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Active Transportation Routes Using Canal Corridors: Decision Tools in Creating Successful Canal Trail Projects

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ACTIVE TRANSPORTATION ROUTES USING CANAL CORRIDORS:

DECISION TOOLS IN CREATING SUCCESSFUL CANAL TRAIL PROJECTS

by

Matthew Scott Crump

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ABSTRACT

Active transportation routes using canal corridors:
Decision tools in creating successful canal trail projects

by

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The state of Utah has shown an increasing need for active transportation infrastructure, especially in the rapidly developing areas across the Wasatch Front. Canal corridors offer ideal locations for siting shared-use paths because they are linear, flat, and have an interlaced presence within communities. In the past, concerns such as safety, maintenance, and lack of a management entity have inhibited the establishment of formal canal trails. More recently, local governments and canal companies have worked to overcome these challenges and have completed successful canal trail projects. The purpose of this study is to provide valuable insights and tools that can be used in developing new canal trails across the state. In order to accomplish this, the study documents various case studies of past canal trail projects, interviews stakeholders for future projects, summarizes findings into a guide, and explores decision making tools in prioritizing new trails.

A review of case studies for five distinct and significant canal trail projects in Utah is completed. Stakeholders such as canal companies, local government officials, and

engineering firms are interviewed to obtain experience and understand considerations. The interviews are summarized and potential solutions for concerns are explored. A prioritization tool for the five most populous counties along the Wasatch Front is created using predictors for future trail use and the trail's importance in creating a multimodal network.

The results of the study provide five unique case studies that can be used as models for future projects. The study found that land ownership, maintenance, safety, liability, funding, and privacy are the main concerns of stakeholders. These concerns can be overcome by long-term planning, stakeholder collaboration, iterative design, and active public involvement. The study also provides insights on canal trail design, including trail width, trail type, corridor cross sections, and intersection design. The prioritization tool shows ranked tables that suggest which potential canal trails are predicted to provide the greatest transportation benefits. Future work on the topic could explore other uses of canal corridors, the challenges for canal trails in different states, or the ability of canal trails to serve as the backbone for multimodal networks.

(126 pages)

PUBLIC ABSTRACT

Active transportation routes using canal corridors:

Decision tools in creating successful canal trail projects

Matthew Scott Crump

The state of Utah has many canal corridors that offer potential opportunities for establishing public trails. In the past, concerns such as public safety and canal companies' abilities to perform maintenance have inhibited the construction of canal trails. Recently, local governments and canal companies have worked to overcome these challenges which has led to the establishment of some canal trails. The purpose of this study is to provide valuable insights and tools that can be used in developing future canal trails. In order to accomplish this, the study documents various case studies of completed canal trail projects, interviews stakeholders for future projects, summarizes findings into a guide, and explores decision making tools in prioritizing new projects.

The results of the study provide five unique case studies that can be used as a model for future projects. The study found that land ownership, maintenance, safety, liability, funding, and privacy are the main concerns of stakeholders. These concerns can be overcome by long-term planning, stakeholder collaboration, iterative design, and active public involvement. The study also provides insights on canal trail design, including trail width, trail type, corridor cross-sections, and intersection design. A prioritization tool is created for local governments to assist in deciding which canal trails to pursue first based on the projected transportation benefits.

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I would like to express my appreciation to the Utah Department of Transportation for sponsoring this project. They provided me the original idea to study canal trails and gave important guidance throughout. I am also grateful to the many individuals that were willing to be interviewed. They graciously donated their time to provide me with essential information.

Finally, I have my family to thank for their love and support. My father for helping to edit my paper and always pushing me to succeed academically. My mother for teaching me, believing in me, and encouraging me in whatever decisions I make. Lastly, my wife, Shannon, for allowing me to discuss canal trails at every dinner conversation, visiting all the canal trails with me, and providing the love and support I needed.

Matthew Scott Crump

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LIST OF ABBREVIATIONS

AGRC	Automated Geographic Reference Center
BOR	Bureau of Reclamation
CHWA	Cache Highline Water Association
MAG	Mountainland Association of Governments
MPO	Metropolitan Planning Organization
NRCS	Natural Resources Conversation Service
PRWUA	Provo River Water Users Association
RAP	Recreation, Arts, and Parks
TIF	Transportation Investment Fund
UDOT	Utah Department of Transportation
UDWR	Utah Division of Water Rights
USU	Utah State University

1 INTRODUCTION

1.1 Problem Statement

The state of Utah has always been home to people who enjoy outdoor recreation. Those within the state, as well as visitors from across the nation, cherish Utah because of the abundant outdoor recreation opportunities it provides. Evidence of this was the creation of the nation's first state office of outdoor recreation in 2013 due to unprecedented recreation demand (Office of Outdoor Recreation, 2021).

In addition to the increasing demand for outdoor recreation, Utah now has the fastest growing population in the country according to the 2020 Census (Epstein & Lofquist, 2021). As the state continues to see rapid population growth, and land becomes increasingly urbanized, local governments and planning agencies have struggled to provide outdoor recreation opportunities within communities.

The recent events of the COVID-19 pandemic have exacerbated the need for local governments to provide infrastructure that allows its citizens to safely enjoy the outdoors. Strava, a mobile phone application used to track workouts, showed a 55% increase in both bicycle trips and walk, run, and hike trips from 2019 to 2020 (Strava Metro, 2021). People throughout the state experienced a renewed interest in the recreational facilities available in their communities.

Off-street transportation facilities, such as trails, are also the preferred routes for most individuals commuting to work or school via walking and bicycling (Kang & Fricker, 2013). Off-street trails diminish the risk of injury from vehicles by removing segment crash susceptibility and reducing the amount of intersection crossings. The safe

routes to school program implemented by the state has the goal of promoting safe walking and bicycling to and from elementary, middle, and junior high schools (Safe Routes Utah, 2021). Off-street pathways are the ideal infrastructure in providing safe routes for students to walk or bike to school.

Another benefit of trails is that the level of stress along an off-street path is significantly reduced because there is little to no adjacent traffic. Reducing the level of stress allows for an even more enjoyable bike/walk commute, which has already been shown to have the most positive ratings of commute liking (Runa & Singleton, 2021). Additionally, trails often provide more direct routes than on-street facilities which reduces the overall commute time.

In summary, public trails, in addition to parks, are the primary means used by municipalities to provide the outdoor recreation facilities that residents want. Additionally, trails are preferred for all types of commuters because of the safe and direct routes they create. Research has shown that residents are valuing local trails more and more, with the trails improving quality of life, community connectivity, and property values (Corning, 2012; Parent et al., 2013). Trails are easier to accommodate when creating new developments, but can pose challenges in urban areas that are already built out. These developed urban areas are where canal corridors have the most potential impact as a solution to providing active transportation benefits to a community.

As local governments have worked to find locations for building these trails, many have looked to canal corridors as a potential resource. Canal corridors run in and around communities with less traffic and roadway crossings than on-street facilities. Canals also frequently connect or run through local parks. This interlaced presence of

canals has led many local governments to include trails within canal corridors as an essential part of their planned trail network.

In past years, local governments have been largely unsuccessful at formalizing trails along canal corridors. A variety of challenges have historically impeded these trails, including concerns of liability from the canal company, safety of the trail users, or loss of privacy from adjacent landowners. As the demand for local trails has built up over time, however, some local governments have recently had more success at establishing canal trails. Despite this fact, a majority of canal corridors in Utah remain under-utilized from a transportation perspective. For the purpose of this paper, a canal trail is any public trail located near an irrigation facility such as a canal or ditch. A canal trail is an off-street, shared-use path that can be paved or un-paved. Figure 1-1 and Figure 1-2 show examples of canal trails in Utah.

Figure 1-1. Canal trail along the East Jordan Canal in Draper.

Figure 1-2. Canal trail along the Jacob Canal in Saratoga Springs.

1.2 Objective

The objective of this study is to provide a better understanding of the concerns and considerations involving the establishment of trails on canal corridors in Utah. To accomplish this, the study reviews successful canal trail projects in Utah to collect valuable insights and lessons-learned. Second, interviews are conducted with various stakeholders typically involved in the establishment of canal trails. Third, the study summarizes the information and provides a guide for the implementation of future canal trail projects. Finally, the study seeks to provide a method for the prioritization of canal trail projects in the largest five counties in Northern Utah. Canal trails along open channel canals as well as trails atop enclosed canals are both investigated in the study.

1.3 Document Organization

This thesis document contains six sections. Section 1 contains an introduction to the topic and presents the motivation, scope, and objectives of the study. Section 2 provides a history of Utah canals, explains their current recreational use, and summarizes previous research works. Section 3 presents the methods used to collect and analyze the data. Section 4 presents the results of the study. Section 5 draws conclusions from the study, makes recommendations for implementation, and suggests future work related to the topic.

2 BACKGROUND

The purpose of this section is to provide an overview of the development of canals in Utah, how they are being used for recreation today, and past research related to canal trails. A history of canals is provided to better understand the current complexity of canals, especially with regards to land ownership. The current use of canal corridors by the public is explained to underscore the need for action on the topic. Finally, a brief overview of past research is given, with details on why the efforts of this study are important to the field.

2.1 History of Utah Canals

Prior to the arrival of European settlers, Native Americans across what is now the state of Utah raised their crops with the help of simple irrigation ditches (Pritzker,2000). These ditches were often times very rugged but provided the ability to remain in one location for longer periods of time. As European settlers in the Eastern United States began to migrate to the western regions of the United States in the 1800s, it became evident that irrigation diversion from water sources was essential in allowing the widespread settlement of arid lands. Irrigation canals eventually became an integral part of each new settlement, especially in what is today the state of Utah. Mormon settlers specifically constructed many of the existing canals in Utah and were the first Anglo-Saxons to practice irrigation on such a large scale in the United States (Hutchins & Jensen, 1965).

Mormon settlers brought a unique sense of community and religious zeal to each settlement they established in Utah. According to Joanna Endter-Wada, natural resource

and social science professor at Utah State University, “The land and all its natural resource were treated as public property” (Endter, 1987). This idea of shared resources meant that irrigation ditches, or canals, were a community asset in which everyone had a part.

During the 1900s many of these settlements grew into urban areas and land was divided up more precisely among private landowners. With this change, and the shift away from all citizens operating farms, canals became less of a community-wide asset and specific organizations obtained the responsibility of operating the canals. This change brought up the question of who actually owned the land where the canal was located. Land ownership for each canal was resolved differently, but in many cases, easements were established to allow the canal companies to continue operating and maintaining the canal. Today, hundreds of canals in Utah have prescriptive easements that allow them to access a designated right-of-way to convey irrigation water.

A large number of Utah’s canals not operating under a prescriptive easement are owned or were previously owned by the Bureau of Reclamation (BOR), a federal agency within the United States Department of the Interior. In 1902, the BOR was established with the goal of reclaiming the western United States from the dry, desert conditions that control the settling of land. The BOR created several different projects in Utah that involved the construction of dams, power plants, and canals. According to the BOR website, “These water projects led to homesteading and prompted the economic development of the west” (Bureau of Reclamation, 2021). The canals associated with these projects are still owned by the BOR today, but each project has a local partner that conducts the operations of the canals. In some cases, the local partners have undergone a

process of transferring the title to the canal corridor land from the BOR to the local partner itself.

2.2 Public Use of Canals

The informal and often times illegal use of canal corridors for public recreation is widespread in Utah. Some residents incorrectly assume that maintenance roads alongside canals are open to the public. This is exacerbated by the fact that online map servers such as Google have trails shown along canals that are actually closed to public access. As development has increased around these canals, unauthorized use has also increased. This unmanaged recreational use of the canal corridors has become a real concern for canal companies and local governments alike.

In order to combat the unauthorized use, canal companies have posted signage, including no trespassing signs, on access points to deter public use. An example of this signage is shown in Figure 2-1. In some cases, canal companies post signage with the sole purpose of liability protection and do not actively enforce it. Other canal companies simply inform the public they encounter on the maintenance road of the private property they are on and ask them to leave. Most canal companies do not have the manpower or financial means to regularly police their canal corridor. This can lead to the misconception that public access is permitted.

Figure 2-1. No trespassing signage at canal corridor entrance.

Formalizing the use of canal corridors as public trails is something local governments have been planning to do for decades. The vast majority of urban cities or counties with larger canals in them have included canal trails as part of their Master Plans. These trails can also be an essential part of completing the planned trail network. For example, Riverton City has four canals running through the city and its Active Transportation Master Plan relies heavily on the establishment of at least a couple of the trails as there are no alternatives that offer the same beneficial routing. As a result, the

establishment of trails on many of Utah's canal corridors is a planned for and anticipated event.

2.3 Literature Review

A few studies have been conducted on the issues relating to the establishment of canal trails in Utah. In 1974, two professors from Utah State University, Kennedy and Unhanand, published a paper titled, "Multiple uses of Utah Irrigation Canals: Cache County as a case study" (Kennedy & Unhanand, 1974). The paper explains the importance of canals for recreational use and suggests that measures be taken to equitably share the cost of public use. The authors argued that, "if communities don't begin to recognize the value of their canals and cooperate with canal companies… canals of Utah will continue to be withdrawn from public use and become another amenity that is sacrificed to urbanization." For the next 25 years following the publishing of the 1974 paper, little research was performed on the topic, and no canal trails were formalized in the state.

Additional research on canal trails was completed in 2000 by James Carlson, a graduate student from Utah State University (Carlson, 2000). Carlson interviewed a few canal companies and found that maintenance and liability were the primary reasons for canal companies refusing to allow the establishment of public trails. Carlson also determined that the loss of privacy for adjacent landowners was a major obstacle to canal trails. Carlson mentioned the importance of having a pilot canal trail project that could navigate the challenges and provide valuable insights.

Since the publication of Carlson's paper, the attitude towards public trails, the legal protections for canal companies, and the urbanization of lands around canals have

all changed substantially. Evidence of this is shown in the increasing number of trails being planned in canal corridors throughout the state. Utah also currently has a number of completed pilot canal trail projects that can be used to gain insights. As a result, there is a need to document successful canal trail projects as well as evaluate current issues and concerns inhibiting future projects.

2.4 Related Topics

Trails have been established along canals in many locations outside of Utah. A few examples of nearby projects include the Salt River Project Canal Trails in the Greater Phoenix area, the High Line Canal Trail in the Greater Denver area, and multiple different canal trails in the Greater Albuquerque area. These facilities, along with similar ones throughout the Western United States, are examined but are not the primary focus of this study. Canal management, facility size, legal protections and other important details vary significantly by state. As a result, it was determined to narrow the scope of this project to the establishment of canal trails within Utah.

Trails within railroad or electric utility corridors are similar to those along canals in that they follow a linear right-of-way, connect communities, and provide ideal locations for establishing trails. These types of trails provide a unique set of challenges, however, and do not deal with open water which is an important aspect of many canal trails. Although insights may be obtained from the study of railroad or utility trails, they are not included in the scope of this study.

Finally, recreational trails are common near other types of water bodies such as rivers or lakes. For rivers, the maintenance, liability, and landownership aspects of recreational trails are very different than canals. Lakes have all the same differences as

rivers and also do not include the aspect of moving water. Consequently, the information provided in this study can be useful in the establishment of trails along any water body but the primary focus is on irrigation and drainage facilities.

3 METHODS

A review of case studies throughout Utah is performed in order to better understand completed canal trail projects. Personal interviews are held with applicable stakeholders to summarize key concerns and considerations for future canal trail projects. A prioritization tool is created to compare potential canal corridors for trails in the five most populated counties of Northern Utah.

3.1 Case Study Review

Case studies of successful canal trail projects are reviewed to understand the successes and lessons-learned from each project. Projects in the state of Utah and surrounding states are reviewed; however, only projects located in Utah are examined in detail because of the unique circumstances of the region. Case studies are found using a combination of personal knowledge and experience, recommendations from those interviewed, and an examination of canal corridors via Google Maps. Information regarding case studies was obtained primarily through interviews with those involved with the projects, and supplemented with information available online. The details of the planning, design, and construction process for each case study is reviewed, along with lessons learned by those involved.

As of the June 2021, there were approximately 18 canal trails in the state. Table 3-1 shows canal trails in Utah along with their sponsor, respective canal, and trail type. There may be additional canal trails that are not found as part of this project, as the list is not guaranteed to be comprehensive. It is also important to note that some trails are not continuous and can traverse multiple municipal boundaries but be on the same canal.

Table 3-1. Canal Trails in Utah as of June 2021.

Canal Trail	**Trail Sponsor**	**Canal**	**Trail Type**
Smithfield Canal Trail	Smithfield City	Logan, Hyde Park, Smithfield Canal (Cache Highline)	Paved - Asphalt
Lundstrom Park and Highline Canal Trails	Logan City	Logan, Hyde Park, Smithfield Canal (Cache Highline)	Unpaved
North Ogden Parkway	North Ogden City	Ogden-Brigham Canal	Paved - Asphalt
West Haven Canal Trail	West Haven City	Wilson Canal (South Branch)	Unpaved
Clearfield Canal Trail	Clearfield City	Davis and Weber Canal	Paved - Asphalt
Onion Parkway Trail	West Bountiful	DSB Canal Drain	Paved - Asphalt
Redwood Trail	Salt Lake County	Brighton North Point Canal	Paved - Asphalt
Utah & Salt Lake Canal Trail	Salt Lake County	Utah & Salt Lake Canal	Paved - Asphalt
Phebe Brown Trail	Draper City	East Jordan Canal	Paved - Asphalt
Oquirrh Mountain Trail	South Jordan City	Welby Jacobs Canal	Paved - Asphalt
Draper Canal Trail	Draper/Sandy	Former Draper-Sandy Canal	Paved - Asphalt
Canal Trail	Sandy City	East Jordan Canal	Paved - Asphalt
Murray Canal Trail	Murray City	Jordan and Salt Lake Canal	Unpaved
Jacobs Canal Trail	Saratoga Springs	Welby Jacobs Canal (South)	Paved - Concrete
Murdock Canal Trail	Utah County	Murdock Canal	Paved - Asphalt
Mapleton Lateral Canal Trail	Mapleton City	Mapleton Lateral Canal	Paved - Asphalt
Kids Canal Trail	Vernal City	Ashley Central Canal	Unpaved

3.2 Personal Interviews

Interviews for the study were an essential part of obtaining information on past projects, current challenges, and future considerations. This section first explains who the stakeholders typically are in canal trail projects. Second, the process for recruiting and interviewing the stakeholders is described. Finally, a list of the completed interviews is shown, displaying the variety of different perspectives that were obtained.

3.2.1 Stakeholders

Depending on the size of the projects, stakeholders involved in canal trail projects can include: local governments such as towns, cities, and counties; metropolitan planning organizations, water districts or canal companies, and engineering firms. Each of the stakeholders are discussed along with the reasoning for interviewing them. One stakeholder group that was not interviewed were landowners adjacent to canal corridors. The opinion of adjacent landowners will vary greatly along the canal corridor length as hundreds of residents may abut the length of a planned canal trail. As a result, the general opinion of adjacent landowners was obtained indirectly through the other interviews.

Local governments are generally the organizations that initiate canal trail projects. The local government understands the need to provide its citizens with transportation resources and looks for opportunities for trails within their jurisdiction. Many cities in Utah have Master Plans that propose the construction of trails along canal corridors. In more urban areas, the metropolitan planning organization is generally involved in the planning process, especially if the trail covers a larger region.

For the purpose of this paper, a canal company is any organization that operates and maintains an irrigation canal. In Utah, this could be a canal company, irrigation

company, water users association, or a conservancy district. The canal company has the primary purpose of conveying irrigation water to its stakeholders. Canal companies are an important group to interview because most agreements for public use of canal corridors involve a local government and a canal company. Historically, canal companies have been the most reluctant group in allowing the establishment of canal trails.

An engineering firm is usually only involved in more complex projects but plays an important role in designing the canal trail. Engineering firms assist the local government and canal company in designing safe and appealing trails. Engineering firms can also play a large role in obtaining funding for trail projects. Trail intersections with roadways often require the expertise of engineering firms to ensure safe crossings for trail users. In cases where canal waters are enclosed in a pipe or box culvert, the engineering firm often provides designs for the canal enclosure as well as the recreational trail.

3.2.2 Interview Process

All interviews for the study were conducted either over the phone or via online video calls. Research at Utah State University is required to follow guidelines set by the Institutional Review Board. One of these guidelines prevented in-person interviews due to concerns with COVID-19. Another guideline was the requirement for individuals to sign an informed consent document in order to participate in the study. The interviews lasted between 30 and 60 minutes and were more conversational in nature.

The questions used in the interviews were developed from a combination of material from the paper written in 2000 by James Carlson on canal trails (Carlson, 2000) and general experience on topics commonly related to canal trail projects. Different questions were used depending on what stakeholder was interviewed and whether or not

they had past experience with canal trail projects. The questions used in the study can be found in the appendix.

An effort was made to contact every local government with known experience on canal trails. Using the Utah Division of Water Rights information for canal companies (UDWR, 2020), an attempt was made to contact every canal company in urbanized areas of the state. Those interviewed were also asked for the names of other individuals who would be good interview candidates. Interviews continued until a saturation of topics was reached. The interviews were conducted between January and June of 2021.

3.2.3 Completed Interviews

Stakeholders throughout the state were interviewed in an effort to gain a variety of different opinions. Table 3-2 shows a list of all formal interviews conducted as part of the study. The trail status could be a combination of built, planned, or unplanned because many of the individuals correspond to multiple canal facilities. In addition, canal trails could be established on only part of a canal, with possible future development along other sections.

Table 3-2. List of interviewed stakeholders.

Name	Organization	Stakeholder Type	Trail Status
Andy Neff	The Langdon Group	Engineering Firm	Built/ Planned
Angelo Calacino	Salt Lake County Parks and Recreation	Local Government	Built/ Planned
Ben Frye	Clearfield City Parks and Recreation	Local Government	Built
Ben Wolf	Bureau of Reclamation	Government	Planned/ Unplanned
Benjamin Quick	Pineview Water Systems	Canal Company	Unplanned/ Built
Brent Michaelson	Utah Lake Distributing Canal Company	Canal Company	Unplanned
Brian Lopez	Bernalillo County Public Works	Local Government	Built/ Planned
Charlie Ewert	Weber County	Local Government	Planned
Clay Bodily	Smithfield City Public Works	Local Government	Built
Dan Medina	Sandy Parks and Recreation	Local Government	Built/ Planned
Dave Foster	Alta Planning + Design	Engineering Firm	Planned
David Stroud	Saratoga Springs	Local Government	Built
Greg Hilbig	Draper City Parks and Recreation	Local Government	Built/ Planned
Jim Price	Mountainland Association	Local Government	Built/ Planned
Jon Hardman	Wellsville-Mendon Canal Company	Canal Company	Planned
Jon Luthie	Cache County Attorneys	Local Government	Built/ Planned
Jon Parry	Weber Basin Water Conservancy	Canal Company	Planned/Unplanned
Nathan Daugs	Cache Water District	Local Government	Planned
Nolan Bennet	AMAFCA	Canal Company	Built
Norm Evenstad	NRCS	Government	Built/ Planned
Richard Nielson	Utah County Public Works	Local Government	Built/ Planned
Rick Smith	Davis & Weber Counties Canal Company	Canal Company	Built
Ron Thompson	Washington County Water Cons. District	Canal Company	Planned
Russ Akina	Logan City Parks and Recreation	Local Government	Built/ Planned
Steve Anderson	West Haven	Local Government	Built
Steve Cain	Provo River Water Users Association	Canal Company	Built
Wade Tuft	Welby Jacobs Canal Company	Canal Company	Built/ Planned
Wayne Simper	Ashley Central Irrigation Company	Canal Company	Planned
Yasmeen Najmi	Middle Rio Grande Cons. District	Canal Company	Built/ Planned
Zan Murray	JUB Engineers	Engineering Firm	Built/ Planned

3.3 Canal Trail Prioritization Tool

The state of Utah has hundreds of canals that offer the potential for siting canal trails. In order to assist local governments in deciding which canal trails to pursue, a prioritization tool is created to rank and compare canal trails in the state. The purpose of the tool is to identify which canal trail would be most impactful in creating a safe, multimodal transportation network in the area. The tool is created for five of the most populated and urban counties in the state. These counties include: Salt Lake County, Utah County, Davis County, Weber County, and Cache County.

The prioritization tool takes into account five different factors that are important when deciding between different canal corridors. The factors included in the prioritization tool include: population density, active transportation use, bicycle and pedestrian crashes, inclusion in a master plan, and whether or not the trail is the first one in an area. These factors are indicative of the transportation benefit that a future canal trail would provide. Each of the factors are explained in more detail, with reasoning for their inclusion in the prioritization tool.

Data for the canals is downloaded from Utah AGRC. The National Hydrography Dataset for Lakes, Rivers, Streams, and Springs contains shapefiles of canals. The canals are extracted from the dataset and used in the remainder of the analysis. Some of the canal shapefiles required editing to best represent the current conditions.

3.3.1 Population Density

The surrounding population has a direct relationship with the expected use of the canal trail. Primarily, the more people living near the trail, the more people who are expected to use it. In addition, canal trails in highly urbanized areas are often the location

of illegal use of the canal corridors which needs to be addressed. Finally, research has shown higher amounts of physical activity in urban residents compared to rural residents (Trivedi et al., 2015). In order to represent the density and urbanization surrounding a canal corridor, population density data within a half mile of the canal corridor is analyzed. Population density data is obtained from the Smart Location Database provided by the U.S. EPA Smart Growth Program from 2014.

Canal trails are given a score from 0-10 based on the surrounding population density with 10 being the best or highest score. Z-scores are calculated for each canal trail using the data for all canal trails within the county. The Z-score value is then added to a value of five which represents an average score. Canal trails with scores of less than 0 and more than 10 are rounded up and down, respectively.

3.3.2 Nearby Active Transportation Use

Current use of active transportation facilities near potential canal trails is accounted for in the prioritization tool. It is assumed that many of the trips near the canal corridor would move to the canal trail itself because of the safer, off-street nature of the canal trail compared to existing facilities. A study of the Utah & Salt Lake Canal Trail in Salt Lake County showed that most trail use came from residents who were already participating in physical activity at nearby locations (Burbidge & Goulias, 2009). The opening of new facilities could potentially induce varying amounts of new trips; however, current active transportation in the area is a strong predictor of future trail use. Most residents prefer to travel minimal distances from their residence to access active transportation infrastructure. Bicyclists have been shown to go out of their way, around a quarter of a mile, to ride on routes with bicycle infrastructure (Hood et al., 2011; Dill &

Gliebe, 2008). Recreational walkers have been shown to have trips of around one mile (Agrawal & Schimek, 2007) and people prefer recreational amenities within a quarter mile (Wolch et al., 2005). As a result, Strava data is used to analyze the number of bicycle miles traveled within a quarter mile of the canal corridor.

Canal trails are given a score based on the bicycle miles traveled per mile of the canal. The scores range from 0-10 with 10 being the best or highest score. Z-scores are calculated for each canal trail using the data for all canal trails within the county. The Z-score value is then added to a value of five which represents an average score. Canal trails with scores less than 0 and more than 10 are rounded up and down, respectively.

3.3.3 Bicycle and Pedestrian Crashes

Bicycle fatality rates per mile have been shown to be 12 times more than that of automobile rates (Pucher & Dijkstra, 2003), and in 2020, Utah saw 794 pedestrian-involved crashes and 466 bicycle involved crashes (Numetric, 2021). These types of statistics have led many local governments to focus on safer multi-modal transportation infrastructure. As a result, future canal trails that offer safer transportation routes than typical on-street facilities should be prioritized. Although canal trails generally have frequent roadway crossings and all crashes would not be eliminated, it is assumed that moving active transportation to canal corridors will significantly decrease the number of crashes between bicyclists or pedestrians and motor vehicles.

Data for bicycle and pedestrian crashes in Utah is available through UDOT's Numetric services. As mentioned in the active transportation section, it is assumed that a majority of trips within a quarter mile of a canal corridor would shift to the canal trail. Therefore, all bicycle and pedestrian crashes within a quarter mile of a canal corridor are

analyzed.

Crash data is different than the other data used in the analysis in that it contains a large amount of zero values. Because of this, a bin method is used for scoring canal trails based on the number of pedestrian and bicycle crashes per canal mile. Table 3-3 shows the bins used in assigning a score based on crash numbers. A score of 10 represents the highest or best score.

Table 3-3. Crash data bins for traffic safety scoring.

Number of Crashes (per mile of canal)	Traffic Safety Score
0	0
(0,2]	2.5
(2,4]	5
(4,6]	7.5
[6,∞)	10

3.3.4 Master Plan Inclusion

Many local governments have included canal trails as part of their trails Master Plans. It is assumed that local governments have planned the completion of canal trails as part of their trail networks and would like to focus on that specific canal trail. Many other unknown reasons could exist for the inclusion of a canal trail in a master plan, but local governments have prioritized them for a reason. A map made available by Utah Automated Geographic Reference Center (AGRC) is used to determine whether or not an off-road trail has been planned for each canal corridor (Utah AGRC, 2020). If a trail is

planned for the corridor, the canal trail receives a score of 10, whereas no plans for a trail result in a score of 0.

3.3.5 "Pioneer" Trail

Some areas throughout the state already have established trail networks including trails that act as a type of interstate or arterial that facilitate the connection of numerous other trails. Examples of this would be the Jordan River Parkway in Salt Lake County, the Rio Grande Western Rail Trail in Davis County, or the Murdock Canal Trail in Utah County. These "pioneer" trails are instrumental in the construction of new trails in the surrounding area that can connect into the main arterial type trail.

In addition, if a canal trail does not have any other similar trails nearby, it is assumed that the new trail will attract an unmet demand. On the other hand, if a canal trail is established near another major off-street trail, then it is assumed that some of the new trail use will come from the existing trail users. Each potential canal trail is assigned a value of 10 if no other of-street trail running in a similar direction is within three miles and a 0 if a trail is located within three miles.

3.3.6 Weight Assignment

The scores from the five factors are combined to provide a total score ranging from 0-50 with the highest scores representing the projects that local governments are recommended to prioritize. The prioritization tool will be made available for use by public agencies throughout the state. The weighted factors are set to a default value of one, but are customizable to allow government officials versatility in assigning different weights based on their specific circumstances. The following section contains a list of the canals that are included in the analysis. Each of the canal lengths and locations are

approximate and should be verified by the local government interested in the analysis. The Utah Division of Water Rights website was the primary resource used in determining the names and corresponding canal company for each canal. Canal segments that already have trails established on them are removed from the list.

3.3.7 Potential Canal Trails

Table 3-4. Potential Canal Trails in Cache County, Utah.

Canal	Company	Location	Length (Mile)
Benson Main Canal	Benson Irrigation Company	200 W Logan to 2600 N Logan	2.30
Blacksmith Fork Hyrum Canal 1	Blacksmith Fork Irrigation Company	Diversion to 4600 S Hyrum	3.83
Blacksmith Fork Hyrum Canal 2	Blacksmith Fork Irrigation Company	4600 S Hyrum to End	2.91
Blacksmith Fork Nibley Canal 1	Blacksmith Fork Irrigation Company	Diversion to Highway 165	1.64
Blacksmith Fork Nibley Canal 2	Blacksmith Fork Irrigation Company	Highway 165 to End	1.35
College Irrigation Canal	College Irrigation Company	Highway 165 to 800 W Nibley	1.08
Cub River East Canal	Cub River Irrigation Company	Utah Border to 2400 S Lewiston	5.10
Hyrum Blacksmith Fork Upper Canal	Blacksmith Fork Irrigation Company	Diversion to 300 N Hyrum	2.71
Hyrum Canal	Hyrum Irrigation Company	Diversion to 400 S Hyrum	2.91
Logan Cow Pasture Ditch (SR30)	Logan Cow Pasture Water Company	1900 W Logan to End	3.19
Logan North Field/ Hyde Park Canal 1	Logan North Field & Hyde Park Irrigation	Diversion to 2500 N North Logan	4.53
Logan North Field/ Hyde Park Canal 2	Logan North Field & Hyde Park Irrigation	2500 N North Logan to End	2.64
Logan Northern Canal 1	Cache Highline Water Association	Diversion to 3100 N North Logan	5.65
Logan Northern Canal 2	Cache Highline Water Association	3100 N North Logan to 600 S Smithfield	2.72
Logan Northern Canal 3	Cache Highline Water Association	600 S Smithfield to End	4.26
Logan Northwest Field Canal	Logan Northwest Field Irrigation Company	Diversion to 2500 N Logan	3.33
Logan NW Canal/ Twin Canal West	Logan North Field Irrigation Company	500 E Logan to 200 W Logan	0.96
Logan River BSF Lateral 1	Logan River and BSF Irrigation Company	Diversion to 3000 W Logan	1.72
Logan River BSF Lateral 2	Logan River and BSF Irrigation Company	Diversion to 3200 W Logan	2.00
Millville Lower Canal	Millville Irrigation Company	3700 S Millville to 400 S Providence	2.68
Millville Upper Canal 1	Millville Irrigation Company	Diversion to 3700 S Millville	3.04

Millville Upper Canal 2	Millville Irrigation Company	3700 S Millville to 300 N Millville	1.54
O'Berry Canal	Hyrum Irrigation Company	Diversion to 300 S Hyrum	3.45
Paradise Canal	Paradise Irrigation and Reservoir Company	Diversion to 8300 S Paradise	5.55
Porcupine Highline Canal	Porcupine Highline Canal Company	Diversion to Paradise Dry Rd	8.94
Highline Upper Canal 1	Cache Highline Water Association	1500 N Logan to 200 S Hyde Park	2.94
Highline Upper Canal 2	Cache Highline Water Association	200 S Hyde Park to 600 S Smithfield	2.28
South Logan Benson Canal	Benson Irrigation Company	2600 N Logan to 4000 W Logan	3.32
Spring Creek Cache Canal	Spring Creek Cache Irrigation Company	1400 W Logan to End	1.99
Wellsville-Mendon Lower Canal 1	Wellsville-Mendon Conservancy District	Diversion to 3400 S Mendon	8.02
Wellsville-Mendon Lower Canal 2	Wellsville-Mendon Conservancy District	3400 S Mendon to End	7.43
Wellsville-Mendon Upper Canal	Wellsville-Mendon Conservancy District	Diversion to Center Street Wellsville	3.46
West Cache Amalga Branch	West Cache Irrigation Company	800 S Trenton to End	10.84
West Cache Canal	West Cache Irrigation Company	Utah Border to 800 S Trenton	7.96
West Cache Newton Branch	West Cache Irrigation Company	800 S Trenton to End	5.15

Table 3-5. Potential Canal Trails in Weber County, Utah.

Canal	Company	Location	Length (Mile)
Eden Canal	Eden Irrigation Company	Diversion to 2500 N Eden	3.05
Holmes Ferrin Ditch	Holmes Ferrin Irrigation Company	Diversion to near Nordic Valley Drive Eden	1.94
Hooper Canal 1	Hooper Canal Company	Diversion to Weber-Davis County line	7.00
Layton Canal 1	Bureau of Reclamation	Diversion to Weber-Davis County line	8.92
North Ogden Canal 1	North Ogden Irrigation Company	Diversion to 1500 N Ogden	2.71
North Ogden Canal 2	North Ogden Irrigation Company	1500 N Ogden to Hillsborough Drive Pleasant View	2.67
North Ogden Canal 3	North Ogden Irrigation Company	Hillsborough Drive Pleasant View to End	3.01
Ogden Brigham Canal 1	Pineview Water Systems	Diversion to 1500 N Ogden	3.17
Ogden Brigham Canal 2	Pineview Water Systems	1500 N Ogden to 250 W North Ogden	4.59
Ogden Brigham Canal 3	Pineview Water Systems	250 W North Ogden to End	2.64
Ogden Valley Canal	Weber Basin Water Conservancy District	Diversion to Highway 158 Eden	9.01
Riverdale Bench Canal	Riverdale Bench Canal Company	Diversion to 1050 W Riverdale	6.79
Warren Canal	Warren Irrigation Company	Diversion to 4700 W Plain City	6.04
Warren North Branch	Warren Irrigation Company	4700 W Plain City to End	4.62
Warren South Branch	Warren Irrigation Company	4700 W Plain City to End	10.22
Western Irrigation Canal	Western Irrigation Company	Diversion to 750 W Harrisville	5.51
Willard Canal 1	Weber Basin Water Conservancy District	Diversion to 1000 N Marriott-Slaterville	2.62
Willard Canal 2	Weber Basin Water Conservancy District	1000 N Marriott-Slaterville to End	6.58
Wilson Canal	Wilson Irrigation Company	Diversion to End	7.10

Table 3-6. Potential Canal Trails in Davis County, Utah.

Canal	Company	Location	Length (Mile)
Davis and Weber Canal 1	Davis and Weber Canal Company	Diversion to 5600 S Roy	9.18
Davis and Weber Canal 2	Davis and Weber Canal Company	5600 S Roy to 650 N Clearfield	2.80
Davis and Weber Canal 3	Davis and Weber Canal Company	1200 W Layton to End	2.19
Hooper Canal 2	Hooper Canal Company	Weber-Davis County Line to End	3.17
Layton Canal 2	Weber Basin Water Conservancy District	Weber-Davis County Line to End	2.16

Table 3-7. Potential Canal Trails in Salt Lake County, Utah.

Canal	Company	Location	Length (Mile)
Brighton & North Point Canal 1	Brighton & North Point Irrigation Company	Diversion to 2100 S West Valley	5.73
Brighton & North Point Canal 2	Brighton & North Point Irrigation Company	2100 S West Valley to End	8.40
East Jordan Canal 1	East Jordan Irrigation Company	Diversion to 11400 S Draper	11.33
East Jordan Canal 2	East Jordan Irrigation Company	11400 S Draper to End	9.69
Jordan and Salt Lake City Canal 1	Salt Lake City	Diversion to 11400 S Draper	7.90
Jordan and Salt Lake City Canal 2	Salt Lake City	11400 S Draper to 6600 S Murray	7.22
Jordan and Salt Lake City Canal 3	Salt Lake City	Fontaine Bleu Dr. Murray to End	5.54
North Jordan Canal 1	North Jordan Irrigation Company	Diversion to 4100 S West Valley	8.87
North Jordan Canal 2	North Jordan Irrigation Company	4100 S West Valley to End	3.67
Riter Canal	Kennecott Utah Copper	Diversion to 9000 W Magna	6.35
South Jordan Canal 1	South Jordan Canal Company	Diversion to Bangerter Highway Bluffdale	3.59
South Jordan Canal 2	South Jordan Canal Company	Bangerter Highway Bluffdale to 9400 S West Jordan	6.57
South Jordan Canal 3	South Jordan Canal Company	9400 S West Jordan to End	8.46
Surplus Canal	North Point Consolidated Irrigation	Diversion to Salt Lake County Line	7.73
Utah and Salt Lake Canal 1	Utah and Salt Lake Canal Company	Diversion to Bangerter Highway Bluffdale	5.07
Utah and Salt Lake Canal 2	Utah and Salt Lake Canal Company	Bangerter Highway Bluffdale to 9400 S West Jordan	6.05
Utah and Salt Lake Canal 3	Utah and Salt Lake Canal Company	9400 S West Jordan to 4700 S West Valley City	8.19
Utah and Salt Lake Canal 4	Utah and Salt Lake Canal Company	7200 W. West Valley City to End	4.26
Utah Lake Distributing Canal 1	Utah Lake Distributing Company	Diversion to Bangerter Highway Bluffdale	4.64
Utah Lake Distributing Canal 2	Utah Lake Distributing Company	Bangerter Highway Bluffdale to 9400 S West Jordan	5.92
Utah Lake Distributing Canal 3	Utah Lake Distributing Company	9400 S West Jordan to End	7.35
Welby Jacobs Canal 1	Welby Jacobs Water Users Company	Diversion to 13400 S Bluffdale	5.83
Welby Jacobs Canal 2	Welby Jacobs Water Users Company	13400 S Bluffdale to 11400 S South Jordan	2.63
Welby Jacobs Canal 3	Welby Jacobs Water Users Company	Skye Dr. South Jordan to End	3.49

Table 3-8. Potential Canal Trails in Utah County, Utah.

Canal	Company	Location	Length (Mile)
East Bench Canal	East Bench Canal Company	Diversion to 400 N Spanish Fork	4.90
Lake Bottom Canal 1	Lake Bottom Irrigation Canal Company	Diversion to 2000 S Orem	5.43
Lake Bottom Canal 2	Lake Bottom Irrigation Canal Company	2000 S Orem to End	4.31
Mill Race Canal	Spanish Fork West Field Irrigation Company	Diversion to 750 W Spanish Fork	4.47
Provo Bench Canal 1	Provo Bench Canal and Irrigation Company	Diversion to 200 S Lindon	5.40
Provo Bench Canal 2	Provo Bench Canal and Irrigation Company	200 S Lindon to End	6.09
Utah Lake South	Utah Lake Distributing	Diversion to Silver Park Drive Eagle Mountain	8.15
Salem Canal	Salem Irrigation and Canal Company	Diversion to 2170 W Salem	6.02
Spanish Fork South Field Canal	Spanish Fork South Irrigation Company	Diversion to Arrowhead Trail Road Spanish Fork	4.44
Strawberry Highline Canal 1	Strawberry Highline Canal Company	Diversion to Goosenest Drive Payson	9.73
Strawberry Highline Canal 2	Strawberry Highline Canal Company	Goosenest Drive Payson to 12680 S Payson	3.97
Strawberry Highline Canal 3	Strawberry Highline Canal Company	12680 S Payson to Mountain Road Santaquin	4.74
Strawberry Highline Canal 4	Strawberry Highline Canal Company	Mountain Road Santaquin to Lake Road Genola	4.92
Strawberry Lateral 30	Strawberry Highline Canal Company	Mountain Road Santaquin to 7000 S Spanish Fork	7.98
Welby Jacobs South	Welby Jacobs Water Users Company	Diversion to Parkside Drive Saratoga Springs	8.56

4 RESULTS

The results of the project provide the different stakeholders involved in the establishment of canal trails with information that can be used when approaching future projects. The case studies provide valuable insight for lessons learned and suggestions for future projects. The interviews highlight important considerations that stakeholders feel need to be addressed in order to have a successful canal trail. The results of the prioritization tool show ranked lists for each county on which canal trail would provide the most benefit from a transportation perspective.

4.1 Summary of Interviews

Interviews with canal trail stakeholders revealed six different topics that are essential to address in canal trail projects. Land ownership, maintenance, safety, liability, funding, and privacy were all mentioned repeatedly in the interviews conducted. These concerns vary depending on the canal corridor and the organizations that are involved. The establishment of a canal trail typically involves the creation of a license agreement between the local government sponsoring the trail and the canal company. The trail license agreement is an official document that addresses many of the concerns such as land ownership, maintenance, safety, and liability.

4.1.1 Land Ownership

Land ownership can be one of the greatest obstacles in siting trails within canal corridors. The ownership of the canal corridor can be very complex and not well defined. Canal companies either own the land by fee title or have an easement on the land. The easements are either an express easement or prescriptive easement. In some cases, the

land ownership is a combination of fee title and easements along the stretch of the canal.

If the land is primarily owned in fee, the agreement needed to construct a canal trail is more straightforward because it is strictly between the canal company and the local government pursuing the project. The local government creates a trail license agreement with the canal company which grants public access for recreation under certain limitations. The license agreement specifies that ownership of the land is retained by the canal company.

Express easements have documents recorded by a county recorder that gives the right of a person or organization to use a landowner's property for a distinct purpose. The easement expressly details the reason for the easement as well as its location. The document is signed by both the landowner and the easement holder. Express easements have a specific scope and duration and are less common for canals. Most canals do not have express easements for their property because the canal was located on the property before the property boundary was formalized.

A prescriptive easement is similar to a recorded easement in that it grants a person or organization the ability to use a landowner's property for a purpose, however, a prescriptive easement is created when a person or organization uses another person's property (even though the use was not expressly agreed to) for a prolonged period. According to the Utah Office of the Property Rights Ombudsman, prescriptive easements:

> Recognize long-standing usage, especially if the use was relied upon for the enjoyment of property. To establish a prescriptive easement, the use must be:
> (1) Open, or used in such a way that the property owner would be aware that the property is being used.
> (2) Notorious, or used in such a way that the general public would be

> aware that the property is being used.
> (3) Adverse to the owner's interest, or without permission or approval from the property owner.
> (4) Continuously used for at least 20 years.
> (Utah Office of the Property Rights Ombudsman, 2021)

Prescriptive easements for conveyance of irrigation water are very common in Utah because many canals were built prior to the documentation of land ownership. Over time, the land adjacent to the canals started to be developed and it became important to have a more physically and legally defined right-of-way. As a result, canal companies established prescriptive easements many years after the canal was originally built. The prescriptive easements generally state the easement is for the transportation and conveyance of irrigation and/or storm drainage waters.

In some cases, trails have been established on canals that are owned by prescriptive easement. In most scenarios, this requires the consent of the canal company as well as each private landowner along the length of the canal. In select cases, such as the Utah & Salt Lake Canal Trail, prescriptive easements were sufficient to establish a trail without an individual landowner's consent because it was argued that the canal company must maintain an area sufficient to operate and maintain the canal anyway.

On the contrary, some trails have been established without obtaining the canal company's permission. This is possible because the canal company does not own the land and therefore cannot prohibit a trail so long as the canal company retains the ability to operate and maintain the canal with a trail next to it. A canal trail built in West Haven along the Country Haven Development is an example of this scenario. Although it may be easier to exclude a canal company from the negotiation and planning process of a trail, it is highly recommended to include them whenever possible.

Another aspect of prescriptive easements is the ability to establish a trail easement if an area has seen prolonged public use without preventative efforts. Some canal maintenance roads are regularly used by the public without efforts by the canal company or private landowners to stop it. According to Cache County attorneys, a trail easement can be established if the canal maintenance road has been used for public recreation for 20 consecutive years at any point in time. The process of establishing a prescriptive trail easement within a canal corridor has not yet been carried out in Utah.

A separate concern regarding land ownership and canal trails is the fact that many canals bisect property. The property size can vary from a small residential lot to a larger ranch or orchard. If the canal right-of-way is owned in fee by the canal company, the canal trail may be built through the property despite opposition from the landowner. However, this can cause issues with trail users going through the property and is not recommended. If the canal right-of-way is an easement, the landowner must give their consent to the canal trail. In any case, this poses a challenge in constructing a trail through the property and it may be necessary to reroute the trail around the property.

The establishment of a trail can provide a great opportunity for a canal company, with the potential assistance of a local government, to survey and better document their right-of-way. In many canal corridors, fencing or other encroachments are placed illegally within the right-of-way. As a result, properly defining the right-of-way is important to complete prior to any trail development so the entire right-of-way can be used in design. Trails also help to preserve the right-of-way as the public and local governments become involved in encroachment issues. In situations where canals are enclosed, trails are a natural choice in protecting the right-of-way because they provide

easy access for future maintenance. Canal companies throughout the state constantly struggle to access developed rights-of-way for infrastructure improvements, making the costs of repairs increase substantially.

In summary, landownership along a canal can vary and is not always well defined. The development of a trail creates the opportunity to identify and clarify the land ownership. If the canal corridor is owned in fee by the canal company, the negotiations for a trail are solely between the canal company and the local governments pursing a trail. If the canal corridor is an easement, the private landowner is involved in the negations process as well. When an agreement cannot be reached between specific parties, then rerouting the trail off of the canal corridor for sections may be necessary.

4.1.2 Maintenance

Maintenance for a canal varies depending on the location and channel type. For enclosed canals, maintenance of the buried pipe or culvert is minimal, with occasional work done to maintain the inner lining of the infrastructure, remove sediment, and earthwork in cases of subsidence. In open channel situations, the maintenance depends on the presence of sediment in the irrigation water, the type of canal lining, and the amount of trash or debris entering the canal. The following section discusses in further detail the types of maintenance tasks performed on open channel canals in Utah.

Maintenance of the canal's open channel is a year-round process that is performed primarily by the canal company or water district. The majority of the significant maintenance work is completed in the off-season (October to April) because the canals have little to no water. In some instances, maintenance on the canal is accomplished through volunteer work of the shareholders or community members.

Dredging of a canal is generally done every 3-10 years on canals with earth liners. The frequency of the dredging depends on the type of the canal liner and the amount of sediment in the irrigation water. Dredging the canal is done to reset the flow elevation of the canal to a desired height. The spoils of the dredging are typically placed along the canal banks, so sufficient space needs to be available if a trail is established. In addition, survey data being used in construction along a canal corridor should be updated regularly because of the dredging and movement of sediment.

The maintenance roads for the majority of canals in Utah are made of a road base or dirt material. The road base or dirt material requires constant maintenance from ruts and holes caused by legal and illegal use. During winter, even minimal driving on the maintenance road can cause significant damage. The addition of a trail can help canal companies by providing an improved pavement surface, like asphalt, for the maintenance road, and the assistance of a local government in maintaining the road base where the trail is located.

Weeds on the canal banks and maintenance roads have to be sprayed and cut down regularly. Canal companies often put down pre-emergent herbicides in the fall to prevent weeds in the spring. Trees have to be trimmed and maintained regularly as well. Overgrown weeds, trees, and shrubs are a common complaint from adjacent landowners. This situation offers the potential for a local government to establish a trail and take responsibility for maintaining the weeds, trees, and shrubs.

Trash racks are located at culverts or similar road crossings and have to be maintained on a frequent basis. Depending on the proximity of the canal to population centers, trash racks can require cleaning every day. Trash piles are typically piled up near

the racks until large enough to require removal. As with weed control, this is a task that local governments can assist with because they already have the equipment and personnel doing similar work in the area. The addition of a public trail has reduced littering on many canals, such as the Murdock Canal and the Utah & Salt Lake Canal, because the community has an increased interest and investment in the canal corridor. In addition, illegal dumping of furniture, lawn clippings, or horse manure is also reduced because of the community policing effect created by a public trail.

Inspection and adjustment of canal gates is done on a regular basis and requires the use of normal size pickup truck. A water master traverses the canal on a daily basis to ensure irrigation waters are moving as expected out of the canal. Some canal companies expressed hesitation in allowing local governments to assist in maintenance because roads may be too narrow to allow for the passing of trucks. This can depend on the right-of-way width, but occasional turnouts and regular communication can help alleviate these potential concerns. Check dams are used on some canals to control water levels for gate turnouts or for water quality improvement purposes. These check dams require constant maintenance for which the local government may also give aid.

A common concern for canal companies interviewed was the ability to perform normal maintenance with the presence of the public using a recreational trail. The effects of the public can vary depending on the trail use and the amount of space available in the corridor. However, the canal companies with established canal trails all stated that there was no significant impact in their ability to operate and maintain the canal because of the public trail. As mentioned, much of the significant maintenance on canals is performed in the off-season, which is also a time of significantly reduced trail usage because of the

colder temperatures.

Access points for canal maintenance roads need to have sufficient space for trucks towing large equipment. Some access control methods (discussed in the Canal Trail Design section) are not feasible with the type of equipment that needs to be moved into the canal corridor. For example, raised table crossings with bulb outs are a popular intersection treatment to increase safety for trail users. This infrastructure, however, can easily be ruined by large maintenance equipment turning into the canal corridor. Consequently, a canal company should be involved in the change of any canal access point due to the installation of a trail.

Figure 4-1. Speed table crossing treatment used at trail access points (NACTO, 2012).

In order to establish a canal trail, a license agreement is typically created which details information regarding the continued maintenance of the trail. The agreement should detail the specific maintenance tasks that each organization will

perform. It is important to include the exact location where the maintenance tasks will be done, such as in the canal itself, the banks, the trail, the trail shoulder, and the bank opposite the trail (if applicable).

Common maintenance tasks detailed in the license agreement include: removal and disposal of trash, weed and vector control, trail surface maintenance, snow removal, access control structure maintenance, and safety improvement infrastructure maintenance. The agreement should also state the procedure for when the canal company needs to perform large scale maintenance that requires shutting down the trail. Typically, the canal company notifies the local government in advance and the local government is in charge of managing the trail closure.

When a local government is considering a canal trail, it should at least anticipate performing maintenance on the trail and the trail shoulders. Every agreement for existing canal trails in Utah requires the local government to perform some sort of maintenance in the corridor in exchange for use of the corridor. The commitment of a local government to perform maintenance tasks that will alleviate work by the canal company is an important incentive in the negotiating process.

The establishment of a canal trail requires a fair amount of trust between the canal company and the local government. The canal company has to trust the local government to perform the maintenance tasks agreed to and that the primary use of the corridor will remain for irrigation purposes. The local government has to trust the canal company to be careful with the trail surface while performing maintenance and that the trail will not be closed unnecessarily. In order to continually address these considerations, the license agreement can require regular stakeholder meetings

to continually assess the trail operation and maintenance. It is recommended for any parties looking to create their own trail license agreement to review other license agreements from completed canal trail projects, which are generally available to the public.

4.1.3 Safety

The siting of a trail near open irrigation water raises concern over the safety of the trail users. Some canal companies have experienced deaths due to drownings without legal public access, so there are concerns those would increase with a formal canal trail. In addition, certain water infrastructure, such as a siphon which pulls water underneath other intersecting infrastructure, create significant safety concerns. People that fall into the canal near a siphon can be pulled underwater and trapped inside. Another potential concern is that some canals have concrete liners that pose a higher risk because it can be difficult to get out of the canal channel. These types of hazards require special attention and design. The canal company, local government, and engineering firms should all assist in identifying potential hazards and recommending potential solutions.

Various trail design methods can be used to encourage and promote safe use of the canal trail. Proper signage, conservative geometric layouts, and mode restrictions can significantly reduce risk on the trail. Perhaps most impactful is the placement of fencing between the canal and the trail near higher risk areas. In Draper City, the East Jordan Canal has allowed short fencing to be placed between a canal trail and the open channel canal, as seen in Figure 4-2.

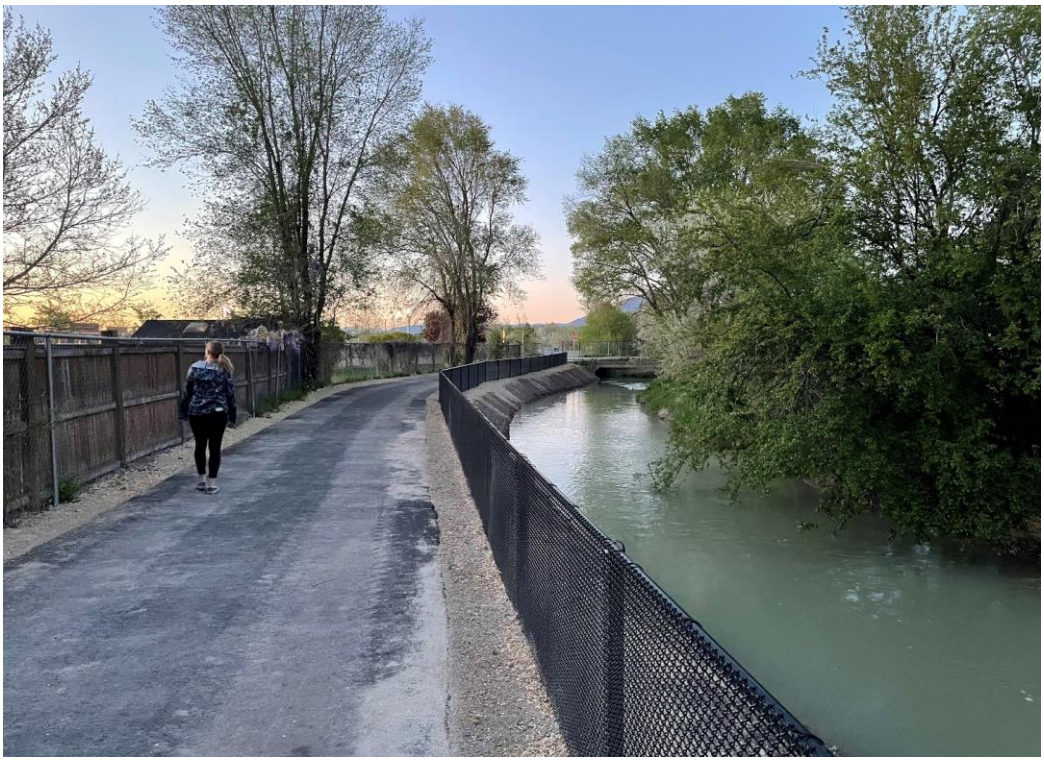

Figure 4-2. East Jordan Canal Trail with fencing between the canal and trail.

Many canal companies, however, are opposed to fences because it inhibits their ability to perform certain maintenance tasks. If this is the case, shrubs or plants might provide an acceptable barrier with the trail being moved as far from the canal as possible within the corridor. Another option is if canal sections need to be accessed on a rare basis for maintenance, then semi-permanent protections can be used such as removable fencing or canal caps/lids. The risks of trail users near open water can never be completely eliminated, but local governments and canal companies can work together to find a solution that satisfies all parties and provides adequate safety.

It is important to remember that trails alongside open waterways are also in countless locations throughout the state such as the Jordan River Trail, Logan River Trail, Weber River Trail, and the Provo River Trail. These trails are often within a few feet of

rivers that carry more water and travel faster than most canals. In summary, risks will always be present with the establishment of a canal trail, but efforts should be made to design as safe an environment as possible. The risks associated with having a canal trail have to be measured against the benefits of providing the public with a valuable transportation resource.

4.1.4 Liability

All canal companies worry about the liability of allowing the public onto their land. If a user of the trail were to get seriously injured or die while using the trail, a lawsuit against the canal company could be devastating. In order to address this, the state of Utah passed legislation in 2013 that prevents a person using land opened to the public for recreation from making a legal claim against the land owner. The 2019 Utah Code states:

> Except as provided in Subsection 57-14-204(1), an owner of land who either directly or indirectly invites or permits without charge, or for a nominal fee of no more than $1 per year, any person to use the owner's land for any recreational purpose, or an owner of a public access area open to public recreational access under Title 73, Chapter 29, Public Waters Access Act, does not:
> (1) make any representation or extend any assurance that the land is safe for any purpose;
> (2) confer upon the person the legal status of an invitee or licensee to whom a duty of care is owed;
> (3) assume responsibility for or incur liability for any injury to persons or property caused by an act or omission of the person or any other person who enters upon the land; or
> (4) owe any duty to curtail the owner's use of the land during its use for recreational purposes (Utah Code- Limitations of Landowner Liability, 2019).

This limitation on liability was an important step in establishing canal trails and has directly led to the construction of some canal trails, such as trails along the East Jordan Canal and the Utah & Salt Lake Canal. However, this does not address the cost of

a defense if a lawsuit were to be filed against the canal company, regardless of whether or not they win. Therefore, most license agreements indemnify the canal company, removing them from any legal issues stemming from the use of the canal trail. Another option is for the local government to contribute money towards insurance taken out by the canal company to provide a legal defense, as was done for the Murdock Canal Trail.

For local governments, the Governmental Immunity Act of Utah, which was originally passed in 1965 and has since been amended multiple times, removes liability to a governmental entity involving the public use of canal corridors as long as the trail meets the conditions detailed below:

> …the operation or existence of a pedestrian or equestrian trail that is along a ditch, canal, stream, or river, regardless of ownership or operation of the ditch, canal, stream, or river, if:
> (i) the trail is designated under a general plan adopted by a municipality under Section 10-9a-401 or by a county under Section 17-27a-401;
> (ii) the trail right-of-way or the right-of-way where the trail is located is open to public use as evidenced by a written agreement between:
> (A) the owner or operator of the trail right-of-way or of the right-of-way where the trail is located; and
> (B) the municipality or county where the trail is located; and
> (iii) the written agreement:
> (A) contains a plan for operation and maintenance of the trail; and
> (B) provides that an owner or operator of the trail right-of-way or of the right-of-way where the trail is located has, at a minimum, the same level of immunity from suit as the governmental entity in connection with or resulting from the use of the trail (Governmental Immunity for Trails, 2007).

In summary, canal companies can benefit from allowing a public trail because a local government can assume responsibility for any litigation. The details of that indemnification should be discussed in the license agreement. It is also important to note that no organizations associated with canal trails in Utah have had a lawsuit filed against them related to a canal trail.

4.1.5 Privacy

One of the major concerns of landowners adjacent to the canal corridor is the loss of privacy resulting from a public trail. Many canals run along the backside of resident's properties which allows trail users to see into backyards, especially when the yard has open fences or no fences at all. Some canal maintenance roads may be elevated or up on a hillside, allowing trail users to easily see what is below them. Another concern with privacy is that, as mentioned previously, canal corridors may bisect private a landowner's property.

In order to address concerns over loss of privacy, the local government pursuing the trail should conduct public relations campaigns throughout the planning process. To begin with, plans for future trails need to be properly publicized and made available well in advance. If public education is not orchestrated correctly, then residents often fill the void with negative or false information. Consequently, project details should be sent out through flyers, social media, and other city news sources. Regular community meetings should also be held to help gather public input.

At the meetings, project maps, cross-sections, and other visuals are vital in providing the public with an accurate concept of the future trail. It is also important to invite key stakeholder groups, such as the canal company, to the community meetings. The local government needs to assure the community, as well as the canal company, that the trail will be maintained properly and become a cherished asset to everyone. Those opposed to the trail are often the most outspoken, so a genuine effort needs to be made to receive feedback from all impacted parties. In some instances, personal meetings at the household of individuals might also be necessary. In the end, the construction of a canal

trail may require some sacrifice of the adjacent landowners for the good of the community as a whole.

4.1.6 Funding

The cost of canal trails can vary significantly depending on the existing facilities, the type of proposed trail, and the number of trail crossings. The Murdock Canal Trail had an approximate cost of $1 million per mile. The cost of the Utah & Salt Lake Canal Trail was approximately $500,000 per mile. In scenarios where the canal trail is located on the existing maintenance road of a canal and left as a road base material, then the cost of the project can be very minimal.

Funding for canal trail projects can come from a variety of local, county, state, and federal sources. Locally, trail impact fees and designated transportation funds are the most used sources. On the county level, the quarter-cent sales tax that is designated for transportation uses can used for canal trails (Utah Code- Local Option Sales and Uses Taxes for Transportation Act, 2019). Most state and federal funding requires some level of local match, so it is important for local governments to have a funding source available for trails. To do this, local governments typically include canal trails in a master plan to ensure proper planning and that funding is available. It is important to note, however, that canal companies should be notified of a local government's intentions to establish a canal trail prior to its inclusion in a master plan. Even though the canal company might be opposed to the trail at the time, it can help in future relationships if the canal company is aware of the local government's intentions.

Metropolitan Planning Organizations (MPOs) help coordinate transportation

projects and can play an instrumental role in the establishment of canal trails. MPOs provide an important resource when planned canal trails cover larger regions and cross through multiple local governments. MPOs can be the source of specific funding as well as political capital to acquire additional funding.

Statewide funds for canal trails have historically come through the recreational trails program. The recreational trails program is administered by the Federal Highway Administration through the Utah Division of State Parks and Recreation (RTP, 2021). This funding requires a 50% match and are automatically included in the Statewide Transportation Improvement Program list. The Utah Outdoor Recreation Grant is another newer funding source available for the construction of recreational trails (UORG, 2021). The outdoor recreation grants require a 50% match and can be used for projects of up to $150,000.

A different funding option is the state transportation investment fund (TIF) which can be used if the canal trail is shown to alleviate congestion on other state facilities (Utah Code- Transportation Investment Fund of 2005). Federal grants from the Rebuilding American Infrastructure with Sustainability and Equity program, formerly the Transportation Investments Generating Economic Recovery program, have also been used for canal trail projects in the past and are targeted at shovel ready, surface transportation projects. Many other trail funding sources are available, depending on the project circumstances, such as the Congestion Mitigation and Air Quality Fund, Transportation Alternatives Program, Land and Water Conservation Fund, and People for Bikes Grants.

The enclosure of a canal can be instrumental in the establishment of canal

trails, so funding for water infrastructure improvements is also discussed. The cost of enclosing a canal in a pipe or a box culvert is significantly higher than the cost of constructing a trail on top of it. In most cases the cost of enclosure is around ten times that of the trail. Funding for the enclosure of canals comes from a mix of state and federal funds.

The two primary grants used for canal infrastructure improvements are the National Resources Conservation Services (NRCS) Watershed grants (National Resources Conservation Services, 2021) and the Bureau of Reclamation WaterSMART grants (Bureau of Reclamation, 2021). Water optimization grants through the Utah Department of Agriculture and Food are also used. All of these funding sources have specific requirements tied to them, such as flood prevention, water optimization, or water quantification. The funding sources usually require matches by the canal companies which can be supplied via loans from the Division of Water Resources or increasing shareholder's prices.

The public law 83-566 Watershed funding through the NRCS is being used for canal infrastructure projects in various locations throughout the state such as Ogden Valley, Cache Valley, Vernal, and Delta. The purpose of the grant is to fund projects that help prevent damage from erosion, floodwater, and sediment or furthers conservation, development, utilization, and disposal of water. The grant provides for 50% of funding for recreation projects related to water conservation projects such as canal enclosures. Enclosure projects that include recreation, such as trails, as part of the proposal are given higher priority. Watershed funding involves the submission of a preliminary report before a complete application can be submitted. The process for funding approval takes about

two years because of the community outreach and the assessment of environmental impacts that are required. The Watershed Program provides for 50-100% of funding for infrastructure improvements depending on the project's purpose.

WaterSMART grants are available through the Bureau of Reclamation (BOR) and are widely used by canal companies throughout the state. The WaterSMART grants typically require a 50% match by the canal company or water district. The BOR website states the projects must help conserve and user water more efficiently, increase production of hydropower, mitigate conflict risk, or accomplish other benefits that contribute to water supply reliability. Projects are selected through a competitive process and the focus is on projects that can be completed within two or three years. One funding group provides moneys for projects up to $500,000 and the other funding group provides moneys for projects up to $2 million.

Future infrastructure funding through federal legislation is also important to consider as it could provide many more opportunities for trail construction. At the time of this writing, the American Jobs Plan, a proposal by President Biden, is a bill aimed at providing trillions of dollars to upgrade the country's aging infrastructure (The American Jobs Plan, 2021). The passage of this bill is not guaranteed, but the bill itself makes it apparent that funding for recreational trails is becoming more of a priority in today's society.

4.2 Canal Trail Design

From a transportation perspective, canal trails are existing, long, flat tracts of land that provide an excellent place for establishing trails. These trails can provide use to pedestrians, bicyclists, equestrians, and other non-motorized means of

transportation. The design of a canal trail is typically done by an engineering firm or city engineer, but guidelines are provided to give a background and important takeaways from completed facilities.

4.2.1 Trail Surface

In most cases, the design of the trail itself depends upon the planned use and the input from the stakeholders. Asphalt trails are more expensive but provide access to a larger range of transportation methods. Gravel or dirt trails are less expensive but limit the number of transportation uses. Canal companies may prefer a gravel or dirt trail because it does not require constant repair following maintenance activities. The Murray Canal Trail used chat gravel for the trail surface, which is cheaper and easier to repair than asphalt but does allow for more transportation uses than traditional gravel trails.

Large equipment, such as excavators with steel tracks, can quickly tear up asphalt trails. A trail section that includes increased amounts of asphalt and road base, similar to a typical highway section, might be an option to allow heavy equipment on the trail while still providing maximum transportation uses. Local governments and canal companies should work together to determine the ideal trail section to satisfy the needs of each party.

Another consideration for trail type is the amount of vegetation in and around the canal corridor. If trees are prevalent or desired along the corridor, then an asphalt trail will require increased amounts of future maintenance work. Different methods exist in preventing tree roots from destroying paved trails, such as root barriers shown in Figure 4-3, but consideration should be made for the long-term

maintenance costs associated with each trail type.

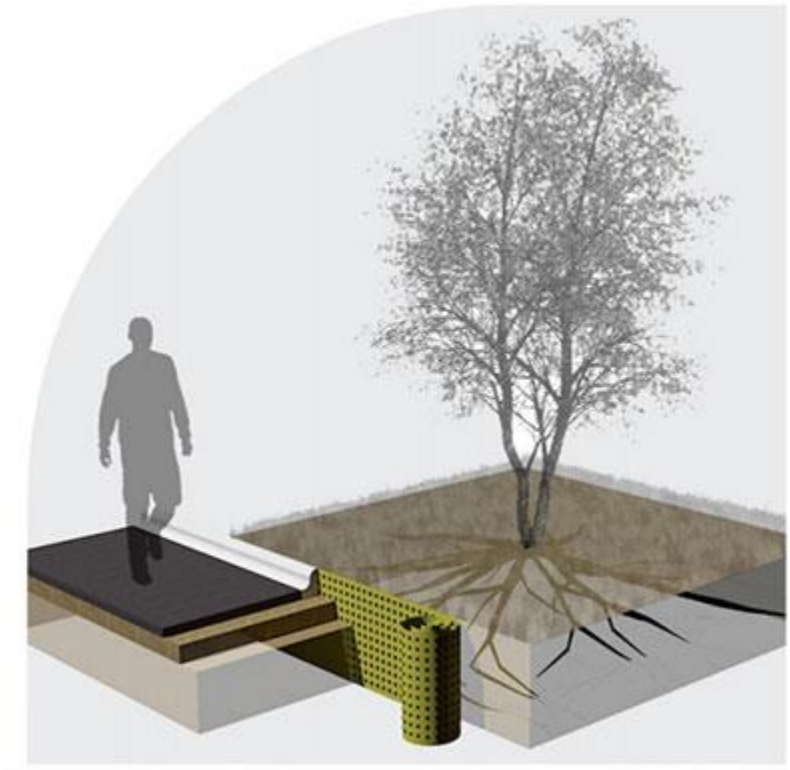

Figure 4-3. Example of root barrier, called BioBarrier, used to prevent damage to paved trails (TYPAR, 2012).

4.2.2 Trail Width

The width of the canal trail will depend upon the amount of space available in the corridor, the anticipated amount of use, and the requirements or standards involved. The majority of asphalt canal trails around the state are between 10 and 12 feet wide. Trails with a larger right-of-way and higher amounts of use, such as the Murdock Canal Trail, have trails that are 15 feet wide or greater. Even wider trails may be desirable to minimize conflicts between trail users traveling at different speeds.

The canal company may require or prefer the asphalt trail to encompass most of the maintenance road in order to reduce the necessary maintenance. A gravel or dirt trail established on an existing maintenance road will typically assume the width of the road itself, as shown in Figure 4-4. When certain funding is involved, trail design may be required to follow different standards such as AASHTO Guide for the Planning, Design, and Operation of Bicycle Facilities. In these cases, minimum trail widths and setbacks are set forth in the design standards.

Figure 4-4. Murray Canal Trail built on the Jordan & Salt Lake Canal maintenance road.

4.2.3 Corridor Cross Sections

Canal rights-of-way vary significantly in size and type, so each situation

requires analysis to determine the best location for siting a trail. A canal trail may be built in a corridor with an enclosed canal or with an open channel canal. If the canal is enclosed and the entire corridor is filled in, then the trail can be placed on top of the fill. If the canal is enclosed underneath the maintenance road and the open channel is left intact, like with the Lundstrom Park Trail shown in Figure 4-5, then the trail can be placed anywhere within the corridor as described in the following section about open channel trails.

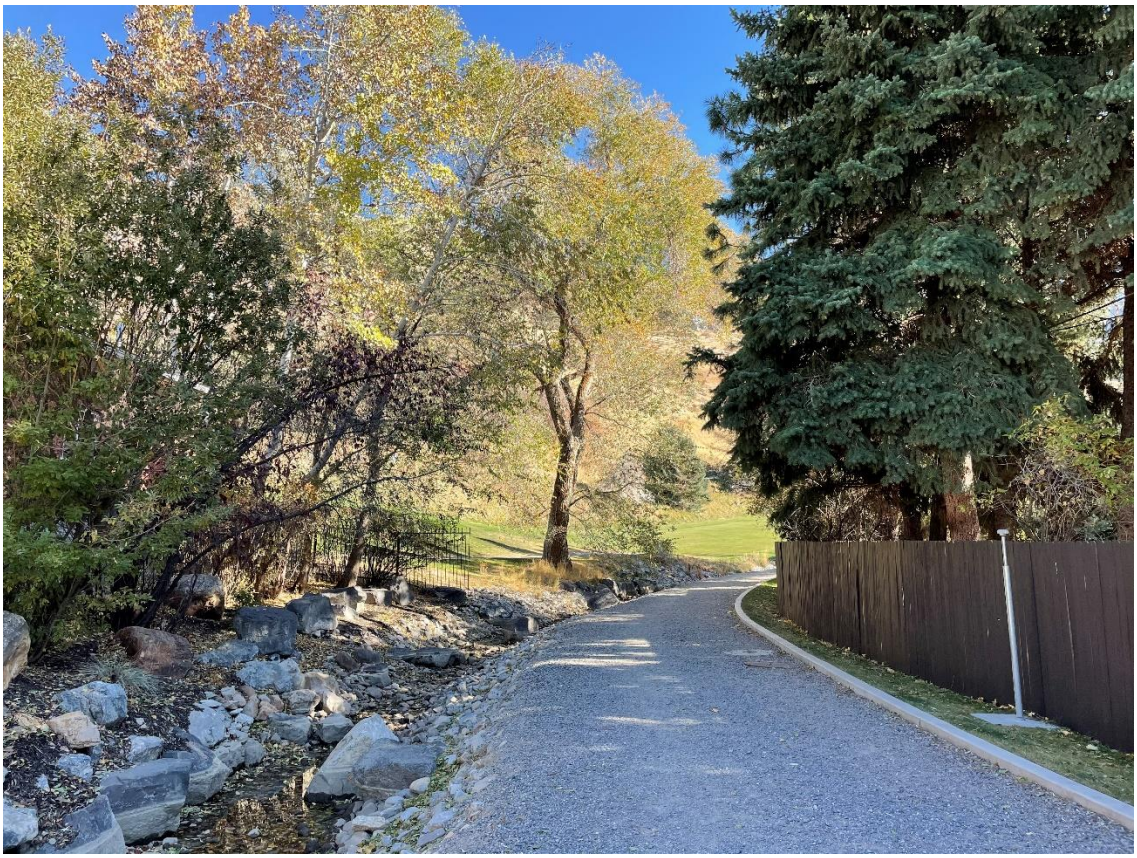

Figure 4-5. Lundstrom Park Trail with trail atop piped canal under maintenance road.

For open channel canals, there are three different configurations that have been used throughout the state. First, the trail can be placed on the maintenance road

itself as done on the Davis and Weber Counties Canal Trail. Second, the trail can be placed immediately next to the maintenance road as was done on the Oquirrh Mountain Trail adjacent to the Welby Canal in South Jordan (Figure 4-6). Third, the trail can be placed on the opposite side of the bank from the maintenance road as was done on the Utah & Salt Lake Canal Trail (Figure 4-7).

Figure 4-6. Oquirrh Mountain Trail with view of canal, road, and trail.

Figure 4-7. Utah & Salt Lake Canal Trail with view of road, canal, and trail.

In the design of the cross-section the trail is ideally placed as far from the open channel as possible to create a buffer between the trail and the water. In some locations where the trail has to get especially close to the canal, such as around bends, fencing could be placed between the trail and the water for a short distance. It is also important to note that the canal can be shifted a few feet horizontally in either direction if it would greatly benefit the trail construction. This approach was taken by Draper City which moved a small section of the East Jordan Canal a few feet to better accommodate a trail. Shifting the open channel horizontally is fairly expensive, however, and typically requires hydraulic analysis.

4.2.4 Intersection Design

Canal alignments do not generally follow a linear pattern. As a result, many

canals pass under roadways at mid-block crossings. For canal trails, this requires intersection design at these locations. The current roadway traffic volume and the estimated trail volume is used to determine the location specific treatment. For locations with low traffic volumes, a basic crosswalk with trail crossing signage may be sufficient (Figure 4-8). For locations with higher traffic volumes, a rapid flashing beacon crossing may be used (Figure 4-9). For locations with very high traffic volume, a pedestrian hybrid beacon or separate grade crossing might be the best option (Figure 4-10). In some cases, the trail traffic may be high enough to merit a situation where vehicle traffic must yield to pedestrian traffic.

Figure 4-8. Basic intersection treatment with crosswalk and crossing signage.

Figure 4-9. Pedestrian activated crossing light at canal trail intersection.

Figure 4-10. Pedestrian hybrid beacon at canal trail intersection.

One of the challenges with trail access points, typically at roadway crossings, is to design an entrance that prevents or inhibits use by unauthorized motor vehicles without being an obstruction for trail users or maintenance workers. A common method is to use a flag gate with a small gap that only allows for non-motorized transportation to pass through. Another method is to use collapsible or foldable bollards to prevent unauthorized motor vehicles. These gates or bollards can be moved or collapsed by the canal company for access as shown in Figure 4-11.

Figure 4-11. Trail intersection treatment with collapsible bollards.

The disadvantage to these traditional access control methods is that they require canal maintenance crews to constantly open and close gates as they perform regular maintenance. In many cases, canal companies simply end up leaving the gates open due

to the time savings. Because of this, other treatments can be explored such as the use of a raised landscaped area that discourages, but does not prevent unauthorized motor vehicles. This treatment design, shown in Figure 4-12, has been used by Alta Planning + Design for different trail applications. The access control method allows canal maintenance trucks to pass through without constantly opening and closing gates while still discouraging non-motorized access.

Figure 4-12. Access control treatment method (Alta Planning + Design).

4.3 Benefits and Considerations

This section explores the benefits and considerations associated with establishing a canal trail. Canal enclosure is often closely tied with the constructing of a trail, so the benefits and considerations of enclosing canals is discussed as well. Each of the benefits and considerations may or may not be applicable to every canal trail project as the circumstances in each situation can vary.

4.3.1 Canal Trails

The establishment of a canal trail brings many benefits as well as considerations to each stakeholder involved. This section is meant to summarize key benefits mentioned in the interviews from both a local government's perspective and a canal company's perspective. The benefits list is helpful in preliminary trail discussions as well as during the creation of the license agreement. The actual benefits to each stakeholder are dependent on the final agreement put into place.

The benefits of a canal trail for a canal company can potentially include any of the following items:

- Assistance with regular maintenance
- Assistance with survey work (create a defined right-of-way)
- Improved maintenance road surface
- Community policing of the canal corridor
- Improved community image and education
- Adaptation to increasingly urbanized areas
- Reduction in canal company liability
- Address issues associated with illegal access
- Preservation of right-of-way

For local governments, potential benefits of allowing public trails could include:

- Community active transportation asset
- Completion or additions to a trail network
- Improved utilization of land

- Trail located in built out/urbanized area
- Safer transportation routes (including Safe Routes to School)
- Enhanced canal corridor appearance
- Increased property values near trail

Throughout the process of establishing a canal trail, it should be clear to all those involved that the primary purpose is and must continue to be for irrigation water conveyance. Although a trail may have an impact on the ability of the canal company to perform regular maintenance, the impact can be minimized with the aid of local governments and the education of local residents.

A canal trail does necessitate additional communication between a canal company and a local government. The fostering of a well-working relationship between the two parties is essential for successful projects. Ongoing communication following the completion of the project for maintenance and other trail issues is also vital. Regular meetings between all stakeholders are something that should be considered.

The establishment of a canal trail will require work from both the canal company and the local government. The amount of work will vary depending on the trail design, but it should be understood by all parties that the canal trail will require a serious investment of time and resources. It is important to note that many canal company board members are volunteers, so expecting a large amount of work from them is not feasible or fair. If the personnel at the respective organizations do not have sufficient time, then hired assistance should be factored into the canal trail costs.

The local government needs to show a strong commitment to the continued maintenance of the canal trail. Annual budgets should include all of the maintenance activities agreed to in the trail license agreement. Some license agreements are created with the caveat that it can be revoked if the local government does not perform the maintenance as agreed upon. Once the public views the canal trail as a public asset it is very difficult to reverse the process, so a local government must take the maintenance tasks it has consented to very seriously.

4.3.2 Canal Enclosure

The enclosure of a canal can be crucial for the establishment of a trail when canal companies are reluctant, due to liability and safety concerns, to have an open channel of water by the trail. Consequently, the enclosure of canals seems to create a win-win scenario for both the canal company and public recreation. An enclosed canal poses virtually no safety concerns and a trail helps to preserve the right-of-way where the canal is buried.

The enclosing of an open channel canal in a box culvert or pipe has many benefits to the canal company itself. This is evident in that every canal company interviewed expressed a desire to enclose their open channel canal. Many of the canal companies that were interviewed are currently in the process of enclosing all or part of their canals. In almost all scenarios, funding for the enclosure is the main obstacle that canal companies face. Benefits of enclosing a canal can consist of:

- Improvement in water quality
- Elimination of losses from seepage and evapotranspiration
- Elimination of safety concerns from an open channel

- Increased control over water flows
- Increased flow capacity
- Decreased maintenance costs (weed removal, road maintenance, etc.)

It should be noted, however, that the enclosure of open channel waterways has faced public opposition in some places because of the aesthetic appeal of flowing waters. The vegetation that naturally borders an open channel canal because of the unlimited access to water is also something many people enjoy. As mentioned previously, the Cache Highline Canal Trail remedied this by enclosing the canal in a pipe but leaving the open channel with reduced amounts of water in it. However, the benefits of enclosing a canal are important enough in some cases that public opposition to enclosing the open channel canal might be negated.

Another important point to consider with the enclosure of a canal is that many open channels receive stormwater into them. Local governments generally have agreements with canal companies that allow predetermined amounts of stormwater to drain into canals. If the canal is enclosed and the open channel is filled, then special designs will need to be created that allow stormwater input into the pipe/culvert. This can be especially challenging if the system is pressurized, so it may be preferable to divert the stormwater elsewhere. Another option would be to enclose the canal under the maintenance road and leave the open channel to collect the stormwater. Either way, the stormwater entering the canal is something that needs to be addressed and may require additional expenditures.

4.4 Case Studies

In order to provide a variety of different scenarios and circumstances, five different canal trail projects are summarized in this section. The selection of which canal trail to provide a case study for is done based on available information, usefulness to future projects, and uniqueness of the trail design. The diversity in these projects show there is no set method for establishing a public trail along a canal corridor and each situation should be evaluated individually. Trails built atop enclosed canals as well as alongside open channel canals are included.

4.4.1 Murdock Canal Trail

The Provo Reservoir Canal was originally built in the early 1900s to convey irrigation water from the Provo River to Northern Utah County. The Provo River Water Users Association (PRWUA) eventually became the owners of the canal, and the canal's name was changed to the Murdock Canal. After many years of upgrades and expansion, the open channel canal was completely enclosed in a 10.5-foot diameter pipe in 2012. Utah County, Mountainland Association of Governments, and local agencies worked with PRWUA to construct an asphalt trail on top of the newly enclosed canal. The trail has since become a priceless asset for Utah County residents, with approximately half a million user trips a year. The pipeline enclosure and subsequent trail construction provide a model for how similar projects can be completed across the state.

Figure 4-13. Map of Murdock Canal Trail in Utah County.

Trail Facts:

Canal Length: 21 miles

Canal Type: Enclosed/piped

Begin/End Points: Mouth of Provo Canyon to Lehi near Thanksgiving Point

ROW Width: 70-125 feet

Trail Length: 17 miles

Trail Type: Paved asphalt

Trail Width: 15 feet

Trail Uses: Non-motorized including walking, cycling, and horseback riding

Land Ownership Type: Fee title (via title transfer from BOR)

Enclosure Cost: $150 million

Trail Cost: $18 million

Talks of a trail along the Murdock Canal started in the 1980s, but PRWUA was reluctant to allow one until the canal was enclosed. During this time, the maintenance road along the canal saw fairly high amounts of illegal recreational use. In the late 1990s, PRWUA received grant money for the enclosure of the canal and began preparations to pipe the entire length of the canal. As time went on, the canal enclosure and construction of a trail became a joint operation. From 2006 to the completion of the project in 2013, PRWUA, Utah County, and Mountainland Association of Governments (MAG) did a tremendous amount of work to complete the project.

Steve Cain (PRWUA), Richard Nielson (Utah County), and Jim Price (MAG) presented information at many city council meetings in order to gain support from the cities the proposed trail would run through. PRWUA had to resolve 140 encroachments

of canal property and work with cities to deal with 560 utility crossings for the project. In addition, thousands of adjacent landowners and other residents needed to be informed of the project, which was realized using various public meetings and outreach.

Figure 4-14. Murdock Canal prior to enclosure. (Johnson, 2013).

Figure 4-15. Murdock Canal Trail after enclosure (Trip Advisor, 2014).

The majority of the funding for the trail came through a federal earmark of around $12.75 million, $11.75 million for the trail, and $1 million for the canal enclosure. Other trail funding was provided by Utah County and the seven cities through which the trail runs. Continued maintenance of the trail is managed by the county, with each city providing a portion of the maintenance by either performing maintenance themselves or contributing money for the county to perform the maintenance.

The license agreement for the trail is between PRWUA and Utah County which reduces the points of contact necessary for PRWUA. Utah County in turn has an interlocal agreement with the seven cities involved with the trail. The license agreement states that PRWUA retains rights to the land, while Utah County is in charge of the maintenance of the corridor surface including the trail. PRWUA notifies Utah County if maintenance with the buried water infrastructure is necessary and the county is in charge of closing those sections of the trail. To address liability, the cities (through the county), and the county itself contribute to an insurance premium held by PRWUA that it uses to provide legal protection. The license agreement also puts forth the trail rules and establishes a Murdock Canal Trail Committee that meets on a regular basis to discuss the ongoing needs of the trail.

Since the construction of the trail in 2013, very few crashes have been reported on the trail and crime is also low. Trail intercept surveys show about 17-19% of the trips on the trail are for utility or commuting purposes. The trail initially had five different trailheads along its length, but additional trailheads have since been added. The trailheads include cross-sections of the buried pipeline along with information about the history of the canal to help educate trail users.

A study of the economic impacts of the Murdock Canal Trail shows that the trail generates over $3.6 million annually for the area (Engineers, H.D.R., 2017). These include benefits that come from increased productivity, household spending on goods and services, averted healthcare expenditures, and other recreational relating spending. This is a massive benefit compared to the $113,000 spent annually to maintain the trail.

As the enclosure of the canal was vital to the establishment of the trail, the enclosure funding is also discussed. The enclosure of the open channel canal was originally planned in 1994 as part of PRWUA's Master Plan. PRWUA later received grant money from Central Utah Water to get water from Strawberry projects to Salt Lake County. Central Utah Water would essentially buy the water savings involved in the enclosure of the canal. PRWUA, Metro Salt Lake, Sandy, Jordan Valley Water and other shareholders each paid for portions of the canal enclosure which totaled approximately $150 million. The enclosure saves PRWUA between 10 and 12 thousand acre-feet of water per year, meaning about 50% of water was previously being lost to evapotranspiration or seepage.

Project contact information:

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Richard Nielson - Utah County - richardjn@utahcounty.gov

4.4.2 Davis and Weber Counties Canal Trail

The Davis and Weber Counties Canal was originally built in 1880s and has since been upgraded numerous times to increase its width and improve its liner. The canal runs from the mouth of Ogden Canyon and ends near Church Street in the middle of Layton

City. The canal suffered a severe breach in 1999 in the Riverdale area that prompted the enclosure of a portion of the canal. Since the breach, the canal company has worked to enclose multiple sections of the canal, which is now about one-third enclosed in its entirety.

Around 1999, shortly after the canal breach, the city of Clearfield approached the canal company to build a recreational trail along some open channel and enclosed section of the canal. The negotiation process took several years, with each party worried about the liability it faced. Eventually the trail was finished in 2006 after a number of environmental reviews that were necessary. The trail starts at 650 North in Clearfield and runs on the maintenance road alongside an open channel for a section before a break in the trail at 300 North. The trail resumes around 200 South and eventually moves to the top of the enclosed canal.

Figure 4-16. Map of Davis and Weber Counties Canal Trail (Clearfield City).

Trail Facts:

Canal Length: 17.3 miles

Canal Type: Mix of open channel and enclosed

ROW Width: Varies 33-100 feet, usually about 50 feet

Trail Length: 2.1 miles

Begin/End Points: 650 North to 1200 South in Clearfield City

Trail Type: Paved asphalt

Trail Width: 10 feet

Trail Uses: All non-motorized transportation

Land Ownership Type: Fee title

Trail Cost: $125,000

The trail was funded through a grant from the recreational trails program managed by the state Division of Parks and Recreation. The grant paid for 80% of the trail cost, with the remaining cost being paid for by Clearfield City. The grant also included the construction of two 25-foot bridges that allow the trail to cross the canal.

The license agreement for the canal trail between Clearfield City and the Davis and Weber Counties Canal Company was originally made in 1999 and was amended in 2006 when the trail was completed. The license agreement states that the city is responsible for maintenance of the trail surface while the canal company maintains everything else in the right-of-way. The agreement also currently states that the canal company and the local government have to each pay a portion of the cost to repair the asphalt trail if the canal company damages it due to maintenance on the canal. The

license agreement also states that the city shall be responsible for maintaining sufficient insurance to cover any claim of third parties relating to the trail license agreement.

Figure 4-17. Davis and Weber Counties Canal Trail in Clearfield City.

Project contact information:

Rick Smith – Davis and Weber Counties Canal Company - ricks@davisweber.org

Ben Frye – Clearfield City - ben.frye@clearfieldcity.org

4.4.3 Utah & Salt Lake Canal Trail

The Utah & Salt Lake Canal was built by Salt Lake County from 1872 to 1881 and was instrumental in the settlement of the west side of the Salt Lake Valley. The canal runs from the Jordan Narrows on the southern end of Salt Lake County to the northwest

corner of Magna township. In the 1990s, plans began to be made to construct a trail within the canal corridor, but the canal company was hesitant due to concerns over liability.

Following the passing of state statutes that specifically protected canal companies from liability when allowing public use, Salt Lake County began formal negotiations with the canal company to establish a public trail. In 2007, following years of planning and negotiation, Salt Lake County finished construction of an asphalt trail alongside the open channel canal in West Valley City. The trail was built on the opposite side of the channel from the maintenance road. Prior to the construction of the trail, the trail side of the canal corridor was in a dilapidated condition. The corridor had overgrown weeds, garbage, abandoned furniture, and was the location for many unruly activities.

Figure 4-18. Utah & Salt Lake Canal Trail in West Valley City.

The asphalt trail is located on the opposite bank of the canal maintenance road on a 12-to-15-foot-wide easement. The canal company preferred the trail to be built there in order to minimize conflicts with maintenance crews who use the other bank. The trail is approximately 2.1 miles long and work is currently being done to extend it into Magna township.

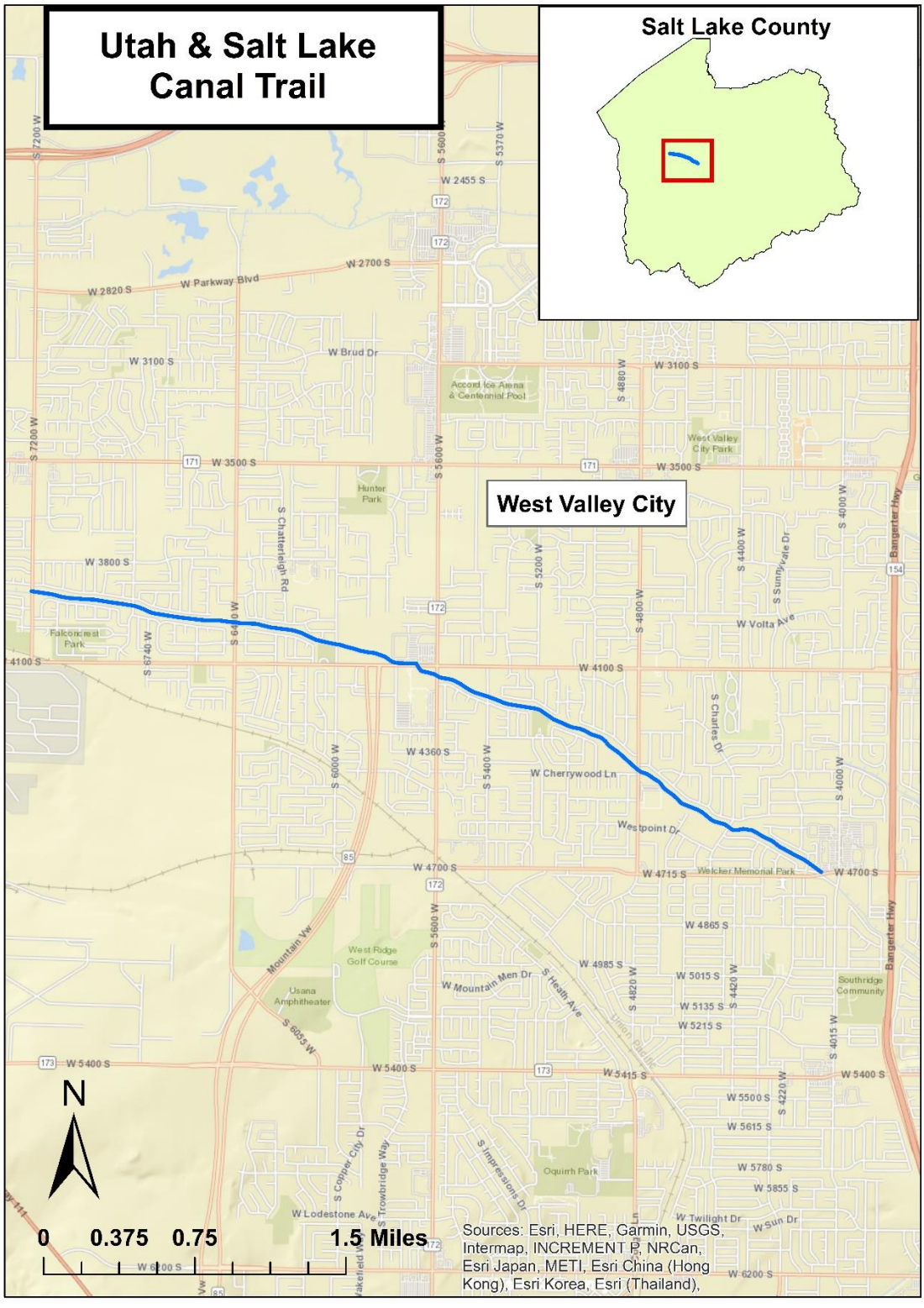

Figure 4-19. Map of Utah & Salt Lake Canal Trail (West Valley City).

Trail Facts:

Canal Length: About 30 miles

Canal Type: Open Channel

Begin/End Points: 4130 West to 5600 West in West Valley City

ROW Width: About 70-90 feet

Trail Length: 4.6 miles

Trail Type: Paved asphalt

Trail Width: 8 feet

Trail Uses: All non-motorized transportation

Land Ownership Type: Prescriptive Easement

Trail Cost: $300,000 to $500,000 per mile

The license agreement for the trail was created in 2006 and is between Salt Lake County and the Utah & Salt Lake Canal Company. The agreement explains that the county is in charge of maintenance on the bank where the trail is located, including the control of trees, shrubs and weeds. The canal company remains in charge of maintenance of the canal itself and the maintenance road. In terms of liability, the agreement refers to the state statute that protects canal companies who allow public use and states that both parties agree to indemnify, hold harmless, and defend the other party. The canal company must approve of any future trail projects in the corridor.

Funding for the trail came from Salt Lake County general improvement funds, West Valley City parks funds, and grants from the recreational trails program managed by the state Division of Parks and Recreation. County funds were available because a

trail on the canal corridor has been part of the county Master Plan since 1993. Future sections of the trail will be funded using similar funding sources, as well as the Utah outdoor recreational program. The construction of the canal trail has been completed in phases.

Since the construction of the trail, the primary concern has been vandalism and graffiti on the canal trail's signs and fences. The addition of the trail has significantly reduced illegal use of the maintenance road which was a priority of the canal company. Overall, the crime and disruptive activities in the corridor have decreased because of the community policing effect from the trail users and neighbors.

Project contact information:

Angelo Calacino - Salt Lake County - acalacino@slco.org

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4.4.4 Cache Highline Canal Trail

The Logan, Hyde Park, Smithfield Canal or Highline Canal was originally built in the early 1900s to carry irrigation water from the Logan River to farmland north of the canyon. The beginning of the canal was built using a flume along the north face of Logan Canyon. This allowed the canal to maintain a higher elevation coming out of the canyon, allowing the canal to provide water to residents below the bench. The project involved rockwork and tunneling on the mountainside to create a flume elevated high above the canyon floor.

The canal is currently operated by the Cache Highline Water Association (CHWA) which also operates the Logan and Northern or middle canal. In 2009, a breach in the canal prompted the CHWA to begin work on the enclosure of the Highline Canal.

Prior to the enclosure of the canal, residents used the open channel for inner tubing and other recreational activities which created a major safety concern.

After the completion of the enclosure project, Logan City established a trail on top of the canal in 2016. The trail is divided into two different sections, the Highline Trail and the Lundstrom Park Trail. The Highline Trail begins in Logan Canyon and runs along the north side of the canyon wall before ending on the southeast side of the Country Club Golf Course. The Lundstrom Park Trail begins on the northeast side of the Country Club Golf Course and ends near 1500 North in Logan.

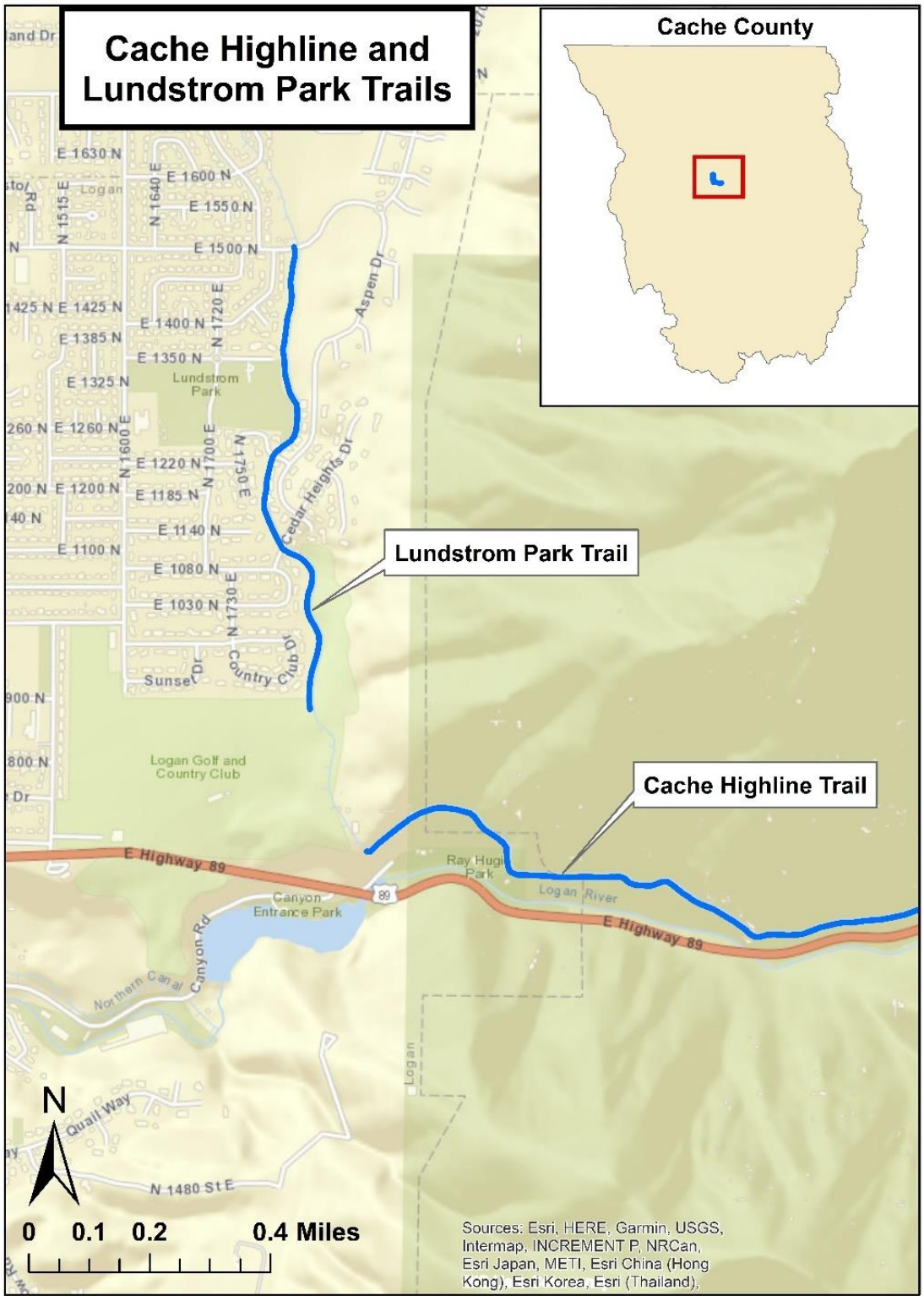

Figure 4-20. Map of Cache Highline and Lundstrom Park Canal Trails (Logan City).

Trail Facts:

Canal Type: Enclosed/piped

Begin/End Points: Mouth of Logan Canyon to Smithfield City

ROW Width: About 30-40 feet

Trail Length: Highline 1.5 miles, Lundstrom 1.4 miles

Trail Type: Gravel

Trail Width: Highline about 6-8 feet, Lundstrom about 10-12 feet

Trail Uses: Pedestrian only

Land Ownership Type: Prescriptive easement

Enclosure Cost: $25 million

Trail Cost: $90,000

Funding for the enclosure of the canal was provided by the National Resources Conservation Service Watershed grant program and CHWA. Other water infrastructure improvements on nearby facilities were also completed as part of the project. Funding for the trails was provided by Logan City and County Recreation, Arts, and Parks (RAP) tax funds. The trail had been included in Logan City's Master Plan for many years which allowed for funding to be available.

The license agreement for the trail between Logan City and CHWA was created in 2015 and details the rules and regulations of the trail. The license agreement provides indemnification to CHWA and releases CHWA from any liability. Logan City is responsible for the maintenance of the trail and for the closure of the trail in the event of canal infrastructure maintenance. Specific trail rules are detailed in the agreement such as prohibiting of all modes of transportation except walking/jogging and requiring the

cleanup of all litter and dog waste.

The Highline Trail is built on top of the enclosed canal on the north wall of Logan Canyon. Cache County worked with J-U-B Engineers to design a five-foot-by-five-foot box culvert on the steep slope of the canyon wall that would also support a trail as shown in Figure 4-21 and 4-22.

Figure 4-21. Depiction of box culvert and trail on Highline Canal Trail in Logan Canyon.

Figure 4-22. Highline Canal Trail in Logan Canyon.

The Lundstrom Park Trail is built atop the maintenance road where the canal has been enclosed in a pipe. The open channel adjacent to the maintenance road has been made shallower and landscaped with large boulders as shown in Figure 4-23 and Figure 4-24. The open channel was retained for stormwater and aesthetic purposes. Some shareholders of the canal donated minimal amounts of water that could be left in the open channel in order to have water in the absence of stormwater.

Figure 4-23. Lundstrom Park Trail in Logan City.

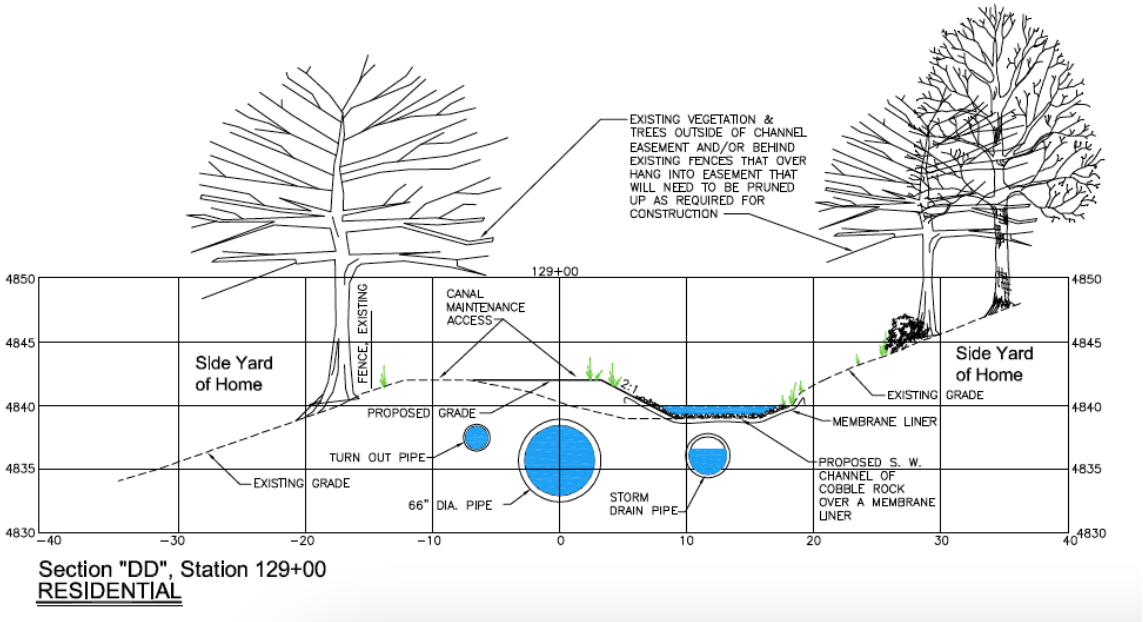

Figure 4-24. Cross Section of the Lundstrom Park Trail in Logan City. (J-U-B Engineers)

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4.4.5 Jacob Canal Trail

Between 2003 and 2006, the Harvest Hills Development in Saratoga Springs included the dedication of the land for the Jacob Canal in Saratoga Springs in order to build a canal trail. The Welby Jacob Canal Company has a canal that runs from the Jordan Narrows southward through Saratoga Springs that is considered the Jacob District or Jacob Canal. The trail is built within a 33-foot easement on the east side of the canal, with the 16.5-foot easement on the west side being left as open space. As each phase of the development was built, the city continued to require each section along the canal to be dedicated as a canal parkway. The land for the trail is owned by Saratoga Springs so no official trail license agreement was created. The responsible party for liability issues stemming from the use of the canal trail is currently ambiguous.

Figure 4-25. Map of Harvest Hills Canal Trail along Jacob Canal.

Trail Facts:

Canal Type: Open Channel

Begin/End Points: Harvest Moon Dr. to Mountain View in Saratoga Springs

ROW Width: About 50 feet

Trail Length: 0.9 miles

Trail Type: Concrete

Trail Width: 8 feet

Trail Uses: All non-motorized transportation

Land Ownership Type: Owned by Saratoga Springs via development

Trail Cost: Included as part of residential development

A similar process of constructing a canal trail in conjunction with a residential or commercial development has been used multiple times throughout the state. The Country Haven development in West Haven and the Fairway Heights development in Smithfield are other examples of this process. The emphasis for the case study is on the process of developing canal trails as part of a development rather than the Jacob Canal Trail itself. As a result, general guidelines for canal trails in new developments are discussed.

Constructing canal trails at the time of land development helps resolve many difficulties associated with establishing canal trails, especially that of land ownership and privacy. By requiring the developer to dedicate the land where the canal easement is located, the city can build the trail without approval of private landowners. When the canal trail is included in the original development plat, the residents purchasing the homes are already aware of the trail. As a result, adjacent landowners have fewer concerns over privacy, especially because the development of the canal corridor can be

done in such a way that shields the landowners from the public using the trail. Figure 4-26 shows trees planted as a barrier between the landowners and the canal trail, providing additional privacy.

Figure 4-26. Canal trail on the Jacobs Canal in Saratoga Springs.

Overall, the establishment of canal trails is significantly easier when included as part of a residential or commercial development. Adding the trail to the development from the beginning allows all parties to be informed and give their input prior to construction. Local governments should include canal trails on undeveloped lands in their Master Plans to facilitate their future construction. The canal company should always be consulted in the planning of canal trails, regardless of whether or not the land is owned in

fee by the local government.

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4.5 Canal Trail Prioritization

The results of the prioritization tool are shown for each of the counties analyzed. Each of the five factors are weighted evenly, with 50 maximum possible points. The results of the analysis show the majority of the canals with the most amount of points run through highly urbanized areas. These urban areas have a need for trails because historically trails haven't been a high priority for local governments and available land is now difficult to find. As a result, canal trails in these locations should be prioritized by local governments, despite the many obstacles that may be present.

Canal trails in rural areas received a lower score because less use is predicted for the future trail. As is the case with public transit, demand is not always the only priority in creating transportation infrastructure (Walker, 2019). Coverage is also important in providing infrastructure to rural communities. Canal trails in rural areas should not be dismissed solely because predicted use is lower than urban areas.

The prioritization tool does not take into account land ownership status and right-of-way width for the canals. These considerations play a role in trail prioritization but the information for each canal is not easily accessible and can vary significantly along different sections of the same canal. Therefore, local governments should investigate further into the canal trail options available within their jurisdiction and collect all applicable information.

Table 4-1. Cache County Canal Trail Analysis Results.

Canal	Safety Score	Volume Score	Density Score	Pioneer Score	Master Plan Score	Total Score
Logan North Field/ Hyde Park Canal 1	10	7.76	10.00	10	10	47.76
Logan Northern Canal 1	10	4.99	10.00	10	10	44.99
Highline Upper Canal 1	2.5	7.32	6.54	10	10	36.36
Logan Northwest Field Canal	10	4.87	10.00	10	0	34.87
Logan North Field/ Hyde Park Canal 2	2.5	6.82	5.04	10	10	34.36
Logan Northern Canal 2	2.5	5.63	5.43	10	10	33.56
Logan Northern Canal 3	2.5	4.94	4.81	10	10	32.26
Highline Upper Canal 2	2.5	4.46	4.91	10	10	31.88
Wellsville-Mendon Lower Canal 1	2.5	2.37	3.53	10	10	28.41
Logan NW Canal/ Twin Canal West	5	7.24	5.93	10	0	28.17
Wellsville-Mendon Lower Canal 2	0	2.90	3.30	10	10	26.21
Blacksmith Fork Nibley Canal 2	2.5	8.30	4.12	10	0	24.92
Millville Lower Canal	2.5	7.18	5.11	10	0	24.79
Logan Cow Pasture Ditch (SR30)	0	1.35	3.25	10	10	24.61
Benson Main Canal	0	8.46	5.39	10	0	23.85
Millville Upper Canal 1	0	10.00	3.73	10	0	23.73
College Irrigation Canal	2.5	6.25	4.62	10	0	23.36
Blacksmith Fork Nibley Canal 1	2.5	7.03	3.64	10	0	23.17
West Cache Newton Branch	2.5	6.44	3.20	10	0	22.14
South Logan Benson Canal	0	8.68	3.33	10	0	22.01
Millville Upper Canal 2	2.5	4.48	4.71	10	0	21.69
Hyrum Blacksmith Fork Upper Canal	2.5	4.11	4.57	10	0	21.18
Blacksmith Fork Hyrum Canal 1	2.5	4.73	3.77	10	0	21.00
O'Berry Canal	2.5	3.93	4.35	10	0	20.79
Blacksmith Fork Hyrum Canal 2	2.5	2.90	4.34	10	0	19.74
Hyrum Canal	2.5	2.90	4.34	10	0	19.74
Spring Creek Cache Canal	2.5	1.71	4.47	10	0	18.68
Wellsville-Mendon Upper Canal	2.5	1.64	3.58	10	0	17.73
Porcupine Highline Canal	0	4.07	3.55	10	0	17.61
Cub River East Canal	0	3.49	3.23	10	0	16.72
West Cache Canal	0	3.52	3.19	10	0	16.71
West Cache Amalga Branch	0	3.37	3.33	10	0	16.70
Logan River BSF Lateral 2	0	2.48	4.17	10	0	16.66
Logan River BSF Lateral 1	0	1.84	4.17	10	0	16.01
Paradise Canal	0	2.65	3.29	10	0	15.94

Table 4-2. Weber County Canal Trail Analysis Results.

Canal	Safety Score	Volume Score	Density Score	Pioneer Score	Master Plan Score	Total Score
North Ogden Canal 1	10.00	6.01	10.00	10	0	36.01
Riverdale Bench Canal	2.50	8.00	5.11	10	10	35.62
Willard Canal 1	2.50	8.12	3.10	10	10	33.72
North Ogden Canal 2	10.00	6.53	7.13	10	0	33.67
Western Irrigation Canal	10.00	3.69	9.78	10	0	33.48
Willard Canal 2	2.50	3.25	3.37	10	10	29.12
Warren Canal	0.00	5.98	3.06	10	10	29.05
Warren North Branch	0.00	5.64	2.94	10	10	28.57
North Ogden Canal 3	2.50	10.00	4.47	10	0	26.97
Ogden Brigham Canal 2	2.50	6.58	6.97	10	0	26.05
Layton Canal 1	5.00	3.21	7.10	0	10	25.30
Ogden Brigham Canal 1	2.50	4.18	8.58	10	0	25.26
Warren South Branch	0.00	1.64	2.94	10	10	24.57
Ogden Valley Canal	0.00	1.71	2.61	10	10	24.32
Ogden Brigham Canal 3	2.50	6.61	4.04	10	0	23.15
Hooper Canal 1	2.50	1.92	4.88	0	10	19.30
Eden Canal	0.00	4.01	2.61	10	0	16.61
Holmes Ferrin Ditch	0.00	3.44	2.50	10	0	15.94
Wilson Canal	2.50	2.96	3.34	0	0	8.81

Table 4-3. Davis County Canal Trail Analysis Results.

Canal	Safety Score	Volume Score	Density Score	Pioneer Score	Master Plan Score	Total Score
Davis and Weber Canal 2	10	7.21	7.48	10	0	34.68
Davis and Weber Canal 3	10	2.35	7.23	0	10	29.59
Davis and Weber Canal 1	2.5	7.81	2.87	10	0	23.17
Layton Canal 2	2.5	2.71	5.44	0	10	20.65
Hooper Canal 2	2.5	4.93	1.98	0	0	9.40

Table 4-4. Salt Lake County Canal Trail Analysis Results.

Canal	Safety Score	Volume Score	Density Score	Pioneer Score	Master Plan Score	Total Score
Jordan and Salt Lake City Canal 3	10	5.57	7.52	10	10	43.09
Upper Canal	10	10	5.98	10	0	35.98
Jordan and Salt Lake City Canal 2	10	5.67	6.66	0	10	32.33
South Jordan Canal 2	10	7.16	4.54	0	10	31.7
Utah Lake Distributing Canal 3	10	3.3	8.27	0	10	31.57
North Jordan Canal 1	10	4.29	7	0	10	31.29
Utah and Salt Lake Canal 3	10	3.38	7.77	0	10	31.15
Utah and Salt Lake Canal 4	10	2.71	7.87	0	10	30.58
Welby Jacobs Canal 3	10	4.32	5.76	0	10	30.08
Utah and Salt Lake Canal 2	10	4.25	4.71	0	10	28.96
Utah Lake Distributing Canal 2	7.5	5.68	4.24	0	10	27.42
East Jordan Canal 1	7.5	5.91	3.57	0	10	26.98
Surplus Canal	7.5	3.49	3.54	0	10	24.53
Welby Jacobs Canal 1	2.5	8.79	1.59	0	10	22.88
North Jordan Canal 2	10	2.73	9.36	0	0	22.09
East Jordan Canal 2	10	5.4	6.62	0	0	22.02
South Jordan Canal 3	10	2.98	7.53	0	0	20.51
Brighton & North Point Canal 1	10	3.92	6.5	0	0	20.42
Utah Lake Distributing Canal 1	2.5	5.62	1.96	0	10	20.08
Riter Canal	2.5	2.76	4.47	0	10	19.73
Welby Jacobs Canal 2	2.5	4.12	2.69	0	10	19.31
Utah and Salt Lake Canal 1	2.5	4.15	2.12	0	10	18.77
Jordan and Salt Lake City Canal 1	5	4.7	2.82	0	0	12.52
South Jordan Canal 1	2.5	5.9	1.63	0	0	10.03
Brighton & North Point Canal 2	2.5	3.52	0.26	0	0	6.28

Table 4-5. Utah County Canal Trail Analysis Results.

Canal	Safety Score	Volume Score	Density Score	Pioneer Score	Master Plan Score	Total Score
Lake Bottom Canal 2	10	4.64	10.00	10	0	34.64
Strawberry Highline Canal 2	2.5	4.30	4.68	10	10	31.48
Lake Bottom Canal 1	10	5.32	6.00	10	0	31.32
Salem Canal	2.5	4.65	3.87	10	10	31.02
Provo Bench Canal 1	10	9.90	8.67	0	0	28.57
Strawberry Highline Canal 1	0	2.36	3.56	10	10	25.92
Provo Bench Canal 2	5	10.00	6.64	0	0	21.64
Strawberry Highline Canal 3	2.5	2.36	2.93	10	0	17.79
Strawberry Highline Canal 4	0	5.29	1.97	10	0	17.27
Mill Race Canal	5	4.37	7.03	0	0	16.40
Strawberry Lateral 30	0	2.31	1.95	10	0	14.26
Welby Jacobs South	2.5	6.67	3.03	0	0	12.20
East Bench Canal	2.5	3.60	5.94	0	0	12.03
Spanish Fork South Field Canal	2.5	3.71	4.65	0	0	10.85
Utah Lake Distributing South	2.5	4.19	2.98	0	0	9.67

5 CONCLUSION

In conclusion, Utah has many canal corridors that offer ideal locations for the construction of public trails. The state has shown a great need for active transportation facilities, especially in increasingly urban areas, and canal trails are the ready solution. Historically, canals were seen as a community asset which complicates landownership and liability questions today. Past literature on the topic is outdated and needs to be updated due to changes in law, recently completed projects, and a changing active transportation climate.

Based on the acquired information from the literature review and current circumstances, the purpose of this study was to provide a better understanding of the concerns and considerations involved in the establishment of trails on canal corridors in Utah. To accomplish this, the study evaluated previous projects, interviewed stakeholders of future projects, compiled valuable information into a guide, and created a tool for prioritizing future canal trails. Local governments, canal companies, and engineering firms were the primary sources for information and discussion. The prioritization tool was created using predictors of future trail use and the trails impact on creating a multimodal network.

The results of the study provide case studies for a variety of different successful canal trail projects in Utah. In addition, the study showed that liability, land ownership, maintenance, safety, funding, and privacy were the main concerns that need to be addressed for successful projects. Key elements of canal trail design were set forth as starting points for future canal trail planning. The results of the prioritization tool provide suggested canals in five different urban Utah counties

where future canal trails could be established.

5.1 Implications of the study

The results of the study emphasize the complex nature of establishing trails in canal corridors. The projects are typically started by local governments like cities, but in some cases larger-scale planning and more political capital is needed from counties or MPOs. In other instances, canal companies would be willing to accept a trail if offered assistance with maintenance or infrastructure improvements. If this is the case, it can be the local government that is unwilling or uninterested in establishing a trail because of the costs, liability, or commitment to maintenance. In the end, the start of each trail project requires a trail sponsor that is committed to providing a valuable transportation resource and is willing to work with the many stakeholders involved.

Each canal corridor offers a unique set of challenges that can be addressed by long-term planning, stakeholder collaboration, iterative design, and active public involvement. The following chart shows a generic outline for the planning and design of a canal trail in Utah. The chart is directed at local governments because they are typically the driving force behind canal trail projects. The purpose of the chart is not to detail every step in the design process but to point out specific tasks pertinent to canal trail projects.

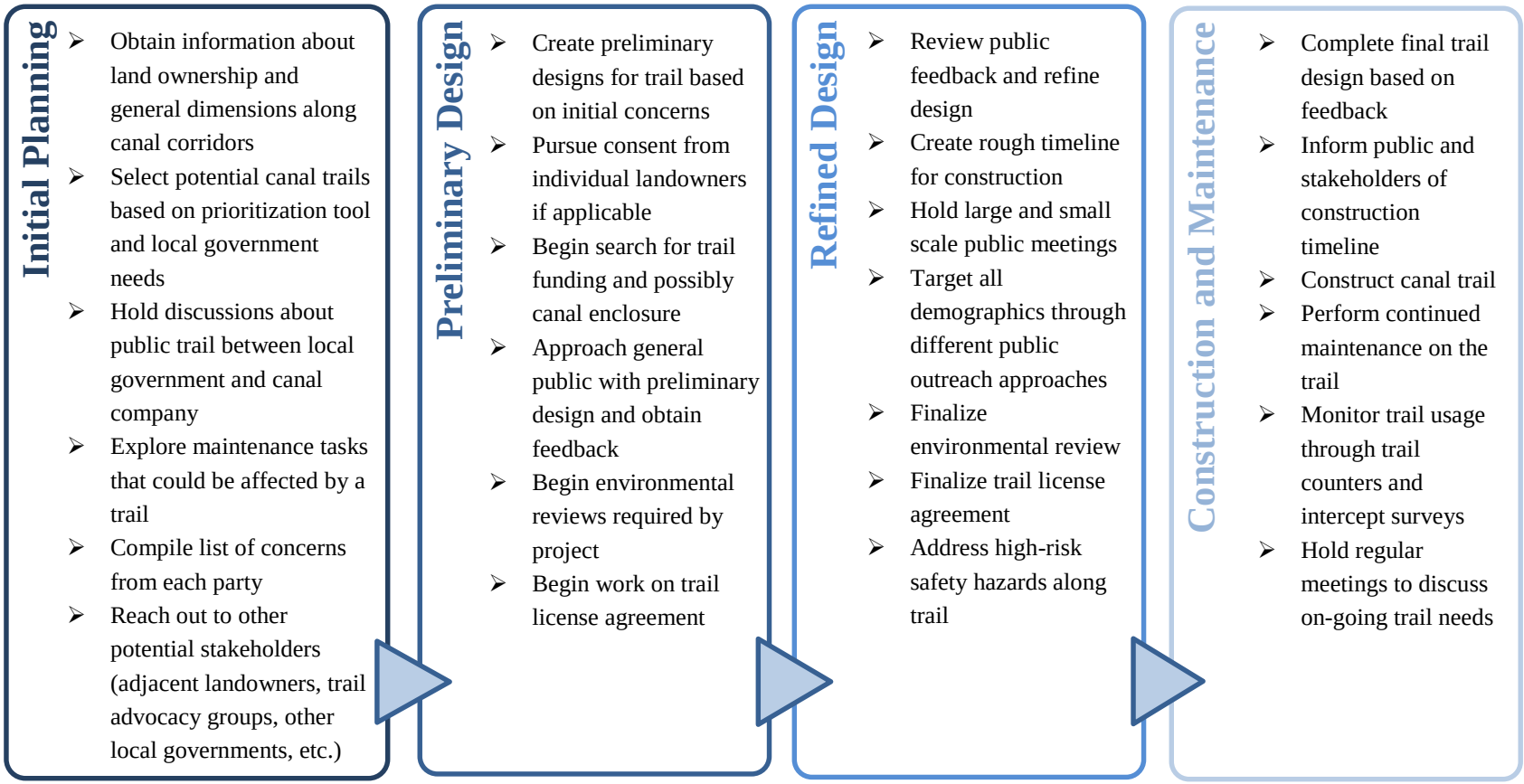

Figure 5-1. Flow chart for canal trail design process.

In summary, stakeholders need to have constant and reliable communication throughout the process of establishing a canal trail. If every organization seeks to serve the public good using the best information at hand, then an agreement can almost always be reached. The agreement could be that a trail should be pursued or that it is not feasible for the particular canal corridor. Regardless of the outcome, each stakeholder should engage in open and honest discussions and be willing to accept any result.

To facilitate a realistic and educated discussion, local government officials involved in the trail should seek to gain a better understanding of the canal systems and the work being done to operate them. Canal companies should be open to discussions regarding public trails with the understanding that a trail could be beneficial to their organization. Adjacent landowners should understand that they may lose a measure of privacy but in turn gain an important community asset. A canal trail requires sacrifice and work from everyone involved, but the tradeoffs are minimal compared to the invaluable transportation resource that is created.

5.2 Limitations and Future Research

One limitation of this study is the inherent bias that comes from volunteer-based sampling. The interviews conducted were with individuals who were willing to discuss canal trails and were generally more receptive of the topic. It should be noted, however, that a significant effort was made to receive a variety of different opinions and perspectives from the sample group. Canal companies with known opposition to trails were contacted as well as local governments without plans for

canal trails. In the future it may be beneficial to conduct an anonymous online survey to try and improve the diversity of the sample group.

Another limitation of the study is the legal difficulties that are often enlaced in canal trail projects. Landownership and liability for canal trails can be complex, with different attorneys having varying opinions on the same issue. As a result, local attorneys should be consulted for each unique canal trail situation. The purpose of this paper is not to provide legal advice for any issue related to canal trails.

Related to the legal difficulties surrounding canal trails is the fact that laws governing the liability of a canal company or city, land ownership claims, funding options are constantly changing. Therefore, those pursuing future canal trails should verify that the information obtained in this study is still applicable. It is also critical that the situation regarding canal trails be reevaluated every 10 to 15 years to update information based on current circumstances.

The prioritization tool is from a transportation perspective only. Local governments' efforts to establish canal trails should take into account other factors such as land ownership status and the canal operator's willingness to allow a trail. The available data for the canal corridor and surrounding roadways was also a limitation for the prioritization tool. Data for the canal width, right-of-way width, and the level of stress on nearby roadways would also be useful to include in the prioritization tool. Additionally, information regarding the amount of illegal use to potentially alleviate trespassing concerns would also be something to consider. All of this data is not widely available and would require a significant amount of effort to obtain. It is recommended that local governments should obtain this type of

information for the limited number of canal trails they are considering.

Future work could also consist of quantifying the benefits of canal enclosure. In all the interviews conducted, canal companies were more than willing to enclose their canal, provided funding was available. As a result, the scope of the study did not include a more in-depth look at the benefits of canal enclosure. In areas where canal companies are hesitant to enclose canals, however, this type of information may be helpful.

Additional work could be performed on the ability of a canal trail to serve as the backbone to a multimodal network. The Murdock Canal Trail has spurred the construction of countless other trails and trailheads that connect into the main trail. Research on the effects of the Murdock Canal Trail in creating what is now a fairly robust network in Utah County would be useful in showing the impact that other canal trails could have on the surrounding areas.

As the desire for local trails continues to increase, urbanization creates denser communities, and technology continues to advance, canal corridors may evolve into multi-use sections of linear land. Underground vehicle tunnels, hover board pathways, or drone flying rights-of-way are just some of the possible uses for the corridors. When stakeholders all come together and create win-win scenarios for everyone, then Utah's canal corridors can become the highly utilized and cherished parts of a community that they were in the beginning.

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APPENDICES

Canal Company Interview Questions

Intro Script:

Thank you for being willing to take the time to talk to us today! The purpose of this interview is to discuss the relationship between your canal company and the public use of canal corridors. The Utah Department of Transportation (UDOT) is interested in understanding the use of canal corridors for public trails. UDOT recognizes the essential nature of canals and would like to better understand the considerations and concerns of canal companies when it comes to public use. We hope you will feel free to express your opinions and perceptions regarding this topic. Before we begin, we would like to remind you of several things:

- Thank you for filling out the Informed Consent form [online or on paper]. Do you have any questions about our study or our study procedures?
- As a reminder, your name, organization, and interview responses will be used in a final report submitted to UDOT. All responses provided in the interview will be identifiable.
- You can skip any question you do not feel comfortable answering. You may end the interview at any time.
- We will be recording this interview and creating a written transcript of it afterward. If you do not wish for this interview to be recorded, please let us know. We can still conduct the interview, but we will be taking detailed notes instead.
- Within three months of this interview, you may contact us to request the interview transcript. You will be allowed to review the transcript and revise, add to, or omit any of your responses. Within three months, you may also request to withdraw from this study, and we will delete your responses.
- Please answer the questions to the best of your knowledge, and let us know if any part needs clarification.
- Do you have any other questions before we begin?

Preliminary Information

Date of interview:

Name:

Title/titles:

Organization:

Email address:

Phone number:

Applicable canals:

Approximate begin and end points:

Canal length:

Flow capacity and depth:

Width of the canal R.O.W. and the canal itself:

Year the canal opened:

What percentage of the canal corridor land is owned by your canal company?

____% Canal or WUA Ownership

____% Easement

(If easement) What percentage of the land would you estimate is owned by the following:

____% Federal Government (Bureau of Reclamation)

____% Local Government

____% Private Ownership

To the best of your knowledge, what is the existing adjacent land use along the canal/canals by percentage?

____% Residential

____% Agricultural

____% Business

What percent of your canal would you estimate is enclosed (piped) or open channel?

____% Enclosed

____% Open Channel

Do you allow legal, public use and access of your canal corridor?

Questions for canal companies with corridors OPEN to the public

Case study information

1. Can you describe the current use allowed by the public on your canal corridor?
2. What year did the canal corridor open to the public?
3. Can you describe the general process of how the canal corridor was opened to the public?
4. What were the major obstacles that were overcome in order to construct a trail?
5. What specific funding sources were used in the enclosure of the canal and/or the construction of the trail?
6. If applicable, how important was the enclosure of the canal to providing public access?
7. If applicable, was the decision to enclose the canal influenced by the ability to construct a trail on top of it?
8. Can you describe any interactions between the canal company and other cities or agencies in the process of developing a trail along the canal corridor?
9. What was done to gain the support of adjacent landowners?
10. If applicable, how was the easement land granted use by the public? (donation of easement or creation of a cooperative Recreational Use Agreement, sale of fee title to the land under the canal easement, sale of recreational use easement)

Operations and maintenance

11. Can you describe any current agreement(s) in place between the canal companies and local governments in terms of maintenance?
12. From what month to what month does the operating season of the canal last?
13. Does public access cause any issues concerning canal maintenance?
14. Do paved trails, rather than gravel trails, cause any issues concerning canal maintenance?

Liability

15. Can you describe any current agreement(s) in place between the canal companies and local governments in terms of liability?

16. To the best of your knowledge, have there ever been any liability or injury claims lodged against your canal company or other entities or individuals associated with the canal? If so, what claims?

General

17. Have there been any major issues since the construction of the canal trail? (ask specifically about: liability, maintenance, crime, easement encroachment)
18. Is there anything you would do differently or change about your canal trail project?
19. Is there anything you would tell other canal companies that are considering canal trails?
20. Is there anyone else you would recommend we talk to that would be familiar with the topic of canal trails?
21. Do you have any final thoughts, feelings, or general concerns regarding canal trails?

Notes:

Questions for canal companies with corridors CLOSED to the public

General

1. Have you ever been contacted by anyone concerning trail development along any of your canals? If so, who is it and where do negotiations stand?
2. Do you foresee any obstacles in developing a canal trail? (allow them to volunteer concerns first, but examples include)
    A. Liability- Liability should cover entire corridor not just trail.
    B. Crime- Law enforcement, Time of response, Protection of facilities and hydraulic structures, vandalism, and littering.
    C. Operation and Maintenance – increased costs for maintenance, daily headgate maintenance and canal inspection, annual maintenance (dredging canal)
    D. Funding - Lack of funding options
    E. Lack of Management entity – No clear responsible party
    F. Other- Canal easement owned by private property owners (taking without compensation). Opposition from adjacent landowners
3. What improvements would your company like to make to your canal system?

Funding

4. If enclosing your canal was an option, without regard to funding, do you feel that is something your canal company would be willing to do? What benefits do you see in enclosing the canal?
5. If applicable, what options have you explored for funding the enclosure of the canal? Division of water resources, transportation funding, etc…
6. If a transportation agency made funding available to help in the development of water infrastructure, with the condition that a trail would be constructed, would you pursue that funding?
7. When applying for funding, do you think the addition of a canal trail in the proposal would be helpful in attaining that funding?

Liability

8. To the best of your knowledge, have there ever been any liability or injury claims lodged against your canal company or other entities or individuals associated with the canal? If so, what claims?
9. What existing precautions do you have in place to prevent litigation? (signing, fencing, etc…)
10. How do you feel about piping or covering canals as a solution to liability?
11. Do you feel that local governments could protect your canal companies from liability issues if something did occur?

Access

12. How is access management currently enforced for your canal?
13. Does your company have the legal authority to provide (if you wish to) the right for recreation trail use for all parties or some parties? Please explain.
14. Conversely, would consent from your canal company be legally required if easements for recreational trail use on your canals were acquired from the underlying landowner by a recreational entity or agency?
15. If a trail were developed along one of your canals, what implementation measures would you like to see? (risk management, setbacks from maintenance road, fencing, restrictions on time of use or closure, etc.)
16. What forms of recreational use permission, if any, have been explored to allow public access? (donation of easements, sale of recreational use easement, sales of fee title to the land under the canal easement)
17. Do you feel that opening up your canal to public use could prove beneficial to the canal company? (reducing access enforcement, improving public relations, funding opportunities)

Operations and maintenance

18. From what month to what month does the operation season last?
19. Briefly discuss the operation and maintenance tasks you feel would most likely be interfered with due to construction of a canal trail. (Annual and daily)

20. Do you feel a developed trail would increase, decrease, or have no effect on your ability to maintain the canal? Why?

General

21. In summary, what do you feel are the primary obstacles in preventing the construction of a trail along your canal corridor? Land ownership, funding, liability, etc…
22. Is there anyone else you would recommend we talk to that would be familiar with the topic of canal trails?
23. Do you have any final thoughts, feelings, or general concerns regarding canal trails?

Notes:

Public Agency/ Engineering Firm Interview Questions

Intro Script:

Thank you for being willing to take the time to talk to us today! The purpose of this interview is to discuss the relationship between your organization and the public use of canal corridors. The Utah Department of Transportation (UDOT) is interested in understanding the use of canal corridors for public trails. UDOT recognizes the importance of government agencies and engineering firms in developing trails along canal corridors and would like to better understand the considerations and/or obstacles that these organizations may face. We hope you will feel free to express your opinions and concerns regarding this topic. Before we begin, we would like to remind you of several things:

- Thank you for filling out the Informed Consent form [online or on paper]. Do you have any questions about our study or our study procedures?
- As a reminder, your name, organization, and interview responses will be used in a final report submitted to UDOT. All responses provided in the interview will be identifiable.
- You can skip any question you do not feel comfortable answering. You may end the interview at any time.
- We will be recording this interview and creating a written transcript of it afterward. If you do not wish for this interview to be recorded, please tell us know. We can still conduct the interview, but we will be taking detailed notes instead.
- Within three months of this interview, you may contact us to request the interview transcript. You will be allowed to review the transcript and revise, add to, or omit any of your responses. Within three months, you may also request to withdraw from this study, and we will delete your responses.
- Please answer the questions to the best of your knowledge, and let us know if any part needs clarification.
- Do you have any other questions before we begin?

Preliminary Information

Date of interview:

Name:

Title/titles:

Organization:

Email address:

Phone number:

Applicable Canals:

Have you been involved in the development of canal trails within your jurisdiction?

Questions for public agencies or engineering firms WITH canal trail experience

1. What are the names of the canal trails you have been involved with?
2. Please describe the process, or steps taken, to create the canal trail.
3. What were the major obstacles that were overcome to construct the canal trail?
4. Did the construction of the canal trail begin with the canal company or a public agency taking the initiative?
5. What funding was used in the enclosure of the canal and/or the construction of the trail?
6. Was the construction of the canal trail a result of piping the canal?
7. If applicable, how was the easement land granted use by the public?
8. What agreement is in place between the canal company and the agencies involved in terms of liability?
9. What agreement is in place between the canal company and the agencies involved in terms of maintenance?
10. Were there issues with the construction of the canal trail involving adjacent landowners?
11. What was done in order to gain public support for the canal trail?
12. Does your agency use the canal for stormwater purposes? If applicable, did enclosing the canal prove to be an issue?
13. Have there been any major issues since the construction of the canal trail? (Ask specifically about liability, maintenance, crime, and easement encroachment)
14. Are there any other canal trails that are being planned or under construction that you are aware of?
15. How were roadway crossings for the trail designed to promote safety and ease of use?
16. Is there anyone else you would recommend we talk to that would be familiar with the topic of canal trails?
17. In summary, what would you say are the keys to a successful canal trail project?
18. Do you have any final thoughts, feelings, or general concerns regarding canal trails?

Questions for public agencies or engineering firms WITHOUT canal trail experience

1. Are there any canals that you are specifically working to build trails along?
2. What obstacles do you feel are preventing the construction of canal trails? (allow them to volunteer concerns first, but examples include)
    A. Liability- Attractive nuisance, Liability should cover entire corridor not just path.
    B. Crime- Law enforcement, protection of facilities and hydraulic structures, vandalism, and littering.
    C. Operation and Maintenance
    D. Funding
    E. Lack of Management entity
    F. Land ownership issues or opposition from adjacent land owners.
3. Is enclosing the canals in a pipe a possible solution? If so, is funding the only obstacle?
4. Is the respective public agency willing to take responsibility in terms of maintenance of the canal trail?
5. Is the respective public agency willing to take responsibility in terms of liability of the canal trail?
6. If applicable, what forms of recreational use permission have been explored? (Donation of easements, sale of recreational use easement, sale of fee title to the land under the canal easement)
7. Is the open channel used for stormwater purposes? If so, has enclosing the canal under the maintenance path while leaving the open channel for stormwater been considered?
8. Is there anyone else you would recommend we talk to that would be familiar with the topic of canal trails?
9. In summary, what do you feel is the biggest challenge preventing the construction of canal trails?
10. Do you have any final thoughts, feelings, or general concerns regarding canal trails?