ELK RIDGE BRIC STUDY

APRIL 2026

PREPARED FOR:

ELK RIDGE

PREPARED BY:

Jones & DeMille Engineering

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Project #: 2503-013

RICHFIELD ▪ PRICE ▪ MANTI ▪ ROOSEVELT ▪ SPRINGVILLE ▪ ST. GEORGE

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1. INTRODUCTION

1.1. PURPOSE AND SCOPE

Elk Ridge (the City) contracted Jones and DeMille Engineering (JDE) to perform a flood study identifying flood risks and proposing preliminary alternatives to mitigate flooding for watersheds draining in and around Elk Ridge. This study is funded through the Federal Emergency Management Agency (FEMA) Building Resilient Infrastructure in Communities (BRIC) program. This report is to be used as a reference for drainage information in terms of correcting current deficiencies and planning for the future as the area experiences growth.

The primary tasks of this project are to:

- Develop a database which catalogs existing stormwater conveyance infrastructure.
- Evaluate pre-development, existing conditions, and future development hydrology and hydraulics.
- Identify existing deficiencies (flooding).
- Propose alternatives to mitigate future flooding.
- Provide high level cost estimates and benefits to aid in project prioritization and determine future fundability of proposed projects.

For the purposes of this study, flooding in the City is categorized into three types: nuisance, minor, and major flooding. Nuisance flooding is frequent, low-level flooding caused by minor runoff sources like groundwater seepage, irrigation, or light rain. Minor flooding originates within city limits and is typically localized, while major flooding results from runoff generated outside the city, though it can still impact areas within the City as it flows through. This classification helps clarify funding eligibility. The major flooding issues are generally fundable through FEMA and NRCS programs while the nuisance and minor flooding will need to be funded through programs available to the City such as the Utah Community Impact Board.

1.2. STUDY AREA

Elk Ridge City is a small community of approximately 4,925 residents located in the south end of Utah County. The city is tucked in the foothills of Mount Loafer between Payson and Salem. The City takes pride in its rural mountain feel and prioritizes clean air, open space, and quiet surroundings. Until a golf course was installed in the early 1990's, the City remained small and mostly unknown but has since experienced major growth. Elk Ridge is an entirely residential city, with no existing or planned commercial buildings. Because of its young age and mountainous feel, the City lacks complete storm drainage infrastructure and has little data reporting of the existing infrastructure. Several small drainages from Mount Loafer drain through the east side of the City. This study includes all drainage basins running into and throughout the City boundaries.

1.3. HISTORICAL FLOODING

Historic flooding within Elk Ridge has consisted of minor roadway overtopping and ponding issues in some areas. However, the Loafer Canyon floodplain through the City has been developed with little stormwater infrastructure, which has caused past flooding issues. The most significant flooding occurred shortly after a 2018 wildfire in the mountains above the City. Following the flooding, several problem areas were identified by residents and are shown in Appendix A – Exhibit 1.

2. EXISTING STORM DRAINAGE

2.1. STORM DRAINAGE SYSTEM OVERVIEW

The existing storm drainage system in the City is made up of natural waterways, canals, irrigation ditches, storm water sumps, retention basins, and storm drainage piping. The newest developments have installed conventional stormwater systems with inlets and piping; however, most neighborhoods only have storm water sumps and the oldest neighborhoods have little or no storm infrastructure. A large natural gully (Loafer Canyon) traverses the east side of the City. Roadways and homes have been constructed in and across this gully. These homes have flooded in the past due to their location in the drainage channel. Several engineered detention basins are spread throughout the newly developed portions and lower elevations of the City.

For the purposes of this study, the existing infrastructure has been organized into three categories: nuisance flow control infrastructure, minor flow control infrastructure, and major flow control infrastructure. The definition and description of how the existing infrastructure fits into these categories is provided in subsequent sections of this report. All existing infrastructure is shown in the exhibit in 0 .

2.1.1. EXISTING STORM DRAINAGE CAPACITIES

2.1.1.1. NUSIANCE FLOW CONTROL INFRASTRUCTURE

Nuisance flow control infrastructure consists of improvements that prevent minor stormwater ponding but are not designed to store or convey larger storm events such as the 10-year storm. This would include the stormwater sumps found throughout the City. These sumps typically handle nuisance flows, which include irrigation runoff, groundwater seepage, and other low-volume discharges that occur outside of major storm events.

Sumps are typically placed at low points or depressions within the drainage system where water naturally collects. They typically consist of a curb inlet box in the gutter that flow into a storm drain manhole surrounded with gravel drain rock. The storm drain manhole is generally perforated on the sides with an open bottom to allow for infiltration. During significant rainfall events, the sump's limited capacity is quickly exceeded, and water bypasses the sump entirely and is conveyed by the street and natural topography.

The capacity and performance of sumps in the City are closely tied to the soil types at each sump's location. Soil types for the city were downloaded using the NRCS Web Soil Survey and percolation rates were found in NRCS studies. The soils in the City are generally loam with gravels, silts, and cobbles mixed in. Table 2-1 shows estimated capacities and the time required to drain a sump based on the Hydrologic Soil Groups.

Table 2-1. Sump capacities based on hydrologic soil group

Soil Type	Silty Loams	Loams	Cobbly Loams
Percolation Rate (min/in)	120 (range 60-180)	90 (range 60-120)	40 (range 20-60)
Infiltration Capacity (in/hr)	$^{1}/_{3}$ to 1	½ to 1	1 to 3
Time to Drain (hr)*	216	162	72
Design Storm	<1-year	<1-year	<1-year

*Time to Drain uses the average percolation and can be faster.

In areas with cobbly or gravely loam soils, which are highly permeable, sumps can infiltrate water quickly, allowing them to drain efficiently which increases capacity. Typical loam soils offer moderate infiltration rates, meaning sumps in these zones still perform well, but may retain water longer after each event. In addition to the fact that the storm water sump volume is relatively small, lower infiltration capacities also reduce a sumps capacity – resulting in more overflow during storm events. Understanding the distribution of these soil groups across the City is essential for designing sump systems that are appropriately sized and located to manage nuisance flows. Soil testing is critical when placing sumps to ensure adequate infiltration.

The City has standard details showing the recommended design for sumps as a 5-foot diameter perforated manhole, 9-feet deep, with 4-feet of drain rock surrounding. Assuming 35% pore space in the drain rock, each sump has roughly 570 cubic feet of volume. The amount of impervious area each sump can contain was calculated. These calculations assume completely impervious area draining to the sump and no infiltration occurs as the sump fills. See Table 2-2 for the impervious area captured by a typical Elk Ridge stormwater sump.

Table 2-2. Impervious Area Captured by Typical Elk Ridge Stormwater Sump

Storm	Rainfall Depth (in)	Sump Volume (ft^3)	Impervious Area Captured (ft^2)
1-year 24-hour	1.24	570	5,516
5-year 24-hour	1.85	570	3,697
10-year 24-hour	2.10	570	3,257
25-year 24-hour	2.44	570	2,803
50-year 24-hour	2.70	570	2,533
100-year 24-hour	2.97	570	2,303

A Stormwater Utility Fee Survey conducted for the Greater Salt Lake Municipal Services District found that the average impervious area for a single-family residence is roughly 3,800 square feet[1]. Comparing this area to the area captured by a single sump shows the need for more than 1 sump per residence on all storms greater than the 5-year storm. As was previously mentioned, the allowable soil infiltration rate at the sump location will greatly affect the amount of runoff each sump can manage. The above numbers are conservative as they do not account for any infiltration.

In addition, these estimates only includes residential impervious area and do not account for roadways, other municipally based impervious areas, or any pervious areas such as lawns. This further shows that while sumps are effective for improving water quality and reducing nuisance flows, they play a minimal role in the overall flood control system and can be largely ignored for the purpose of handling larger storm events.

2.1.1.2. MINOR FLOW CONTROL INFRASTRUCTURE

Minor flow control infrastructure consists of improvements that convey storm events to the major flow control infrastructure. This infrastructure includes features such as catch basins, culverts, swales, roadside ditches, curb and gutter, and storm water piping through the city. These are typically designed to collect and convey water away from streets, driveways, and developments – and direct the flow to major stormwater control infrastructure. These minor flow control infrastructure features are designed to manage frequent, low-volume runoff events like the 25-year storm or less. These features are designed to manage on-site flow (i.e. runoff generated within the city) and smaller drainage areas.

Capacities for these features were estimated based on the average slope through the piped sections of the city, and known pipe sizes and materials. Capacities for generic gravity storm water pipes were calculated for each pipe size and type found in the City and were used in the storm modeling. Table 2-3 presents the flow capacity of different sized pipes made of different materials at a slope of 1.50%. Actual flow capacities will vary slightly but will be close to those listed.

Table 2-3. Estimated Pipe Capacities

Diameter (in)	Material	Capacity (cfs)
24	ADS	31
18	ADS	14
15	ADS	9
12	ADS	5
36	RCP	82
30	RCP	50
24	RCP	28
18	RCP	13

[1] https://www.utah.gov/pmn/files/510741.pdf

2.1.1.3. MAJOR FLOW CONTROL INFRASTRUCTURE

Major flow control infrastructure in Elk Ridge is designed to manage high-volume runoff such as the large mountainous watersheds above the City. The major flow control infrastructure is also designed to handle large infrequent storms, such as the 100-year storm. This system includes large culverts, detention basins, and engineered channels that convey or temporarily store excess water to prevent widespread flooding. These features are typically designed to convey off-site flows (i.e. water draining through the city from watersheds above) and larger drainage areas as well. Very little major flow control infrastructure currently exists within the City, and most of the areas of concern identified by stakeholders within the City lie in areas where major flow control infrastructure should be implemented.

2.2. MAPPING, SURVEYING, AND DATA COLLECTION

Several site visits were conducted by JDE as part of this study for data collection. The collected data, consisting of locations and brief descriptions, were input into a GIS database for the City. The database is intended to be maintained by the City to enable management of the stormwater infrastructure as the area continues to develop. This existing infrastructure mapping includes only the general location and sizing of the existing stormwater infrastructure. A web map was provided to the City to allow residents and city staff to report on known problem areas. This data was used to create an areas of concern map which is included in Appendix A.

Other data referenced in this study includes soil type, historic precipitation data, land use and cover types, and digital elevation models (DEM). This data was used for hydrologic calculations and modeling.

3. HYDROLOGIC AND HYDRAULIC ANALYSIS

3.1. METHODOLOGY & DESIGN CRITERIA

3.1.1. HYDROLOGY

Hydrologic analysis was performed for the watersheds in and around Elk Ridge using two sets of software. Hydrology in both sets of software used the Soil Conservation Service (SCS) hydrology methodology documented in Technical Release 55 – Urban Hydrology for Small Watersheds, commonly referred to as the TR-55 method, as well as National Engineering Handbook (NEH) – Part 630 Hydrology. These two references overlap and contain much of the same information applicable for hydrology calculations in urban and rural developments as well as undeveloped areas characteristic of the mountains above the study area.

The mountain watersheds were modeled in the Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS). HEC-HMS was used for the mountain watersheds to only provide an outflow hydrograph as it was assumed that where the water moved in these watersheds was not critical. A rain-on-grid precipitation model was then created in the Hydrologic Engineering Center's Riverine Analysis System (HEC-RAS) for the in-town areas. The HEC-HMS model results were input into the rain-on-grid model above the City using boundary conditions. This combination modeling approach allowed the mountainous watersheds to quickly be analyzed only for peak flows, while a more detailed modeling of water flow through the City could be conducted.

3.1.2. HYDRAULICS

The hydraulics of stormwater conveyance structures (e.g., culverts, open channels, detention basins) were modeled using HEC-RAS software. Data required to analyze the hydraulics of each conveyance structure, such as invert elevations, sizing measurements, and cross-sections, were taken first from the limited collected survey data, followed by topography (DEM), and then based on aerial imagery. Pipe entrance and exit loss coefficients as well as pipe and open channel roughness coefficients (Manning's n values) were estimated based on field notes, pictures, and aerial imagery.

3.2. DESIGN STORM

3.2.1. FREQUENCY AND DURATION

Design storm events are classified by their recurrence interval—how often a storm of a certain size is statistically expected to occur. These intervals are expressed in years, such as 2-year, 10-year, or 100-year storms. A 100-year storm, for example, has a 1% chance of occurring in any given year—not that it will only happen once every 100 years. Multiple 100-year storms can occur within a short time span, or none over a century.

The choice of design storm depends on the acceptable level of risk, cost-benefit considerations, and the type of infrastructure. For instance, culverts under small local roads are often designed for a 25-year storm, since flooding would cause limited damage. In contrast, culverts under major roads or highways are typically designed for a 100-year storm due to the higher potential for costly damage and broader community impact.

Storm durations for stormwater infrastructure are commonly a 24-hour duration storm. While storms in Utah are more commonly monsoonal with short durations, the 24-hour storm is used to provide conservative flow rates. As detailed in the Elk Ridge Development and Construction Standards, storms for this study were a 25-year recurrence for minor draining and a 100-year recurrence for major drainage. A 24-hour storm duration was used for all storms. It should be noted that while drainage originating within the City is generally described as minor drainage, it sometimes requires using a 100-year storm for design. As is common in many cities, all detention or retention basins with the City are designed for the 100-year storm even though they may be minor drainage.

3.2.2. RAINFALL

Precipitation depths were taken for the centroids of each watershed from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Point Precipitation Frequency Data Server.

3.2.3. DISTRIBUTION

A rainfall distribution refers to how much rain falls and how intense that rain is over a period of time. A NOAA 24-hour rainfall distribution was used in the hydrology models for this report. The NOAA distributions break a rainfall event into 4 quarters based on the quartile where the most rainfall occurs. These NOAA distributions are based on historic rainfall data for the southwestern US. For this study, the NOAA 2^{nd} quartile 50% probability storm distribution was used.

3.3. DRAINAGE BASIN CHARACTERISTICS

3.3.1. DRAINAGE BASIN DELINEATIONS

A drainage basin, also referred to as a watershed or catchment, is an area where all rainfall collects and discharges to a single point. Drainage basins are generally delineated to break up areas of different land types or areas of interest. Drainage basins were delineated using LiDAR elevation rasters in ArcGIS Pro.

Two drainages were identified for this study including Loafer Canyon and West Elk Ridge. To differentiate between major and minor drainage, the Loafer Canyon watershed was broken into two sub-watersheds. The upper portion of Loafer Canyon covers a large mountainous area and is mostly outside the City boundaries, while the lower portion of Loafer Canyon mainly covers the Elk Ridge and Woodland Hills. The delineated watersheds are shown in Appendix A.

3.3.2. SOILS AND HYDROLOGIC SOIL GROUPS

The hydrologic soil group (HSG) is a general indication of a soil's relative rate of infiltration. The NRCS via TR-55 classifies soils into hydrologic soil groups for hydrologic modeling. These soil groups are designated as A, B, C, and D. Soil group A results in the highest infiltration rate and thus the least amount of runoff, and D results in the lowest infiltration rate and thus the most amount of runoff.

Spatial soils data for the area around the City was downloaded through the NRCS Web Soil Survey. The data shows soil ratings from A to D surrounding the City. The soil group most common within the City boundary is group C with small areas of group A, B, and D. The mountain drainages above the City were mainly groups C and D but had large areas of unidentified soil groups. The areas with no identified soil group were assigned groups based on the surrounding areas. A map of the hydrologic soil groups present in the City is shown in Appendix A.

3.3.3. LAND COVER AND IMPERVIOUSNESS

Land cover and imperviousness have a significant effect on runoff. Impervious surfaces, such as roof tops, paved parking lots, driveways, and paved roads significantly increase runoff peaks and volumes. Depending on the natural land cover, as an area is developed and the land cover is altered, an increase in runoff can occur. For example, if the natural land cover is well vegetated and development results in a decrease in vegetative cover and an increase in imperviousness, a decrease in infiltration and vegetative interception will occur resulting in an increase in runoff.

Landcover data was obtained through the U.S. Geological Survey (USGS) in the form of the 2023 National Land Cover Database (NLCD). The landcover in the City is mainly low density residential with some developed open space and cultivated crops. The area above the City is a mix of Shrub/Scrub, evergreen forest, and deciduous forest in the NLCD dataset.

While the NLCD was used to obtain land cover types, the NLCD values do not align with the land cover values found in TR-55. The NLCD values were therefore converted to TR-55 based on field visits and aerial imagery, the groundcover was estimated to range from fair to good condition.

3.3.4. INFLITRATION AND RUNOFF CALCULATIONS

When using the SCS methodology, infiltration is estimated using Curve Numbers (CN). Curve numbers are based on land cover type, soil hydrologic condition, and the soil type. A drainage basin's CN number defines the relationship between the precipitation, infiltration, and runoff. Larger CN values result in more runoff relative to lower CN values. Tables 2-2a, 2-2b, 2-2c, and 2-2d in TR-55 were used to find CN values for the City. Weighted average CN values for the sub-watersheds were calculated while a CN raster was created and used for the rain-on-grid modeling in HEC-RAS. These values are presented along with other pertinent drainage basin characteristics in the modeling result in Appendix B.

3.3.5. TIME OF CONCENTRATION

The time of concentration represents the time for rainfall to travel from the most hydraulically remote location within a drainage basin to the drainage basin discharge point. For this study the NRCS National Engineering Handbook (NEH) Watershed Lag methodology was used. The Watershed Lag method uses a basins size, average slope, longest flow path length, and curve number to determine a time of concentration. The time of concentration calculations were only used for the HEC-HMS model, the HEC-RAS rain-on-grid model calculates flow times during modeling. Refer to Part 630 Chapter 15 of the NEH for further explanation as well as the equations used for this calculation.

3.3.6. DRAINAGE BASIN SUMMARY

Three basins were delineated and analyzed as part of this study. The basins and their characteristics are shown below in Table 3-1. It should be noted that the listed curve numbers are a weighted average for each basin calculated from a CN raster. The HEC-RAS model used for this report used the curve number raster and calculated its own time of concentration.

Table 3-1. Watershed characteristics

Watershed	Area (Sq. Mi.)	Pre-Development Curve Number	Existing Curve Number	Buildout Curve Number	Time of Concentration (min)
Lower Loafer Canyon	1.74	58.8	69.9	71.4	59
Upper Loafer Canyon	6.53	60.8	61.8	62.4	64
West Elk Ridge	4.71	65.8	69.7	70.3	72

4. STORMWATER MODELING RESULTS

4.1. HYDROLOGIC MODEL RESULTS

Three different model conditions were created using HEC-HMS software to identify flows for pre-development, existing conditions, and future build out. The land cover values for areas outside of Elk Ridge were not altered for pre-development or buildout conditions. This was done to show only hydrologic due to development of Elk Ridge. The runoff increase over pre-development conditions for the 100-year storm is shown in Table 4-1.

Table 4-1. 100-year Storm Runoff Increase from Urbanization of Elk Ridge

Watershed	Pre-Development	Existing Conditions			Future Build Out		
	Flow (CFS)	Flow (CFS)	Percent Increase (Over Pre-Development	Flow Increase Over Pre-Development (CFS)	Flow (CFS)	Percent Increase (Over Existing)	Flow Increase Over Existing (CFS)
Lower Loafer Canyon	35	89	154%	54	90	1%	1
Upper Loafer Canyon	189	199	5%	10	212	7%	13
West Elk Ridge	140	191	36%	51	195	2%	4

As expected, the existing urbanization and development of The City has increased the amount of stormwater runoff in all three watersheds. As seen in the table above, the future build out of The City is unlikely to cause a significant increase in flooding risks at any of the drainages over existing conditions. Any mitigation measures designed for the existing conditions should be upsized to accommodate the future build out of the City.

4.2. HYDRAULIC MODEL RESULTS

The HEC-HMS models created for this study provided an outflow hydrograph for each watershed. To better understand how the water moves through the watersheds a hydraulic model was created in HEC-RAS. The results of the HEC-HMS hydrologic model were used to help calibrate and ensure accurate results in the HEC-RAS model. Similar to the HEC-HMS model, the HEC-RAS model looked at pre-development, existing, and build out conditions. See Table 4- for a flow comparison of the 100-year models. Note that the modeling software names have been shortened to HMS and RAS for the table to better fit the page.

Table 4-2. 100-Year Hydrologic and Hydraulic Model Results Comparison

Watershed	Pre-Development Conditions			Existing Conditions			Buildout Conditions		
	HMS	RAS	Percent Difference	HMS	RAS	Percent Difference	HMS	RAS	Percent Difference
Loafer Canyon*	224	185	17%	288	252	13%	302	278	8%
West Elk Ridge	140	114	19%	191	164	14%	195	173	11%

*The HEC-RAS model used the Upper Loafer Canyon HEC-HMS results as a direct input to reduce computation time. Therefore, there is only a HEC-RAS result for the overall Loafer Canyon drainage. It should be noted that the Upper and Lower Loafer HEC-HMS results were simply added together. This is a simplification of what would generally occur.

It should be noted that because Upper Loafer Canyon is a large mountainous drainage with little development, it was not modeled in the hydraulic HEC-RAS model. This was done to balance model run times with the accuracy of the results. The HEC-RAS model results shown are therefore for the bottom of the Loafer Canyon drainage. The HEC-HMS results for Upper and Lower Loafer Canyon were added together for an approximate peak flow. This is a simplification and likely shows a larger than expected peak flow rate.

Because HEC-HMS looks at an overall watershed and not what happens within the watershed the results can vary from the HEC-RAS results. For instance, the HEC-HMS model will not model the effects of the drainage basins in the City while the RAS results will. The comparison in Table 4- shows that the HEC-RAS results are less than 20% off of the HEC-HMS results. This shows that the HEC-RAS results are within the expected range when compared to the HEC-HMS results.

When comparing the existing condition results to the buildout results it should be noted that current Elk Ridge stormwater regulations require future construction to attenuate the increased runoff. Both the hydrologic and hydraulic models do not account for this. If the existing stormwater regulations are enforced the buildout runoff should not show any increase over the existing conditions.

4.2.1. NATURAL DRAINAGE IDENTIFICATION

Elk Ridge City is flanked by significant drainages on the east and west: Loafer Canyon and the smaller canyon where the Gladstan Golf Course is situated. Both of these can impact specific areas, but relatively small portions of the City. Two smaller drainages connect within Parkside Loop and were previously redeveloped within subdivisions into retention basins with overflows. The first of the smaller drainages follows near the path of Hillside Drive. The other smaller drainage encompasses the area north of Salem Hills Drive, Cove Drive and Lighthouse Circle. The smaller drainages primarily impact the subdivisions that developed in their path. Solutions for the impacts of these natural drainages are discussed in this report.

4.3. DEFICIENCIES AND OTHER CONSIDERATIONS

Deficiencies in the existing storm drain system have been identified by city staff as well and the storm modeling. These are described below and are shown on the exhibit in Appendix C.

- Loafer Canyon is a very large mountainous drainage that has numerous homes built within the floodplain. There appears to be almost no infrastructure protecting this area.
- Several areas of the City only have sumps for stormwater control. As shown in Section 2.1.1 these sumps will only control very small storms and resulting nuisance flooding.
- Olympic Lane sits within a depression that collects significant amounts of stormwater. The model shows significant flooding of more than a foot in the road and houses.
- The basins along 11200 South such as Bear Hollow Lane and Twilight Way are unable to capture all onsite stormwater of the Elk Ridge subdivisions leading to flooding along 11200 South.
- As noted in the stakeholder concerns, the model also shows that the small basin at the corner of Hillside Dr and Salem Hills Dr overflows into an undeveloped natural drainage. The small basin should be upgraded to control the flow into the natural drainage.
- Stakeholder concerns also identified home flooding along Elk Ridge Drive near the intersection with Oak Ridge Drive. This flooding is due to reverse slope driveways, which are no longer allowed within the City.

Possible solutions for each of these deficiencies have been explored. Recommendations for these deficiencies will be discussed in the following sections.

5. PROPOSED DRAINAGE SYSTEM IMPROVEMENTS

5.1. STORMWATER CONTROL IMPROVEMENTS

5.1.1. FLOOD CONTROL IMPROVEMENTS

Modeling and local experience led to the development of six flood control improvement concept projects: Lighthouse Subdivision pond improvements, Shuler Park pond overflow improvements, Olympic Lane pond improvements, Twilight Way and Bear Hollow Lane inlet improvements, Christley Lane pond improvements, and Rocky Mountain Way storm drain improvements. Each of these projects are shown on the proposed improvements exhibits in Appendix C.

The Lighthouse Subdivision pond is undersized for the 100-year storm by 1.25 acre-feet. The recommendation is to add a hydraulically identical pond approximately 100 feet to the east, on the other side of the existing pavilion, that will add 1.25 acre-feet of capacity.

The Shuler Park pond overflow is undersized and does not terminate at the next storm drain infrastructure. The proposed improvements would replace and realign the overflow for the existing retention pond. The existing 12” RCP should be replaced with an 18” pipe that is approximately 334 feet. The pipe should align between the two houses and terminate above the storm drain ponds within

Parkside Loop in a rock swale into the pond. An alternative to increasing the size of the overflow is to increase the size of the pond to 13.5 acre-feet of retention. Any expansion of the pond should include additional investigation, surveying, and the dam safety review process.

The Olympic Lane retention pond does not have enough capacity to handle flooding. The capacity of the pond should be expanded to a capacity of 5.5 acre-feet. At the current footprint, the pond would need to be about 3 feet deep. Additionally, an overflow pipe connection from the existing sumps to the pond should be installed, which is approximately 122 feet.

The intersections of Twilight Way and Bear Hollow Lane with 11200 South struggle to collect all the stormwater from the subdivisions. The existing inlet boxes at those intersections should be replaced with double inlet boxes connected to the same infrastructure.

The existing retention pond at Christley Lane overflows directly onto 11200 South. Three options were identified to resolve the issue. The first option is to catch the excess water before it reaches the Christley Lane pond at the Armstrong Drive pond. This would require installing a double inlet box on the east side of Christley Lane just north of Armstrong Drive, replacing the single inlet box on the west side of Christley Lane at Armstrong Drive and expanding the Armstrong Drive pond by 1.25 acre-feet. The second option is also to catch the excess water at Armstong Drive and create an overflow from the Armstong Drive pond to the storm drain pipe in Quail Run Lane approximately 185 ft of pipe, which leads to the Bear Hollow Lane retention pond. In this option the Bear Hollow Lane retention pond would need to be expanded by the same amount. The third option includes installing an overflow from the Christley Lane pond and carrying the excess water to the Bear Hollow Lane pond infrastructure. A minimum of 575 feet of 15-inch pipe would be able to convey the overflow from the Christley Lane pond to the inlet boxes at Bear Hollow Lane. This option should also include expanding the Bear Hollow Lane pond by 1.25 acre-feet.

Rocky Mountain Way is a 2,600 foot long mostly straight road that slopes down to 11200 South at more than a 6% slope with only five sumps trying to manage the stormwater flows. The recommended improvements for Rocky Mountain Way include replacing the two inlet boxes at 11200 South with double inlet boxes that would lead to a 7.14-acre-foot pond. Some of the storage and catchment could be located higher up on Rocky Mountain Way, but the total volume will be the same.

5.1.2. NUISANCE STORMWATER CONTROL IMPROVEMENTS

Local experience led to the recommendation of two stormwater controls for nuisance flooding: Elk Ridge Drive reverse slope driveways protection and the west end of Park Drive.

Two houses along Elk Ridge Drive just south of Oakridge Drive have reverse slope driveways and the City is interested in reducing the likelihood of flooding for those houses. It should be noted that no stormwater control improvements that the City installs within the City right-of-way will prevent rain that falls on the reverse slope driveways from flooding the homes. That being said, adding a curb inlet and a sump alongside the existing sump to the south would prevent City stormwater from flooding the reverse slope driveways.

The west end of Park Drive including the intersections with Columbus Lane and Elk Ridge Drive. An inlet box on the north side of Park Drive that connects into the existing sump and basin. Additionally, an inlet box should be installed on Park Drive just east of Columbus Lane. The inlet box could be connected to a new sump or connected to the other new inlet box mentioned, which would be about 261 feet of pipe.

Due to the high level, city-wide nature of this study the proposed projects described above for both the flood control and nuisance projects were designed on a high-level basis. If the city does decide to move forward with any of these projects, a detailed analysis of each contributing area and existing infrastructure should be completed along with the design.

5.2. PROGRAM IMPROVEMENT RECOMMENDATIONS

5.2.1. STORMWATER UTILITY

The current Elk Ridge stormwater utility charges a flat fee of $6.50 per month. An ongoing survey conducted by Western Kentucky University (WKU) shows that Utah cities have an average stormwater fee of $6.39. However, the costs reported in the study are outdated as a 2024 Spanish Fork City study[2] shows stormwater fees for several cities that are higher than the WKU study. Spanish Fork City looked at 10 cities within Utah County and reported an average fee of $9.66.

Based on the average Utah County monthly fee of $9.66 reported by Spanish Fork, Elk Ridge may be able to increase the stormwater fee in order to better fund necessary project improvements. A detailed stormwater utility fee analysis would be required to determine the appropriate fee and is beyond the scope of this study.

5.2.2. STORMWATER IMPACT FEES

Another potential source of stormwater funding could come from impact fees for new construction. This would allow for public storm infrastructure upgrades to accommodate new growth. The stormwater impact fee for several other communities in Utah County averages $2,737 with a high of $6,690 and a low of $770. This would be a one-time fee required for new construction and would go towards future storm drain infrastructure improvements. To determine a reasonable impact fee for the City, a detailed impact fee analysis would need to be completed prior to implementing this program and is beyond the scope of this study.

5.2.3. STORMWATER DEVELOPMENT STANDARDS

The Elk Ridge Development and Construction Standards contain well defined construction standards for storm drain construction. However, there is little information on how to size the storm drain infrastructure. It is recommended that the City update the standards to include acceptable hydrology

[2] https://www.spanishfork.gov/departments/public_works/stormwater/index.php

methods, storm recurrence and duration, infrastructure design criteria, and required reporting requirements. The most important of the recommended changes to the standards is the discussion of acceptable hydrology methods. Numerous hydrology methods are available with differing input types that can be used to show smaller storm results. Without a clear direction, developers may be able to produce hydrology results showing undersized infrastructure is acceptable.

Recommended stormwater design criteria is included in Appendix E. If desired, this could be adopted by the city to regulate all new development.

5.2.4. STORMWATER INSPECTION AND MAINTENANCE PLAN

To track and complete the required maintenance, it is recommended that the City adopt a plan to inspect the stormwater conveyance systems at regular intervals. The stormwater conveyance systems could be inspected over a four-year period, focusing on one quadrant of the City each year. Inspection of inlets and dry wells should be done on a more frequent basis, for example quarterly or after large rainfall events. As inspection occurs, the inventory of City-owned infrastructure can be updated and mapped. As maintenance or replacement projects are discovered, they can be added to a work order list or a Capital Improvement Projects (CIP) list. Having an updated inventory, work order list, and CIP list will facilitate building a long-term plan for the stormwater program, enable plan progress to be objectively measured, and allow similar projects to be conducted or bid together which can reduce material or mobilization costs.

5.3. ESTIMATED CONSTRUCTION COST

Based on the recommended improvements listed above, preliminary estimates have been prepared for each of the projects. This was done to provide the city with guidance on potential future costs to budget for and to allow them to prioritize projects based on potential costs. These are summarized below in Table 5-1.

Table 5-1. Recommended Improvements

Recommended Improvement	Estimated Cost
Lighthouse Subdivision Pond Expansion	$88,700
Shuler Park Basin Overflow Improvements	$80,600
Park Drive and Elk Ridge Drive Improvements (option 1)	$37,960
Park Drive and Elk Ridge Drive Improvements (option 2)	$25,580
Elk Ridge Drive Reverse Slope Driveway Improvements	$16,000
Olympic Lane Basin Improvements	$285,760
Twilight and Bear Hollow Lane Improvements	$49,000
Chrisley Lane Improvements (option 1)	$91,100
Chrisley Lane Improvements (option 2)	$107,750
Rocky Mountain Way Improvements	$382,000
Total projects (assuming option 1)	**$1,031,120**

Copies of the detailed estimate breakdowns are included in Appendix D for reference.

6. POTENTIAL FUNDING SOURCES

Due to the lack of a full stormwater system in Elk Ridge, and the potential for flood damage downstream of the town, larger projects could be required to reduce flood risk. These projects will have costs which are difficult for the City to fund on its own. Several funding opportunities were identified to assist the City. The federal funding opportunities require a benefit-cost analysis of the impacts to the area to determine the fundability of the projects. Many of the federal funding opportunities are also meant for large scale drainage projects and not municipal issues. The funding opportunities are summarized below.

6.1. FEMA BRIC FUNDING

In the past, FEMA has provided funding for flood protection projects through several programs including the BRIC program, which was used to fund this study. The BRIC program funds up to 75 percent of a project's total cost. Originally, BRIC funding was for large flooding issues and was not available for municipal drainage issues. However, in April of 2025 the BRIC program ended. It is unknown if the program will restart or if another program with similar goals will be started.

6.2. NRCS PL-566 FUNDING

The National Resources Conservation Service (NRCS) provides flood protection funding through the Watershed Protection and Flood Prevention Act (PL-566). NRCS PL-566 projects are required to benefit rural communities and have varying cost-share requirements. For flood control projects, the NRCS PL-566 program will fund 100 percent of construction excluding culverts, roadway crossings, and any property rights (e.g., land purchase, easements, or water rights). Funding through NRCS PL-566 requires a Preliminary Investigation and Feasibility Study (PIFR), an Environmental Assessment or Environmental Impact Statement (EA or EIS, depending on project cost), and a design and construction phase. This process spans 3-5 years to reach construction and requires reapplication and acceptance before each phase. The design and planning costs are covered under NRCS PL-566 and only applicant involvement is required. Application requires the submittal of a simple letter outlining the project's needs to the Utah NRCS.

The PL-566 program has similar restrictions and uses similar BCA methodology as the FEMA BRIC process to determine project feasibility. The in-town storm conveyance projects are unlikely to be fundable through the PL-566 program while any larger off-site drainage issues will likely qualify. It is assumed that the recommended improvements outlined in this report consist of smaller municipal drainage projects that likely do not meet PL-566 requirements.

6.3. COMMUNITY IMPACT FUND BOARD (CIB)

Potential in-town projects could be funded through the Utah Permanent Community Impact Fund Board (CIB). Funding through the CIB ranges from all loans to a 40/60 loan to grant combination. The funding is dependent on how essential a project is to the health, safety, and welfare of a community. Generally, stormwater projects are not funded through CIB on their own. However, road improvements with a stormwater component may be fundable.

7. FUTURE DEVELOPMENT

Typically, as an area experiences growth, government entities require developers to not increase peak flows discharged from their developments. This is accomplished by installing the necessary detention or retention systems to attenuate post-development peak flows to pre-development peak flows. This is done to ensure the existing drainage conveyance do not become inadequate, as a stormwater system is typically sized for the existing conditions. The current Elk Ridge Storm Water Design Standards require all new developments to provide a maximum release rate of 0.20 cfs per acre.

It is recommended that the hydrologic model developed as part of this study be updated as new development and stormwater conveyance is built so it can be a valuable up-to-date reference for the town.

8. CONCLUSIONS AND RECOMMENDATIONS

This study was completed to identify stormwater drainage patterns within Elk Ridge City, evaluate existing system performance, and develop conceptual improvements to reduce flood risk. Hydrologic and hydraulic modeling, combined with field observations identified several deficiencies in the existing stormwater system.

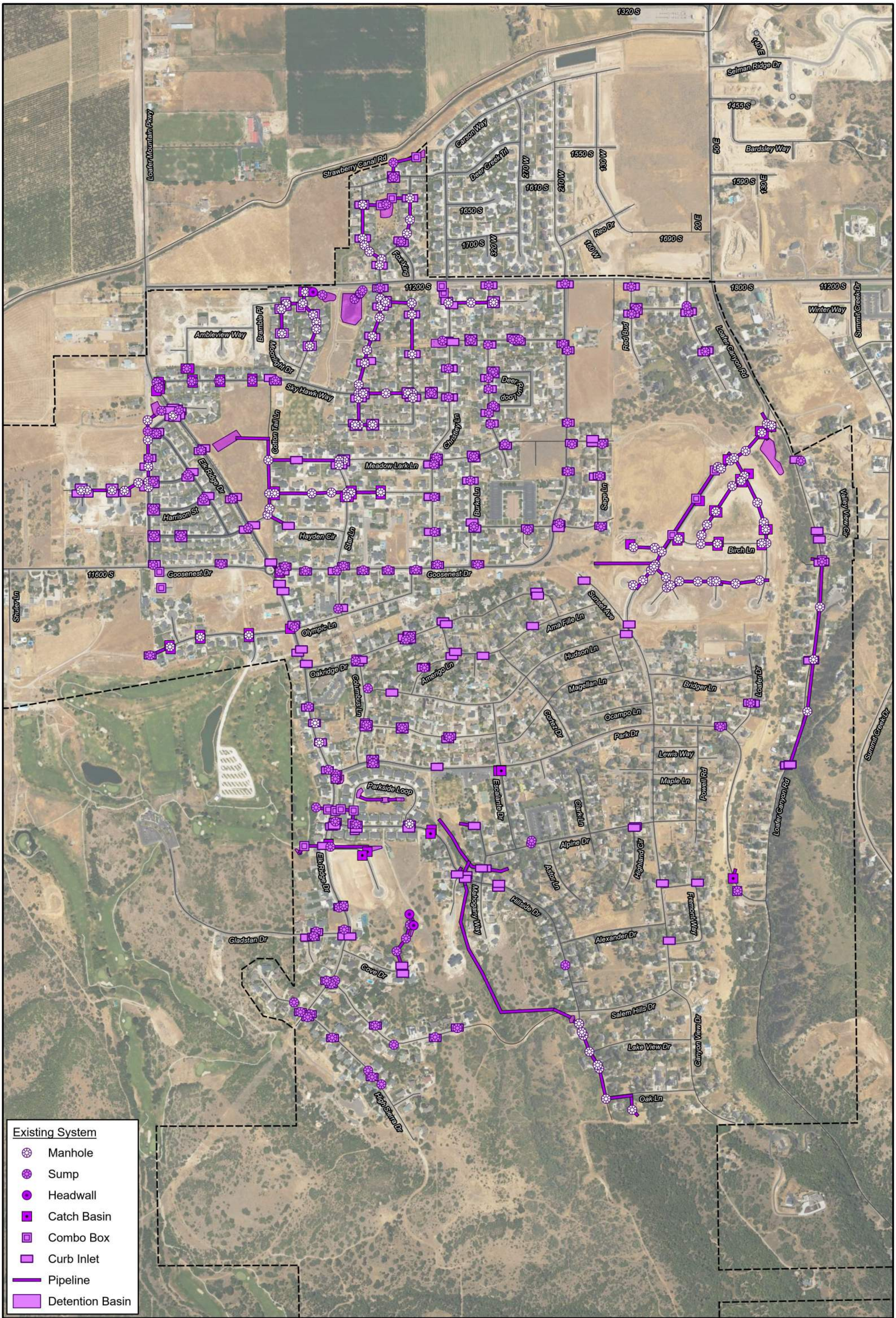
The results show that development within the City has increased runoff compared to pre-development conditions, particularly in the Lower Loafer Canyon and West Elk Ridge watersheds. However, future buildout is not expected to significantly increase peak flows beyond existing conditions if current stormwater regulations are maintained. This reinforces the importance of enforcing development standards that limit runoff.

Much of the City currently lacks adequate major stormwater infrastructure, relying instead on sumps that are only effective for nuisance flows. Several areas remain vulnerable to flooding due to undersized or missing conveyance and storage systems, particularly within natural drainage paths and low-lying areas.

Conceptual improvement projects were identified to address these issues, including detention basin expansions, inlet upgrades, and improved conveyance systems. In addition to these physical improvements, updates to stormwater standards, implementation of a maintenance program, and evaluation of funding mechanisms will be important for long-term system performance.

This study provides a basis for prioritizing future stormwater improvements and planning for continued growth within Elk Ridge City.

APPENDIX A. BACKGROUND MAPS



N

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Jones & DeMille Engineering

Elk Ridge City

FEMA BRIC Scoping Study 2025
Existing Stormwater Infrastructure Overview

Map Name: H:\2503-013\GIS\Projects\2503-013_Study\2503-013_Study.aprx - 1. Existing Stormwater Infrastructure Overview 11x17P

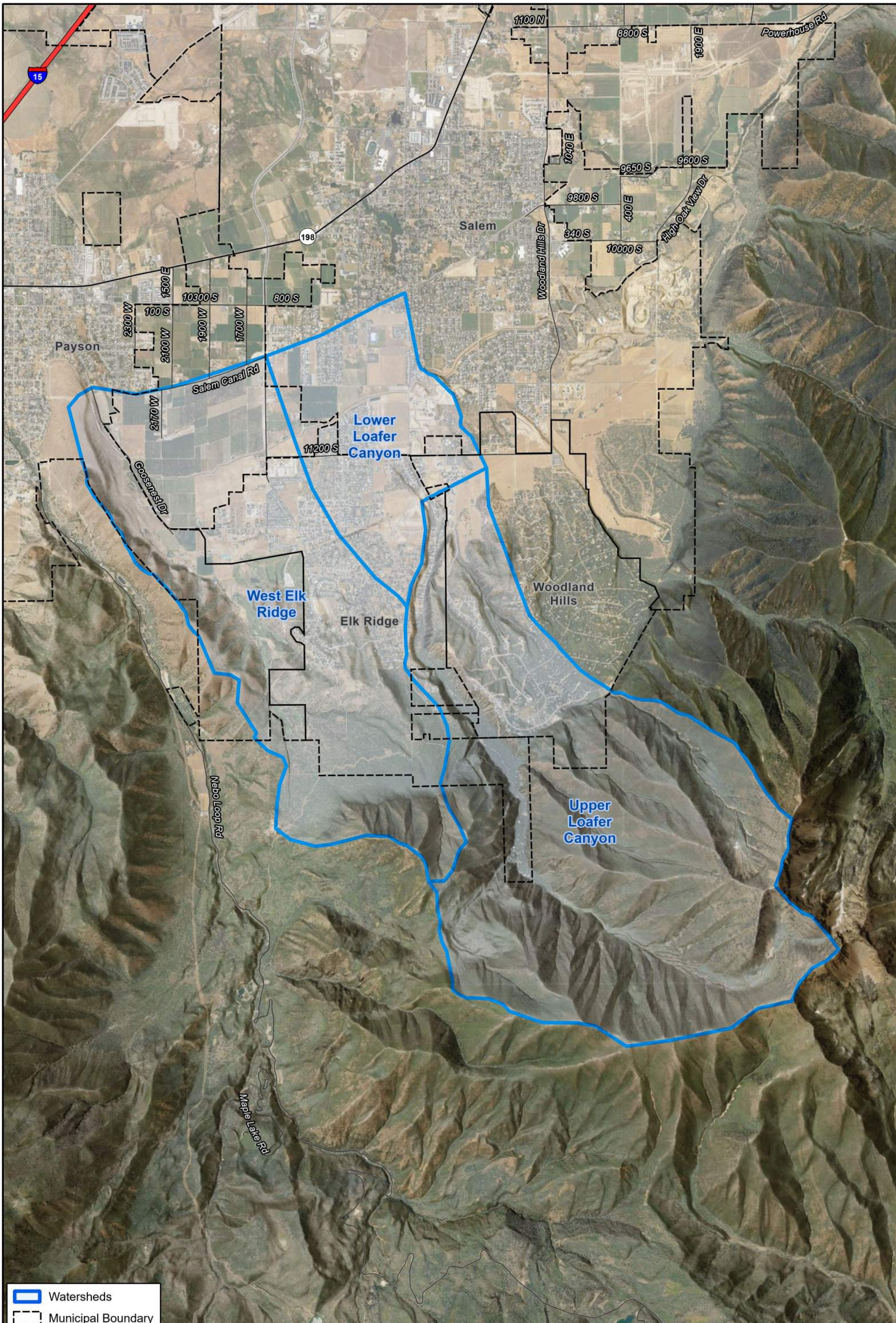
Project Number: 2503-013 | Drawn by: JEM 03-26 | Last Edit: 03/30/2026

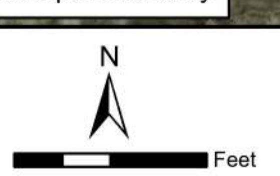
Utah County, Utah

Scale: 1" = 800'

1

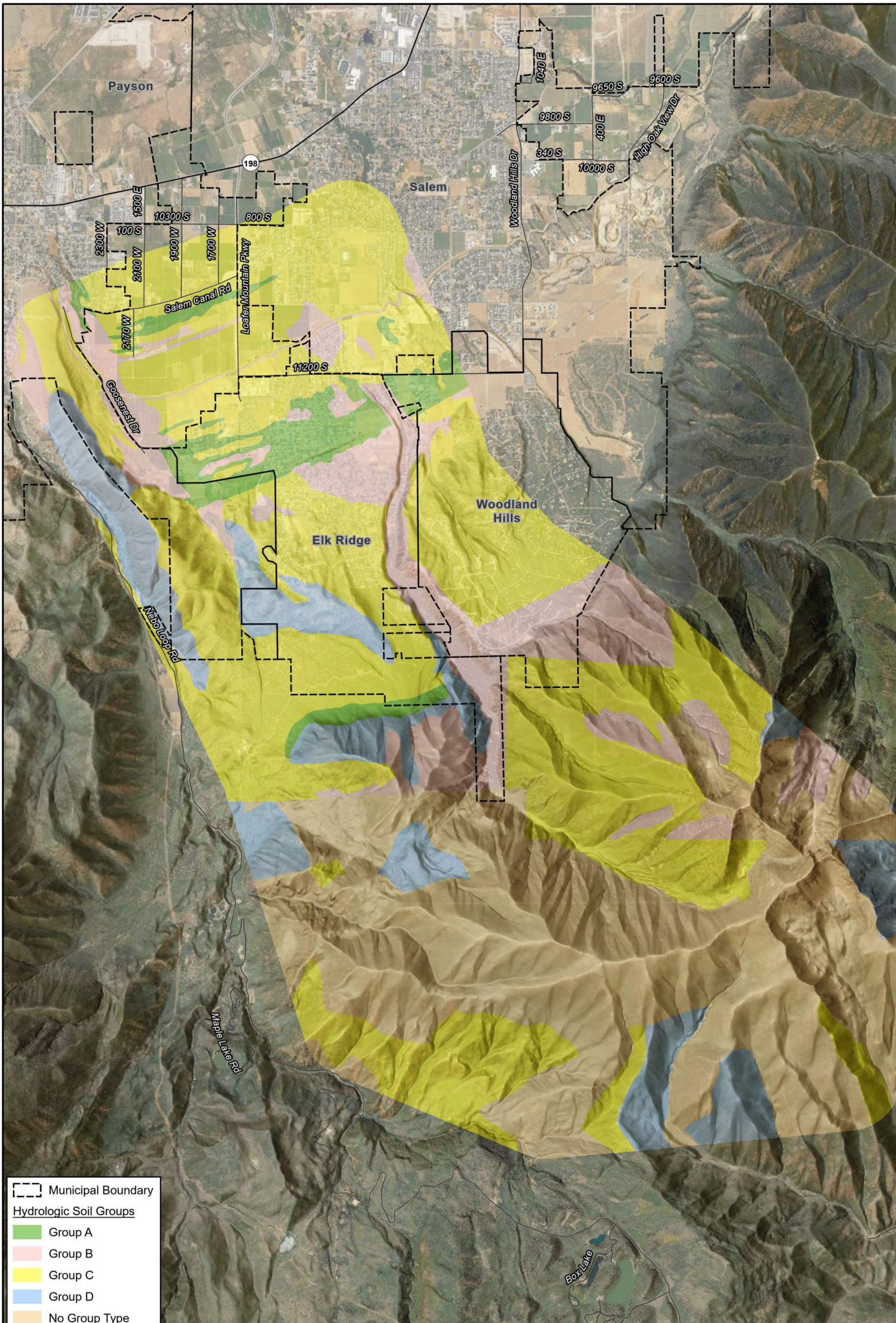
Basemap: © 2026 HxGN Content Program, Hexagon (flight 07/2024); UGRC SGID





Jones & DeMille Engineering

Elk Ridge City			Utah County, Utah
FEMA BRIC Scoping Study 2025 *Watersheds Overview*			Scale: 1" = 3,200'
Map Name: H:\2503-013\GIS\Projects\2503-013_Study\2503-013_Study.aprx - Watersheds Overview 11x17P			1
Project Number: 2503-013	Drawn by: JEM 01-26	Last Edit: 01/09/2026	



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Jones & DeMille Engineering

Elk Ridge City

FEMA BRIC Scoping Study 2025
Hydrologic Soil Groups Overview

Map Name: H:\2503-013\GIS\Projects\2503-013_Study\2503-013_Study.aprx - Hydrologic Soil Groups Overview 11x17P

Project Number: 2503-013	Drawn by: JEM 01-26	Last Edit: 01/09/2026

Utah County, Utah

Scale: 1" = 3,200'

2

Jones & DeMille Engineering

Elk Ridge City

FEMA BRIC Scoping Study 2025
Hydrologic Soil Groups Overview

Map Name: H:\2503-013\GIS\Projects\2503-013_Study\2503-013_Study.aprx - 2a. Hydrologic Soil Groups - Elk Ridge Overview 11x17P

Project Number: 2503-013 | Drawn by: JEM 01-26 | Last Edit: 01/09/2026

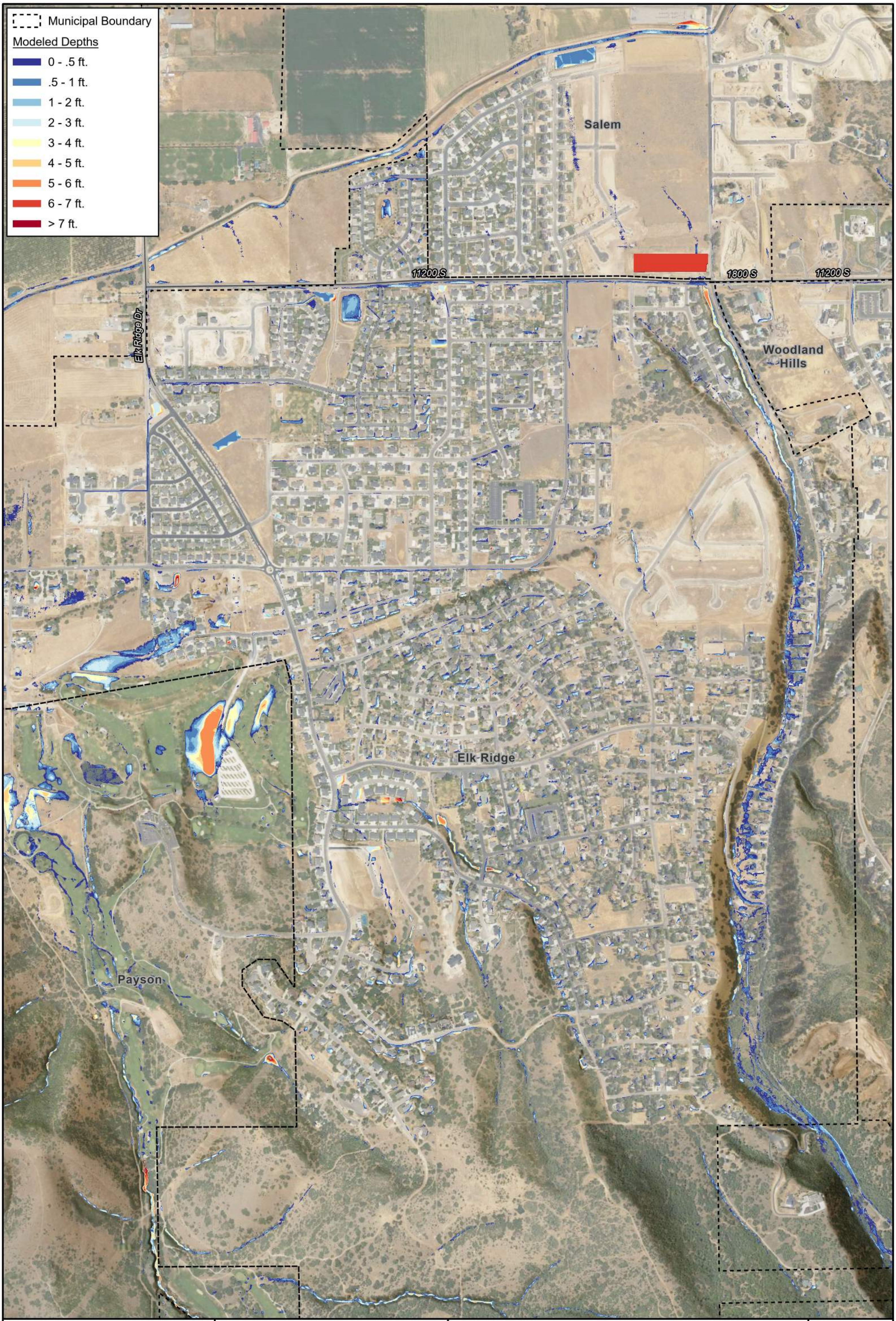
Utah County, Utah

Scale: 1" = 800'

2a

Basemap: © 2025 HxGN Content Program, Hexagon (flight 07/2024); NRCS; UGRC SGID

APPENDIX B. HYDROLOGIC MODEL RUNOFF DEPTHS



Jones & DeMille Engineering

Elk Ridge City

FEMA BRIC Scoping Study 2025
Existing Conditions: 25-Year Modeled Depth Overview

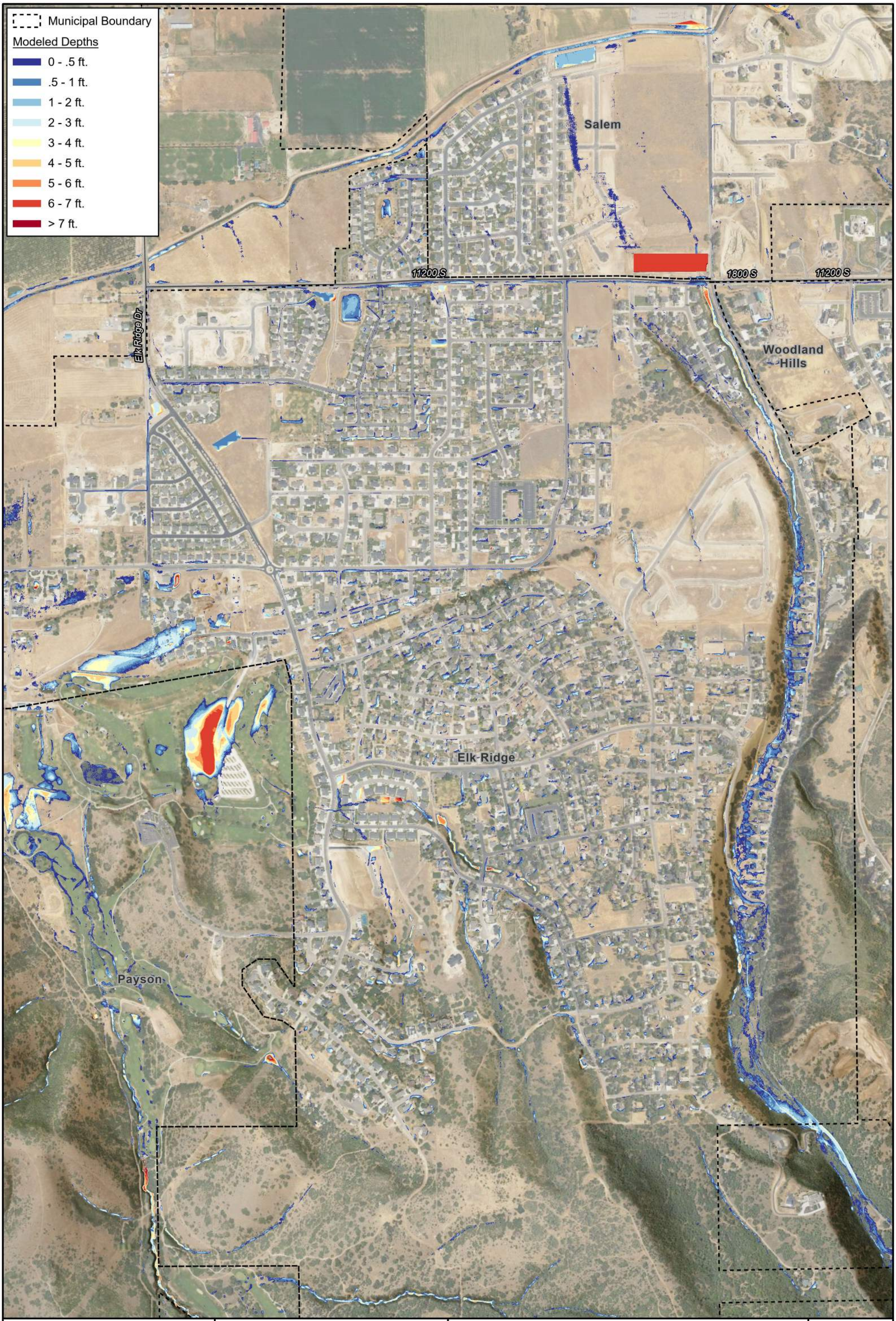
Utah County, Utah

Scale: 1" = 800'

3a

Map Name: H:\2503-013\GIS\Projects\2503-013_Study\2503-013_Study.aprx - 3a. Existing 25-year Depth Overview 11x17P

Project Number: 2503-013 | Drawn by: JEM 01-26 | Last Edit: 01/14/2026



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Jones & DeMille Engineering

Elk Ridge City

FEMA BRIC Scoping Study 2025
Existing Conditions: 100-Year Modeled Depth Overview

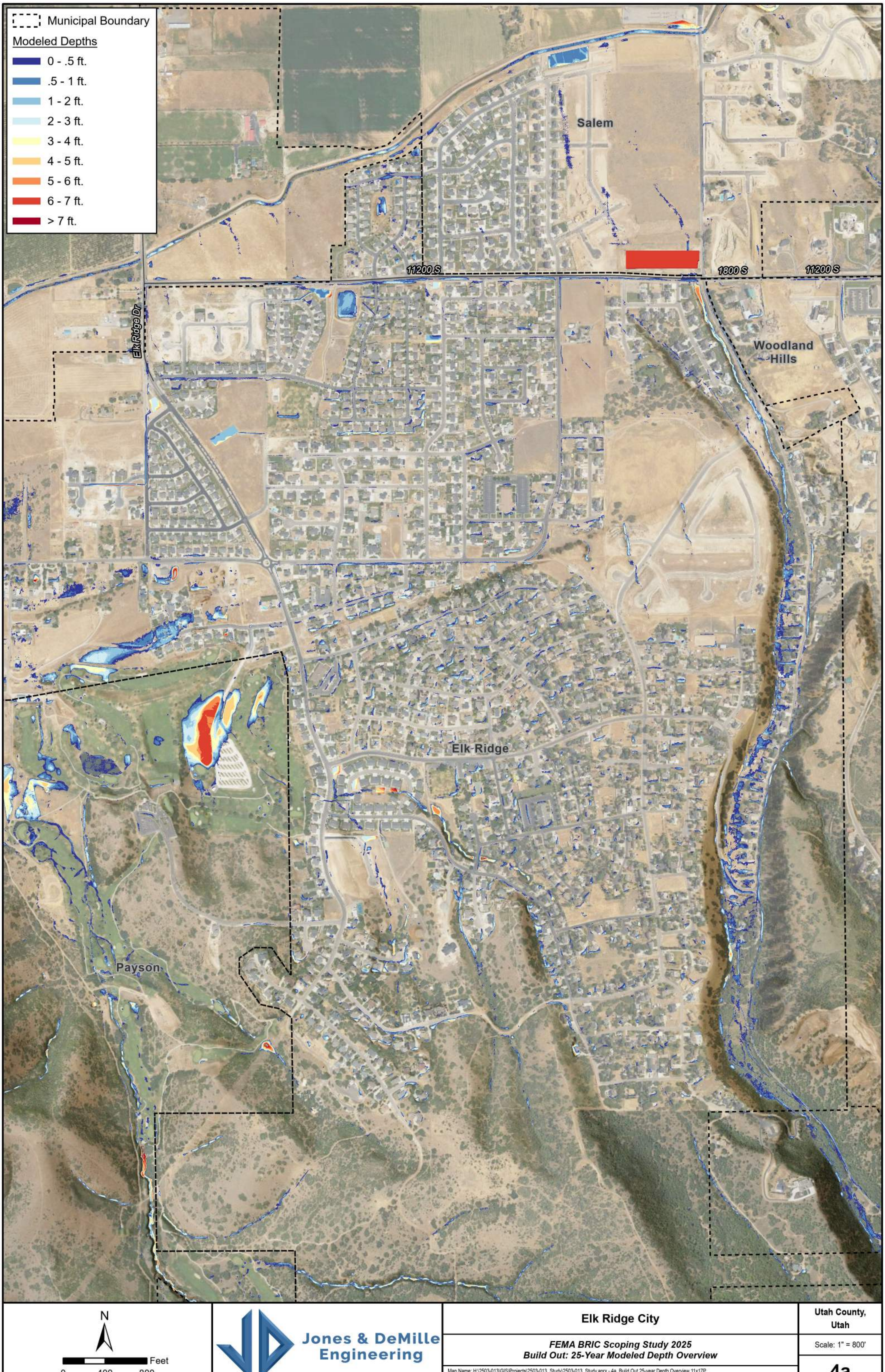
Map Name: H:\2503-013\GIS\Projects\2503-013_Study\2503-013_Study.aprx - 3b. Existing 100-year Depth Overview 11x17P

Project Number: 2503-013 | Drawn by: JEM 01-26 | Last Edit: 01/14/2026

Utah County, Utah

Scale: 1" = 800'

3b



Jones & DeMille Engineering

Elk Ridge City

FEMA BRIC Scoping Study 2025
Build Out: 25-Year Modeled Depth Overview

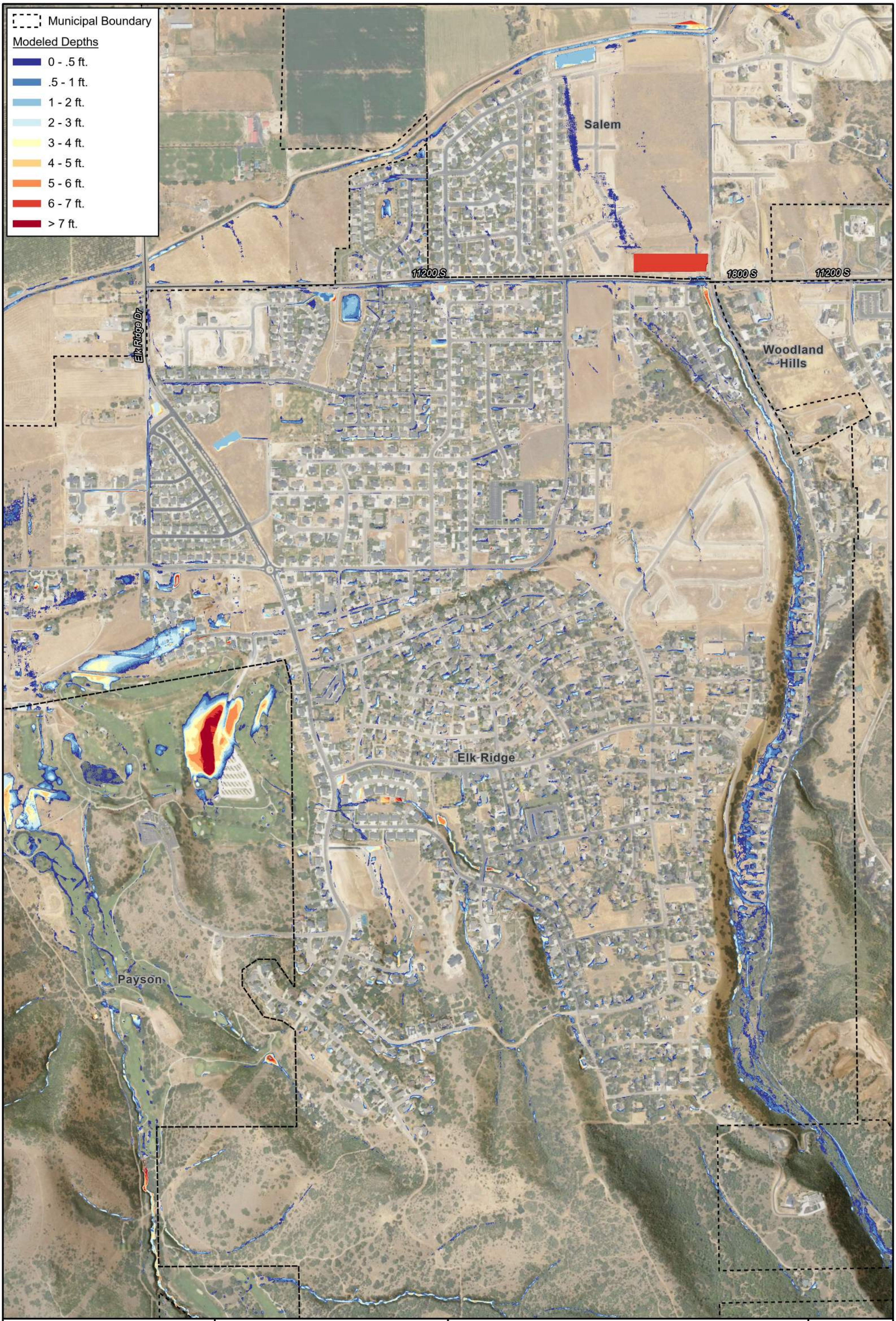
Map Name: H:\2503-013\GIS\Projects\2503-013_Study\2503-013_Study.aprx - 4a. Build Out 25-year Depth Overview 11x17P

Project Number: 2503-013 | Drawn by: JEM 01-26 | Last Edit: 01/14/2026

Utah County, Utah

Scale: 1" = 800'

4a



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Jones & DeMille Engineering

Elk Ridge City

FEMA BRIC Scoping Study 2025
Build Out: 100-Year Modeled Depth Overview

Map Name: H:\2503-013\GIS\Projects\2503-013_Study\2503-013_Study.aprx - 4b. Build Out 100-year Depth Overview 11x17P

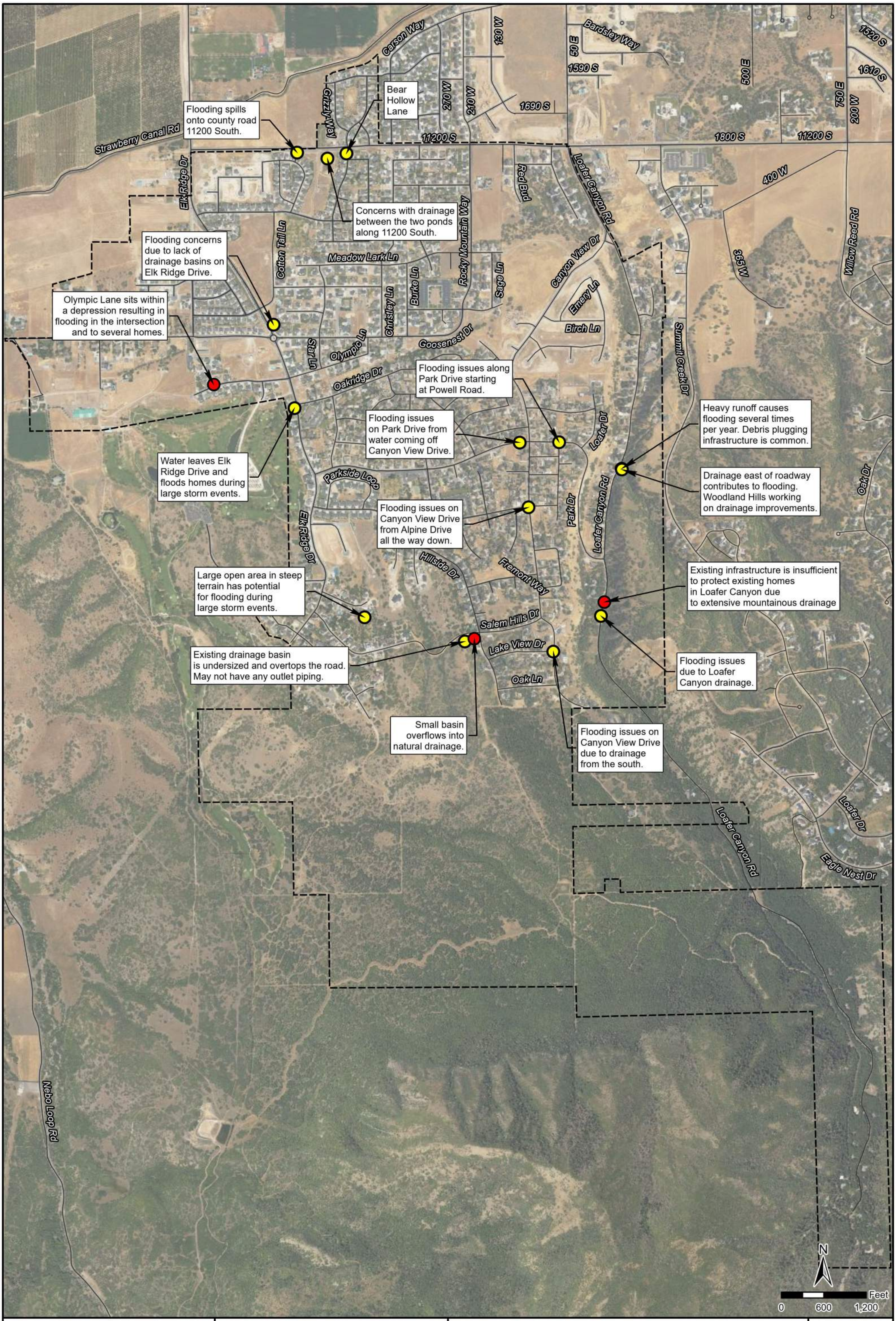
Project Number: 2503-013 | Drawn by: JEM 01-26 | Last Edit: 01/14/2026

Utah County, Utah

Scale: 1" = 800'

4b

APPENDIX C. PROPOSED IMPROVEMENTS



- Modeled Areas of Concern
- Stakeholder Areas of Concern
- Local Roads
- City Boundary

Jones & DeMille Engineering

Elk Ridge City

Utah County, Utah

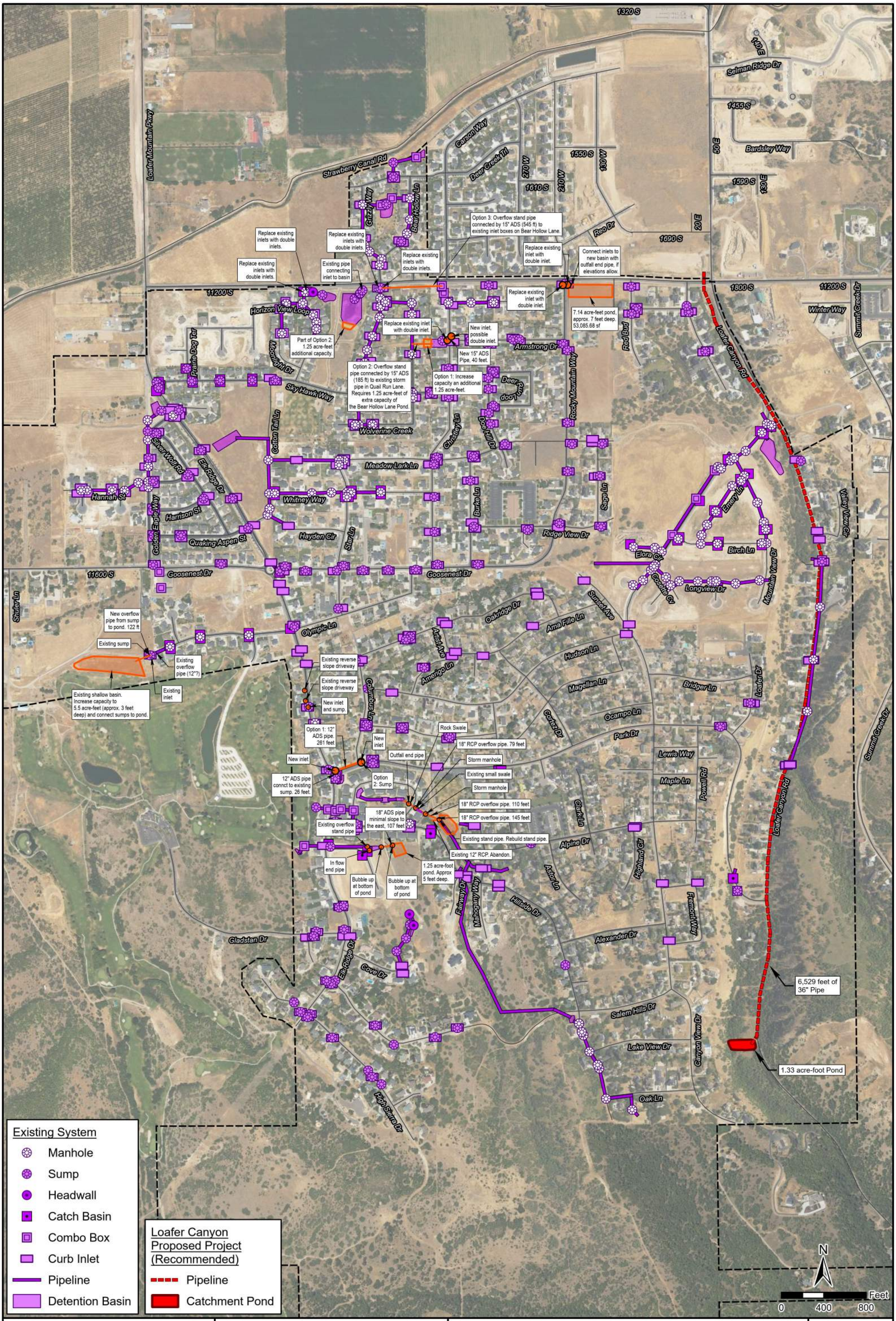
FEMA BRIC Scoping Study 2025
Areas of Concern Overview

Scale: 1" = 1,200'

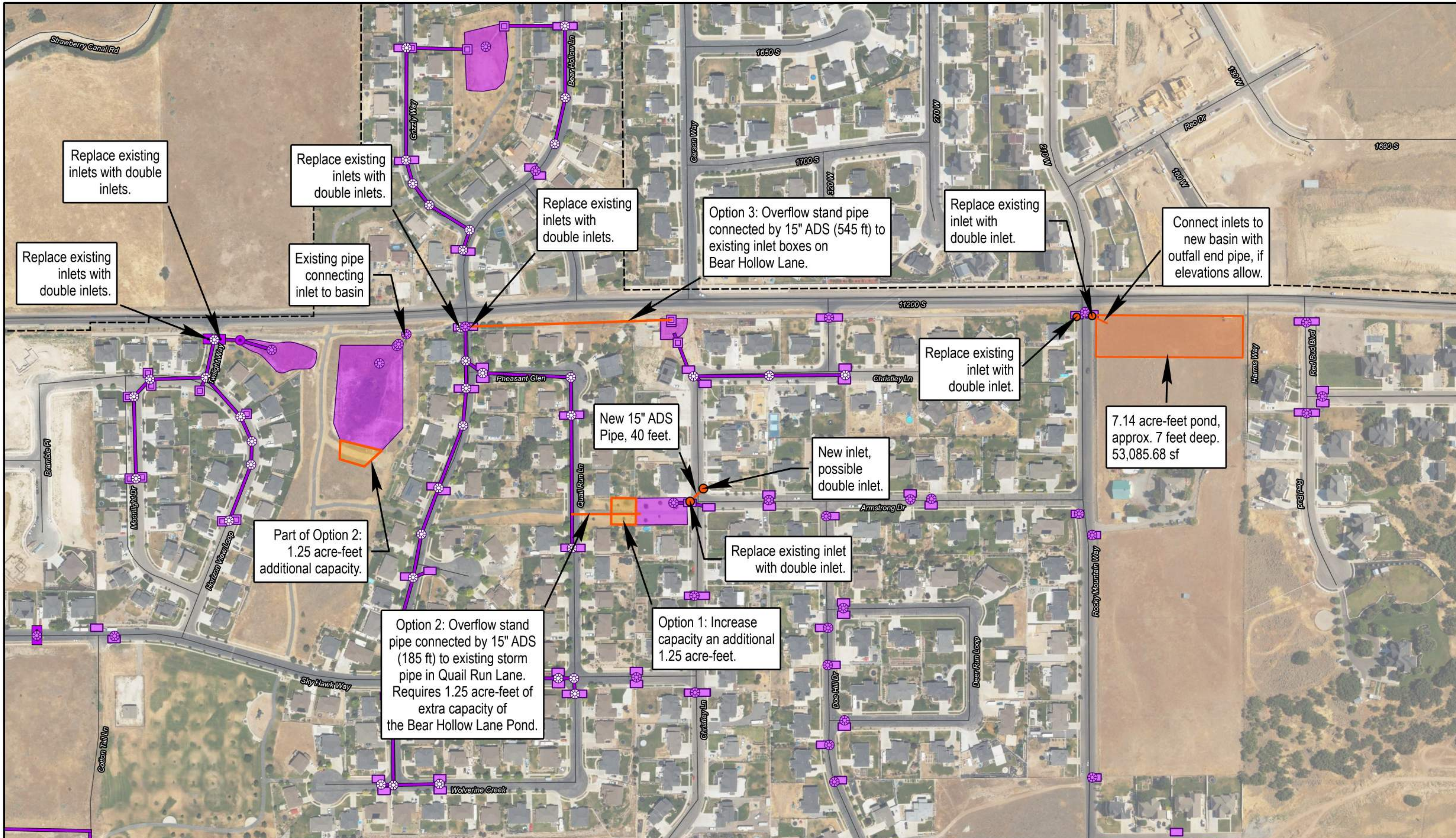
Map Name: H:\2503-013\GIS\Projects\2503-013_Study\2503-013_Study.aprx - Areas of Concern Overview 11x17P

Project Number: 2503-013 | Drawn by: JEM 12-25 | Last Edit: 01/08/2026

1



Concept Project Component Concept Project Pipeline Concept Project Basin	Jones & DeMille Engineering	**Elk Ridge City**	**Utah County, Utah**
		FEMA BRIC Scoping Study 2025 ***Concept Projects Overview***	Scale: 1" = 800'
		Map Name: H:\2503-013\GIS\Projects\2503-013_Study\2503-013_Study.aprx - 2. Concept Project Overview 11x17P Project Number: 2503-013 · Drawn by: JEM 01-26 · Last Edit: 03/30/2026	**2**



Existing System

- Manhole
- Sump
- Headwall
- Catch Basin
- Combo Box
- Curb Inlet
- Pipeline
- Detention Basin

Proposed Improvements

- Concept Project Component
- Concept Project Pipeline
- Concept Project Basin

N

0 250 500 Feet

Jones & DeMille Engineering

Elk Ridge City

FEMA BRIC Scoping Study 2025
Concept Improvements - 11200 S Concepts

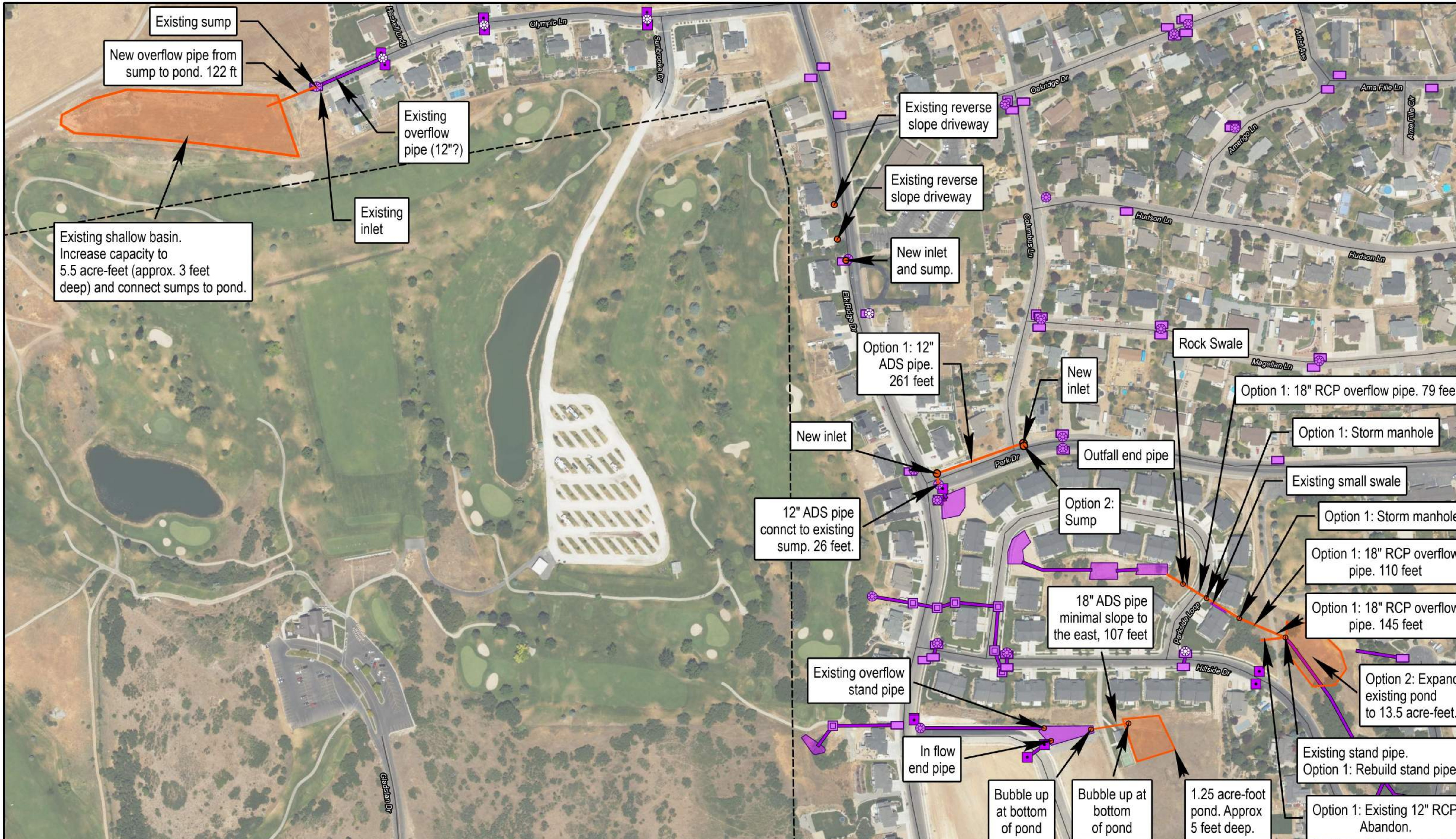
Map Name: H:\2503-013\GIS\Projects\2503-013_Study\2503-013_Study.aprx - Concept Improvements - 11200 S 11x17L

Project Number: 2503-013 | Drawn by: JEM 01-26 | Last Edit: 03/30/2026

Utah County, Utah

Scale: 1" = 250'

3



Existing System

- Manhole
- Sump
- Headwall
- Catch Basin
- Combo Box
- Curb Inlet
- Pipeline
- Detention Basin

Proposed Improvements

- Concept Project Component
- Concept Project Pipeline
- Concept Project Basin

N

0 250 500 Feet

Jones & DeMille Engineering

Elk Ridge City

Utah County, Utah

FEMA BRIC Scoping Study 2025

Concept Improvements - South Concepts

Scale: 1" = 250'

Map Name: H:\2503-013\GIS\Projects\2503-013_Study\2503-013_Study.aprx - 4. Concept Improvements - South 11x17L

Project Number: 2503-013 | Drawn by: JEM 01-26 | Last Edit: 03/30/2026

4

APPENDIX D. PROPOSED IMPROVEMENTS COST ESTIMATES

Item No.	Item Description	Unit	Estimated Quantity	Unit Price	Price
1-0	**Lighthouse Subdivision Pond Expansion Project**				
1-1	Stormwater Basin Excavation and spoils removal	Acre-ft	1.25	$ 50,000.00	$ 62,500.00
1-2	Bubble up structures	Each	2	$ 6,500.00	$ 13,000.00
1-3	18" ADS Pipe	L.F.	107	$ 100.00	$ 10,700.00
1-4	Asphalt and Landscape Surface Restoration	L.S.	1	$ 2,500.00	$ 2,500.00
			Total		**$ 88,700.00**
2-0	**Shuler Park Basin Overflow Improvements**				
2-2	18" RCP Pipe	L.F.	334	$ 150.00	$ 50,100.00
2-3	Rebuild Overflow Manhole/Stand pipe	Each	1	$ 7,500.00	$ 7,500.00
2-4	Stormwater Manhole	Each	2	$ 6,500.00	$ 13,000.00
2-5	Outfall End Pipe	Each	1	$ 1,250.00	$ 1,250.00
2-6	Rock Swale	L.F.	50	$ 125.00	$ 6,250.00
2-7	Landscape Surface Restoration	L.S.	1	$ 2,500.00	$ 2,500.00
			Total		**$ 80,600.00**
3-0	**Park Drive and Elk Ridge Drive Improvements**				
3-1	Curb inlets	Each	2	$ 6,500.00	$ 13,000.00
3-2	12" ADS Pipe	L.F.	26	$ 80.00	$ 2,080.00
3-3	Option 1: Pipe Connection 12" ADS	L.F.	261	$ 80.00	$ 20,880.00
3-4	Option 2: Sump	Each	1	$ 8,500.00	$ 8,500.00
3-5	Asphalt and Curb Surface Restoration	L.S.	1	$ 2,000.00	$ 2,000.00
			Total	Option 1	**$ 37,960.00**
			Total	Option 2	$ 25,580.00
4-0	**Elk Ridge Drive Reverse Slope Driveways Improvements**				
4-1	Curb inlet	Each	1	$ 6,500.00	$ 6,500.00
4-2	Sump	Each	1	$ 8,500.00	$ 8,500.00
4-3	Asphalt and Curb Surface Restoration	L.S.	1	$ 1,000.00	$ 1,000.00
			Total		**$ 16,000.00**
5-0	**Olympic Lane Basin Improvements**				
5-1	Stormwater Basin Expansion and Spoils Removal	Acre-ft	5.5	$ 50,000.00	$ 275,000.00
5-2	12" ADS Pipe	L.F.	122	$ 80.00	$ 9,760.00
5-3	Asphalt Surface Restoration	L.S.	1	$ 1,000.00	$ 1,000.00
			Total		**$ 285,760.00**
6-0	**Twilight Way and Bear Hollow Lane Improvements**				
6-1	Double Inlet Structure	Each	4	$ 12,000.00	$ 48,000.00
6-2	Remove existing inlets and Curb Surface Repair	L.S.	1	$ 1,000.00	$ 1,000.00
			Total		**$ 49,000.00**
7-0	**Christley Lane Basin Improvements**				
7-1	Double Inlet Structure	Each	2	$ 12,000.00	$ 24,000.00
7-2	15" ADS Pipe	L.F.	40	$ 90.00	$ 3,600.00
7-3	Remove existing inlets and Curb Surface Repair	Each	1	$ 1,000.00	$ 1,000.00
7-4	Option 1: Stormwater Basin Expansion and Spoils Removal	Acre-ft	1.25	$ 50,000.00	$ 62,500.00
7-5	Option 2: Pipe Connection 15" ADS Pipe	L.F.	185	$ 90.00	$ 16,650.00
7-6	Option 2: Stormwater Basin Expansion and Spoils Removal	Acre-ft	1.25	$ 50,000.00	$ 62,500.00
			Total	Option 1	**$ 91,100.00**
			Total	Option 2	$ 107,750.00
8-0	**Rocky Mountain Way Storm drain Improvements**				
8-1	Stormwater Basin Excavation and spoils removal	Acre-ft	7.14	$ 50,000.00	$ 357,000.00
8-2	Double Inlet Structure	Each	2	$ 12,000.00	$ 24,000.00
8-3	Remove existing inlets and Curb Surface Repair	L.S.	1	$ 1,000.00	$ 1,000.00
			Total		**$ 382,000.00**
				Total Project Cost	**$ 1,031,120.00**

APPENDIX E. PROPOSED STORM DRAIN DESIGN STANDARDS

Introduction

The following design standards apply to the design of all stormwater and floodplain improvements for areas within Elk Ridge City (the City). All hydrologic and hydraulic evaluations and designs for a proposed commercial or industrial site or multi-house development shall be performed in accordance with sound and accepted engineering practices by a professional engineer, licensed in the State of Utah and qualified to perform such work. The overarching objective of this guidance is to:

- Eliminate increased peak runoff which naturally occurs with development due to an increase in impervious surfaces (i.e., do not increase downstream flows from pre-development or existing/natural conditions).
- Implement site-specific solutions for conveyance and detention/retention as required to maintain pre-development flows, thus not creating downstream flooding issues.
- Formalize the process for the design and review of stormwater calculations, designs, etc. between developers and the City.

To this end, the stormwater system design guidelines are provided as outlined below:

1. General Design Criteria
2. Methodology
3. Low Impact Development Guidelines
4. Conveyance Facilities
5. Storage Facilities
6. Other Related Permits
7. Drainage Report

1. General Design Criteria

- The overall storm drainage system must be designed to ensure the downstream total peak flowrate does not increase with additional runoff created by the proposed site or development; or in other words, the downstream post-development peak flowrate must be equal to or less than the downstream pre-development peak flowrate for the 10-year 24-hour and 100-year 24-hour storm events.
- The capacity of downstream infrastructure should be considered. If the downstream conveyance capacity is insufficient, the developer should work with the City to develop a design that reduces flows sufficient to meet downstream capacities (possibly reducing flows less than the pre-development conditions).
- The stormwater drainage analysis and proposed system should consider on-site and off-site flows. This includes drainage areas upstream of the project site, which drain onto and through the project site. Conveyance and/or storage facilities should be sized to accommodate predicted site drainage as well as historic off-site drainage. Storage facilities do not need to store or retain off-site drainage but must be able to safely pass off-site drainage without affecting the storage of on-site drainage.

- Components of the storm drainage system shall be sized based on the design frequency in the table below:

Facility Type	Design Storm	Description
Minor Conveyance	10-year, 24-hour	Facilities which convey on-site flows only, such as culverts, drainage swales, pipelines, channels, & curb inlets. Minor conveyance facilities drain to major conveyance and storage facilities.
Major Conveyance	100-year, 24-hour	Facilities which convey off-site and on-site flows (mixed water) including culverts, pipelines, and channels.
Storage Facilities	100-year, 24-hour	All storage facilities are to be designed for the 100-year storm even if they only store on-site flows. Storage facilities are not required to store or retain off-site drainage as long as the storage facility discharge does not exceed pre-development levels.

- Existing commercial, industrial or residential properties may be evaluated on an individual basis if improvements required by these guidelines would adversely impacting neighboring properties.

2. Methodology

- Hydrology calculations which require the peak flowrate and volume shall follow the SCS method as outlined in the NRCS National Engineering Handbook using the Type II distribution.
- The rational method can be used if only the peak flowrate is needed (only conveyance features are required such as culverts and channels).
- Precipitation data shall be obtained from NOAA Atlas 14.
- The time of concentration should be calculated using the NRCS Velocity method as outlined in the Natural Resources Conservation Service Technical Release 55, June 1986 (TR-55).
    - A minimum time of concentration of 5 minutes shall be used.

3. Low Impact Development Guidelines

Typical storm drain design consists of collect and convey systems to route runoff through and away from developed areas. Low Impact Development (LID) practices utilize storm drain infrastructure to collect, clean, and infiltrate runoff. There are many benefits to LID practices including reducing downstream discharge, groundwater recharge, reduced pollutants, and infrastructure cost savings.

All new developments implement LID design practices to the greatest extent possible, where feasible. “A Guide to Low Impact Development within Utah” which was published by the Utah Department of Environmental Quality should be used as a resource to design LID techniques within new development areas. This manual as well as other LID design resources can be downloaded from the following website.

https://deq.utah.gov/water-quality/low-impact-development

All site and subdivision designs shall control the peak flow rates of storm water discharge associated with design storms specified in this chapter and reduce the generation of post-construction storm water runoff volumes and water quality to pre-construction levels. These practices should seek to utilize pervious areas for storm water treatment and to infiltrate storm water runoff from driveways, sidewalks, rooftops, parking lots, and landscaped areas to the maximum extent practical to provide treatment for both water quality and quantity. Other LID methods are also encouraged.

The 80th percentile storm volume shall be retained on site. Areas with high groundwater or poor soil may be exempt from this requirement due to poor infiltration rates. Evidence supporting claims of poor infiltration such as soils testing or infiltration testing shall be submitted for developments where retention of the 80^{th} percentile storm is unfeasible.

4. Conveyance Facilities

All conveyance facilities should be designed to carry the design storms listed in the General Design Criteria section. Special criteria for conveyance facilities are as follows:

- The minimum size of all culverts and storm drainage pipe diameter is 15 inches to allow for maintenance such as cleaning. This includes driveway culverts.
- All culverts are to be constructed with an intake apron, for City maintained culverts (under city roadways) a trash grate is required.
- Main drain lines connecting manholes are to be reinforced concrete pipe class III.
- Conveyance systems should be evaluated for scour and erosion.
- Piped conveyance systems should be designed to maintain minimum velocities of 2 feet per second, to allow for flushing of debris and sediment. Open channel conveyance systems should be designed to not exceed a peak velocity of 5 feet per second to avoid scour and erosion. Special cases not meeting this requirement must be approved by the city.
- Manholes are required every 400 feet for storm drainage pipelines, and at changes in grade or direction.
- Minimum manhole diameters shall follow the following minimum requirements:
    - Four (4) foot minimum manhole diameter for main lines less than 18 inches in diameter
    - Five (5) foot minimum manhole diameter for main lines 18” to 30” in diameter.
    - Six (6) foot minimum manhole diameter for main lines greater than 30” in diameter
    - The minimum structural leg width (6” minimum) between pipe core holes must be maintained when multiple pipes intersect a manhole.
- Drainage swales within street right-of-way are required for roadside drainage where curb and gutter is not used. Swales must be sized to convey the site conditions, having a minimum of 18-inch depth with max side slope of 3:1.
- Preserve and protect natural flood water conveyance corridors and channels in easements dedicated to the City and with improvements where necessary.
- Drainage ways that allow infiltration in minor storm events are encouraged.

5. Storage Facilities

All storage facilities should be designed based on the design storms listed in the General Design Criteria section. Storage facilities can be either retention (stores 100% of flow with no release) or detention (temporarily stores flows and releases at controlled rate) facilities. Special criteria for storage facilities are as follows:

- Post-developed discharge rates shall not exceed pre-developed discharge rates for the 10-year and 100-year storms. Check both storms and design/size detention pond outlet structures accordingly. In no case shall the storm drain discharge from a development or site exceed 0.20 cfs/acre for on-site runoff. LID practices as described in Section 3 above shall be implemented.

- Retention ponds must be sized to capture and contain the entire 100-year event.
- For detention basins, the entire 100-year storm shall be routed through the principal outlet without activating the emergency spillway. This is typically accomplished with a grate at the top of the outlet structure. The routed 100-year water surface is typically set at the emergency spillway crest elevation.
- All storage facilities shall be designed to completely drain within 3 days of the end of a storm event (retention facilities must be designed to infiltrate in this time, field testing with a single ring infiltrometer is required to confirm adequate infiltration).
- Detention basin principal outlet pipes shall be at least 18-inches in diameter to minimize the chance of clogging and to facilitate cleaning. Orifice plates are to be used on the upstream end of the principal outlet pipe to reduce the maximum release flowrate and must be inside a storm drain box to facilitate cleaning.
- Emergency spillways shall be designed to safely pass the 100-year storm, without endangering life or property downstream, assuming the principal spillway outlet is not functioning.
- A minimum of 1 foot of freeboard above the emergency spillway design water surface elevation is required (routed 100-year storm assuming principal spillway outlet is clogged).
- The invert or lowest point of a storage basin must be minimum 12-inches above historic groundwater levels.
- All storage facility slopes shall have a maximum slope of 3:1 and must be stabilized with rock or planted vegetation to prevent erosion.
- No part of the bottom of the basin shall have a slope of less than 3% sloped toward the outlet. Within 10-feet of the outlet, the slope of the basin bottom must not be flatter than 5% unless a concrete apron is constructed around the outlet. In this case, the minimum slope for the concrete apron shall be 0.50%.
- Storage basins should be designed with a maximum water depth of 3 feet. Deeper basin may be permitted as approved by the city but will require at minimum a two-rail perimeter fence.
- Underground systems are not allowed in drinking water source protection zones.
- Underground systems shall provide adequate access for cleaning and maintenance.
- If the detention basin is classified as a dam, the facility shall also comply with prevailing dam safety standards as outlined by the Utah State Dam Safety and the Utah Division of Water Rights. See applicable design standards to determine if the pond should be classified as a dam.
- Field testing with a single ring infiltrometer is required to confirm adequate infiltration in all basins or sumps where infiltration will be used. A supporting report shall be stamped by a licensed geotechnical engineer and submitted as part of the drainage report.
- If sumps are used to manage storm water runoff, calculations shall be provided showing how the sumps in combination with other drainage features will manage the required runoff volume.

6. Other Related Permits

Other permits may be required for the proposed development. These permits should be considered as part of the proposed drainage system and be referenced in the documentation. Applicable permits may include:

- Stream Alternation Permit
- Floodplain Development Permit (if in FEMA designated floodplain)
- Small Dam Application (assuming pond is classified as a dam per Utah Dam Safety)

This list is not exhaustive. Additional permitting may be identified and required during the approval process.

7. Drainage Report

All proposed developments are required to submit a drainage report for the Cities review and approval. The report is to include enough detail to provide assurance that the development will control stormwater drainage in a safe manner, and not pose a flood risk to residents downstream or within the development. The following information is required at a minimum:

- Drainage Report Outline
    - Introduction
    - References
    - General property description
        - Include known flooding issues
    - Off-site and on-site drainage description
        - Include relevant downstream conveyance facilities
    - Design runoff computations
        - Map of drainage basins delineated
        - Precipitation
        - Land cover and soil conditions
        - Runoff curve number and/or rational method coefficient
        - Time of concentration
        - Hydrology model results for all drainage basins comparing pre-development and post-development peak flows and volumes, considering on-site and off-site areas
    - Design of drainage facilities
        - All hydraulic and hydrologic calculations used to design conveyance facilities
        - All hydraulic and hydrologic calculations used to design storage facilities
        - Operation and maintenance considerations
        - LID design summary and/or limiting factors including retention basin drain times
    - Other related permits
        - Indicate implications to streams, wetlands, FEMA designated floodplains, if ponds should be classified as a dam, etc. – and indicate if permitting is needed (e.g., stream alteration permit, Floodplain Development Permit, Small Dam Application, etc.)
    - Statement of compliance
        - Include stamp by professional engineer
    - Appendix
        - Modeling results, hydrographs, tables, etc.
        - Maps of drainage basin characteristics, existing and proposed contours, including drainage basin delineation, land cover, soils, drainage paths, etc.
        - FEMA floodplain maps, if applicable
        - A supporting report shall be stamped by a licensed geotechnical engineer supporting the infiltration rates used.

APPENDIX F. WESTERN KENTUCKY STORMWATER UTILITY SURVEY

APPENDIX G. HMS MODEL RESULTS AND CALLCULATIONS