATS	Emerging competitors Changing regulatory environment Negative press/media coverage Changing customer attitudes toward its activities	• Elimination of surface flow in Little Logan River and North Branch of the Logan River will deteriorate their riparian edges and ecology. • Need for minimum flow to protect habitats and enhance amenities is not currently considered in state policy. • Infrastructure and riprap hamper fluvial functions. • Water is wasted on landscapes ill adapted to local climate. • Climate change presents uncertain future. • Increased growth without reduction in demand is a present and future threat. • Agricultural and irrigation shareholder interests demand more water than the river can offer sustainably, despite decrease in agricultural lands due to development.	• Water shortage due to misuse or climate factors • The river's energy and load can result in erosion or flooding. • Lack of understanding or interest about river processes can damage riparian areas. • Focused interest groups can skew process toward singular interests without considering whole. • The misuse of public spaces can ruin outdoor and riparian experiences for the whole community. • The Little Logan River (i.e., Crockett Canal) and North Branch of the Logan River are no longer considered a natural part of the Logan River system and could be eliminated with the piping of the Crockett Canal.	• Ability to provide enough water for demands • Unintended consequences of a secondary irrigation piping project of the Little Logan River. • Siltation presents maintenance challenges. • The river's energy and load can result in erosion or flooding in areas that would compromise infrastructure and developed areas. • Lack of understanding about river processes can damage riparian areas. • The misuse of public spaces increases operation and maintenance costs. • Lack of precision and respect for laws in accounting for water flows create imbalances and conflicts in water distribution.

GOALS and DESIGN PRINCIPLES

The River:
Improve Riparian Ecology

The confinement and diversion of the river has reduced its capacity to provide the ecosystem services required for a healthy ecological balance. Hard, bare riparian edges and impermeable surfaces eliminate the absorptive qualities of natural surfaces, promoting runoff, flooding and species succession.


1


2


3


4

Increase summer base flow and oxygen levels
Decrease summer water temperature
Increase stock density of salmonids
Increase natural condition of riparian areas
Improve floodplain function

The Residents:
Increase Recreation & River Access

Residential development along the river and a historic emphasis on agriculture and property rights has closed off public access to the river in most areas. With decreased access to the river and understanding of how the resource is used, preservation of it is also at risk. Access to it and engaging in activities around it promotes health and understanding.


5


6


7


8

Increase trail connectivity
Expand navigability
Improve public river access
Expand public spaces and facilities
Expand outdoor recreation options for all ages
Preserve heritage

The City:
Manage Flood & Infrastructure

Given the mandate to protect citizens and enhance the community within the constraints of a balanced budget, the government and related agencies work with the residents to find the best solutions to present and future challenges such as flood or drought mitigation, infrastructure repair and development, effects of climate change and resource management.


9


10


11


12

Reduce flood risk
Improve infrastructure
Protect natural resources
Promote outdoor recreation
Balance hydric resource for appropriate needs
Serve all constituents

Table 3. Goals and Design Principles Derived from the SWOT analysis.

The River: Improve Riparian Ecology

1. Increase summer base flow and oxygen levels
i. Increase the number of beaver dams higher up in the watershed
ii. Improve efficiencies in irrigation for agriculture and secondary use
iii. Obtain a complete picture of how much water is used, from where and by whom
v. Determine quantities needed for basic activities vs. wants
vi. Show water users the comparative amounts of water they us

2. Decrease summer water temperature
i. Vegetate riparian edges with local-appropriate species to provide shade
ii. Prepare deep pools in strategic areas along riverbed
iii. Increase base flow

3. Increase stock density of salmonids
i. Improve habitat conditions
ii. Increase macroinvertebrate population
iii. Reduce pesticide and herbicide use near riparian edges

4. Increase natural condition of riparian areas
i. Use native and location-appropriate plants whenever possible
ii. Use natural stream-bank features such as boulders or gravel instead of riprap
iii. Use plants with deep roots to help stabilize riverbanks

5. Improve floodplain function
i. Promote municipal codes that protect riparian edges and increase easements whenever possible
ii. Provide guidelines for best practices to landowners with riparian edges

The Residents: Increase Access, Recreation and User Education

1. Increase trail connectivity
i. Identify and support areas that have the space and goodwill of landowners for a trail connection
ii. Provide the amenities that maintain successful trails, such as trash receptacles, benches at strategic locations, shade, and maintenance services
iii. Design trails that connect strategic connections or landmarks, such as schools to parks; river edge to services, ADA parking near concrete paths etc.

2. Educate users and protect private property
i. Establish a riparian neighborhood watch to communicate and coordinate principles to be followed
ii. Coordinate with city to develop and place signage in appropriate places
iii. Encourage schools to include civics, understanding and respect for nature and local features as part of outreach efforts

3. Improve public river access and navigability
i. Provide designated areas for access with appropriate amenities such as parking, signage, appropriate launch ramp and ADA equipment, restrooms, etc.
ii. Ensure pedestrian trails connect to river access areas
iii. Remove obstructions from thalweg
iv. Work with professional paddlers when designing and placing features in the riverbed
v. Execute annual reviews of river conditions with regard to navigability

4. Expand public spaces and facilities
i. When developing or redeveloping new properties, favor the use of open space for community benefit
ii. Develop Fox Farm Launch and Council Circle with the children at Riverside Preschool in mind

5. Expand outdoor recreation options for all ages
i. Include amenities for all ages and abilities in park and open space design

6. Preserve heritage
i. Work with art councils and local artists and designers to make visible and promote the local heritage of the place as a legacy to future generations
ii. Promote the education about the local, pluralistic cultures we have acquired from nature, native peoples, and immigrants
iii. Add educational water feature to River Hollow Park

The City: Manage Flood and Infrastructure

1. Reduce flood risk
i. Raise the berm level at Fox Farm Road to prevent spillover from river at high flow
ii. Create a braid at River Heights property that diverts and detains water at high flow
iii. Modify city codes to mandate permeable surfaces wherever feasible, including parking lots and roads
iv. Use park strips and urbanized public areas as bioswales to collect water that sustains aesthetically pleasing raingardens or trees

2. Improve infrastructure
i. Replace undercut bridges at 100 N and Center Street with longer-span bridges that accommodate pedestrian underpass
ii. Replace the concrete channels in the Crockett Area with terraces that allow for natural ebb and flow of river while also supporting native flora and fauna
iii. Replace Crockett dam with a safer, more efficient inflatable weir as per January 2014 construction drawings
iv. Replace Sumac Park footbridge with a 14 ft wide bridge that goes directly from Sumac Park to Lauralin cul-de-sac via River Hollow Park to allow for emergency egress should bridge at 100 N fail

3. Protect natural resources
i. Plant native, locally adapted species in public spaces
ii. Promote the use of native, local species in landscaping
iii. Promote the use of rain gardens and permeable hard surfaces to mitigate runoff

4. Promote great communities
i. Adopt policy of including sidewalks and adopting trail connections as required amenities for new developments
ii. Promote development and responsible use of trails with signage, trash receptacles and adequate maintenance

5. Balance hydric resources for appropriate needs
i. Seek ways to promote climate-appropriate use of water
ii. Participate actively in conversations about resource use

6. Serve all constituents
i. Define who the constituents and stakeholders are
ii. Develop a complete, holistic understanding of their needs
iii. Ensure all constituents' needs are understood and addressed

Table 4. Elaboration of Specific Elements to Be Considered in Design Based on Design Goals and Principles.

BUILDING A HOLISTIC AND SUSTAINABLE VISION FOR THE UPPER REACH

FOCUS ON CROCKETT PLAY AREA

Scope

◊ Increase egress options from Hidden Village

◊ Replace undercut 100 N Bridge with longer-span bridge that allows river to breathe and provides space for river access

◊ Realign Crockett Ave to allow for longer bridge

◊ Correct channeling issues such as thalweg obstruction and pool/ripple areas along Riverside Drive

◊ Replace Crockett Dam structure with flexible structure that improves operation, allows paddle passage and reduces risk of obstructions

◊ Replace concrete channels with vegetated, native riparian edges

◊ Convert River Hollow Park into a park that connects the public with the river, its history and local flora and fauna. This includes providing the following amenities:

* Wading area
* Put in/Take out
* Access to Botanic Garden Island
* Native botanic garden
* River wave observatory
* Features that allow for play and learning about the river heritage and links to its past
* Sufficient parking areas for public access to parks
* Open space

◊ Create parking and take-out at Denzil Stewart Nature Park

Design Principles

- Promote education about history, culture and environment
- Vegetate riparian edges with local-appropriate species to provide shade
- Prepare deep pools in strategic areas along riverbed
- Emphasize multi-story and appropriate diverse vegetation
- Use native when possible
- Use natural stream-bank features such as boulders or gravel instead of riprap
- Recycle materials when possible
- Use plants with deep roots to help stabilize riverbanks
- Connect trails with parks or other gathering places
- Public spaces should be ADA accessible to the extent possible
- Highlight cost efficiencies

Table 5. Scope and Design Principles for the Crockett Area.

Program (Scope) Development for the River, the Residents, and the City:

River

a) Educate the public about the importance of conserving water and how to do so (info panels)
b) Vegetate riparian edges with local-appropriate species to provide shade
c) Prepare deep pools in strategic areas along riverbed
d) Improve habitat conditions
e) Use native and location-appropriate plants whenever possible
f) Use natural stream-bank features such as boulders or gravel instead of riprap
g) Use plants with deep roots to help stabilize riverbanks

Residents

a) Identify and support areas that have the space and goodwill of landowners for a trail connection
b) Provide the amenities that maintain successful trails, such as trash receptacles, benches at strategic locations, shade, and maintenance services
c) Design trails that connect strategic connections or landmarks, such as schools to parks, river edge to services, ADA parking near concrete paths, etc.
d) Remove obstructions from thalweg
e) Provide designated areas for access with appropriate amenities such as parking, signage, appropriate launch ramp and ADA equipment, restrooms, etc.
f) Ensure pedestrian trails connect to river access areas
g) Develop Fox Farm Launch and Council Circle with the children at Riverside Preschool in mind
h) Add educational water feature to River Hollow Park

City

a) Raise the berm level at Fox Farm Road to prevent spillover from river at high flow
b) Create a braid at River Heights property that diverts and detains water at high flow
c) Use park strips and urbanized public areas as bioswales to collect water that sustains aesthetically pleasing raingardens or trees
d) Replace undercut bridges at 100 N and Center Street with longer-span bridges that accommodate pedestrian underpass
e) Replace the concrete channels in the Crockett Area with terraces that allow for natural ebb and flow of river while also supporting native flora and fauna
f) Replace Crockett Dam with a safer, more efficient inflatable weir as per January 2014 construction drawings
g) Replace Sumac Park footbridge with a 14 ft wide bridge that goes directly from Sumac Park to Lauralin cul-de-sac via River Hollow Park to allow for emergency egress should bridge at 100 N fail
h) Plant native, locally adapted species in public spaces
i) Promote development and responsible use of trails with signage, trash receptacles, and adequate maintenance

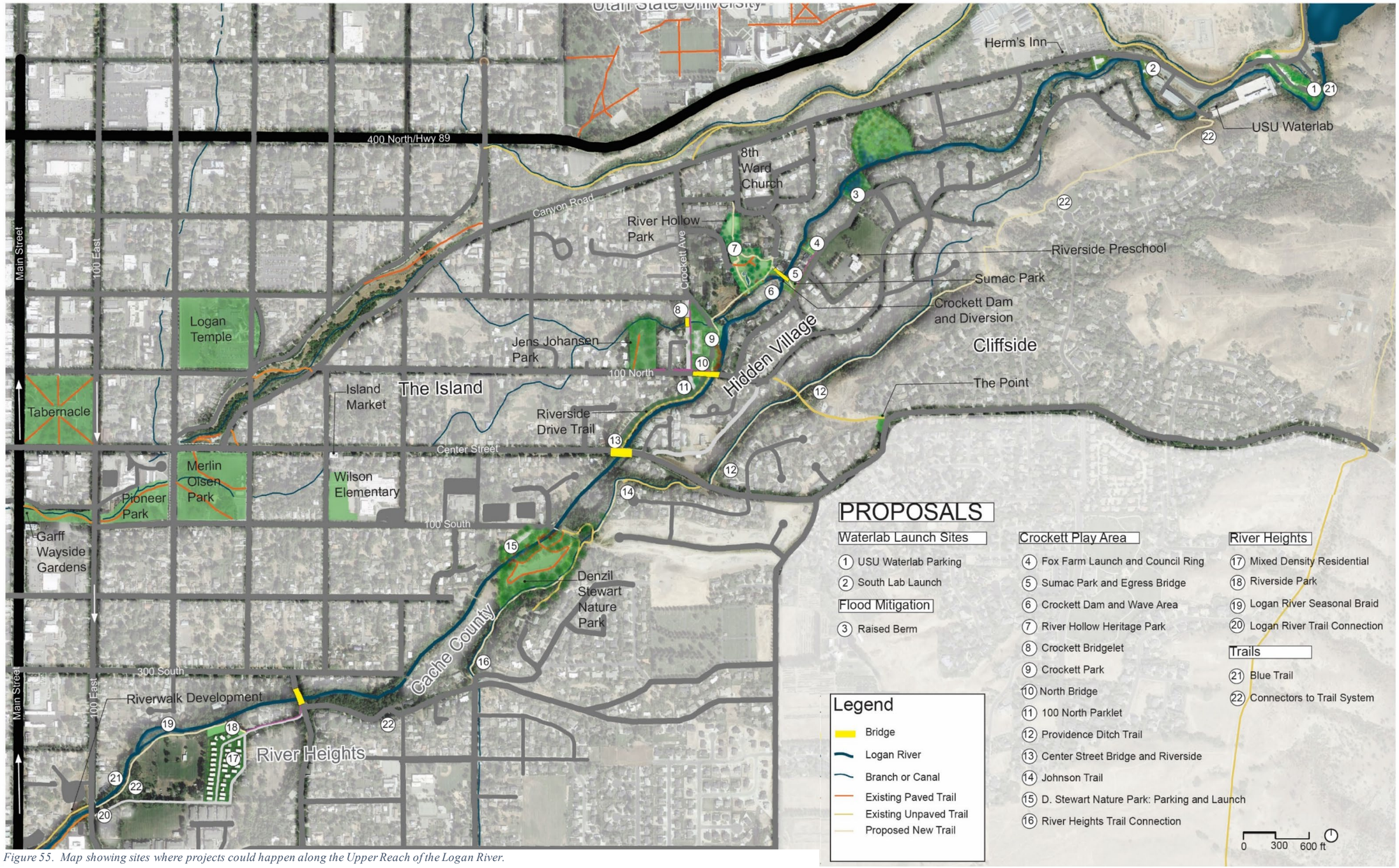


Figure 55. Map showing sites where projects could happen along the Upper Reach of the Logan River.

CONCEPTUAL FRAMEWORK FOR VISIONING LOGAN RIVER'S UPPER REACH

Area		Project number and description	Property Owner	USR Rating*		Conservation Action Plan (CAP) Goal Alignment (Whether proposal can make a difference)																					
				Ecological	Societal	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20*	21*	22
Waterlab	1	USU Waterlab Parking	USU	2	4	---	---								---												---
Launch Sites	2	South Lab Launch	USU	3	4	---	---								---												---
Flood	3	Raised Berm	Private	4	4	---	---								---			---	---			---		---			---
Recreation and Amenities: Crockett Wave Area	4	Fox Farm Launch and Nature Park	Private --> Convert to Public	4	3	---	---								---												
	5	Sumac Park and Bridge	Public/Irrigation Companies	3	4	---	---								---				---	---	---		---	---			
	6	Crockett Dam and Wave	Utah & Irrigation Companies	4	4										---	---	---				---		---	---			
	7	River Hollow Heritage Park	Logan	4	4	---	---								---								---	---	---	---	
	8	Crockett Bridgelet	Private --> Convert to Public	2	4	---	---	---	---			---			---				---	---	---	---	---	---	---	---	
	9	Crockett Park	Private --> Convert to Public	4	4	---	---			---	---	---	---											---			
	10	100 N. Bridge	Logan	3	4	---	---																---	---	---	---	---
	11	100 North Parklet	Logan	3	2	---	---	---	---	---	---	---	---					---	---	---	---	---	---	---	---	---	
	12	Providence Ditch Trail	Logan/Private	3	4	---	---	---	---	---	---	---	---	---	---				---	---	---	---	---	---			
	13	Center Street Bridge and Riverside Drive	Logan	3	4	---	---								---									---	---	---	
	14	Johnson Trail	Private	3	4	---	---	---	---	---	---	---	---						---	---	---	---	---	---		---	
	15	D. Stewart Nature Park: Parking and Launch	Logan	3	4	---	---	---				---											---	---	---		---
	16	River Heights Trail Connection	River Heights	3	4	---	---	---		---	---	---	---						---			---	---	---		---	
River Heights	17	Mixed Density Residential	Private	2	4	---	---			---	---	---	---	---					---	---	---	---	---	---	---	---	---
	18	Riverside Park	Private	2	3	---	---	---	---	---	---	---	---					---	---	---	---		---	---		---	---
	19	Logan River Seasonal Braid	Private	4	3	---	---											---	---			---	---	---			---
	20	Logan River Trail Connection	Private	3	4	---	---	---	---	---	---	---	---						---				---	---			
Trails	21	Blue Trail	Utah/Logan	3	4																						
	22	Connectors to Trail System (Total)	Various	3	4																						

Proposal Origin

- = proposed by student capstone group
- = proposed by author
- = proposed by private entity
- = proposed by public entity (LRTF/Municipality/County/UDOT)

*The Urban Stream Renewal (USR) framework provides a rating code for a project's Ecological or Societal emphasis, where:

1 = indirect, not part of an objective, not planned or anticipated

2 = indirect, part of a secondary objective, anticipated but minimally planned compared to the primary objectives

3 = indirect, part of the primary objectives and required planning, but an indirect result of actions to accomplish the objective

4 = direct, part of the primary objectives, accomplished by a single to few actions occurring over a small spatial scale (possibly a singe reach)

5 = direct, part of the primary objectives, accomplished through multiple actions over a broad spatial scale (possibly catchment scale), requires extensive planning. (Not considered relevant for any of the proposals in the Upper Reach).

1= Flow Regime: Spring Peak Flows
2= Flow Regime: Summer Base Flow
3= Hydrology: Flood Conveyance / Mitigation
4= Hydrology: Floodplain Function
5= Hydrology: Instream Habitat
6= Water Quality: All UDEQ Beneficial Uses
7= Aquatic Biology: Trout Density & Size
8= Aquatic Biology: Benthic Invertebrates Observed
9= Riparian Ecology: Vegetation Condition
10= Riparian Ecology: Cache County Noxious Weeds
11= Terrestrial Biology: Bird Species # and Diversity
12= Terrestrial Biology: Amphibians and Reptiles
13= Recreation: Trail Continuity
14= Recreation: Blue Recreation (Paddles)
15= Recreation: Legal Access to River Bed (Wading)
16= Recreation: Legal Access to River Bank
17= Recreation: Access (ADA, WC, Parking, Launch etc.)
18= Recreation: Fishing Success/Catch Rate
19= Recreation: Blue Ribbon Fishery Status
20= Private Property: Adverse Impact from Recreation
21= Private Property: Adverse Impact from Restoration
22= Distance of Trail Segment: miles (m) or feet (ft)

* 20 and 21 refer to potential for adverse impact

From LRTF CAP Summary Spreadsheet (2016)

= Great potential = Some potential = Little potential --- = No Effect/Not relevant

Table 6. Evaluation Matrix of the Proposed Projects in the Upper Reach

The conceptual framework matrix follows the illustrative map, wherein, for example Project Number 1, USU Water Lab Parking, focuses on providing access to the river for paddlers. More information, such as details about the improved parking and drop-off area with an ADA appropriate launch site, is imparted with the design itself. The matrix continues, showing that the owner of the property is USU. The USR rating indicates that the direct objective of the project is Societal (4), with indirect, secondary objectives related to ecological goals present but not to the extent of the direct objective. The final segment relates the project to the Conservation Action Plan by the Logan River Task Force. The 22 goal titles are included to assess (subjectively) whether the project has "great potential", "some potential", "little potential" or "no relevance" to each goal.

Design Proposals

Based on the identification of potential projects, the following are conceptual designs to start the conversation about what the possibilities could be. The numbering is based on the project proposals indicated in Figure 55, and the conflict map in Figure 44. An effort has been made to highlight which of the goals outlined in Table 7 are being met. As part of a vision, this is necessarily a subjective interpretation of feedback from the conversations, meetings, surveys, and impressions received from the research performed. No part of this should be construed as imperative or part of any official plan, but merely suggestions of what could be.

Waterlab - Areas of Interest 1 1 2

River: First Dam construction in 19011 and subsequent changes in the river channel create problems of erosion and disturbed habitat. Logan Northern canal diversion also decreases the flow. Piping of the Crockett Canal here will further decrease it.

Residents: This property belongs to USU, but location B is used as an informal put-in by local paddle enthusiasts. Other options could be possible with coordination.

City: The Logan & Northern Canal Diversion changed and the canal was covered and converted to a trail after the 2009 landslide. With the City Council adopting the Blue Trail in 2020, coordination with USU could offer options for official paddle put-ins.

1 The current parking area is poorly defined and could be improved to maximize the space while also incorporating bio-swales to treat runoff before it reaches the river.

A This site is part of the employee parking for USU Waterlab and could be a formal launch site. Beaver sightings should be studied to ensure the best decision is made.

B The unofficial, informal put-out for paddlers until now. Situated just below the eroding cutbank, this could also be a launch site.

C Overflow parking for the Waterlab can be used by paddlers for parking their vehicles while paddling down the Logan River.

2 Situated past the two Waterlab bridges and on a straight stretch, this is a third option for a put-out. Parking is limited

1 The energy of the river scours the steep bank and into the unstable soil. This erosion weakens the slope, creating the risk of a landslide which could dam up the river and cause it to overflow and flood areas downstream.

150 ft

Waterlab - Launch Sites, Cut Bank Remediation and Piping of Crockett Canal 1 1 2

River: Modifying the channel to remediate the cutbank erosion is a minimal attempt at correcting the encroachment of development. Accompaying it with appropriate plants along the edge and a naturalized access area for paddlers adds a popular social component. (1 ii, iii; 2 i; 3 i; 4 i,ii,iii and 5 i,ii).

Residents: This property belongs to USU. Public access would be limited by the interests and concerns of USU. (1 i; 2 i, iii; 2 i, iii; 3 iv, v; 5 i and 6 i, ii).

City: Infrastructure improvements would be needed if C is developed. Conflict area 1 would involve the participation of USACE. Crockett Canal renovation might imply piping near A. This would involve several stakeholders. (1 iii, iv; 3 ii, iii; 4 i, ii; 5 ii and 6 iii).

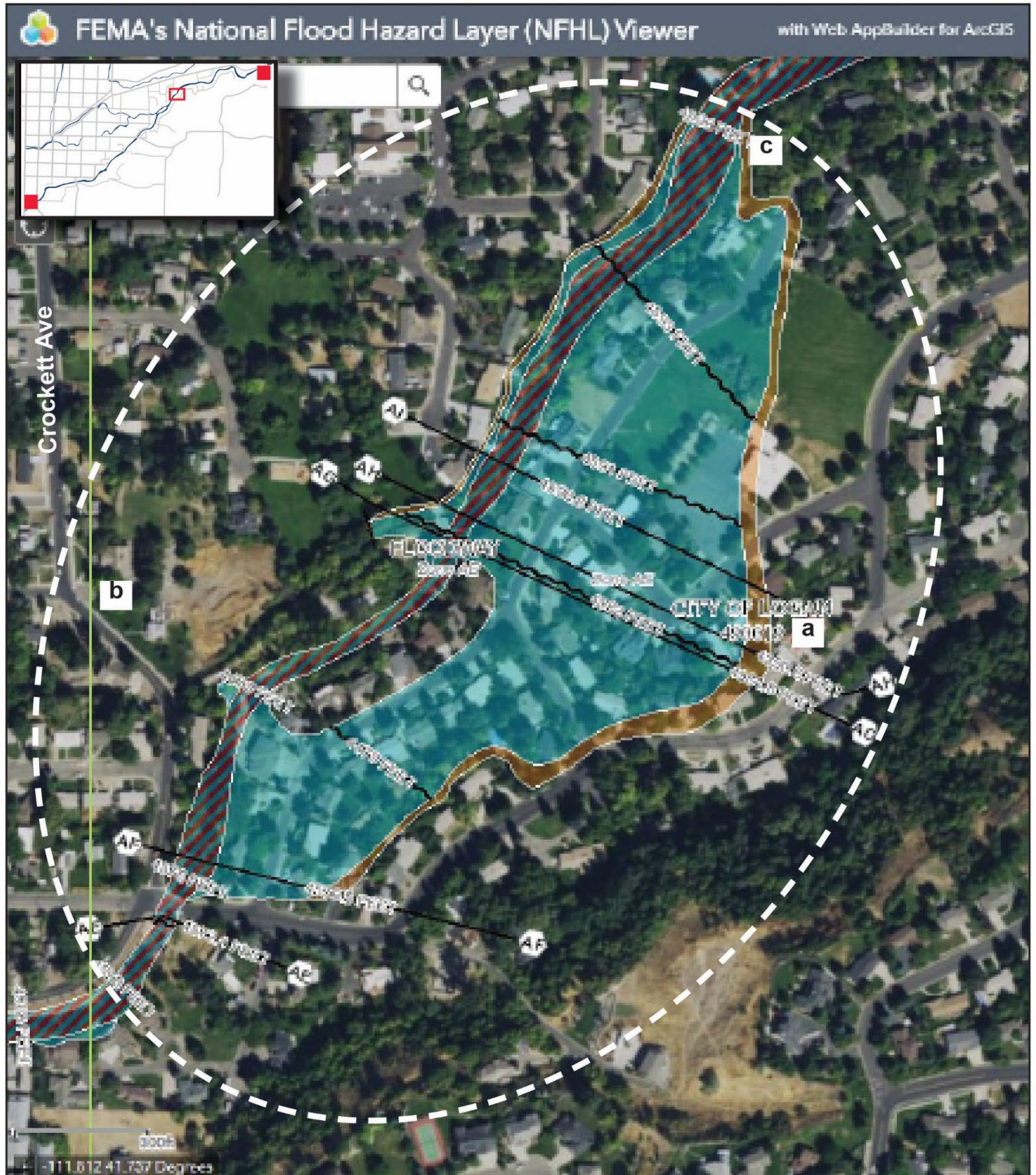
1 A B C Two options: A drop-off for kayakers at the East end (1) of the renewed Waterlab main parking area connects to a pathway to the launch ramp: Ramp A provides a view of the 1st Dam spillway, but might disturb a beaver family. Ramp B would be a logical place to develop a ramp together with the channel modification to solve erosion risk.
Area C would be the official parking area for paddlers using “A” or “B” launch. There should be a marked street crossing for safety.

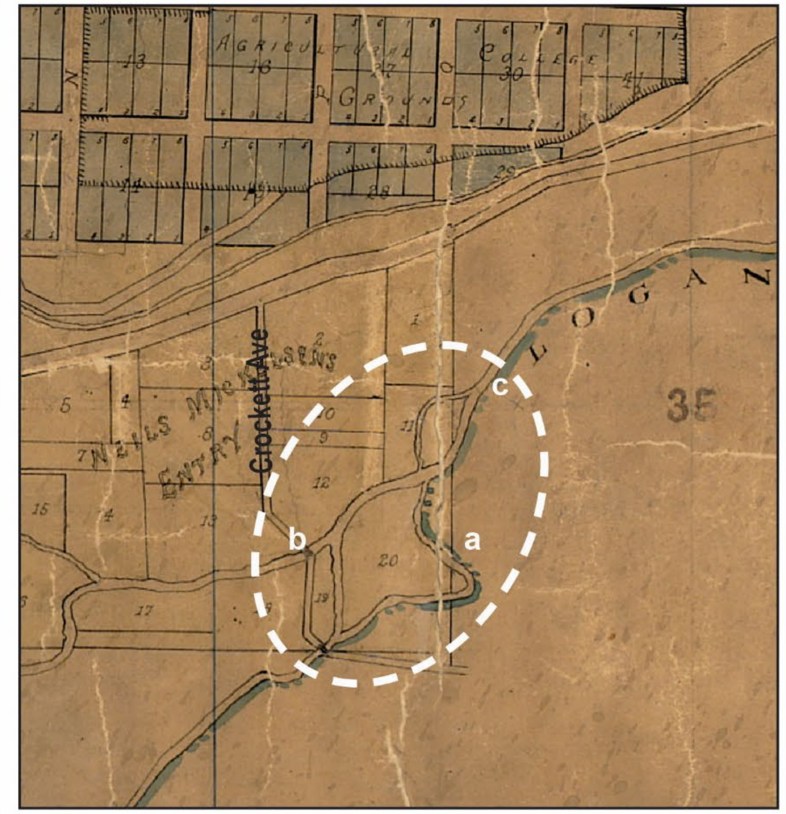
2 This option allows for dedicated paddler parking (1 ADA and 4-5 regular spaces). It interferes less with the operations of the Waterlab and optimizes use of an already compromised riparian edge.

1 To mitigate the risk from slope failure, the river and point bar are rerouted closer to the parking area. The cut bank or outer side of the channel should be built up to strengthen it and reduce the risk of sliding into the river (as per Darren Olsen, Bio-West).

150 ft

Flood Mitigation Area 2 3





Comparing the FEMA flood map with the 1891 Survey Map it becomes apparent that the main channel in 1891 (a) of the river follows the East rim of the FEMA flood limit (a). As development ocurred and the channel changed, residences were placed in the flood zone.

(b) shows the bend in Crockett Ave that still exists today. Due to the seepage and gravel deposit collected over millennia it was easier to have the road work around it than cross it.

The current flood risk is based on a low -laying riverbank area (c) which can flood if the water level runs higher than it. As can be seen, the area behind it is part of historic braids and meanders within the river system at that location.

The River:

At high flows, the river naturally flows over the left bank(c) and spreads out until collected near the 100 N Bridge and drains into the river again. While this is a rare occasion, especially considering the level of water that is diverted upstream and the control measure provided by the dams, 40 residences are built in this flood zone.
(1i, iii; 2i,ii,iii; 3i,ii,iii; 4i,ii,iii; 5i,ii)

The Residents

Being in a FEMA flood zone represents a risk of flooding. Flood insurance is mandated by mortgage providers and building codes may have special provisions and setbacks to minimize the risk.Insurance premiums for flood insurance varies, but $300 annually is average (KSL 2020).
(2i,ii, iii; 3iv, v; 5ii)

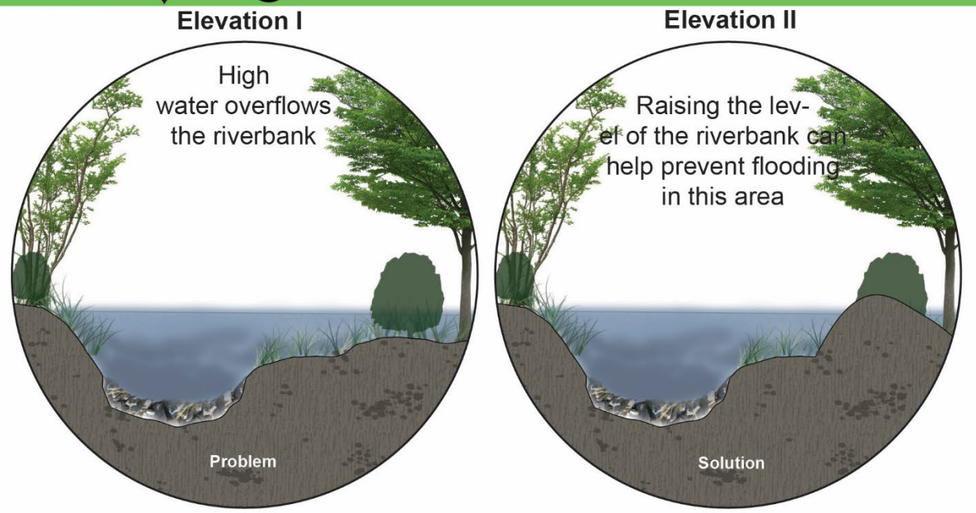
The City:

In the 1960s, Logan City allowed developers to build Hidden Village on the East bank of the river within the known flood zone. While this expansion allowed for increased tax revenues to the city, it also increased long-term maintenance costs and the potential for liability related to flooding and infrastructure maintenance.
(1i, iii, iv; 3i, ii, iii; 4i, ii; 5i, ii; 6i, ii, iii)

Flood Mitigation Area - Levee Protection

2 3

This area represents the source of the flood issue in Hidden Village. Built near a historic meander of the river, not enough caution was taken when preparing the development, leaving this area exposed to the 1% storm runoff as stipulated by FEMA.
The best solution would have been to not build on the floodplain.
The second-best solution is to raise part of the riverbank over 4595 feet (green hatch, elevation II) with a levee and a setback that allows for some lateral movement of the river. This allows it to expand and contract with the seasons, affording greater habitat diversity.



The River:
The flood area can be modified by creating a levee in the overflow area. Appropriate vegetation can help dissipate the river's energy and preserve the strength of the levee. (2 i; 4 i, ii, iii; 5 ii).

The Residents:
This is private property and public access is not a question here. The levee will protect other residents from flooding and can serve as an aesthetic addition to the landscape of the property owners.
(2 i).

The City:
The levee helps protect property owners as well as Riverside Preschool from potential flooding. Conversations and collaborations should be possible to protect the area from flooding.
(1 i, iii, iv; 3 i, ii, iii and 6 i,, ii, iii).

Crockett Play Area

Crockett Play Area

- (4) Fox Farm Launch and Council Ring
- (5) Sumac Park and Bridge
- (6) Crockett Dam and Wave
- (7) River Hollow Heritage Park and Essig Island Botanical Garden
- (8) Bridge over Seepage and Ancient Sand Deposit Area
- (9) Crockett Pollinator Park
- (10) 100 North Bridge Trail Underpass
- (11) 100 North Hammock Parklet
- (12) Providence Ditch Trail Connection
- (13) Center Street Bridge and Riverside
- (14) Johnson Trail
- (3) Service/Secondary Access Bridge to Replace Pedestrian Bridge
- (4) Straighten Crockett and Naturalize Canal/ Create Pollinator Park
- (5) Replace Failing Bridge With Greater Span and Functionality

6 Below Crockett Dam at high flow (May 2019) Photo: Author

11 Looking upstream South of 100 North Bridge Photo: Author

The Crockett Play Area is the public recreational focal point in the Upper Reach. The parks have dedicated parking areas and amenities to make them more accessible. Paved urban loop trails and unpaved connector trails to the Logan and Cache Valley network offers something for everyone.

The River:
Water scarcity in August deteriorate riparian areas below the Crockett Dam. Much of the river in this area is confined and edged with hard surfaces. Infrastructure renewal and recreationists can help promote education about riparian areas; improve habitat conditions for flora and fauna, and help stabilize banks naturally.

The Residents:
Access and pleasing aesthetics around the river is blighted by deteriorating infrastructure. There is a greater interest in preserving nature and improving habitat for wildlife as well as enhance recreation in and around the river.

The City:
Infrastruture renewal provides opportunities to develop multi-functional spaces while also addressing environmental and recreational concerns. Flooding, emergency egress, improved sidewalks, bike paths and trail systems, education and aesthetics can all benefit if communication and collaboration are part of the development process.

Crockett Play Area

Crockett Project Area Source: Cache County GIS

Crockett Play Area - Fox Farm Launch and Council Ring (4)

River: The riparian edge of this vacant property is thick with willows and underbrush. Any project should disturb this area as little as possible to protect the native habitat.
(1ii, iii; 2i, ii; 3i, ii, iii; 4i, ii, iii; 5i, ii)

Residents: Located across from Riverside Preschool this property is ideal for blending learning and recreation. Dense planting of native species should screen neighboring properties to protect their privacy.
(1i, ii, iii; 2i ii, iii; 3i, ii, ii, iv, v; 4i, ii; 5i; 6i, ii)

City: With native plantings, maintenance would be minimal and irrigation unnecessary. Alliances can be made with the school and groups of paddlers and recreationists to help maintain the park and services.
(1i, iii, iv; 3i, ii, iii; 4i, ii; 5i, ii; 6i, ii, iii)

The emply lot on Fox Farm Road has a perfect frontage on the river to create a paddle launch/take-in area. Situated across from the Riverside Pre-school it is also an ideal site for an outdoor classroom. The council ring is the highest point on the property. It is a tribute to the Danish landscape architect Jens Jensen (many of Logan's pioneer settlers came from Scandinavia) and the connection with Native Tribe's symbolic use of circles. Native Sumac (lemonade trees) shade the circular path. Local boulders arranged around a sand-filled circle make up the council circle classroom. Pathways are ADA accessible, with no slopes more than 5%. Parking/drop-off area and pathways are made of permeable surface material, such as crushed, compacted gravel. All runoff is designed to be treated on site, with swales and rain gardens offering more habitat variation. All vegetation should be native to serve as a teaching vehicle in local ecology and ethnobotany for the young students.

ⓐ Riparian edge - minimal disturbance to current native vegetation

ⓑ Native trees, shrubs and perennials throughout the property

ⓒ Sumac trees (Rhus glabra) surround the council circle

ⓓ Sandbox play area

ⓔ Council ring of native boulders

ⓕ Paddle launch and take-out

ⓖ Parking for 2 vehicles, permeable surface

"A garden, to be a work of art, must have the soul of the native landscape in it."
-Jens Jensen


Council Ring Source: Pinterest https://www.toddhaimanlandscapedesign.com/blog/2009

Crockett Play Area - Fox Farm Launch and Council Ring - Section 4

Composite photo of Fox Farm Property looking Northwest towards the river By: Author

The River:
Protection of the riparian area and the planting of native plants enhance the habitat of flora and fauna. (1 i, ii; 3 i, ii, iii; 4 i, ii, iii; 5 i, ii).

The Residents:
Combining recreation and education with habitat protection creates the win-win solution described by Smith et al. (2016). (1 i, ii, iii; 2 i, ii, iii; 3 i, ii, iv, v; 4 i, ii; 5 i and 6 i, ii).

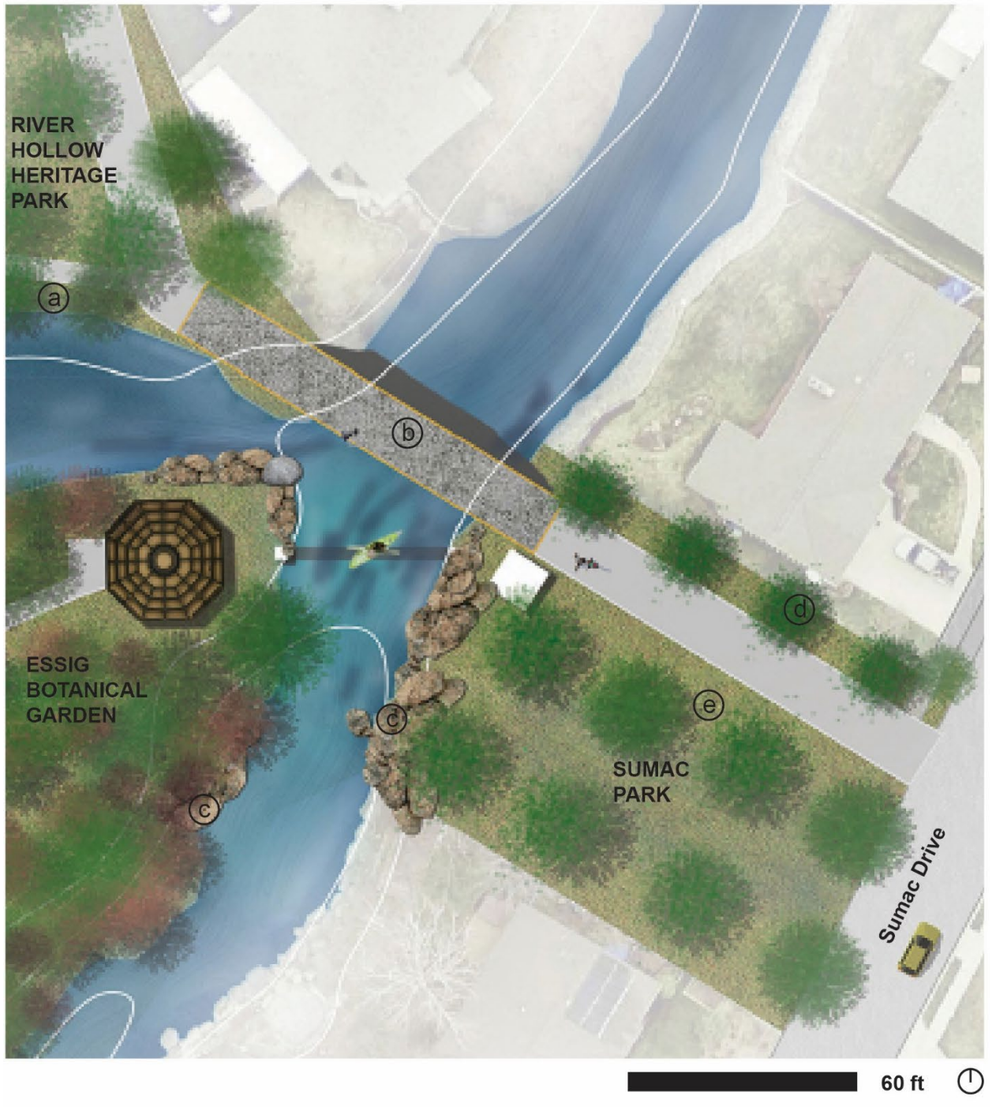
The City:
Responding to residents' and recreationists' wishes are characteristics of a responsive government. Grants might be obtained from state and other sources. (1 iii, iv; 3 i, ii, iii; 4 i, ii; 5 ii and 6 i, ii, iii).

Crockett Play area - Sumac Park and Bridge (5)

River: The Crockett Diversion was part of the natural braiding of the river that gave rise to the Crockett Canal and North Branch. The proposal is to naturalize the river as much as possible. (1 ii, iii, iv, v; 2 i, ii, iii; 3 i, ii, iii; 4 i, ii, iii and 5 i, ii).

Residents: The Park and bridge provides access to the dam structure that allows irrigation flows to agricultural fields and ditches throughout the Valley. It encumbers passage for paddlers and fish. (1 i, ii, iii; 2 i, ii, iii; 3 i, ii, iii, iv, v; 4 i; 5 i and 6 i, ii).

City: Infrastructure and access can be improved. Replacing footbridge with a more functional and alternate access is the first piece in replacing the 100 N bridge and can also help recreationists and wildlife. (1 iii, iv; 2 ii, iii, iv; 3 i, ii, iii; 4 i, ii; 5 i, ii and 6i, ii, iii).



The current footbridge needs to be replaced. Considering the need for another point of egress in addition to the 100 North bridge, the new Sumac bridge could be widened to 12' to allow for emergency egress. The new bridge at Denzil Stewart Nature Park (pictured) is a good example. It would also serve as an observation area of the river. The clearance should allow paddlers to pass underneath on their way over the weir or into the Crockett diversion canal.
Sumac Park will maintain its stately, tree-lined appearance, though a low-growing groundcover which doesn't require mowing or chemical applications would be recommendable.

(a) Riparian edge is shaded by trees and allows for paddle take-out and wading in the cana.

(b) 12' wide bridge allows emergency egress from Hidden Village to the Island.

(c) Boulders line the edge of the river.

(d) Trees line the pathway to bridge. Native species would be preferred.

(e) Groundcover can include native grasses and low-growing perennials.


Footbridge to River Hollow Park By: Author


Existing footbridge over Crockett Dam By: Author


Sumac Park pathway to footbridge over the river By: Author

Crockett Play Area - Crockett Dam and Wave (6)

The 540 foot long Crockett reach of the Logan River has an elevation drop of 13ft, or 2.4% slope. This is enough to create a kayak feature that could attract enthusiasts from the region.
Outlook spots, including the bridge, Parksides and an “Outlook Gazebo” serve spectators and picnicers alike.
The old diversion structure is replaced with an inflatable weir that diverts water but that also allows kayakers to paddle over it, assuming minimum cfs flow is met. The old concrete canal walls are replaced with sloping edges and native vegetation. A widened service bridge improves safety and connection between Hidden Village and Island Area. Sufficient clearance under the bridge allows kaykers to pass underneath. The inflatable weir allows objects to flow over it, minimizing the obstruction of floating debris. Boulders are arranged for optimum play features.

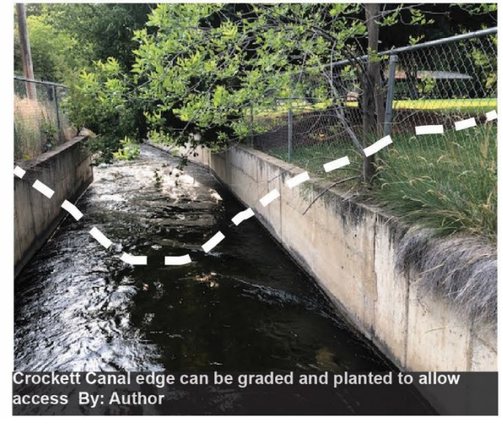

Crockett Wave area By: Author


Paddling whitewater - Pixabay By: Dieter G

(a) Old dam structure to be replaced by inflatable weir with control house structure.

(b) Boulders on edges and as coordinated with paddlers and fluvial geomorphologist for a wave feature.

(c) Boulders on edges of Essig Island serve to protect from erosion as well as rustic river observation spot.

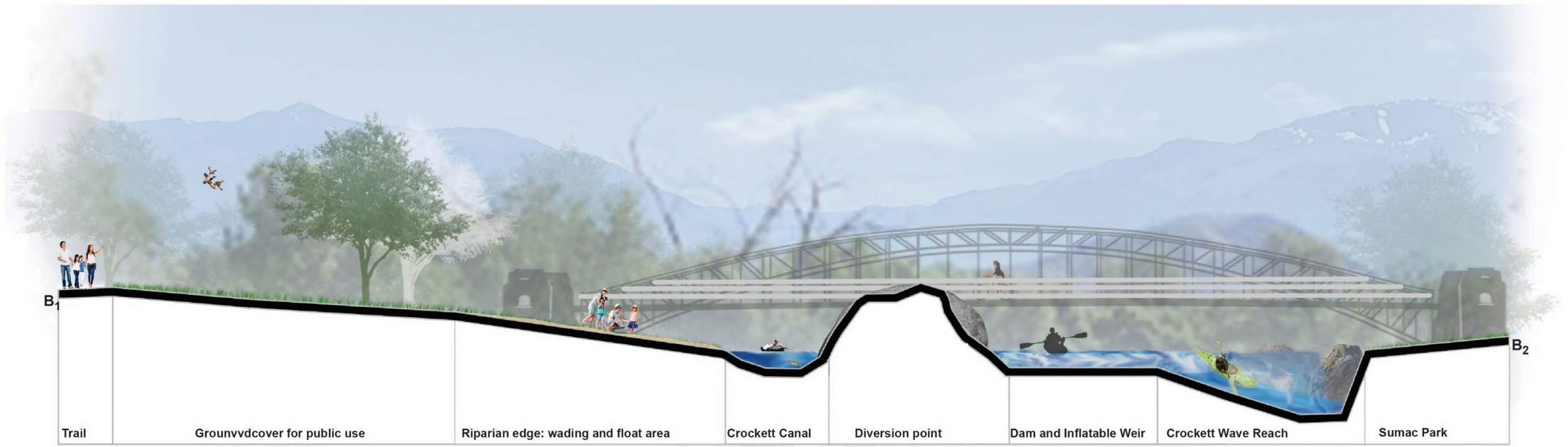

Crockett Canal edge can be graded and planted to allow access By: Author

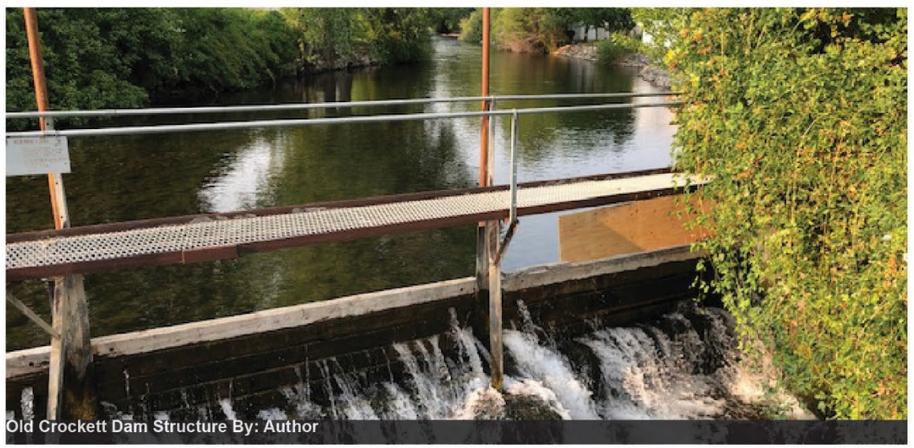
Crockett Play Area - Crockett Dam and Wave - Section 6

River: Dams cut off paths for fish swimming upstream to spawning areas. Structures also obstruct the natural flow of debris downstream. This design would help a little. (1 iv; 3 i; 4 i, ii, iii and 5 ii).

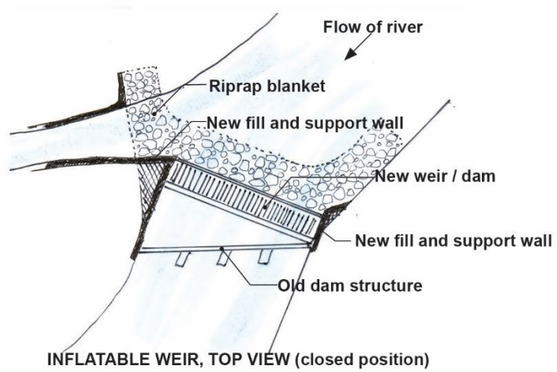
Residents: The Blue Trail will give the Logan River greater visibility among residents and recreationists. Property owners along the river could also benefit, as long as measures are taken to protect their properties (1 i, ii, iii; 2 i, ii, iii; 3 i, ii, iii, iv, v; 4 i; 5 i and 6 i, ii).

City: The attraction of a wave feature and replacement of decaying dam with passable dam structure can help bring recreationists to the city. It would take collaboration with several stakeholders. (2 ii, iii, iv; 4i, ii; 5 i, ii and 6 i, ii, iii).

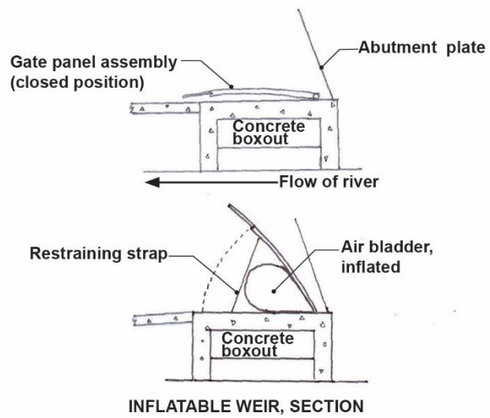




Old Crockett Dam Structure By: Author



INFLATABLE WEIR, TOP VIEW (closed position)



INFLATABLE WEIR, SECTION

Illustrations adapted from design by Anderson Consulting Engineers (NTS) By: Author

Crockett Play Area - River Hollow Heritage Park (7)

The Logan River has played a vital role in the development of the area. River Hollow Heritage Park is a tribute to its legacy.

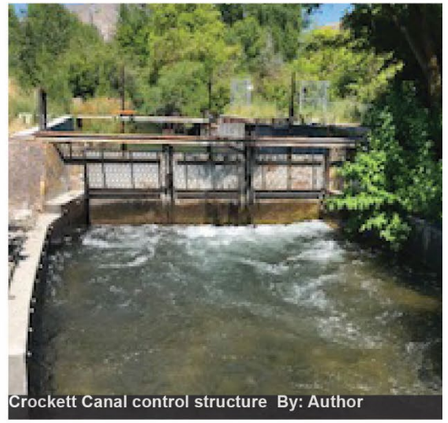
7a. Parking area and main entrance. Rip rap and fill from infrastructure renewal contribute to building the mounds that symbolize the mouth of the Logan Canyon in the park. The pathway flows like the river.

7b. 'Spiralwater' is a play area that teaches about the irrigation system and how it operates. A waterpump fills the top of the mound and runs down the spiral at a 1% slope to branches that can be diverted throughout the "fields" of native perennials to help teach about the irrigation system.

7c. Central Area between restrooms and covered picnic area also functions as trail node for new and old pathways.

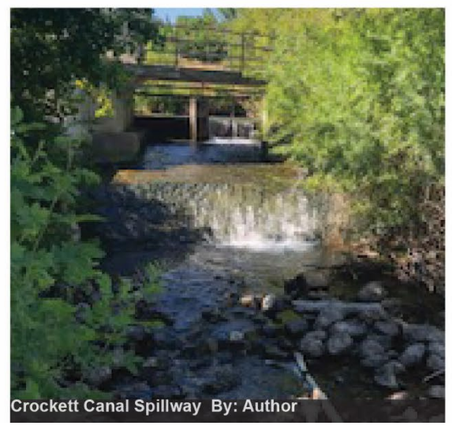
7d. The Island functions as a botanical garden, specializing in native riparian species and ethnobotanical food plants.


Logan River entry into Cache Valley By: Author


Crockett Canal control structure By: Author


Crockett Canal dewatered for maintenance By:Author


Little Logan River; now Crockett Canal By: Author


Crockett Canal Spillway By: Author


Sage and Arrowleaf Balsamroot By: Author

Crockett Play Area - North Entrance 7a

Logan Canyon wildflowers By: Author

ⓐ Runoff from parking and sidewalk is treated on-site in bioswales and raingardens

ⓑ Sidewalks surround the parking area and lead into park

ⓒ Mounds of 'urbanite' become mountains that frame the entrance

ⓓ Boulders mark the entrance

ⓔ Benches line the trail

ⓕ Signage for wayfinding and education

River: Using this area for recycling urbanite taken from river infrastructure renovation sites reduces cost and creates new habitat for flora and fauna. (5 i).

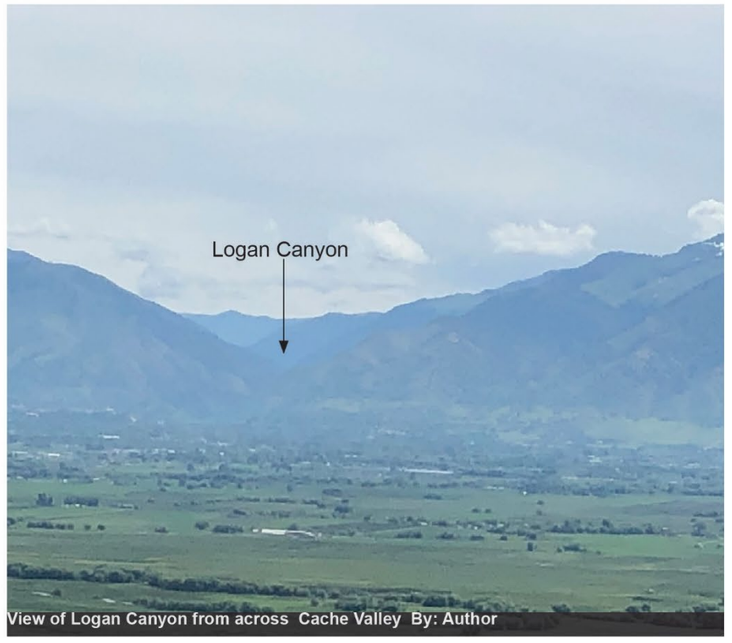
Residents: A formal entrance with defined parking improves visibility and accessibility to the park.
(1 ii, iii; 2 i, ii, iii; 3 i, ii; 4 i; 5 i; 6 i, ii).

City: A naturalized landscape design reduces the amount of water and maintenance required. Some reseeding of annual wildflowers might be needed, but perennial shrubs and native trees predominate. (1 iii, iv; 2 ii, iii, iv; 3 i, ii, iii; 4 i, ii; 5 i ii; 6 i, ii, iii). vv

Crockett Play Area - North Entrance Section (7a)

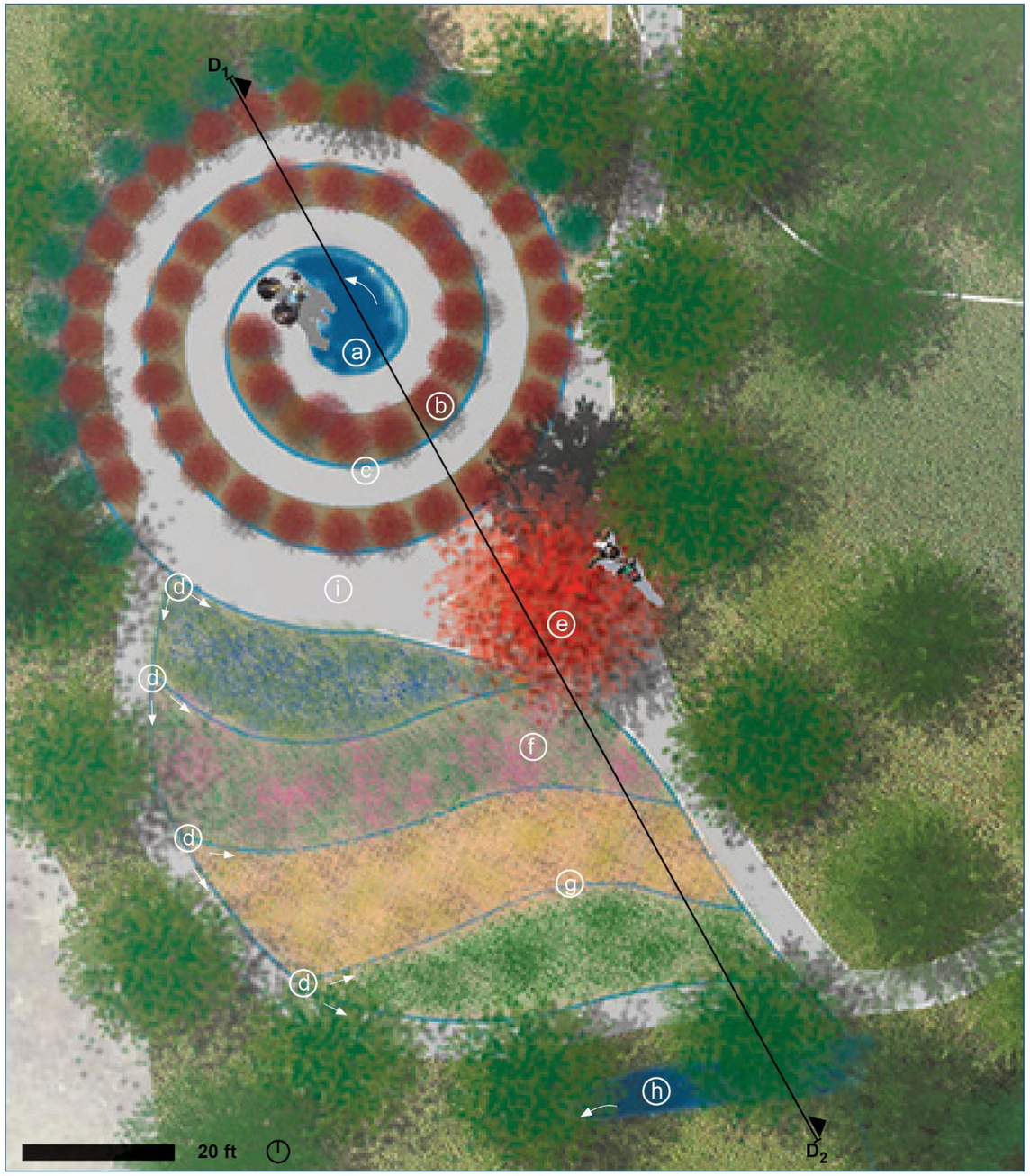
Mounds built with urbanite derived from the demolition of old bridges and concrete canals provide a mystique to the North entrance of the Crockett Play Area. The new topography is a miniature version of the landscapes found in Cache Valley. Native flora with seasonal displays of flowers and berries offer improved habitat for local and migrant fauna. Benches offer places to relax and observe. The trail leads from the parking area to the water play areas. Hardscape surfaces should be permeable, allowing water to percolate into the soil. Excess runoff should drain to bioswales with plants that can filter the polluted water naturally.

Interlocking Spurs - Inspiring Topography of Cache Valley By: Author



View of Logan Canyon from across Cache Valley By: Author

Crockett Play Area - Spiral Water 7b



Spiral Water was conceived as a tribute to the different spirals that exist in nature: wind patterns, water drain patterns etc. due to the Coriolis effect. [The counterclockwise alignment can also be changed to counterclockwise]. It is also a nod to Smithson's "Spiral Jetty" in the Great Salt Lake. The water starts with a pool or "lake" that overflows at an elevation of 6 ft . It then runs down at a 1% slope in a narrow channel on the inside of the pathway. The channel can be diverted at certain locations in the lower "field" section, providing opportunities for educational water play.

(a) Water is pumped up and overflows down narrow, channels (6" x 6") to provide a steady flow of water. A hand-operated water pump adds an additional play feature.

(b) Native plantings reflect flora in the Bear River Range. (Scrub Oak, others).

(c) Narrow channel guides the water down the spiral.

(d) Diversions are features that allow the water to be directed towards 1 or 2 channels via floodgates to provide water to different areas. At this scale it enables observers to understand how the whole system functions, allowing interaction to control flow direction.

(e) An emblematic tree (Bigtooth Maple for example) provides shade at the intersection of Spiral and Fields.

(f) Each irrigated field is planted with a type of plant that has meaning to Logan. (Camas, Yampa, Wheat, Serviceberry, or others).

(g) Diversion channel going through planted field. Other elements can be added, such as a waterwheel to show how water powered industry early on.

(h) The water eventually collects in a small pond (i.e. The Great Salt Lake) where it drains into the Crockett Canal or its spillway into the Logan River.

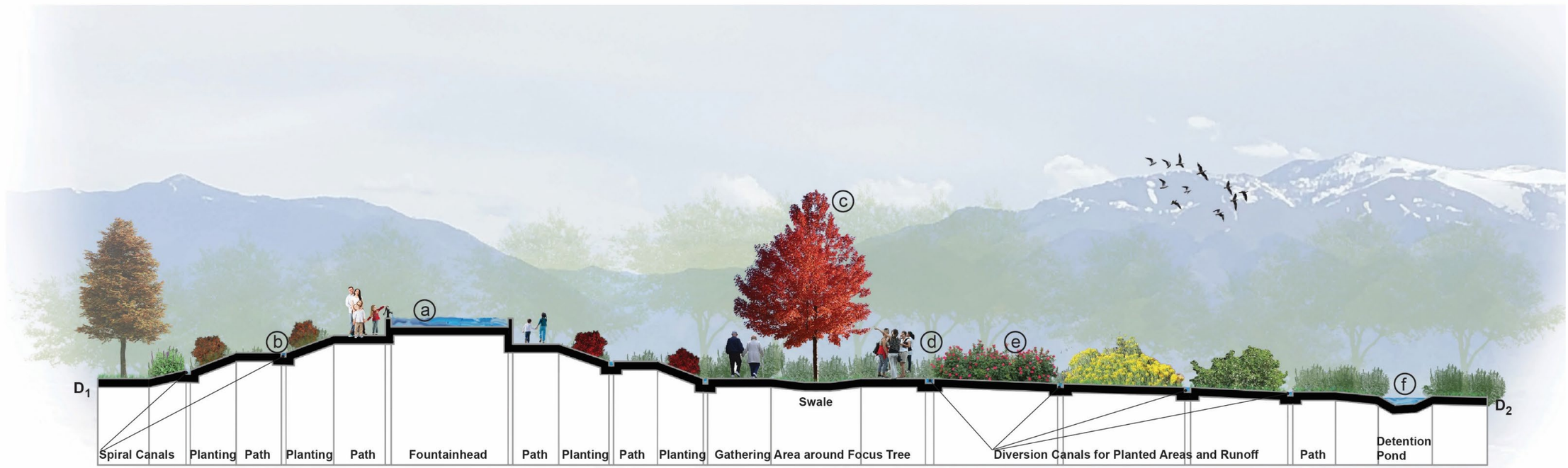
(i) Gathering/interpretive area

River: The artistic interpretation of the river system offers an opportunity to educate park visitors about watersheds, riparian zones, pioneer irrigation systems, etc. as well as entertain park visitors. Water from the fountain is part of the park's irrigation sys terminates in the Logan River.

Residents: Spiral Water offers an additional feature to River Hollow Park, and increases the amount of ADA accessible trails. (1 ii, iii; 2 ii, iii; 3 ii; 5 i; 6 i, ii, iii).

City: The artistic feature adds interest to the park installation. (1 iii; 3 i, ii, iii; 4 i, ii; 5 ii).

Crockett Play Area - Spiral Water Section 7b



ⓐ Water is pumped up from underground into a collection area ("lake") which overflows down a narrow channel (6" x 6") to provide a steady flow of water. A hand-operated water pump adds an additional play feature. The "lake" can be a naturalistic pool with rocks and short vegetation around it, or as shown, as a concrete structure.

ⓑ Narrow channel guides the water down the spiral. The spiral path is 5' wide and consists of permeable surfacing appropriate for ADA access.

ⓒ An emblematic native species grows at the crossroads between the spiral path and the fields. Its planting area is graded so that it collects runoff from the nearby pathways.

ⓓ Diversion canals frame the fields to provide them with water.

ⓔ The Fields are planted with species meaningful to Logan.

ⓕ All water eventually drains to the lower pond, which when full, overflows into a drainage duct back into the Logan River.

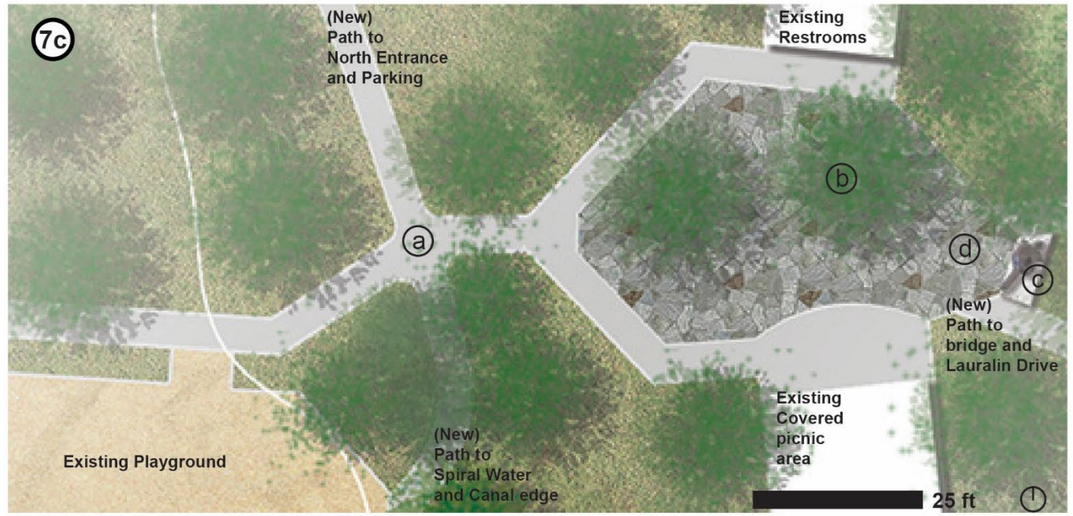

Small pioneer era irrigation ditch By: Author

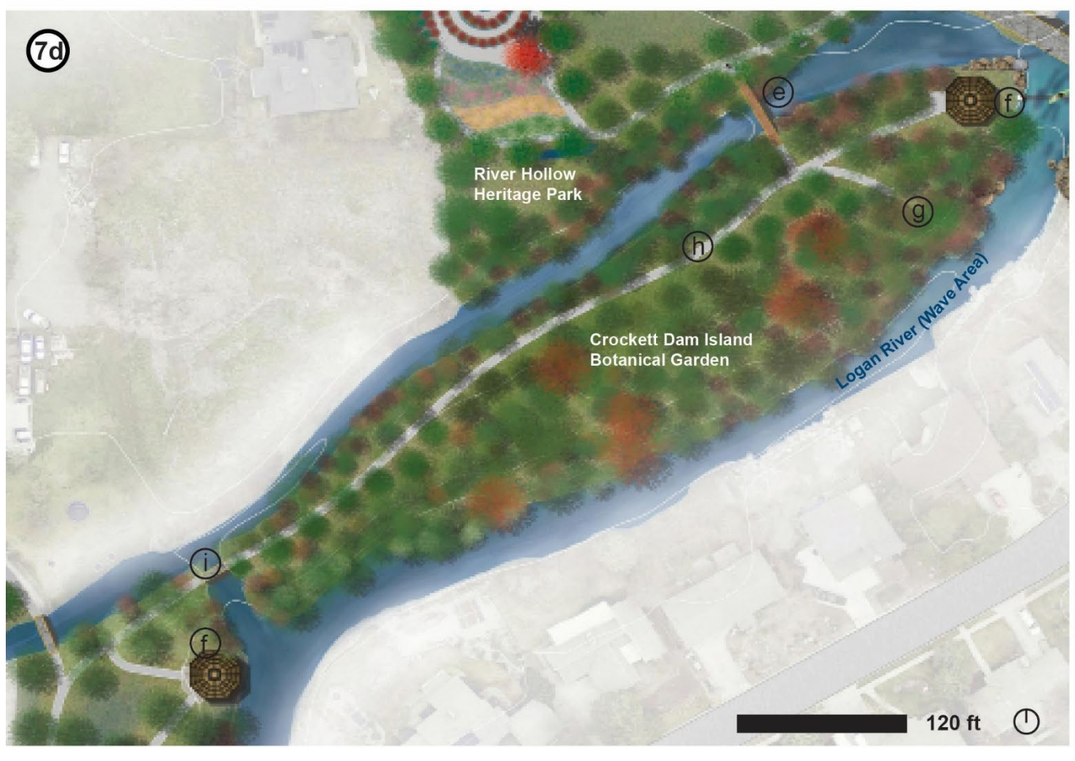

Small floodgate in Logan ditch By: Author


Waterpump at Buffalo Botanical Garden
By: Connie Oswald Stofco


Child playing with paperboat on irrigation ditch Source: GettyImages-803491942

Crockett Play Area - River Hollow Heritage Park Node and Island Botanical Garden 7c 7d





ⓐ The Node area is an intersection of existing pathways with new paths leading to added features within the park.

ⓑ To the extent possible, existing trees are kept. If needed, other shade trees are added. Trees that require removal can be converted into treestump carvings of large mammals typicall to the area's history.

ⓒ Commemorative/Informative statue and sign explaining the function and importance of beavers to the area.

ⓓ Small plaza with permeable pavers laid around existing shade trees.

ⓔ Footbridge from Crockett Diversion Island to River Hollow Heritage Park.

ⓕ Covered gazebo lookout over diversion and Crockett Wave feature for kayak events or a picnic in the park.

ⓖ Path to boulder lookout area over fast water at Crockett Wave.

ⓗ Pedestrian pathway runs through the native botanical and ethno-botanical garden the length of the island.

ⓘ Pedestrian bridge connects Crockett Park area to Crockett Dam Island Botanical Garden.


Treestump carving Photo: Author

River: Naturalizing the riparian edge improves river function and habitat. (1ii, iii, iv; 2i, ii, iii; 3i, ii, iii; 4i, ii, iii; 5i, ii)

Residents: Multiple opportunities to interact with nature helps us learn and love what we have. (1i, ii, iii; 2i, ii, iii; 3i, ii, iii, iv, v; 4i; 5i; 6i, ii)

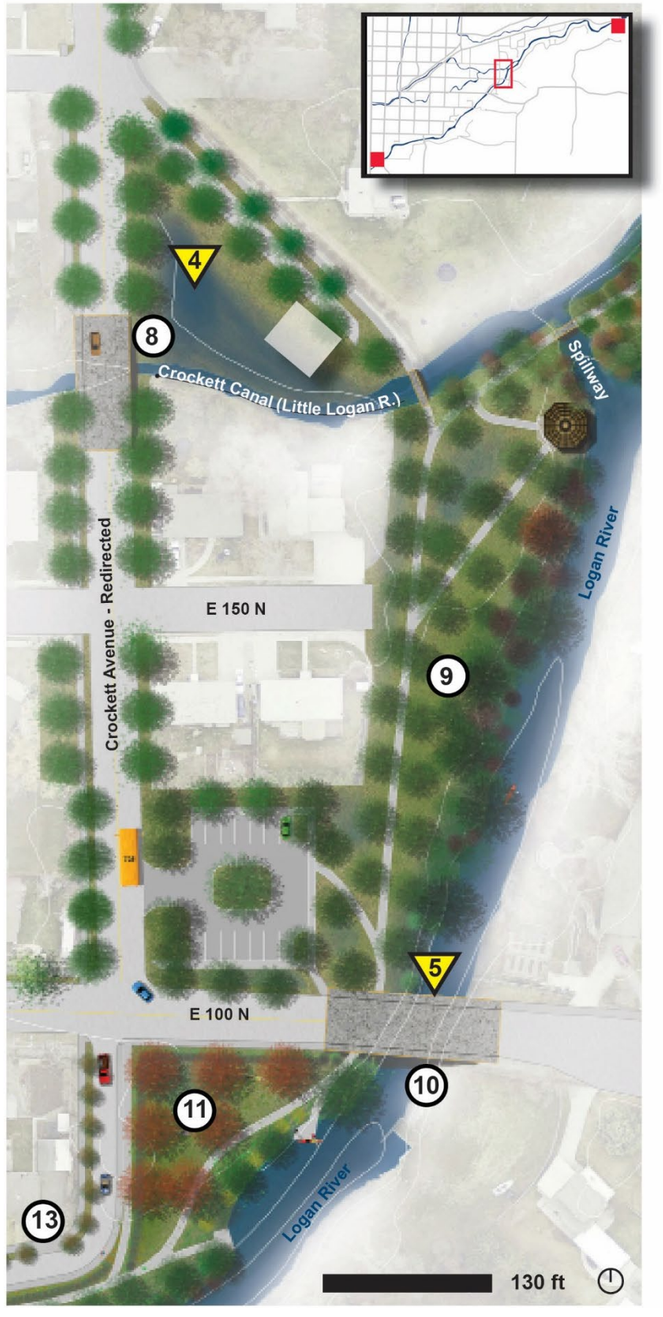
City: Concentrating activities in one area helps facilitate management of the area. (1iii, iv; 2ii; 3i, ii, iii; 4i, ii; 5i, ii; 6i, ii, iii)


Crockett Wave area and Island on right Photo: Author


Existing footbridge over Crockett Canal Photo: Author


Fremont Cottonwood Photo: Ann Gordon

Crockett Play Area - Crockett Avenue and 100 N Bridge 4 5 8 9 10 11 13



The Crockett Avenue and 100 N Bridge area is characterized by pre-existing features of the Logan River such as the Little Logan River branch (now Crockett Canal); seepage and gravel deposits at the current bend in Crockett Avenue (4). Infrastructure has developed around it, but a second layer of development to update service and efficiency has the possibility of changing the area into more public river access with parking and pedestrian walkways.

4 When the Logan Northern Canal failed with the landslide in 2009, the water came through existing irrigation ditches and Crockett Ave to this area where it joined the Crockett Canal. The house built on this triangular property is very close to a seepage area and the gravel deposit area, though it may be possible to build the new infrastructure around it.

5 The footings to the 100 N bridge are being eroded by the river. A replacement bridge with a longer span will accomodate the river better, but the Crockett Ave. needs to be realigned. The City has purchased the corner properties to accomodate this.
This proposal straightens Crockett Ave. to align better with the pioneer-era grid structure, creating treed sidewalks, a bridgelet (8) and a parking area for formal access to riverside trail and a South access to Crockett Park (9) and the Heritage Park.

8 A new bridge crosses the Crockett Canal.

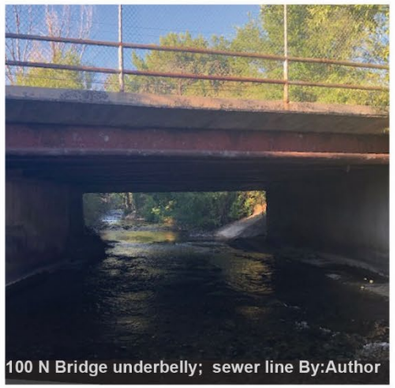
9 The purchase of 2 properties along the river provides trail continuity and preserves the natural river edge. A covered gazebo on existing berm structure enables viewing over the bottom half of Crockett Wave and the spillway.

10 The new 100 N Bridge offers pedestrian walkways which continue to Jens Johansen Park, passing over the continuation of the Riverside trail. Sewer line, runoff outlet.

11 100 North Parklet provides room for trail continuity; kayak take-out, and an observation deck. The Park is planted with trees that provide shade and support for hammocks.

13 Riverside Drive becomes a one-way, North to South tree-lined road with a bicycle path that leads to the Center Street Bridge. Center St. bridge will also be replaced.

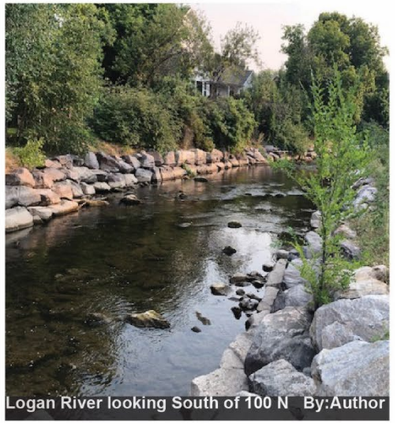
Existing Conditions:

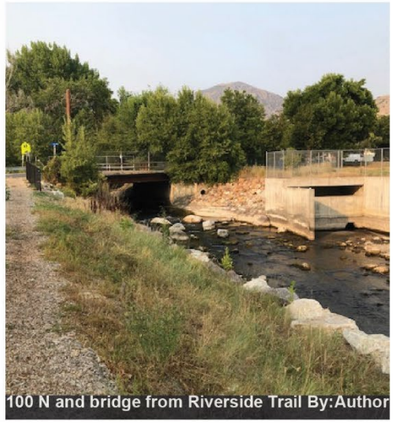

100 N Bridge underbelly; sewer line By:Author


100 N and bridge By:Author


Irrigation ditch along 100 N By:Author


Riverside Trail - Possible Parklet By:Author


Logan River looking South of 100 N By:Author


100 N and bridge from Riverside Trail By:Author

Crockett Play Area - Crockett Bridgelet and Sandbank Access

4 8

Historic gravel deposits by the river, seepage, runoff from old canals in addition to needed infrastructure renewals make this an area with potential for renewal. The historic bend in the road could be straightened and realigned with the city street grid.

(a) Crockett Ave. is straightened while allowing for riparian and subsurface processes to happen.

(b) Old portion of Crockett Ave. kept for bank access.

(c) Gravel accumulation from Logan Northern Canal failure and underground seepage make area complex.

(d) Bridgelet over Crockett Canal gives continuity to road grid structure and allows for treatment of gravel area.

(e) Existing residence could be protected. Engineering studies on soil and subsidence etc. are required.

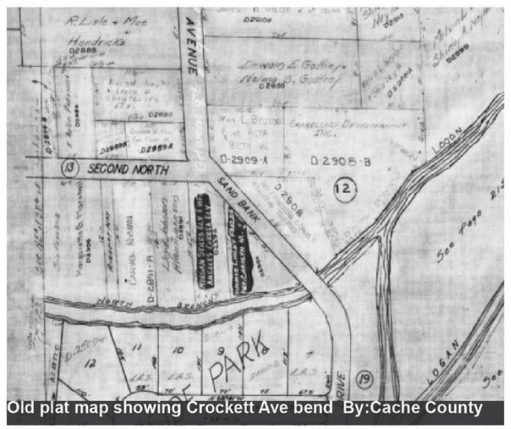
(f) Old bridge over Crockett Canal is used for pedestrian/bike traffic.

(g) Crockett Canal is naturalized at control gate


Crockett Canal control gate East of Crockett Ave By:Author

Crockett Ave. bend Source: Google Maps, 2021


Crockett Ave. looking South to Sand Bank By: Author



Old plat map showing Crockett Ave bend By:Cache County


Proposed Crockett Ave pass-through area By:Author

River: Naturalizing this sand bank area gives the river room to breathe and provides access to gravel deposits. The natural spring offers a unique habitat opportunity for native flora and fauna. (1ii, iii; 2i, ii, iii; 3i, ii, iii; 4i, ii, iii; 5i, ii)

Residents: Replacing the bend offers the opportunity to build a safer road and sidewalk. It can also help bring residents in closer contact with the river and its history. (1i, ii, iii; 2i, ii; 3i, ii, v; 4i; 5i; 6i, ii)

City: The purpose for modifying the bend is to allow space for a wider bridge-span at 100 North. Additional infrastructure improvements and greater public amenities are possible here. (1iii, iv; 2i, ii; 3i, ii, iii; 4i, ii; 5i, ii; 6i, ii, iii)

Crockett Play Area - Crockett Park and Parking (9)

Loss of habitat and use of chemicals is reducing wildlife populations. The purpose of Crockett Park is to improve patches of habitable areas for wildlife. Benches and trees provide pleasant areas to rest and contemplate Nature.

(a) Trail connection to Crockett Island and River Hollow Heritage Park

(b) All runoff from trails is graded to collect in swales. Crockett Park is a naturalistic pollinator garden.

(c) E 150 N becomes a cul-de-sac to make room for the trail and park that connects to River Hollow Heritage Pk

(d) Runoff from parking area drains to planted bioswales.

(e) Drop-off/pick-up area for paddlers

(f) Trail that leads down under bridge to put-in/take-out is graded for ADA accessibility (<5%).

(g) Wider bridge span allows for trail on terraced edge underneath bridge.

(h) River edge stays as natural as possible. Select plants with taproots help counteract erosion.

Existing Crockett Area Source: Google Maps, 2021


Precedent: Path in D. Stewart Nature Park By:Author


Precedent: L.A. Zoo parking bioswale By: Ciara Gonzalez


Naturalized riverbank and service bridge By: Author

Crockett Play Area - 100 North Bridge, Parklet and Riverside Drive

5 10 11 13

The 100 North Parklet Park is created by the realigned Crockett Avenue. As a one-way street, Riverside Drive leaves more room for riparian vegetation and a bike lane with an improved Riverside Trail.

The Park itself is planted with native trees appropriate for hammocking. Perennial groundcover and native vegetation abounds. Amenities for paddlers and nature watcher provide public access to the river.

ⓐ **Existing trees should be protected as possible. More trees for hammocking are planted amid perennial groundcover and native shrubs**

ⓑ **Riverside Trail connects to River Hollow Heritage Park with access to points of interest en route.**

ⓒ **Put-out/Take-in at 30-45° angle.**

ⓓ **Removal of rip rap and revegetation with deep pools offers improved fish habitat.**

ⓔ **Observvation deck at this site puts eyes on nature but also on runoff and human interventions.**

ⓕ **Overflow box for runoff from Hidden Village and Cliffside.**

ⓖ **Riverside Drive is one-way (Southbound only), with bike path, trail (East), sidewalk (W) and park strip.**

ⓗ **River edge stays as natural as possible. Select plants with taproots help counteract erosion.**

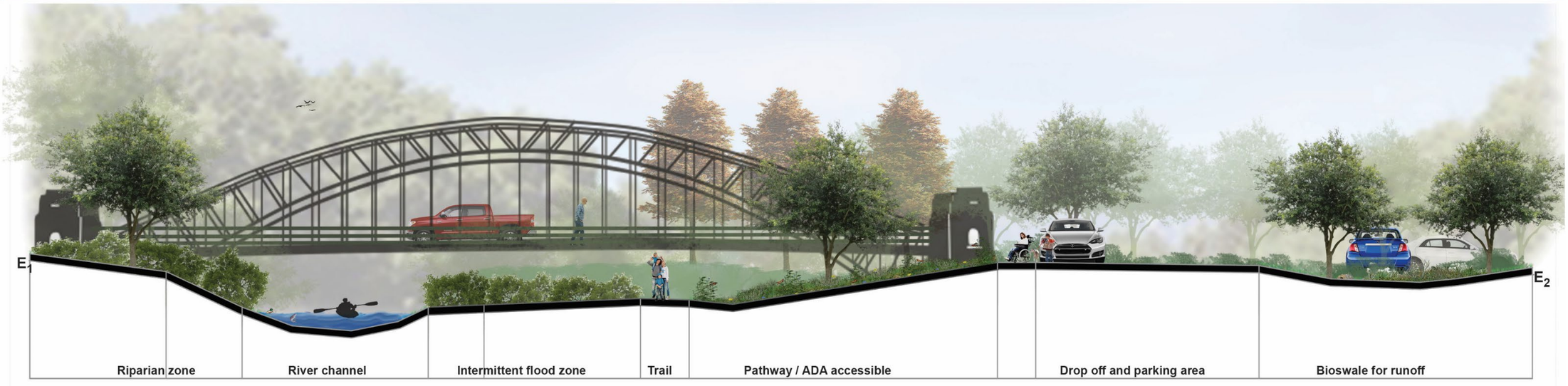
Precedent: Hammock Forest (precedent)
By:Lotoya - Pixabay

Precedent: Path, River, Bridge
Photo © Robert Eva (cc-vy-sa/20)

100 North bridge area By: Author with Google Earth Pro

Precedent: Observation deck at 1st Dam By: Author

Crockett Play Area - Crockett Park and Bridge Underpass Section



ⓐ Native riparian vegetation improves habitat for wildlife and protects against erosion. Graded slopes under bridge also protect against erosion.

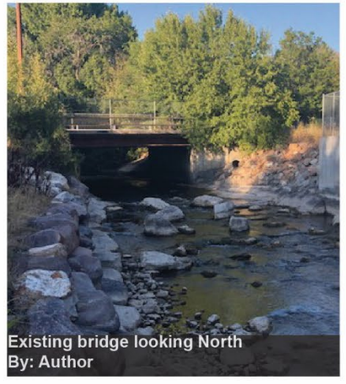
ⓑ Trail passes under bridge. Minimum clearance is 8 ft.

ⓒ Trails are graded for runoff to be sent to swales or rain gardens

ⓓ Trails are ADA accessible

ⓔ Drop-off area. Graded for runoff to flow towards central rain garden in the middle of parking area.

ⓕ Rain garden bioswale with native trees and perennials



Existing bridge looking North
By: Author

Precedent: “Seneca” Bridge (precedent - as built) Source: U.S. Bridge Company

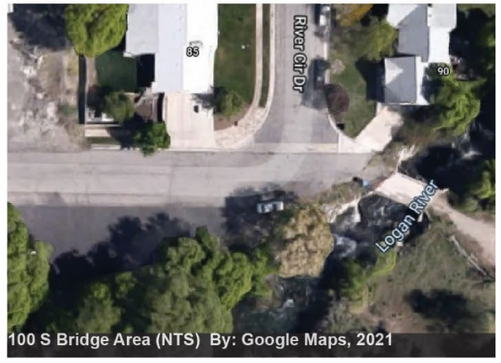
River:
There are multiple opportunities to improve the riparian zones and river channel with the infrastructure renovations planned. Runoff can be collected and treated with bioswales before entering the river. (1iii, 2i, ii; 3i, ii, iii; 4i, ii, iii; 5i, ii)

Residents:
This project offers improvements to infrastructure and pedestrian access to the river as well as improved connectivity to parks and neighborhoods. Parking also allows for access by visitors. (1i, ii, iii; 2i, ii iii; 3i, ii, iii, iv, v; 4i; 5i; 6i, ii)

City:
As a capital improvement project, there are many parallel opportunities to enhance the surrounding area at different levels: Expanding park areas, improving pedestrian trails and bicycle paths.
(1iii, iv; 2i; 3i, ii, iii; 4i, ii; 5i, ii; 6i, ii, iii)

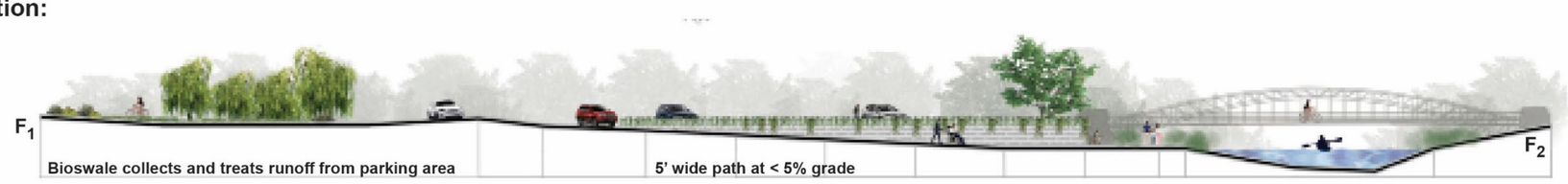
Denzil Stewart Nature Park - Parking Plan and Section (15)

The engagement of the Logan River Task Force and the guidelines offered by the-Conservation Action Plan played a role in restoring and replanting the Denzil Stewart Nature Park. Native trees and pollinators contribute to improved habitat and an opportunity to learn about the local ecological system. What is missing is a formal parking lot and put-in/take-out for paddlers. This design is a suggestion to accomplish both with ADA access and restroom amenities.



100 S Bridge Area (NTS) By: Google Maps, 2021

Section:



ⓐ Restrooms are within easy reach of city infrastructure

ⓑ 11 regular parking areas; 1 ADA parking

ⓒ Retention wall functions as Sitting wall on North side. Planters are planted with climbing vines that cascade down the South wall.

ⓓ 5 ft wide pathway at < 5% for ADA accessibility

ⓔ River outlook and paddle put-out/take-in

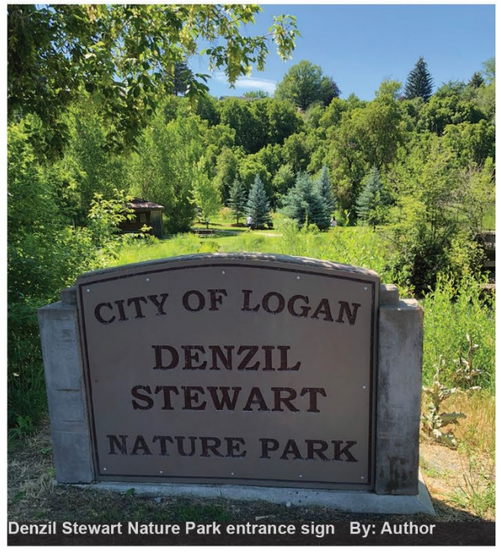
River:
Ensuring runoff is treated in bioswales before entering the river helps keep the river clean. Native vegetation is emphasized on restored edges, with a variety of habitats for native species. (1ii; 2i, ii; 3i, ii, iii; 4i, ii, iii; 5i, ii)

Residents:
Safer access (sidewalk, paddle put-out/take-in, ramp to river's edge) and enhanced services (restroom, parking) can help make this site more than a community park, offering instruction, recreation and inspiration to all its visitors. (1i, ii, iii; 2i, ii, iii; 3i, ii, iii, iv, v; 4i; 5i; 6i, ii)

City:
The limited service bridge connects the new Johnson Subdivision to the Island area and doubles as pedestrian and bicycle access. The compact functionality of the services maximizes space and efficient maintenance. (1iii, iv; 3i, ii, iii; 4i, ii; 5i, ii; 6i, ii, iii)

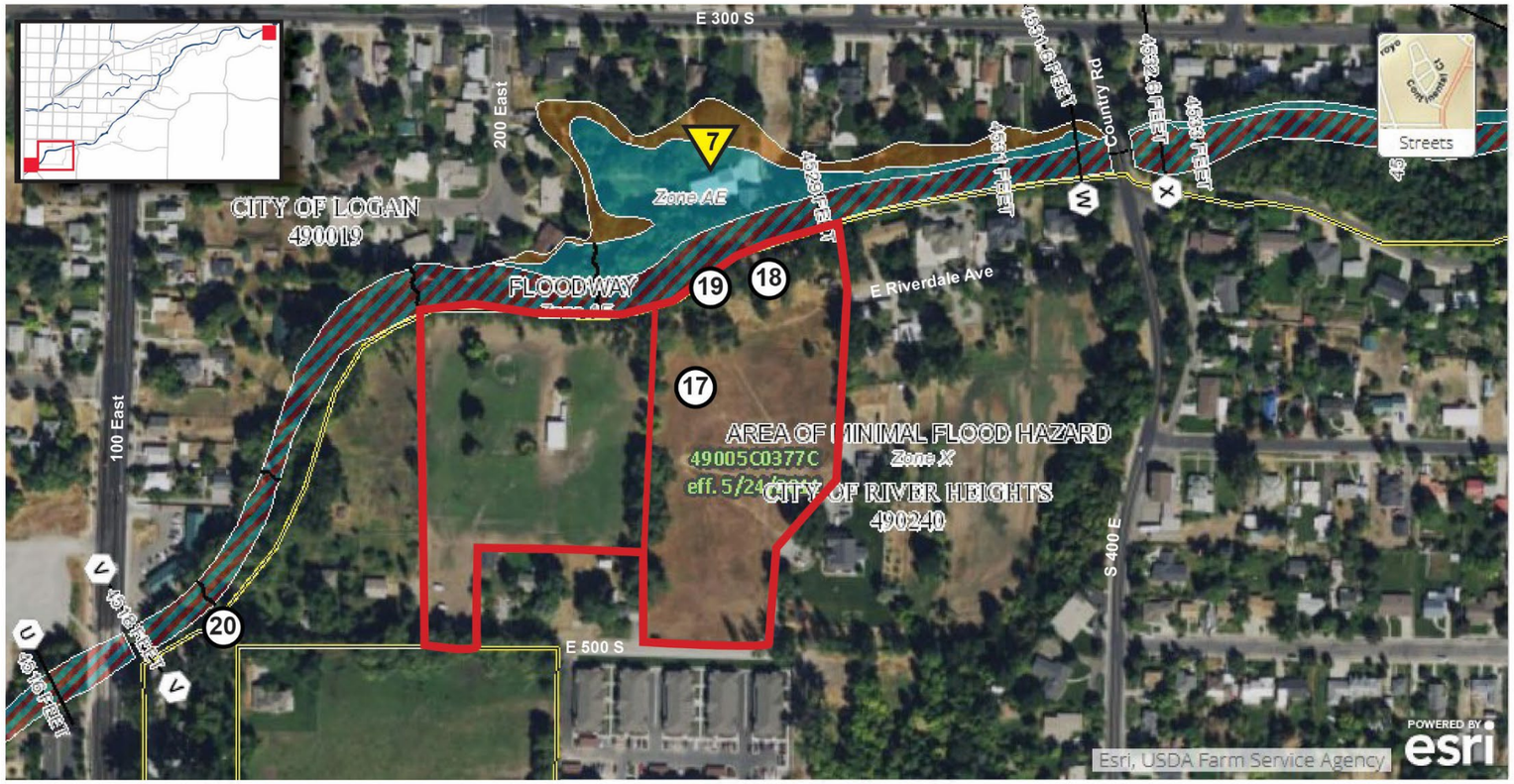

Narrow pathway By: Author

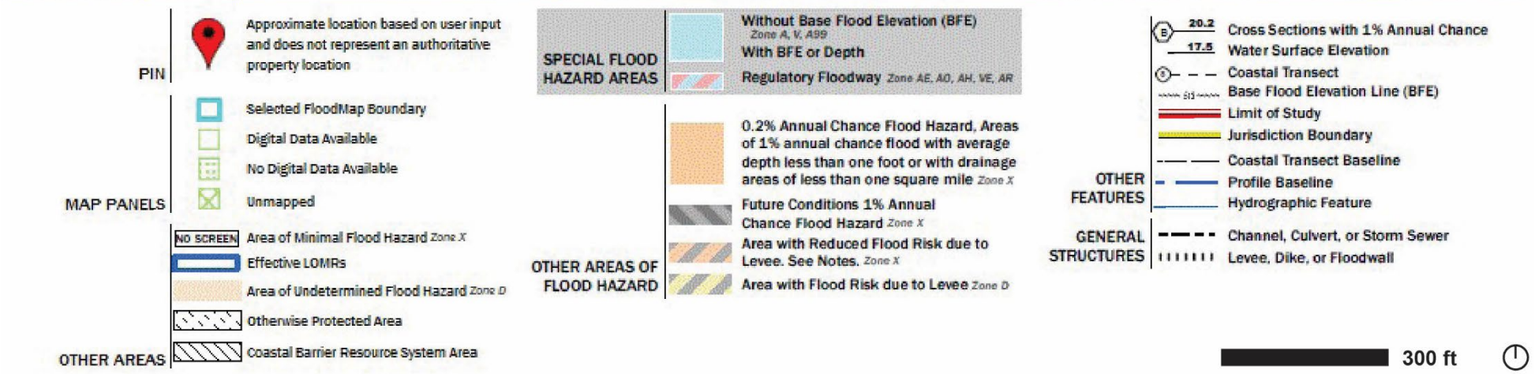

Milkweed (*Asclepia*) By: Author



Denzil Stewart Nature Park entrance sign By: Author

River Heights - Existing Conditions 7 17 18 19 20





The above FEMA map shows agricultural riverfront properties (outlined in red) within the jurisdiction of River Heights. These properties are currently under contract for development. As of this publication (February 2021), the city council had decided on a six month moratorium on development to decide what the zoning and code should be to ensure that appropriate development could happen. The developer has a 12 month due diligence period to ensure the proposal can work economically. There are opportunities for win-win solutions here.

River Heights' only river frontage to the Logan River consists of private properties in a rural section at the South end of the reach. Two of the properties are currently for sale, and it would be an opportune moment for the city to require river easements for trail connections as part of any development project. That could also help solve the flood risk faced by Logan properties on the North/right bank of the river. Following are the project proposals for this area:

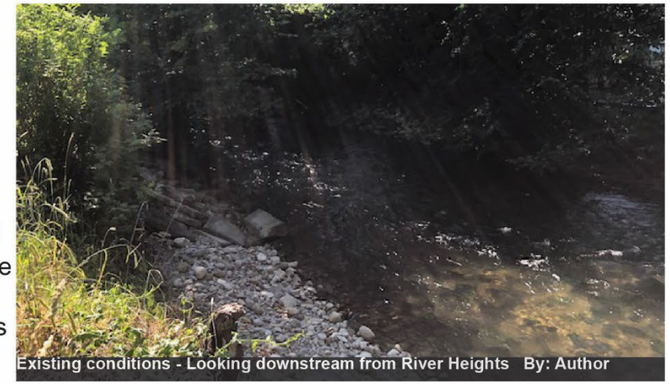
7 Mitigate flood risk by creating a seasonal braid (diversion or swale) that at a certain flow level spills into the braid where it can detained before flowing back into the Logan River further downstream.

17 The Mixed Density Residential proposal would be a "green" community development project. Smaller lots with rainwater collection and runoff treated on site; passive solar design and solar energy generation, and community amenities including an activities building and pre-kinder.

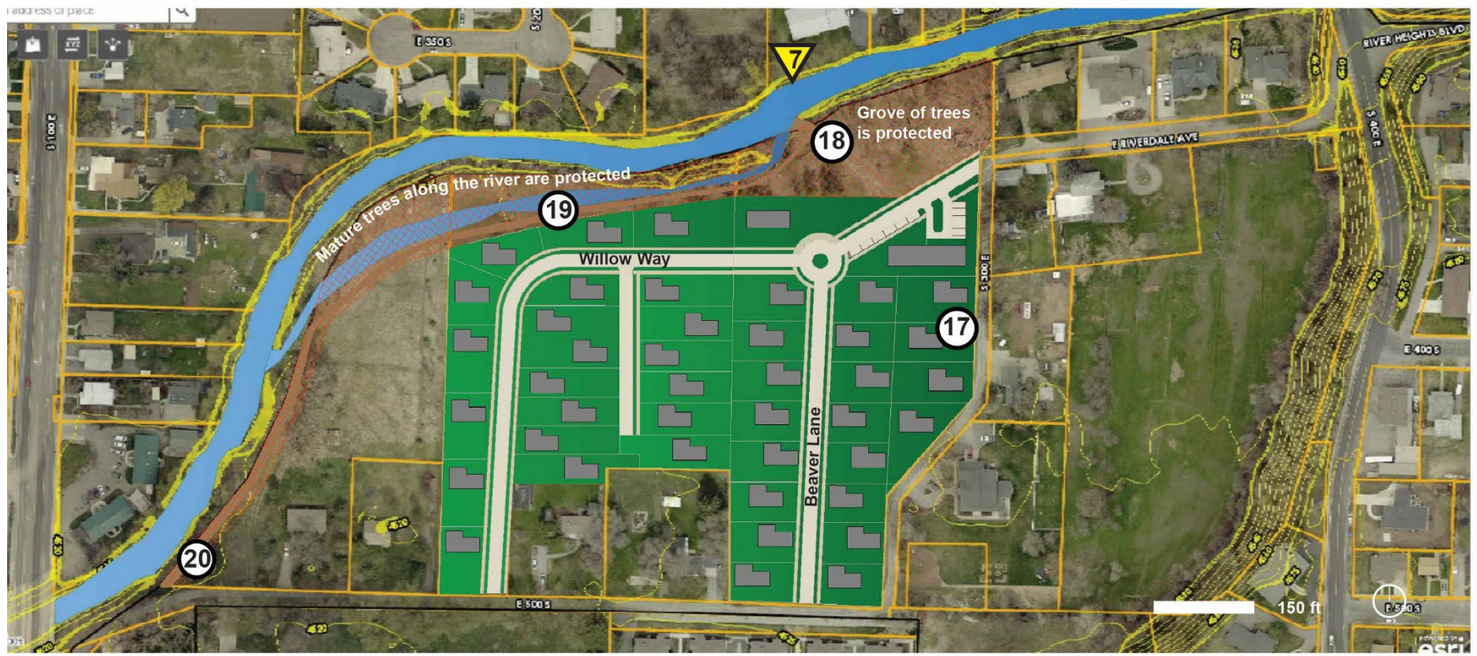
18 Riverdance Park represents the Common area of the Planned Unit Development (PUD) and consists of the riverfront conservation easement that protects the riparian edge, making public access to this amenity possible.

19 The Seasonal Braid protects the houses built on the right bankd of the river and can serve as an ecotone between the former farmland and riparian area, improving habitat for flora and fauna.

20 The Logan River Trail Connection connects the South West part of the trail to the North East part of the trail, continuing up to First Dam and the Bonneville Shoreline Trail.


Existing conditions - Looking downstream from River Heights By: Author

River Heights - Green Community




Solar village in Freiburg, Germany, generates 4x its need
Source: Solarsiedlung_Dachaufsicht - rolfdisch.de

Existing Situation: Property for sale - Potential Green Village By: Author

Logan has an elevation of 4,534 ft with temperatures varying between 1°F to 96°F. Most of the precipitation occurs between October and May, with the total annual average being less than 15". The climate is classified as Dfa/Dfb (Hot summer; humid continental zone) To take advantage of its geographic and climatic position, the shade pattern at Winter Solstice when the sun at noon is at its lowest level and casts the longest shadow dictates both the orientation and placement of the buildings. Staggering them allows for maximum solarization of each individual dwelling. The roof design serves the triple function of protecting the dwelling, collecting water, and capturing solar energy.


Roof integrates solar and rainwater catchment.
Source:https://turfhugger.blogspot.com/2012/01/golf-course-sustainability-through.html


Existing Condition: Property for sale - Potential Green Village By: Author

River Heights - Green Community

7 17 18 19 20

Houses are designed and oriented to capture the maximum amount of sun for energy and passive solar heating. The location and height of the South-facing windows give the winter sun the best opportunity to heat up the interior of the home, while the roof partially shades the interior in the summer. The roof also captures rainwater and is connected to a harvest and storage system with a 2,500 gallon storage capacity (Greene et al., 2015). Conceptually, the only secondary water sources for irrigation in the community would be rainwater and gray water recycling, providing some relief to the river and aquifer system. Runoff from the development should also be treated on site.

(a) **The slanted South-facing roof maximizes energy capture as well as rainwater which is efficiently collected on one side and conveyed to the storage tank.**

(b) **A rainwater storage tank provides gravity-based flow to irrigate garden areas.**

(c) **A control valve allows graywater from bathroom sinks and showers to flow directly into the garden or follow the course of blackwater for municipal treatment.**

(d) **The garden area is filled with a variaty of native and climate-appropriate species. Goats and chickens offer lawnmowing services. No pesticides or artificial fertilizers are needed.**

(e) **The building structure is post and beam with strawbales and plaster. The strawbale insulation offers an insulation or R-value of 50+, while the natural plaster is breathable, flame retardant, and protects the strawbales. All these materials are also locally sourced and recyclable.**

River: Treating runoff on site protects the river from contaminants. Reducing the secondary water supply to runoff and gray water also helps create a greater conservation consciousness. Native plants are adapted to the local conditions and offer ecologic benefit. (1ii, iii, iv, v; 2i, ii; 3i, ii, iii; 4i, ii, iii; 5i, ii)

Residents: There are many benefits to living in a green home. Savings on operation and maintenance accompany the benefit of being less dependent on external inputs, including fossil fuels. Natural materials also sequester carbon, offsetting greenhouse gases (GHGs). (1i, ii, iii; 2i, ii, iii; 3i, ii, iii, iv, v; 4i; 5i; 6i, ii, iii)

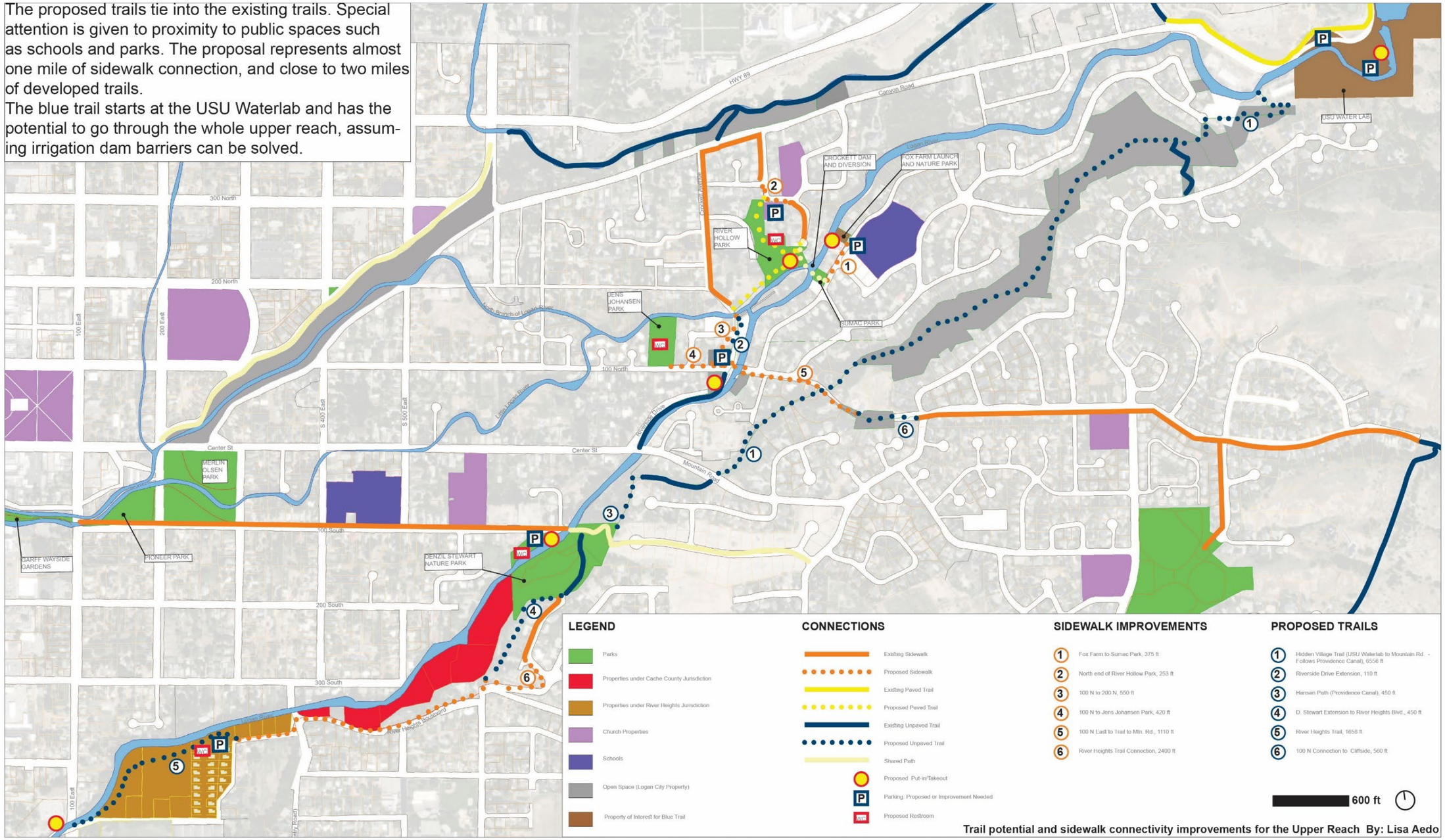
City: A community that thrives on less demand for services and helps reduce risks such as floods reduces maintenance costs while allowing greater independence for its residents. (1ii, iii, iv; 3i, ii, iii; 4i, ii; 5i, ii; 6i, ii, iii)


Winter Solstice, December 21 at noon By: Author


Summer Solstice, June 21 at noon By: Author

Trails 12 14 16 20 21 22

The proposed trails tie into the existing trails. Special attention is given to proximity to public spaces such as schools and parks. The proposal represents almost one mile of sidewalk connection, and close to two miles of developed trails.
The blue trail starts at the USU Waterlab and has the potential to go through the whole upper reach, assuming irrigation dam barriers can be solved.



Trail potential and sidewalk connectivity improvements for the Upper Reach By: Lisa Aedo

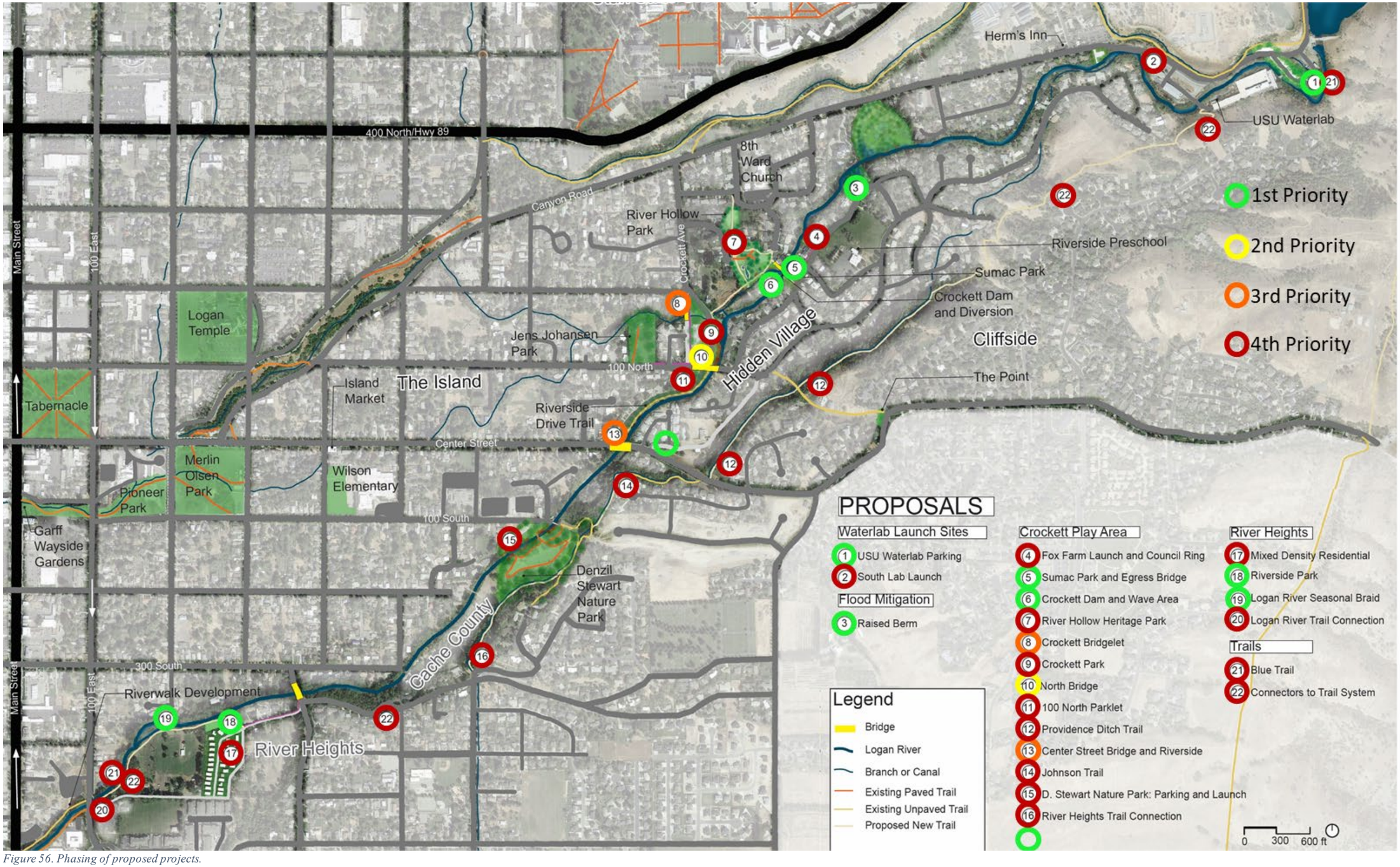


Figure 56. Phasing of proposed projects.

Conclusions

From the outset, the intent of this thesis was to help identify potential projects and areas for applying perspectives derived from the river, the residents, and the city (cities). The Conservation Action Plan by the Logan River Task Force served as an expression that represented the river and recreational interests that serve both residents and the city. Upon further research, I found that there are challenges related to infrastructure decay or inadequate infrastructure planning as pertaining to egress from Hidden Village. Current residents also express an interest in improved access to the river, while also protecting their properties from trespass and vandalism. To some, erosion and flood risk are an additional source of worry. Local governments and residents are also concerned about environmental degradation and ecological decline, particularly related to low summer flow, riprap and hard-surface edges with poor vegetative cover, and the pressures of existing development on riparian zones. The vision for the Upper Reach thus became an amalgamation of potential sites where different types of opportunities exist.

My understanding of the area was informed by the frameworks provided by the Cultural Values Model (CVM) which was useful in conceptualizing the historical and cultural influences that have given us the current appearance of the Upper Reach. The evolution of the Upper Reach from wilderness to agricultural land and then suburban residential development implies different ways of evaluating and thinking about the land throughout the years, including changes to land use codes. Such codes have not been uniform or consistently applied or maintained, resulting in a somewhat patched pattern of planning, development and riparian treatment. The advent of the automobile further pitted the social vs. the ecological in terms of how land was developed. Another factor is

the conveyance and use of water. Until now, this has been controlled by irrigation companies and the supervision of the Utah Department of Water Rights under the supervision of the State Engineer. All these influences affect the reach in different ways, and not necessarily in any particular area or by any one group of people. Evidence of this is the ongoing debate about a proposal to pipe the irrigation canals and ditches from the Crockett Canal (Christian, 2021). One can wonder at the entanglement of the economic, social, and ecological interests in this discussion as the curse of triplopia continues. Finding solutions goes beyond the Upper Reach and should be part of a holistic systems perspective. Applying the understanding provided from the CVM could help us understand the historical significance of the existing system and unify the individual objectives into a whole, multifunctional approach that does more than solve one problem. By thinking about the whole reach from different perspectives there is a better chance at creating positive synergies within and between proposals. The reference boxes organized by "River," "Residents," and "City" in the design chapter (Chapter VI) help define whose and which objectives are met or are possible as part of the design.

In terms of next steps, I refer to the Urban Stream Renovation (USR) model. For over 100 years, Anthropocene interventions favored social benefit over ecological. This predilection is now in flux as we recognize the need for ecological balance to our interventions and use social impetus to further demand ecological benefits. An example is the formation of the Logan River Task Force as a voice to represent the ecology of the region. The masterplan developed relied on their Conservation Action Plan in addition to original research, and illustrates areas and opportunities that exist to bridge the social and ecological gaps. As can be seen, strategic properties can be acquired and returned to a

more nature-friendly state while offering greater opportunities for recreation and learning. Figure 46 outlines the hierarchy of priorities in addressing the proposals. More should be done as we face the real challenges related to climate change. While the proposed projects are physical sites where positive changes can be realized, there is a need to educate ourselves and society at large about current detrimental paradigms related to our own thought processes and behaviors. Our dependence upon cars, technology with high associated carbon footprints, and polluting, social injustice-promoting global supply chains, all combine to put world ecology, and thus society in jeopardy. The Upper Reach is only a three-mile segment of the Logan River, yet it reflects all the challenges that are part of that paradigm. The best way to address it, I believe, is through education and the use of positive examples in our designs and in our media. School curricula should be designed to help us think realistically and critically about the consequences of what we have done and are currently doing to our environment. The green community proposal, in addition to solving some existential challenges, is also an opportunity to offer learning and leadership. As such it can help in the process of changing how we relate to our environment and curb our excessive wants.

With regard to implementation of the proposed projects, the suggested hierarchy of priorities in Figure 56 is primarily based on the feasibility of renewing the infrastructure to meet the urgent need for a solution to access and egress to Hidden Village. This takes priority in order to safeguard the ethic of protecting health, safety and welfare of human beings. It also considers the ethic of doing no harm. It does not, however, preclude doing much good to benefit society as well as ecology.

Since the start of writing this thesis, some things are happening that could portend

a better future for both ecology and society. The Wilson Neighborhood Council, which is operative around the Upper Reach, is engaged in conversations about the use and distribution of water in the Logan River. Wasatch Development, which is in charge of development properties across the 100 East bridge just past the end of the Upper Reach, has expressed interest in incorporating more of the ecological principles recommended by Bio West and the Logan River Task Force into their designs. The Cache Water District is more actively engaged in obtaining public comment regarding their plans to pressurize the water used for irrigation. Such opportunities for hearing and being heard are important for the future of holistic design. They are essential in making the decisions that can help us survive the environmental challenges we face.

Final Thoughts

This attempt at developing a vision for the Upper Reach of the Logan River became a collection of project proposals and design development ideas that reflects a desire to design with Nature and promote the restoration of ecology negatively affected by human development over the past 170 years. Our cultural heritages have been influenced by European royalty and the Industrial Revolution, which historically treated nature as a canvas for aesthetic and existential preferences. Our government, economic system and predilection for bottom-line efficiencies also affect the ways in which we interact with our local ecosystems. The shift in design from human scale to automobile scale plays an important role in how we have approached the development of infrastructure. As we face climate change, the Covid-19 pandemic and increasing financial uncertainty, we need to reconsider our coexistence with Nature and each other. With regards to the Upper Reach, I have three thoughts about improving our relationship

to it:

First, we need to understand that each river is part of a larger system, and that every reach, tributary, and system is unique, offering unique habitats for unique species whose development and relationships have taken centuries and millennia to become what they are. This is the opposite of the industrialized cookie-cutter, single-function mentality we often use to propose interventions in nature. A focus on observing and understanding the ecological system and local cultural background that an intervention site is part of should be a priority. The efforts of the Logan River Task Force and the Conservation Action Plan are good foundations upon which to build. More educational initiatives could be developed with the local schools at all grade levels to learn about and sustainably interact with our unique cultural and natural resources. The designs put forth here contemplate the use of nature itself as an educational tool to help sensitize the residents and the city to its past and the needs of our ecosystem, our common ground.

Secondly, the local and state governments have the power to define zoning and code that affects development around natural resources. They have the power to determine easements around rivers and canals, set goals to improve infrastructure, and motivate sustainable growth in the best interest of their communities. The proposal to convert the existing irrigation system with piped secondary water from the Logan River, and the development of water banking, is fraught with many unanswered questions. While it is understood that no more water can be taken from the river than is currently allowed, under such a development some amenities, such as the water running through public parks, may be lost (Lavoie & Sleipness, 2018). Additionally, excess unused water, if put in a “bank”, may further exacerbate the evaporation of the Great Salt Lake. Also, if

municipalities see such bank-water as an opportunity to generate income, there will be a greater disincentive to release it back to its natural course. For these reasons, greater evaluation, and coordination, both locally and state-wide, should be realized before steps are taken to implement such mechanisms.

Finally, understanding the human ecosystem and local needs and wishes is of paramount importance for successful designs. Because these needs and wishes change with time, being aware of the historical progress that brought us to the here and now is important in projecting for the future, as in this case where naturalization and renovation provide an opportunity for bringing back part of a natural system for ecological benefit while also seeking to foster social benefit through recreation and education. Because our society is not only more diverse and pluralistic than ever before, but also more politically polarized, polarization, greater effort needs to be made to widen be made to widen the circle and build the bridges necessary to hear one another with openness.

The proposals in this thesis are the result of my research and conversations with professionals and community members, attendance at conferences, as well as observations from the LAEP coursework and WATS capstone classes I attended. While there is no agreement or commitment for anyone to heed these proposals, my hope is that they might be a source of inspiration. As a collective vision, they serve to provide a basis for ideas and a starting point for discussions about renovation projects along the Upper Reach of the Logan River.

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APPENDIX I
Members of the Logan River Task Force
(letters in red indicate a change):

Member	**Affiliation**	**Expertise/Title**	**[Comments]**
Akina, Russ	Logan City	Parks and Recreation Director	
Artz, Neal	Cache Anglers	Natural Resources Management and Rural Sociology	
Allred, Mike	Utah Division of Water Quality	Environmental Scientist	
Davies, Eve	PacifiCorp	Environmental Scientist	
DeRito, Jim	Trout Unlimited	Fisheries Restoration	
Dettenmaier, Megan	USU	Forestry Extension	
Fotheringham, Bob	Cache County	Irrigation Districts [Water Manager]	
Hardman, Jon	Natural Resource Conservation Service	District Conservationist	
Hawkins, Chuck	USU	Stream Ecology and Assessment	
Henderson, Bracken	Utah Association of Conservation Districts	Zone 1 Coordinator	
Horsburgh, Jeff	USU-Utah Water Research Lab	Engineer	
Houser, Lance	Logan City	Engineer	Now with Franson Engineering
Howe, Frank	Bridgerland Audubon	Avian Ecology	
McKee, Mac	USU-Utah Water Research Lab	Engineer	
Messner, Nancy	USU	Water Quality and Watershed Management	
Nielsen, Mark	Logan City	Public Works Director	Now overseeing Wastewater Treatment Plant
Roper, Brett	USU	Stream and Fish Ecology	
Runhaar, Josh	Cache County	Development	Now with

		Services Director	Neighborhood Housing Solutions
Sorenson, Kent	Utah Division of Wildlife Resources	Habitat Biologist	
Thompson, Paul	Utah Division of Wildlife Resources	Aquatic Program Manager	
Wheaton, Joe	USU	Fluvial Geomorphology and River Restoration	
Wilcock, Peter	USU	River Sedimentation and Stream Restoration	
Advisors	**Affiliation**	**Expertise/Title**	
Booton, Beth	Citizen	Recreationist	
Daugs, Nathan	Cache Water District	President	
De Giorgio, Joan	The Nature Conservancy	Conservation Planning	
Norman, Nate	Cache Valley Wildlife Association	River Restoration Revegetation	
Organizations			
Logan City	Logan River Observatory	Cache County	Utah State University
Utah Division of Water Quality	Utah Division of Wildlife Resources	Natural Resources Conservation Service	Utah Association of Conservation Districts
PacifiCorp	Cache Anglers	Trout Unlimited	Bridgerland Audubon Society
The Nature Conservancy	Cache Water District		

The key task force contacts are Frank Howe and Darren Olsen, of Bio-West, a multi-disciplinary environmental science firm.

APPENDIX II

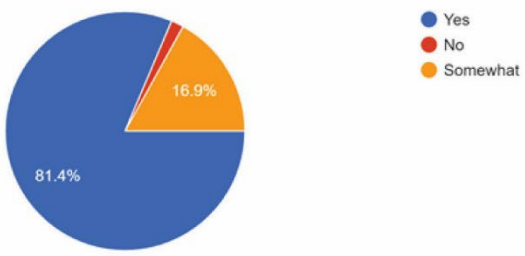
Survey: What would you like the future of the upper reach of Logan River to be?

Purpose: To understand local perceptions and attitudes about different aspects related to the Logan River Reach from the USU Water Lab by First Dam to 100 East 600 South. (See map below). Your feedback and comments will be included in a vision study to guide and inspire future interventions in this reach.

This survey was realized via Google Forms between December 2019 and January 2020. It was sent out through the Nextdoor app to the neighborhoods around the Upper Reach, reaching approximately 2,000 residents. Additionally, the Wilson Neighborhood Council promoted it at their meeting in December 2019. While some thought it was "too long", the objective was to understand the qualitative preferences of the river aesthetic as well as other aspects regarding recreation, access to the river and water use. The survey was granted IRB approval #10522 on 2019-08-23.

The Upper Reach of Logan River

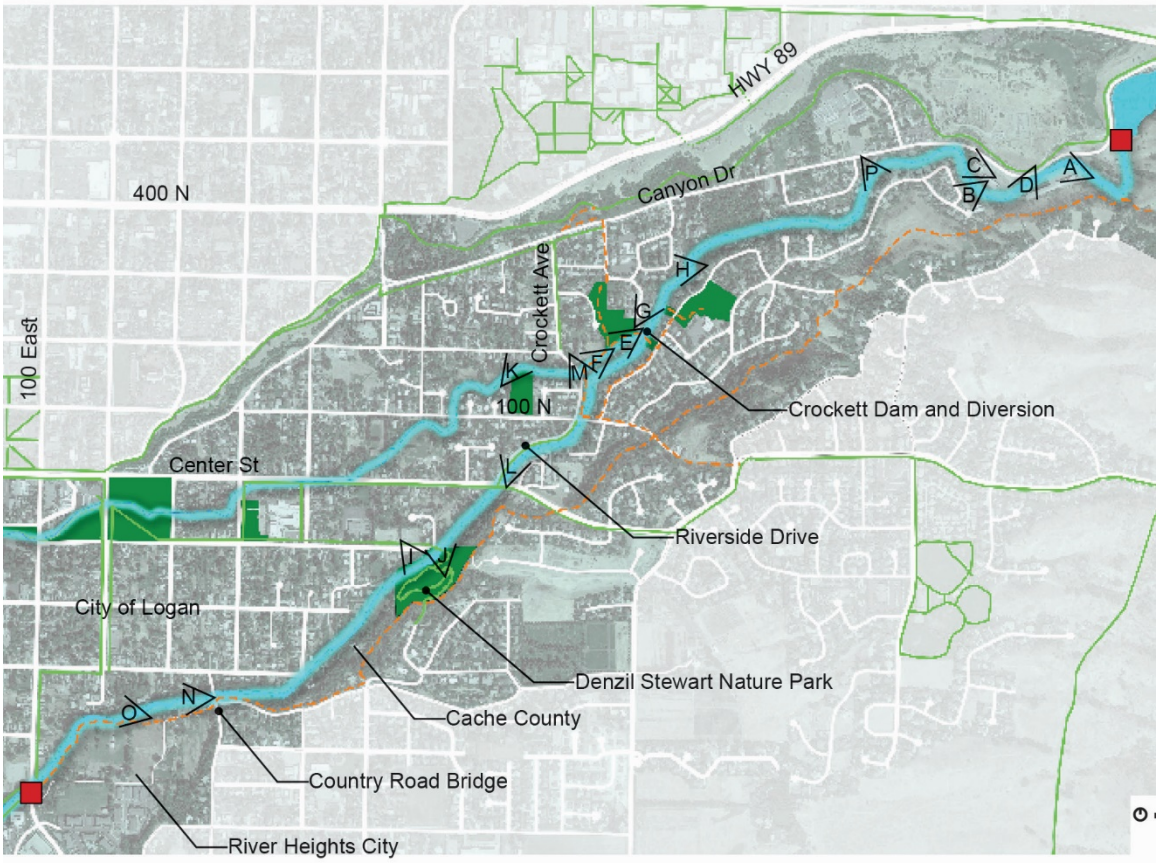
Q 1. Are you familiar with the above-mentioned reach?



Q 2. Qualitative aesthetic evalutation of riparian edges along the Upper Reach (N=59)

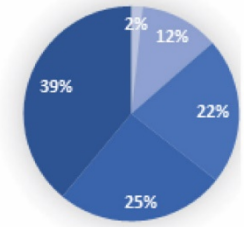
The following map shows the location and direction of the photos used for the survey.

For each image, the participant was prompted to express to what degree they approved of the river edge, where 1=Not at all, and 5=Very much.



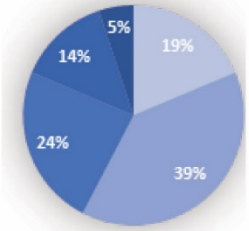
Q 2. For the following images please indicate how well you like the appearance of the river and the river's edge:

A - From USU Waterlab bridge



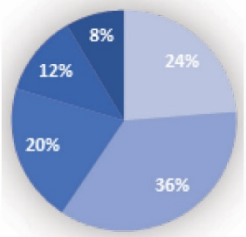
64% liked this edge "very much" or "much". 14% did not like it, and 22% were unsure.
The density of the underbrush could be a factor, as well as the seasonal drabness.

B - Looking across to river property from USU Waterlab

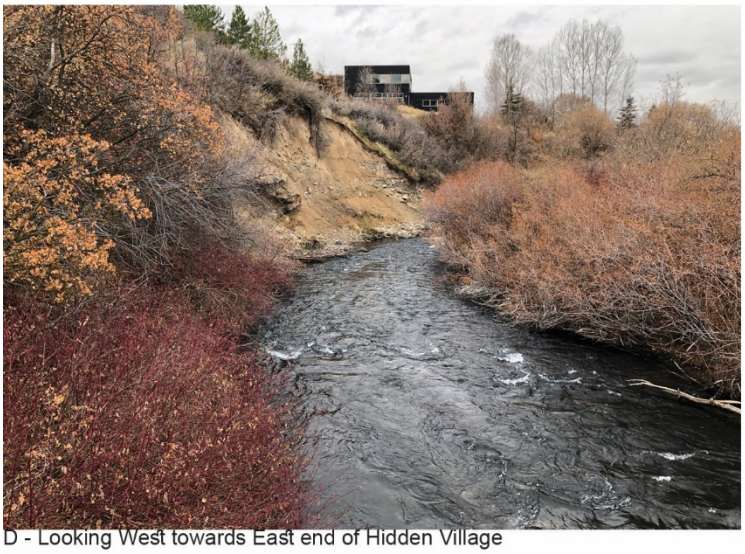


58% do not like it; 19% like it, and 5% are not sure.
The untidy appearance of rip rap adds to the lack of life in the hardscaped edge.

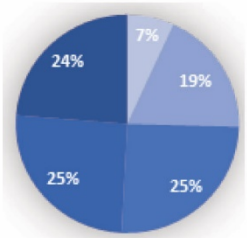
C - Looking at Canyon Road from SW tip of USU Waterlab



60% do not like it; 20% like it, and 20% are not sure.
Here the river was redirected to allow for Canyon Road. The rip rap levee, while stable, creates a hard surface channel.

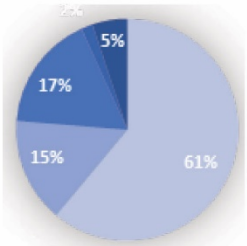


D - Looking West towards East end of Hidden Village



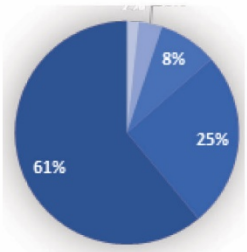
49% in favor, 26% negative, and 25% undecided. The opinion on this image is divided; vegetation could be the plus, but severe erosion on the left bank is a concern.

E - Crockett Canal, or Little Logan River after diversion



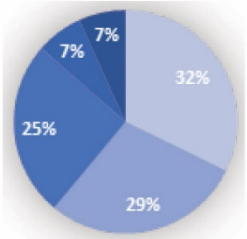
76% agree that this lacks aesthetic appeal. Only 7% approve. This infrastructure was put up after a 1984 flood in the park and neighborhood.

F - Just after the channel, this canal seems more natural



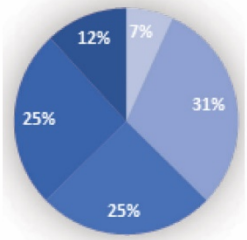
85% like the aesthetics and 6% disapprove of this stream appearance, flowing quietly through the South tip of River Hollow Park. Native vegetation lines the streambank.

G - Crockett dam and diversion; dam infrastructure at right



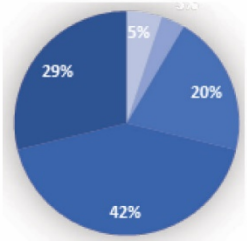
61% disapprove; 14% approve of this treatment. The hardscaped banks offer some protection from erosion and flooding, but nature is absent from the banks.

H - Hardscaped edge on right bank; instream feature



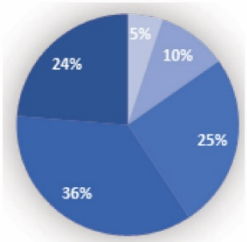
37% approve; 38% disapprove, and 25% undecided. Verdict is mixed. Note naturalistic boulder-edge hardscape on right bank and native vegetation on the left. The weir creates riffle effect.

I - Left bank at Denzil Stewart Nature Park. Some erosion



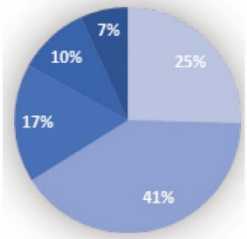
71% approve; 4% disapprove. The setting and vegetation framing the river creates a pleasant aesthetic. Banks are open allowing access to the river.

J - Looking North from East bank of D. Stewart Nature Park



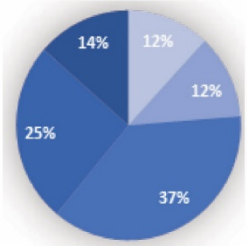
60% are in favor of this appearance with 15% opposed. The bridge is high enough to allow the passage of paddlers. Hardscape is mixed with grasses and other vegetation.

K - Backyard pump across from Jens Johansen Park



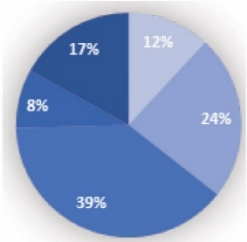
17% in favor; 66% against. Boulders line the riverbank with a "homemade" pump system to take advantage of watering.

L - Riverside Drive channel of the 2014 dispute, looking North



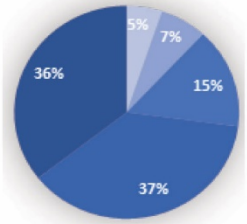
39% in favor and 24% opposed; 37% neutral. The hard river edge with boulders in the channel and shade-creating vegetation eliminated on the West bank were at the heart of the dispute in 2014.

M - Looking down the spillway from the Crockett canal



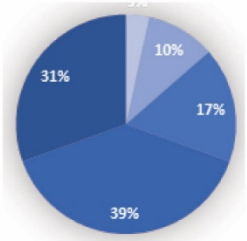
Mixed opinions for mixed appearance: 25% favor and 36% against; most are neutral. The property in center has a hardscaped riparian edge with no vegetation for habitat or to shade the river.

N - View downstream from Country Road Bridge



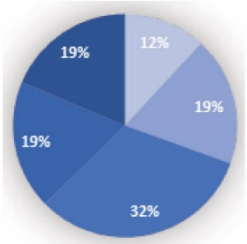
73% approve of this appearance with 12% opposed. Tall shady trees with mixed vegetation understory frame a tranquil flow through the River Heights and Logan area.

O - River Heights on left bank; Logan on right



70% favor; 13% not. Natural edges and tall trees. Residences on Logan side are close to the river's edge.

P - Below Herm's and USU Waterlab, mixed edges



38% approve and 31% not, with 32% neutral. Different elevations create interest. Vegetation is also varied, arranged between areas of themed hardscape. River energy reflects slope.

The comments received about the above photos and evaluations were:
Channelization sucks!

The brush provides places for the fish since the banks are not undercut. The rocks are necessary for stabilization because all the vegetation has been removed, so not natural in appearance.

Natural banks with willows, brush, and native plants and natural rocks look best and are good, better looking erosion control.

I believe that homeowners have the right to protect their property from flooding. dead brush needs to be cleared out, and native vegetation planted. Trash needs to be removed.

You should look at what other cities with famous riverwalks have done.

I like best the most natural looking scenes. Where there are houses, etc., it's most appealing if there's a minimum of junk visible.

I like a river to be in its natural state as much as possible. The thing is, people have purchased properties on the river and have changed the look of the river and river's edge around those properties. Some are tasteful, some are not but that view is in the eye of the beholder, of course. The only thing I did to my river property, from when I purchased it in 2013, was add riparian plants and trees to the edge to help support the bank. There is much concrete, placed many years ago, instability and erosion around my property. I pay for flood insurance and even have a basement. I currently am renting out my home but will be there most of this coming summer. If you ever have any questions for me, as a somewhat environmentally conscious river property owner, feel free to call. I am thinking that is why I got this email as I own a river property.

Keep it wild and natural and hard to access

Laid back banks are easier for river access and better floodplains for the river but already built houses may still need some hard structures put in place to protect them. Vegetated banks are better for ecosystem function but willow thickets make it hard to access the river.

Recognizing the existing constraints of houses, and roads encroaching on the river I would like the Logan River to look and function as naturally as possible.

I realize the river has been contained in some places but it's not worth tearing everything out just to put a more natural edge on the river. These sections seem to be very short. The natural edges of the river, minus trash, looks good. I wonder about places for tubers/kayakers/canoers to get out. The private property 'amenities' are just part of individuals wanting to enjoy the slice of river next to their properties. It's not so bad that expense should pay for 'clean-up' or change. Lisa, aren't all rivers owned by the state. When you said in the Nov 21st Wilson Neighborhood Council meeting that some property owners didn't want people floating past their homes, that isn't for them to say 'nay', is it ?

Like areas where there are no buildings and where the rocks and/or plants are in good condition

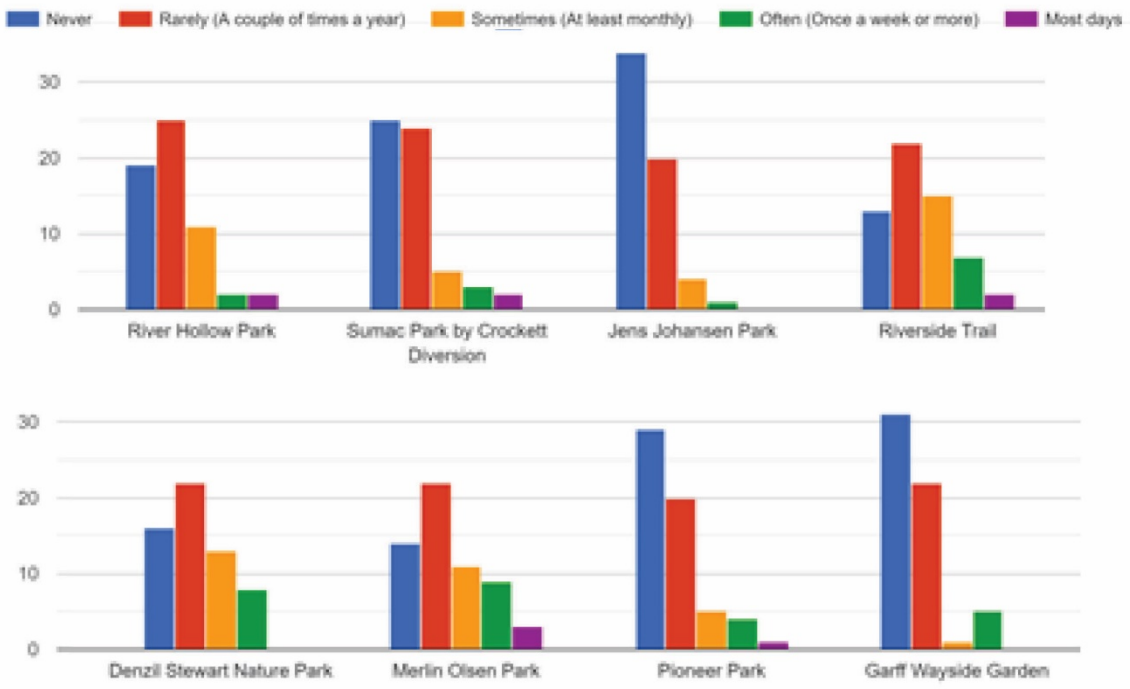
Where there are homes there has got to be mitigation against the once every century or so floods

These modifications were put in place to move water downstream as quickly as possible. They are in direct conflict with fish-friendly and attractive waterscapea.
Aesthetics should follow function, i.e. a healthy riparian corridor that doesn't endanger property owners is a difficult enough endeavor. Make it look as nice as possible in the process.

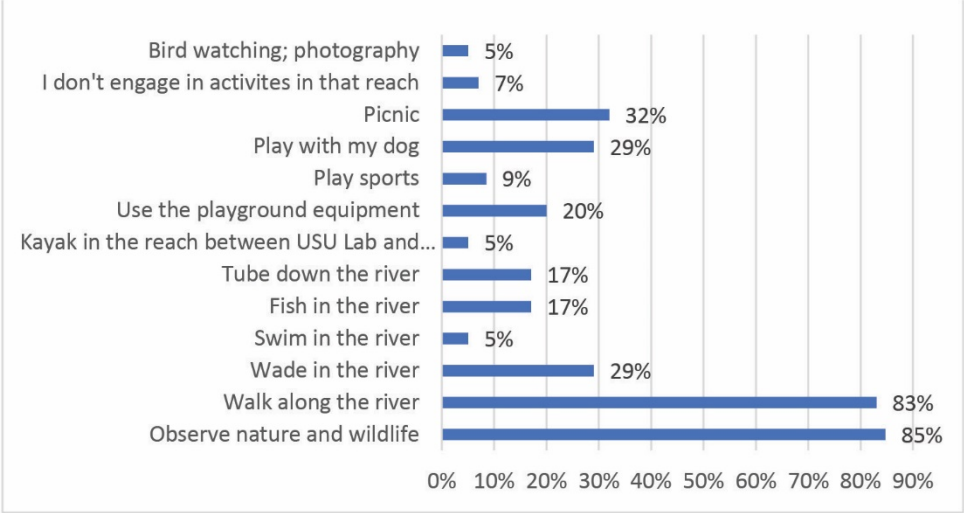
River can and should have different looks. There are locations where it is difficult to do much because of how houses have been built. Should be open and provide recreational activities for citizens.

I hope that in the course of improving the function of the river as an asset to our community, that the city can implement setbacks that prevent construction immediately next to the river as shown in some of these photos.

Q 3. Below is a map showing public parks along the reach. These are the only official public areas on the Logan River and Little Logan river in this reach. Please indicate how often you use each of these parks.

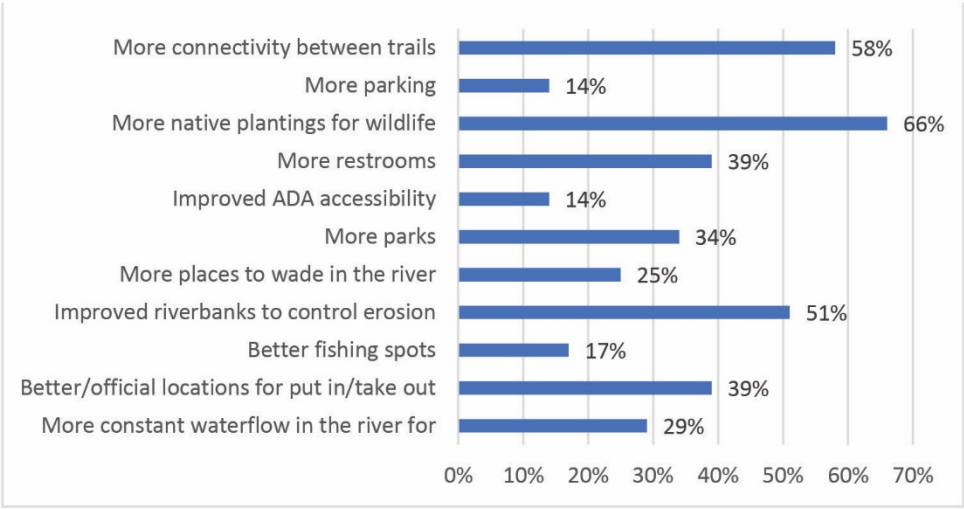


Q 4. What activities do you engage in along the reach (check all that apply)



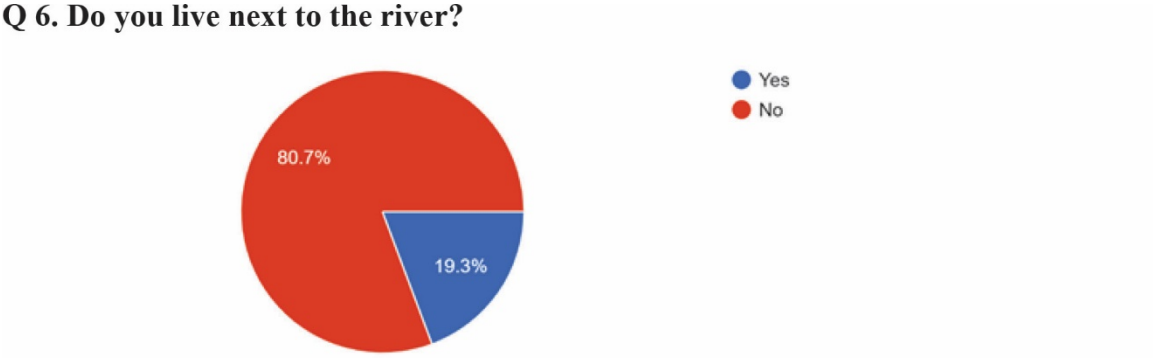
Other activities added were: Drawing, reading, oil painting, running through, jogging

Q 5. Are there amenities or recreational opportunities that are missing from this reach? (Check all that apply and/or add your comment at the end)

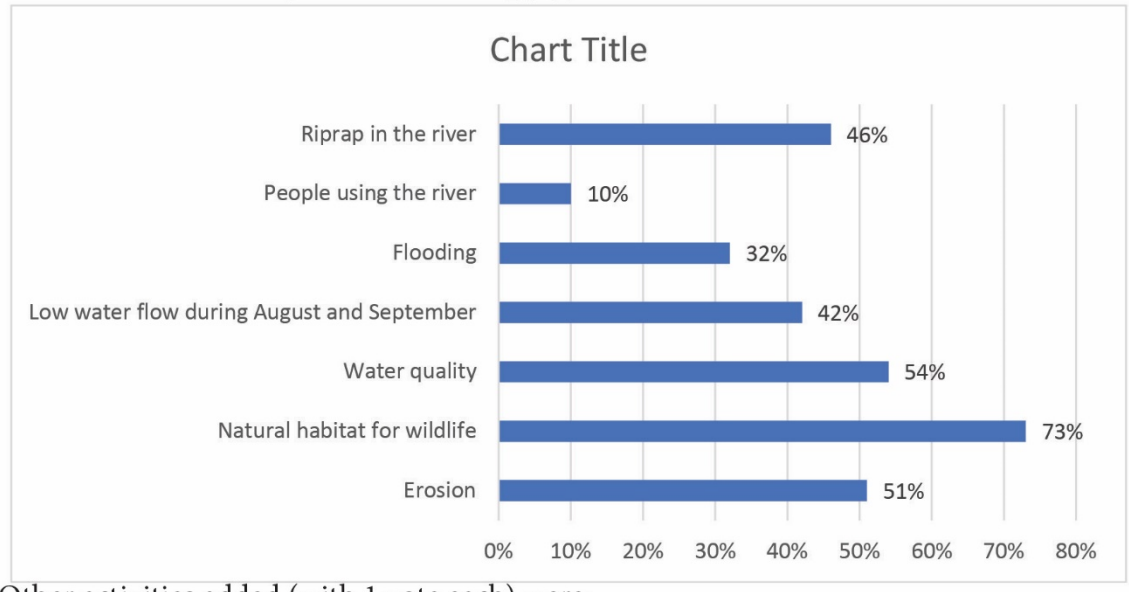


Other activities added (with 1 vote each) were:
More connectivity beteween trails along the river
Not enough secluded private areas
Open stream access as guaranteed in Utah state law
Removal of invasive species
Wasn't even aware of recreational opportunities
More natural growth and brush
More dog parks/ access

Q 6. Do you live next to the river?

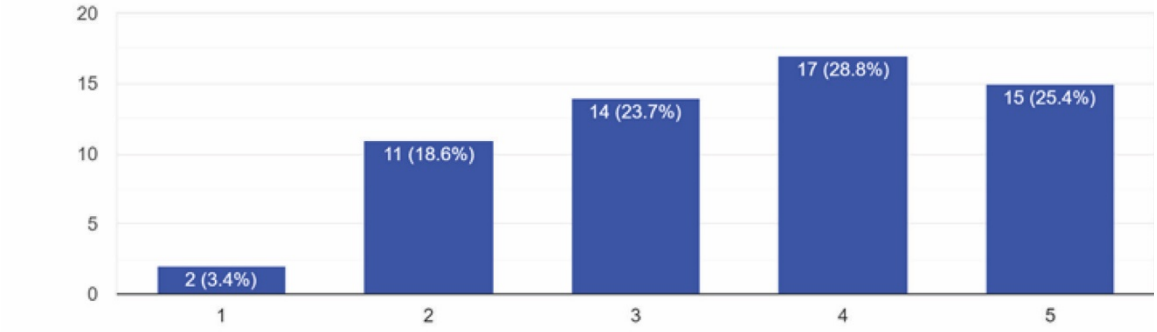


Q 7. What are your concerns about the Logan River reach from the Water Lab to 100 East 600 South? (Check all that apply)

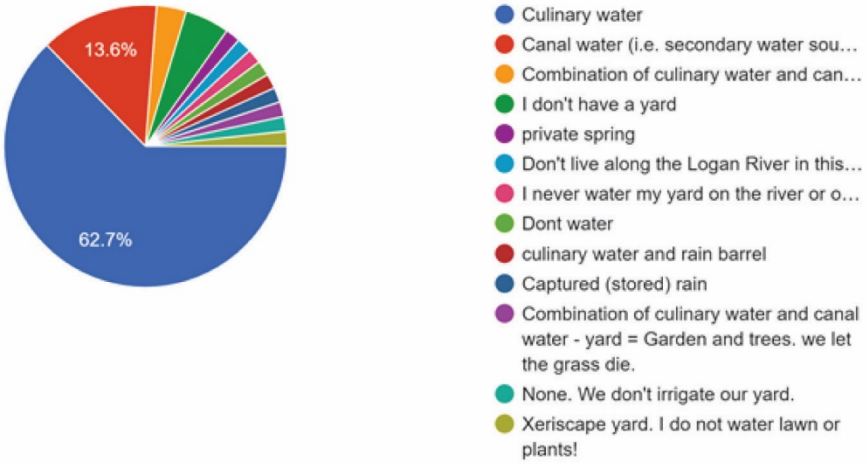


Other activities added (with 1 vote each) were:
Destroying the natural look
Access
I witness white stuff being dumped in the river last summer and reported it to the city
There has been no effort whatsoever to make the building friendly to the community, in spite of its location in the middle of residences and amenities
Lack of access
Lack of access at Crockett Diversion for kayakers to exit/enter the river to avoid the falls.
Need to remove the diagonal concrete diversion dam that is below Stewart Nature Park
Breaking up the corridor. For example, with the extension of 2nd East across it.
Run off from yards. Many yards throughout the season have "do not walk, spray.." signs out. Most of the overflow from irrigation shares goes straight from houses along the river corridor back in to the Logan River.
Too much private property restriction; need trails corridor.
Loss of shading as the war on Crack willow continues. Perhaps move to targeted pruning until some of the replantings have gotten established.
All residents having access to river to enjoy its beauty.
Loss of natural foliage cut down by city not good for the natural vision of Logan River Canyon: Leave it natural!

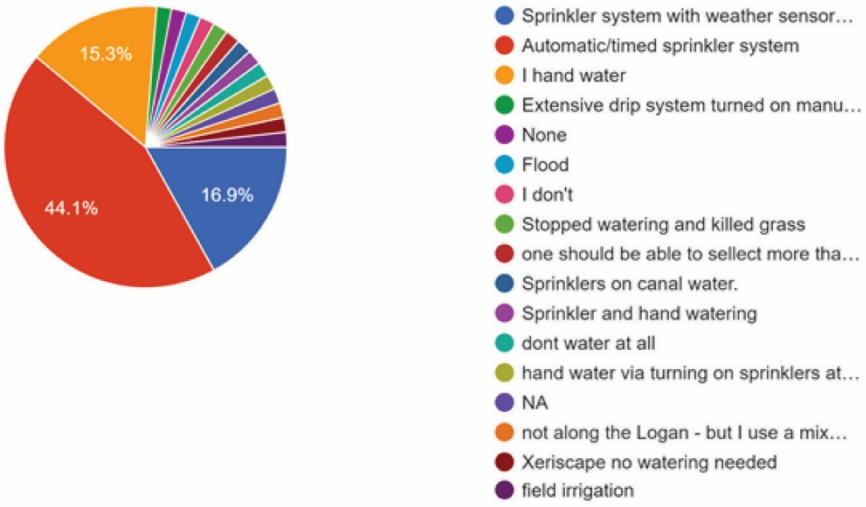
Q 7. What is your level of concern about the river drying up in the summer? (1= Not at all concerned, 5 = Very concerned)



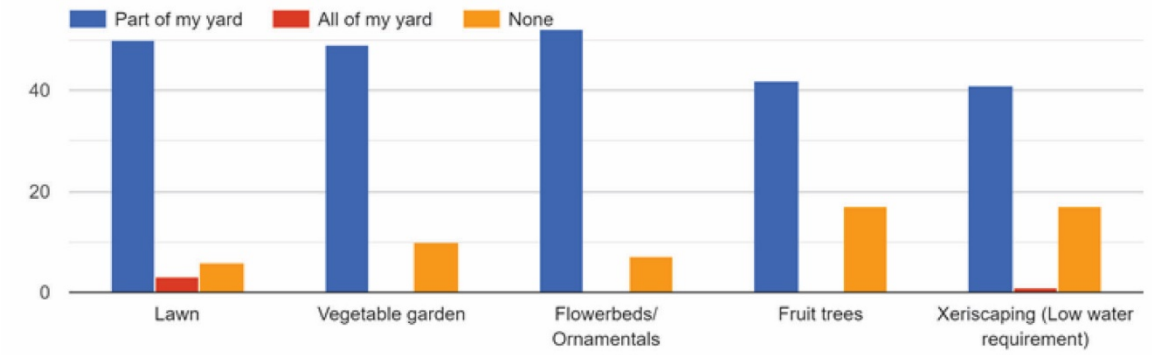
Q 8. What water do you use to irrigate your yard?



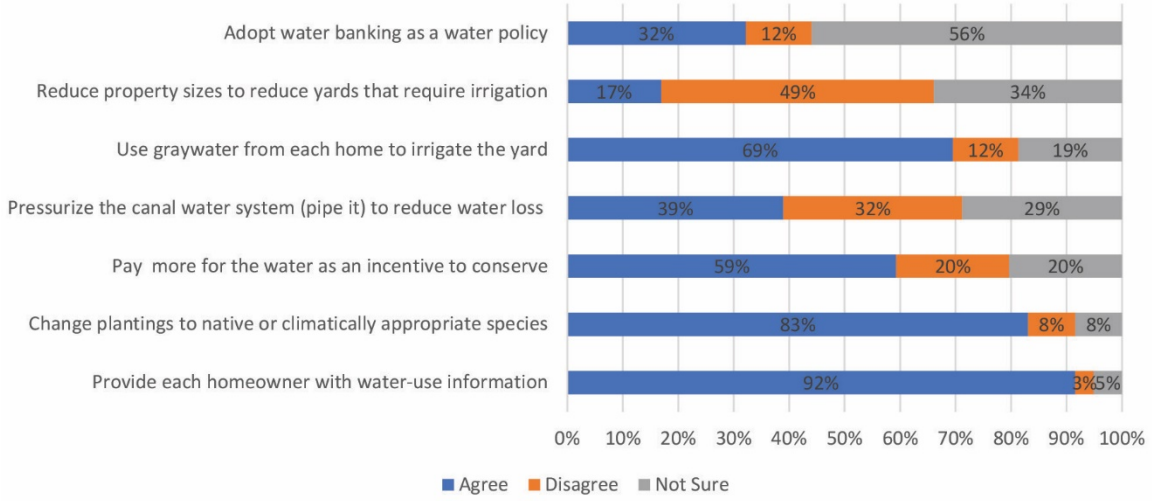
Q 9. How do you irrigate your yard?



Q 10. Please indicate the types of landscaping you have in your yard:



Q 11. Please indicate whether you agree or disagree with the following about how to conserve water:



Other comments:

Flood irrigation for 12 years really helped our garden/ back yard when we lived on 64 e 400 s until Wasatch bought our property and we moved to a yard that has a sprinkler system with no option of canal water. We will probably get a barrel to catch rainwater when we put in our garden next spring.

I know, in the West, there is a need to conserve water but I've researched using gray water for irrigation and find there are quite a few undesirable aspects associated with that. I don't know what 'water banking' is. I don't know how pressurizing the canal will impact water use or conservation. Pamphlets are a waste of money. I found the website 'Slowthe-flow' myself that helps me know how much to irrigate. I would not want to increase the price of water. How to reduce property sizes or change plantings without infringing on individual's rights to have the size and plantings they want ? I grew up with a rainwater cistern and learned at an early age to not waste water. How do you teach 'saving water' techniques to people who haven't had to worry about it before ?

Limit population growth.

You listed all of them!

Increasing housing choice to include yardless high density housing would make a huge difference.

Change sprinklers to drip

Need a secondary irrigation system. My wife kayaks these sections many times each year. I don't kayak anymore--too old--but I have canoed or kayaked here in past years.

Incent home rainwater collection. Stop municipal lawn installations. Incentivize xeriscape. Strongly discourage sprinkler systems that send out a mist that evaporates before it hits the ground. Discourage watering during hottest, windiest parts of the day.

Education is more effective than punitive, dictated regulations.

limit growth

Education and supplies for catching rain water to use on yard

allow sale of unused irrigation rights for domestic watering

Allow irrigation only on certain days to prevent people from watering their lawns Every Single Day.

Establish an native plantings nursery through USU, Utah Conservation Core and/or the County Extension. River front houses get native plugs and bareroots at cost. As well as free consultations on their properties from grad students, Extension, and/or nursery staff.

Non-river properties should be offered Xeriscaping plantings and/or consultations as well.

The prospect of free should get the homeowner into contact with valid information.

Allow local nurseries to host events so they do not feel like they are losing business but riparian or xeriscaping plants should not be just handed out.

Remove more lawn. Add more trees for shade. Accept "weeds" as adapted plants. Limit watering to once a week. Raise lawnmower mowing height. Make friends with a brown lawn. Make friends with your neighbors who have brown lawns. Capture water from roof tops for garden and lawn. Water garden/lawn at night only.

Ban people from washing their cars, 4 wheelers, RVs, etc. in their driveways, have driveways that conserve water instead of solid concrete slabs, better sprinkler systems, less water used by the university, public schools, public properties, more reycling of gray water everywhere

Question about landscaping (before this question) doesn't provide a native vegetation option (NOT necessarily xeriscaping).

increase education on water use in arid states

Our home has no access to canal or pressurized water. Most homes in Logan have no access to it. A big mistake by the city in days gone by.

Not sure what water banking or Row 8 refers to

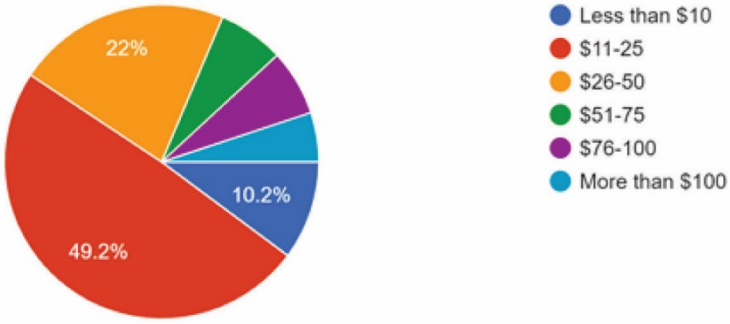
Use wood chips or mulch, inexpensive from city facility

Make large water users such as business is a lot more responsible

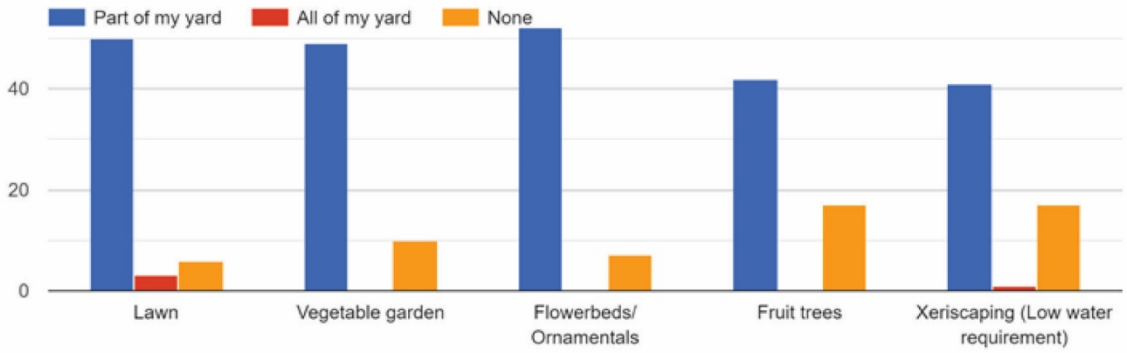
Make it illegal to water your lawn before sunset and after sunrise.

Not sure

Q 12. If irrigation water were billed separately from culinary water, what would be the maximum amount you would be willing to pay per month for irrigation water?

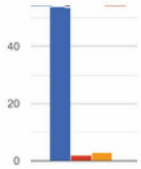


Q 13. Please indicate the types of landscaping you have in your yard.



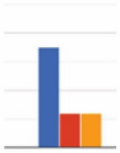
Q 14. Please indicate whether you agree or disagree with the following about how to conserve water: Agree Disagree Not sure

i. Provide each homeowner with water-use information

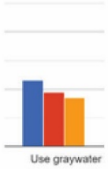


ii. Change plantings to native or climatically appropriate species

iii. Pay more for the water as an incentive to conserve



iv. Pressurize the canal water system (pipe it) to reduce water loss via evaporation



v. Use graywater from each home to irrigate the yard

vi. Reduce property sizes to reduce yards that require irrigation

vii. Adopt water banking as a water policy

Comments:

Flood irrigation for 12 years really helped our garden/ back yard when we lived on 64 e 400 s until Wasatch bought our property and we moved to a yard that has a sprinkler system with no option of canal water. We will probably get a barrel to catch rainwater when we put in our garden next spring.

I know, in the West, there is a need to conserve water but I've researched using gray water for irrigation and find there are quite a few undesirable aspects associated with that. I don't know what 'water banking' is. I don't know how pressurizing the canal will impact water use or conservation. Pamphlets are a waste of money. I found the website 'Slowtheflow' myself that helps me know how much to irrigate. I would not want to increase the price of water. How to reduce property sizes or change plantings without infringing on individual's rights to have the size and plantings they want ? I grew up with a rainwater cistern and learned at an early age to not waste water. How do you teach 'saving water' techniques to people who haven't had to worry about it before ?

Limit population growth

You listed all of them

Flood irrigation for 12 years really helped our garden/ back yard when we lived on 64 e 400 s until Wasatch bought our property and we moved to a yard that has a sprinkler system with no option of canal water. We will probably get a barrel to catch rainwater when we put in our garden next spring.

Increasing housing choice to include yardless high density housing would make a huge difference.

Change sprinklers to drip

Need a secondary irrigation system. My wife kayaks these sections many times each year. I don't kayak anymore--too old--but I have canoed or kayaked here in past years.

Incent home rainwater collection. Stop municipal lawn installations. Incentivize xeriscape.

Strongly discourage sprinkler systems that send out a mist that evaporates before it hits the ground. Discourage watering during hottest, windiest parts of the day.

Education is more effective than punitive, dictated regulations.

Flood irrigation for 12 years really helped our garden/ back yard when we lived on 64 e 400 s until Wasatch bought our property and we moved to a yard that has a sprinkler system with no option of canal water. We will probably get a barrel to catch rainwater when

we put in our garden next spring.

Limit growth

Education and supplies for catching rain water to use on yard

allow sale of unused irrigation rights for domestic watering

Allow irrigation only on certain days to prevent people from watering their lawns Every Single Day.

Establish an native plantings nursery through USU, Utah Conservation Core and/or the County Extension. River front houses get native plugs and bareroots at cost. As well as free consultations on their properties from grad students, Extension, and/or nursery staff. Non-river properties should be offered Xeriscaping plantings and/or consultations as well. The prospect of free should get the homeowner into contact with valid information.

Allow local nurseries to host events so they do not feel like they are losing business but riparian or xeriscaping plants should not be just handed out.

Remove more lawn. Add more trees for shade. Accept "weeds" as adapted plants. Limit watering to once a week. Raise lawnmower mowing height. Make friends with a brown lawn. Make friends with your neighbors who have brown lawns. Capture water from roof tops for garden and lawn. Water garden/lawn at night only.

Ban people from washing their cars, 4 wheelers, RVs, etc. in their driveways, have driveways that conserve water instead of solid concrete slabs, better sprinkler systems, less water used by the university, public schools, public properties, more reycling of gray water everywhere

Question about landscaping (before this question) doesn't provide a native vegetation option (NOT necessarily xeriscaping).

increase education on water use in arid states

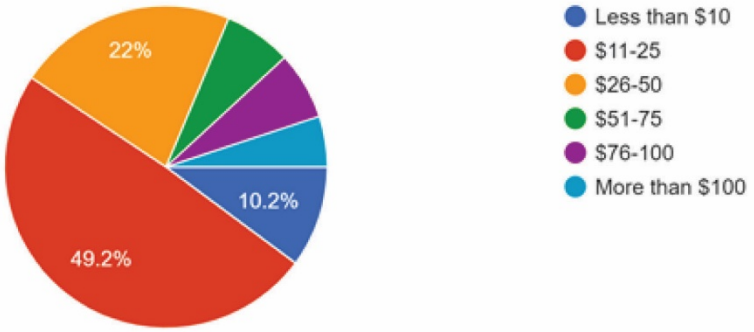
Our home has no access to canal or pressurized water. Most homes in Logan have no access to it. A big mistake by the city in days gone by.

Use wood chips or mulch, inexpensive from city facility

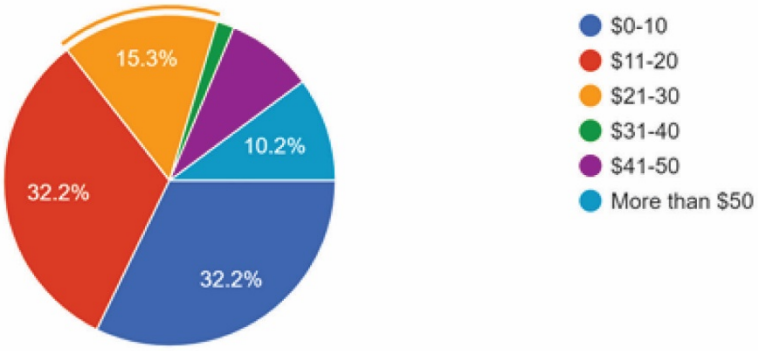
Make large water users such as business is a lot more responsible

Make it illegal to water your lawn before sunset and after sunrise.

Q 15. If irrigation water were billed separately from culinary water, what would be the maximum amount you would be willing to pay per month for irrigation water?



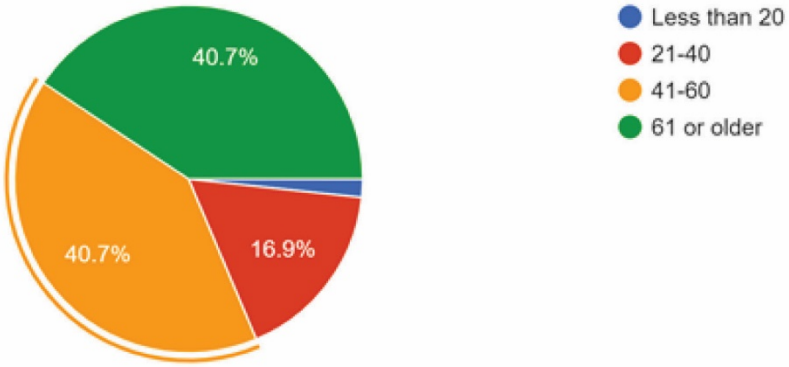
Q 16. Low flows in the river degrade habitats along the river. If money could keep more water in the river and improve the ecosystem services it provides, how much would you be willing to spend on a monthly basis to keep water flowing in the river?



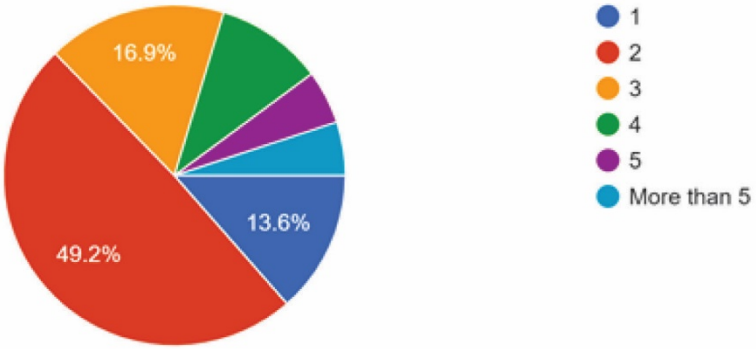
Q 17. Where do you reside?

Demographic questions

Q 18. Age



Q 19. People in your household



Q 20. Household earnings