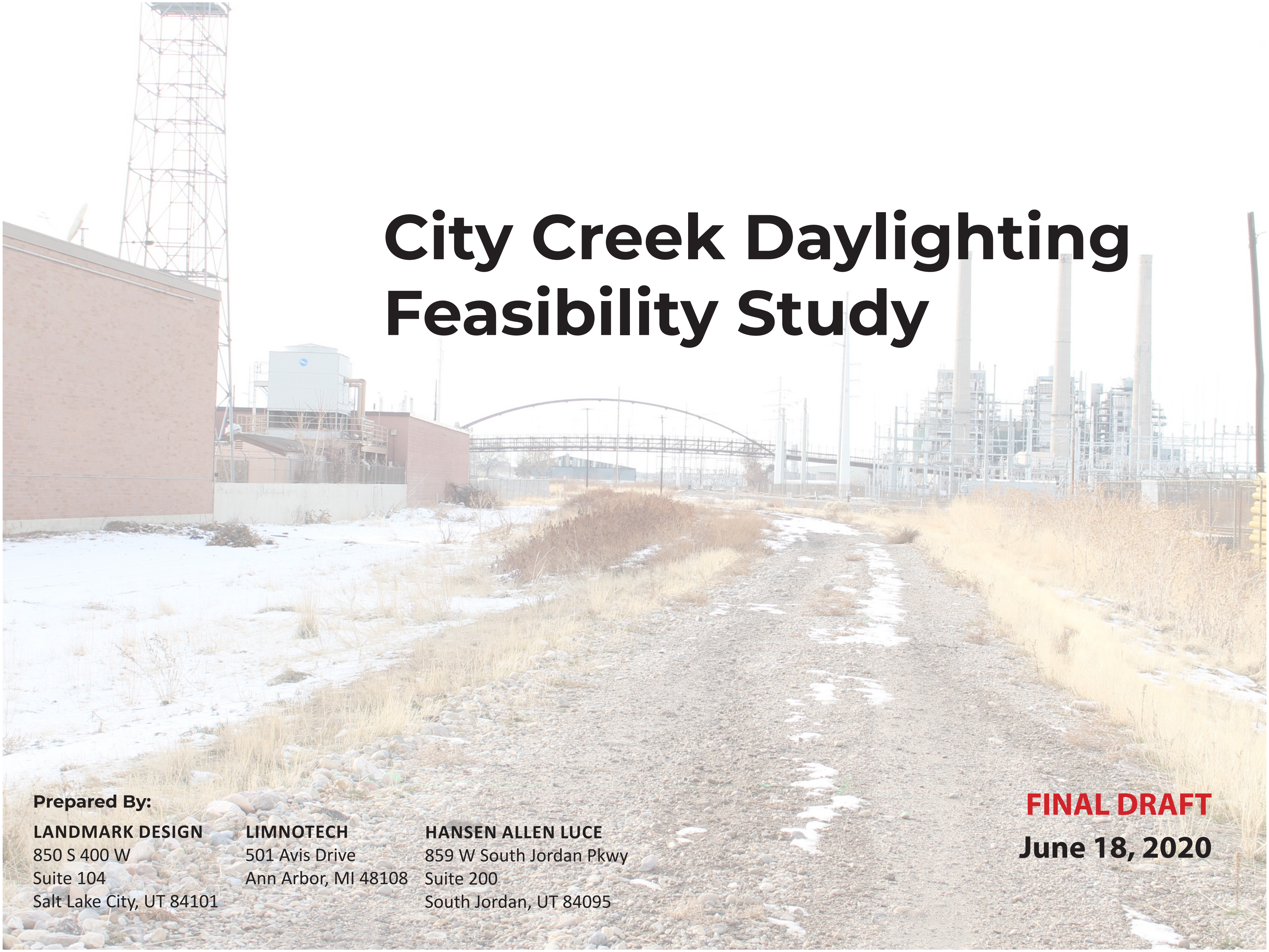


City Creek Daylighting Feasibility Study

Prepared By:

LANDMARK DESIGN
850 S 400 W
Suite 104
Salt Lake City, UT 84101

LIMNOTECH
501 Avis Drive
Ann Arbor, MI 48108

HANSEN ALLEN LUCE
859 W South Jordan Pkwy
Suite 200
South Jordan, UT 84095

FINAL DRAFT

June 18, 2020

Table of Contents

1 - BACKGROUND & INTRODUCTION 1
Purpose of the Feasibility Study 1
Background 1
Project Approach 2

2 - DAYLIGHTING FEASIBILITY ANALYSIS 3
Introduction of the Project Area 3
Summary of Existing Conditions 4
Preliminary Hydrological Analyses 11
Detention Basin & Stormwater Management 14
Green Infrastructure Opportunities 16

3 - SUMMARY OF OPPORTUNITIES & CONSTRAINTS ..19
Opportunity and Constraints 20

4 - CONCEPTUAL DESIGNS 22
Concept 1 - Daylighting Partial Creek Flow (Version A) 28
Concept 1 - Daylighting Partial Creek Flow (Version B) 32
Concept 3 - Combination of Full and Partial Creek Flow 34
Preliminary Opinion of Probable Costs 38
Analysis of Concepts 40

5 - RECOMMENDATIONS & PHASING STRATEGY.......... 42

References 43

APPENDIX A - ENVIRONMENTAL DATA & FIGURES
Terracon Report Soil Figures A1
EPA Assessment Sites (SLCRDA) A4
Mountain Fuel Environmental Covenant Site Map A5
Monitoring Well Locations (Millennium Science and Engineering, 2003)A6
Water Quality Data (SLCDPU) A7

APPENDIX B -UTILITY LOCATIONS B1

LIST OF MAPS, FIGURES & TABLES
Map 1. Opportunity and Constraints Map 20
Map 2. Concept 1 - Daylighting Partial Creek Flow (Version A) 28
Map 3. Concept 1 - Daylighting Partial Creek Flow (Version B) 32
Map 4. Concept 3 - Combination of Full and Partial Creek Flow 34

Figure 1. Study Area 1
Figure 2. Six Segments of the Project Area 3
Figure 3. Zoning for the Euclid Neighborhood 6
Figure 4. Salt Lake County Flow Records for City Creek 7
Figure 5. USGS Historical Flow Records for City Creek 7
Figure 6. Environmental Conditions 9
Figure 7. Typical Creek Street Crossing (Inverted Siphon) 11
Figure 8. Water Surface Profile for Open Channel Options for Concept 2 12
Figure 9. An Example of a Compound Channel 13
Figure 10. Potential Solutions for Existing Issues East of 1000 West 14
Figure 11. Example of bioretention basin located near Frederick Albert Sutton building at the University of Utah 16
Figure 12. Example of bioretention located in Salt Lake City 17
Figure 13. Example of green streets 17

Table 1. Return Period Peak Flowrates for City Creek 7
Table 2. Monitoring and Remediation Sites in the Corridor 9
Table 3. Recommended Design Channel Dimensions Concepts 1 & 2 13
Table 4. Potential Creek Dimensions for an Estimated Range of Flows and Slopes 22

1 - Background & Introduction

Purpose of the Feasibility Study

THE CITY CREEK DAYLIGHTING FEASIBILITY STUDY

The *City Creek Daylighting Feasibility Study* is a feasibility analysis for daylighting a portion of City Creek's flow within the Folsom corridor, which is located in the Euclid neighborhood of Salt Lake City at approximately 50 South between I-15 and the Jordan River (Figure 1). The Folsom corridor, which once housed a railroad line, is now home to an underground, 4 x 12 foot box culvert called the Folsom Drain Line.

Figure 1. Study Area

What is a Feasibility Study?

The term "feasibility" can refer to many things, but for the purpose of this report it addresses two primary considerations:

1. Does the physical environment (available property, existing topography, environmental conditions, the benefits to the public, etc.) allow the project to be built?
2. Is the cost of implementing the project reasonable for the improvements and benefits that come from the project?

While finding answers to these questions may take some "soul searching" for the City, this report provides a comprehensive look and contains the information required to make informed decisions about whether or not this is right place to daylight City Creek, and if/when municipal or other funds should be designated to design and construct the creek.

Background

In 1909, City Creek was enclosed in an underground culvert running beneath North Temple from the mouth of the City Creek Canyon to the Jordan River.

The Enclosure of City Creek in 1909 (Source: "Bankside Salt Lake City" by Ron Love, in Rivertown: Rethinking Urban Rivers; Editor: Paul Stanton Kibel; The MIT Press)

The idea of bringing City Creek to the surface and restoring its surface connection with the Jordan River emerged during the past few decades, beginning with daylighting of a small portion of the creek in 1985 from the southern entrance of Memory Grove to City Creek Park, located at State Street and North Temple. The concept was first identified as a goal in the *Salt Lake City Open Space Plan (1992)* and has become a key part of the community vision for the area. The United States Army Corps of Engineers (ACOE) initiated a feasibility study at approximately the same time but, for a variety of reasons a full analysis of daylighting the creek was never completed and the project failed to gain traction. Recent renewed interest, including funding for a new trail in the area, has reinvigorated the project and this feasibility study has followed suit.

RECENT CHANGE AND ACTIVITY WITHIN THE CORRIDOR

Folsom Drain Line

In 2012, a large 4 x 12 foot box culvert was installed in the Folsom corridor to convey City Creek flood flows. A diversion structure in North Temple directs a portion of the flows into the Folsom culvert. Salt Lake City's Public Utilities Department actively operates and maintains the Folsom culvert.

Folsom Trail Project

Culvert pipes await installation during the construction of the Folsom Drain Line (Source: Salt Lake City Engineering Department)

Salt Lake City is currently working with Utah Transit Authority (UTA) to design and construct the Folsom Trail, a 12-foot wide walking and bicycling path that will connect the downtown area to the Jordan River Parkway Trail. The 1.5-mile trail is intended to create a safe connection for residents on the west side of the city, linking the Jordan River Parkway Trail to downtown and beyond. The Folsom Trail is anticipated to be constructed as early as 2020 and will primarily be built on top of the Folsom Drain Line. For the daylighted creek to be easily integrated in the future, the two projects will need to be coordinated.

Project Approach

As outlined below, a comprehensive process was used to develop this Feasibility Study, beginning with an existing conditions report, preliminary hydrological analyses and the identification of key opportunities and constraints. Conceptual design and opinions of probable cost for two concepts, accompanied by phasing and future recommendations, conclude the report.

1 - RESEARCH & EXISTING CONDITIONS REVIEW

The review of existing conditions included the available data for the following key elements:

- Master Plans and Other Studies
- Land Use & the Built Form
- Existing City Creek & Stormwater
- Utilities Conflicts & Crossings
- Environmental Conditions

2 - PRELIMINARY HYDROLOGICAL ANALYSES

Three hydrological analyses were investigated to understand plausible creek channel options within the corridor. These preliminary analyses looked at a range of potential options, including daylighting a portion of the creek's flow and planning for high flow capacities, as well as a combination of the two. These analyses, along with a summary of existing conditions, are detailed in Chapters 2 and 3.

3 - OPPORTUNITIES & CONSTRAINTS

Based on the existing conditions and preliminary hydrological analyses, opportunities and constraints were identified and one hydrology concept was eliminated as a result. Opportunities and constraints were also considered as the conceptual designs were further developed.

4 - CONCEPTUAL DESIGNS

For the two conceptual designs that were carried forward, basic details and layout were fleshed out. Preliminary opinion of probable costs and an evaluation of the physical and financial implications were also completed for each concept.

5 - PHASING STRATEGY & RECOMMENDATIONS

Potential recommendations and phasing strategies are provided for the City as they consider implementing the project.

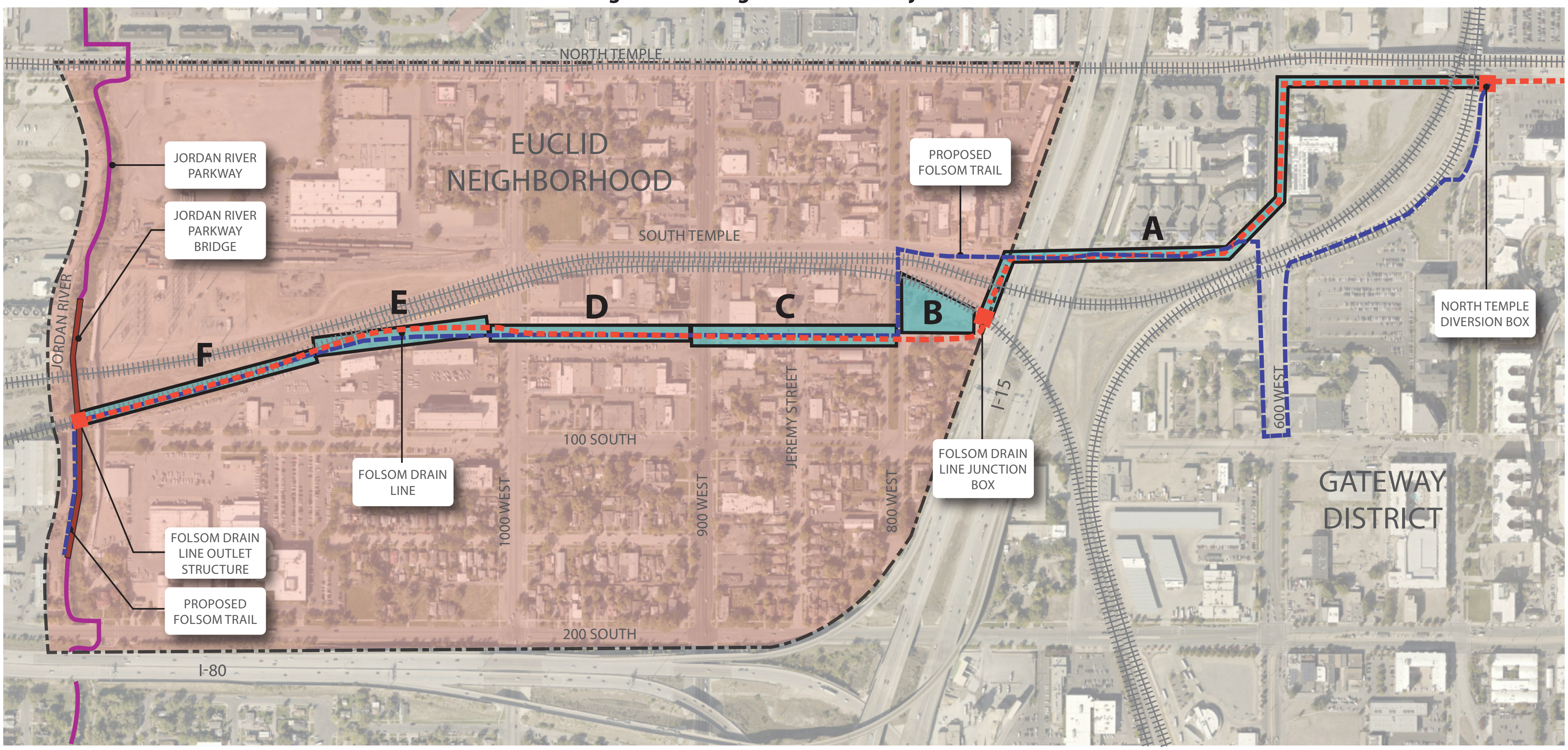
2 - Daylighting Feasibility Analysis

Introduction of the Project Area

For the purpose of this report, the project area has been divided into six unique segments. Beginning at the upstream (eastern) end of the site, these six segments are described below and illustrated in Figure 2:

- **SEGMENT A** begins at the North Temple Junction box and ends at the Folsom Junction Box. It includes the culvert connecting these boxes.
- **SEGMENT B** consists of the vacant land owned by the city near 800 West. The Folsom Junction Box lies on the east side of the property and the drain line along its southern edge.
- **SEGMENT C** begins at 800 West and runs between an array of businesses to 900 West.
- **SEGMENT D** is a wider segment that lies between 900 West and 1000 West.
- **SEGMENT E** begins at 1000 W and continues about "1100 West" through a more industrial area.
- **SEGMENT F** runs from "1100 West" along the railroad tracks until it meets the Jordan River.

Figure 2. Six Segments of the Project Area



Summary of Existing Conditions

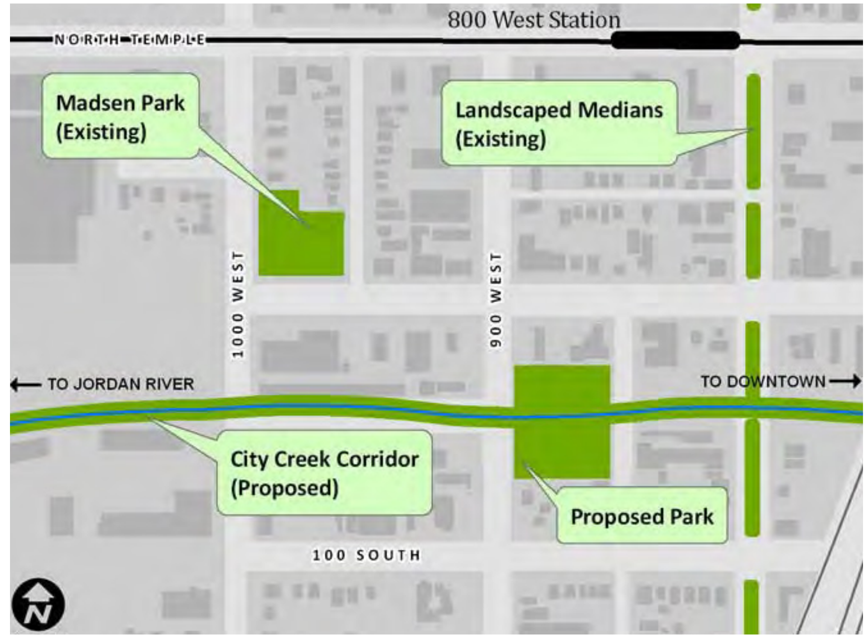
Understanding and documenting existing, known and unknown conditions is an important component of determining feasibility. The following is a summary of these conditions.

MASTER PLANS AND OTHER STUDIES

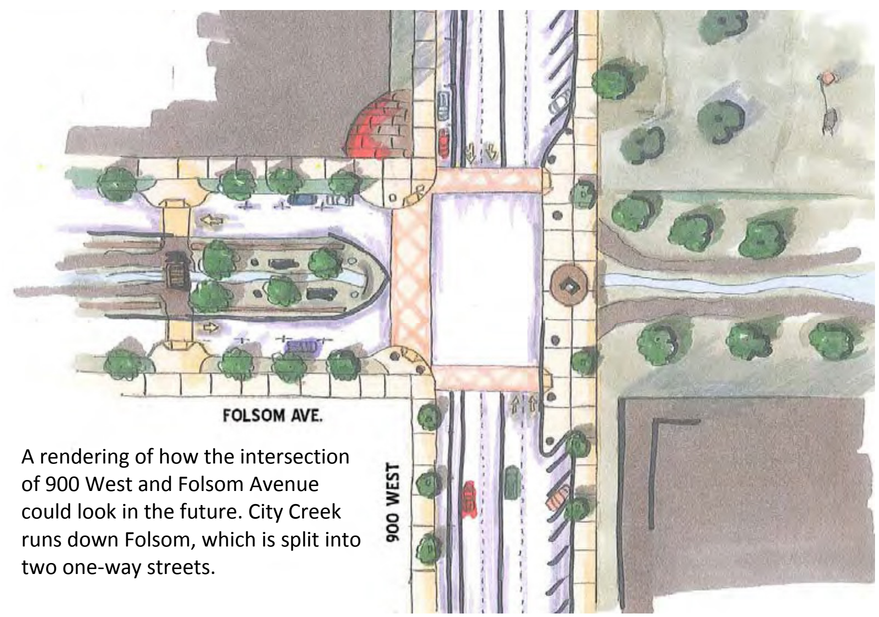
Ideas for daylighting City Creek in the Euclid neighborhood have been explored over the years and are captured in multiple City planning documents. The *North Temple Boulevard Plan* (HAL, 2010) is the current master plan for the Euclid neighborhood, which focuses on the transformation of North Temple through the Airport light rail line, and envisions the corridor becoming a "mixed use, multi-modal boulevard that unites neighborhoods and becomes the main street for the community." The Euclid neighborhood (800 West Station Area) is envisioned to be a walkable, pedestrian-friendly, transit-oriented neighborhood with a mix of uses around the station including vibrant public spaces and higher density residential.

The following are key ideas from the *North Temple Boulevard Plan* (HAL, 2010) regarding the creek and immediate area:

- Bring City Creek to the surface along the abandoned Folsom Avenue rail line and create a correlated trail system that connects the Station Area to Downtown and the Jordan River Parkway.
- Create a neighborhood center between 900 and 1000 West by fronting the City Creek corridor with residential development and locating commercial at the corners.
- Create a focal point at the intersection of 900 West and Folsom Avenue as part of the City Creek open space corridor.
- Relocate the existing Madsen Park (1000 West and South Temple) to a more central location at 900 West and Folsom Avenue.
- Explore a one-way street couplet for Folsom Avenue between 900 West and 1000 West. The couplet could provide access to development along the corridor while also encouraging positive activity to the relocated park.
- Develop design guidelines for the City Creek corridor to create unique, but safe, convenient, well-lit space. The corridor should also encourage a wide range of activities for all ages and abilities and require all development to be oriented toward the corridor to provide "eyes on the park".
- Explore a trailhead, with educational and historic information, at City Creek near I-15.



Proposed, relocated park location from the North Temple Boulevard Plan (2010)

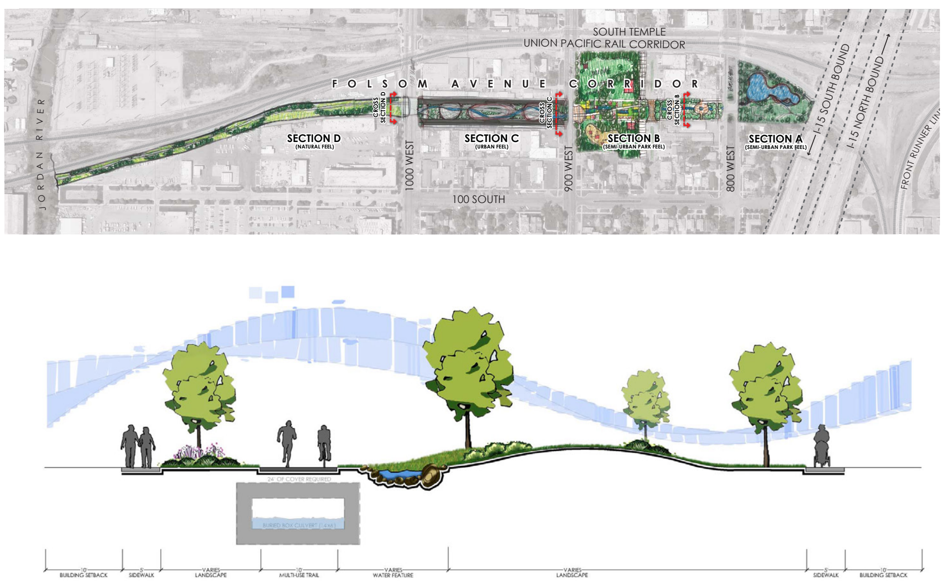


A rendering of 900 West and Folsom Ave. intersection from the North Temple Boulevard Plan (2010)

A rendering of the City Creek corridor from the North Temple Boulevard Plan (2010)

The Construction of the Folsom Drain Line

Following the adoption of the *North Temple Boulevard Plan* in 2010, the Folsom Drain Line has since been implemented. The culvert is centrally located within the corridor and is located relatively close to the ground surface with only one to two feet of cover in some locations. The shallow depth and central location of the culvert adds an interesting challenge to daylighting the creek through this area. During the planning/design process of Folsom Drain Line, daylighting concepts were explored, but not implemented. It does not appear that the culvert was implemented with daylighting the creek in mind.



Folsom Avenue Corridor Concept Plan & Example Section Developed During the Folsom Drain Line Project (JUB Engineers)

LAND USE & BUILT FORM

The Euclid Neighborhood includes a wide range of land uses, including large scale commercial/industrial uses on its western boundary to small pockets of residential uses to the south. The majority of the area is composed of small blocks conducive to creating a walkable neighborhood. An active rail line along South Temple divides the neighborhood and brings challenges to the realization of that goal. The historic, city-owned Albert Fisher Mansion (see Figure 3) is located on the southwestern corner of the neighborhood.

Land uses are predominantly commercial along the Folsom corridor, encompassing automotive repair and catering services. Structures are varied and uncoordinated, with many in need of repair.

SEGMENT B - VACANT LAND NEAR 800 WEST *(City-owned Property: Approx. 1.5 ac)*

City-owned vacant land near 800 West is envisioned as a future detention basin

SEGMENT C - 800 WEST TO 900 WEST *(City-owned Property: Approx. 91-98 feet wide)*

The corridor between 800 West to 900 West is wide and offers the greatest flexibility for the daylighted creek.

SEGMENT D - 900 WEST TO 1000 WEST *(City-owned Property: Approx. 78 feet wide)*

Availability for a daylighted channel is limited by Folsom Avenue (left side of photo) and its current uses.

(Folsom Avenue Right-of-Way: Approx. 80 feet wide)

Folsom Avenue serves primarily as a parking access between 900 West and 1000 West.

SEGMENT E - 1000 WEST TO "1100 WEST" *(City-owned Property: Approx. 58-76 feet wide)*

A large, underground water quality structure on the west side of 1000 West limits the area available for a daylighted channel.

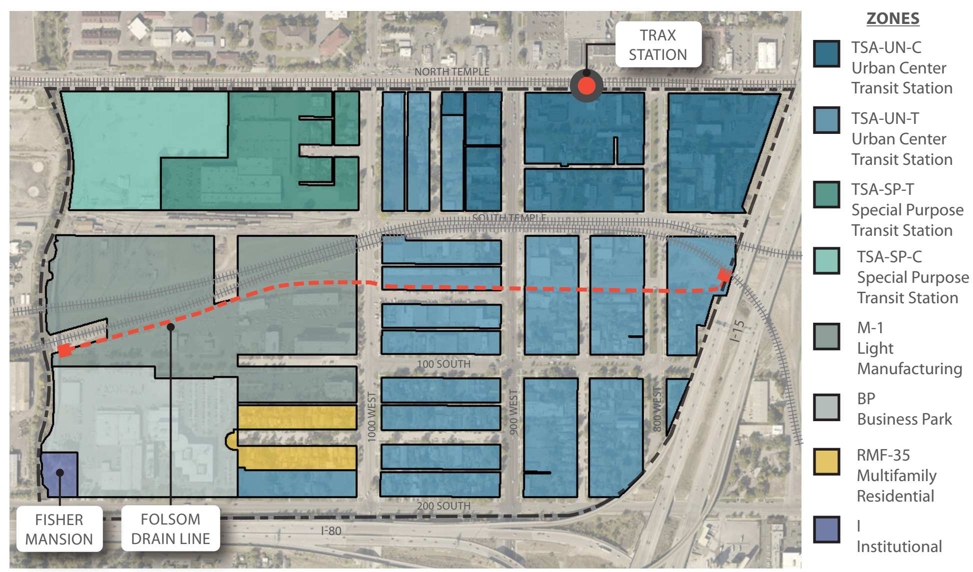
SEGMENT F - "1100 WEST" TO JORDAN RIVER *(City-owned Property: Approx. 28-39 ft. wide)*

City-owned property narrows and uses become more industrial west of 1000 West. The recently completed Jordan River Parkway Trail bridge is at the western end of the project area.

Euclid Neighborhood Zoning

Current zoning reflects the vision established in the *North Temple Boulevard Plan (2010)*, with most of the neighborhood zoned Transit Station Area with Urban Neighborhood Station focus (TSA-UN). Light Manufacturing (M-1) and Business Park (BP) zoning prevails on the western edge.

Figure 3. Zoning for the Euclid Neighborhood



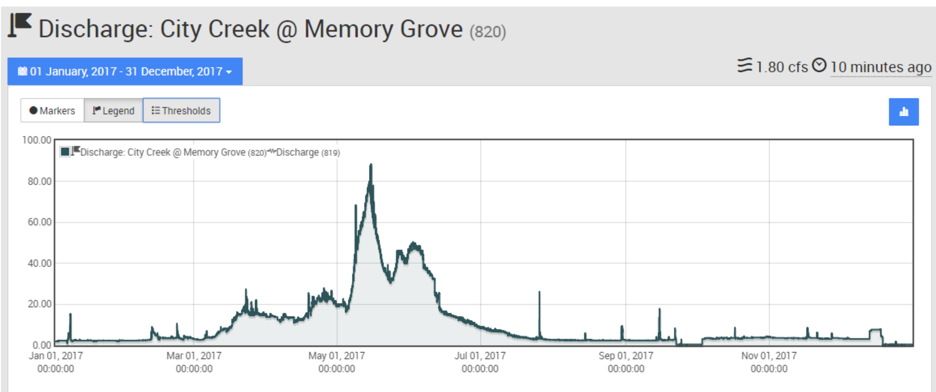
City-Owned Property

City-owned property along the corridor varies (see images/descriptions on pages 5-6), with greater available widths on the east and increasingly lesser widths as one moves west toward the Jordan River. Corridor widths are sufficient for daylighting a stream between 800 West and 1000 West (from 78 to 98 feet), but available property becomes much more challenging west of 1000 West where the existing railroad moves to the south, widths vary narrow down to as little as 26 feet in some sections.

HISTORICAL CITY CREEK FLOWS

Salt Lake County actively measures City Creek flows at Memory Grove, downstream of the City Creek treatment plant. This data shows that a baseflow of approximately 1 to 4 cfs is available most of the time. A baseflow is defined as the sustained low flow in a stream that is present between precipitation or snowmelt events. Peak flows occur in late May or early June corresponding with the peak snowmelt period. Flow data for 2017 are presented in Figure 4.

Figure 4. Salt Lake County Flow Records for City Creek - 2017



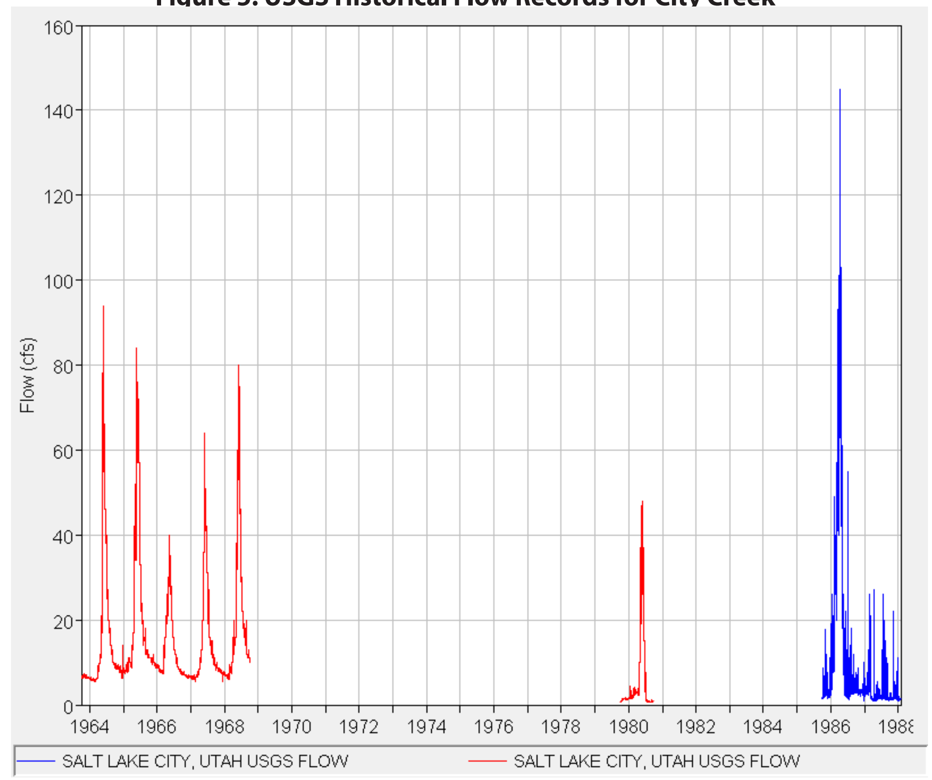
The historical USGS flow records for City Creek were also obtained and analyzed to predict what flows can be expected from City Creek in the future. There were 72 years of annual peak flow records available for City Creek. A Log Pearson III statistical evaluation of these records indicates the return period flowrates presented in Table 1. Return period is defined as the inverse of the probability of a storm event being met or exceeded in any given year. For example, a 100-year storm event has a 1% chance of being met or exceeded in any given year. The 100-year storm event is the most severe event presented because it approximately matches the design capacity of the existing Folsom Drain Line system. Larger events would not make it to the Folsom Drain due to a lack of capacity.

Table 1. Return Period Peak Flowrates for City Creek

	2-year	5-year	10-year	25-year	50-year	100-year
City Creek	65 cfs	100 cfs	122 cfs	147 cfs	165 cfs	181 cfs

Only about eight years of daily flow records were found for City Creek from the USGS records. The baseflow for the flow records from 1964-1968 ranges between 6-8 cfs. The approximate baseflow for flow records in 1980 and from 1985-1987 ranges between 1-3 cfs. These available flow records are shown in Figure 5.

Figure 5. USGS Historical Flow Records for City Creek



THE EXISTING STORM DRAIN SYSTEM

With the enclosure of City Creek in 1909, water flow was diverted underneath North Temple from the mouth of the City Creek Canyon to the Jordan River. Small portions of the creek have since been daylighted through Memory Grove, City Creek Park and along North Temple in front of the LDS Church Conference Center.

In 2012, the Folsom Drain Line project was completed, extending a 12' x 4' box culvert from the end of an existing 54" reinforced concrete pipe (RCP) located between 800 West and I-15 (see Segment A of Figure 2). The Folsom diversion, located at North Temple, currently splits the base flow of City Creek, with a portion continuing down the North Temple conveyance and a portion diverted into the Folsom Drain Line. The Folsom culvert was designed to convey 150 cubic feet per second (cfs) which allows for all of the City Creek's base flows to be diverted down the Folsom Drain Line. The base flows in City Creek at the Folsom diversion include the base flows as measured at Memory Grove, as well as groundwater inflows pumped from underground parking lots between Memory Grove and the Folsom Drain Line. The total baseflow at the Folsom diversion is currently not known. However, with the instigation of this study the City has begun flow monitoring at the North Temple diversion.[1]

UTILITY CONFLICTS & CROSSINGS

The greatest potential for utility conflicts within the corridor occur at road crossings. However, the majority of these utilities were relocated when the box culvert was installed in 2012, usually by lowering the utility under and adjacent to the box culvert forming a loop in the utility. It is possible that the utility loop may need to be extended to clear any additional culverts needed as part of the daylighting project.

The box culvert system includes a large water quality vault just west of 1000 West, which includes a depressed floor and baffle to trap floatables and allow sediment deposition. This structure reduces existing available right-of-way and may require a daylighted stream to be located to the north in this area. Additionally, the right-of-way significantly decreases as the culvert runs west alongside the railroad track toward the Jordan River. The existing ground through this area also rises in elevation.

Storm drain boxes installed as part of the box culvert project likely conflict with any daylighting concept and would likely need to be relocated or abandoned.

1 Monitoring by Salt Lake City's Department of Public Utilities has begun with measurements completed on May 2, 2019 (during spring runoff) and August 8, 2019 (dry weather), with others to follow.

WATER QUALITY

Water quality conditions could have significant implications for the success of stream design. Good water quality allows for more flexibility in design options while poor quality water may require the addition of site access barriers if the quality does not support human contact. Initially, water quality data was only available downstream (Jordan River) and upstream of the Folsom Drain at Memory Grove. This data may not represent water quality within the Folsom Drain. Lacking site data, the team made assumptions regarding water quality based on existing water quality regulations for City Creek and the Jordan River (see inset box below). However, additional water quality monitoring was suggested to better inform the final design of the daylighted stream channel.

CURRENT WATER QUALITY REGULATIONS

The following water quality regulations are implemented for City Creek and the Jordan River and could affect the daylighted creek design:

About one and a half miles upstream from the Folsom Corridor, City Creek (from the City drinking water plant to Memory Grove) currently has two designated uses (Utah Administrative Code, 2018):

- Class 2B—Protected for infrequent primary contact recreation. Also protected for secondary contact recreation where there is a low likelihood of ingestion of water or a low degree of bodily contact with the water. Examples include, but are not limited to, wading, hunting, and fishing.
- Class 3A—Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.

Downstream of the daylighted stream at the confluence with the Jordan River has three designated uses (Utah Administrative Code, 2018):

- Class 2B (same as above)
- Class 3B—Protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain.
- Class 4—Protected for agricultural uses including crop irrigation and stock watering.

The project team recommends a minimum Class 2B designated use (secondary contact recreation) for the daylighted stream. Two water quality samples were taken by SLC's Department of Public Utilities (SLCDPU) on May 2 and August 8, 2019 during high and low runoff periods, upstream of the Folsom Drain diversion from the North Temple drain. Preliminary results from SLCDPU sampling indicate that the water quality would meet the Class 2B designated use (See Appendix A). Future tests during a summer/fall with wet weather are planned to continue to inform this evaluation with a more rigorous sampling program for the design phase of this project.

BROWNFIELD & SUPERFUND SITES

Properties along the corridor also include multiple brownfield and Superfund sites that have resulted in the contamination of both soils and groundwater within and around the project area. Impacts from past industrial activity in shallow soils and groundwater include: metals, organics, and oil and grease contamination. A list of site conditions are summarized in Table 2 and site and monitoring well locations in Figure 6.

All of these sites receive regular monitoring and some have been successfully remediated. For example the Mountain Fuel Supply site (now Dominion Energy) has organic residue contamination from past coal gasification operations. To remedy this, a slurry wall was installed around the perimeter of the contamination, and within the containment area, groundwater is extracted and treated (Millennium Science and Engineering, 2003). The monitoring has confirmed that the remaining contamination at the site has been contained and is being treated.

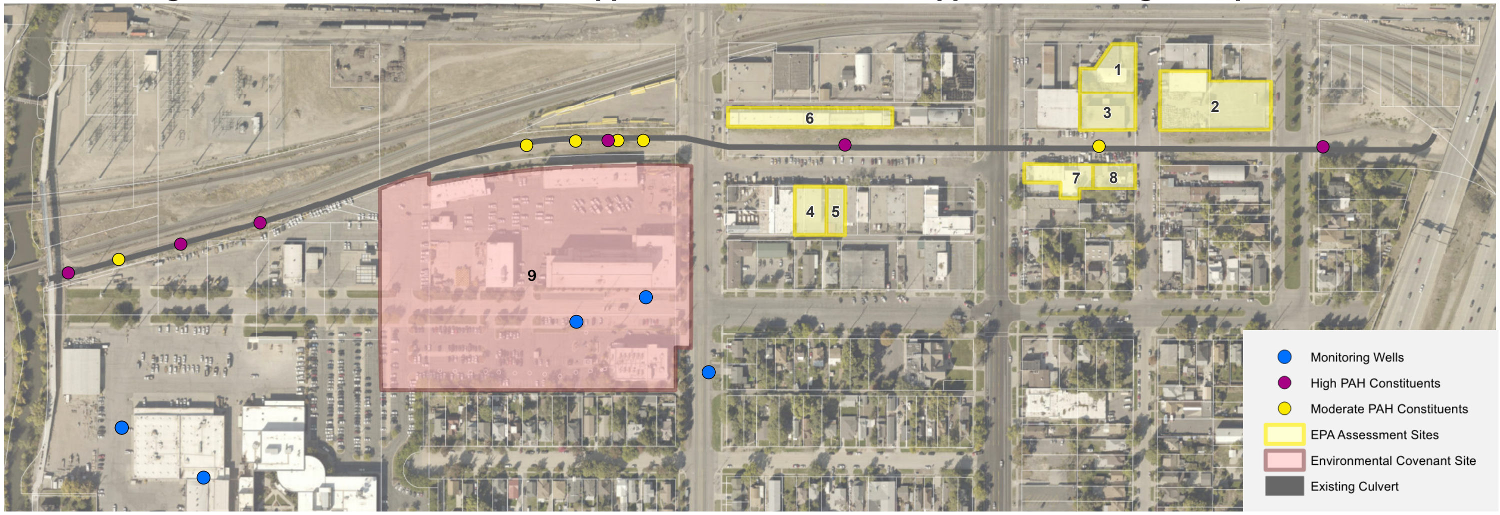
In the daylighting design phase, a detailed review of monitoring data and some additional reconnaissance monitoring is recommended. While a report associated with the culvert's construction (Terracon 2011) provided information on what is potentially in the corridor, much of the contaminated sediment could have been removed when the Folsom Drain was installed. Therefore, additional sampling at the hotspots identified by Terracon (2011) would be warranted prior to daylighting design and construction.

Table 2. Monitoring and Remediation Sites in the Corridor

Site #*	Site Name	Observed Issues
1	Crown Plating Facility	Hexavalent chromium and cyanide in soils, and TCE in groundwater
2	Heritage Forge	Lead in soil, and PCE and TCE in groundwater
3	Schovaers Electronic Facility	Hexavalent chromium in soil and groundwater, and TCE in groundwater
4	Swaner Properties	No environmental concerns noted
5	Marblecast Products	Minor impacts of lead and oil & grease in shallow soil
6	Tire Express	No environmental concerns noted
7	El Compadre and Mutual Engine Repair	No environmental concerns noted
8	Liberty Auto & Auto Work	Minor impacts of oil & grease in shallow soil
9	Mountain Fuel Supply site (now Dominion Energy)	Organic residue from past coal gasification operations

**See site numbers on Figure 6 for locations. Addresses for individual sites can be found in Appendix A.*

Figure 6. Environmental Conditions (Approximate Locations; See Appendix A for Original Reports/Data)



GEOTECHNICAL CONDITIONS

In order to understand the soil likely to be encountered when constructing a daylighted stream channel, existing geotechnical conditions were assessed. Since the proposed daylighted stream alignment follows the Folsom Drain Line, data from the recent Folsom Drain Line installation were used, along with reports from the early 2000s, which provide some of the necessary information for this assessment. Although not comprehensive, those reports contained the following information:

- A 2011 geotechnical report shows that the soils along the corridor are made up of gravel fill with silt and sand, underlain by 10 feet of silt, silty clay and clay (Terracon, 2011). At depth (16.5 feet), sand with silt was encountered. Groundwater was encountered between 7.5 feet and 9.5 feet below grade, and the direction of groundwater flow was west towards the Jordan River.
- In 2002, soil and groundwater sampling was conducted to characterize the subsurface conditions along the Folsom Corridor (Millennium Science and Engineering, 2003). Surface soils were found to contain several polynuclear aromatic hydrocarbons (PAH), with benzo(a)pyrene exceeding the industrial/commercial Risk Based Concentration (RBC). With the exception of arsenic and lead, metals concentrations were below EPA Region 3 RBC for soils at industrial sites. Arsenic exceeded the RBC, but is naturally occurring at generally high concentrations in the area. EPA usually considers human exposure to soil with lead concentrations less than 400 mg/kg to be safe for residential land use. Only one soil sample had a lead concentration greater than 400 mg/kg. Volatile organic compounds (VOC) and PAHs were detected in the subsurface soils at concentrations less than the RBCs. Arsenic was detected in groundwater at concentrations exceeding the RBC.
- During the planning of the Folsom Drain, Terracon collected more than 100 soil samples along the corridor (Terracon, 2011). Soil samples were collected to a maximum depth of 10 feet. Terracon summarized their findings as follows: “In the soils along the alignment, the most common contaminant type detected was relatively low concentrations of PAH constituents, most of which occur within the upper portion of the soil profile (most commonly within the upper 3 feet). Approximately half of the detected PAH concentrations were below the most conservative regulatory screening level (U.S. EPA RSLs - residential). At twelve localized “hot spots” along the alignment, PAH concentrations exceed the residential RSLs, and at six of these locations PAH concentrations also exceed industrial RSLs (see Figure 7 for approximate locations and Appendix A for a more detailed summary of contamination from the Terracon report). Relatively low concentrations of TPH-Oil & Grease are also locally present. There is no indication of the presence of VOCs in soils. Because of the types of contaminants detected and their widespread distribution along the former railroad corridor (predominantly within the upper portion of the soil profile), the detected contaminants appear to be mainly associated with past activities along the former railroad corridor”.
- Slag disposed of along the rail road corridor is high in metals. This would need to be disposed of properly if disturbed.

It is likely that all of the contaminants identified above were there because of the former rail line and the past activities surrounding that line (Terracon, 2011).

REMEDIATION REQUIREMENTS

Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund) (42 U.S.C. §9601 et seq. (1980)) a “facility” is defined as any area, place, or property where a hazardous substance in excess of the established cleanup standard for residential property has been released, deposited, disposed of, or otherwise comes to be located. An owner that is liable for a facility is obligated by law to take appropriate response activities at that property. Even if the owner is not liable for the contamination, they have “due care” obligations. “Due care” means that an owner or operator of a facility is required to take measures to prevent unacceptable exposures to hazardous substances or create conditions that worsen the contamination.

Due to the presence of PAH impacts along the culvert alignment (Terracon 2011), the soils in the construction area should be evaluated prior to project initiation. Additional soil samples should be collected in the excavation area (to the depth of planned excavation) and analyzed for total metals, volatile organic compounds and PAH. In addition, if subsurface soils that are disturbed during construction activities exhibit staining, noxious odors, sheens, or any other abnormalities that indicate the likely presence of contaminants, then proper procedures should be followed with respect to worker health and safety, and any impacted soil encountered should be property characterized. Soils exceeding the EPA Regional Screening Levels should be removed and disposed in accordance with Utah Department of Environmental Quality requirements.

Preliminary Hydrological Analyses

PRELIMINARY CONCEPTS

The scope for this feasibility analysis is focused on three main daylighting concepts, which follow:

CONCEPT 1: Daylight only the consistent base flow historically available in City Creek, which is about 2 to 4 cfs as described previously.

CONCEPT 2: Daylight the full creek design flow of 150 cfs, which would involve removing some or all of the existing box culvert.

CONCEPT 3: Combine concept 1 and 2, where feasible, so that some reaches have full flow capacity while others only have capacity for the base flows.

CONCEPT 1 - DAYLIGHTING PARTIAL CREEK FLOW (2 TO 4 CFS)

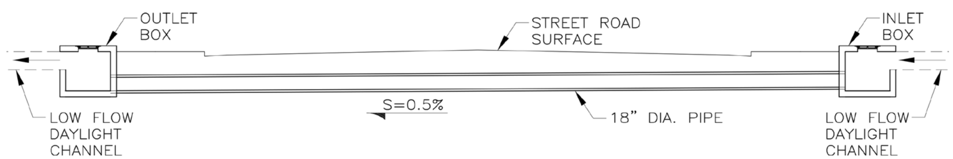
This concept includes daylighting the normal baseflows of City Creek using the cross section shape proposed by the US Army Corps of Engineers (Section 206 Preliminary Restoration Plan, 1999). The Mannings flow equation with flow a function of velocity, flow area, channel roughness (Manning's n), and slope was used to define a conceptual channel cross section. The proposed cross section shape is trapezoidal with a 2-foot bottom width and 2.67-ft Horizontal:1-ft Vertical side slopes. Assuming the same slope as the existing culvert of 0.00058 ft/ft and a Manning's n of 0.05, the computed depth in the channel is 1.27 feet with a top width of 8.8 feet and a flowrate of 4 cfs. The roughness coefficient would vary depending on the composition of the channel bed but the Manning's n value assumed is sufficient for conceptual feasibility purposes. The coefficient assumes coarse gravel and small cobbles in the bottom of the channel with vegetation growing on the side slopes.

The channel would need to cross several existing roadways. Crossing options may include traditional culverts, inverted siphons, or other options that offer flow, but are cost effective considerations for the site.

Maintaining Flow at Street Intersections (Concept 1)

In order to mitigate problems caused by the low culvert crossings at the roadways, inverted siphons may be an option (see Figure 7). This will allow for a shallower channel upstream and downstream of each roadway crossing, while still allowing the necessary cover – at least 2 feet – on the pipe crossing. Reducing the depth of the channel results in a smaller width, which gives more room for the channel to meander, if desired. Storm drain boxes installed with the box culvert would need to be relocated or removed where located on the same side of the box culvert as the siphon. At the road crossing, the utility conflicts should be minimal because most of the crossing utilities were looped (around/beneath the culvert) when it was installed in 2012. The loop for the uppermost utility (telecommunications) will likely need to be extended depending on the final design depth of the siphon and the location of the utility. There is a possibility that the gas line may need to be extended as well although it can likely be avoided. The other looped utilities (water and sanitary sewer) will not need to be altered.

Figure 7. Typical Creek Street Crossing (Inverted Siphon)



CONCEPT 2 - DAYLIGHTING FULL CREEK FLOW (150 CFS)

This concept daylights the full design flow of the existing box culvert (150 cfs), making the existing culvert redundant. Limits in property width would require the non-essential culvert be removed in order to construct the new channel. Assuming the same slope as the existing culvert 0.00058 ft/ft, a HEC-RAS hydraulic model was built using the current alignment of the existing box culvert (see profile in Figure 8). The channel was assumed to be trapezoidal except at the narrowest segment downstream of 1000 West where a rectangular channel would be needed to convey the entire flow. At road crossings it was assumed that the existing box culverts would be used to pass flow under the roads. An initial cross section shape for both options was assumed and then adjusted until the proposed cross section provided sufficient capacity for the full 150 cfs. The downstream boundary condition was assumed to be the 100-year water surface elevation of the Jordan River at the confluence of City Creek and the Jordan River. A Manning's n of 0.03 was assumed which would be representative of cobbles and small boulders in the bottom of the channel and minor vegetation lining the side slopes of the trapezoidal channel.

The conceptual sizes for the assumed trapezoidal cross sections for Concepts 1 and 2 are presented in Table 3.

Figure 8. Water Surface Profile for Open Channel Options for Concept 2 (150 CFS)

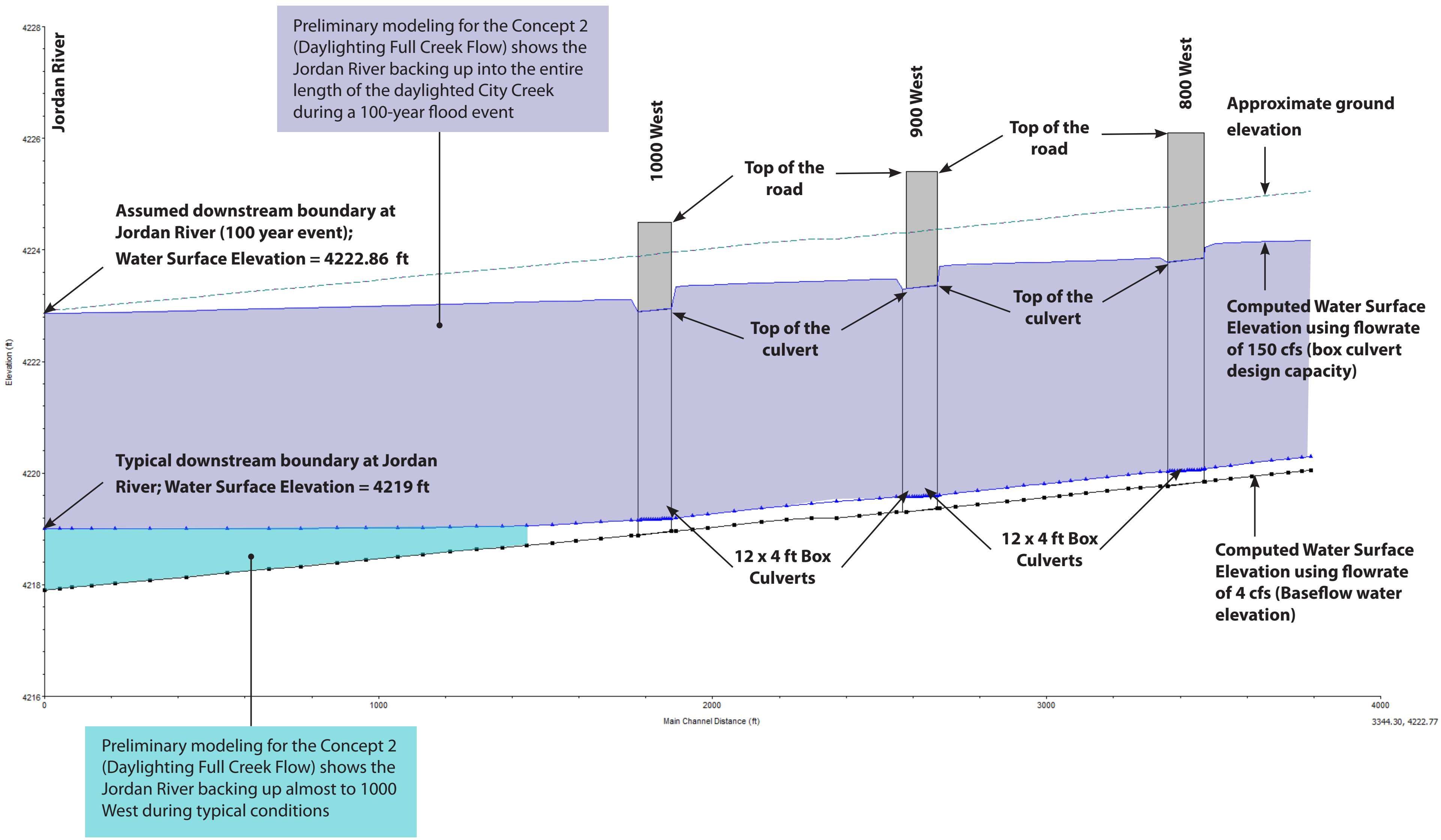


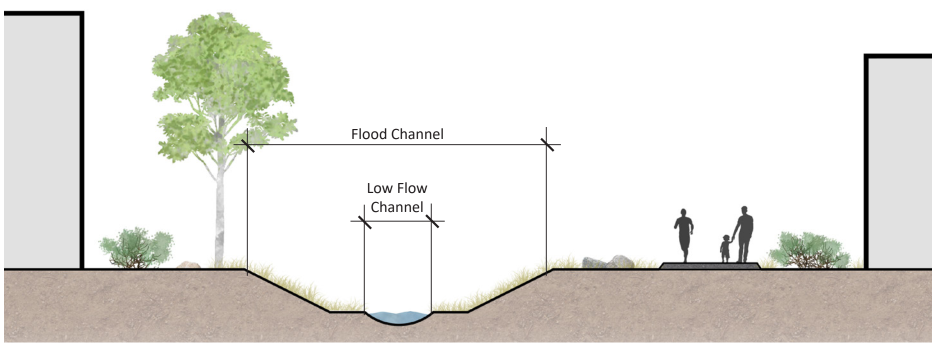
Table 3. Recommended Design Channel Dimensions Concepts 1 & 2

	Bottom Width (ft)	Side Slopes (H:V)	Top Width (ft)	Water Depth (ft)
Concept 1 - Partial Creek Flow (2 to 4 CFS)	2	2.67:1	8.8	1.27
Concept 2 - Full Creek Flow (150 CFS)	16	2:1	32-36	Approx. 0.5 to 5 feet

The water level in the Jordan River has a very significant impact on the depths in the proposed daylighted channel due to backwater effects. The 100-year flood level in the Jordan River (4222.86 ft) was used as the downstream condition in the HEC-RAS model. Model runs with varying Jordan River flow elevations were also performed and confirmed how much the total capacity of the proposed City Creek channel is dependent on the conditions in the Jordan River. As proposed, the channel has capacity to carry the full 150 cfs flowrate when the Jordan River is at 100-year flood stage. At lower stages in the Jordan River, the proposed channel would have lower water surface elevations and a greater flow capacity.

The Folsom Drain was constructed to carry 150 cfs during a major storm event. A replacement channel would also need to convey the full design flow (150 cfs). As shown in Figure 8, the normal base flow (4 cfs or less) would have a small flow depth. A compound channel (see Figure 9) could be used to provide a normal base flow depth.

Figure 9. An Example of a Compound Channel



Maintaining Flow at Street Intersections (Concept 2)

Concept 2 removes the existing box culvert in between the intersections of the roads, replacing it with an open channel. The existing box culvert remains under the roads in order to convey the flows under the intersections. A transition between the box culverts and the new open channel sections will need to be installed, which will most likely include the construction of headwalls, wingwalls, and safety railings, on both the upstream and downstream sides of each intersection. Since sections of the major conveyance are being replaced with an open channel, local drainage can either go directly to the channel or can be directed first into a green infrastructure system.

CONCEPT 3 - A COMBINATION OF CONCEPTS 1 & 2

The corridor west of 1000 West has significant space limitations. The existing box culvert shifts farther north when crossing 1000 West, resulting in less city-owned property available to construct the channel. Also, the large water quality vault immediately west of 1000 West further reduces the usable space north of the box culvert. In order to extend Concept 1 past this structure, either steeper side slopes on the channel would be required, reducing the flowrate in the channel by removing part of the baseflow, or the water quality vault would need to be removed. If the vault were removed or relocated, approximately 76 feet of land would be available before the channel narrows just before "1100 West".

West of "1100 West", the city-owned property continues to narrow, in some places to only 26 feet in width. Furthermore, railroad tracks run along the north side and private property on the south. For the full base flow for the Concept 1 channel to continue to the Jordan River, a very deep channel would be required (4.5' deep, if inverted siphons are used), with nearly vertical walls running straight along the box culvert. There is not sufficient room to implement Concept 2 through this section.

Given these constraints and the varying conditions along the corridor, a concept that explores possible combinations of Concept 1 and Concept 2, as well as removing some of the baseflow through this constrained section should be explored.

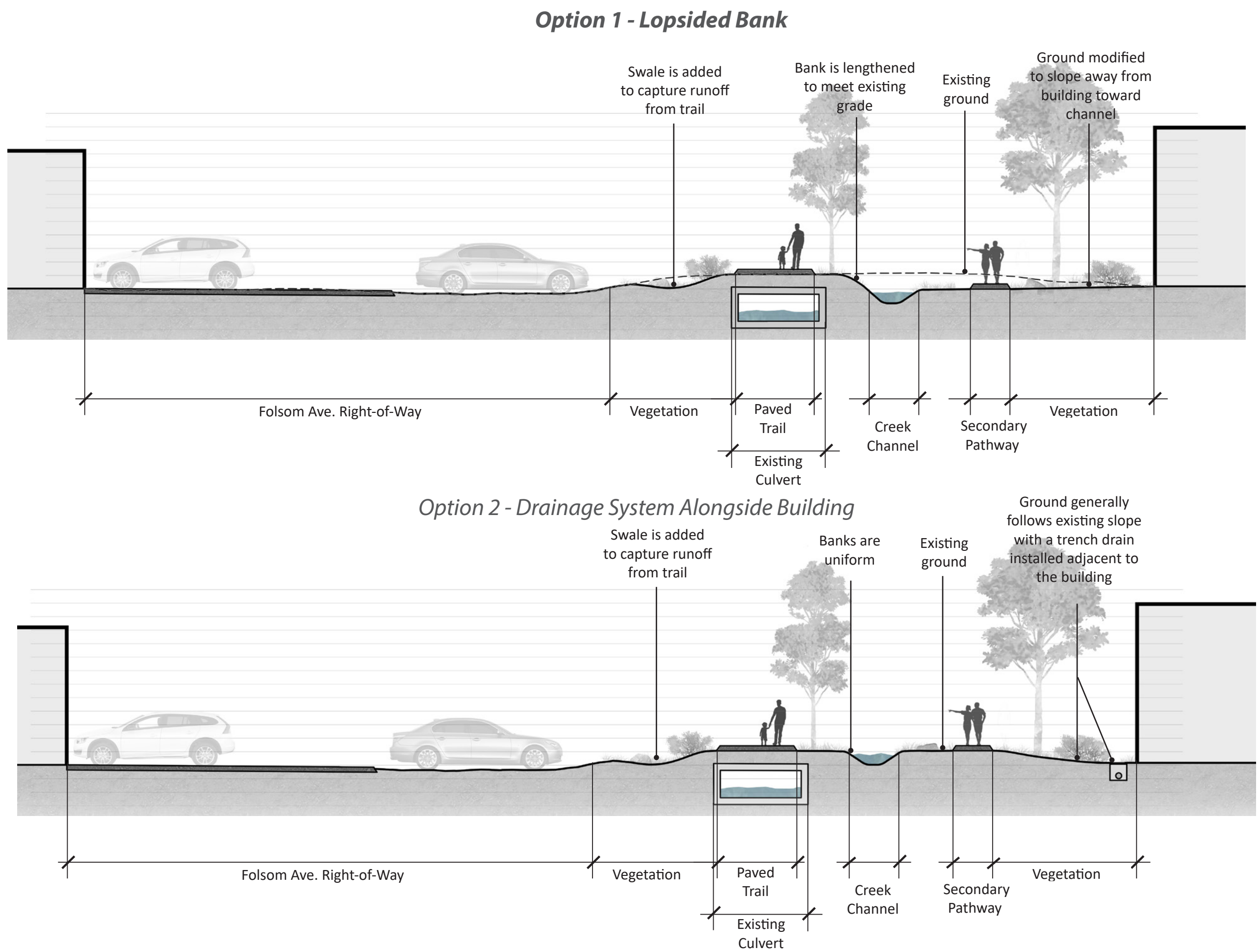
Detention Basin & Stormwater Management

EXISTING CULVERTS, STORMWATER & GROUNDWATER OPPORTUNITIES

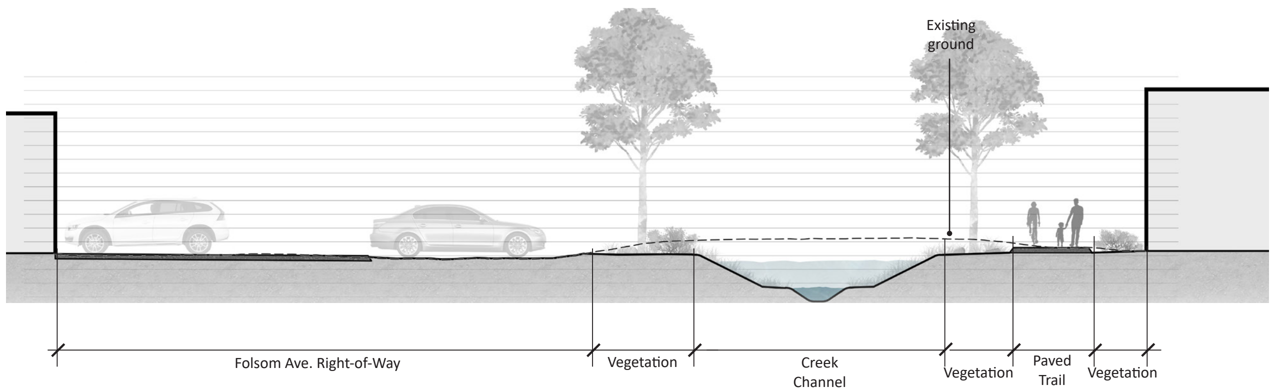
Record drawings from 2011 for the box culvert project indicate that local drainage through the Folsom corridor was reconstructed and connected to the new box culvert. This included the removal of older storm drain pipes and inlets and the addition of new inlets and storm drain pipes at 800 West, Jeremy Street, 900 West and 1000 West. At that time, no additional culverts were identified to be connected to the Folsom Drain Line.

According to City staff, multiple downtown structures currently pump groundwater to the North Temple drainage system. The amount of groundwater that is pumped is currently not known. The City measured the flow rates at the North Temple diversion box during the spring and summer of 2019 (May 2 and August 8, see Appendix A). Continued efforts to make additional measurements could help determine the base flow produced by the continuous pumping of groundwater in the area . The city could also consider installing a water level data logging or other devise in this location over a few seasons (early spring to late fall) before or during the next phase of the project. These groundwater flows are in addition to the base flows that come from City Creek. This determination will help define the parameters for the design of the preferred

Figure 10. Potential Solutions for Existing Issues East of 1000 West



Option 3 - Replace Culvert with Channel



daylighting concept. While the precise flowrate of the pumped groundwater is not currently known, the availability of additional base flow from groundwater will not have a significant impact on the feasibility of the concepts presented herein.

EXISTING DRAINAGE ISSUES EAST OF 1000 WEST

East of 1000 West, the box culvert runs along the northern side of Folsom Avenue, a street that provides business access and parking for businesses on the south side of the corridor. Although improvements (catch basins at low points) were made during the construction of the box culvert, the street and parking area remain relatively flat and drainage is poor. Existing structures on the both sides of the culvert are also approximately two feet lower than the existing culvert/ground service. Any modifications to the area will require careful grading and design to prevent flooding (see Figure 10).

Will adding the creek channel further complicate these drainage issues?

While the addition of a creek channel in any of the concepts will not automatically solve drainage issues within Folsom Avenue, they do not appear to complicate them and will provide a low point to grade surrounding areas to. With good grading and drainage design, all of the channel concepts could be implemented while avoiding flooding the existing buildings (see Figure 10).

The poor drainage found in the Folsom Avenue corridor will require an in depth study of the existing storm drain system and soils. With additional information, such as depth of storm drain lines and inlets and/or soil profiles, options such as regrading the road, providing additional catch basins and the incorporation of green infrastructure measures such as those included on the following page can be verified or dismissed.

DETENTION BASIN

On the east side of 800 West at approximately 29 South, an open area is planned for a detention basin that will reduce peak storm runoff flow rates by storing flow during peak periods. Concepts presented later in this report propose the construction of a combined detention/water quality basin that not only provides storm water detention for future development, but also an opportunity for water quality enhancement.

As conceptualized, the detention/water quality basin would contain two parts: 1) a forebay, and 2) a detention pond. The addition of a forebay will facilitate the removal of floatables and heavy sediments before they are allowed to enter the detention pond. The forebay would include a concrete floor and trash racks promoting removal of trash and grit from the storm water flows. The forebay would require ongoing maintenance to remove the accumulated material. The water quality component of the forebay would also allow for the removal of the existing water quality structure located west of 1000 West.

There is insufficient elevation difference between the detention/water quality basin and the head of the proposed low flow channel (Concept 1) for the basin to function using gravity. Two alternatives for daylighting the base flows for the low flow channel alternative include: 1) providing a pump vault after the trash racks in the forebay of the proposed detention/water quality basin, and 2) installing grates in the floor of the existing box culvert with a pipe leading to a pump vault. Both alternatives would require submersible pumps, which are controlled based on the water level in the pump vault.

Green Infrastructure Opportunities

Green infrastructure provides environmental benefits that can potentially reduce flooding, improve water quality, reduce stormwater runoff and pollutant transport, recharge groundwater, and more generally provide societal and economic benefits. Green infrastructure is typically designed to treat precipitation and runoff as far upstream as possible, thereby avoiding large, high-budget, heavily-engineered downstream solutions.

The area around 1000 West has demonstrated flooding issues. Green infrastructure could help provide robust and resilient solutions that would provide aesthetic, environmental, and neighborhood benefits in addition to water quality and flooding benefits.

Prior to selecting a specific suite of green infrastructure tools for the area, the causes of existing flooding needs to be fully understood. The scenarios under which flooding occurs and the circumstances surrounding the reported flooding are key in identifying the right green infrastructure practices to be applied. The following steps are therefore recommended to gain a better understanding before designing a flood control and green infrastructure solution:

- Calculate the contributing overland flow drainage area to this site
- Gather data related to projected land cover, specifically soil infiltration and impervious surfaces, of the contributing drainage area. Depending on available data and comfort with development projections, assumptions can be made.
- Develop projected runoff and flooding estimates for a variety of precipitation scenarios. Green infrastructure can be designed to treat low flows and first flush for water quality or to detain larger volumes of runoff for flood protection. These estimates can be developed using basic, straightforward hydrological modeling.
- Determine the difference between runoff volume that can be controlled via existing infrastructure and allocate the additional volume to potential future projects, including green infrastructure.

Green infrastructure can be implemented in a centralized or decentralized fashion, and understanding the projected development patterns for the area will lead to the most appropriate approach. If the entire projected flood volume cannot be treated with green infrastructure, additional grey infrastructure such as sewer upgrades, modified surface drainage or on-site treatment may need to be considered.

In addition to providing flood benefits, green infrastructure could also provide water quality benefits including meeting targets for the Jordan River TMDL. A similar model exercise could be performed to calculate contributions to the TMDL.

In a semi-arid climate such as Salt Lake City, particular attention should be paid to the selection and maintenance of vegetation. Practices should be effective, sustainable, and conserve water resources. Plants should be selected with water needs in mind. Soil amendments are also required to improve subsurface storage and soil moisture retention. Ongoing maintenance will be essential.

The following are potential green infrastructure options that should be considered and encouraged in the Euclid area and throughout the Folsom Corridor.

RAIN GARDENS AND BIORETENTION

Rain gardens and bioretention are vegetated areas that retain and treat stormwater runoff from impervious areas such as rooftops, sidewalks, and streets (Figures 11 and 12). A healthy rain garden receives runoff from an upstream area, retains it, and infiltrates it before excess water runs off. Bioretention may have engineered subsurface layers to maximize runoff storage capacity and infiltrate or detain stormwater. In arid climates, rain garden design must be conscious of limited water supply.

Figure 11. Example of bioretention basin located near Frederick Albert Sutton building at the University of Utah

(Source: deq.utah.gov/water-quality/low-impact-development)

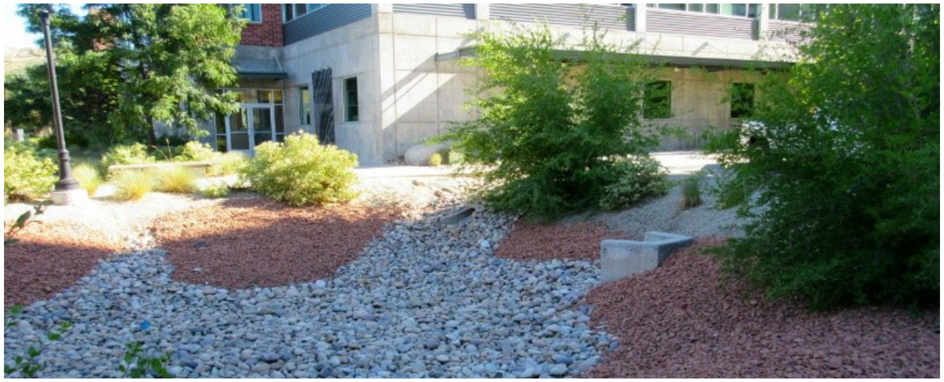


Figure 12. Example of bioretention rain garden located in Salt Lake City
(Source: deq.utah.gov/water-quality/low-impact-development)

COMPLETE STREETS AND GREEN STREETS

Complete streets utilize design tools aimed at implementing stormwater management within the street right-of-way. This can help ensure that streets drain properly and are available to all user groups. As such, they can provide social, economic and environmental benefits to the community (NACTO, 2019). Complete streets can also provide easier access to transit stations, safer driving conditions for vehicle traffic, reduced likelihood of flooding for businesses and residences, and increased public utility access for the city.

According to the National Association of City Transportation Officials (2019), some of the benefits of this design approach include:

- Incorporating planters or vegetation into right-of-way design
- Capturing runoff and reducing flooding to promote safer walking and driving conditions
- Evaluating a complete range of uses and transportation modes when designing streets.

As illustrated in Figure 13, green streets can easily integrate rain gardens, bioswales, bioretention, pervious pavements, and other practices, providing greater benefits than implementation of individual methods as standalone practices. Many green street tools can be implemented in the right-of-way prior to, after, or as development occurs. By planning and considering a suite of green infrastructure practices for the study area prior to the redevelopment of streets and city blocks, green infrastructure options can be considered as a system contributing to a complete green street.

According to the US EPA (2019), green streets can be designed to:

- Minimize stormwater impacts on the surrounding area through a natural system approach that incorporates a variety of water quality, energy-efficiency, and other environmental best practices;
- Integrate green stormwater management features to increase infiltration and/or filtration of runoff, reduce flows, and enhance watershed health;
- Reduce the amount of water that is piped and discharged directly to streams and rivers;
- Make the best use of the street tree canopy for stormwater interception, as well as temperature mitigation and air quality improvement;
- Improve the aesthetics of a community and increase it's livability.

Most right-of-way updates in the project area include potential opportunities to incorporate green street design elements and can help reduce flooding, improve stormwater runoff quality, communicate neighborhood environmental values to the public, and provide an educational opportunity for environmental issues.

Green street design concepts need not be green in color. Native plants appropriate for the area can be selected to increase evapotranspiration and rely on precipitation instead of irrigation.

Figure 13. Example of green streets
(source: www.thomasrainer.com/)

REGIONAL GUIDANCE

Salt Lake City, Salt Lake County, and the State of Utah Department of Environmental Quality (DEQ) have adopted green infrastructure, low impact development (LID), and stormwater guidelines (Michael Baker International, 2018; Salt Lake County, 2018; Salt Lake City, 2016). However, regulatory requirements that mandate green infrastructure are not currently established.

DEQ Low Impact Development guidance, for example, is still in draft form and is moving toward becoming enforceable regulations (Utah DEQ, 2019). A primary purpose of that effort is to assist "planners and designers select what LID practices to incorporate in their projects as well as municipal separate storm sewer systems (MS4s) in evaluating LID practices and determining what is most appropriate for their storm water programs." Accordingly, the draft document should be used a guide for the final design of LID in the next phase of this project (Michael Baker International, 2018).

OTHER GREEN INFRASTRUCTURE OPPORTUNITIES

As the area redevelops and new structures and improvements are made, the following green infrastructure opportunities should be considered.

POROUS PAVEMENT

Porous pavement reduces runoff and contaminants by allowing precipitation to infiltrate into the soil, through pavement. Water drains through a pervious surface, or engineered gaps in the road surface, and infiltrates or enters a subsurface retention area. Parking lots, on-street parking, and other areas are all appropriate areas for porous pavement.

Example of previous concrete located at the Associated General Contractors' parking lot (2207 S. 1070 W., Salt Lake City)

GREEN AND BLUE ROOFS

Green roofs in arid and semi-arid regions reduce and treat stormwater runoff, reduce the urban heat island effect, and can provide an amenity for building occupants. Blue roofs provide additional water storage. Green and blue roofs require the cooperation of private land-owners and developers to implement on a large scale. Green and blue roofs can be combined with other practices including on-site stormwater detention, reuse, and other storage before discharging runoff to public-space green infrastructure and conveyance.

Example of Green Roof at LDS Conference Center in Salt Lake City, Utah (Source: www.greenroof.hrt.msu.edu)

Example of Green Roof at University of Colorado Anschutz Wellness Center Aurora, Colorado (Source: www.aslacolorado.org)

3 - Summary of Opportunities & Constraints

Based on existing conditions and preliminary analyses, opportunities and constraints were identified and addressed for the corridor (see the Opportunities and Constraints map on p. 20-21). The following are key findings and data gaps.

KEY FINDINGS

- The property ownership boundaries, road crossings, Folsom Trail concepts, and the alignment and shallow positioning of the Folsom Drain within the project area may limit design considerations for the creek channel.
- The width of the corridor in the eastern end of the project area (from 800 West to 1100 West) is greater than the width in the western project area (from 1100 West to the Jordan River) and may require a complex mix of channel design considerations.
- The gradient in the east portion of the project area (from 800 West to 1000 West) is greater than the western portion of the project area (from 1000 West to the Jordan River), potentially creating some flow conveyance and flow volume challenges in the channel design.
- Potential contaminated soils would need to be sampled, prior to construction, to identify appropriate removal and disposal requirements.

DATA GAPS

Several data gaps were identified as part of this analysis, described below. If resolved, the new information could improve options in the design of the daylighted stream channel. Identified data gaps follow.

Additional flow data is needed in Folsom Drain.
It is assumed there is continuous flow diverted to the Folsom Drain. It is recommended that flow measurements at the North Temple diversion box, the Folsom Drain junction box, the Folsom Drain at 1000 West, and the Jordan River Outfall be collected. The city measured the flow rates at the North Temple diversion box during the spring and summer (May 2 and August 8, 2019, Appendix A). The city could consider installing water level data logging or other devices over a few seasons (early spring to late fall) before or during the next phase of the project to continue to fill these data gaps. Volume and duration data are needed in the Folsom Drain to inform the daylighting design.

Additional water quality data is needed within the Folsom Drain.
The City measured important water quality parameters on two occasions (May 2 and August 8, 2019, Appendix A). This water quality information showed promise that the water could meet the designated use for contact recreation (Utah Administrative Code, 2018). It is recommended that Salt Lake City continue to collect water quality samples regularly from the Folsom Drain and/or at the diversion box at North Temple, as well as local source inputs from stormwater and continue to evaluate if water quality meets the designated use for contact recreation under all conditions. The most critical period for data collection are during the recreation season (late spring to early fall), and during non-spring runoff wet weather. Due to the current lack of water quality data, it cannot be concluded that daylighting would improve water quality within the Folsom Drain.

Opportunities and Constraints

F "1100 WEST" TO THE JORDAN RIVER

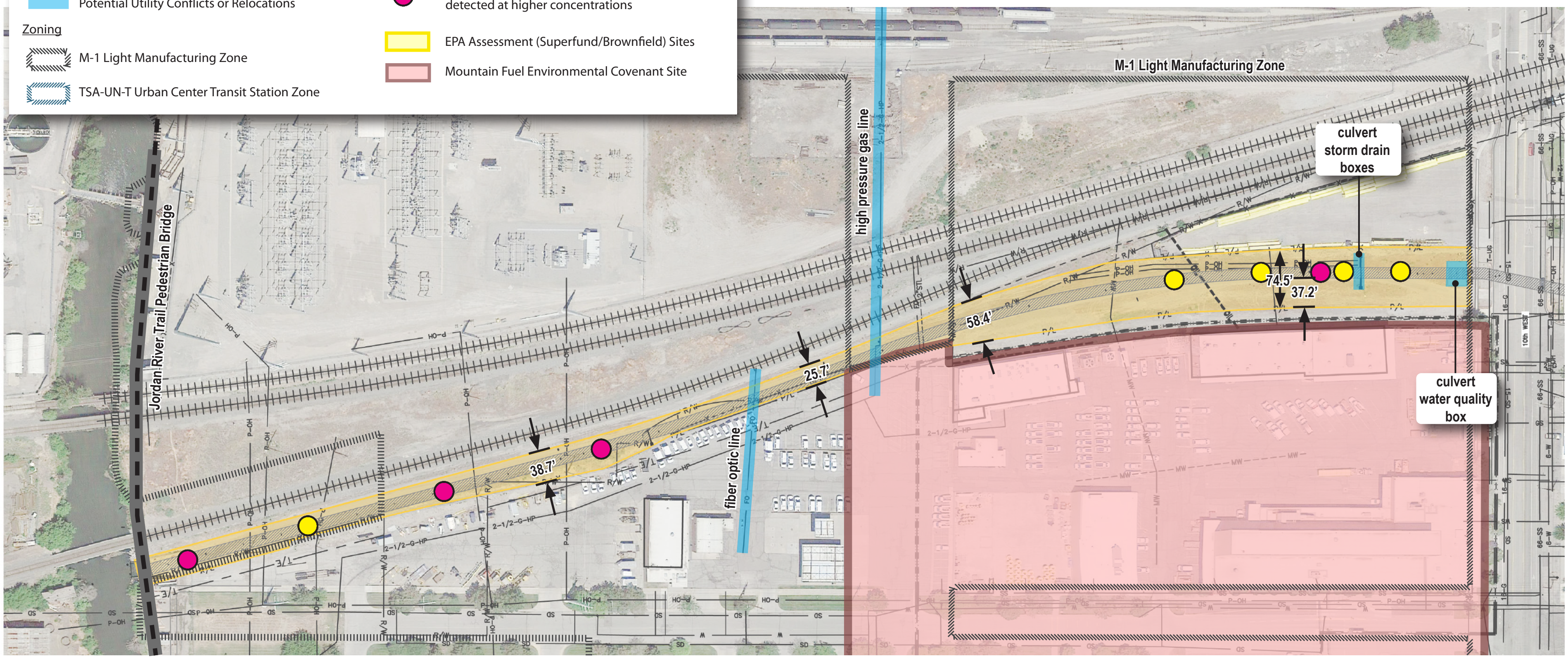
OPPORTUNITIES: *City-owned property significantly narrows in this section. That said, a smaller channel—located on the north side of the culvert—could be considered in this area.*

CONSTRAINTS: *Additional property would need to be acquired if the full creek channel were to continue to the Jordan River. With major rail lines to the north, any additional property acquired would need to be located on property to the south owned by Dominion Energy (Mountain Fuel). This area has additional utility considerations, including existing power poles.*

E 1000 WEST TO "1100 WEST"

OPPORTUNITIES: *City-owned property widths continue to taper moving west. However, there is adequate space, approximately 37' on the south side of the culvert, for daylighting the partial flow creek concept (Concept 1). There is an opportunity in this section for an educational feature.*

CONSTRAINTS: *The existing water quality structure just west of 1000 West occupies a large amount of space and may preclude major improvements, including daylighting the creek, if the detention basin/forebay is not built at 800 West. The alignment of the existing culvert also shifts to the north creating challenges for direct creek crossings (below grade) and trail crossings (at grade).*



D 900 WEST TO 1000 WEST

OPPORTUNITIES: *City-owned property widths narrow in this segment, from nearly 12-20 feet less than Segment C. Widths on the north side are large enough to provide good interaction between the trail and creek, as well as other amenities, such as seating areas or observation decks.*

CONSTRAINTS: *Existing buildings in this section are lower than the existing grade above the culvert. Adding a new channel will require careful grading and additional drainage improvements. Available width to the south of the culvert is much more constrained and will limit the amount of vegetation and preclude any amenities on the south side of the channel. Additionally, the Folsom Avenue right-of-way includes several underground utilities and other existing uses (parking for local businesses) that could impact uses on the south side of the culvert. As in Segment C, road crossings pose challenges to maintaining the gradient of the creek and require inverted siphons or something similar.*

C 800 WEST TO 900 WEST

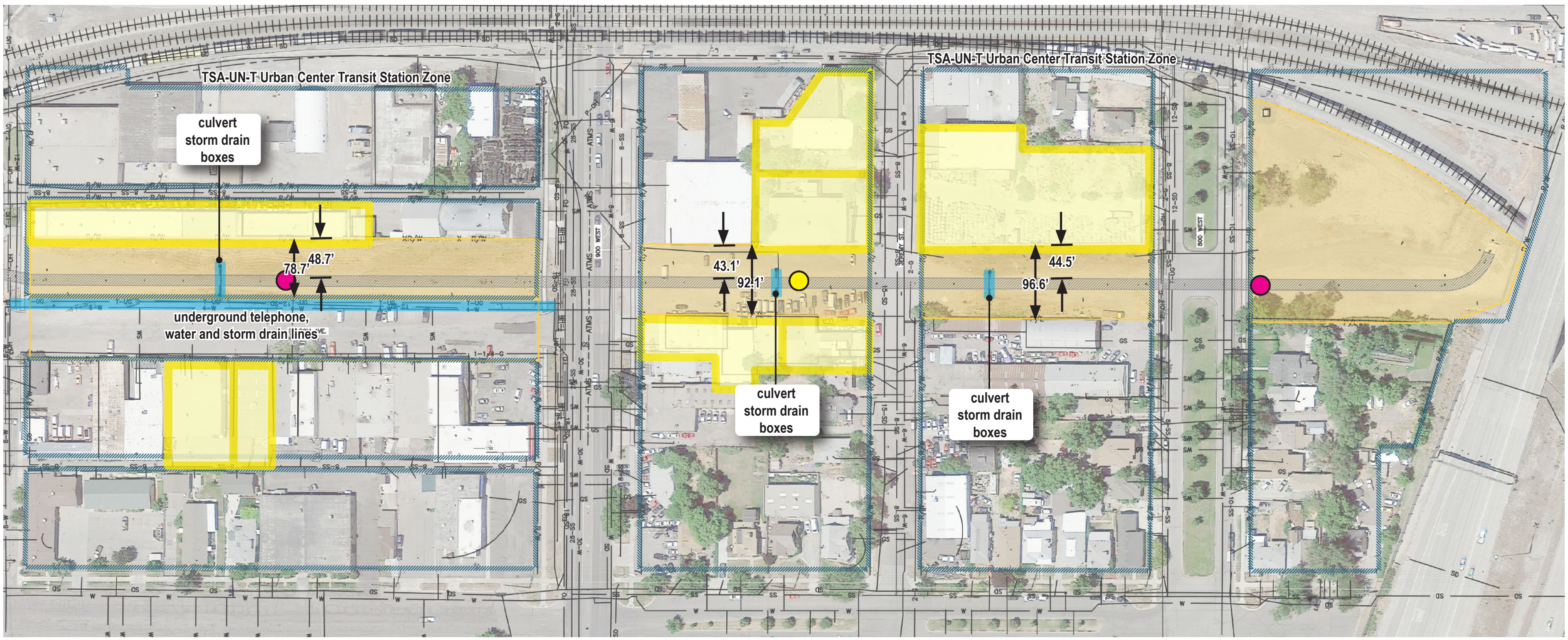
OPPORTUNITIES: *City-owned property widths are largest within this section, providing opportunities to introduce greater sinuosity to the creek, as well as interaction between the trail and creek. While the location of the existing culvert limits the location of the daylighted creek, it does provide a usable area for the Folsom Trail.*

CONSTRAINTS: *The existing culvert is centrally-located and shallow (with only 1-2 feet of cover in most cases), limiting the available area to daylight City Creek. Road crossings pose challenges to maintaining the gradient of the creek and require inverted siphons or something similar.*

B VACANT LAND NEAR 800 WEST

OPPORTUNITIES: *With the addition of a forebay, water quality in the daylighted creek could be improved. If properly designed, this area could be a valuable open/green space for the community.*

CONSTRAINTS: *Existing utilities on the site need to be avoided or relocated as part of improvements. For the partial flow creek concept (Concept 1), elevation change between the basin and the daylighted creek is insufficient, requiring the use of submersible pumps to get the creek to flow from the pond.*



4 - Conceptual Designs

Following completion of the preliminary hydrological analyses, Concepts 1 and 3 were retained with the recommendation that an option that includes acquiring land within the constricted section be explored. Concept 2 (described below) was eliminated from further consideration.

CONCEPT 1 - DAYLIGHTING PARTIAL CREEK FLOW

Three variations for *Concept 1 - Daylighting Partial Creek Flow* follow. With exact flow measurements still unknown, the initial baseflow based on available data measured at Memory Grove was applied. An estimate of potential flow situations for a range of possible slopes were investigated (see Table 4) and a "middle ground" top-width of 8 feet was applied. In order to create a substantial channel, it is recommended that maximum baseflows be used if the channel is designed. Future flow measurements and concept development will be able to determine a more precise baseflow and channel dimensions.

Versions A, B and C

Version A of Concept 1 illustrates an 8 foot wide channel from 800 West to the Jordan River. In this version, the 8 foot wide channel could terminate where existing city-owned property narrows—at approximately 1100 West—and re-enter the existing culvert or continue to the Jordan River if additional property is acquired (see concept illustration on page 28). **Version B** illustrates an alternative that fits within the existing city-owned property, where the size of the channel decreases to approximately 3 feet wide and stays on the north side of the trail west of 1000 West. Any "excess water" would re-enter the existing culvert near 1000 West. **Version C** (not illustrated), terminates daylighting at 1000 West.

CONCEPT 2 - DAYLIGHTING FULL CREEK FLOW

This concept was eliminated due to the lack of available land between approximately 1100 West and the Jordan River.

As illustrated in the Opportunity and Constraints map (page 20), even if adequate land were available, the Jordan River would regularly back up into the daylighted City Creek channel, causing the daylighted creek to take on the murky brown color of the Jordan River. This was deemed unacceptable.

Table 4. Potential Creek Dimensions for an Estimated Range of Flows and Slopes

Flow (cfs)			Slopes (ft/ft) 0.0001	0.0005	0.001	0.003
Flow (cfs)	2	Top Width (ft)	7.8	5.9	5.3	4.5
		Water Depth (ft)	1.61	1.09	0.91	0.68
	4	Top Width (ft)	10.1	7.5	6.7	5.5
		Water Depth (ft)	2.23	1.53	1.29	0.98
	6	Top Width (ft)	11.7	8.7	7.7	6.3
		Water Depth (ft)	2.69	1.86	1.57	1.2
	8	Top Width (ft)	13	9.7	8.5	7
		Water Depth (ft)	3.05	2.12	1.81	1.39
	10	Top Width (ft)	14.1	10.5	9.2	7.6
		Water Depth (ft)	3.37	2.35	2	1.54
	12	Top Width (ft)	15.1	11.2	9.9	8.1
		Water Depth (ft)	3.65	2.55	2.18	1.67
	14	Top Width (ft)	16.1	11.9	10.4	8.5
		Water Depth (ft)	3.9	2.74	2.34	1.81

Assumes a trapezoidal shape, bottom width of 2 feet, side slopes of 1:5H:1V and Manning's n of 0.05.

CONCEPT 3 - COMBINATION OF FULL AND PARTIAL CREEK FLOW

In the combined concept, the full creek flow occurs between 800 and 1000 West (Segments C and D). In order to convey the full design flow of the Folsom Drain Line (150 cfs) during a major storm event, a channel (roughly 36 feet wide and 5 feet deep) would replace the culvert. A compound channel—a channel that could be used to convey major storm events when they occur, but include a "low flow channel" to convey the baseflow on a daily basis—is applied in this concept. The low flow channel would be 8 feet wide and 1.5 to 2 feet deep, based on the same assumptions described in Concept 1, and would be the only portion of a larger channel (36 feet wide and 5 feet deep) that would convey water on a regular basis (see Section Diagrams on pages 36 and 37).

A partial creek flow would be implemented west of 1000 West (Segments E and F) where there is not adequate land available to daylight the full creek flow.

CHANNEL DESCRIPTIONS AND ILLUSTRATIONS

The following descriptions and photos illustrate preliminary channel design concepts for Concepts 1 (Versions A and B) and 3. Plan and section views of the concepts follow the descriptions.

Vegetated Channel Slopes

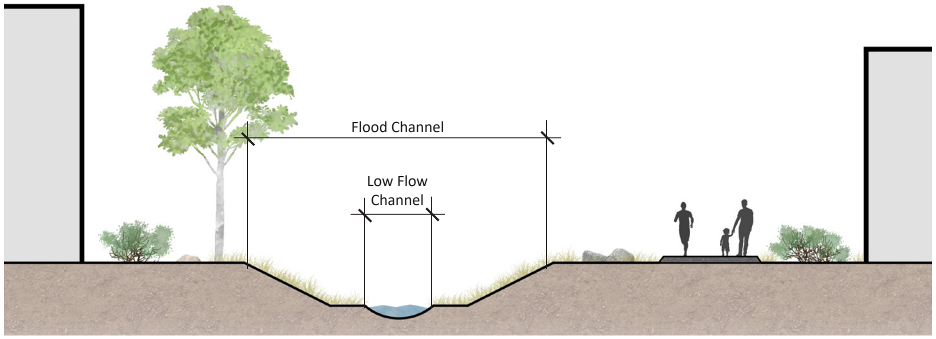
The daylighted City Creek in the Folsom Corridor is envisioned to have vegetated slopes. This sets this segment apart from the downtown/urban portions of the creek, creating a more natural, "green" space. It is assumed that in order to conserve water, the slopes will be vegetated with native grass mixtures that require less irrigation, and will generally take on a golden hue during the hot summer months.

Example of vegetated urban channel in Saint-Ouen, Paris, France (Source: https://agenceter.com/en/projets/saint-ouen-parc-de-la-zac-des-docks/)

Channel Size/Variations

Compound Channel

A compound channel, as included in Concept 2, is a larger channel that can accommodate both larger, occasional storm events as well as day-to-day baseflows. The section below illustrates a compound channel suited to handle occasional/seasonal, maximum flows—equal to the existing Folsom culvert conditions—in the flood channel, while providing a smaller low flow channel for smaller, daily flows.



While the compound channel will accommodate larger storm events, a smaller, low flow channel—as shown here—will be the only portion of the channel that will convey water most days of the year.

Mid-Sized and Narrow Creek Channels

Several upstream segments of City Creek illustrate the approximate size of channels proposed within the Concept 1. While these images illustrate non-vegetated (lined) channels, they are useful for size comparison.

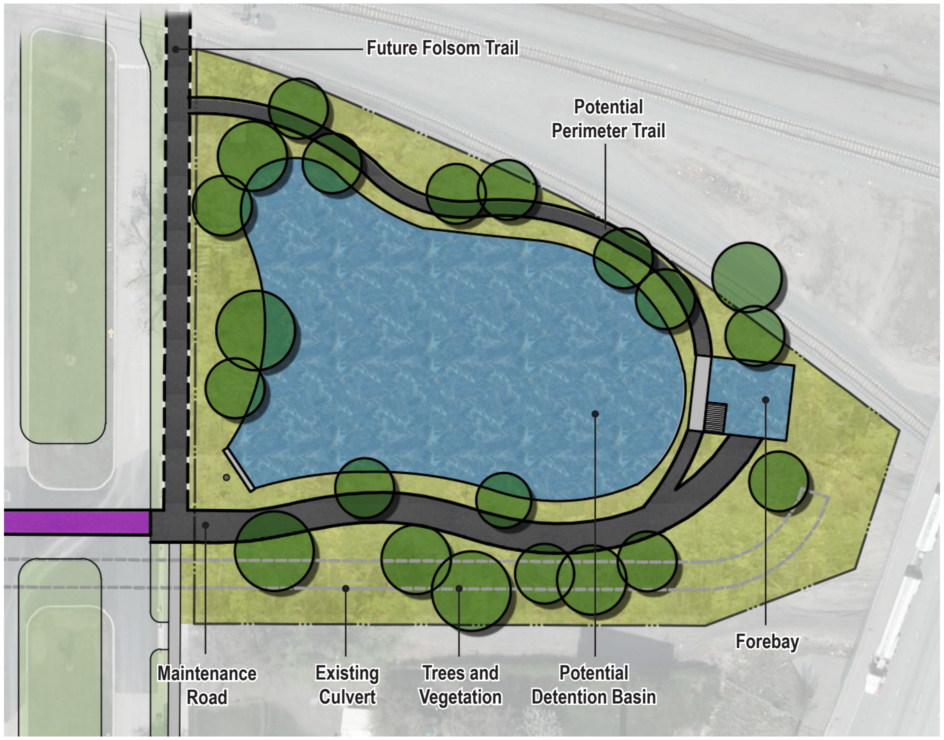
This "mid-sized" section of City Creek currently runs through Memory Grove and is similar in size to the 8' wide daylighted creek illustrated in Concept 1 (Version A).

Smaller daylighted creek channels, as envisioned west of 1000 West in Concept 1 (Version B), can be found in City Creek Center (bottom) and along North Temple in front of the LDS Church's Conference Center (top).

CONCEPT FEATURES

The following features are included in all concepts and versions. They illustrate the basic system amenities, necessary for creating a people-oriented place. Assuming the daylighted creek becomes a funded project, more detailed and refined design effort will be required, in addition to more input from surrounding residents and the community at large.

DETENTION BASIN WITH A FOREBAY AND PERIMETER TRAIL: Located east of 800 West, a detention basin with a forebay provides a functional role while also providing a neighborhood amenity. In addition to providing a maintenance road for access to the forebay, the area could also include a perimeter trail and additional vegetation to help make the area a desirable place to walk, stop, and engage.



While it is envisioned that the detention basin will have trees to provide shade, the majority of the basin is likely to be dominated by vegetation that requires less irrigation, such as native grass mixtures. (Source: https://healthylakes.org/success_stories/thorgren-basin-naturalization/)

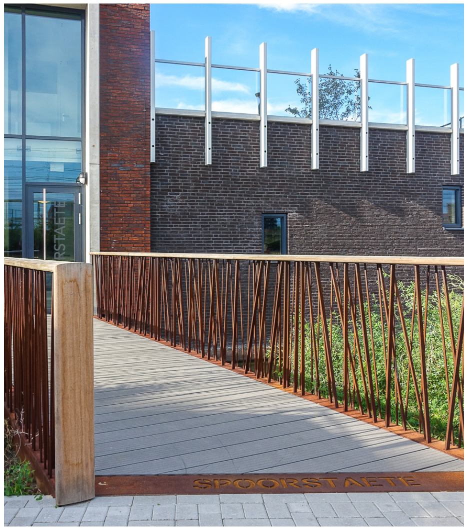
TRAIL: The Folsom Trail is a twelve foot wide multi-use trail that is planned to run from the Gateway Mall to the Jordan River, then south to the 200 South connection to the Jordan River Parkway. In Concept 1 and in portions of Concept 2, the alignment of the trail predominately follows the existing culvert, which is the primary result of a lack of substantial cover over the culvert (which makes other surface uses unsuitable). In contrast, the culvert is removed in Concept 2 and the trail located on the north side of the channel. Both the trail and creek meander slightly where possible in all concepts, creating visual interest and design variation.

It should be noted that the Folsom Trail is being designed as part of another project and is anticipated to be constructed as early as 2020. If Concept 2 is pursued, the trail will need to be removed and relocated at a future date.

TRAIL/ROAD CROSSINGS: The crossing of four streets is necessary along the designated trail route. These crossings are likely to be implemented as part of the Folsom Trail project, and will be designed accordingly.

PEDESTRIAN BRIDGES & SECONDARY PATHWAYS: Pedestrian bridges and secondary pathways allow corridor users to move back and forth between the north and south sides of the daylighted creek, facilitating activities and uses on both sides of the creek. Bridges also provide opportunities to experience varying viewpoints of the daylighted creek.

Smaller, secondary paths offer an alternative to the larger, multi-use path and connections to quieter seating areas/nodes off the main path. These potential bridges and secondary pathways would be built with the creek daylighting.

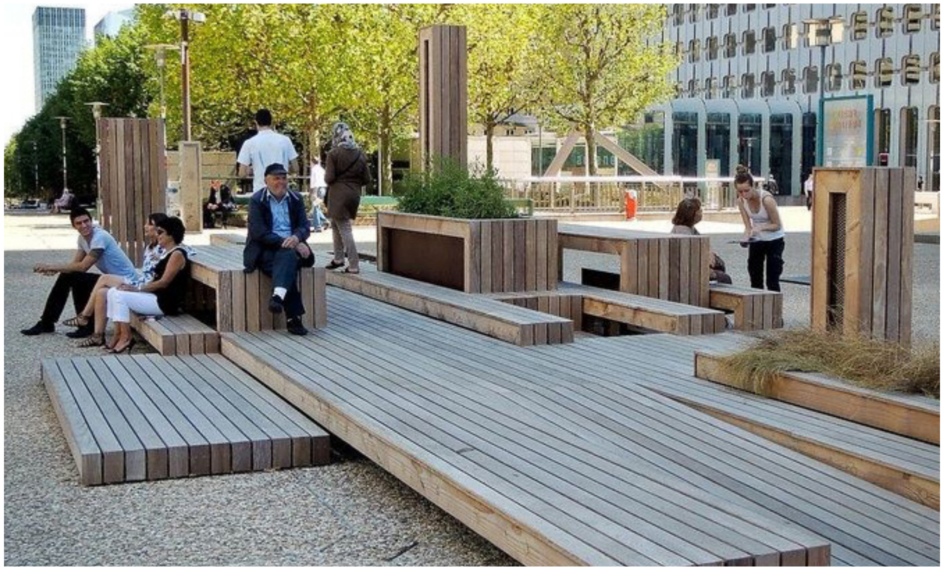


Examples of bridges and secondary paths that allow users to cross the creek and access seating and small destinations off the main path.

SEATING NODES: Seating nodes take the form of small alcoves with benches. They are located along the trail, allowing users as well as local residents to stop, rest and enjoy the daylighted creek and surroundings. It is anticipated that as vegetation matures, the nodes will also offer opportunities for users to view birds and other wildlife, and to enjoy the natural setting.

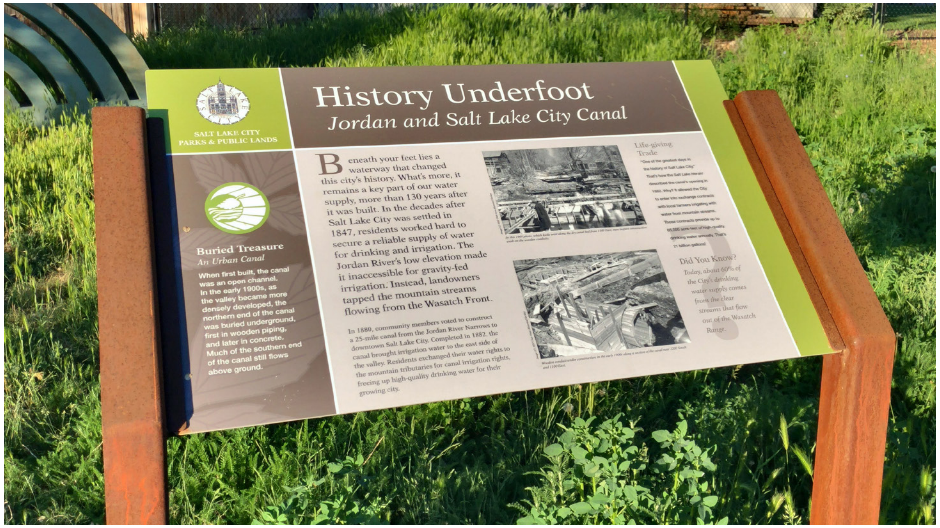
OBSERVATION DECKS (CONCEPT 1 ONLY): Observation decks provide an opportunity to get off the main path and out over the water. Several observation decks are included in the area between 800 West and 1000 West, where space is adequate.

SMALL PLAZAS WITH INTEGRATED SCULPTURAL/SEATING ELEMENTS: Small plazas with sculptural seating elements are located at key locations to signify the beginning and end of the daylighted stream. These are places for trail and area users to sit and enjoy the daylighted stream and surrounding environment. They also demarcate the beginning and end of the trail.



INTERPRETIVE & DIRECTIONAL SIGNAGE: The daylighting of a new section of a creek provides the rare opportunity to bring attention to an area's water system and its importance. Integrating interpretive signage into the project will assist telling that story and increase public awareness. It is envisioned that directional signage will also be incorporated, providing clear signals and directions to important places and intersections such as the Jordan River Trail.

LIGHTING: Proper lighting is essential for making the corridor feel safe and comfortable to the users. Light poles and fixture selection should be according to a unified lighting palette established specifically for this corridor. A corridor lighting plan should be prepared to take into account ambient lighting emanating from adjacent streetlights, buildings and properties, and preferably applying "night-sky" friendly pedestrian-scale fixtures.



CONCEPT 1 - DAYLIGHTING PARTIAL CREEK FLOW (VERSION A)

DESCRIPTION: The daylighted creek is approximately 8 feet wide and 1.5-2 feet deep. It runs on north side of trail/culvert form 800 West to 1000 West with new culvert crossings added at each intersection. The creek is conveyed beneath the existing culvert at 1000 West, resurfacing on the south side of the trail west of 1000 West, where there is adequate room for the 8 foot wide channel. Additional property would be required for the creek to continue from 1100 West to the Jordan River. The existing culvert remains in place, continuing to convey stormwater during peak storms.

OTHER KEY FEATURES:

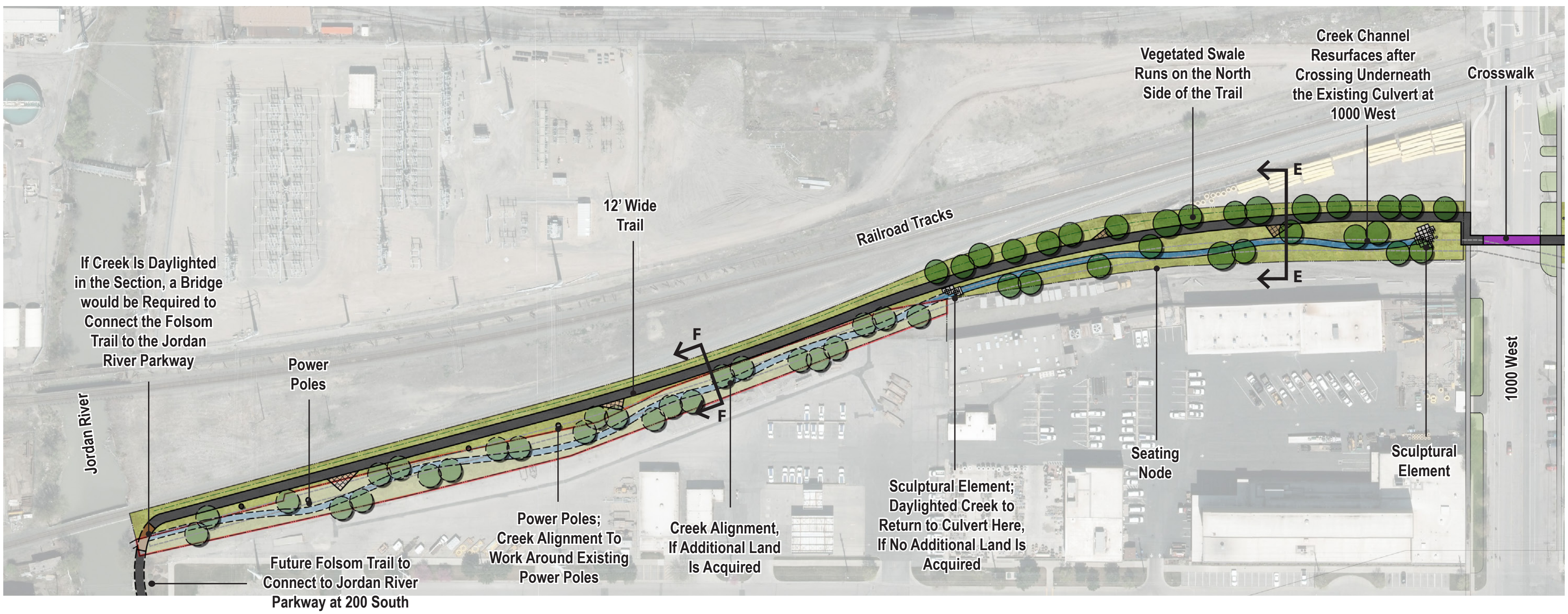
- A 12' wide trail on top of the culvert.
- Portions of the creek bulb-out to form observation decks and places to rest and view the creek up close.
- Seating nodes are distributed along the creek corridor.
- In areas where adequate room exists, such as between 800 West to 1000 West, secondary trails with bridges are incorporated as connections to nearby businesses and other potential future uses.
- Trees and vegetated areas flank both sides of the trail and creek corridor providing shade, cooling effect, visual interest and wildlife habitat.

F "1100 WEST" TO THE JORDAN RIVER

Additional property would need to be acquired if the creek were to continue to the Jordan River. The creek alignment would need to work around existing power poles.

E 1000 WEST TO "1100 WEST"

Small plazas with sculptural elements signify the beginning (and end, if additional property is not acquired) of the daylighted creek in this section.



CONCEPT 1 - DAYLIGHTING PARTIAL CREEK FLOW (VERSION A)

D

900 WEST TO 1000 WEST

*This section includes an **observation deck.** A **smaller secondary trail** crosses the creek, running along its north side, providing an alternative trailside experience. Due to the limited space and utility conflicts near Folsom Avenue, only low growing vegetation are envisioned to be planted on the south side of the trail.*

C

800 WEST TO 900 WEST

***Pedestrian bridges provide linkages to seating nodes** located on the north side of the creek. They link the north and south sides of the surrounding neighborhood. An **observation deck** provides alternative ways to interact with and view the creek.*

B

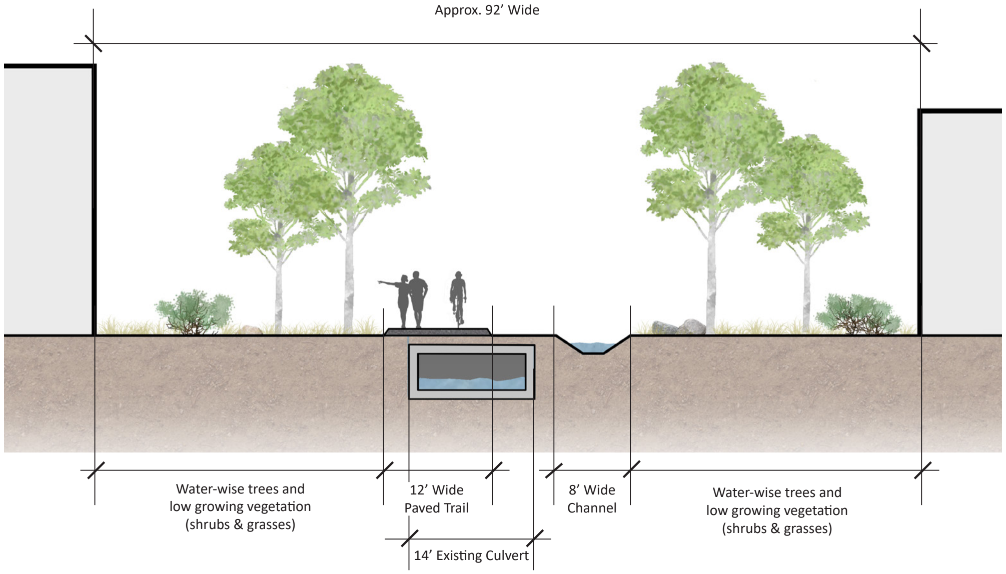
VACANT LAND NEAR 800 WEST

*While the **detention basin with forebay** serves a functional role, it also includes a **perimeter trail and additional vegetation,** transforming the utilitarian space into a desirable place to stop or stroll.*

CONCEPT 1 - DAYLIGHTING PARTIAL CREEK FLOW (VERSION A) SECTIONS

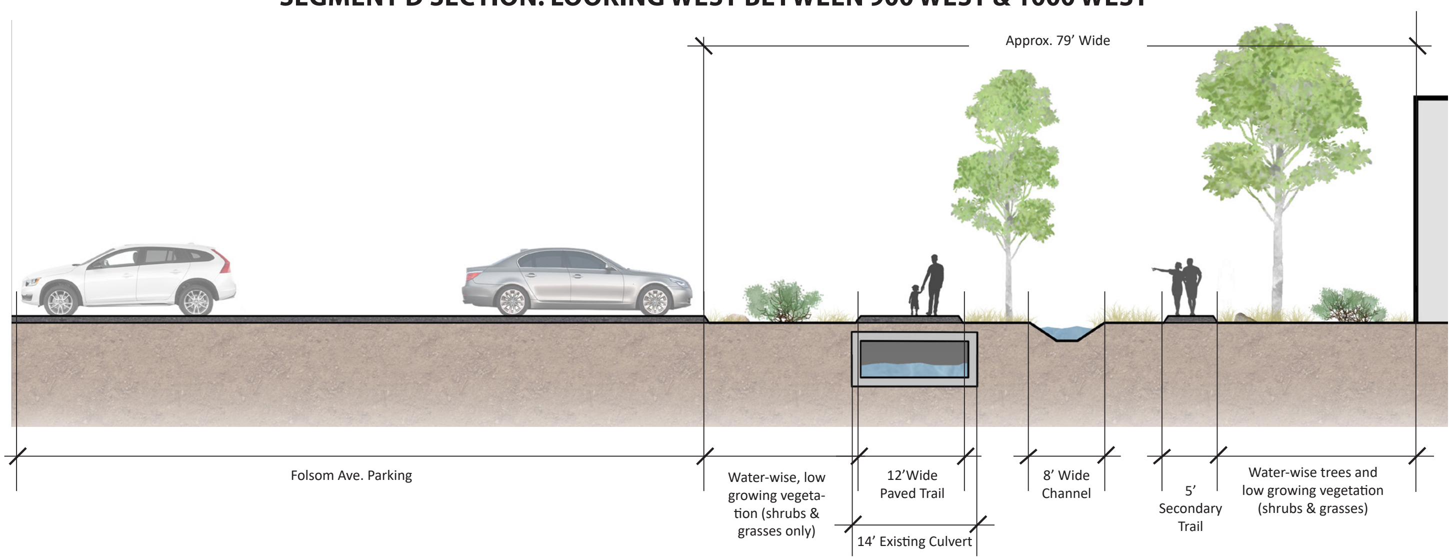
C

SEGMENT C SECTION: LOOKING WEST BETWEEN JEREMY STREET & 900 WEST



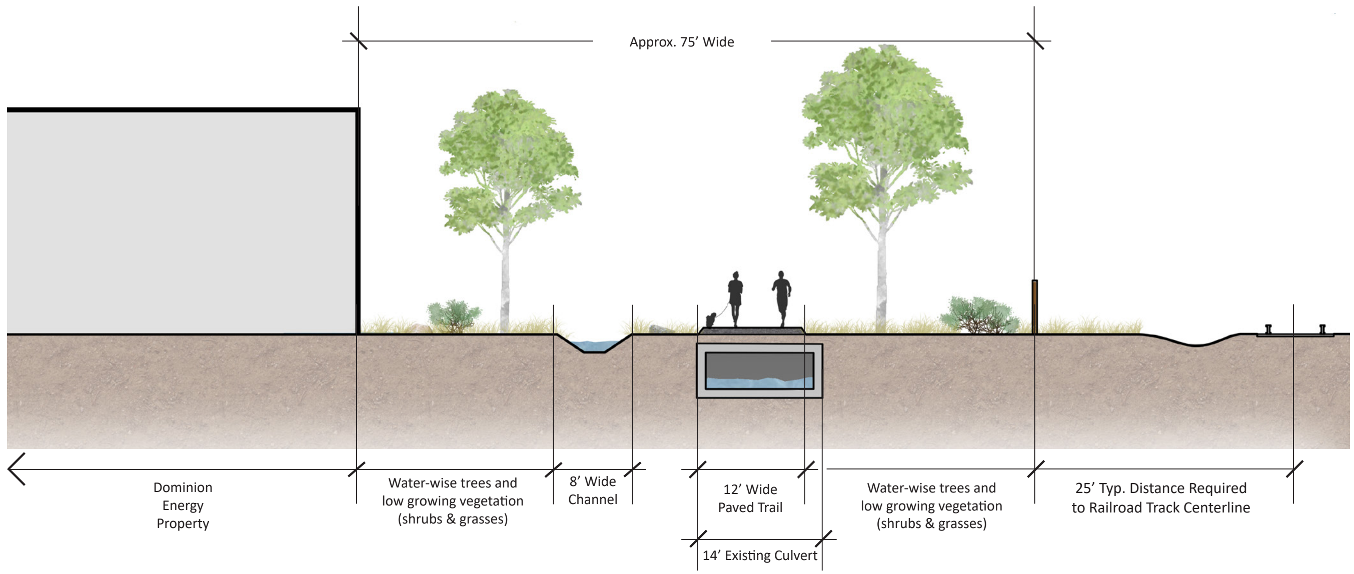
D

SEGMENT D SECTION: LOOKING WEST BETWEEN 900 WEST & 1000 WEST



E

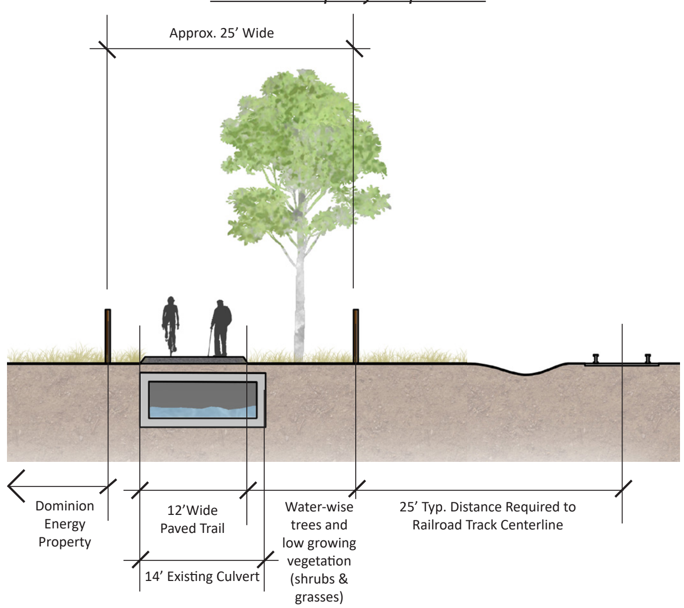
SEGMENT E SECTION: LOOKING WEST JUST WEST OF 1000 WEST



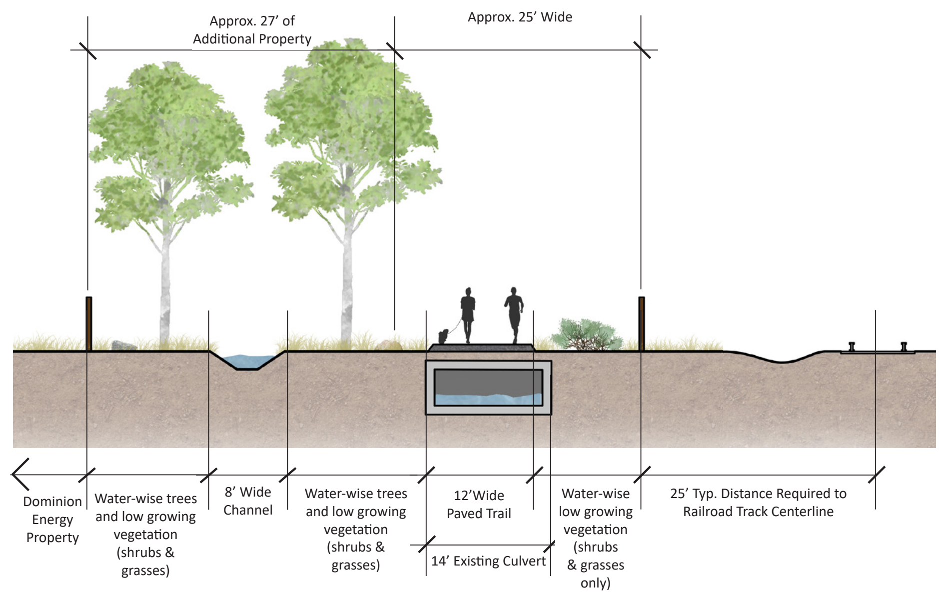
F

SEGMENT F SECTION: LOOKING WEST JUST WEST OF APPROXIMATELY "1100 WEST"

Without Property Acquisition



With Property Acquisition



CONCEPT 1 - DAYLIGHTING PARTIAL CREEK FLOW (VERSION B)

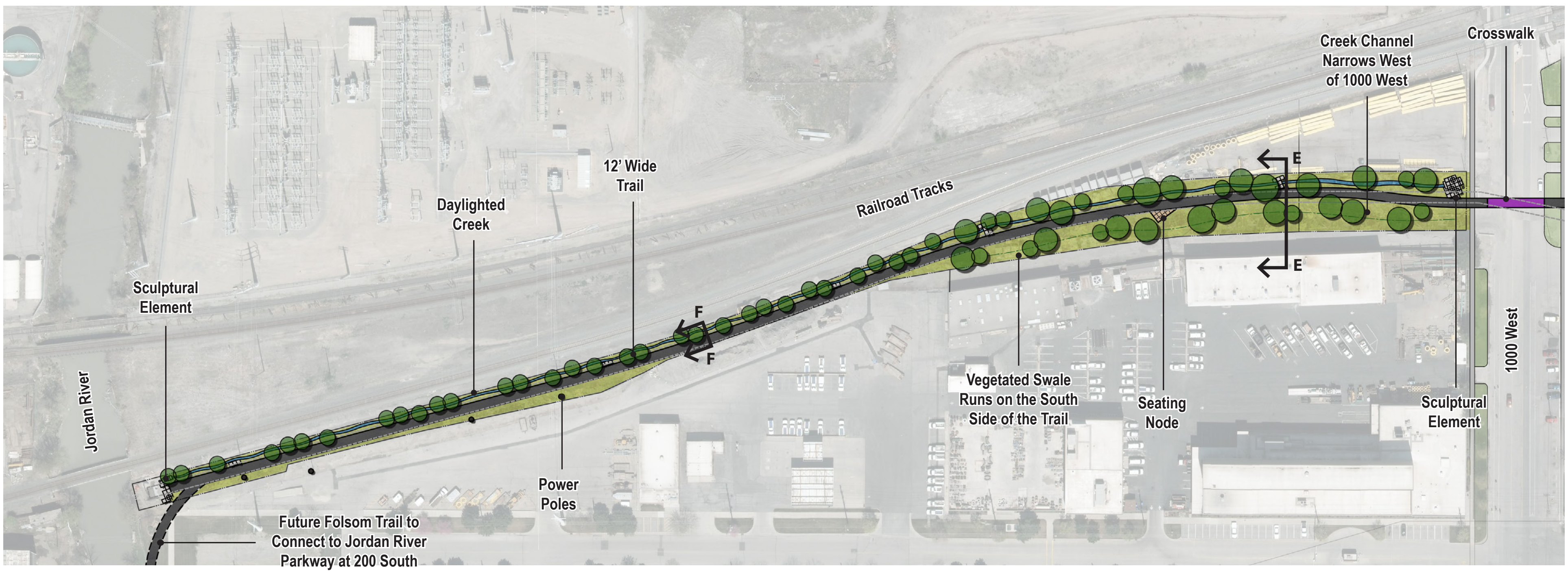
Concept 1, Version B is the same as Version A west of 1000 West, where a portion of the creek flow returns to the existing culvert and a smaller, 2 to 3 foot wide channel is implemented (to avoid acquiring additional property). The smaller channel continues along the north side of the trail until it meets the Jordan River.

F "1100 WEST" TO THE JORDAN RIVER

The smaller creek continues along the north side of the trail and terminates at a small plaza with sculptural elements, just before joining the Jordan River.

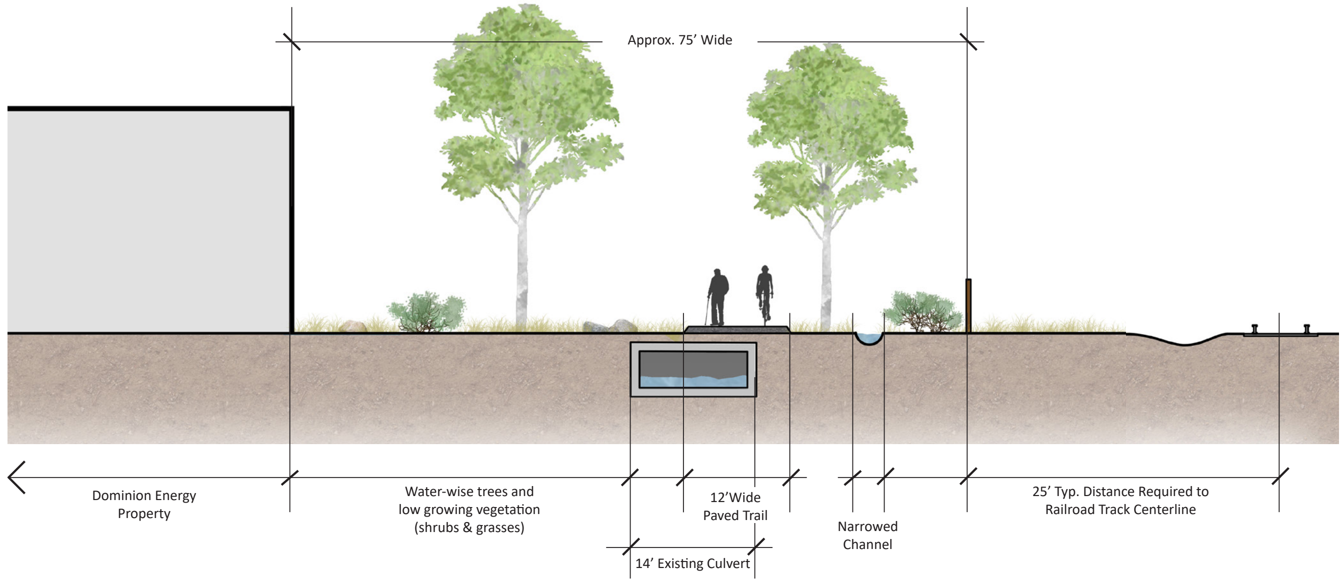
E 1000 WEST TO "1100 WEST"

A small plaza with sculptural elements signifies the beginning of a much smaller daylighted creek. The wider city-owned property allows for trees on both sides of the trail/creek corridor and seating nodes.

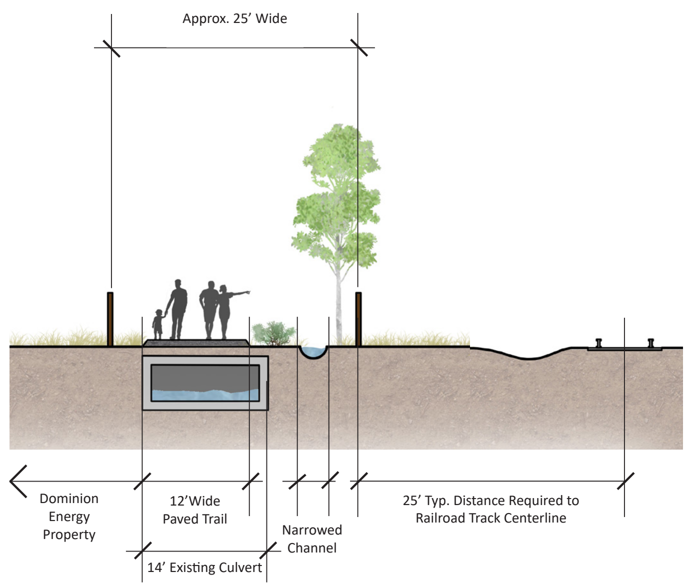


CONCEPT 1 (VERSION B) SECTIONS

SEGMENT E SECTION: LOOKING WEST JUST WEST OF 1000 WEST



SEGMENT F SECTION: LOOKING WEST JUST WEST OF APPROXIMATELY "1100 WEST"



CONCEPT 3 - COMBINATION OF FULL AND PARTIAL CREEK FLOW

From 800 West to 1000 West the daylighted creek channel is approximately 36 feet wide and 5 feet deep, with an 8 feet wide and 1.5-2 foot deep "low flow channel". The larger, compound channel will be filled with water only during peak storm events, while the low flow channel serves as the primary conveyance during the remainder of the year. Where city-owned property narrows west of 1000 West, the extra flows return back to the culvert and as illustrated, the 8 foot wide channel would resume. The creek terminates at approximately 1100 West. The new channel primarily follows the alignment of the existing culvert between 800 West and 1000 West, with the existing culvert being removed between road crossings.

OTHER KEY FEATURES:

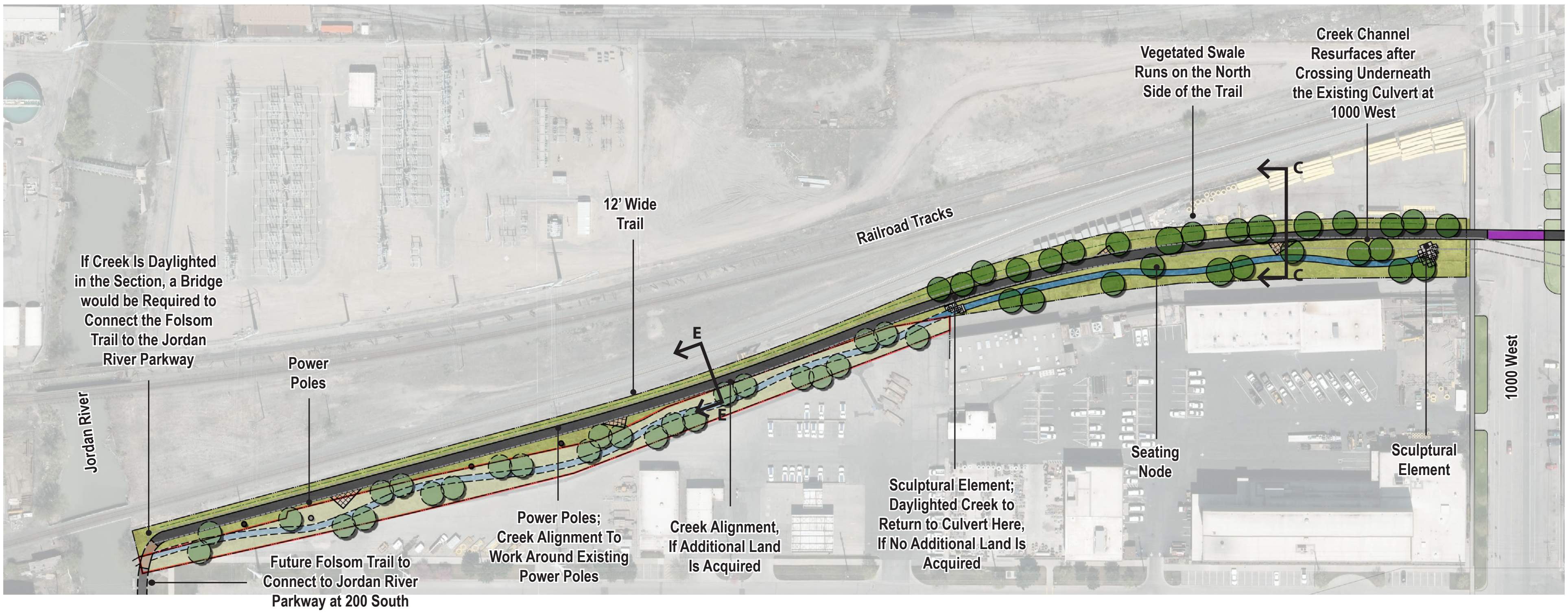
- With the culvert removed, the 12' wide trail hugs the north side of the city property, potentially requiring fencing when the trail is close to railroad tracks. (Note: The Folsom Trail, slated to be constructed in 2020, would need to be removed/ reconstructed between 800 West and 1000 West.)
- Small seating nodes are located along the length of the creek corridor with larger seating areas located on the south side of the creek where space is available.
- Bridges connect businesses or other potential future uses where there is adequate room (between 800 West to 1000 West).
- Trees and vegetated areas flank both sides of the trail and creek corridor to provide shade, a cooling effect, visual interest and wildlife habitat.

F "1100 WEST" TO THE JORDAN RIVER

Additional property must be acquired if the creek is to continue to the Jordan River. The creek alignment will need to be adjusted to accommodate existing power poles.

E 1000 WEST TO "1100 WEST"

Small plazas with sculptural elements signify the beginning (and end, if additional property is not acquired) of the daylighted creek in this section.



CONCEPT 3 - COMBINATION OF FULL AND PARTIAL CREEK FLOW

D

900 WEST TO 1000 WEST

Small seating nodes line the trail. Due to limited city-owned property and the wider creek channel, this section has no small plazas or larger seating nodes.

C

800 WEST TO 900 WEST

***Pedestrian bridges connect to seating nodes** on the south side of the creek, linking the north and south sides of the neighborhood. Small seating nodes are located on both sides of the trail.*

B

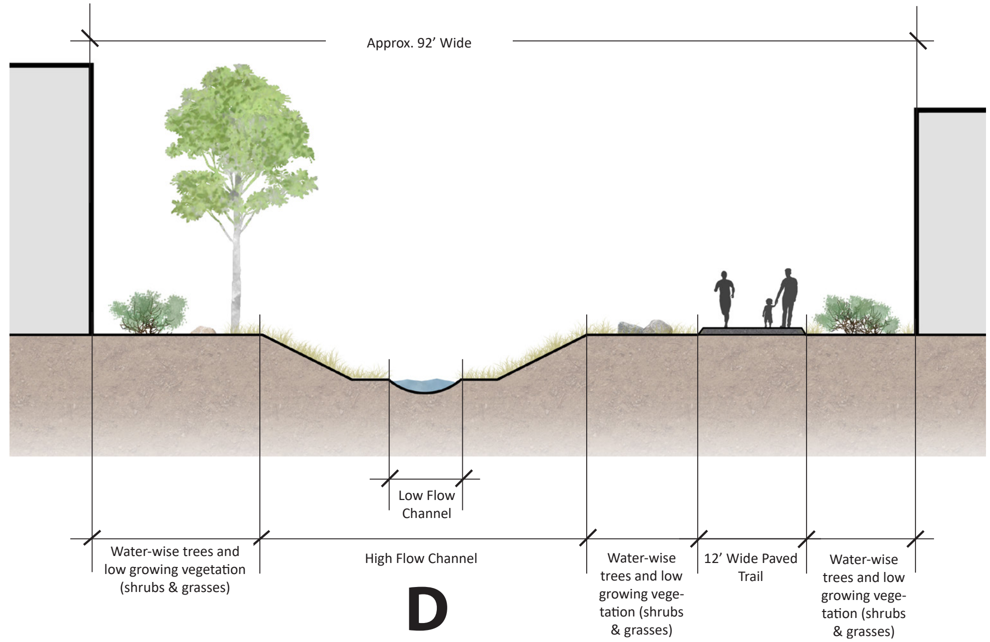
VACANT LAND NEAR 800 WEST

*While the **detention basin with forebay** serves a functional role, the area also includes a **perimeter trail and additional vegetation,** transforming the utilitarian space into a desirable place to stop or stroll.*

CONCEPT 3 - COMBINATION OF FULL AND PARTIAL CREEK FLOW SECTIONS

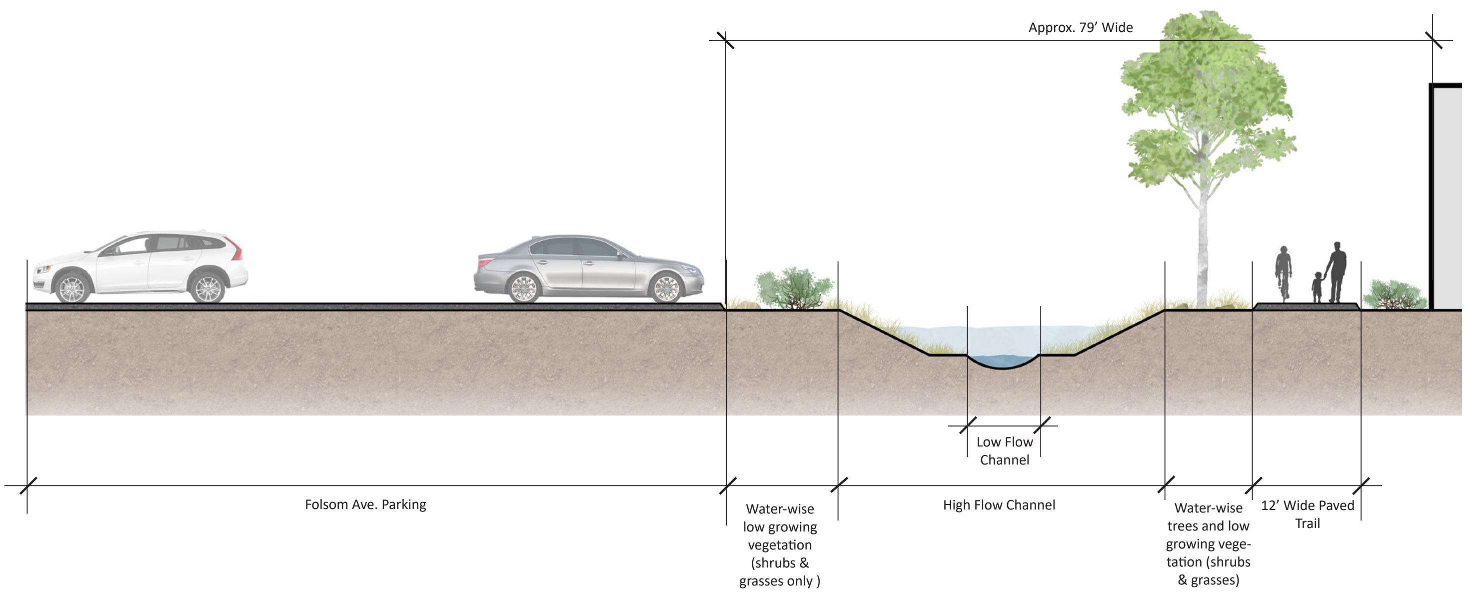
C

SEGMENT C SECTION: LOOKING WEST BETWEEN JEREMY STREET & 900 WEST



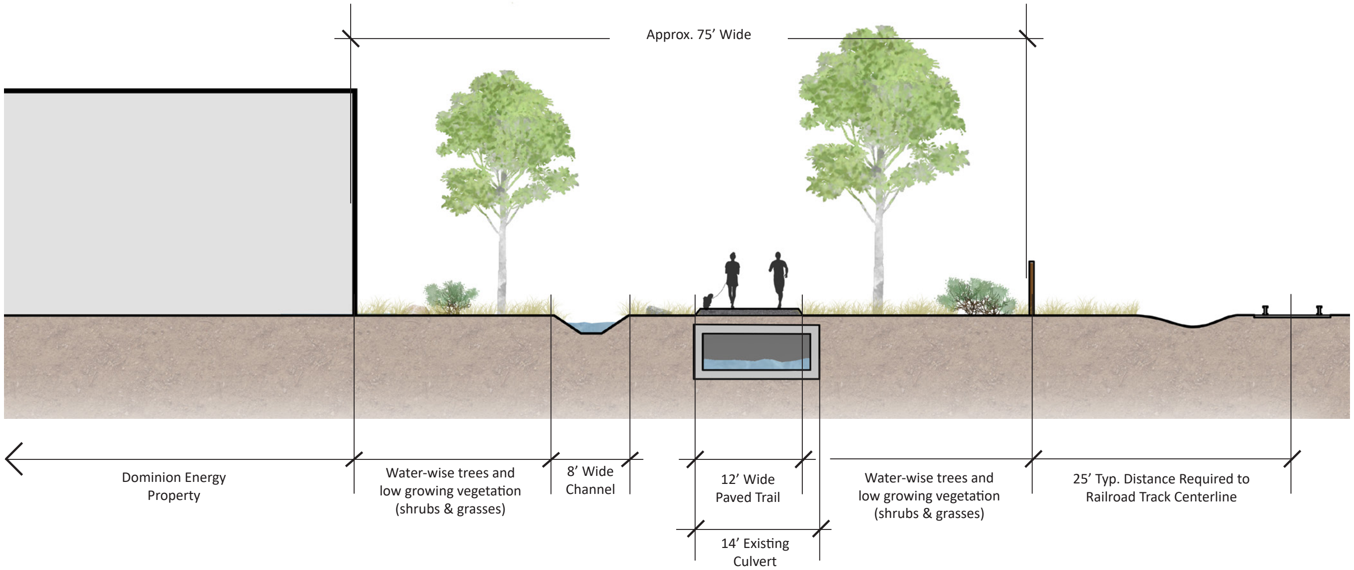
D

SEGMENT D SECTION: LOOKING WEST BETWEEN 900 WEST & 1000 WEST



E

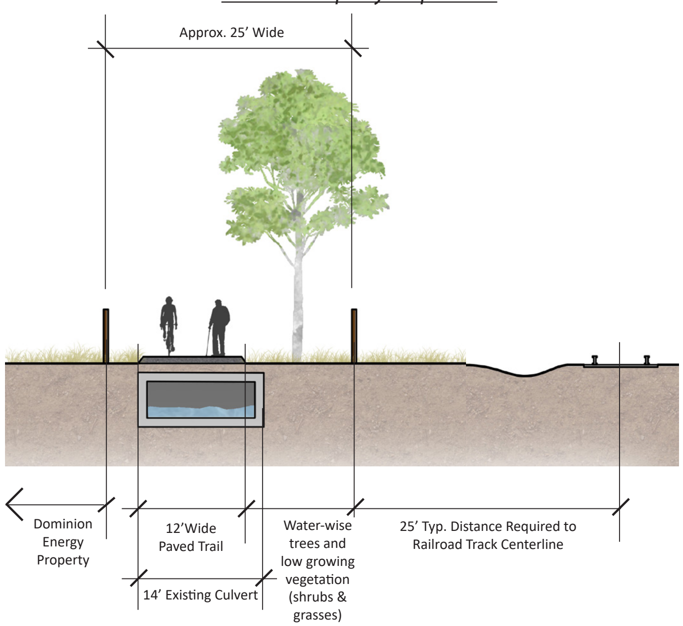
SEGMENT E SECTION: LOOKING WEST JUST WEST OF 1000 WEST



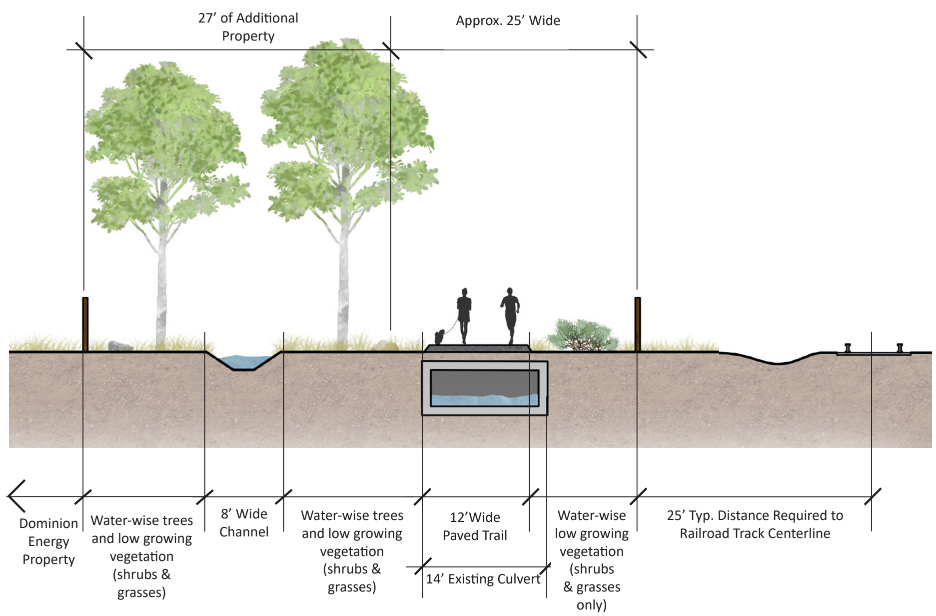
F

SEGMENT F SECTION: LOOKING WEST JUST WEST OF APPROXIMATELY "1100 WEST"

Without Property Acquisition



With Property Acquisition



Preliminary Opinion of Probable Costs

As summarized in the following table, the preliminary opinion of probable costs of the City Creek Daylighting project ranges from $1,450,000 to $2,735,500. The estimates reflect a range of creek channel widths and depths in addition to other associated improvements associated with the six concepts investigated, including the location of the channel; the infrastructure required at inlets, outlets, and beneath roadways; the extent of landscape and irrigation; and other amenities such as pedestrian bridges, secondary pathways, seating, and observation decks. The estimates were developed using information and assumptions about the project available at the time of the study and reflect the project team's understanding of probable unit rates for the labor and materials associated with construction of the creek channel.

CONCEPT 1 (VERSION A) ENDS AT "1100" WEST/NO PROPERTY ACQUISITION*	$1,957,720
CONCEPT 1 (VERSION A) WITH PROPERTY ACQUISITION	$2,443,240
CONCEPT 1 (VERSION B)	$1,762,700
CONCEPT 1 (VERSION C)	$1,450,000
CONCEPT 3 ENDS AT "1100" WEST/NO PROPERTY ACQUISITION*	$2,237,600
CONCEPT 3 WITH PROPERTY ACQUISITION	$2,735,500

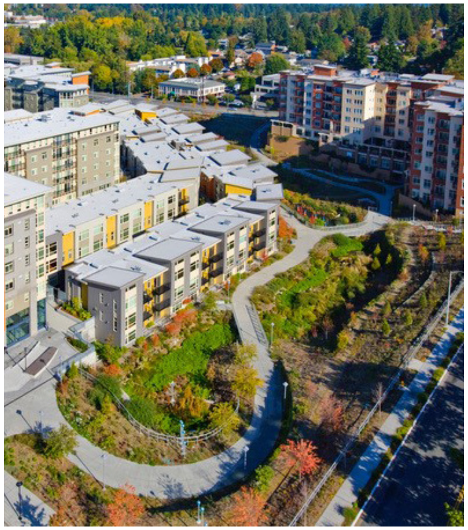
* Totals calculated elsewhere/not included.

It should be noted that:

1. The costs for the Folsom Trail and associated road crossings were not included in any of the concepts, and
2. It is assumed that all soils removed will likely be contaminated. However, since a variety of conditions and levels of contamination are possible, it is recommended that reconnaissance soil sampling be completed during the early phases of design in order to determine the extent of contamination and associated removal costs. Costs for hauloff of soil are estimated between $12/cy (clean fill for use in a site within 3 miles, assumed for Concept 1) and $39/cy (contaminated soil sent to Salt Lake County landfill, assumed for Concept 3).

It should also be noted that the actual project costs for daylighting similar projects in the United States indicate that the cost of daylighting City Creek in the Folsom Corridor could be much higher than estimated. This is supported by a 2000 study published by the Rocky Mountain Institute (RMI), that suggests using a general rule of thumb of $1,000 per linear foot of daylighted stream. Since the concepts developed for this feasibility study for a proposed daylighted City Creek Channel cover approximately 2,000 to 4,000 linear feet, the rule of thumb indicates a potential cost of approximately $2,000,000 to $4,000,000 (2000), or $3,000,000 to $6,000,000 when adjusted for inflation (2020).

As another comparison, the Thornton Creek Water Quality Channel in Seattle (illustrated below) was completed in 2009, creating a 2.7-acre natural space with a meandering channel. The total construction cost for the project was $10,700,000, or an average of $4,000,000 per acre. Although obviously a different project serving a different region, it is indicative of the potential costs that daylighting this segment of City Creek could run. Since the area proposed in the daylighted City Creek covers an area approximately 3 to 4 acres, a project similar in scope, materials and detailing would suggest a comparable cost of $12,000,000 to $16,000,000 (2009), or $14,000,000 to $19,000,000 when adjusted for inflation (2020).



Thornton Creek Water Quality Channel, Seattle, Washington

Analysis of Concepts

The following summary of the pros and cons of the final concepts has been established to help determine the best daylighting solution for City Creek through the Folsom Corridor.

	PROS	CONS
CONCEPT 1 - DAYLIGHTING PARTIAL CREEK FLOW (VERSION A)	1. Provides a creek channel that will have a fairly consistent flow for most of the year. 2. The channel allows room for attractive amenities, such as vegetated areas, observation decks, seating areas, and secondary paths. 3. Existing box culvert would not require removal. 4. Would not require alteration of the current Folsom Trail design, or removal/relocation of the future trail once constructed. 5. Volume of contaminated soils likely to be encountered/disturbed during construction is lower than the volume for the full creek flow alternatives. 6. Creek channel provides corridor with habitat for wildlife and migratory birds. 7. Creates an amenity that attracts people to the area. 8. Engages the public with educational opportunities about Salt Lake City's watersheds and ecosystems.	1. Requires property acquisition for the channel to be daylighted through the entire corridor. 2. Requires the removal of the water quality structure west of 1000 West.
CONCEPT 1 - DAYLIGHTING PARTIAL CREEK FLOW (VERSION B)	1. Requires no additional property acquisition. 2. Provides a creek channel that will have a fairly consistent flow for most of the year. 3. The channel allows room for attractive amenities, such as vegetated areas, observation decks, seating areas, and secondary paths. 4. Existing box culvert would not require removal. 5. Would not require alteration of the current Folsom Trail design, or removal/relocation of the future trail once constructed. 6. Volume of contaminated soils likely to be encountered/disturbed during construction is lower than the volume for the full creek flow alternatives. 7. Creek channel provides corridor with habitat for wildlife and migratory birds. 8. Creates an amenity that attracts people to the area. 9. Engages the public with educational opportunities about Salt Lake City's watersheds and ecosystems.	1. Existing city-owned property allows for only a very narrow creek channel west of 1000 West. 2. Requires the removal of the water quality structure west of 1000 West.

CONCEPT 2 -DAYLIGHTING FULL CREEK FLOW (150 CFS)	1. Allows existing water quality structure to remain in place 2. Utilizes the existing culvert at road crossings and no additional/new road crossings required. 3. Nutrient filtering in vegetated, compound channel provides opportunities to improve stormwater runoff water quality. 4. Channel designed for the full creek flow increases the hydraulic capacity for flood control over that provided by the static, box culvert system, improving the City's resiliency in the face of climate change uncertainty. 5. Doesn't require submersible pump to convey flow from the detention basin/pond to the creek channel west of 800 West. 6. Provides a more natural creek channel and corridor with habitat for wildlife and migratory birds. 7. Creates an amenity that attracts people to the area. 8. Engages the public with educational opportunities about Salt Lake City's watersheds and ecosystems.	1. Large areas of vegetated side slopes require on-going maintenance. 2. Will require some property acquisition if the channel is to be daylighted through the entire corridor. 3. Requires a pump to bring a portion of the creek back to the surface west of 1000 West. 4. Leaves little extra room for such amenities as observation decks and larger seating nodes due to the wider channel. 5. Flow varies substantially throughout the year, with long periods where only a small part of the channel (the low flow channel) will convey water. 6. Backwater from the Jordan River may inundate the daylighted City Creek channel during high flow events and may cause a stagnant area where the creek and river converge. 7. Requires the removal of the major portions of the recently constructed box culvert and in turn a possible relocation of the future Folsom Trail, which is designed to be located directly above the box culvert. 8. May require the removal of the water quality structure west of 1000 West. 9. Volume of contaminated soils likely to be encountered/ disturbed during construction is greater than the volume for the partial creek flow alternatives and will therefore be more costly to manage.
CONCEPT 3 -COMBINATION OF FULL/PARTIAL FLOW	Similar to Concept 2	Similar to Concept 2

5 - Recommendations & Phasing Strategy

Developing a phasing strategy and associated recommendations for implementation requires that we return to two critical questions posed in Chapter One regarding **What is a Feasibility Study**:

1. Is daylighting City Creek within the Folsom Corridor feasible?
2. Are the costs of daylighting aligned with the potential benefits that may result from daylighting City Creek within the Folsom Corridor?

Three variations of a low-flow daylighted creek were developed as **Concept 1 (Versions A, B and C)**. Two of the versions terminate the exposed waterway at 1100 West, while the third includes property acquisition, one option fitting the channel within existing city-owned property to the west, and the other terminating the exposed creek at 1000 West. **Concept 2** daylights the full creek flow, which was eliminated from further consideration due to the lack of available land between 1100 West and the Jordan River. **Concept 3** is a combination of full and partial creek flow between 800 and 1000 West, with partial creek flow further to the west.

Each variation of Concept 1 and Concept 3 were determined to be physically feasible. However, the costs range significantly, from a low of $1,450,000 for Concept 1, Version C to a high of $2,735,000 for Concept 3, which includes property acquisition. The daylighted creek that results in each option varies significantly in extent, scope and the amount of water conveyed.

When implemented properly, daylighting can restore ecosystem services, improve water quality, allow for greater flood control capacity, attenuate peak flows, and return drainage patterns to a pre-development hydrology. Salt Lake City Public Utilities generally supports daylighting and understands the tremendous value of such efforts, which are aligned with the mission of the department. For Public Utilities to support and permit this specific daylighting effort, flood control and/or water quality improvements need to be evident. In order for such determination to be made, additional documentation and analysis is required, addressing the following needs and conditions:

- Historical development of the waterway
- Hydrologic and hydraulic design criteria
- Flood control requirements and commitments
- Water quality impacts
- Right-of-way and requisite property for channel naturalization
- Required permitting
- Capital and maintenance commitments and costs

This feasibility study addresses hydrologic and hydraulic design criteria, flood control requirements, and utility conflicts associated with varying levels of daylighting of the Folsom Drain. It is necessary to study and address in greater detail the water quality impacts, right-of-way and requisite property for channel naturalization, required permitting, and maintenance commitments and costs of any proposed efforts discussed in this study.

PHASING

Regardless of the Concept that is selected, full implementation as a single and complete project should be the goal. If phasing is required, property should be acquired and the forebay and detention basin installed as a first phase, the complete channel installed as a second phase, with primary finishing features such as seating nodes, bridges, observation decks, walking paths and irrigation systems installed as a third phase. Full completion of a phased project would require a fourth and final phase, encompassing the planting of trees and vegetation and the installation of sculptural features and interpretive/wayfinding signage. Combinations of these phases are also possible and encouraged if a phased approach is selected.

References

Cirrus Ecological Solutions, LC. (2013). Jordan River Total Maximum Daily Load Water Quality Study - Phase 1. Salt Lake City: Utah Department of Environmental Quality, Division of Water Quality.

JUB Engineers, Inc. (2010?). Folsom Avenue Corridor Plan View. Salt Lake City, Utah, United States: Salt Lake City Department of Public Utilites.

JUB Engineers, Inc. (2011, January 29). City Creek Flood Control and Folsom Parkway Contaminant Area - Drawings. Salt Lake City, Utah, United States: JUB Engineers, Inc.

JUB Engineers, Inc. (2011, October). Folsom Avenue Storm Drain Salt Lake City Project No. 53470823 - Drawings. Salt Lake City, Utah, Unted States: Salt Lake City Corporation Department of Public Utilites.

King, A. R. (2012, January 31). Folsom Ave Storm Drain Results; Email to: Dana Shuler, JUB; From: Andy R. King, Terracon. Bluffdale, Utah, United States.

Lundmark, S. (2016). EPA Brownfield Assessment Grant Sites.

Michael Baker International. (2018). A Guide to Low Impact Development within Utah. Salt Lake City: Utah Department of Environmental Quality, Division of Water Quality.

Millennium Science and Engineering. (2003). Geotechnical and Landscape/Revegetation Soil Testing Report. Salt Lake City: Salt Lake City Corporation.

PacifiCorp. (2018). Semi-Annual Groundwater Monitoring Report July through December 2017 for the American Barrel Site Salt Lake City, UT.

Questar Gas Company. (2012). Environmental Covenants for the Mountain Fuel Supply Company.

SLCRDA. (2016). USEPA Assessment Sites (MAP). Salt Lake City, Utah: Redevelopment Agency of Salt Lake City.

Salt Lake City. (2016). Salt Lake City Municipal Separate Storm Sewer System (MS4) Stormwater Management Plan UPDES PERMIT NO. UTS000002. Salt Lake City.

Salt Lake City Planning Division Department of Community & Economic Development. (2010). North Temple Boulevard. alt Lake City : alt Lake City Planning Division Department of Community & Economic Development.

Salt Lake County. (2018, December 19). Public Works-Engineering Stormwater Guidance Documents. Retrieved from Salt Lake County: https://slco.org/engineering/stormwater/guidance-documents/

Salt Lake County Watershed Planning and Restoration Program. (2016). 2016 Salt Lake County Water Quality Annual Report. Salt Lake City: Salt Lake County.

Terracon Consultants, Inc. (2011). Geotechnical Engineering Report City Creek Folsom Ave Culvert. Bluffdale: Terracon Consultants, Inc.

Terracon Consultants, Inc. (2011). Limited Site Investigation Report Proposed City Creek Box Culvert Folsom Avenue Corridor. Salt Lake City: Terracon Consultants, Inc.

Terracon Consultants, I. (2016). Phase I Environmental Site Assessment: El Compadre and Mutual Engine Repair.

Terracon Consultants, Inc. (2015). Phase I Environmental Site Assessment: Swaner Properties.

Terracon Consultants, Inc. (2015). PhaseI Environmental Site Assessment Crown Plating.

Terracon Consultants, Inc. (2016). Phase I Environmental Site Assessment: Liberty Auto and L Auto Work.

Terracon Consultants, Inc. (2016). Phase I Environmental Site Assessment: Tire Express.

Terracon Consultants, Inc. (2016). Phase II Environmental Site Assessment: North Temple Brownfields Assessment: EPA Cooperative Agreement No. 96809601. Marblecast Products Facility: Hazardous Substance and Petroleum Grants for Redevelopment Agency of Salt Lake City.

Terracon Consultants, Inc. (2016). Phase II Environmental Site Assessment: North Temple Brownfields Assessment: EPA Cooperative Agreement No. 96809601 . Crown Plating Facility, 8 and 14 South Jeremy Street, Salt Lake City: Hazardous Substance Grant for Redevelopment Agency of Salt Lake City.

Terracon Consultants, Inc. (2016). Phase II Environmental Site Assessment: North Temple Brownfields Assessment: EPA Cooperative Agreement No. 96809601 . Crown Plating Facility, 8 and 14 South Jeremy Street, Salt Lake City: Hazardous Substance Grant for Redevelopment Agency of Salt Lake City.

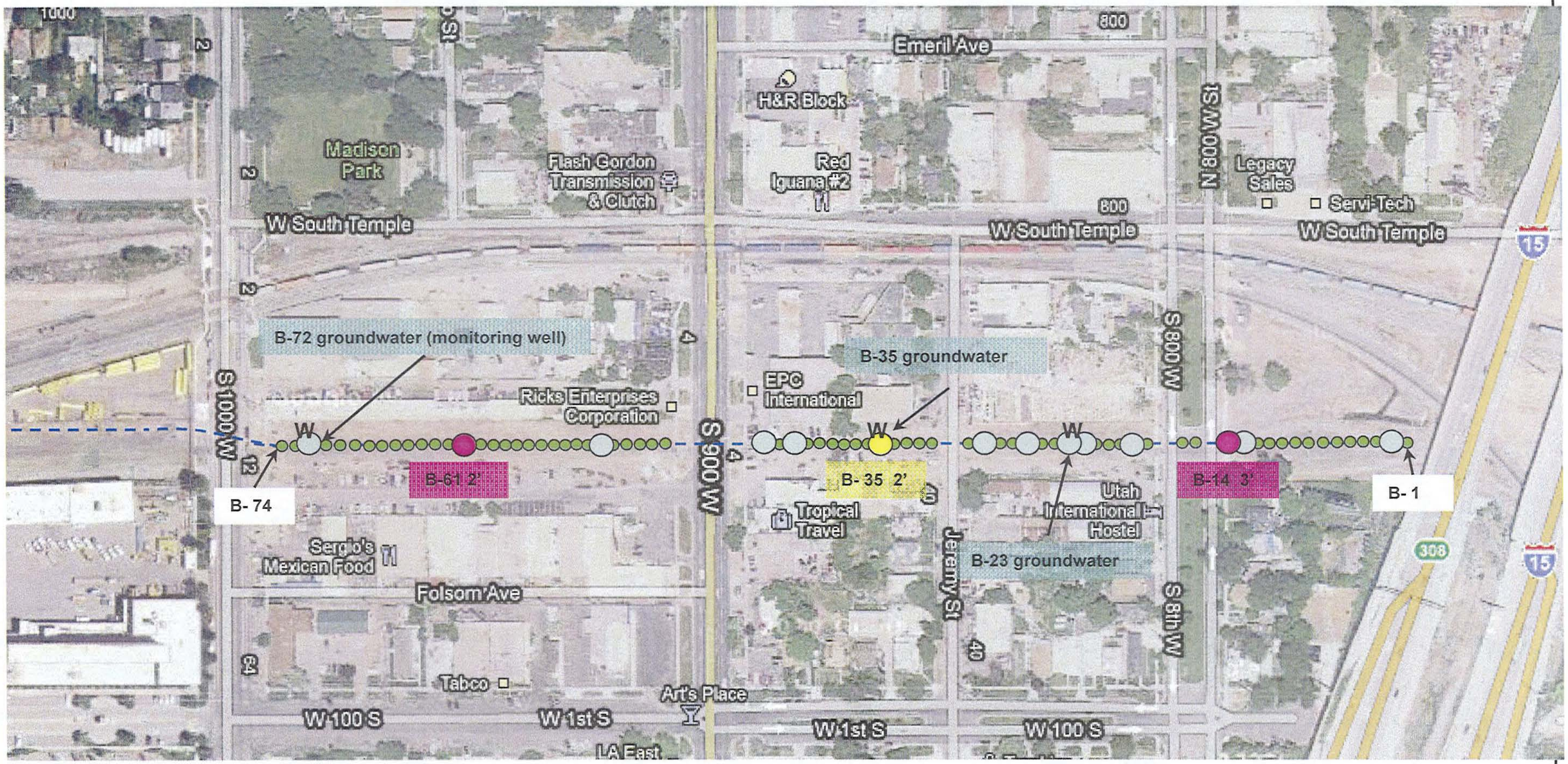
Terracon Consultants, Inc. (2016). Phase II Environmental Site Assessment:

Swaner Properties.
URS. (2006). City Creek Daylighting Public Outreach Element Euclid Small Area Master Plan. Salt Lake City: Salt Lake City.
USEPA Region 8. (2016). Fourth Five-Year Review Report for Utah Power and Light-American Barrel Superfund Site Salt Lake City, Utah.
Utah Administrative Code. (2018, November 1). Utah Administrative Code Rule R317-2. Standards of Quality for Waters of the State. Retrieved from Utah Office of Administrative Rules: https://rules.utah.gov/publicat/code/r317/r317-002.htm#T8
Utah Department of Environmental Quality, Division of Water Quality. (2016). 2016 Final Integrated Report Chapter 3: Rivers and Steam Assessments. Salt Lake City: Utah Department of Environmental Quality, Division of Water Quality.
Utah DEQ. (2019, May 2). Utah Department of Environmental Quality Division of Water Quality. Retrieved from Storm Water Permits: : https://deq.utah.gov/water-quality/storm-water-permits-updes-permits
WilburSmith Associates. (2010, April 26). Airport Light Rall Transit Project 100$ City Creek/Folsom Diversion Submittal - Drawings. Salt Lake City, Utah, United States: Utah Transit Authority.

Appendix A: Environmental Data & Figures

INCLUDES:

- ***TERRACON REPORT SOIL FIGURES***
- ***EPA ASSESSMENT SITES (SLCRDA)***
- ***MOUNTAIN FUEL ENVIRONMENTAL COVENANT SITE MAP***
- ***MONITORING WELL LOCATIONS (MILLENNIUM SCIENCE AND ENGINEERING, 2003)***
- ***WATER QUALITY DATA (SLCDPU)***



Borings along Folsom Avenue corridor; no PAH constituents detected. Series runs from B-1 (east, near I-15) to B-74 (west, near 1000 West)

One or more PAH constituents or TPH-Oil & Grease detected at low concentrations (below U.S. EPA Regional Screening Levels (residential) or Utah DEQ-DERR Initial Screening Level)

One or more PAH constituents detected at moderate concentrations [above U.S. EPA Regional Screening Levels (residential) but below U.S. EPA Regional Screening Levels (industrial)]. Sample name included for reference.

One or more PAH constituents detected at higher concentrations [(above U.S. EPA Regional Screening Levels (industrial)]. Sample names included for reference.

W Groundwater Sample Location

B-23 groundwater

N

0 (approx.) 300 feet

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

Project Mngr:	ARK	Project No.	61107142
Drawn By:	ARK	Task No.	ENV
Checked By:	BBB	Scale:	As Shown
Approved By:	BBB	Date:	06/27/2011

Terracon
Consulting Engineers & Scientists
14850 Pony Express Road, Ste 150N
Bluffdale, Utah 84065

Borings B-1 through B-74, Overview of Boring Locations and PAH Results for Soils

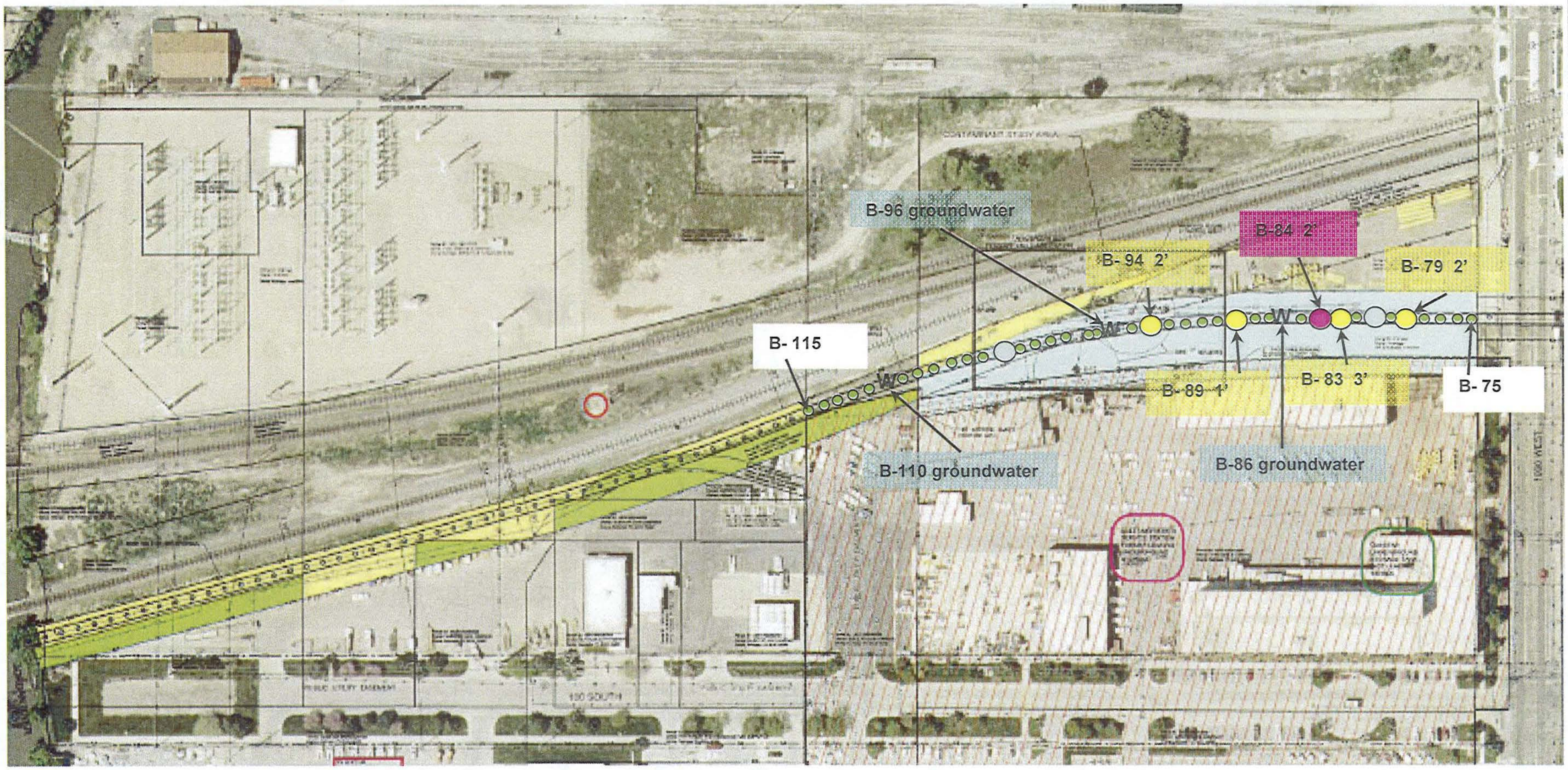
Proposed City Creek Box Culvert

Folsom Avenue Corridor

J-U-B Engineers, Inc.

FIGURE

2



- Borings north of Questar Property; no PAH constituents detected. Series runs from B-75 (east, near 1000 West) to B-115 (west, near 1100 West)
- One or more PAH constituents or TPH-Oil & Grease detected at low concentrations (below U.S. EPA Regional Screening Levels (residential) or Utah DEQ-DERR Initial Screening Level)
- One or more PAH constituents detected at moderate concentrations [above U.S. EPA Regional Screening Levels (residential) but below U.S. EPA Regional Screening Levels (industrial)]. Sample names included for reference.
- One or more PAH constituents detected at higher concentrations [(above U.S. EPA Regional Screening Levels (industrial)]. Sample name included for reference.

W Groundwater Sample Location

B-23 groundwater

N

0 (approx.) 300 feet

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

Project Mngr:	ARK	Project No.	61107142
Drawn By:	ARK	Task No.	ENV
Checked By:	BBB	Scale:	As Shown
Approved By:	BBB	Date:	06/27/2011

Terracon
Consulting Engineers & Scientists
14850 Pony Express Road, Ste 150N
Bluffdale, Utah 84065

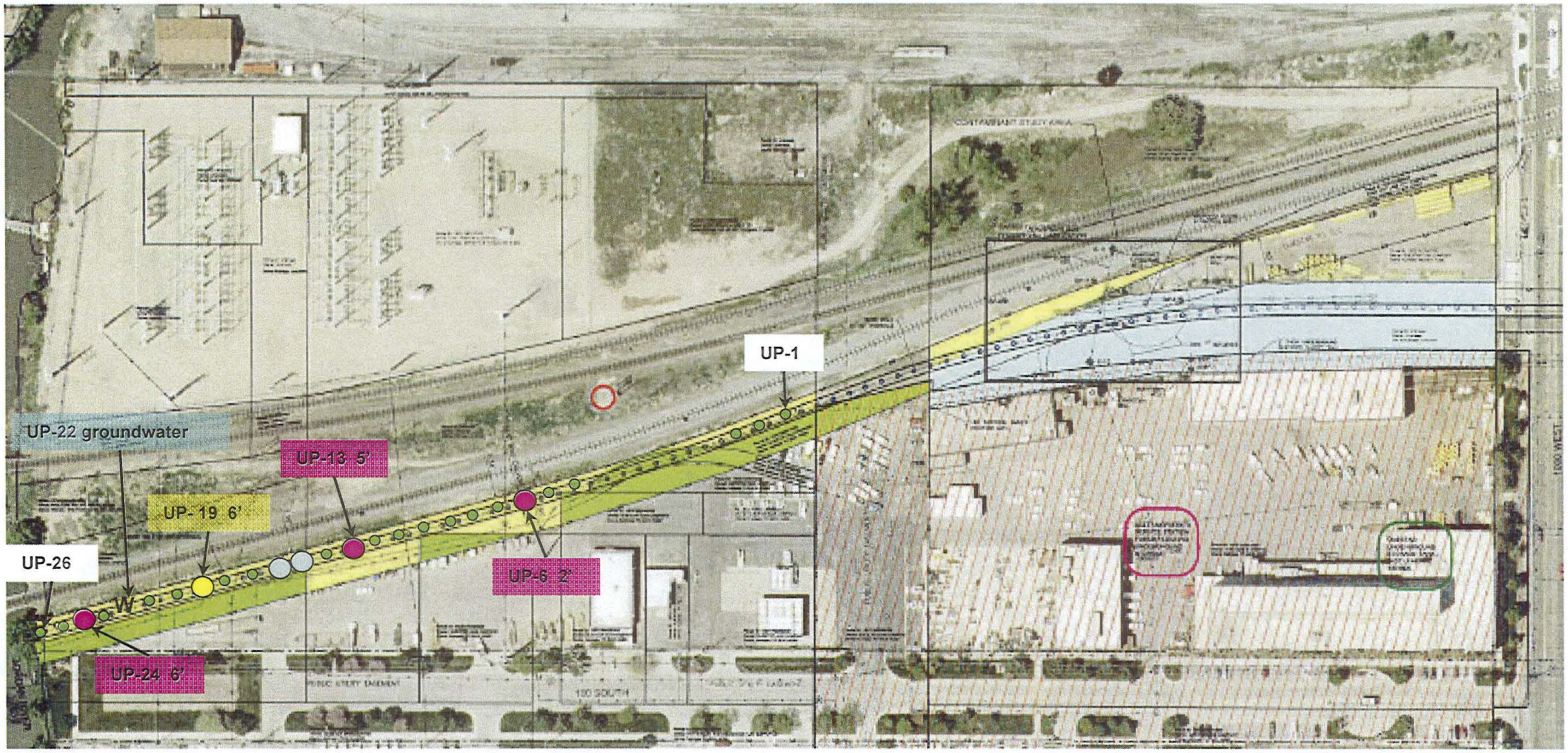
Borings B-75 through B-115, Overview of Boring Locations and PAH Results for Soils

Proposed City Creek Box Culvert

Folsom Avenue Corridor

J-U-B Engineers, Inc.

FIGURE 3



- Borings on UPRR Property ; no PAH constituents detected. Series runs from UP-1 (east, near 1100 West) to UP-26 (west, near Jordan River)
- One or more PAH constituents or TPH-Oil & Grease detected at low concentrations (below U.S. EPA Regional Screening Levels (residential) or Utah DEQ-DERR Initial Screening Level)
- One or more PAH constituents detected at moderate concentrations [above U.S. EPA Regional Screening Levels (residential) but below U.S. EPA Regional Screening Levels (industrial)]. Sample name included for reference.
- One or more PAH constituents detected at higher concentrations [(above U.S. EPA Regional Screening Levels (industrial)]. Sample names included for reference.

W Groundwater Sample Location

B-23 groundwater

N

0 (approx.) 300 feet

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

Project Mngr:	ARK	Project No.	61107142
Drawn By:	ARK	Task No.	ENV
Checked By:	BBB	Scale:	As Shown
Approved By:	BBB	Date:	06/27/2011

Terracon
Consulting Engineers & Scientists
14850 Pony Express Road, Ste 150N
Bluffdale, Utah 84065

Borings UP-1 through UP-26, Overview of Boring Locations and PAH Results for Soils

Proposed City Creek Box Culvert

Folsom Avenue Corridor

J-U-B Engineers, Inc.

FIGURE 4

EPA Assesment Sites

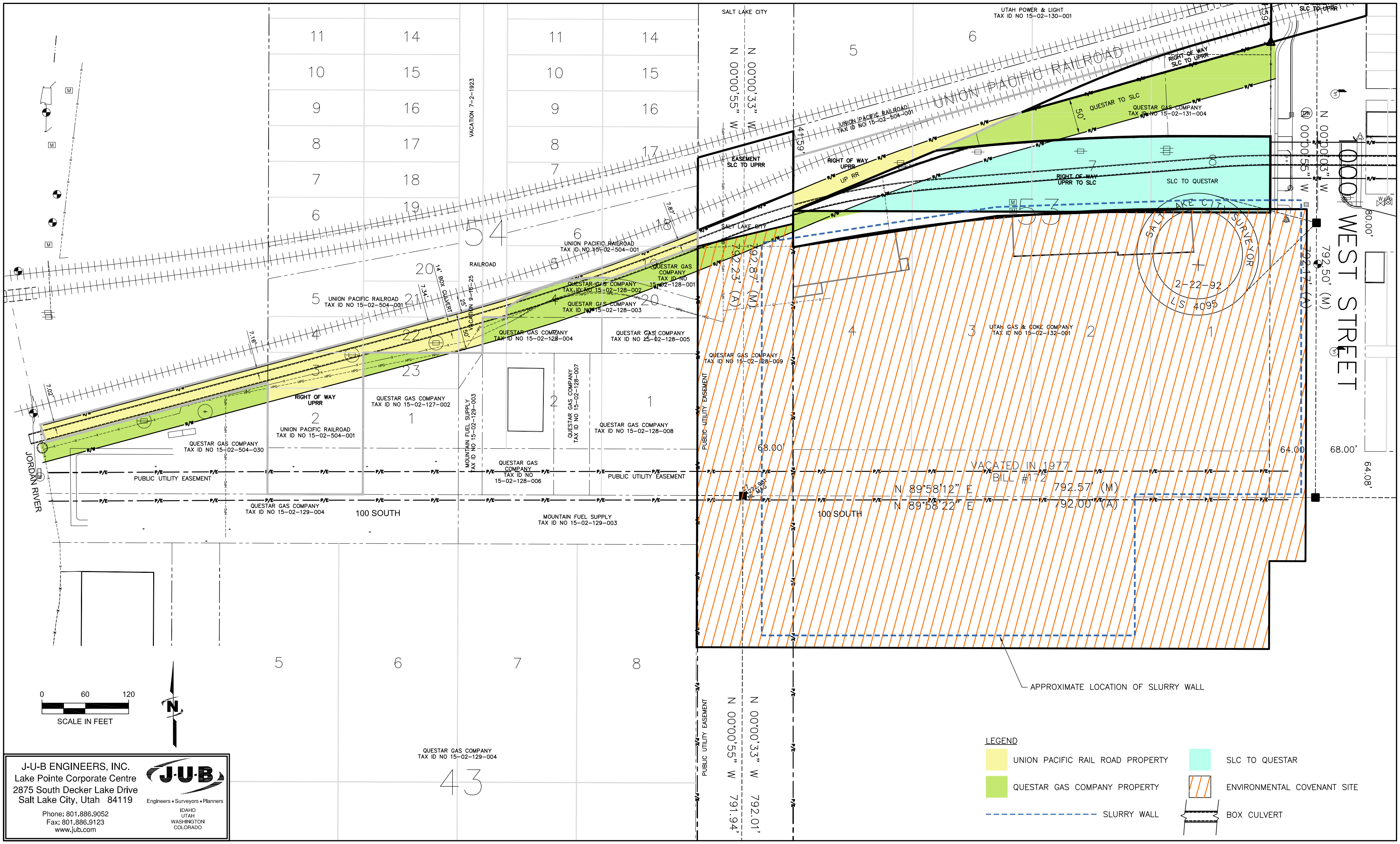
North Temple Project Area

General Results:

1. Low to moderate impacts of hexavalent chromium and cyanide in soils, and TCE in groundwater.
2. Low to moderate impacts of lead in soil, and PCE and TCE in groundwater.
3. Low to moderate impacts of hexavalent chromium in soil, and hexavalent chromium and TCE in groundwater.
4. Minor impacts of oil & grease in shallow soil.
5. Minor impacts of lead and oil & grease in shallow soil.
6. No Recognized Environmental Conditions found - sampling not required.
7. No Recognized Environmental Conditions found - sampling not required.
8. No Recognized Environmental Conditions found - sampling not required.

SLCRDA

Site #	Site Name	Address
1	Crown Plating Facility	8 South Jeremy St
2	Heritage Forge	15 South Jeremy St
3	Schovaers Electronic Facility	22 South Jeremy St
8	Liberty Auto & Auto Work	42 South Jeremy St
5	Marblecast Products	947 W Folsom Ave
4	Swaner Properties	957 W Folsom Ave
7	El Compadre and Mutual Engine Repair	35 South 900 West
6	Tire Express	25 South 1000 West



SALT LAKE CITY CORPORATION
DEPARTMENT of PUBLIC UTILITIES
1530 SOUTH WEST TEMPLE
SALT LAKE CITY, UTAH 84115

PRESENTED TO THE MAYOR OF SALT LAKE CITY AND APPROVED THIS ____ DAY OF ____ 20__
CITY RECORDER

APPROVALS
DATE ____ CITY ENGINEER
DATE ____ FIRE MARSHALL

CITY CREEK FLOOD CONTROL AND FOLSOM PARKWAY PROPERTY MAP

REVISIONS
NUMBER | AUTHORIZED BY | MADE BY | DATE

DESIGNED BY: XXX
DRAWN BY: XXX
CHECKED BY: XXX
DATE: OCT 2010
SCALE – HORIZ: VERT:
EWO NUMBER: XXXX
ACCOUNT: XXXXXX
SHEET 1 OF 1 SHEETS

MONITORING WELL LOCATIONS
MILLENNIUM SCIENCE AND ENGINEERING (2003)

APPENDIX 1
Summary of Survey Results
(all measurements in feet)

LOCATION ID	NORTHING [1]	EASTING [1]	GPS ELEV. [2]	DIFF. ELEV [3]	WATER LEVEL [4]
Wells					
B-1	887079.054	1887824.358		4243.378	15.76
B-2	887504.309	1887617.729		4240.096	15.09
AB-3	887647.976	1887650.648		4240.279	15.05
AB-4	887712.331	1887431.852		4240.047	18.12
BT-5	887477.152	1883601.347		4223.566	11.3
BT-6	887415.765	1883416.220		4222.939	10.15
UPL-7	887152.741	1882198.452		4226.56	11.5
UPL-8	887154.648	1882166.657		4220.892	5.85
MMW2	887034.577	1882393.750		4224.018	9.85
MPZ1	887294.876	1883765.356		4219.513	7.33
MMW1	887276.836	1885578.028		4222.37	9.85
Soil Samples					
MGP3	887271.468	1886973.539	4229.746		
MSS1	887435.154	1886552.729	4226.865		
MSS2	887252.134	1886447.368	4227.331		
MGP2	887317.466	1886114.57	4225.820		
MSS3	887225.44	1884986.100	none		
MGP1	887212.232	1884557.663	4220.510		
MSS4	887294.648	1884386.321	4219.416		
MSS5	887138.766	1882807.698	4220.330		

Notes:

[1] = Referenced to the National Adjustment Datum (NAD) 1927

[2] = Referenced to the National Geodetic Vertical Datum (NGVD) 1927

[3] = Differential Level Measurement

[4] = Measured with Heron Instruments "dipper-T" water level meter

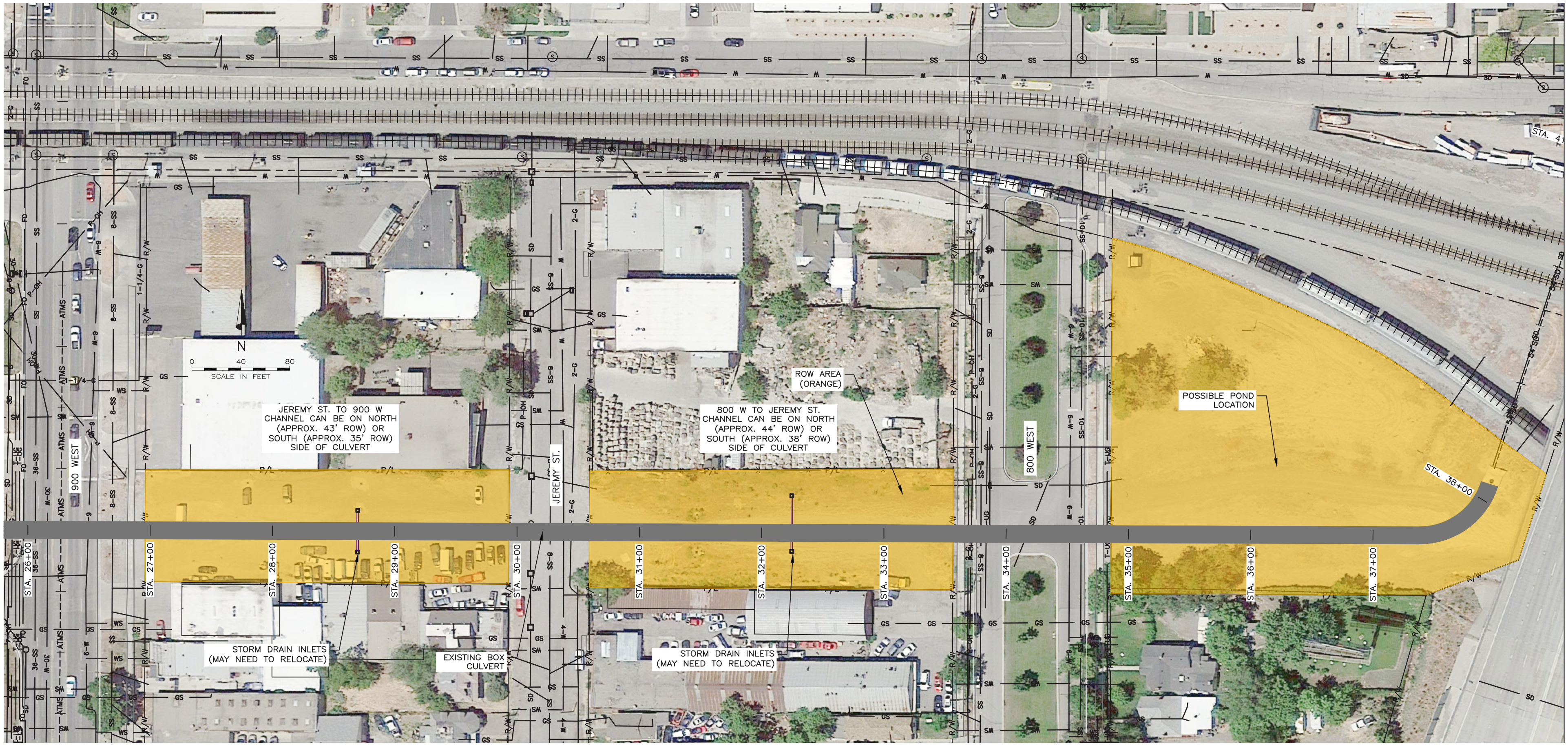
Class 2B designated use standards and water quality data collected by Salt Lake City along with discharge, May 2, and August 8, 2019.

		SALT LAKE CITY SAMPLES	
Parameter, Units	**Class 2B Standard**	**5/2/2019**	**8/8/2019**
Discharge (cfs)	N/A	45	9.65
Turbidity (NTU)	10	200	0.47
Nitrate as N (mg/L)	N/A	ND	2.3
Coliform, Total (Org/100 mL)	N/A	Not measured	>2400
E. Coli (Org/100 mL)	206/668*	10	101
Total Suspended Solids (TSS, mg/L)	N/A	261	ND
pH	6.5-9.0	8.1	Not measured
Ammonia as N (mg/L)	N/A	Not measured	ND
Phosphorus, Total as P (mg/L)	N/A	0.1	0.03
Biochemical Oxygen Demand (BOD) (mg/L)	5	ND	ND

*30 day Geometric mean/maximum
N/A- not applicable
ND – not detected

Appendix B: Utility Locations

Utility Locations for I-15 to 900 West (Segments B & C)



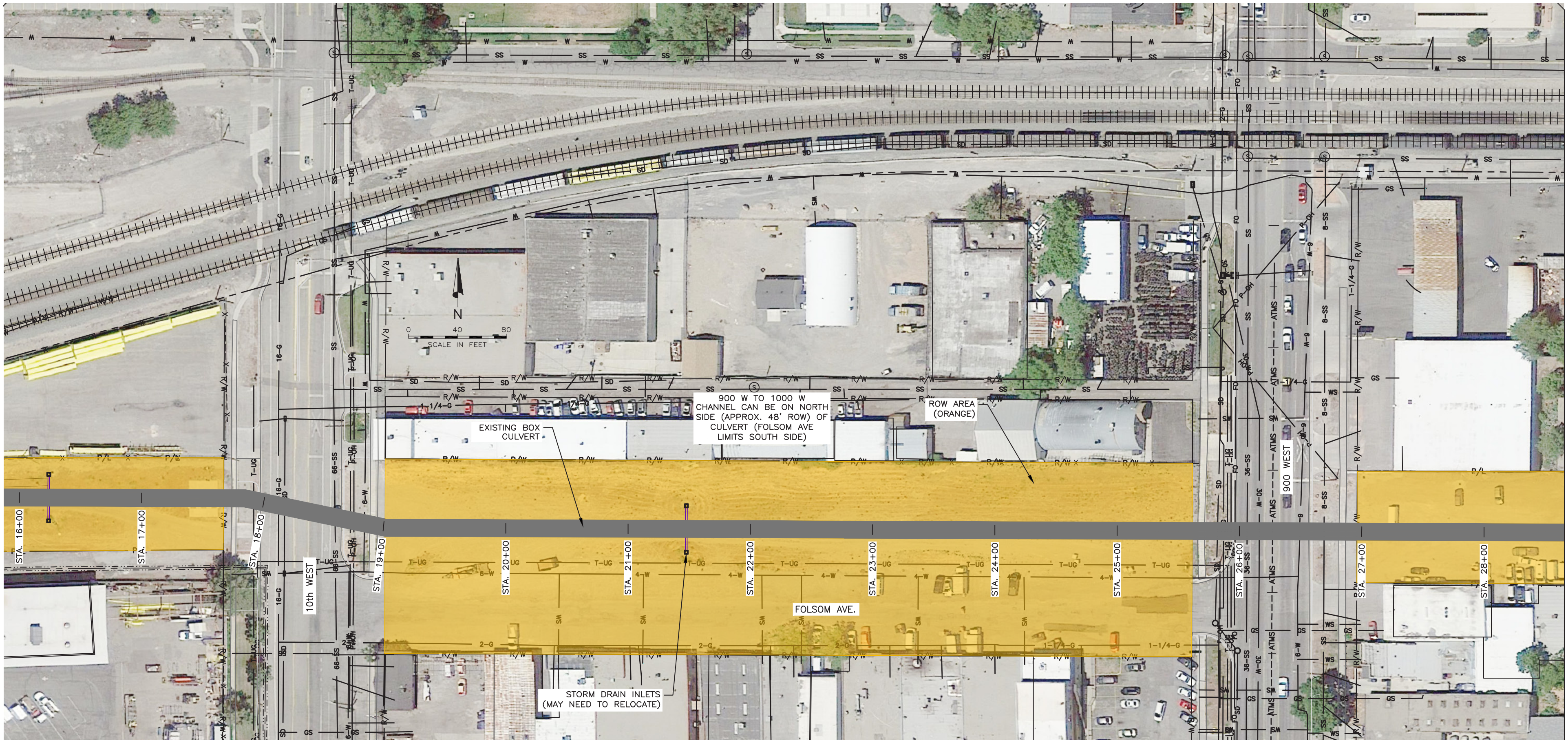
Utility Locations

Sta. 29+93 to 30+59 Jeremy St. Crossing
- Sta. 30+11 Storm Drain Line
- Sta. 30+27 8" Sewer Line
- Sta. 30+38 4" Waterline
- Sta. 30+45 2" Gas Line
- Sta. 32+25 Storm Drain Inlets

Sta. 33+56 to 34+85 800 West Crossing
- Sta. 33+69 2" Gas Line
- Sta. 33+79 8" Sewer Line
- Sta. 33+84 Underground Telephone
- Sta. 33+86 18" Storm Drain Line
- Sta. 34+22 Storm Drain Line
- Sta. 34+52 6" Waterline
- Sta. 34+61 10" Sewer Line
- Sta. 34+83 Underground Telephone

Other unknown utilities from aerial imagery: Sta. 26+62

Utility Locations for 900 West to 1000 West (Segment D)



Utility Locations

Sta. 17+67 to 19+00 10th West Crossing

- Sta. 17+90 Underground Telephone
- Sta. 18+10 16" Gas Line
- Sta. 18+15 Storm Drain Line
- Sta. 18+57 66" Sewer Line
- Sta. 18+70 Underground Telephone
- Sta. 18+73 6" Waterline
- Sta. 21+48 Storm Drain Inlets

Sta. 25+62 to 26+96 900 West Crossing

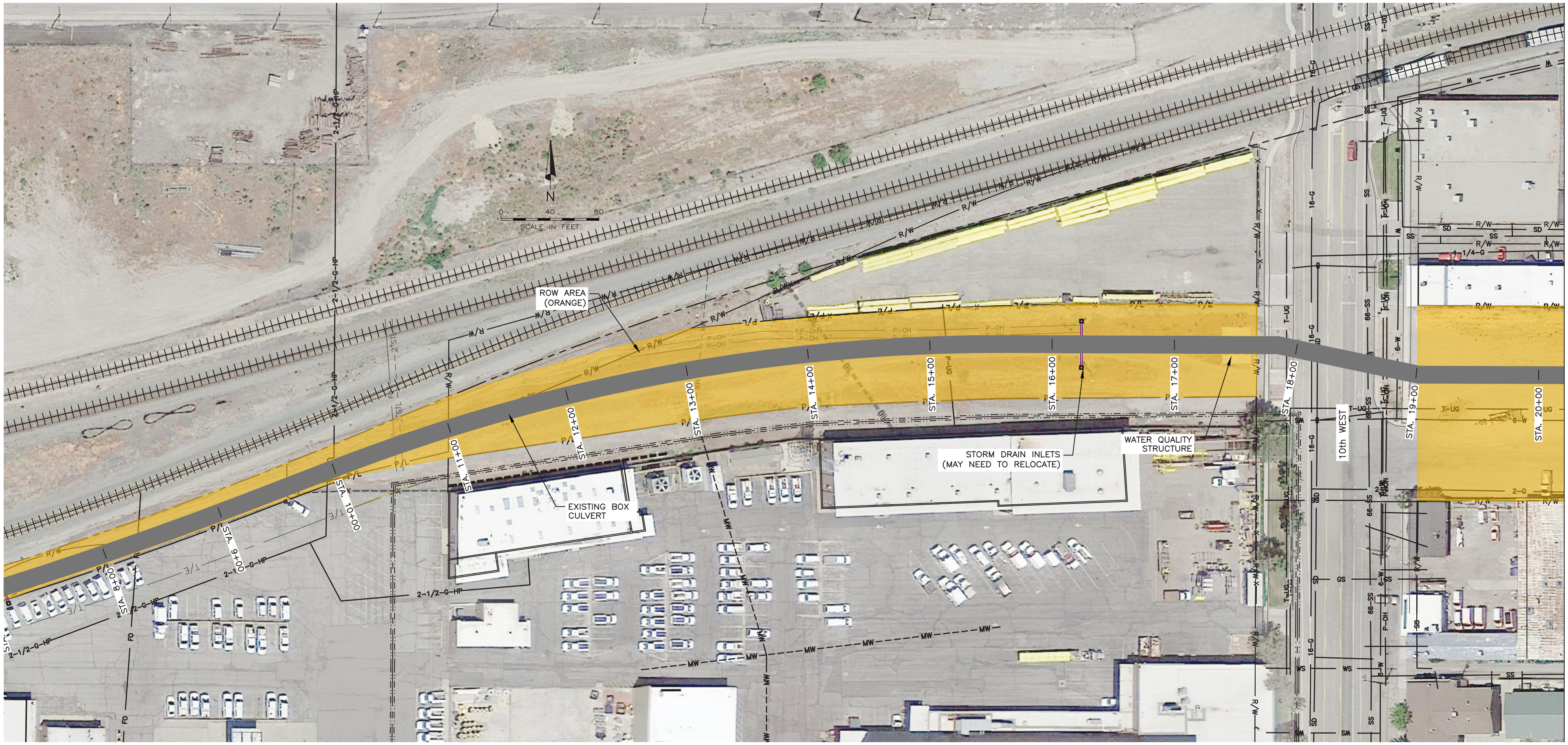
- Sta. 25+81 Cleanout Box
- Sta. 25+82 Storm Drain Line
- Sta. 25+87 2" Gas Line
- Sta. 25+90 Underground Telephone
- Sta. 25+93 Underground Telephone
- Sta. 25+96 Underground Fiber Optic
- Sta. 26+06 36" Sewer Line
- Sta. 26+16 30" Waterline

Sta. 26+50 6" Waterline
Sta. 26+69 8" Sewer Line
Sta. 28+70 Storm Drain Inlets

Other unknown utilities from aerial imagery:

- Sta. 17+83
- Sta. 18+78

Utility Locations for 1000 West to "1100 West" (Segment E)



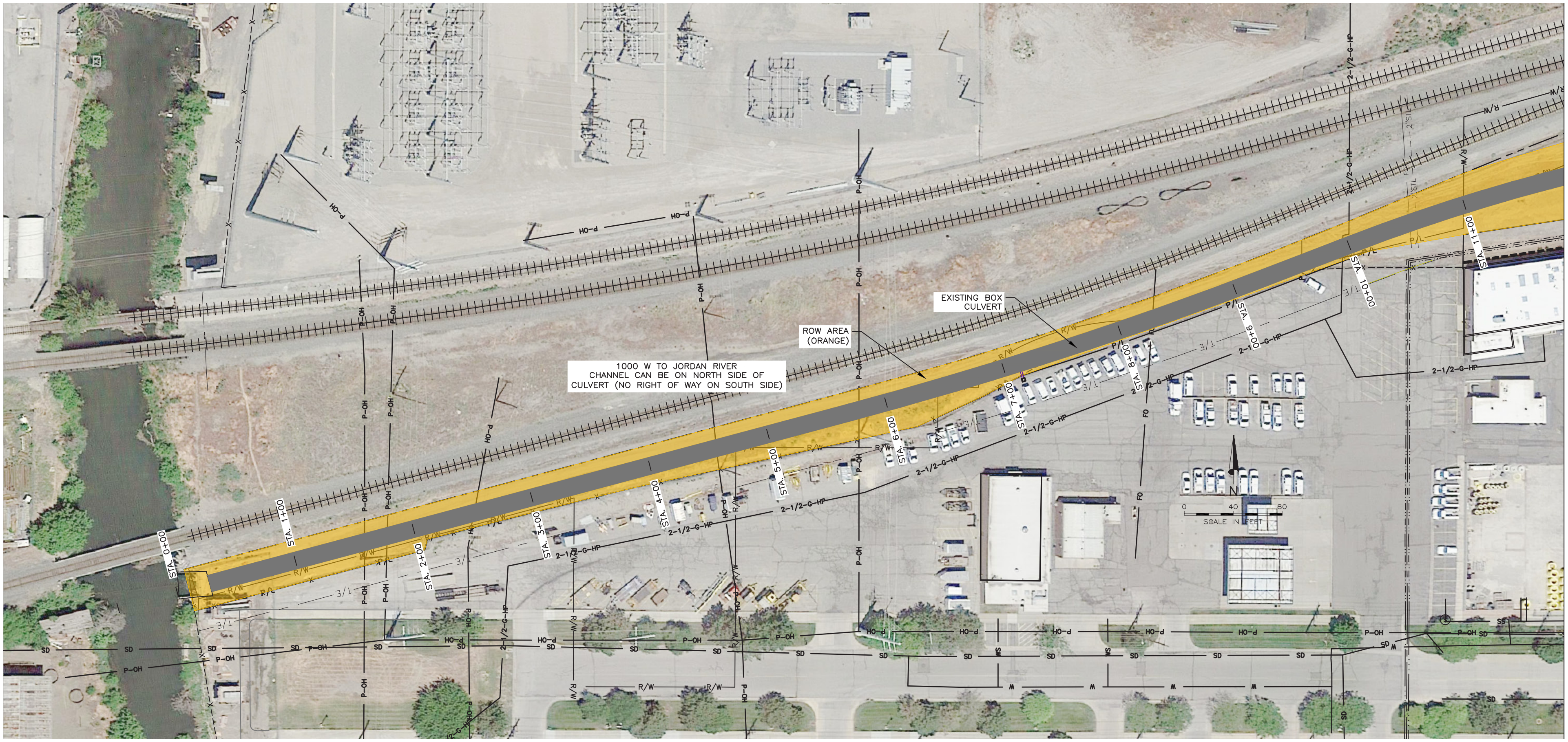
Utility Locations

Sta. 15+13 Underground Power Line

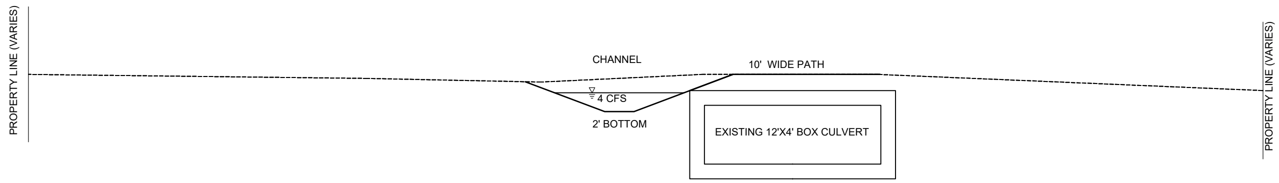
Sta. 16+24 Storm Drain Inlets

Sta. 17+37 to 17+63 Canal Vault

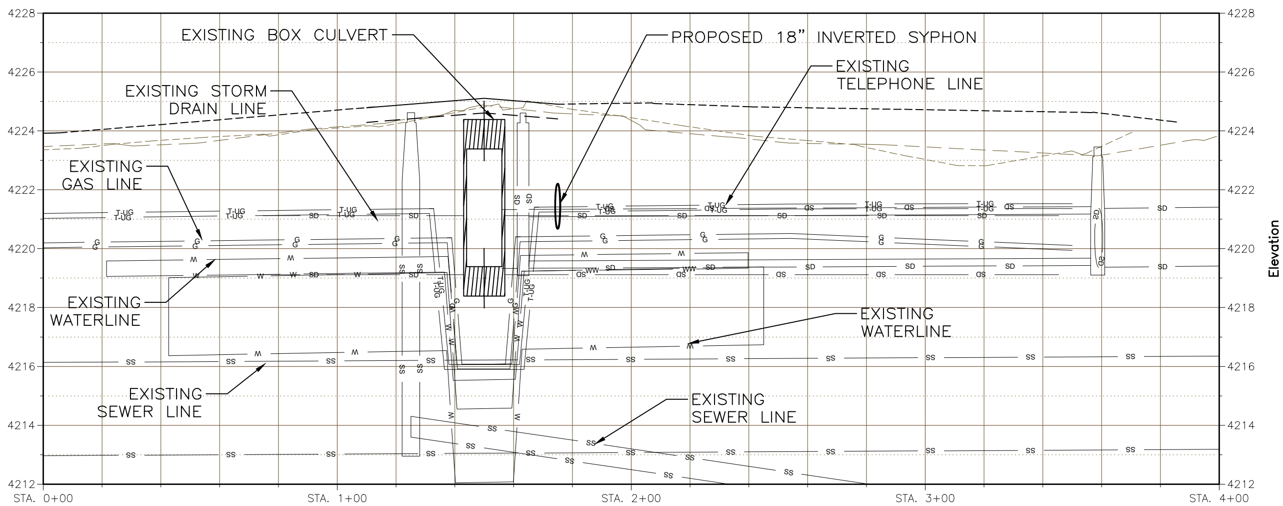
Utility Locations for "1100 West" to the Jordan River (Segment F)



Utility Locations
Sta. 8+33 Fiber Optic Line
Sta. 10+02 High Pressure Gas Crossing



TYPICAL CHANNEL CROSS SECTION FOR CONCEPT 1



900 WEST CROSSING (STA. 26+27) FOR CONCEPT 1

FILE NAME: PROJECTS\344 – GENERAL MISC\02.600 LANDMARK – CITY CREEK DAYLIGHTING\CAD\WORKING\XSEC 855.DWG

FILE DATE: 1.9.2019 07:58:19 (CAH)

HANSEN ALLEN & LUCE INC ENGINEERS

TYPICAL CONCEPT 1 CROSS SECTIONS

FIGURE 5