



PARADISE VALLEY STORM WATER MASTER PLAN

June 30, 2025



Prepared by

Kimley»Horn

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I. EXECUTIVE SUMMARY

The Paradise Valley Master Plan identifies and assess areas susceptible to flooding and proposes mitigation strategies to address the highest-risk areas. This plan supports the Town's efforts to prioritize projects for Capital Improvement Program (CIP) and grant funding opportunities. Potential flood risk areas were identified through input from Town staff and residents, previous studies, and new comprehensive townwide hydrology and hydraulic modeling.

Purpose of Study

The primary objective of the study is to identify flood-prone areas and offer solutions that will assist the Town of Paradise Valley in strategic planning for flood mitigation.

Methodology

The Master Plan incorporates data from Town staff and residents, previous efforts and two-dimensional (2D) hydrologic and hydraulic modeling from the Flood Control District of Maricopa County (FCDMC) Area Drainage Master Studies/Plans (ADMP/S). These data are coupled with new town-wide 2D modeling using current rainfall, land use, topography, and hydraulic structures data to pinpoint potential flood hazards and effective mitigation strategies.

Study Location

The study covers the entire Town of Paradise Valley, encompassing approximately 15 square miles. The area is significantly impacted by runoff from surrounding mountains, including Mummy Mountain and Camelback Mountain. In addition, townwide modeling also included flow inputs from the surrounding areas in both the City of Phoenix and the City of Scottsdale. A Hydrology Report was prepared under separate cover detailing the modeling approach.

Data Collection

Data was aggregated from diverse sources, including past drainage studies, FCDMC ADMP/Ss, reports from Town staff and residents, and on-site documentation. This preliminary understanding of flooding hazards forms the foundation for the Master Plan. Housing this data in one reference was also a primary goal of the Master Plan.

Existing Infrastructure Evaluation

The Master Plan evaluates existing basin, channel, storm drain, and culvert capacities by reviewing performance during the 2-, 10-, and 100-year storm simulations per the modeling effort. This approach allows for an estimate of existing capacities as less than 2-year, between 2- and 10-year, between 10- and 100-year, and greater than 100-year. Significant findings include undersized inlets/storm drain affecting residential neighborhoods, and culverts that impede the traveling public and emergency access.

Flood Hazard Analysis

Flood analysis includes evaluating inundation risk, erosion and sediment deposition hazards, and potential risks to passenger vehicles. These insights were crucial in identifying flood hazard areas within the Town. These analyses were also coupled with staff and resident flood complaints, road closure locations, and undersized culvert locations to better develop a holistic understanding of flood hazards throughout the town. The Master Plan creates a database of each hazard that can be used in the future to plan routine maintenance and smaller scale improvement projects as part of the annual maintenance budget.

Flood Hazard Area Classification

Nineteen distinct flood hazard areas were identified and classified within the Town based on the extent and nature of flooding. Each the flood hazard for each identified area was characterized as either nuisance, moderate, or severe using the following criteria:

- **Nuisance Flooding:** Water depth approximately 0.5 to 1 foot along roads and adjacent to structures.
- **Moderate Flooding:** Water depth approximately 1 to 2 feet along roads and adjacent to structures.
- **Severe Flooding:** Water depth greater than 2 feet along roads and adjacent to structures.

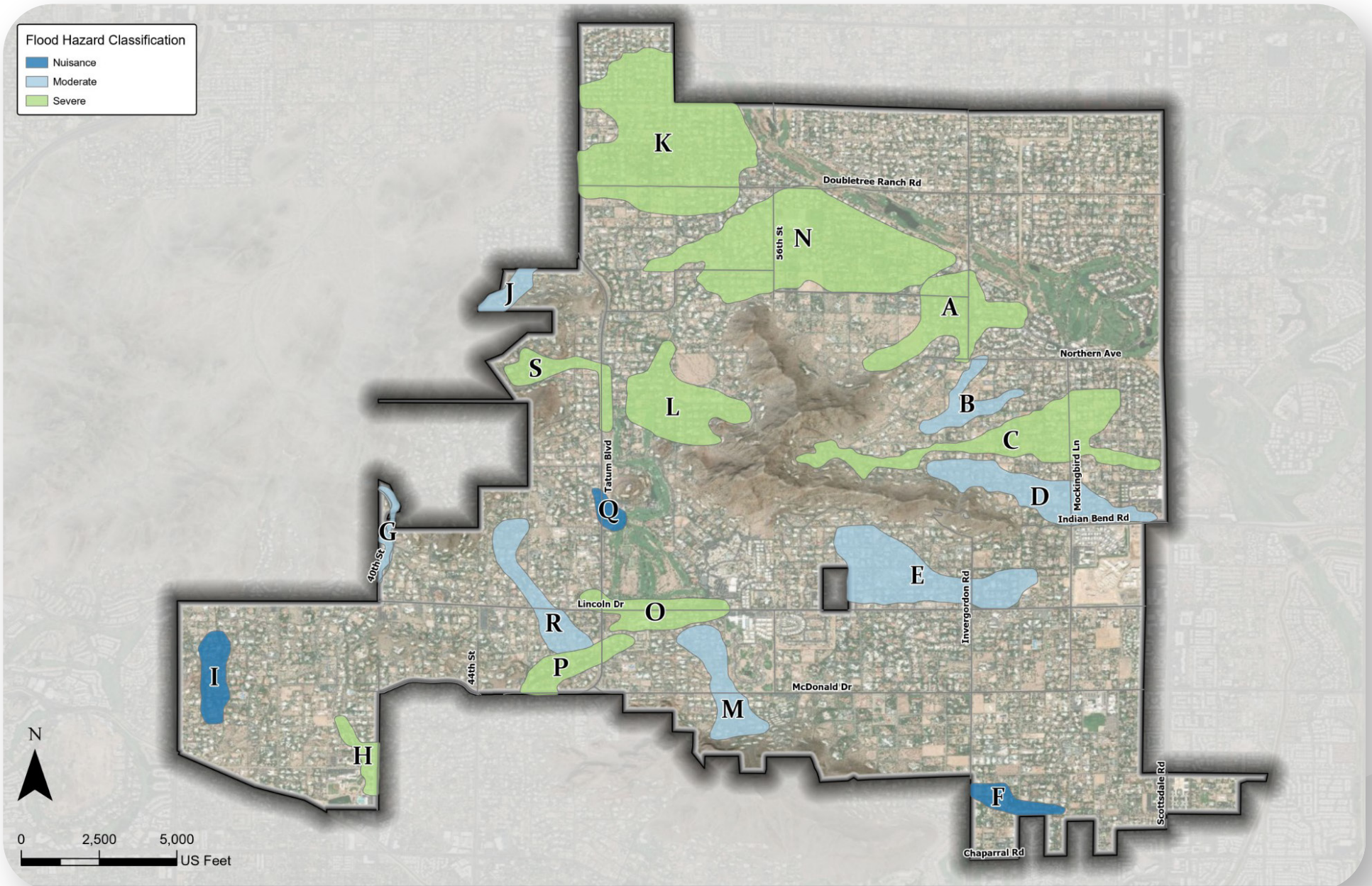
A decision matrix is used to rank the flood hazard areas incorporating the criteria and weights shown below, allowing the plan to prioritize areas that would benefit the greatest from flood mitigation.

1. Severity of Flooding (Weight: 5)

- This criterion received a weighted score of 5, as it directly impacts the safety



Figure 7: Classifications of Flood Hazard Areas





PARADISE VALLEY STORM WATER MASTER PLAN

and well-being of residents and the community. The degree of flooding, whether nuisance, moderate, or severe, influences the urgency and scale of necessary interventions.

2. Potential Structures Protected (Weight: 5)

- The number of structures that could be protected by mitigation measures was also heavily weighted. This criterion reflects the plan's focus on minimizing property damage and protecting as many residential and commercial buildings as possible.

3. Potential Streets Protected (Weight: 4)

- The number of roads (local, collector, arterial) affected by flooding and their role in community connectivity and accessibility were considered significant, but slightly less critical than the direct impact of flooding on structures and severity.

4. Impacts to Emergency Access (Weight: 3)

- Evaluating how flooding affects emergency vehicle access and response times was important, as maintaining reliable emergency services is crucial during and after flood events. This criterion was given a moderate weight.

5. Multi-Use Opportunities (Weight: 1)

- This criterion considered the potential for projects to incorporate additional community benefits beyond flood mitigation, such as recreational spaces or aesthetic enhancements. It had the lowest weight, reflecting its lower priority relative to immediate flood risk reduction.

For a detailed review of how each criterion was scored and its weight, please refer to the decision matrices included within the full text of the Master Plan and **Appendix D** where the area decision matrix and area data sheets are provided.

Snapshot of Decision Matrix (Table 6 from the Master Plan)

Criteria	Scoring Criteria	Score Range	Weighted Score
Severity of Flooding	Nuisance, Medium, Severe	1, 3, 5	5
Potential Structures Protected	1 to 30 Structures, 31-50 Structures, >51	1, 3, 5	5

Criteria	Scoring Criteria	Score Range	Weighted Score
Potential Streets Protected	Local Street Benefits Only, Arterial/Collector Street or Multiple Local Streets Benefits, Multiple arterial/collector & Local Street Benefits	1, 2, 4	4
Impacts to Emergency Access	No Impact to Emergency Access, Impacts to Emergency Access	1, 3	3
Multi-Use Opportunities	No Opportunities, Possible Opportunities	1, 2	1

The nine-highest ranking flood hazard areas are furthered for project alternative development. Nine areas were chosen to advance based on the scoring results and a logical breakpoint. The nine highest-ranking flood hazard areas identified are:

- Flood Hazard Area A:** Invergordon Road and Mockingbird Lane
- Flood Hazard Area C:** Cheney Wash
- Flood Hazard Area E:** Lincoln Wash
- Flood Hazard Area H:** 40th Street and Stanford Drive
- Flood Hazard Area K:** Mountain View Road
- Flood Hazard Area L:** Upstream Cherokee Wash
- Flood Hazard Area N:** Downstream Cherokee Wash
- Flood Hazard Area O:** Lincoln Drive
- Flood Hazard Area P:** Tatum Boulevard and McDonald Drive

Proposed Project Alternatives

For the nine highest-ranking flood hazard areas, flood mitigation projects are identified and/or developed. Identified projects are those from previous studies. These projects and new projects are further developed. Projects are categorized into maintenance projects, medium-sized projects, and large projects based on their estimated construction costs:

- Maintenance Projects:** Costs less than \$250,000.
- Medium Projects:** Costs between \$250,000 and \$1.3 million. These are eligible for the Flood Control District of Maricopa County's Small Project Assistance Program (SPAP).
- Large Projects:** Costs exceed \$1.3 million. These projects qualify for other grant programs like the Flood Control District of Maricopa County's Capital Improvement Project Partnership Program (CIPPP) or other grant opportunities through FEMA.



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For the nine areas, two to three medium and large-scale project alternatives are developed and proposed. Small projects are not included as these projects are more appropriate as annual maintenance projects. Project costs, benefits, and multi-use opportunities are determined such that the most effective flood mitigation strategies are recommended for each area. A decision matrix similar to the matrix used to rank flood hazard areas is used to rank the alternatives for a given area.

Snapshot of Project Prioritization Matrix (Table 8 from the Master Plan)

Criteria	Scoring Criteria	Weighted Score	Highest Possible Score	Lowest Possible Score
Potential Structures Protected	1 to 30 Structures	5	15	5
	31 to 50 Structures	5	15	5
	> 51 Structures	5	15	5
Design & Construction Cost/Benefit	Most Expensive	10	10	5
	Least Expensive	10	10	5
Potential Streets Protected	Local Street Benefit Only	4	12	4
	Arterial/Collector Street or Local Streets Benefit	4	12	4
	Multiple Arterial/Collector Streets and Local Streets Benefit	4	12	4
Green Storm Water Infrastructure	No Opportunities	1	2	1
	Some Opportunities	1	2	1
Project Partnership	Grant Funding or Partnerships Likely	4	12	4
	Local Partnership/Grant Eligible	4	12	4
	Local and Federal Partnerships/Grant Eligible	4	12	4
Multi-Use Opportunities	No Opportunities	2	4	2
	Some Opportunities	2	4	2
Operation and Maintenance Costs	Maintenance After Every Storm Event	3	6	3
	Maintenance at Standard Intervals	3	6	3
Utility Constraints	Major Constraints	3	6	3
	Minor Constraints	3	6	3

This table outlines the criteria used to prioritize projects, assigning a weighted score to each criterion to help determine the overall priority of each project, and ultimately selected a recommended project alternative.



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Highest Priority Alternatives – Benefit Cost Analysis

Of the nine highest-ranking flood hazard areas identified in the Paradise Valley Master Plan, recommended alternatives for the top six are further developed into 15% conceptual plans, with engineer's opinion of probable costs (EOPC) and cost/benefit analysis also included. The top six areas and recommended alternatives are:

1. Flood Hazard Area A – Invergordon and Mockingbird Lane

- Recommended Alternative: Implementation of new storm drain systems along Invergordon Road and Maverick Road, with inlets and lateral extensions. The estimated construction cost for this alternative is approximately \$11,616,355.

2. Flood Hazard Area H – 40th Street and Stanford Drive

- Recommended Alternative: Improvements to the existing roadway drainage infrastructure including curb inlets, a flood control basin at the corner of Stanford Drive and 40th Street, safety rails, staff gages, and warning signs. The estimated construction cost for this alternative is approximately \$1,039,500.

3. Flood Hazard Area K – Mountain View Road

- Recommended Alternative: Construction of a detention/retention basin upstream of Mountain View Road to reduce runoff discharge at Tatum Boulevard. The estimated construction cost for this alternative is approximately \$6,072,476.

4. Flood Hazard Area L – Upstream Cherokee Wash

- Recommended Alternative: Replacement of low water crossings at Crestview Drive, Arroyo Drive, and Desert Jewel Drive with box culverts and necessary road improvements. The estimated construction cost for this alternative is approximately \$6,113,214.

5. Flood Hazard Area N – Downstream Cherokee Wash

- Recommended Alternative: Replacement of four low water crossings at 58th Place, 59th Place, Morning Glory Road, and 61st Place with box culverts and channel improvements. The estimated construction cost for this alternative is approximately \$2,800,333.

6. Flood Hazard Area O – Lincoln Drive

- Recommended Alternative: Increase culvert capacity at Desert Fairways Drive, Lincoln Drive, and 51st Place by replacing undersized culverts with new configurations and making corresponding road improvements. The estimated construction cost for this alternative is approximately \$1,979,147.

Grant Funding Opportunity

The plan identifies accessible grant funding options, including the Flood Control District of Maricopa County's (FCDMC) SPAP and CIP programs, and outlines other state and federal funding opportunities.

Prioritization

Projects were prioritized based on cost, benefit/cost ratios, and mitigation impacts. Key considerations included grant funding accessibility and overall project effectiveness. Prioritization is qualitative in nature, as both medium and large projects are included, as well as projects that benefit both roadway and residential structure. This will allow the Town to program projects into CIP planning based on funding, grant opportunities, and overall Town priorities.



PARADISE VALLEY STORM WATER MASTER PLAN

Abbreviation Guide

Abbreviation	Meaning
PV-SWMP	Paradise Valley Storm Water Master Plan
CIP	Capital Improvement Project
2D	Two-dimensional
FCDMC	Flood Control District of Maricopa County
ADMP/S	Area Drainage Master Plans/Studies
ACDC	Arizona Canal Diversion Channel
CIPPP	Capital Improvement Project Partnership Program
FEMA	Federal Emergency Management Agency
EOPC	Engineer's Opinion of Probable Cost
SPAP	Small Project Assistance Program
CCW	Cudia City Wash
MIBW	Middle Indian Bend Wash
LIBW	Lower Indian Bend Wash
ESC	East Shea Corridor
PE	Professional Engineer
FLO-2D	Floodplain Modeling in Two-dimensions
RCBC	Reinforced Concrete Box Culvert
CMP	Corrugated Metal Pipe
PCSWMM	Personal Computer Storm Water Management Model
GIS	Geographic Information System
USD	United States Dollar
USACE	United States Army Corps of Engineers
BCR	Benefit-Cost Ratio



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II. INTRODUCTION

A. Purpose of Study

The primary objective of the Paradise Valley Master Plan Master Plan is to identify and quantitatively assess areas vulnerable to flooding and to propose flood mitigation strategies to address areas at the highest risk. The flooding solutions proposed in this study are intended to assist the Town with prioritizing projects for Capital Improvement Program (CIP) and for identifying grant funding sources to aid in project development.

B. Methodology

The Master Plan utilized data collected by previous efforts in the Town, and two-dimensional (2D) hydrologic and hydraulic modeling from Flood Control District of Maricopa County (FCDMC) Area Drainage Master Studies/Plans (ADMP/S) for an initial assessment of flood hazards. New, comprehensive town-wide 2D modeling was also developed by incorporating up-to-date rainfall, land use, topography, and hydraulic structures data. These models serve as the basis for identifying and characterizing potential flood hazard areas, utilizing defined criteria to assess the level of risk. Subsequently, multiple drainage solutions were established for each identified area. Based on feedback and priorities provided by the Town Council, staff, and residents, the most beneficial flood mitigation projects were selected. The selected projects were further developed into conceptual plans with associated cost. With the results and recommendations derived from this comprehensive study, Paradise Valley can formulate an informed and strategic plan for effective flooding mitigation.

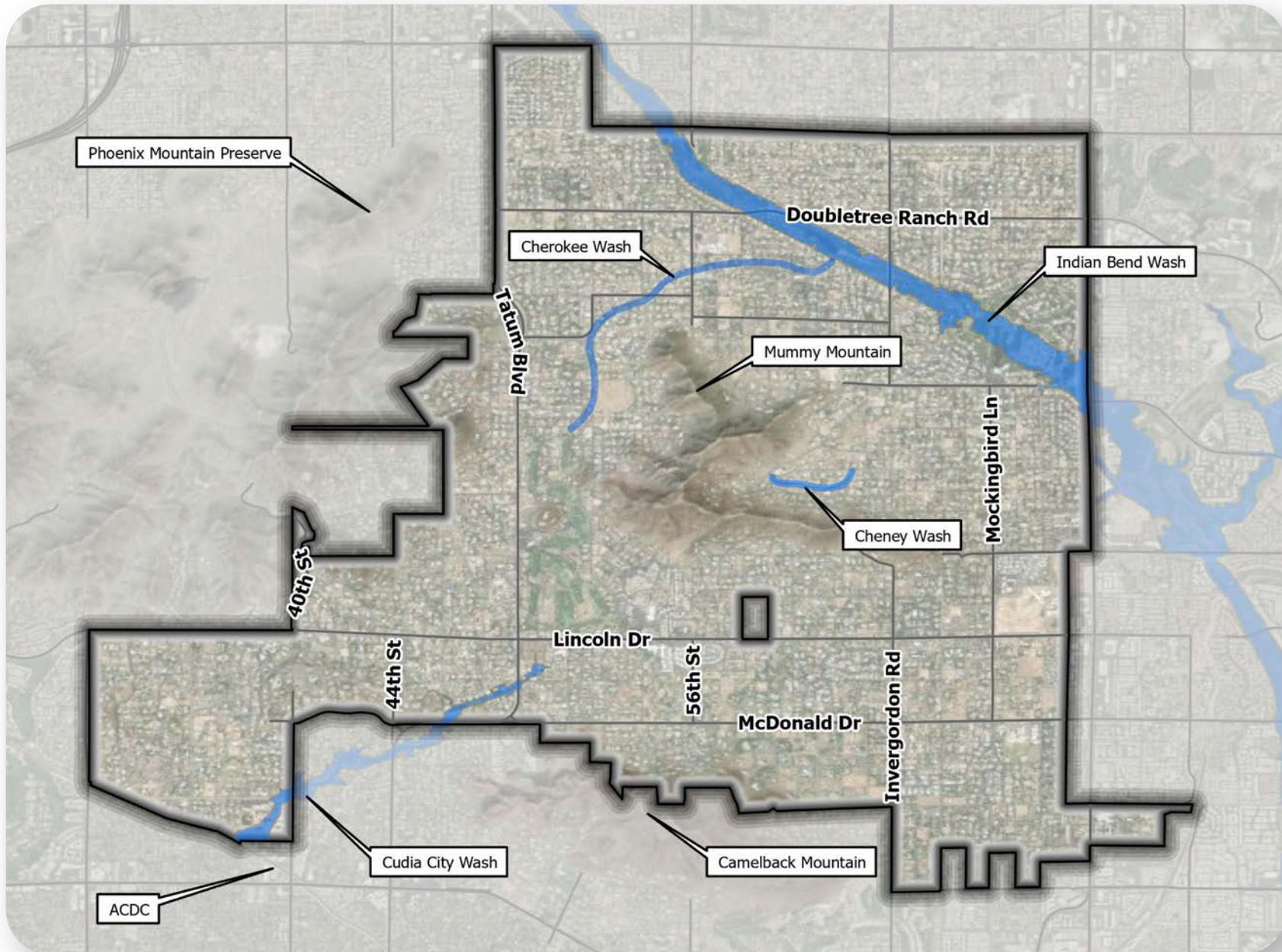
C. Study Location

The project area is the entire Town of Paradise Valley, approximately 15 square miles. Paradise Valley is bordered roughly by Shea Blvd to the north, Scottsdale Rd to the east, Camelback Mountain and Camelback Road to the south, and the Phoenix Mountain Preserve and Arizona Canal to the west. Flooding in the Town is primarily attributed to runoff from surrounding mountains and lack of conveyance through residential areas. Mummy Mountain, centrally located in Paradise Valley, plays a significant role in contributing runoff to the major washes in the area, namely Cherokee Wash, Cheney Wash, and Cudia City Wash. Camelback Mountain, situated along the southern border of the Town, contributes to the flow in Cudia City Wash. The western portion of the Town is impacted by runoff from the Phoenix Preserve Mountains, which flow into both Cudia City Wash and Cherokee Wash. Indian Bend Wash (IBW) is the largest flood conveyance corridor in the Town and is the ultimate outfall for the northern and southeast portion of Paradise Valley. The southwest portion of the Town primarily drains to Cudia City Wash and then to the Arizona Canal Diversion Channel (ACDC). The location and major features within Paradise Valley are shown in **Figure 1 and Appendix A**.



PARADISE VALLEY STORM WATER MASTER PLAN

Figure 1: Location Map





III. DATA COLLECTION

The data collected for the Paradise Valley Master Plan was from multiple sources and consisted of both qualitative and quantitative flood related information. These sources included past drainage studies and FCDMC ADMS/Ps with corresponding modeling results, reports of flooding issues from Town staff and residents, and on-site documentation. By incorporating and analyzing these diverse sources of data, a preliminary understanding of the extent of flooding hazards existing within the Town was developed. This comprehensive approach forms the basis for the creation of an effective and tailored Master Plan.

A. Existing Studies

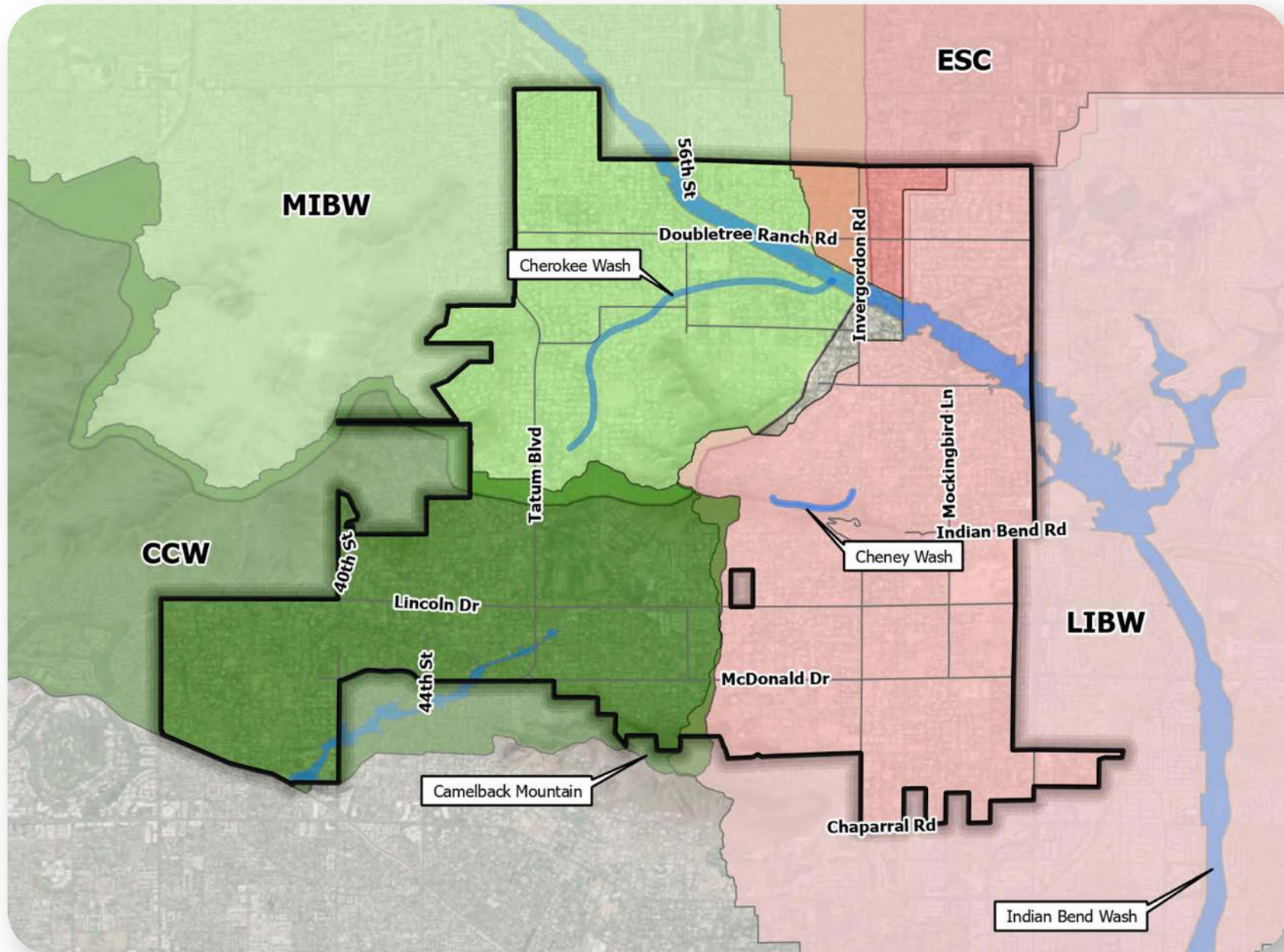
The Flood Control District of Maricopa County previously completed five Area Drainage Master Studies or Plans that cover portions of Paradise Valley. These studies were completed between 2017 and 2022. In addition, Paradise Valley conducted several studies and evaluations focused on flood hazard identification. In combination, these studies were used to compile information on existing drainage infrastructure and previously proposed solutions for flooding. They also formed the basis for the updated FLO-2D modeling. For more details on the town-wide FLO-2D modeling, please refer to the Hydrology & Hydraulics report. See **Figure 2 and Appendix A** for a map of the previous study boundaries. The studies incorporating portions of the Town include:

- Cudia City Wash (CCW) ADMS (Michael Baker, 2020)
- Middle Indian Bend Wash (MIBW) ADMS (Kimley-Horn, 2019)
- Lower Indian Bend Wash (LIBW) ADMS (Gavin & Barker, 2017)
- East Shea Corridor (ESC) ADMS (Wilson, 2023)
- Paradise Valley Cheney Watershed Hazards Identification (Dibble, 2017)
- Paradise Valley Identified Drainage Problem Areas Technical Memorandum (Kimley-Horn, 2019)
- Cudia City Wash (CCW) Zone 4 Drainage Concept Report (JE Fuller, 2021)



PARADISE VALLEY STORM WATER MASTER PLAN

Figure 2: Previous FCDMC ADMS/Ps





B. Known Flooding Issues

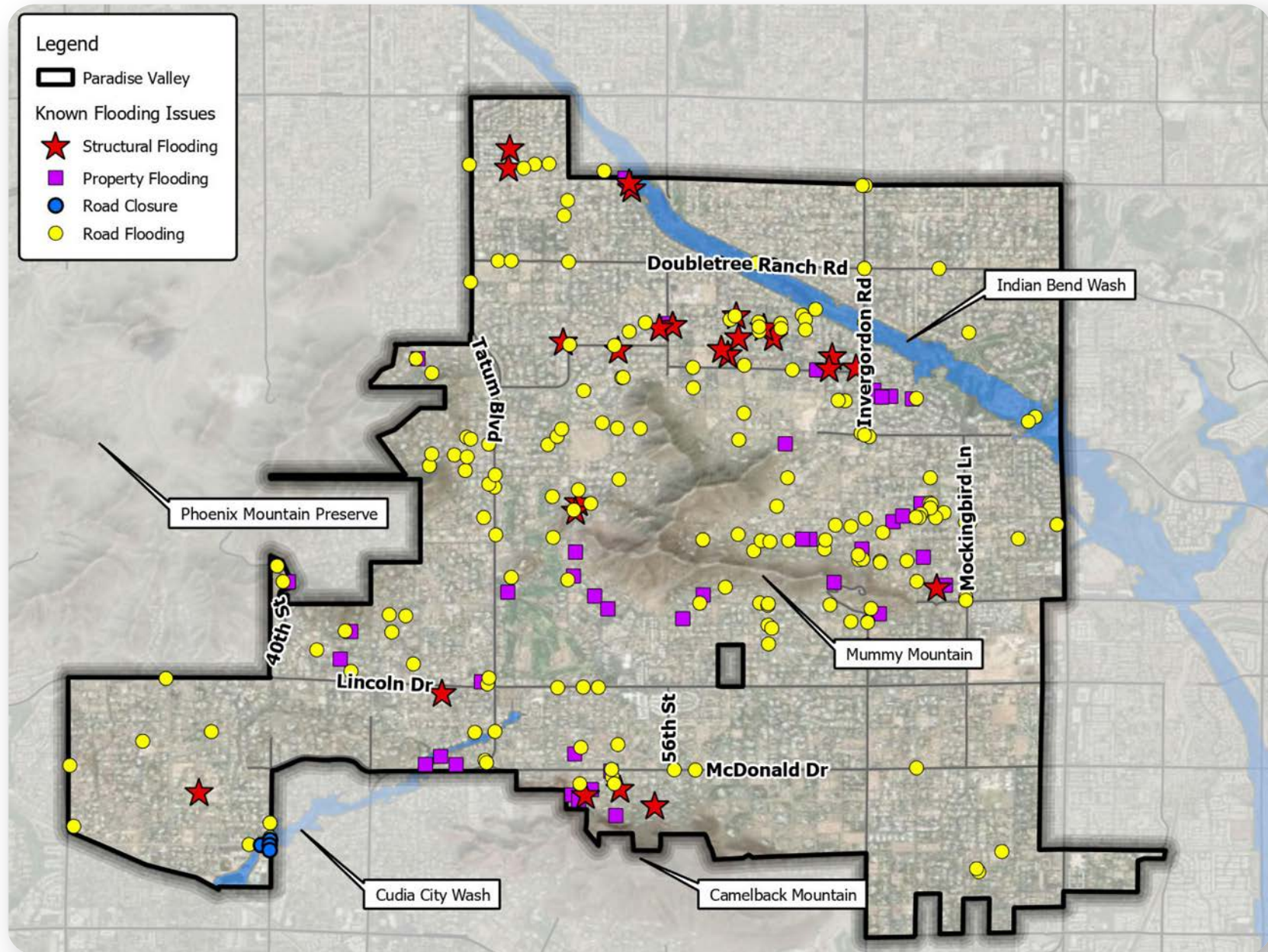
Reports of flooding issues from Town staff and residents played a vital role in capturing direct experiences and observations, ensuring that the Master Plan addressed the concerns of those directly impacted by flooding events.

Past flood complaints from both Town staff and residents were catalogued. Documentation of flooding issues was provided by the Town, including records from Engineering and Public Work's maintenance logs. Records of documented road closure locations were also included. Residents' complaints were extracted from the CivicPlus Portal, an online hub specifically designed for residents to submit issues and receive feedback from the Town.

To enhance the understanding of the frequency and qualitative impacts of flooding throughout the town, the past complaints were categorized accordingly. The categorization was based on both the source of reporting, whether from Town staff or residents, and the type of flooding reported. The types of flooding considered included road flooding, property flooding, and structural flooding. Based on the location of the report, it was noted that the majority of flooding issues occurred at the washes or directly downstream of the Phoenix Mountain preserve. For a detailed list and map of known flooding issues, refer to **Appendix A. Figure 3** shows the location and type of flooding for each past reported or documented issue.



Figure 3: Known Flooding Issues





C. As-Built and Design Plans

Information about drainage infrastructure that has recently been built or is currently in design was not included in past studies. Therefore, coordination was conducted to receive as-builts or Professional Engineer (PE) sealed plans to include recent drainage infrastructure in the updated, town-wide FLO-2D models. **Table 1** contains the information received.

D. Field Assessment

Field assessments were conducted to bridge data gaps as needed to support the modeling effort and to supplement the Town's geodatabase. During these visits, culverts and inlets were measured and assessed to evaluate the Town's existing infrastructure sizes and conditions. A collection of photos documenting the visited sites is included on the following **Pages 9-15**.

Table 1: As-Builts and Plans Received for Data Collection

Type of Document	Consultant	Project	Location
As-Built	TY LIN International 07/28/2021	Roadway and Utility Improvements on Lincoln Drive, Mockingbird Lane and Indian Bend Road	N 68th Street from E Meadowlark Lane to E Lincoln Drive
Drainage Plan Sealed by PE	Coe & Van Loo Consultants, Inc. 05/24/2019	Ritz-Carlton	Between N 68th Street and N Scottsdale from E Lincoln Drive to E Indian Bend Road
Drainage Plan Sealed by PE	Kimley-Horn, Inc. 08/01/2024	Mockingbird Lane Drainage and Roadway Improvements	Mockingbird Lane from N 56th Street and N Invergordon Road



Field Assessment Sheets



STRUCTURE ID: N-23



Number of Barrels: **2**
Barrel Height: **4 ft**
Barrel Width: **10 ft**
Culvert Type: **RCBC**
Culvert Length: **49 ft**

Location: **70th Street & Foothill Drive**

Jurisdiction: **Paradise Valley**

Inlet Sediment: **Clean**
Inlet Vegetation: **None**
Inlet Protection: **Concrete/Riprap**
Inlet Scour: **None**
Inlet Invert: **1297.90**

Outlet Sediment: **Little to none**
Outlet Vegetation: **None**
Outlet Protection: **Concrete/Riprap**
Outlet Scour: **None**
Outlet Invert: **1297.75**

Inlet Photo



Upstream Photo



Outlet Photo



Downstream Photo





STRUCTURE ID: N-27



Number of Barrels: **3**
Barrel Height: **1.5 ft**
Barrel Width: **26 ft**
Culvert Type: **RCBC**
Culvert Length: **170 ft**

Location: **Scottsdale Road & Hummingbird Lane**
Jurisdiction: **Paradise Valley**

Inlet Sediment: **Little to none**
Inlet Vegetation: **Moderate**
Inlet Protection: **Grate**
Inlet Scour: **None**
Inlet Invert: **1290.17**

Outlet Sediment: **Little to none**
Outlet Vegetation: **None**
Outlet Protection: **Riprap**
Outlet Scour: **None**
Outlet Invert: **1291.17**

Inlet Photo



Upstream Photo



Outlet Photo



Downstream Photo





STRUCTURE ID: S-149



Number of Barrels: **3**
Barrel Height: **3 ft**
Barrel Width: **8 ft**
Culvert Type: **RCBC**
Culvert Length: **64 ft**

Location: **Lincoln Drive & Quail Run Road**

Jurisdiction: **Paradise Valley**

Inlet Sediment: **Little to none**
Inlet Vegetation: **None**
Inlet Protection: **Riprap**
Inlet Scour: **None**
Inlet Invert: **1309.30**

Outlet Sediment: **Little to none**
Outlet Vegetation: **Little to none**
Outlet Protection: **None**
Outlet Scour: **None**
Outlet Invert: **1308.48**

Inlet Photo



Upstream Photo



Outlet Photo

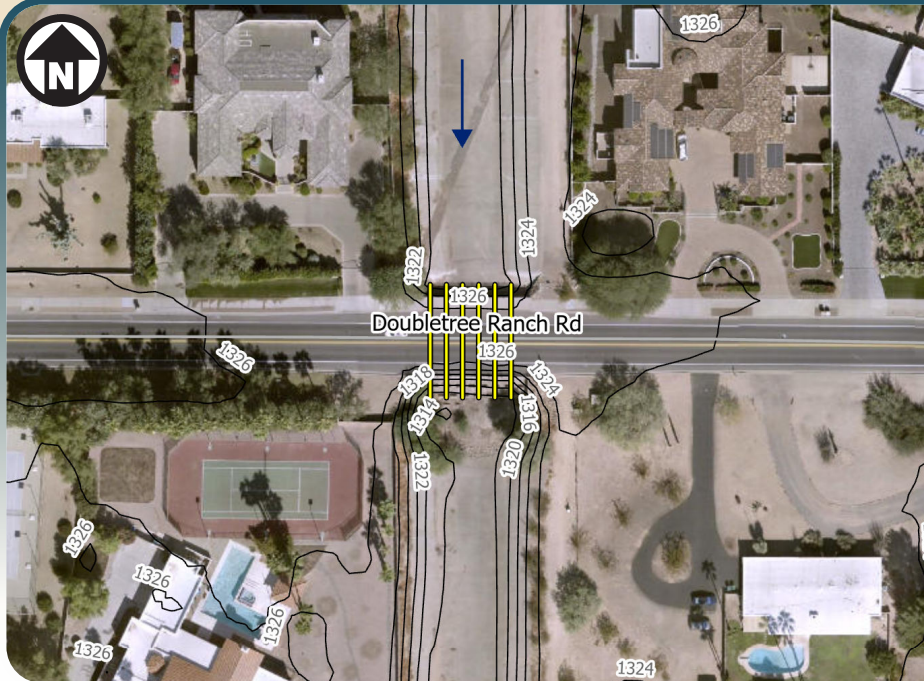


Downstream Photo





STRUCTURE ID: N-26



Number of Barrels: **6**
Barrel Height: **4 ft**
Barrel Width: **10 ft**
Culvert Type: **RCBC**
Culvert Length: **54 ft**

Location: **Along Berneil Ditch**
Jurisdiction: **Paradise Valley**

Inlet Sediment: **Clean**
Inlet Vegetation: **None**
Inlet Protection: **Concrete**
Inlet Scour: **None**
Inlet Invert: **1320.10**

Outlet Sediment: **Moderate**
Outlet Vegetation: **Little to none**
Outlet Protection: **Energy Dissipaters**
Outlet Scour: **None**
Outlet Invert: **1318.75**

Inlet Photo



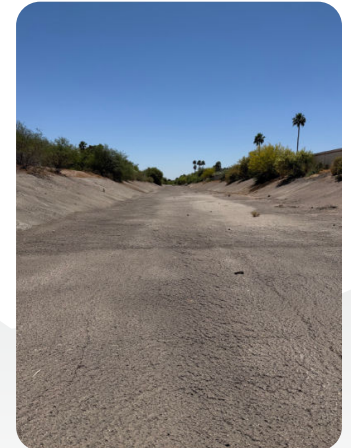
Upstream Photo



Outlet Photo



Downstream Photo





STRUCTURE ID: S-144



Number of Barrels: **2**
Barrel Height: **1.5 ft**
Barrel Width: **1.5 ft**
Culvert Type: **CMP**
Culvert Length: **99 ft**

Location: **Lincoln Drive & Scottsdale Road**

Jurisdiction: **Paradise Valley**

Inlet Sediment: **Moderate**
Inlet Vegetation: **None**
Inlet Protection: **Riprap**
Inlet Scour: **None**
Inlet Invert: **1294.18**

Outlet Sediment: **Moderate**
Outlet Vegetation: **None**
Outlet Protection: **Riprap**
Outlet Scour: **None**
Outlet Invert: **1294.08**

Inlet Photo



Upstream Photo



Outlet Photo

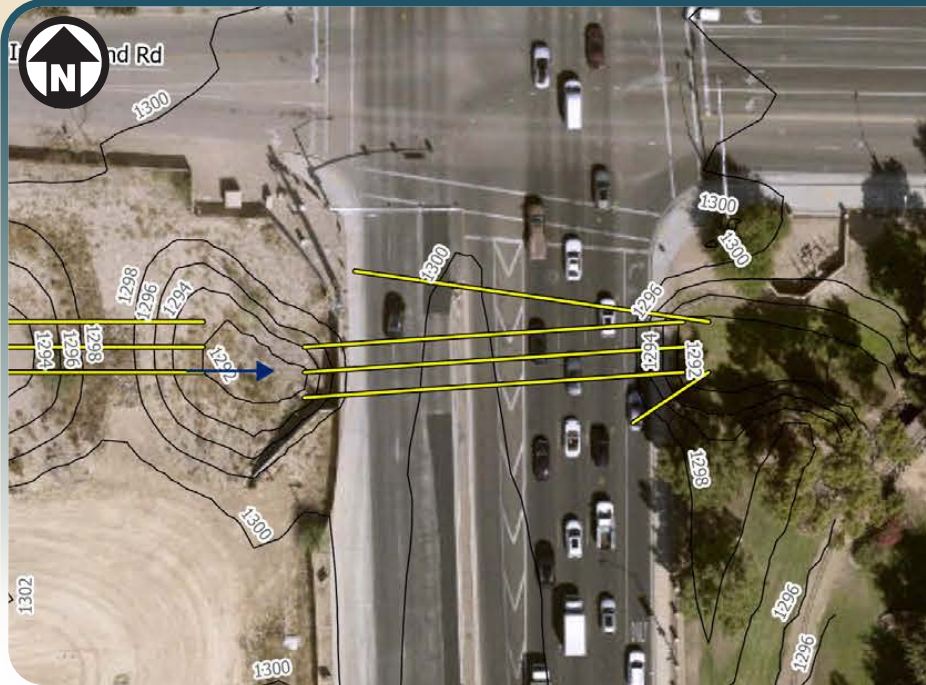


Downstream Photo





STRUCTURE ID: N-26



Number of Barrels: **3**
Barrel Height: **5.5 ft**
Barrel Width: **10 ft**
Cilvert Type: **RCBC**
Culvert Length: **99 ft**

Location: **Indian Bend Rd & Scottsdale Rd**
Jurisdiction: **Scottsdale**
Comment: **Inlet in closed off construction zone**

Inlet Sediment: **N/A**
Inlet Vegetation: **N/A**
Inlet Protection: **N/A**
Inlet Scour: **N/A**
Inlet Invert: **1291.40**

Outlet Sediment: **Little to none**
Outlet Vegetation: **Little**
Outlet Protection: **Grate**
Outlet Scour: **None**
Outlet Invert: **1291.10**

Outlet Photo

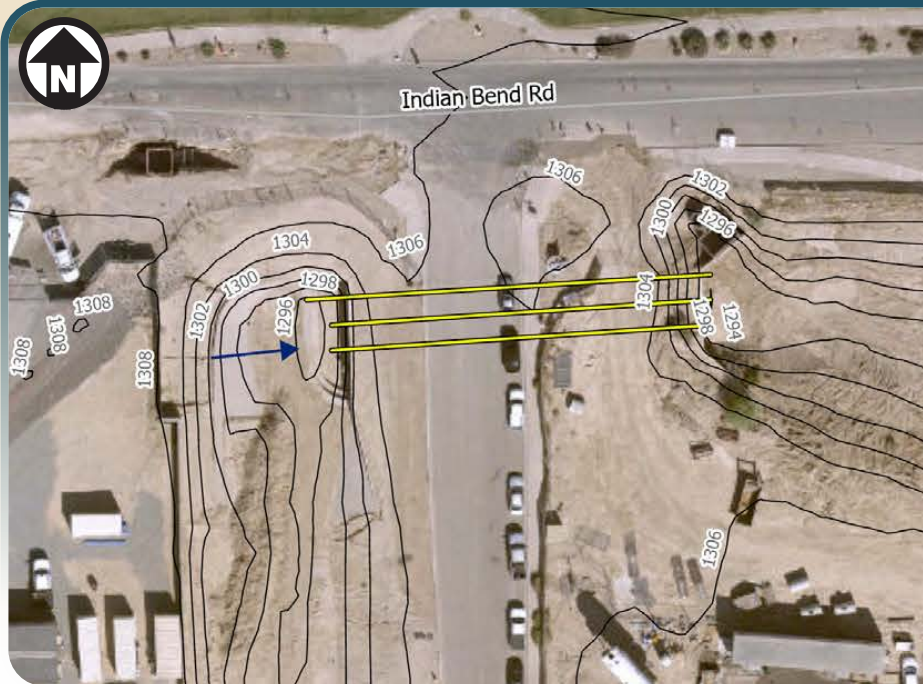


Downstream Photo





STRUCTURE ID: N-25



Number of Barrels: **3**
Barrel Height: **3 ft**
Barrel Width: **8 ft**
Cilvert Type: **RCBC**
Culvert Length: **156 ft**

Location: **Indian Bend Rodd & Palmerai Boulevard**
Juristiction: **Paradise Valley**
Comment: **Outlet in closed off construction zone**

Inlet Sediment: **None**
Inlet Vegetation: **None**
Inlet Protection: **Gabion Mattress**
Inlet Scour: **None**
Inlet Invert: **1294.50**

Outlet Sediment: **N/A**
Outlet Vegetation: **N/A**
Outlet Protection: **N/A**
Outlet Scour: **N/A**
Outlet Invert: **1293.80**

Inlet Photo



Inlet/Channel Protection



Upstream Photo





IV. EXISTING STORM WATER INFRASTRUCTURE EVALUATION

The results of the FLO-2D modeling were used to determine the level of protection provided by the existing drainage infrastructure within the Town. The hydraulic structures were considered existing if they were constructed or are currently contracted to be constructed. This assumption provides the most up to date modeling results. Basins, channels, storm drains, and culverts were evaluated for capacity limitations.

A. Storm Drain

The majority of storm drain in Town of Paradise Valley is north of Mummy Mountain and directs storm water to IBW. The largest storm drain system runs along or is connected to Doubletree Ranch Rd. The capacity of the outfall of this system was evaluated using PCSWMM and is shown on the storm drain outfall capacity figure in **Appendix B**. Storm drain that reduce flows to less than half a foot of water are considered to provide sufficient storm protection. All existing storm drain provide at least 2-year storm protection with the exception of four inlets along the Doubletree Ranch Road storm drain system. Identifying undersized inlets was also used to evaluate the capacity constraints of this storm drain system. Undersized inlets are defined as inlets where a maximum depth greater than 1 foot occurs during the 2-year storm. The 2-year storm was used as the basis of the assessment because of the frequency of occurrence. Three undersized inlets were identified in the storm drain system at Doubletree Ranch Road and one at the corner of Butler Road and 52nd Street. The undersized inlets are shown on the Storm Drain Undersized Inlet figure in **Appendix B**.

B. Culverts

Culverts in the public right-of-way are located throughout the Town, with a large concentration in the southwest quadrant, conveying runoff from the Phoenix Mountain Preserve and ultimately to CCW. Culverts typically convey flow under roadways with culverts sized for smaller storm events resulting in flood flows overtopping the road during larger storms.

Existing culvert capacity was evaluated based on several criteria. A culvert was initially considered undersized if during the 10-year storm, the roadway was overtopped by 0.5 ft of water or more. This criterion was developed based on culvert design guidance from the Maricopa County Drainage Policies and Standards. Based on these standards, culverts should be designed to convey, at a minimum, the storm frequency peak discharge listed below for each street classification with no flow overtopping the roadway. (FCDMC, 2018).

- Arterial and All-Weather Access Streets: 50-year design storm
- Collector Streets: 25-year frequency

- Local Streets: 10-year storm frequency

Based on these criteria, any culvert that overtops during a 10-year storm would be classified as undersized. The threshold depth of 0.5 feet for all streets was used because 0.5 feet of water will reach the bottom of most passenger cars and can cause loss of control. A map of undersized culverts throughout the Town can be seen below.

Impacts to surrounding structures and emergency access restrictions due to road overtopping were also assessed. Culverts with flood flows that overtop the road by more than 3 feet during a 100-year storm were considered undersized due to potential emergency vehicle access impacts. The threshold of three feet was chosen because according to the depth-velocity relationship curve discussed in the Potential Risk to Passenger Vehicles section of this report, depths greater than 3 feet are indicative of a high danger zone where all vehicles cannot safely pass. Additionally, culverts that caused a backwater water surface elevation during a 100-year storm event of at least 0.5 feet against adjacent structures were also catalogued as undersized. The figures on Pages 18-20 show culvert sizes and levels of storm protection throughout the Town with additional maps in **Appendix B**. Undersized culverts and their potential impacts are also listed in **Table 2** below. Of the 195 culverts analyzed, 36 culverts were identified as undersized.

C. Basins

In the southern portion of the Town there is one major basin, the CCW outfall basin. This basin is sufficiently sized for the local watershed, as it effectively contains the 100-year, 6-hour storm event. There is no overtopping and flooding of adjacent structures. In the northern portion of the Town, there are no large basins. This is mainly because of the proximity of the IBW, which functions as the ultimate outfall for a large portion of north Paradise Valley.

D. Channels

Channels are limited in the Town and flows tend to follow the paths of the existing washes. The largest manmade channel is the Berniel Ditch, a concrete lined channel within both the jurisdictions of City of Phoenix and the Town of Paradise Valley. The section of the ditch within the Town of Paradise Valley is approximately 2 miles long and outfalls into the IBW. This channel is sufficiently sized, as it contains the 100-year, 6-hour storm. It should be noted that yearly maintenance is necessary at the section of the channel just downstream of Double Tree Ranch Road. Excess sediment is deposited on the channel's energy dissipators at the downstream side of the culvert. Photos of this sedimentation can be found in the Site Assessment Data Sheets above.



PARADISE VALLEY STORM WATER MASTER PLAN

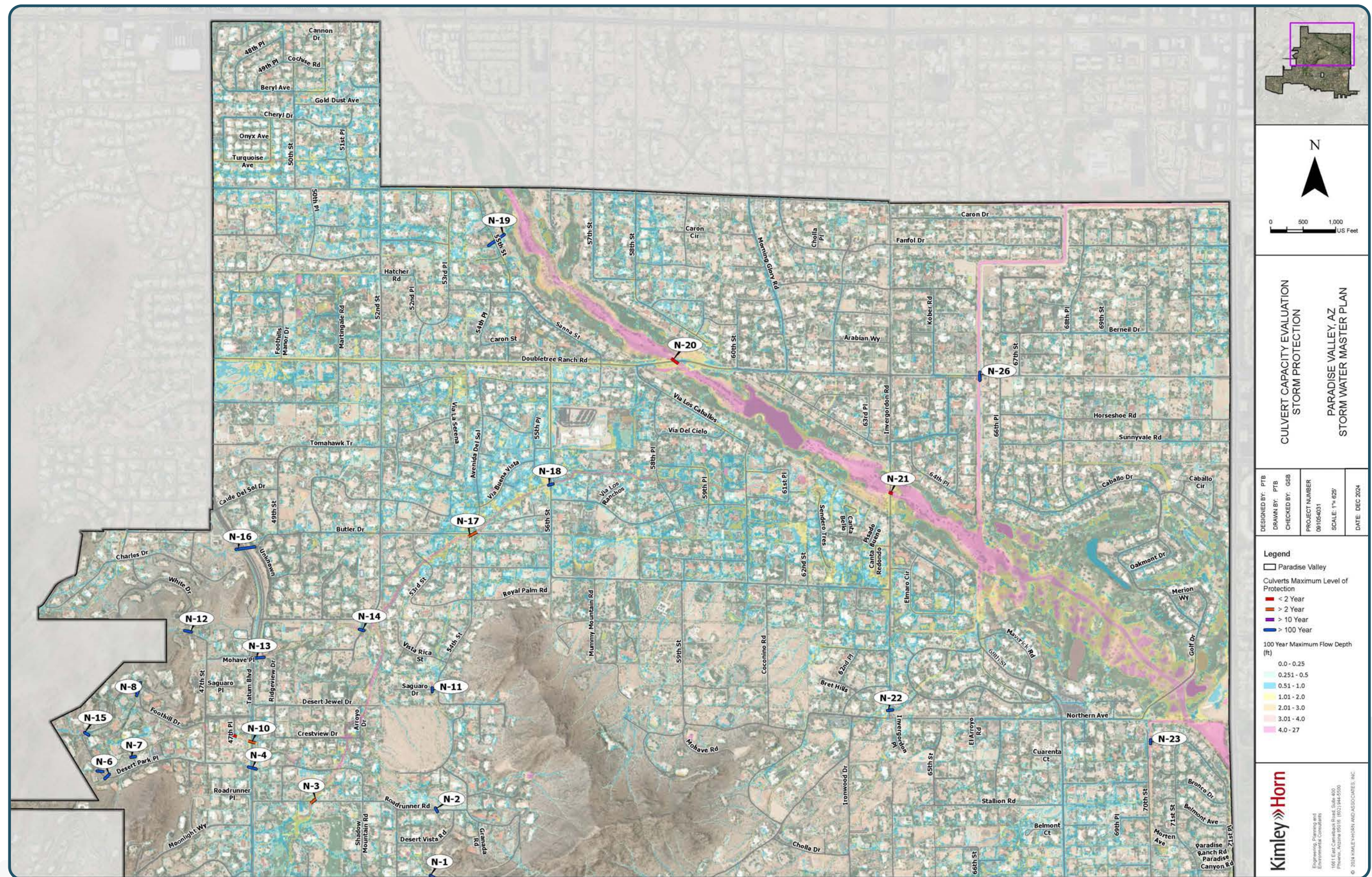
Table 2: Under Sized Culvert Summary Table

Culvert ID	Depth Over Road for 10-Year Storm (ft)	Depth Over Road for 100-Year Storm (ft)	Road Classification	Impacts to Emergency Access	Structures Impacted by Backwater
S-1	>1	>1	Residential	No	No
S-2	>1	>1	Collector	No	No
S-3	>4	>4	Residential	Yes	No
S-4	>2	>3	Residential	Yes	No
S-5	>0.5	>1	Residential	No	Yes
S-6	>1	>2	Residential	No	No
S-7	>2	>3	Residential	Yes	Yes
S-8	>2	>3	Residential	Yes	Yes
S-9	>2	>3	Residential	Yes	No
S-10	>1	>1	Collector	No	No
S-11	>0.5	>1	Residential	No	No
S-12	>0.5	>1	*	No	Yes
S-13	>0.5	>1	*	No	No
S-14	>0.5	>1	Residential	No	No
S-15	>0.5	>0.5	Residential	No	No
N-16	>0.5	>1	Collector	No	No
S-17	>0.5	>0.5	Residential	No	Yes
S-18	>0.5	>1	Local	No	No
S-19	>0.5	>2	Collector	No	Yes
S-20	>0.5	>1	Residential	No	No
S-21	>0.5	>0.5	Residential	No	No
S-22	>1	>1	Residential	No	Yes
S-23	>0.5	>1	Residential	No	No
S-24	>0.5	>0.5	Residential	No	No
S-25	>0.5	>1	Residential	No	No
S-26	>0.5	>0.5	Residential	No	Yes
S-27	>0.5	>0.5	Collector	No	No
S-28	>0.5	>1	Residential	No	Yes
S-29	>1	>2	Residential	No	Yes
S-30	>0.5	>0.5	*	No	Yes
S-31	>1	>2	Collector	No	No
N-10	>1	>1	Collector	No	No
N-17	>1	>1	Collector	No	Yes
N-20	>1	>1	Collector	No	No
N-21	>4	>4	Collector	Yes	No
N-3	>1	>1	Residential	No	Yes

*Indicates a culvert that connects under a structure other than the road such as a wall or roadside covered ditch

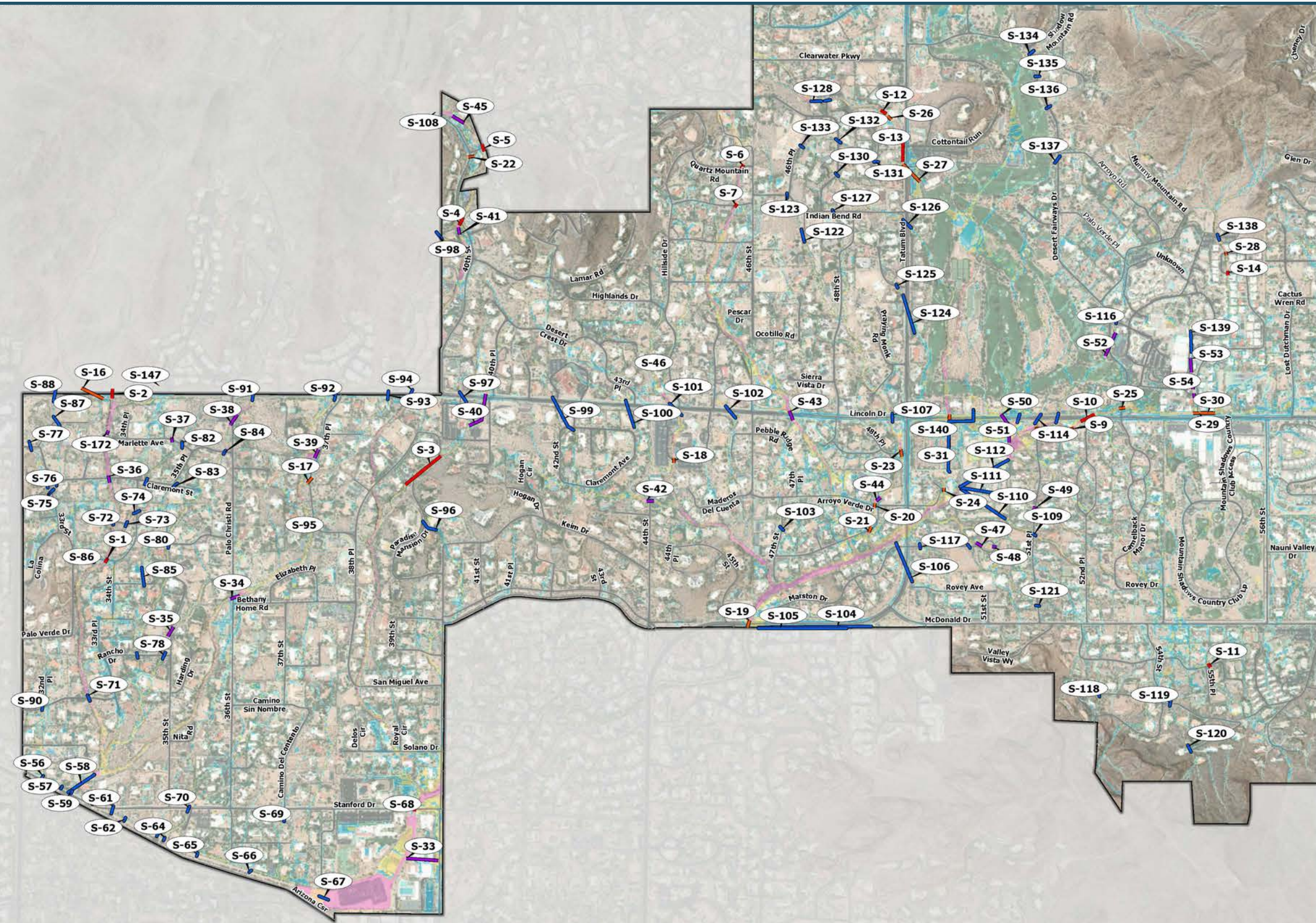


PARADISE VALLEY STORM WATER MASTER PLAN





PARADISE VALLEY STORM WATER MASTER PLAN



N

0 500 1,000 US Feet

CULVERT CAPACITY EVALUATION
STORM PROTECTION

PARADISE VALLEY, AZ
STORM WATER MASTER PLAN

DESIGNED BY: PTB	CHECKED BY: GSB
DRAWN BY: PTB	PROJECT NUMBER: 081054031
SCALE: 1"= 600'	DATE: DEC 2024

Legend

Paradise Valley

Culverts Maximum Level of Protection

- < 2 Year
- > 2 Year
- > 10 Year
- > 100 Year

100 Year Maximum Flow Depth (ft)

- 0.0 - 0.25
- 0.251 - 0.5
- 0.51 - 1.0
- 1.01 - 2.0
- 2.01 - 3.0
- 3.01 - 4.0
- 4.0 - 27

streets

Kimley»Horn

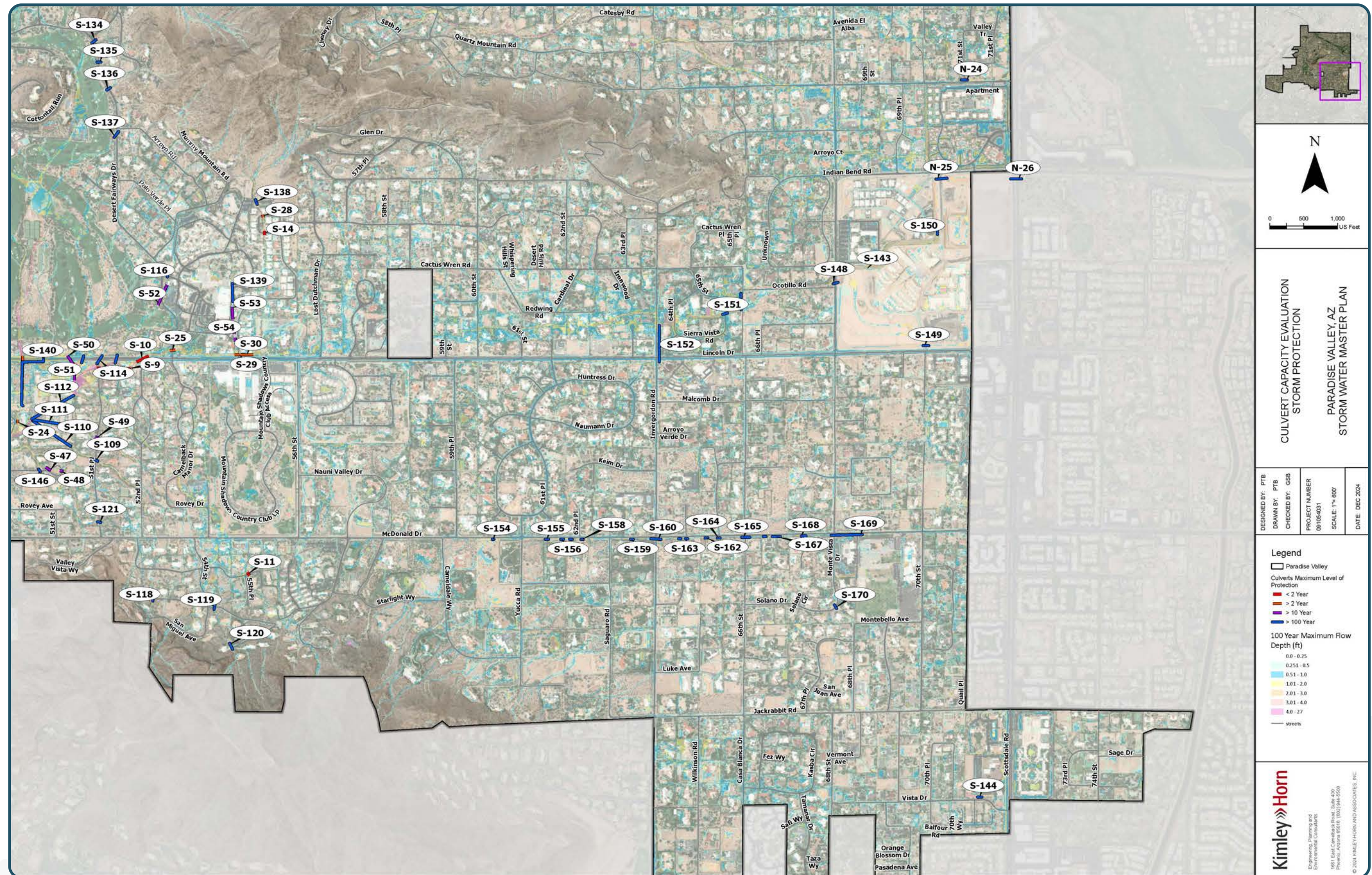
Engineering, Planning and Environmental Consultants

1601 East Camelback Road, Suite 400
Phoenix, Arizona 85016 (602) 944-5500

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PARADISE VALLEY STORM WATER MASTER PLAN





V. FLOOD HAZARD ANALYSIS

Flood hazard analysis was conducted by developing maximum flow depth (ft), velocity (ft/s), and discharge (ft³/s) results datasets for the 2-year, 10-year, and 100-year storm events from the FLO-2D model results. These datasets, along with anecdotal data from Town staff and residents, served as the basis for the in-depth flood hazard analysis. The flood hazard analysis includes building inundation risk, erosion and sediment hazard potential, and passenger vehicle risk. The results of these analyses provide valuable insights to locations with the greatest flooding risk and were used to evaluate distinct flood hazards areas in the Town. The flood hazard analysis exhibits are included in **Appendix C**.

A. Building Inundation Analysis

Utilizing the building footprint Geographic Information System (GIS) data provided by the Maricopa County Assessor, structures were assessed for flood risk potential based on adjacent flood depths per the FLO-2D modeling results. The GIS data was reviewed to ensure consistency with current aerial imagery. Within Paradise Valley, there are approximately 8,272 building structures classified as civil, commercial, education, outbuilding, religious, residential, and service. Flooding potential for each structure was assessed for the 100-year, 10-year, and 2-year storm events. The methodology applied to categorize structures for the three hypothetical storm events using the maximum flow depth modeling results and the building GIS data was as follows:

1. Building structures impacted by at least 0.5 feet of water depth for at least 20% of the building perimeter.
2. Building structures impacted by at least 1 foot of water depth for at least 15% of the building perimeter.
3. Building structures impacted by at least 2 feet of water depth for at least 10% of the building perimeter.

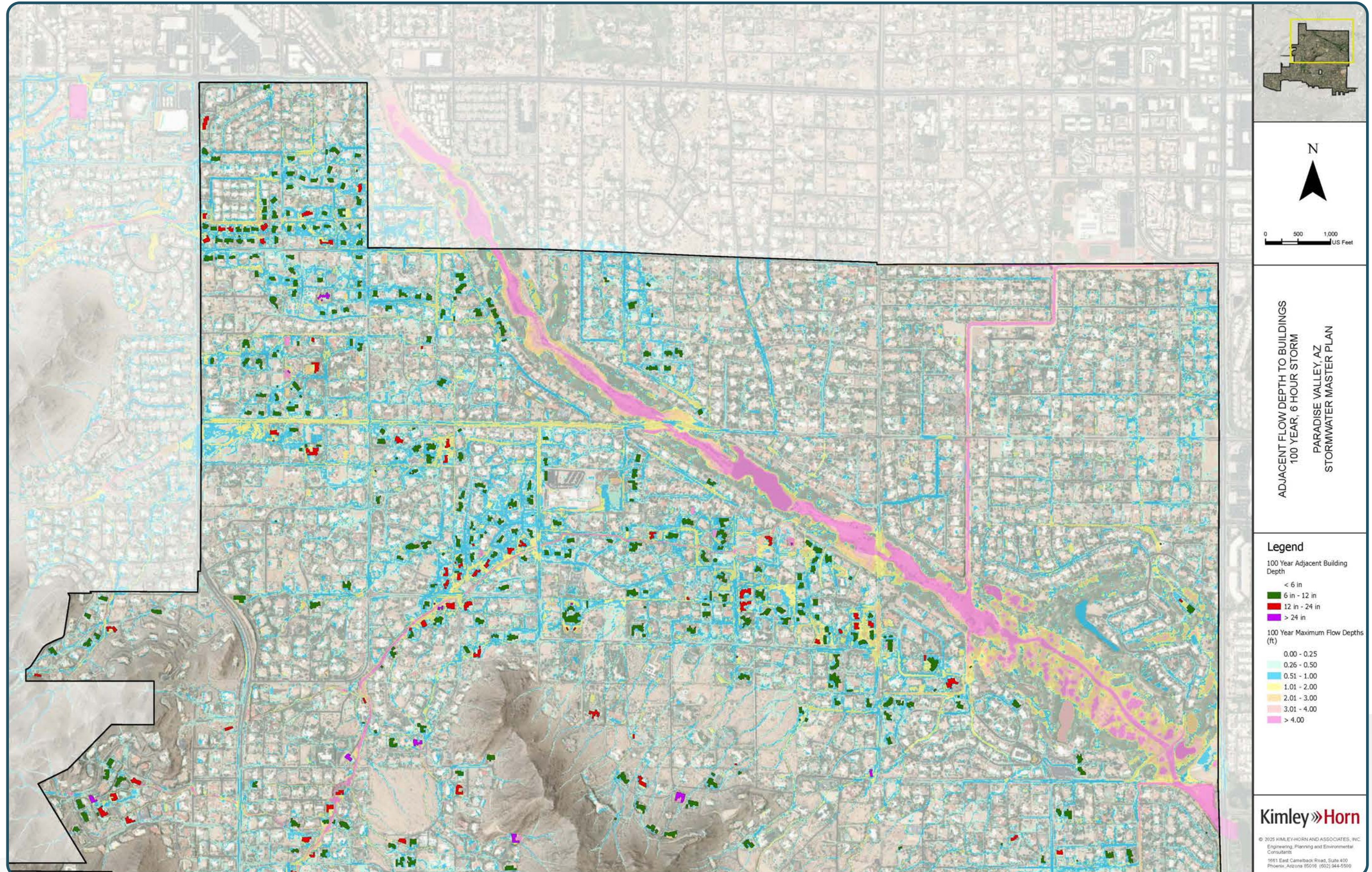
The 100-year results of these analyses are shown in exhibits on Pages 21-23 with 10-year and 2-year maps included in **Appendix C**. **Table 3** includes the number of buildings impacted for each criterion and storm event. It should be noted that the number of buildings identified for each scenario was refined manually to exclude structures where the flood potential is likely not accurately represented in the model results. These conditions include structures where adjacent flooding was associated with backyards or confined areas that are not near stream tributaries. In these cases, the hydraulic modeling falsely indicates trapped water where in practice flooding would likely not occur.

Table 3: Building Inundation Summary Table

Methodology	Number of Buildings Impacted Per Storm Event		
	2-Year	10-Year	100-Year
>0.5 feet of flow depth for at least 20% of the building	43	304	857
>1 foot of flow depth for at least 15% of the building	11	43	283
>2 feet of flow depth for at least 10% of the building	6	9	52
Total Structures Impacted	60	356	1,192

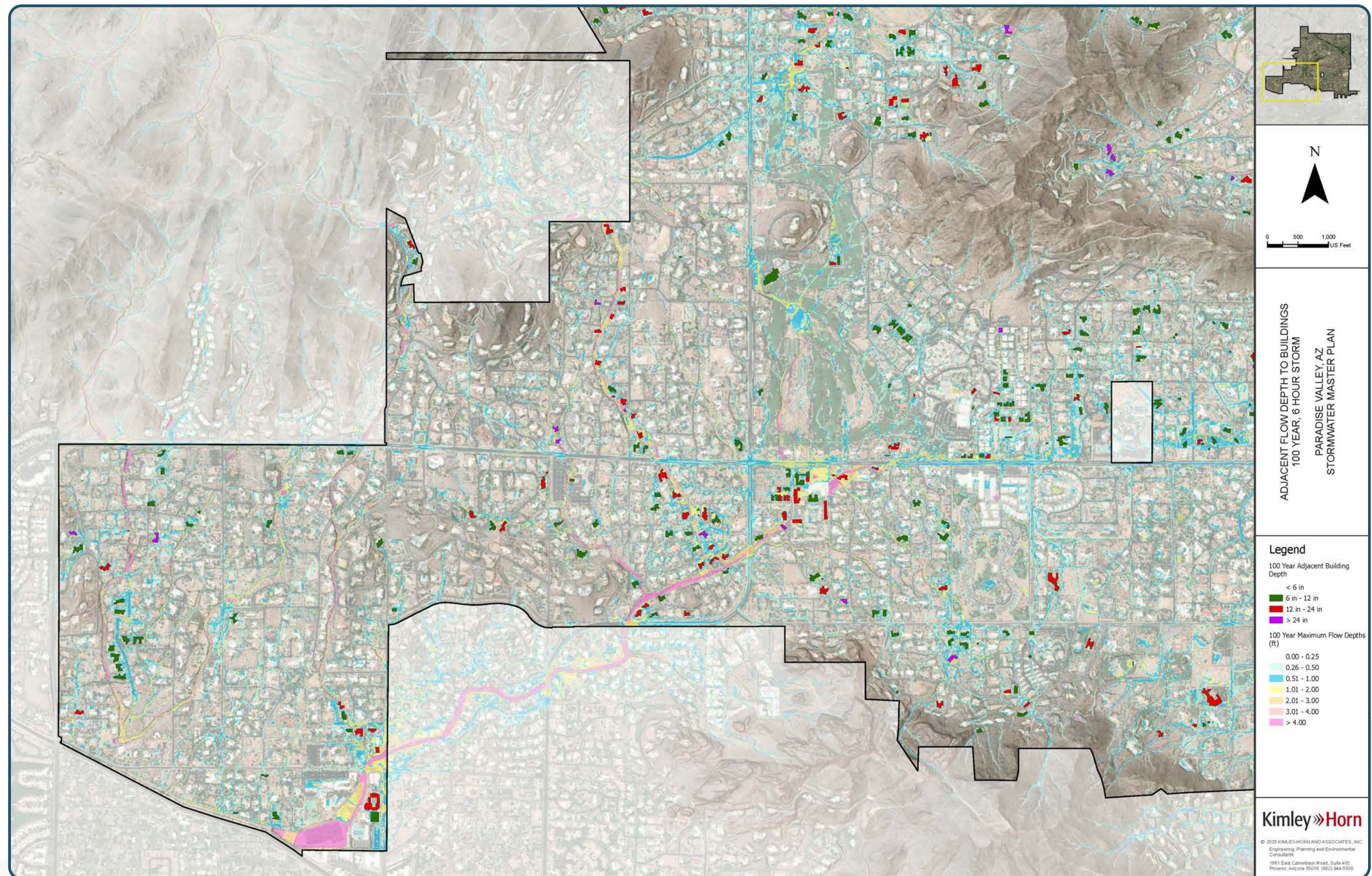


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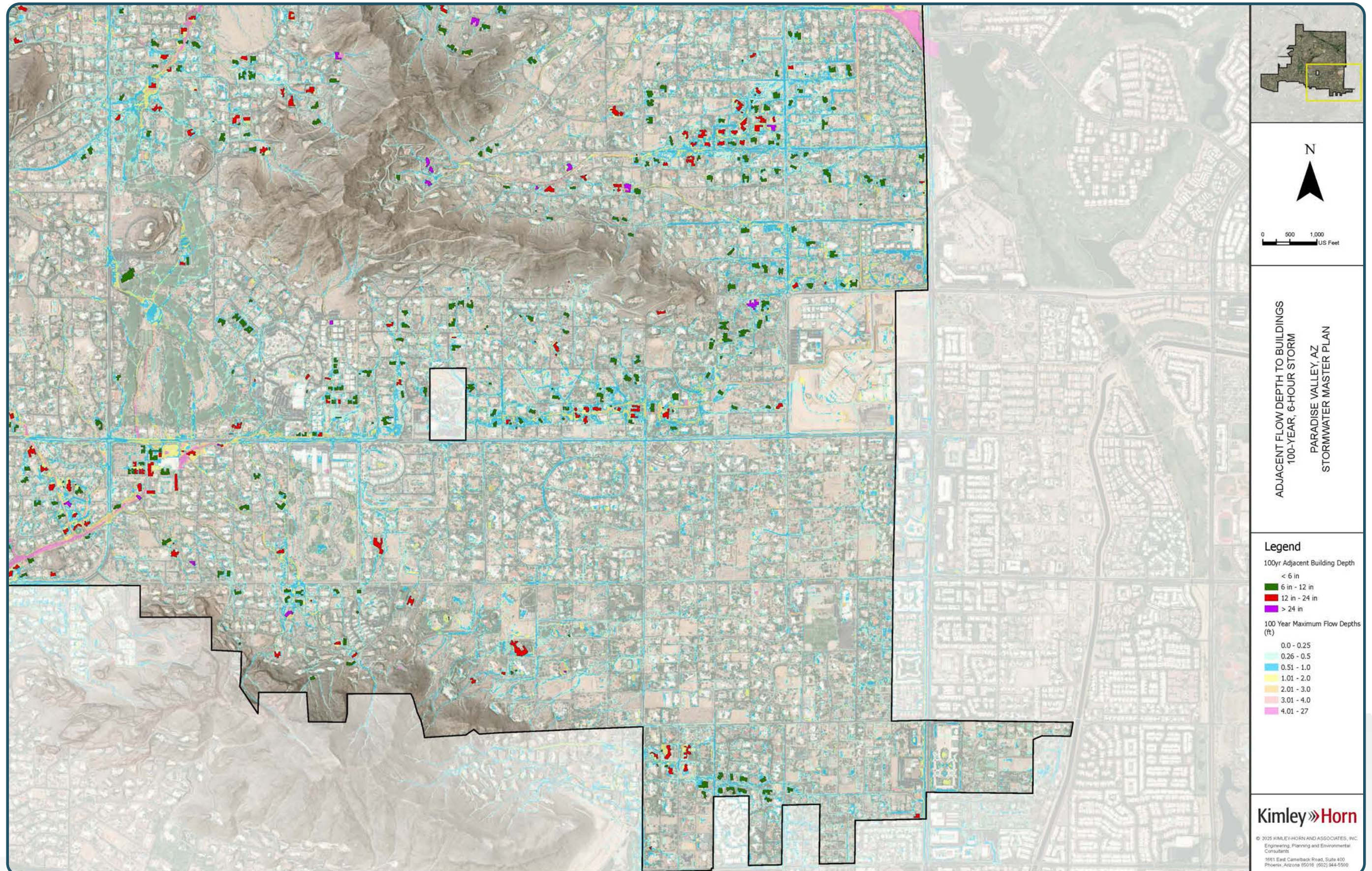


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B. Erosion and Sediment Deposition Hazard

The methodologies used to identify sediment erosion and deposition potential are based on the procedure outlined in Hazard Risk Mapping: Detailed Description of Approach Memo written by West Consultants for the FCDMC in July of 2019 (West Consultants, Inc., 2019). The methodologies developed were deemed appropriate for the Paradise Valley Master Plan because the approach is based on the typical major storms that are specific to the south-central Arizona region, and the memo was written as part of the Carefree Area Drainage Master Plan. Additionally, the methodology similarly uses the same storm events, the 100-year, 6-hour and 10-year, 6-hour, as the basis of assessment.

The erosion hazard methodology provides predictions of the severity of damage and the types of erosion that are likely to take place. By associating ranges of numerical velocities with the likelihood of qualitative results, risks to residents and property can be more easily evaluated. The four categories of erosion potential and the associated velocity ranges in feet per second are listed below.

- Low Erosion Potential: Velocities between 1 and 2.5
 - 10% annual risk of some erosion of desert landscaping (scour of gravel surfaces, potential removal of small plants).
 - Minor scour to the downstream of culverts likely
 - Low risk of scour in washes
 - Low risk to roadways
 - Sand and fine gravel likely washed away during storm events with a recurrence interval > 2 years
- Moderate Erosion Potential: Velocities between 2.5 and 4
 - 10% annual risk of moderate erosion of desert landscaping (scour of sandy surfaces, some risk of damage to small plants).
 - Some scour downstream of culverts likely
 - Potential for scour in major washes
 - Larger gravel and short grass at risk of erosion during storm events with a recurrence interval > 2 years
 - Potential risk to gravel roadways and/or roads with unpaved shoulders during storm events with a recurrence interval > 2 year. Proceed with caution.
- High Erosion Potential: Velocities between 4 and 5.5
 - 10% annual risk of significant erosion of desert landscaping (gravel surfaces likely scoured, small plants likely damaged or removed, larger plants at risk).
 - 10% annual risk of significant scour downstream of culverts
 - High potential for ongoing scour and avulsions in major washes

- Small cobbles and long grass are at risk of erosion during major storm events.
- High risk to gravel roadways and/or roads with unpaved shoulders storm events with a recurrence interval > 10 years.
- Extreme Erosion Potential: Velocities greater than 5.5
 - 90% annual risk of significant erosion of desert landscaping (all plants in danger of removal, surface treatments likely scoured away).
 - 90% annual risk of significant scour downstream of culverts
 - Culvert installations in danger of failure during major storm events.
 - Wash instability likely due to significant scour and avulsion potential
 - All grass types likely scoured during large storm events.
 - Gravel roadway surfaces likely to fail and should be avoided during storm events with a recurrence interval > 10 years.

The 100-year result maps of each of the storm events' erosion hazard potential are included on Pages 26-28, with the 10-year and 2-year results maps in **Appendix C**. Extreme erosion potential is predicted within some washes, near some major roadways, and downstream of culverts within the Town. The number of road crossings on collector, arterial, and residential roads that are subject to extreme potential erosion hazards are summarized in **Table 4**.

The sediment potential hazard methodology provides predictions of the severity of damage and the types of sedimentation that are likely to take place. Sedimentation potential is based on unit discharge of model cells, obtained by dividing each cell's maximum discharge by the size of the cell. By associating ranges of unit discharge with the likelihood of specific outcomes, risks to residents and property can be more easily understood. The four categories of sediment potential and the associated unit discharge ranges in cubic feet per second are listed below. It should be noted that unit discharges with a magnitude of less than 0.5 were excluded from the results.

- Low Deposition Potential ($q > 10$)
 - Low potential of significant deposition of silty sand.
 - Some deposition upstream of culverts may occur.
 - Low risk to roadways.
- Moderate Deposition Potential ($10 > q > 7$)
 - Moderate potential of significant deposition of sands, silts, and gravel.
 - Some deposition upstream of culverts is likely. Smaller culverts may clog.
 - Proceed with caution at roadways.



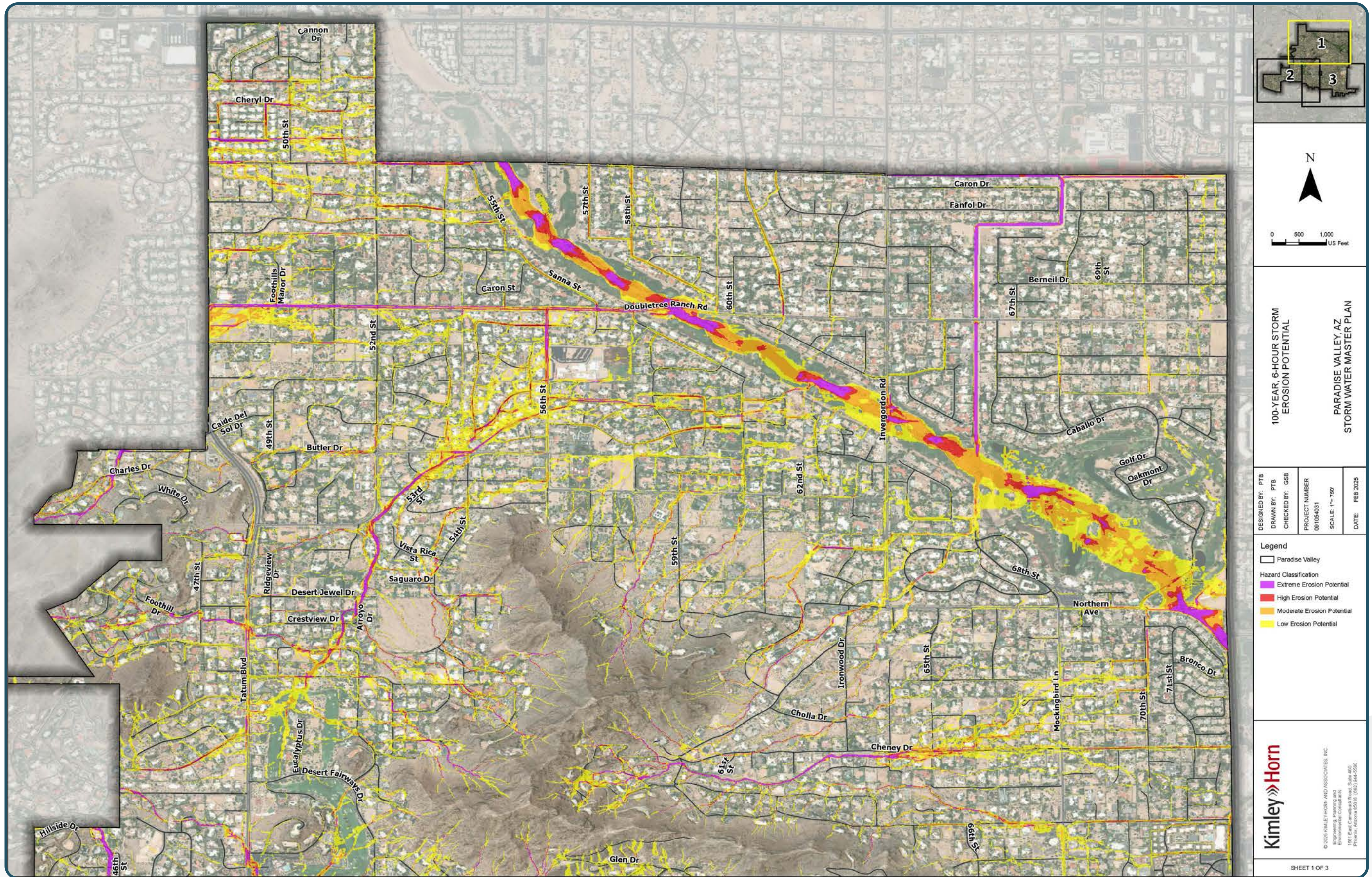
- High Deposition Potential ($7 > q > 3$)
 - High potential for sand and gravel deposition; moderate risk of cobble deposition.
 - Significant deposition of culverts likely. High clogging potential at all culverts.
 - Proceed with caution at roadways.
- Extreme Deposition Potential ($3 > q$)
 - Extreme potential for deposition of sands, silts, gravels, and cobbles.
 - Culvert installation in danger due to likelihood of clogging.
 - Proceed with extreme caution at roadways.

The 100-year result maps of each of the storm events' deposition hazard potential are included on Pages 29-31, with the 10-year and 2-year results maps in **Appendix C**. Extreme sediment deposition potential is predicted within some washes, along some major roadways, and downstream of culverts within the Town. The number of road crossings on arterial, collector and residential roads that are subject to extreme potential deposition hazards are summarized in **Table 4**.

Storm Event	Street Type	Extreme Erosion Risk Locations	Extreme Sediment Risk Locations
100-Year	Arterial	6	28
	Collector	29	144
	Residential	245	989
10-Year	Arterial	2	14
	Collector	12	65
	Residential	92	352

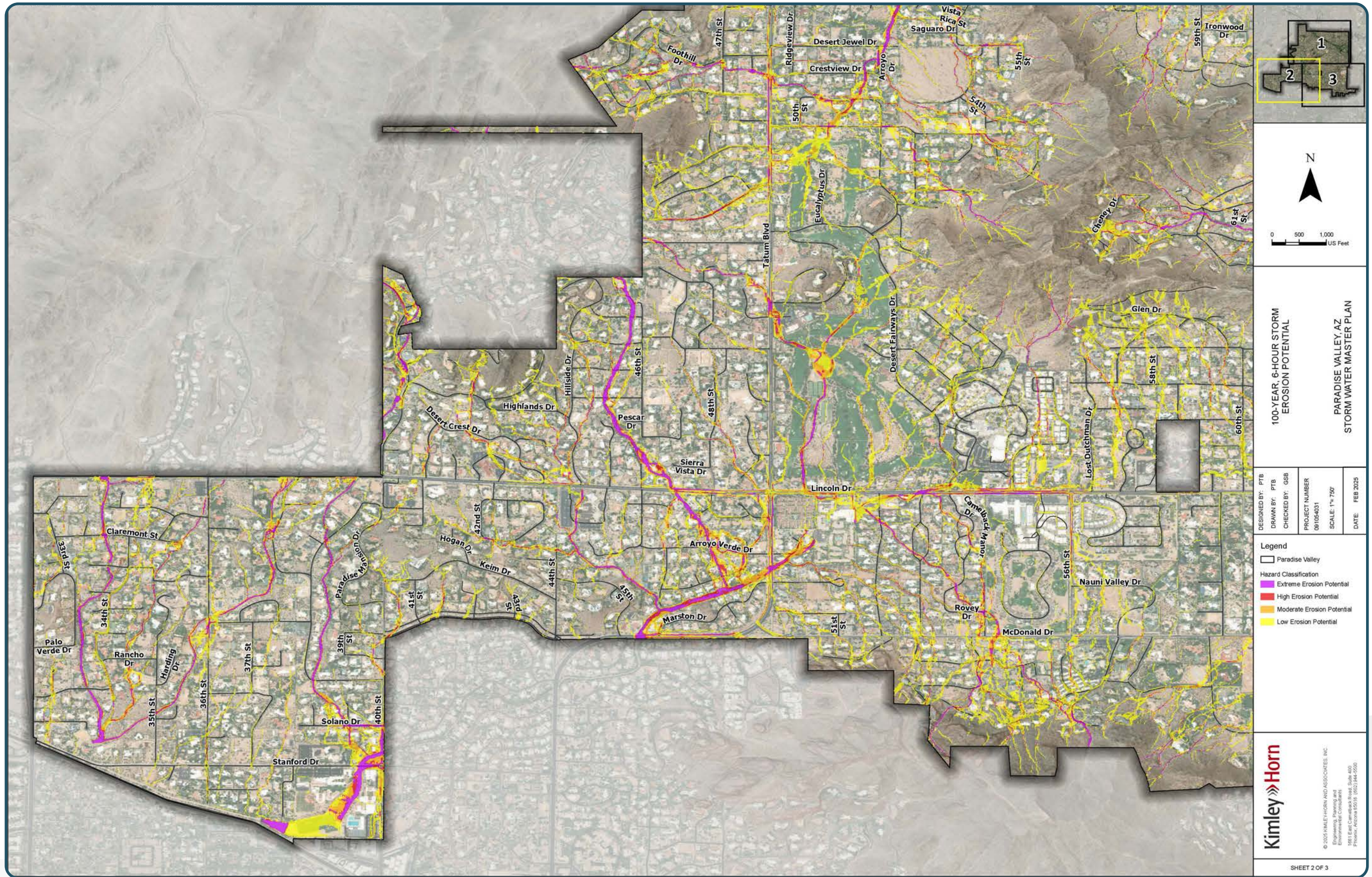


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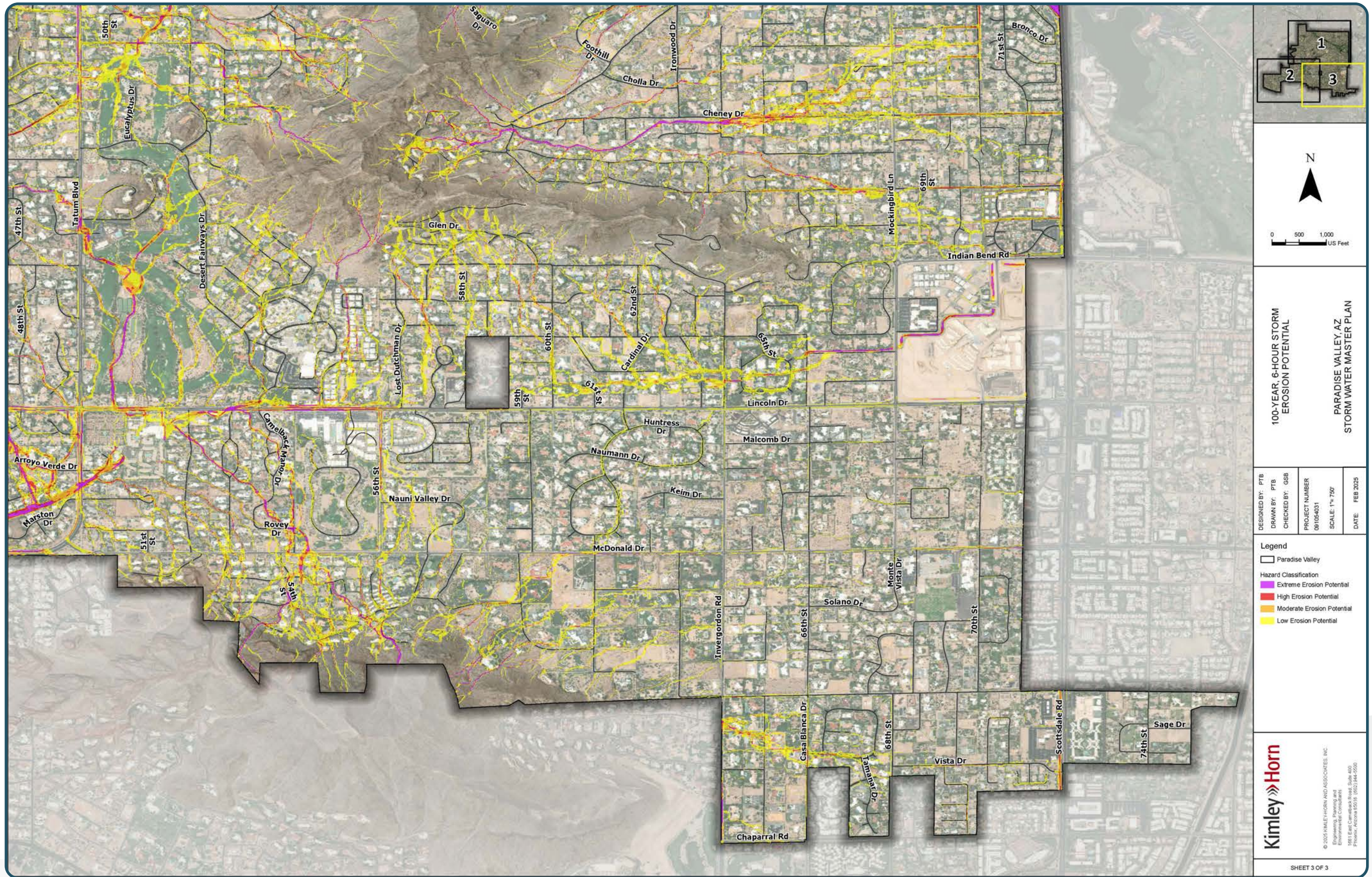


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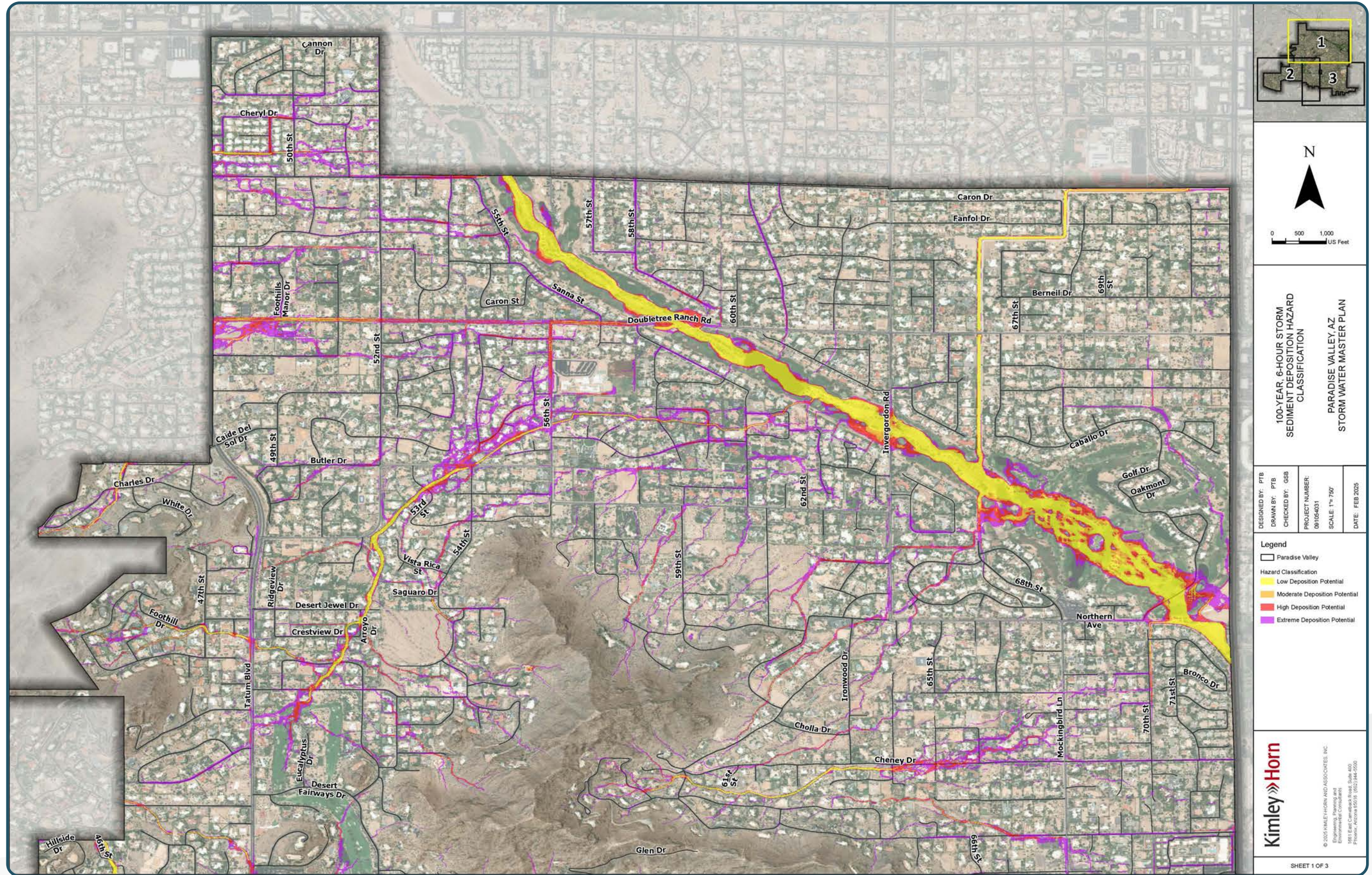


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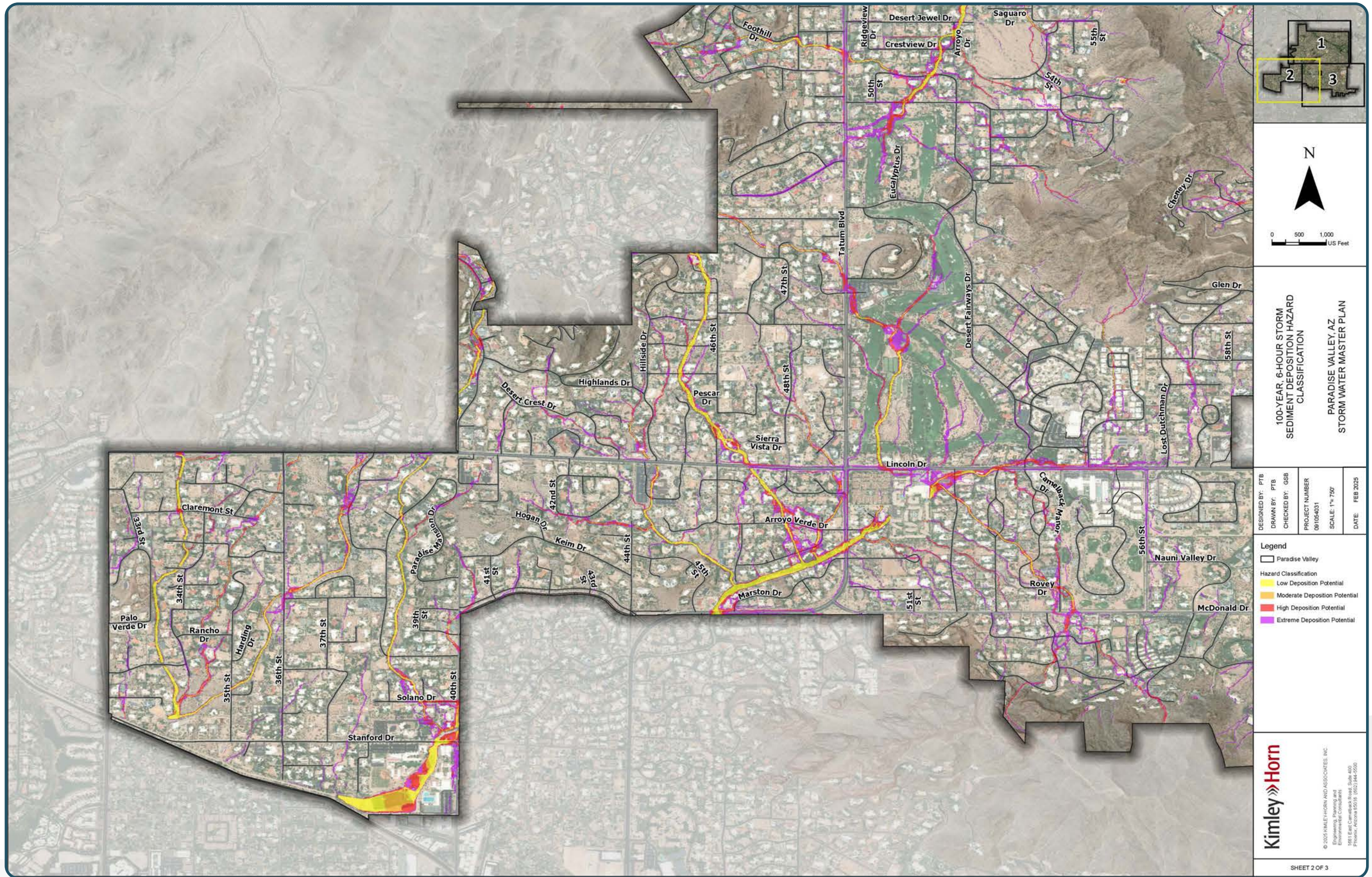


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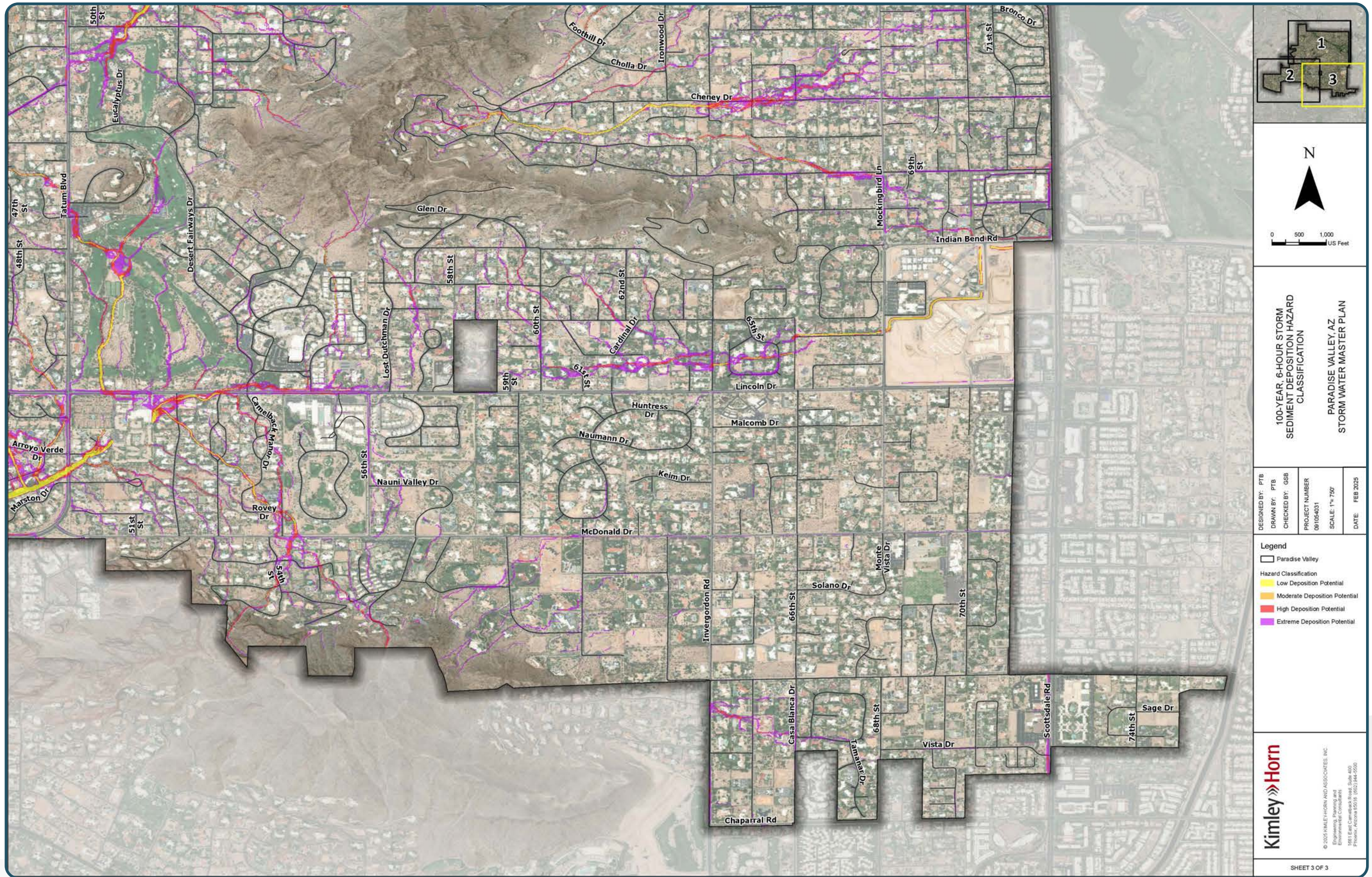


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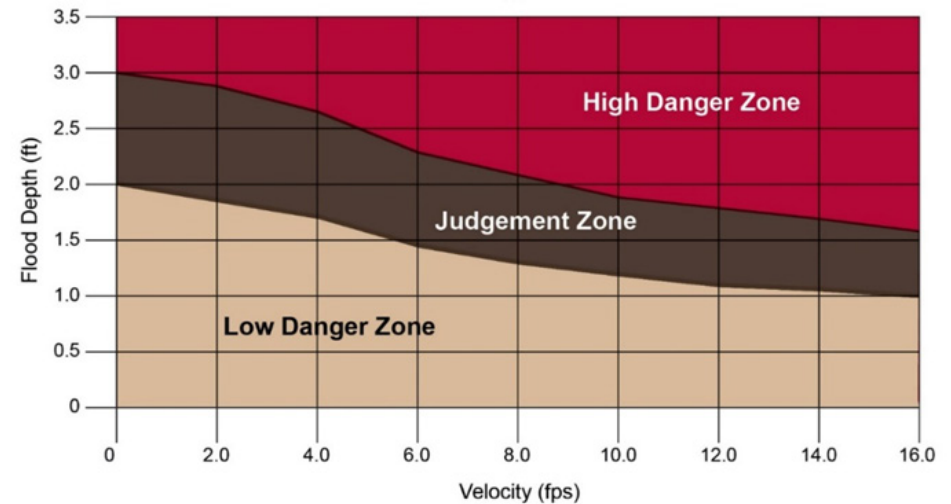
C. Potential Risk to Passenger Vehicles

During large storm events in Town of Paradise Valley, roads such as Doubletree Ranch Road and 40th Street have been closed for passenger vehicle safety. Data obtained from the Town revealed an incident in which a car had been swept off the road at the CCW low water crossing on 40th St. Given the issues identified, risk to passenger safety was an important hazard to evaluate in the Paradise Valley Master Plan.

The methodology used to identify potential risk to passenger vehicles is based on the depth-velocity flood danger level relationship for passenger vehicles developed in ACER Technical Memorandum No. 11: Downstream Hazard Classification Guidelines, (U.S. Department of the Interior Bureau of Reclamation, 1988). The memorandum presents the relationship, created between both the depth and velocity of flood water on a roadway, that is used to classify road conditions as a low danger zone, judgment zone, and high danger zone. **Figure 4** shows the graphical representation of this relationship. Each zone provides predictions of the severity of risk to passenger vehicles.

- **Low Danger Zone** – In this zone, almost all passenger vehicles can safely navigate on the road. The risk categorization is based on the ranges of the depth and velocity relationship shown in **Figure 4**. It should be noted that depths lower than 0.5 feet were removed from this zone due to the negligible effect on passenger vehicles. The depth of 0.5 feet was chosen as the minimum, because at this height, water will begin to reach the bottom of many passenger vehicles.
- **Judgement Zone** – In this zone, roadway flooding with a combination of depths and velocities shown in **Figure 4** present a highly significant hazard to most passenger vehicles. The ranges of depth outlined in this category are 2 to 3 feet of water. At these depths, emergency vehicles should proceed with caution, and passenger vehicles should be blocked from proceeding.
- **High Danger Zone** – In this zone, flood hazards are extreme for all passenger vehicles. The associated depths and velocities of this zone, shown in **Figure 4**, will block access to emergency vehicles.

Figure 4: Depth Times Velocity Graph for Passenger Vehicles (USBR 1988)



Analyses of passenger vehicular risk were conducted for the 10-year and 100-year storm events. Using modeling results, areas of the Town were categorized into each flood zone type. The resulting passenger vehicle flood hazard layer was intersected with the centerline of all roads within Paradise Valley. Two methodologies were utilized to display and quantify the results of the intersection. The polyline method serves to quantify what percentage of roads in the Town are located within the high danger zone risk category, while the point method quantifies the total number of roadway wash crossings subject to the same risk category.

The 100-year result maps of potential risk to passenger vehicles are shown on Pages 35-37, with the 10-year results maps included in **Appendix C**. Examples of the polyline and point methods are shown in **Figures 5 and 6**. **Table 5** contains the percentage and number of roadway segments that are located within high danger zones for passenger vehicles.

Figure 5: Example of Polyline Shapefile for Passenger Vehicles Risks

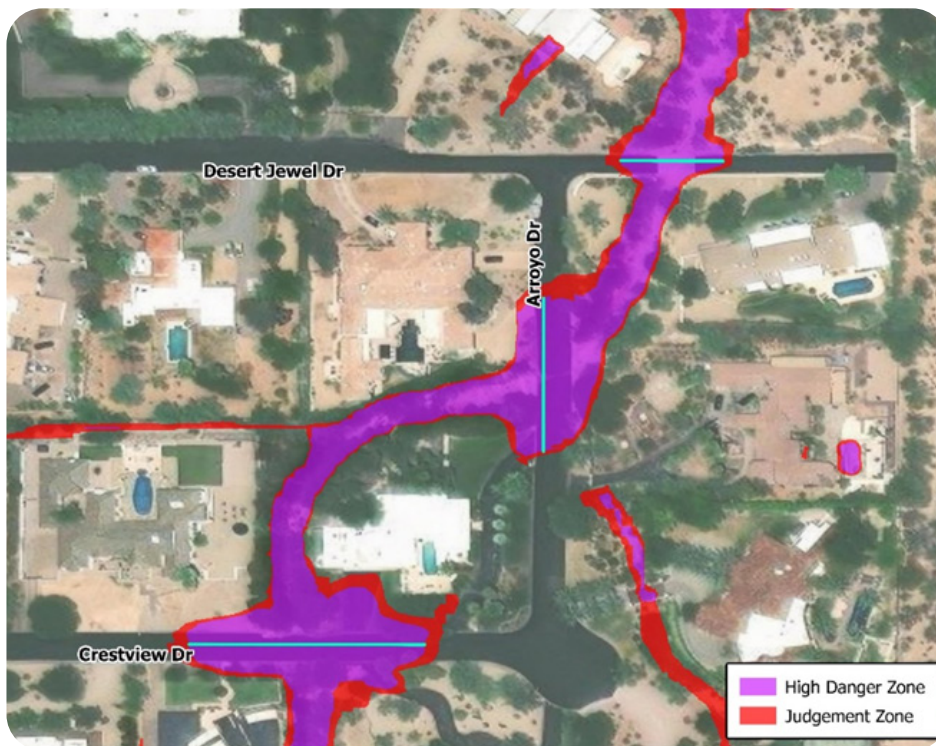


Figure 6: Example of Point Shapefile for Passenger Vehicles Risks

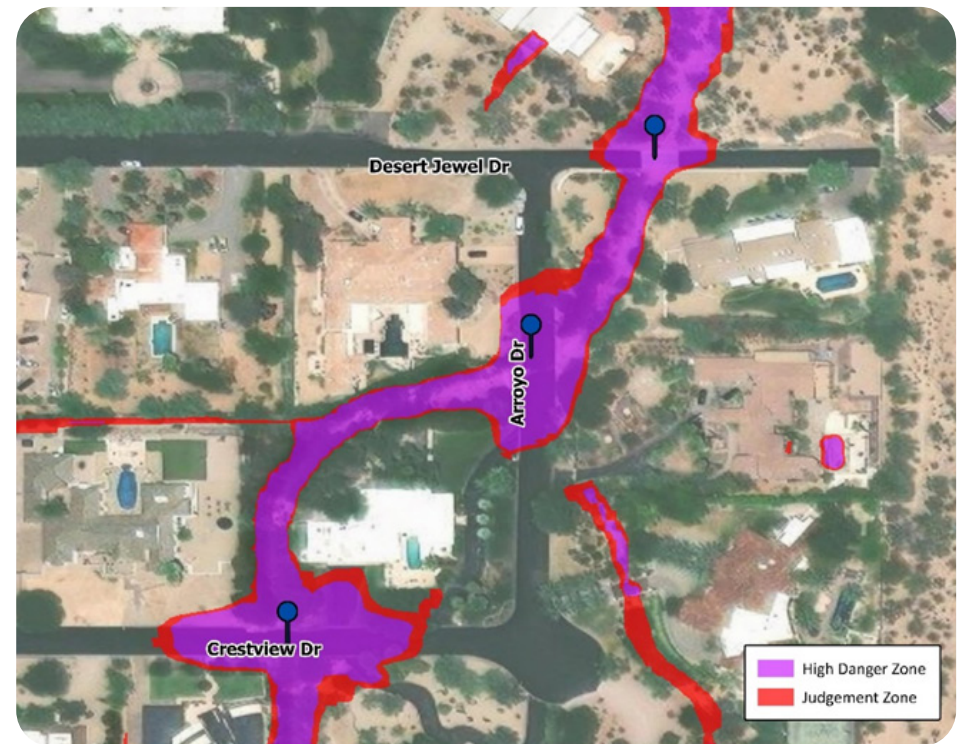




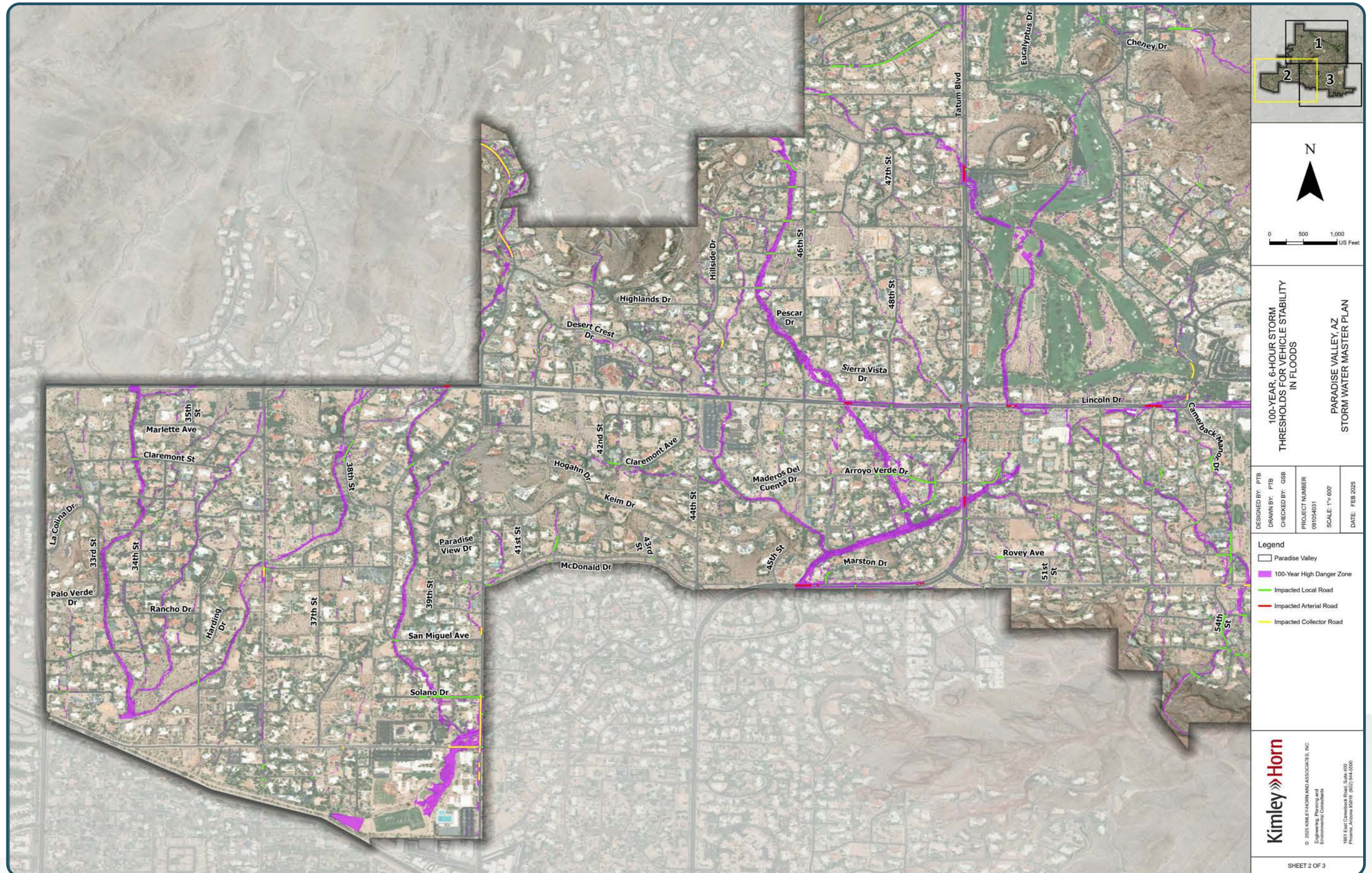
Table 5: Road Flooding Hazard Risk

Storm Event	Street Type	High Danger Zone for Passenger Vehicles
100-Year	Arterial	29 Crossings
		3.9% of Arterial Streets
	Collector	79 Crossings
		9.7% of Collector Streets
	Residential	931 Crossings
		7.0% of Residential Streets
10-Year	Arterial	12 Crossings
		1.2% of Arterial Streets
	Collector	29 Crossings
		3.4% of Collector Streets
	Residential	220 Crossings
		1.6% of Residential Streets



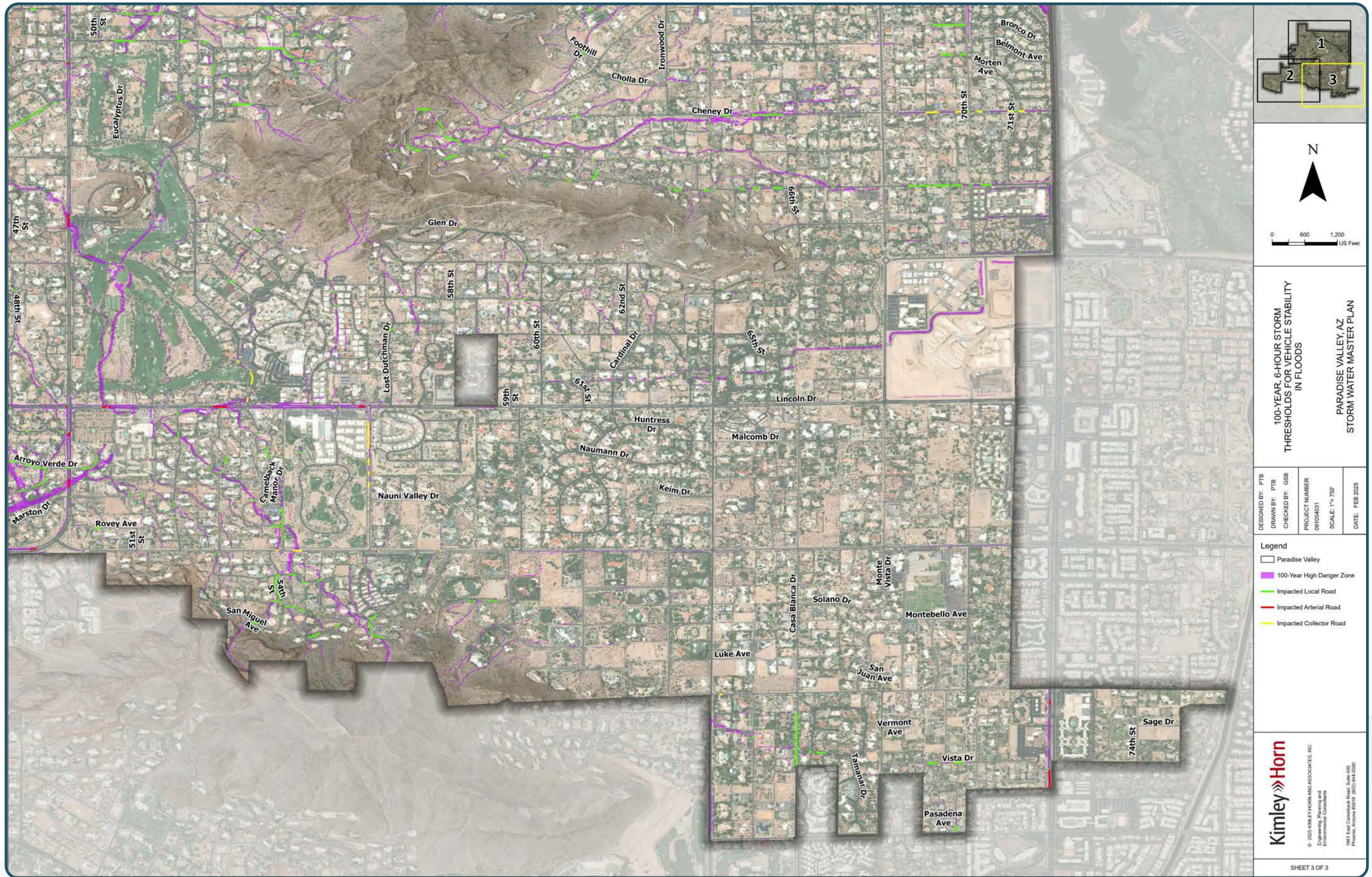


PARADISE VALLEY STORM WATER MASTER PLAN





PARADISE VALLEY STORM WATER MASTER PLAN



N

0 600 1,200 US Feet

100-YEAR, 6-HOUR STORM
THRESHOLDS FOR VEHICLE STABILITY
IN FLOODS

PARADISE VALLEY, AZ
STORM WATER MASTER PLAN

DESIGNED BY: PTB	PTB
DRAWN BY: PTB	GSB
CHECKED BY: GSB	
PROJECT NUMBER	091954031
SCALE: 1"= 750'	
DATE: FEB 2025	

Legend

- Paradise Valley
- 100-Year High Danger Zone
- Impacted Local Road
- Impacted Arterial Road
- Impacted Collector Road

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Engineering, Planning and
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1961 East Camelback Road, Suite 400
Phoenix, Arizona 85016 (602) 944-5000

SHEET 3 OF 3



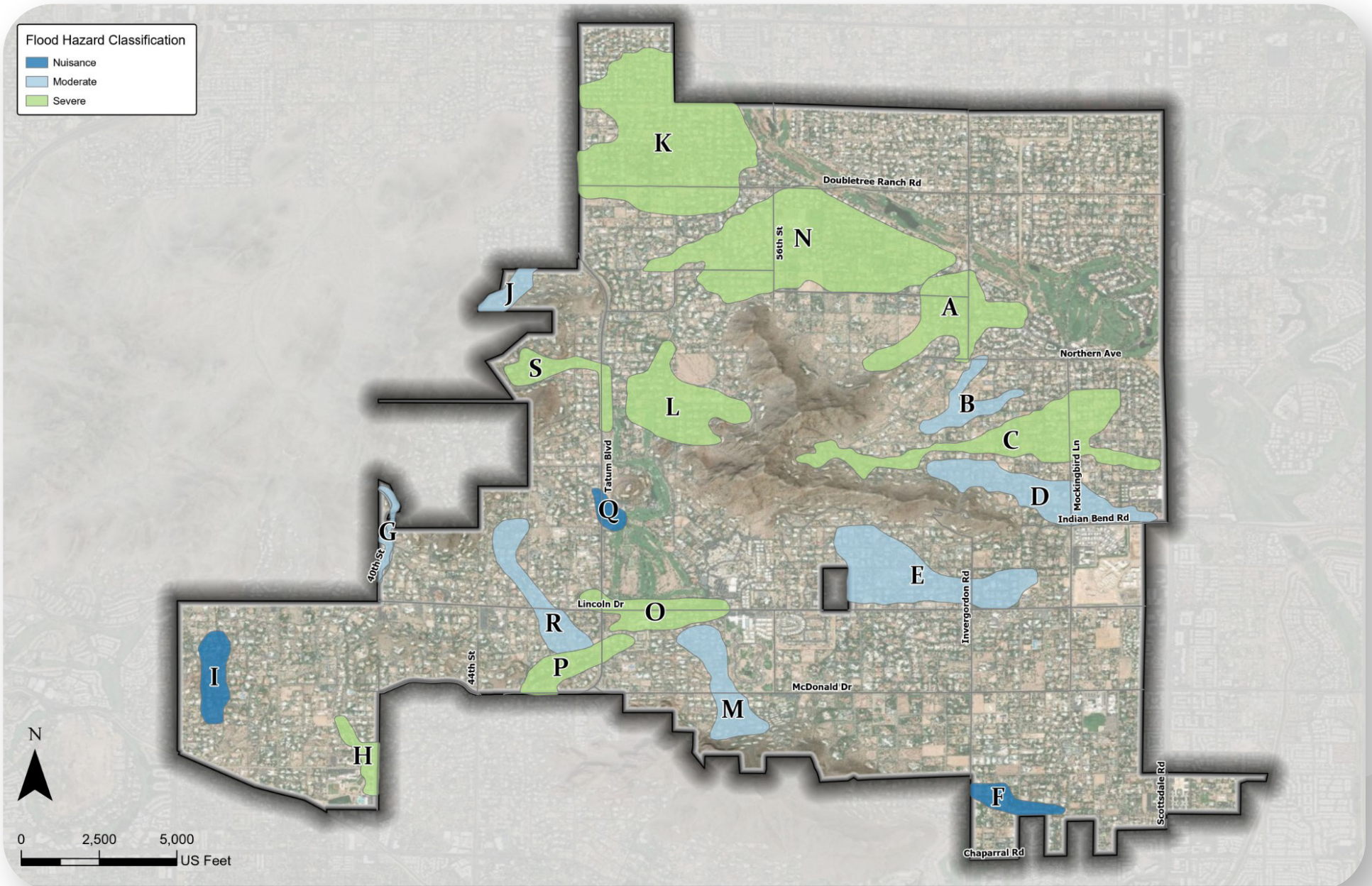
VI. FLOOD HAZARD AREA CLASSIFICATION

Areas of significant flood potential have been identified in several past studies as outlined in the Data Collection section of this report. Utilizing the updated town-wide comprehensive FLO-2D results, these areas were reevaluated and refined, with new areas added as applicable. Areas were either revalidated or added to the list of 'Flood Hazard Areas' based on a combination of factors. Actual reported flooding by Town staff and residents was evaluated against the town-wide modeling results to identify areas with a common flooding source, or areas with clusters of complaints. These areas could allow for mitigation solutions that would benefit multiple structures or roadways at a neighborhood level. In addition, the results of the flood hazard analysis as outlined in the previous section were also used.

Nineteen areas were identified as having some level of flood potential. These areas were further classified based on the potential level of flooding as nuisance, moderate and severe flooding. Areas were classified as nuisance flooding if modeling results showed approximately 0.5' to 1' of water depth along roads and against structures. Moderate flooding was designated if the area showed approximately 1' to 2' of water depth along roads and against structures. Severe flooding was designated to areas with greater than 2' at road and structures. **Figure 7** shows the flood classifications of each of the flood hazard areas.



Figure 7: Classifications of Flood Hazard Areas





PARADISE VALLEY STORM WATER MASTER PLAN

Flood hazard areas with moderate and severe classifications were ranked in a decision matrix based on five criteria, as outlined in **Table 6**. Classification of the severity of flooding and the potential number of structures that could be benefited in the area were the criteria that were given the greatest weight within the matrix with a weighted score of 5. Structures that could be benefitted were defined as any structure with adjacent flood depths of 0.5 feet. The number of streets inundated with at least 0.5 feet of depth was another variable considered in the matrix and was given a weighted score of 4. Impacts to emergency access and the potential for multi-use opportunities were considered in the matrix as well with priority scores of 3 and 1, respectively. The results of the area decision matrix and area data sheets are provided in **Appendix D**.

Table 7 includes the location, the severity designation, the number of buildings impacted, and potential impacts to emergency access for each flood hazard area. Of the 16 areas classified as having severe or moderate flood potential, the top 9 were selected to develop flood mitigation alternatives. The three areas classified as having nuisance flooding potential were not included in the ranking, but can be evaluated further by Town maintenance or engineering staff as annual maintenance budgets allow.

Table 6: Flood Hazard Area Prioritization Criteria

Criteria	Scoring Criteria	Weighted Score	Highest Possible Score	Lowest Highest Score
Severity of Flooding	1- Nuisance	5	15	5
	2- Medium			
	3- Severe			
Potential Structures Protected	1- 1 to 30 Structures	5	15	5
	2- 31-50 Structures			
	3- >51 Structures			
Potential Streets Protected	1- Local Street Benefits Only	4	12	4
	2- Arterial/Collector Street or Multiple Local Streets Benefits			
	3- Multiple arterial/collector & Local Street Benefits			
Restriction to Emergency Access	0- No Impact to Emergency Access	3	6	0
	2- Impacts to Emergency Access			
Multi-Use Opportunities	1- No Opportunities	1	2	1



Table 7: Flood Hazard Area Ranking and Characteristics

Flood Mitigation Alternatives Developed	Flood Hazard Area	Matrix Score	Severity of Flooding	Structures with Adjacent Depths of at Least 0.5 ft	Streets Impacted by at Least 0.5 ft Depths	Potential Impact to Emergency Access
	N	49	Severe	123	2 Collector; 8 Local	Yes
	A	45	Severe	43	2 Collector; 6 Local	Yes
	O	45	Severe	22	2 Collector; 4 Local	Yes
	K	43	Severe	141	2 Collector; 13 Local	No
	L	41	Severe	35	0 Collector; 5 Local	Yes
	H	40	Severe	9	2 Collector; 2 Local	Yes
	P	39	Severe	17	1 Collector; 2 Local	Yes
	C	39	Moderate	70	1 Collector; 2 Local	No
	E	38	Moderate	52	2 Collector; 5 Local	No
	S	36	Severe	14	1 Collector; 1 Local	Yes
	R	36	Severe	27	1 Collector; 5 Local	Yes
	D	33	Severe	20	2 Collector; 1 Local	No
	G	32	Severe	2	0 Collector; 2 Local	Yes
	M	25	Moderate	19	1 Collector; 6 Local	No
	B	25	Moderate	4	1 Collector; 2 Local	No
	J	21	Moderate	8	0 Collector; 3 Local	No



VII. PROPOSED PROJECT ALTERNATIVES

For the nine flood hazard areas that scored highest, proposed project alternatives were developed. Previously identified conceptual projects from past studies were first evaluated, as many of these fell within the nine flood hazard areas. These projects were either classified as maintenance projects, medium sized projects, or large projects based on estimated construction costs. Maintenance project costs were less than 250,000 USD and were not considered for the alternatives evaluation as they typically do not mitigate wider spread flooding. Projects with construction costs between 250,000 and 1.3 million USD were designated as medium sized as they are eligible for FCDMC's Small Project Assistance Program (SPAP) as a cost share opportunity. Large projects were designated as having construction costs that exceed 1.3 million USD and could qualify for other grant programs like FCDMC's Capital Improvement Project Partnership Program (CIPPP) or other grant opportunities through the Federal Emergency Management Agency (FEMA). Medium and/or large projects were proposed for each of the nine areas. These projects were

either previously proposed, previously proposed and further refined, or developed specifically for this master plan. Two or three alternatives were developed in each area. A decision matrix was used to select a recommended alternative for each area. The project variables and their weighted score are shown in **Table 8**. See **Appendix E** for the project alternatives decision matrix for each flood hazard area. It should be noted that because of the direction that all improvements should be confined within existing Town right-of-way, most alternatives are variations of storm drain or culvert configurations. Because of this, cost became the overwhelming determining factor in the scoring matrix for determining the recommended alternative.

Pages 43-76 detail the flood mitigation alternatives developed for each of the nine flood hazard areas studied. Each area has a description of the alternatives developed, including the project sizes (medium or large), and which is the recommended alternative. Schematics of the project alternatives are also included.

Table 8: Project Prioritization Criteria

Criteria	Scoring Criteria	Weighted Score	Highest Possible Score	Lowest Possible Score
Potential Structures Protected	1- 1 to 30 Structures	5	15	5
	2- 31 to 50 Structures			
	3- > 51 structures			
Design & Construction Cost/Benefit	1- Most Expensive	5	10	5
	2- Least Expensive			
Potential Streets Protected	1- Local Street Benefit Only	4	12	4
	2- Arterial/Collector Street or Local Streets Benefit			
	3- Multiple Arterial/Collector Streets and Local Streets Benefit			
Green Storm Water Infrastructure	1- No Opportunities	1	2	1
	2- Some Opportunities			
Project Partnership	1- Grant Funding or Partnerships Likely	4	12	4
	2- Local Partnership/Grant Eligible			
	3- Local and Federal Partnerships/Grant Eligible			
Multi-Use Opportunities	1- No Opportunities	2	4	2
	2- Some Opportunities			
Operation and Maintenance Costs	1- Maintenance After Every Storm Event	3	6	3
	2- Maintenance at Standard Intervals			
Utility Constraints	1- Major Constraints	3	6	3
	2- Minor Constraints			



A. Flood Hazard Area A – Invergordon Road and Mockingbird Lane

Summary and Description

The source of flooding in this area is runoff from the north and east side of Mummy Mountain, including Maverick Wash and Ironwood Wash flowing northeast toward IBW. Insufficient drainage infrastructure results in road and property flooding. The major roads affected by runoff include Northern Avenue, Invergordon Road, Maverick Road, and El Maro Circle. Invergordon Road has the greatest level of flooding, due to additional flooding from Cherokee Wash. During the 100-year storm, a maximum water depth of 3.7 feet per modeling results from this study occurs on Invergordon Road. This poses risks to emergency vehicle access, passenger vehicles, and to the adjacent properties. Maverick Road also has flooding issues 0.5-1-foot water depths for the length of the street between 62nd Place and Invergordon Road. Several smaller washes flow through private property and across public roads with inadequate conveyance capacity. Several residents south of El Maro Circle and north of Maverick Road on the east side of Invergordon Road, residents have reported property flooding. Flooding in this area has been documented in the Cheney Watershed Hazards Identification Report and the Lower Indian Bend Wash Area Drainage Master Study/Plan (LIBW ADMS/P).

Alternative 1 (Large, Recommended)

The first proposed alternative for this area consists of the implementation of new storm drain. 60" RCP storm drain would begin north of the intersection of Invergordon Road and Northern Avenue and have an inlet to capture a portion of the flows from Ironwood Wash. The inlet would be located on the left side of Invergordon Road to alleviate the magnitude of flows through the culvert crossing the road. The storm drain would extend north towards Mockingbird Lane and would connect to the existing 12' by 3' RCBC currently being designed and constructed as part of the Mockingbird Lane project. A 48" RCP lateral would extend west at Maverick Road to capture flows from Maverick Wash. Inlets would be placed at the cul-de-sac to account for the concentrated discharge. The design and construction cost of Alternative 1 is estimated to be **4,145,670 USD**. See **Appendix E** for a detailed cost estimate of the project.

Table 9: Alternative 1 Opportunities and Constraints

Alternative 1 Opportunities	Alternative 1 Constraints
Most Cost-effective alternative	Utility conflicts likely
Reduces discharge entering undersized existing channels that flow through private properties	Potential for sediment issues at Maverick Road that would require routine maintenance
Large area of flood mitigation	Major traffic disruptions to Invergordon Road

Alternative 2 (Large)

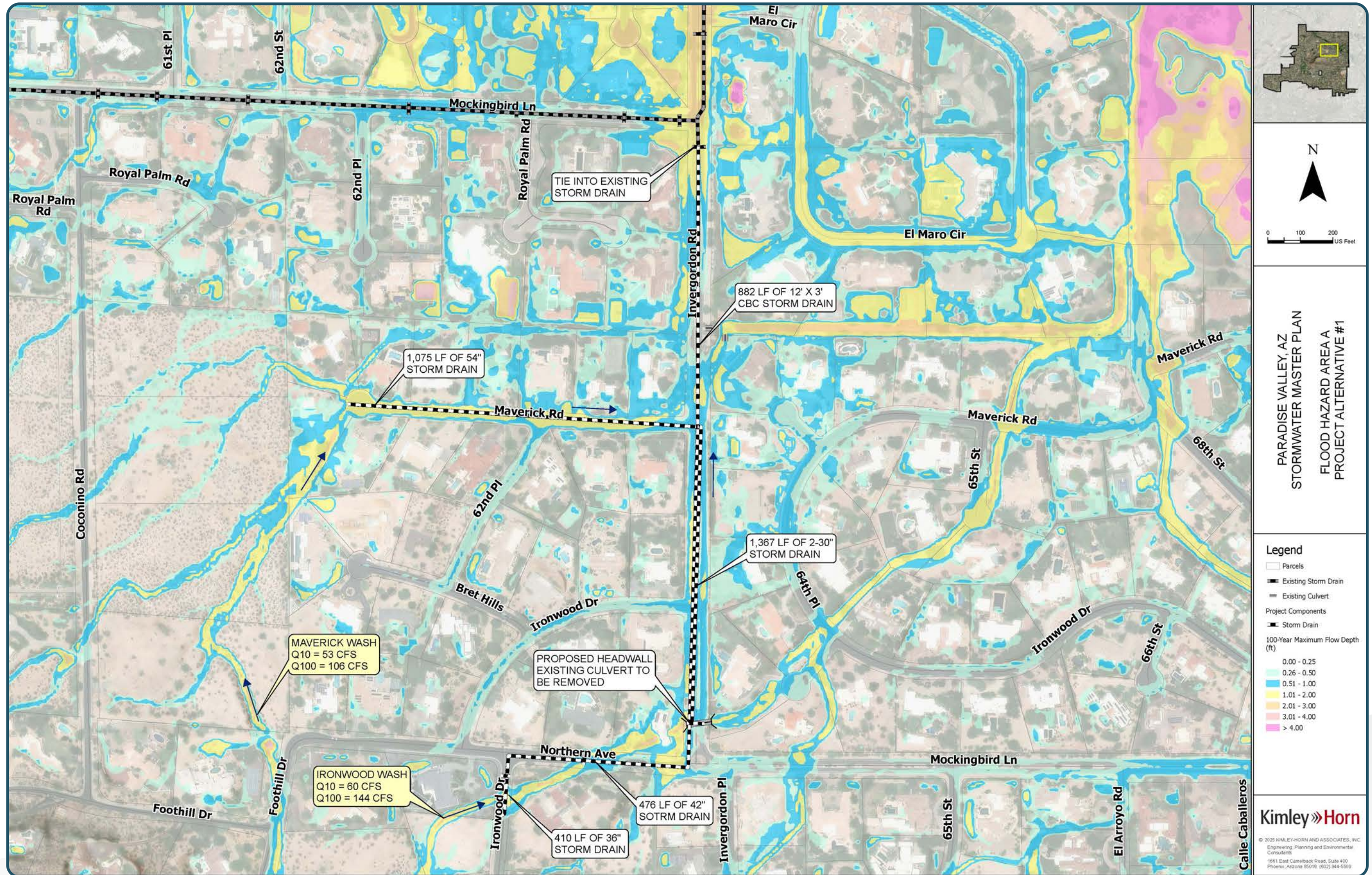
The second proposed alternative for Area A is also the implementation of new storm drain but in a different configuration. The proposed 48" RCP storm drain begins on Foothill Drive, where Maverick Wash overtops the road, and would continue north and turn east on Northern Avenue. Approximately two hundred feet of 48" RCP storm drain would be located on Ironwood Drive and would connect to the main line on Northern Avenue. This would intercept a portion of the discharge from Ironwood Wash. At Calle Caballeros, the storm drain would expand to 60" RCP and would continue east to outfall at the existing channel east of Golf Drive. The channel ultimately outfalls to IBW. The design and construction cost of Alternative 2 is estimated to be **7,083,913 USD**. See **Appendix E** for a detailed cost estimate of the project.

Table 10: Alternative 2 Opportunities and Constraints

Alternative 2 Opportunities	Alternative 2 Constraints
Captures flows from Ironwood Wash and Maverick Wash	Major traffic disruptions to Northern Avenue
Large area of flood mitigation	Utility conflicts likely
Reduce discharge entering undersized existing channels that flow through private property	More expensive alternative

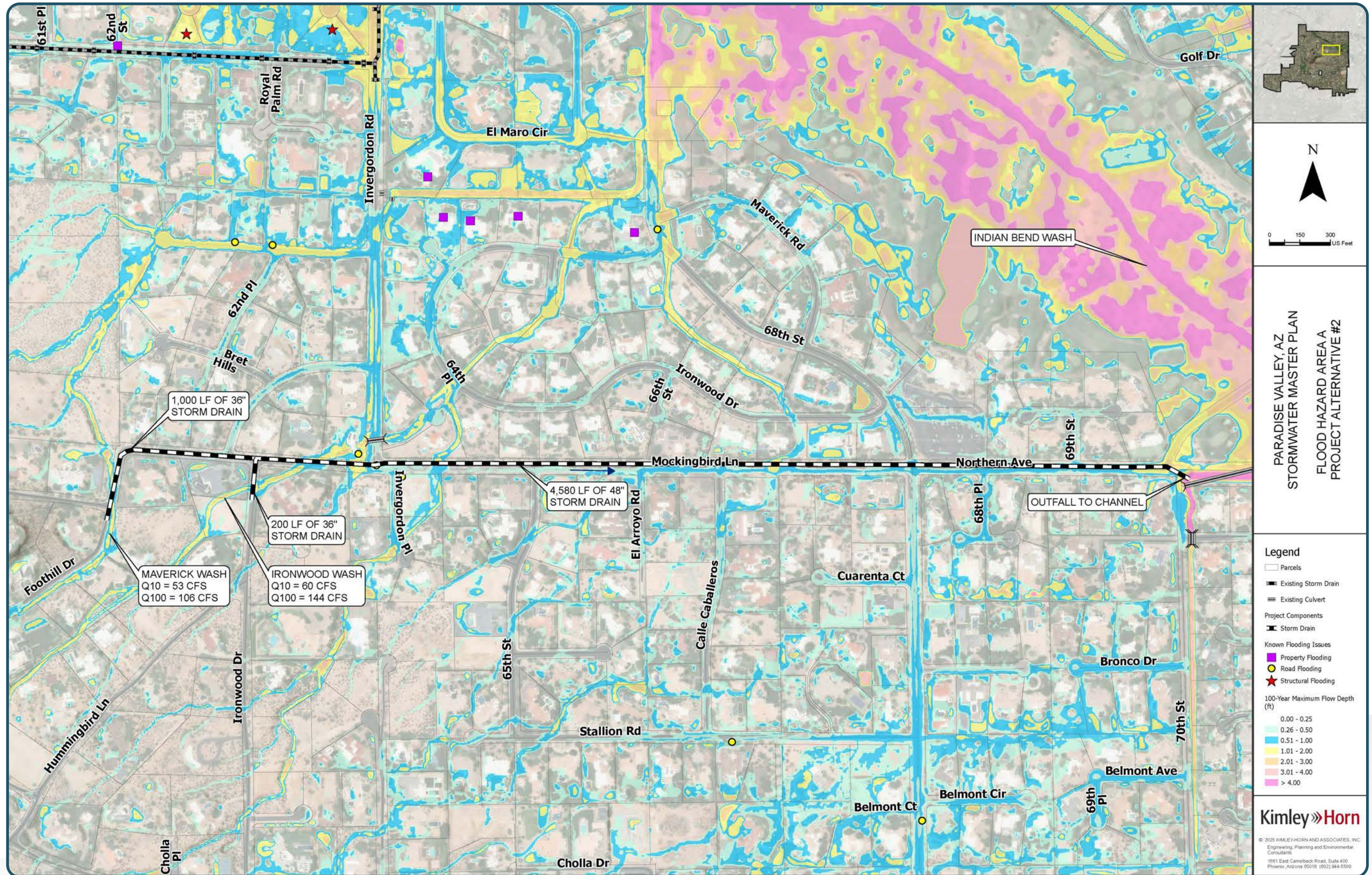


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B. Flood Hazard Area C – Cheney Wash

Summary and Description

The source of flooding in this area is Cheney Wash. Runoff from the east side of Mummy Mountain flows east and parallel to Cheney Drive. Once the wash reaches Invergordon Road, there is no infrastructure to convey the discharge to an outfall. The water fans out onto the street and the adjacent neighborhood properties until it reaches Indian Bend Wash (IBW). As the water crosses Cheney Drive, a maximum water depth of 1.4 ft occurs during the 100-year storm event per the FLO-2D modeling results from this study. Town residents and staff have reported flooding issues in this area. The Lower Indian Bend Wash Area Drainage Master Study/Plan (LIBW ADMS/P) and Cheney Watershed Hazards Identification Report have also identified flood hazards in this area.

Alternative 1 (Large)

The first alternative proposed for Area C consists of storm drain to route runoff from Cheney Wash to IBW. Runoff from Cheney Wash will be intercepted by a 60" storm drain routed from Invergordon Road to 68th Street. Large inlets are proposed at Invergordon Road, as this area contains the highest concentration of discharge. A sediment basin was initially recommended for this alternative, as it would facilitate controlled discharge release. However, large capacity inlets were selected because a sediment basin would require a significant acquisition of land. A 36" lateral of storm drain along 66th Street will connect from the north to the 60" storm drain trunkline along Cheney Drive. The storm drain size increases to 78" at the intersection of Cheney Drive and 68th Street and is routed north until it reaches Northern Avenue. East along Northern Avenue, a 72" storm drain will carry flows east towards 70th Street where it then outfalls into the existing channel running parallel to the IBW. A catch basin and bubble-up structure are proposed at the 70th Street discharge location to dissipate the high discharges in the shallow channel. The design and construction cost of Alternative 1 is estimated to be **14,251,950 USD**. See **Appendix E** for a detailed cost estimate of the project.

Table 11: Alternative 1 Opportunities and Constraints

Alternative 1 Opportunities	Alternative 1 Constraints
No major land acquisition required	Utility conflicts likely
Intercepts additional flow on Northern Avenue	Cost exceeds 15 million USD
Improvements would benefit a large area of streets and structures	Potential for sediment issues at Invergordon Road that would require routine maintenance

Alternative 2 (Large, Recommended)

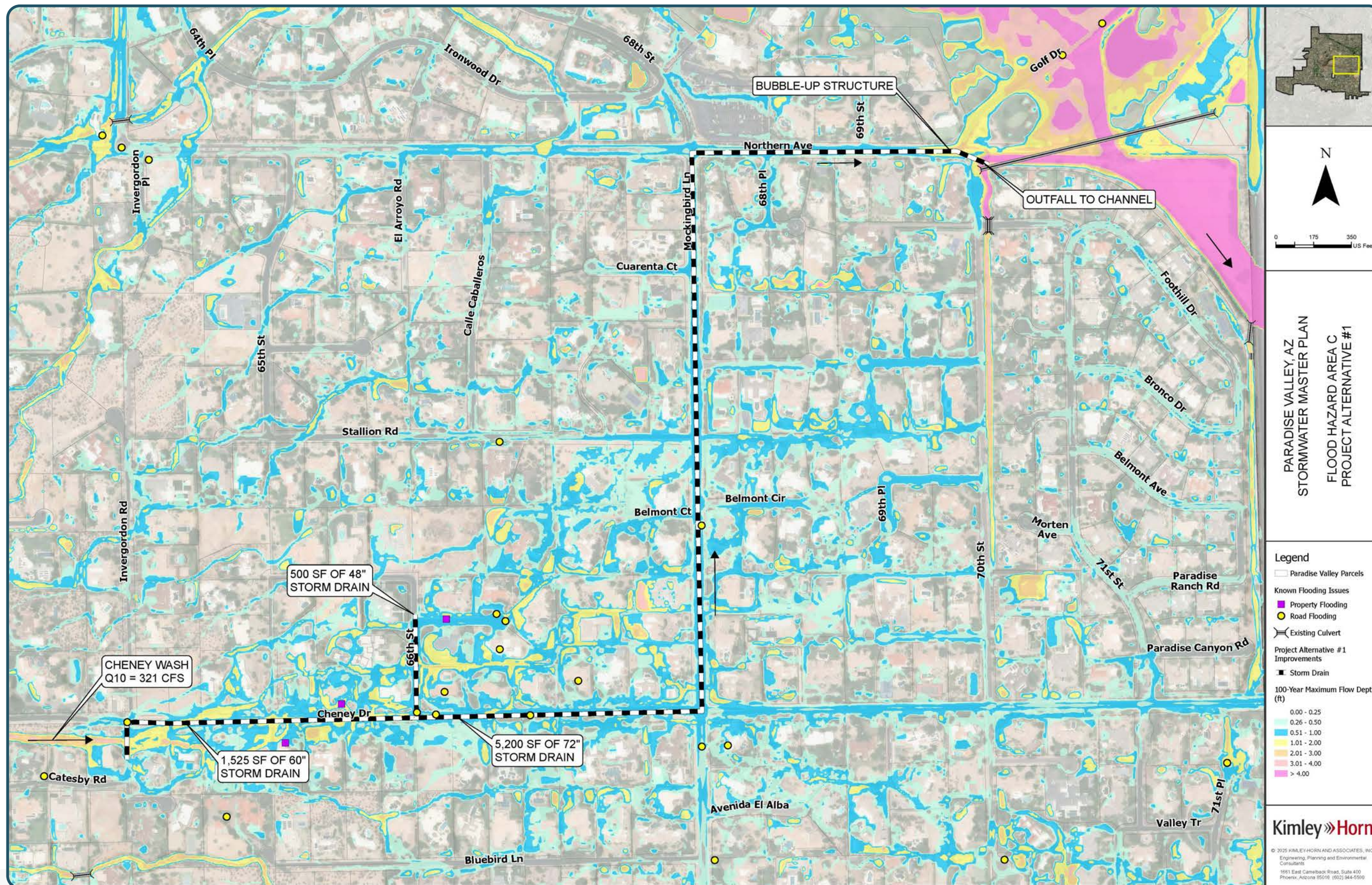
The second alternative proposed for this area is similar to the first alternative. The 60" storm drain begins at the same location as Alternative 1, Cheney Drive, but extends past 70th Street to the existing channel west of Scottsdale Road. Along this section of storm drain there are two laterals. As in Alternative 1, a 36" lateral is located on 66th Street. On 68th Street, a 36" lateral also extends 1,250 feet to Stallion Road. At 70th Street, the storm drain on Cheney Drive splits off towards two outfalls. 72" storm drain is directed north on 70th Street where it outfalls into the existing channel on the east side of the road. That channel continues north, ultimately outfalling to Indian Bend Wash. The second outfall is located at the existing channel on the west side of Scottsdale Road. The design and construction cost of Alternative 2 is estimated to be **11,177,860 USD**. See **Appendix E** for a detailed cost estimate of the project.

Table 12: Alternative 2 Opportunities and Constraints

Alternative 2 Opportunities	Alternative 2 Constraints
Improvements would benefit a large area of streets and structures	Potential for sediment issues at Invergordon Road that would require routine maintenance
Most cost-effective alternative	Utility conflicts likely

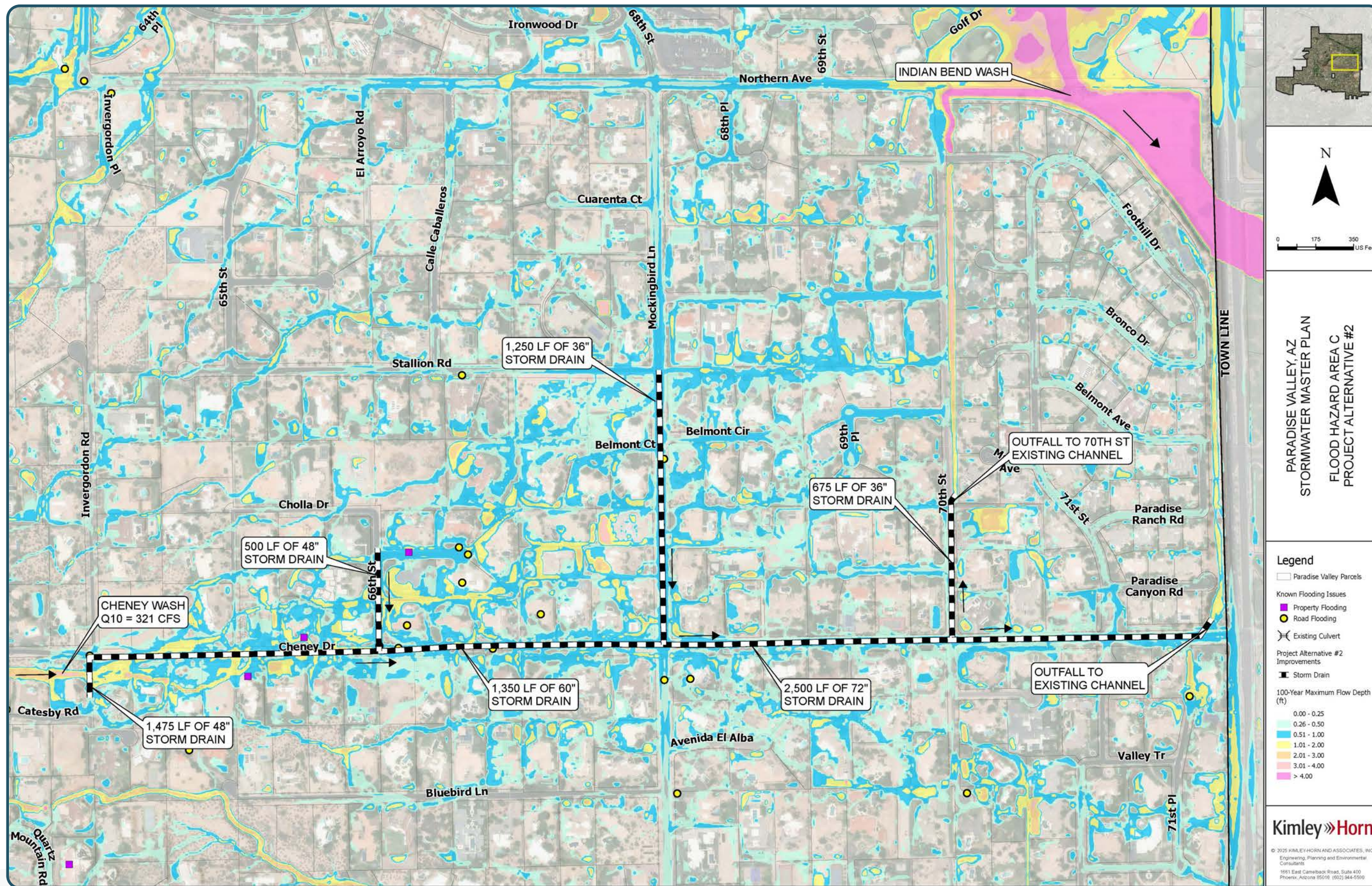


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C. Flood Hazard Area E – Lincoln Wash

Summary and Description

The source of flooding in this area is Lincoln Wash. The areas of interest are located north of Lincoln Drive, between 60th Street and Mockingbird Lane. The wash overtops several roads as flow moves towards Indian Bend Wash (IBW) to the east. Routine maintenance of these streets is required after major storm events. A maximum depth of 1.2 ft occurs at Invergordon Road during the 100-year storm event per FLO-2D model results from this study. The Lower Indian Bend Wash Area Drainage Master Study/Plan (LIBW ADMS/P) has also identified this area as a flooding issue.

Alternative 1 (Large)

The first alternative proposed for Area E consists of storm drain located from 60th Street to Mockingbird Lane along Lincoln Drive. Lateral storm drains would be placed along roads north of Lincoln Drive to capture flow from Lincoln Wash. Three laterals extend north from Lincoln Drive at 60th Street, 61st Street, and Invergordon Road to intercept flows that overtop these roads. At the intersection of Lincoln Drive and Mockingbird Lane, a diversion structure splits the flow towards the two outfalls identified in this alternative. One outfall is located east of the diversion structure, where flow enters an existing 90" storm drain system along Scottsdale Road. A second outfall is located north of the diversion structure. Once the water level in the system reaches a certain height at the structure, flow will spill north to a storm drain system along Mockingbird Lane and towards the second outfall at the Ritz-Carlton Channel. The design and construction cost of Alternative 1 is estimated to be **14,912,386 USD**. See [Appendix E](#) for a detailed cost estimate of the project.

Table 14: Alternative 1 Opportunities and Constraints

Alternative 1 Opportunities	Alternative 1 Constraints
Partially in Scottsdale boundaries	Utility conflicts likely
Improvements would benefit a large area of streets and structures	Cost exceeds 14 million USD
	Least cost-effective alternative

Alternative 2 (Large)

The second alternative proposed for Area E is similar to Alternative 1. The storm drain along Lincoln Drive would have the same configuration as in Alternative 1 but would differ at the intersection of Mockingbird Lane and Lincoln Drive. In this alternative, storm drain will not turn north along Mockingbird Lane to outfall towards the Ritz-Carlton Channel. Rather, the storm drain turns north along Casa Blanca Drive to outfall into the Ritz-Carlton Channel parallel to Ocotillo Road. This alternative does not call for a diversion structure, and all flow would be routed along Casa Blanca Drive via storm drain to the Channel. The design and construction cost of Alternative 2 is estimated to be **9,523,912 USD**. See [Appendix E](#) for a detailed cost estimate of the project.

Table 15: Alternative 2 Opportunities and Constraints

Alternative 2 Opportunities	Alternative 2 Constraints
Improvements would benefit a large area of streets and structures	Cost analysis exceeds 9 million USD
Fully within the Town's boundaries as compared to Alternative 1	Utility conflicts likely
More cost-effective alternative compared to Alternative 1	



Alternative 3 (Medium/Large, Recommended)

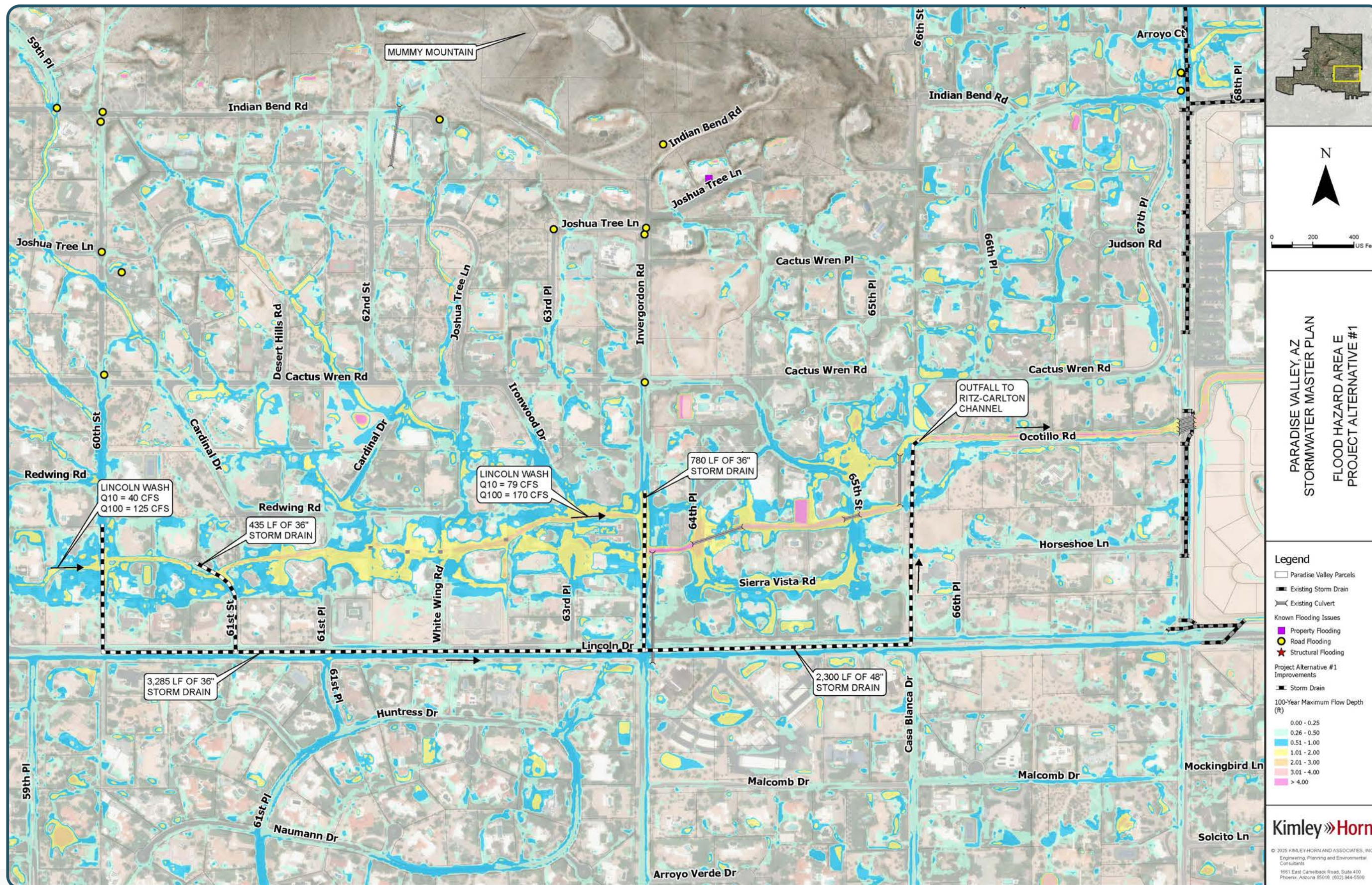
The third alternative proposed for Area E is different from Alternatives 1 & 2, because it focuses on utilizing Green Stormwater Infrastructure (GSI) rather than storm drain. North of Lincoln Drive, all sections of neighborhood pavement that are inundated by at least half a foot of water in the 100-year storm event would be replaced with permeable pavement. Therefore, as the wash overtops roads, water will naturally seep into the pavement, reducing the volume of runoff. Periodic vacuum sweep maintenance is necessary to improve infiltration rates, although less maintenance is required for cracks and potholes in comparison to traditional pavements (NPDES, 2021). The lifespan of permeable pavement is on par with that of traditional pavements and can serve as a durable, low-maintenance alternative to conventional impermeable pavements. The design and construction cost of Alternative 2 is estimated to be **1,358,798 USD**. See **Appendix E** for a detailed cost estimate of the project.

Table 16: Alternative 3 Opportunities and Constraints

Alternative 3 Opportunities	Alternative 3 Constraints
Improvements would benefit a large area of streets and structures	May not be as effective
Most cost-effective alternative	Requires specialized maintenance
Utilizes GSI	

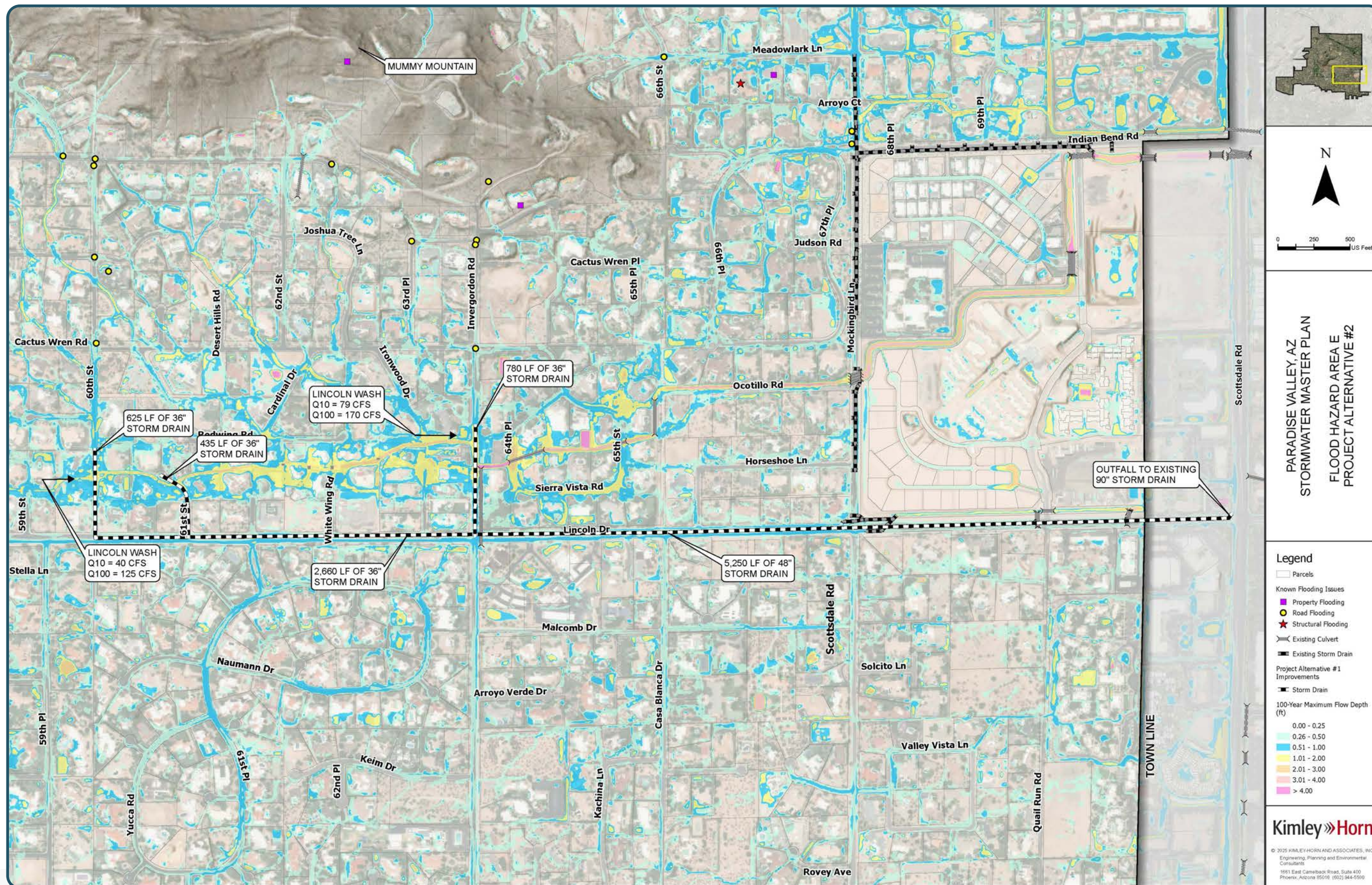


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D. Flood Hazard Area H – 40th Street and Stanford Drive

Summary Description

The source of flooding in this area is Cudia City Wash (CCW). The existing low water crossing at 40th Street is consistently inundated during storm events, with a maximum depth of approximately 5 ft during the 100-year storm event. The roadway flooding leads to road closures that significantly disrupt traffic and impact emergency vehicle access. The crossing poses a hazard to passenger vehicles with at least one vehicle having been swept off the road and into the bollards downstream of 40th Street in a past storm event. The bollards on the downstream side of the crossing build up significant debris after storms and require routine maintenance. The existing curb inlet at Stanford Drive is also a flooding issue. The capacity of the inlet is limited and leads to ponding on the road. Town residents and staff have reported flooding issues in this area. The CCW Area Drainage Master Study/Plan (ADMS/P) and the CCW Design Concept Report (DCR) have also documented this flood hazard. Alternatives 2 and 3 have been studied in detail and proposed as part of the CCW DCR.

Alternative 1 (Medium)

The first project alternative consists of improvements to existing roadway drainage infrastructure. The existing combination curb and grate inlet at Stanford Drive lacks the capacity required to alleviate roadway ponding. This alternative proposes removing this inlet and replacing the outlet with a 36" pipe to allow for larger draining capacity. The existing inlet is a combination curb opening and grate type and sediment often clogs the opening of the grate. It is recommended that the grate inlet be replaced with a larger curb and gutter type inlet. Bollards at the 40th Street crossing would be removed and replaced with safety rails that will continue to prevent cars from entering the wash, while allowing sediment and debris to pass. The implementation of a safety rail will reduce the need for maintenance after storms. For public safety, it is also recommended that a "Do Not Enter When Flooded" warning sign be placed on the north side of the wash, as there is currently only a sign on the south side of the wash. A staff gage is proposed to be placed along the wash to further discourage passenger vehicles and pedestrians from attempting to cross during storms. The design and construction cost of Alternative 1 is estimated to be 68,232 USD. See [Appendix E](#) for a detailed cost estimate of the project.

Table 17: Alternative 1 Opportunities and Constraints

Alternative 1 Opportunities	Alternative 1 Constraints
Improves existing roadway drainage infrastructure	The level of flood mitigation is limited in comparison to Alternative 2 & 3
Improvements would reduce sedimentation on 40th Street	
Least expensive alternative	

Alternative 2 (Medium, Recommended)

This project alternative involves modifying the curb inlet at Stanford Drive, improving the inlet capacity for the culvert crossing under Stanford Drive, and installing a flood control basin on the corner of Stanford Drive and 40th Street. Alternative 2 consists of all items proposed in Alternative 1 including warning signs and safety railing on 40th Street, as well as inlet modifications on Stanford Drive. In tandem with the aforementioned improvements, an offline flood control basin on the northwest corner of Standard Drive and 40th Street is also proposed. A diversion weir is proposed to facilitate overtopping into the basin once water surface elevations exceed a desired height. A 48" drain pipe on the southeast corner of the basin will release stormwater back into Cudia City Wash north of Stanford Drive. The FCDMC owns this parcel of land, so land acquisition would not be required. The design and construction cost of Alternative 2 is estimated to be 880,650 USD. See [Appendix E](#) for a detailed cost estimate of the project.

Table 18: Alternative 2 Opportunities and Constraints

Alternative 2 Opportunities	Alternative 2 Constraints
Improvements would improve flood conditions for Stanford Drive and 40th Street	Maintenance of the flood control basin may be required after every major storm event
Basin area owned by FCDMC	
This alternative may qualify for the Small Project Assistance Program (SPAP) grant	

Alternative 3 (Large)

Alternative 3 proposes the replacement of the low water crossing at 40th Street with a concrete box culvert to convey Cudia City Wash under the road. Analysis



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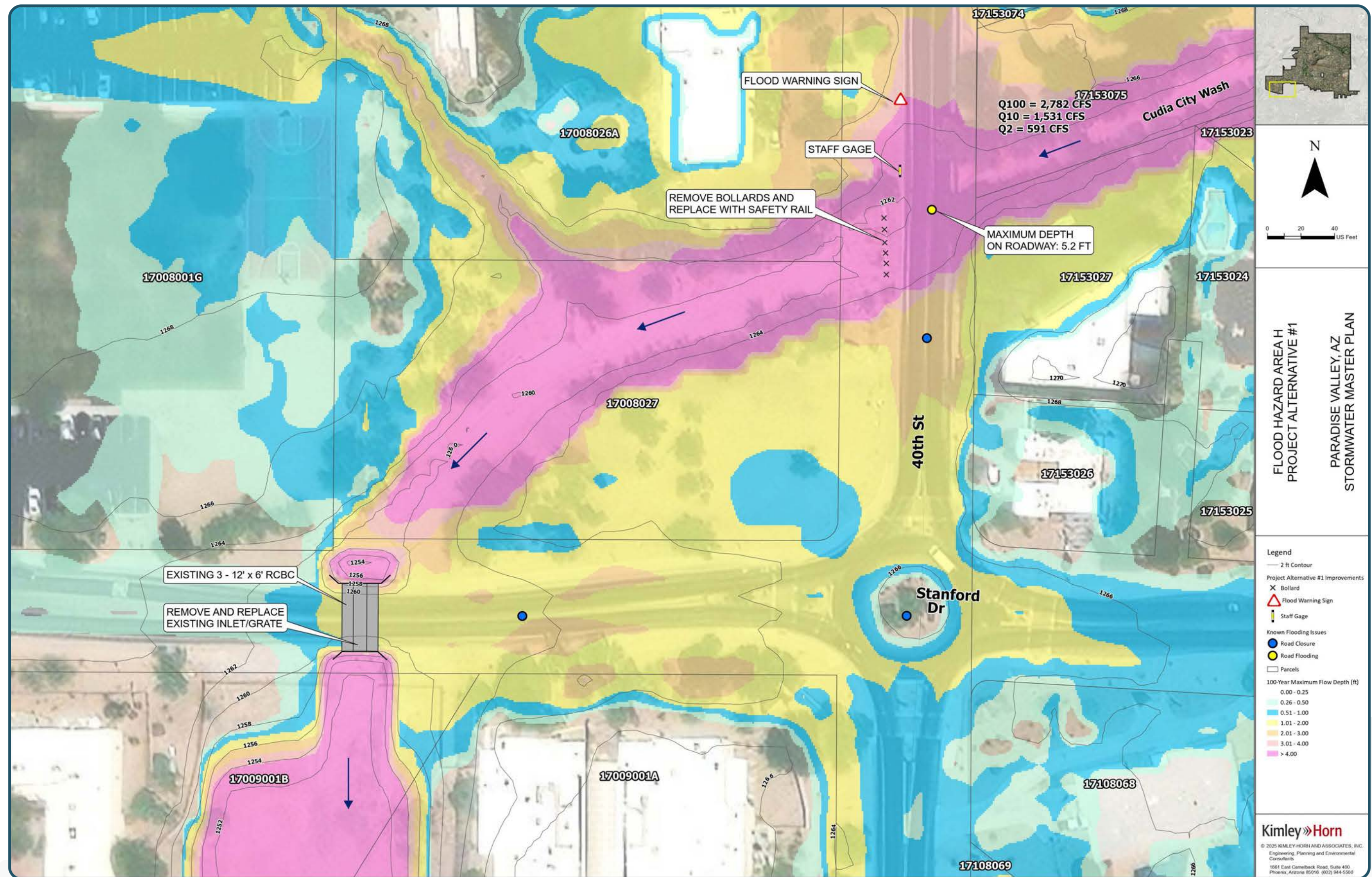
cited in the CCW DCR determined the optimal culvert configuration under 40th Street to be a six barrel 12' x 4' reinforced concrete box culvert. This configuration is wider than the channel bottom and would only partially convey the 100-year storm discharge. This culvert design would effectively convey the 25-year storm. The City of Phoenix's drainage standards require box culverts to have a height of 6 feet due to maintenance considerations. A six barrel 12' x 6' configuration would be required, with two feet of the barrels being buried below the channel invert. Roadwork at 40th Street would be required for this configuration to raise the road. This alternative also proposes modifying the inlet on Stanford Drive (as in Alternative 1) to reduce roadway flooding. The design and construction cost of Alternative 3 is estimated to be 2,240,419 USD. See [Appendix E](#) for a detailed cost estimate of the project.

Table 19: Alternative 3 Opportunities and Constraints

Alternative 3 Opportunities	Alternative 3 Constraints
Improvements would improve flood conditions for Stanford Drive and 40th Street	The culvert can only convey the 25-year storm event and Stanford Drive flooding may still occur
40th Street would no longer need to be closed during storm events	Backwater effects would cause a rise in water surface elevation for the 100-year storm event upstream and east of 40th Street

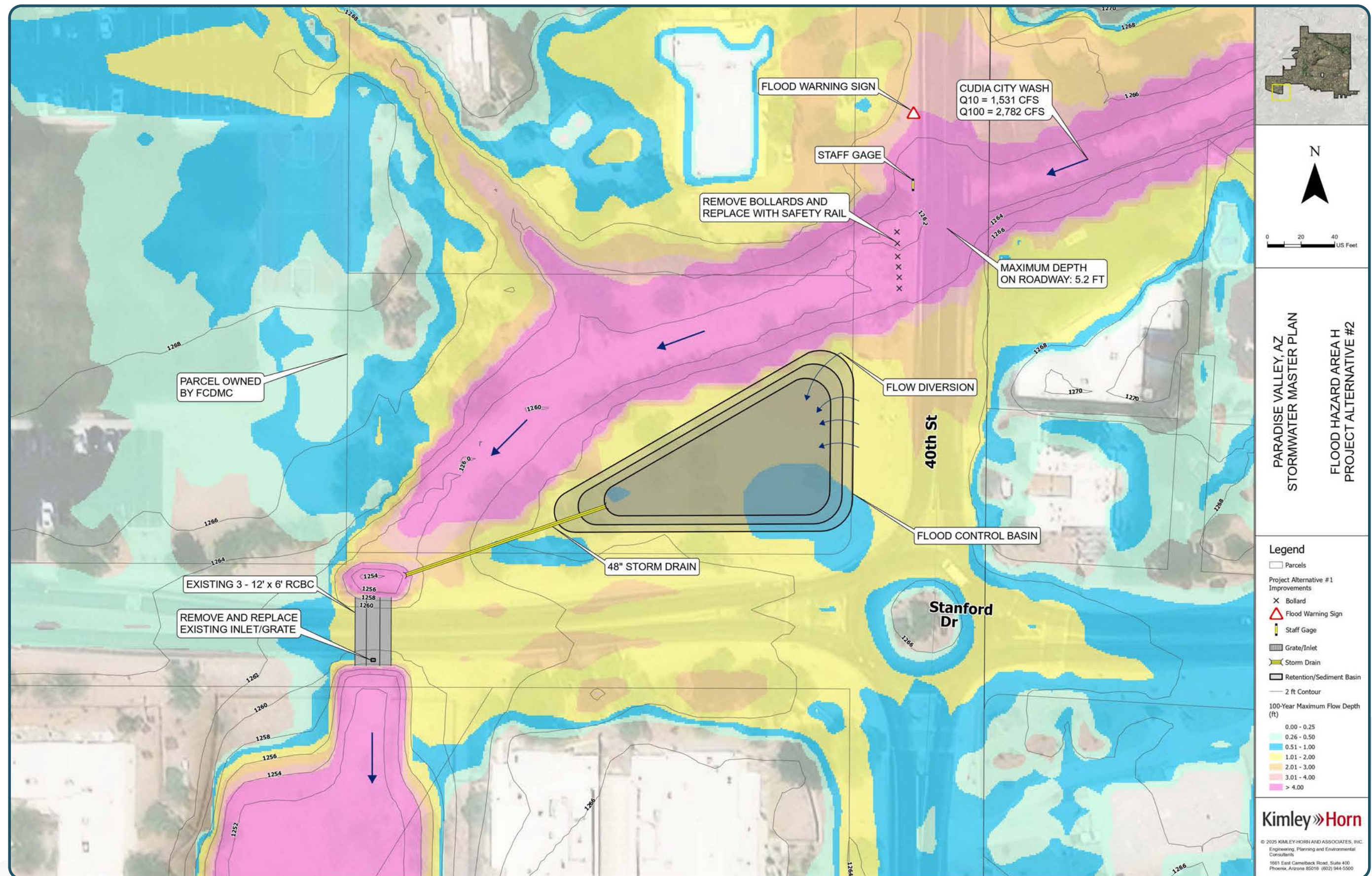


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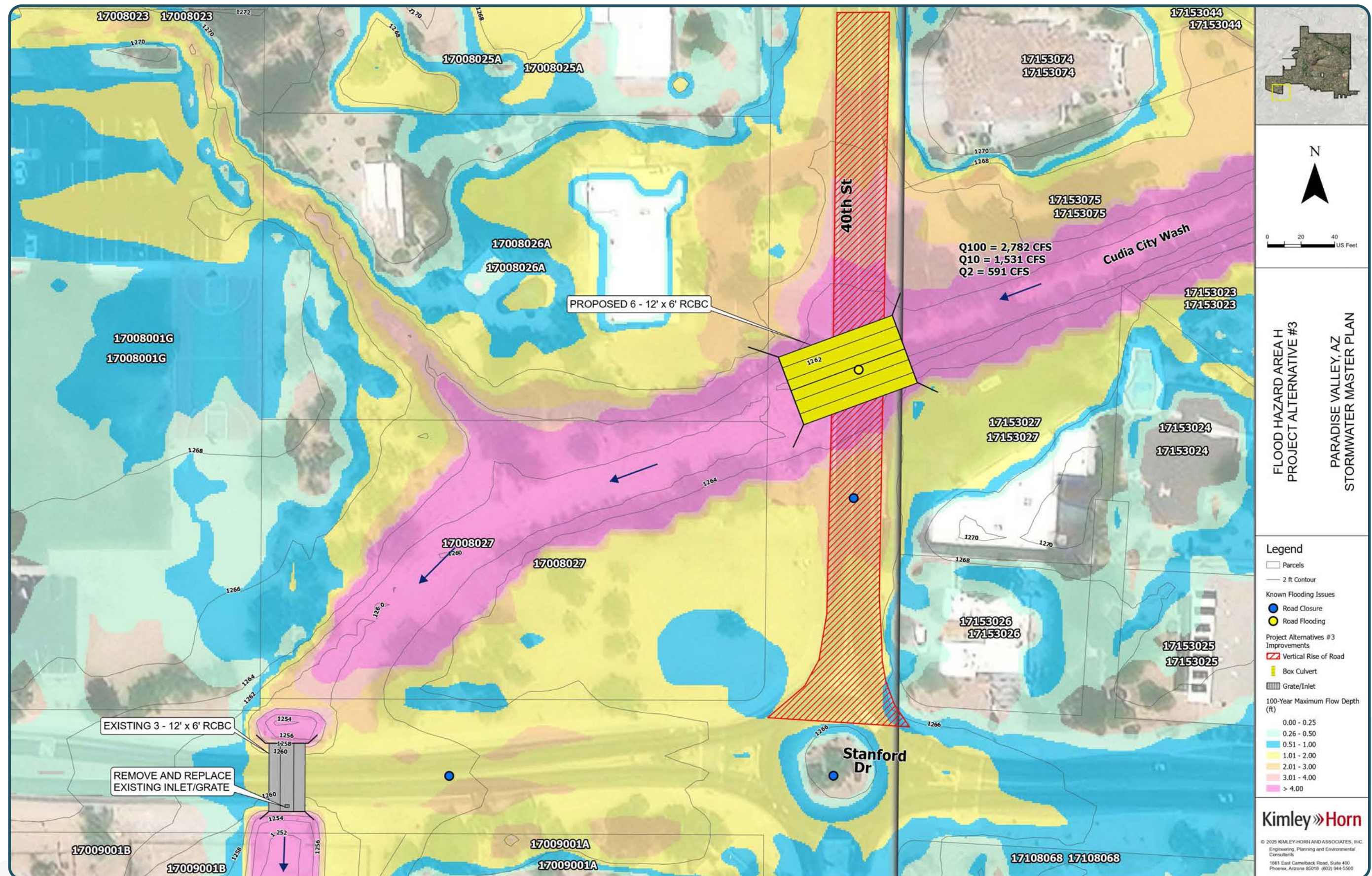


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E. Flood Hazard Area K – Mountain View Road

Summary and Description

The source of flooding in this area is runoff from the east side of the Phoenix Mountain Preserve. Runoff flows east past Tatum Boulevard and breaks out into the neighborhood on the east side of Tatum Boulevard, resulting in flood hazards to roads and private parcels. This occurs both at Mountain View Road and Doubletree Ranch Road. Existing storm drain along Doubletree Ranch Road mitigates flooding, while Mountain View Road lacks the required infrastructure to alleviate flooding issues. In particular, Turquoise Avenue is subject to water depths of up to 2.4 feet during the 100-year storm per FLO-2D modeling results from this study, posing a potential hazard to passenger vehicles and residents. The area has been identified by Town staff and residents as a flood hazard to the road, property, and homes.

Alternative 1 (Large)

Alternative 1 consists of the construction of a storm drain system to reduce flooding on local and collector roads. The storm drain begins on Tatum Blvd and is routed east on Mountain View Road to ultimately outfall to IBW. Additional laterals would extend north along 50th Street and 51st Place, and south along 53rd Place. The likely storm drain sizes would be 36", 48", and 60" RCP, increasing progressively in size. The design and construction cost of Alternative 1 is estimated to be **7,472,758 USD**. See **Appendix E** for a detailed cost estimate of the project.

Table 20: Alternative 1 Opportunities and Constraints

Alternative 1 Opportunities	Alternative 1 Constraints
Large area of flood mitigation	Utility conflicts likely
Improvements reduce flood hazards to roads and passenger vehicles	More expensive alternative
	Major traffic disruptions to Tatum Boulevard and Mountain View Road

Alternative 2 (Large, Recommended)

The second proposed alternative for Area K is the implementation of a detention or retention basin prior to the channel breakout on the upstream side of Tatum Boulevard. The basin is proposed on parcel 168-15-128 and is owned by Rancho Alta Vida Homeowners Association. This parcel is upstream of the channel breakout on Tatum Boulevard and would assist in reducing discharge through the existing culvert on Tatum Boulevard. The design and construction cost of Alternative 2 is estimated to be **2,192,073 USD**. See **Appendix E** for a detailed cost estimate of the project.

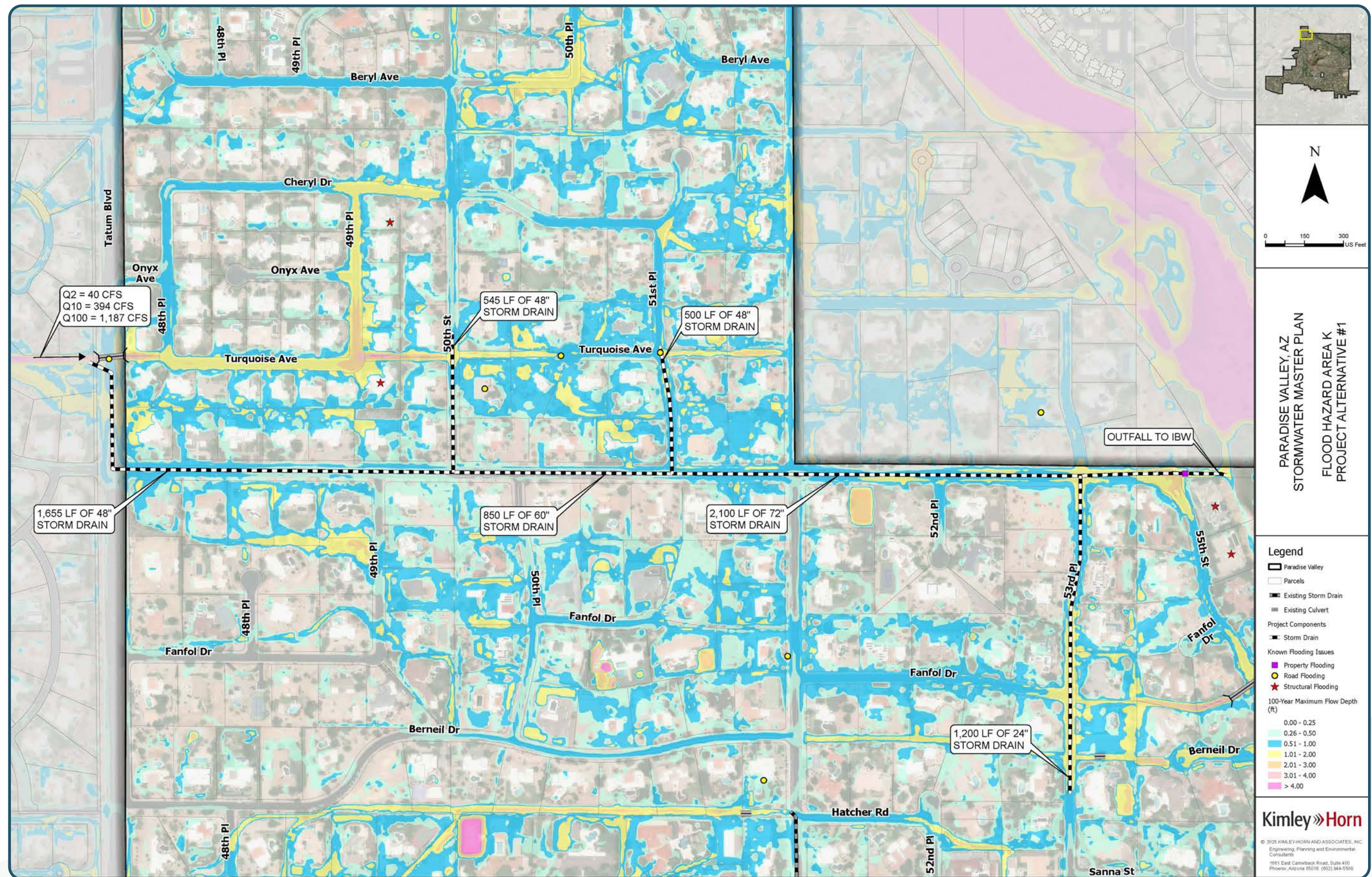
Table 21: Alternative 2 Opportunities and Constraints

Alternative 2 Opportunities	Alternative 2 Constraints
Most cost-effective alternative	Requires easement from the homeowner's association
Reduces discharge at Tatum Boulevard	Outside of Paradise Valley boundaries

*The recommended alternative may not be feasible due to the property constraints. It is recommended because of effectiveness and cost. Further evaluation may be required before advancing to a design concept or design phase.

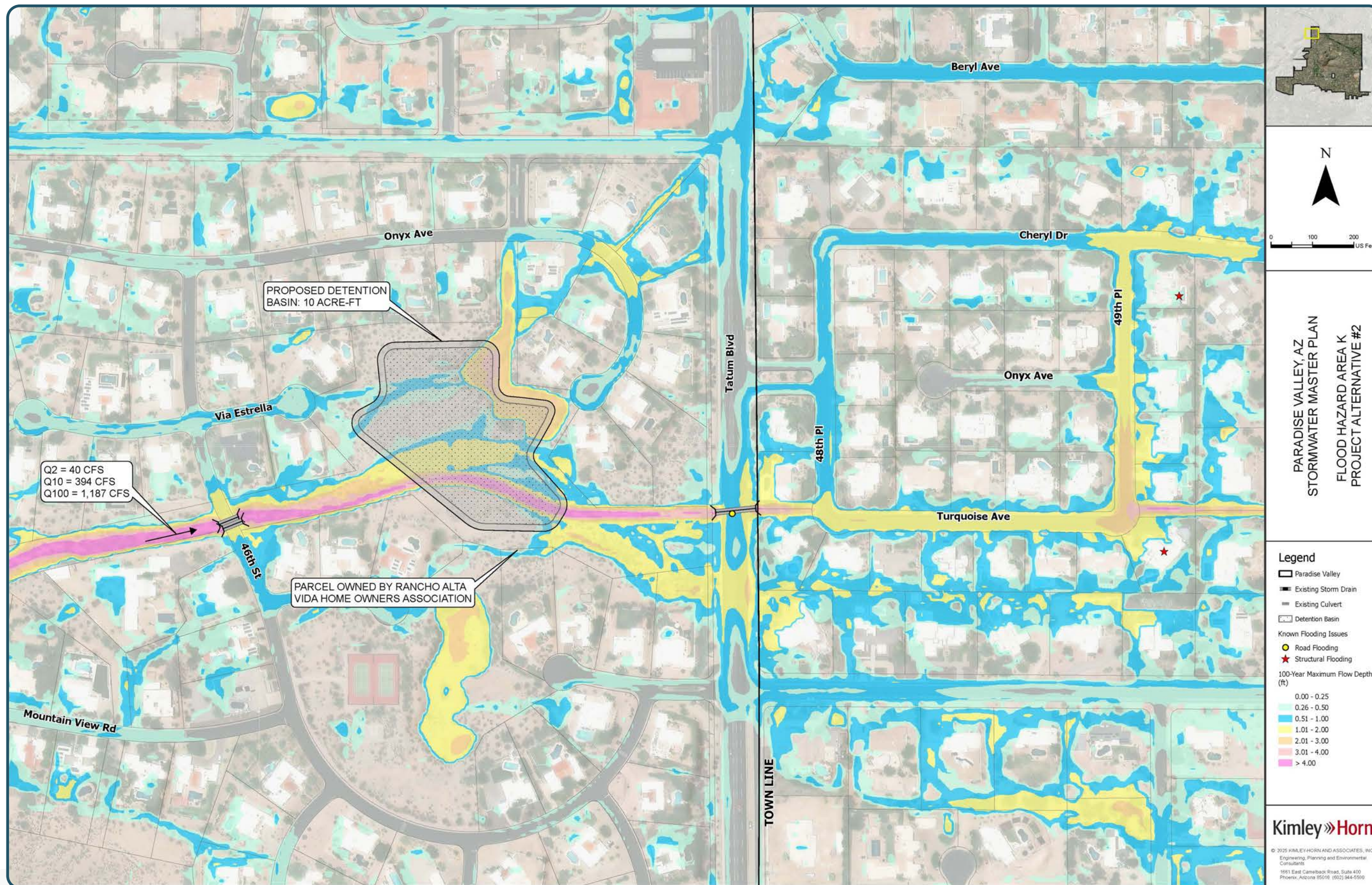


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F. Flood Hazard Area L – Upstream Cherokee Wash

Summary and Description

The source of flooding in Area L is runoff from the west side of Mummy Mountain and from the east of the Phoenix Mountain Preserve. This area is the collection point of discharges that contribute to the beginning of Cherokee Wash. The wash is routed through private parcels and crosses several roads over existing low water crossings in multiple areas. These crossings are undersized resulting in the deposition of sediment and debris that requires maintenance after each storm event. The maximum water depth at road crossings during the 100-year storm in this area is 8.2 feet per FLO-2D modeling results, affecting emergency vehicle access and posing a safety risk to residents and property. Area L has been identified as an issue in the Identified Drainage Problem Areas Technical Memorandum (Michael Baker, 2019). It has also been identified by Town staff and residents as a flood prone area who live adjacent to Cherokee Wash.

Alternative 1 & 2 (Large/Medium, Both Recommended Depending on the Desired Level of Protection)

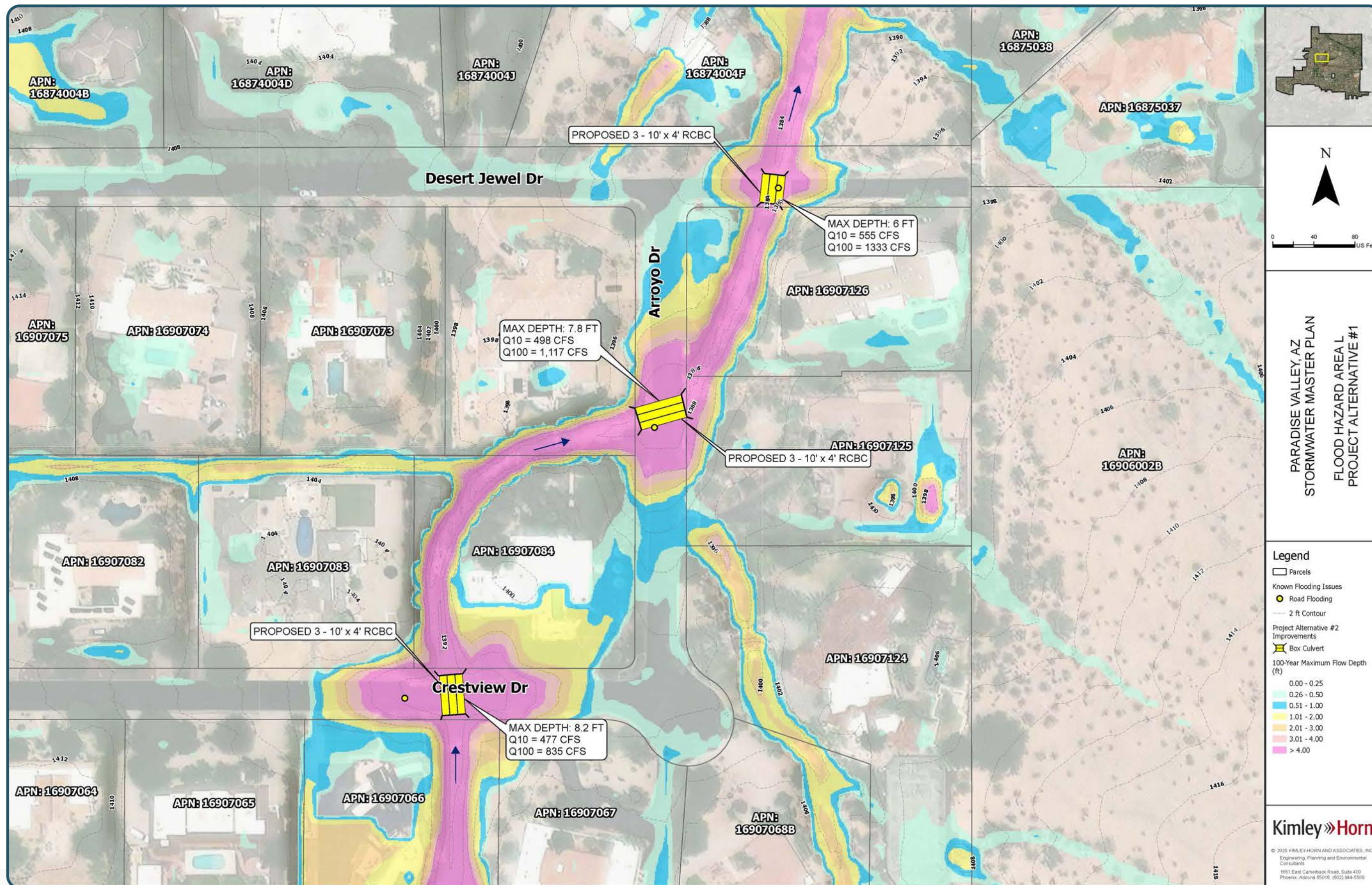
The alternatives proposed for Area L consist of the replacement of low water crossings with culverts to convey Cherokee Wash under three roads. There are three low water crossings that would be replaced: crossings at Crestview Drive, Arroyo Drive, and Desert Jewel Drive. Alternative 1 proposes that at each crossing, a three barrel 10' by 4' reinforced concrete box culvert would be constructed. This culvert configuration would provide the necessary capacity for the 50-year storm event. Alternative 2 proposes the same improvements as Alternative 1, only varying in the configuration size of the culvert to a two barrel 10' by 4' culvert, providing 10-year storm event protection. In both alternatives, road improvements would be required to accommodate the culvert size. The design and construction cost of Alternative 1 and 2 is estimated to be **1,467,265 USD** and **1,163,369 USD**, respectively. See **Appendix E** for a detailed cost estimate of the project.

Table 22: Alternative 1&2 Opportunities and Constraints

Alternative 1 & 2 Opportunities	Alternative 1 & 2 Constraints
Reduces safety hazards to residents, passenger vehicles, and emergency vehicles	Construction would be disruptive for residents
Protects existing flow path of Cherokee Wash	Small overall area of mitigation impact
Reduces maintenance issues due to sediment deposition	



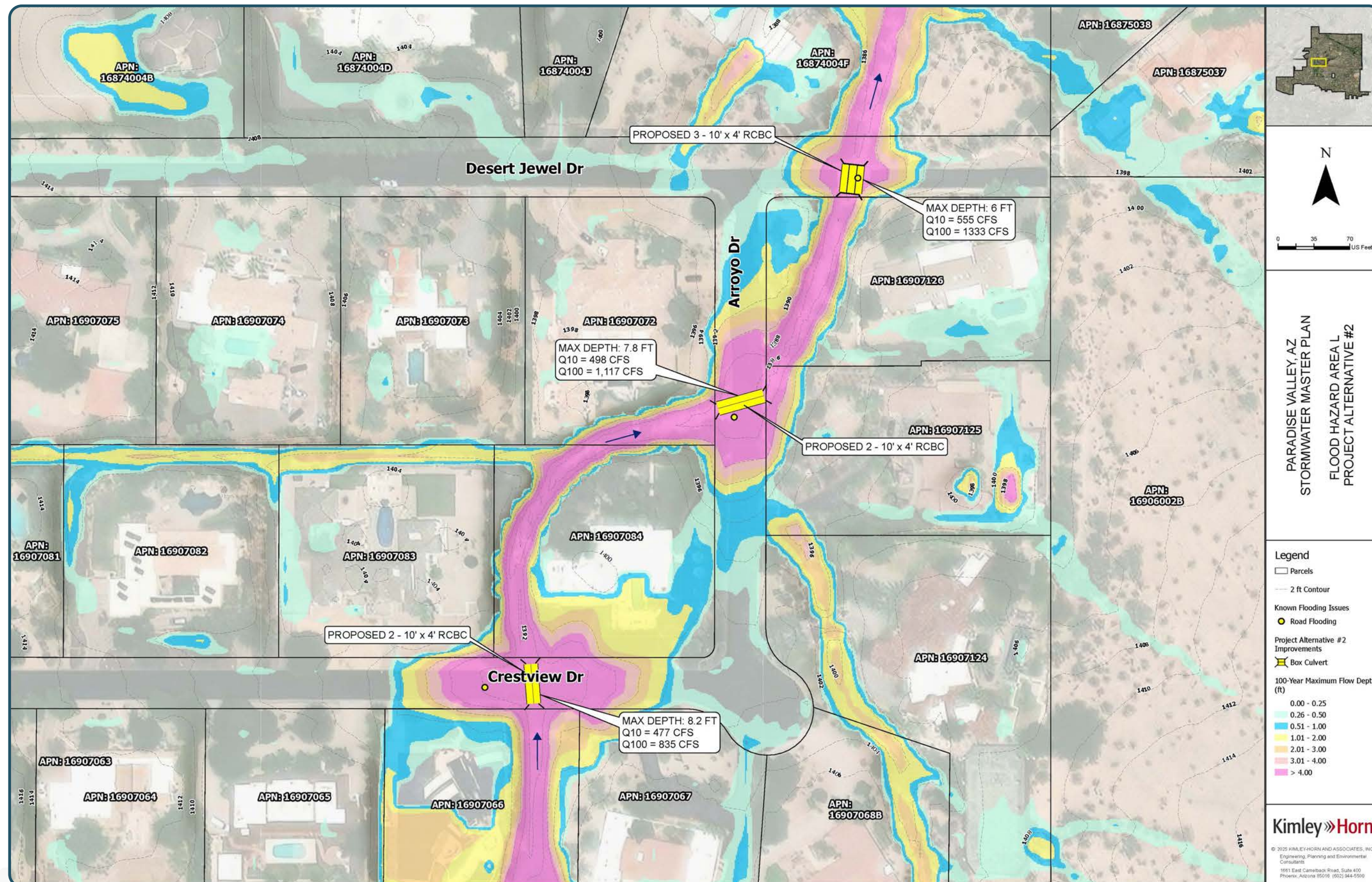
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G. Flood Hazard Area N – Downstream Cherokee Wash

Summary and Description

The source of flooding in Area N is Cherokee Wash. Runoff from Mummy Mountain and the Phoenix Mountain Preserve contribute to Cherokee Wash. The wash flows northeast, turning east and at 56th Street ultimately outfalling IBW. The wash is routed through private parcels and crosses several roads. During large storm events, Cherokee Wash does not have the full capacity required to contain flows, thereby resulting in road overtopping and property flooding. The low water crossings at 58th Place, 59th Place, Morning Glory Road, and 61st Place are inundated during storms, resulting in flooding hazards to residents and passenger vehicles. In particular, the crossing at Morning Glory Road is subject to water depths of up to 5.3 feet during the 100-year storm per FLO-2D modeling results from this study, posing a potential hazard for emergency vehicle access. Area N potential flooding conditions have been modeled in the Middle Indian Bend Wash Area Drainage Master Study/Plan (MIBW ADMS/P) (Gavin & Barker, 2017) and the Lower Indian Bend Wash Area Drainage Master Study/Plan (LIBW ADMS/P) (Kimley-Horn, 2019). The area has also been identified by Town staff and residents as a flooding hazard to the road, property, and homes.

Alternative 1 (Large, Recommended)

The first alternative proposed for this area is the construction of multiple reinforced concrete box culverts where Cherokee Wash over tops roads coupled with corresponding channel improvements. Low water crossings at 58th Place, 59th Place, Morning Glory Road, and 61st Place would be replaced with four barrel 10' by 4' reinforced concrete box culverts. Grouted riprap would be placed on the downstream side of the culverts to reduce erosion potential. At each of the four locations, road improvements will be required to accommodate the culvert. Downstream of the proposed culverts on 58th Place and 59th Place, channel improvements including clearing vegetation and grading would be required to increase conveyance. Drainage easements have been previously acquired at these locations and improvements would remain within the boundaries of the easement. Channel improvements are needed at these two locations to mitigate channel breakouts that could potentially flood the adjacent homes. The design and construction cost of Alternative 1 is estimated to be **2,800,333 USD**. See **Appendix E** for a detailed cost estimate of the project.

Table 23: Alternative 1 Opportunities and Constraints

Alternative 1 Opportunities	Alternative 1 Constraints
More cost-effective alternative	Construction could be disruptive for residents
Reduces flood hazards to residents, passenger vehicles, and emergency vehicles	The total area of flood mitigation is smaller than that of Alternative 2
Provides safe road crossings during runoff event	Utility conflicts likely

Alternative 2 (Large)

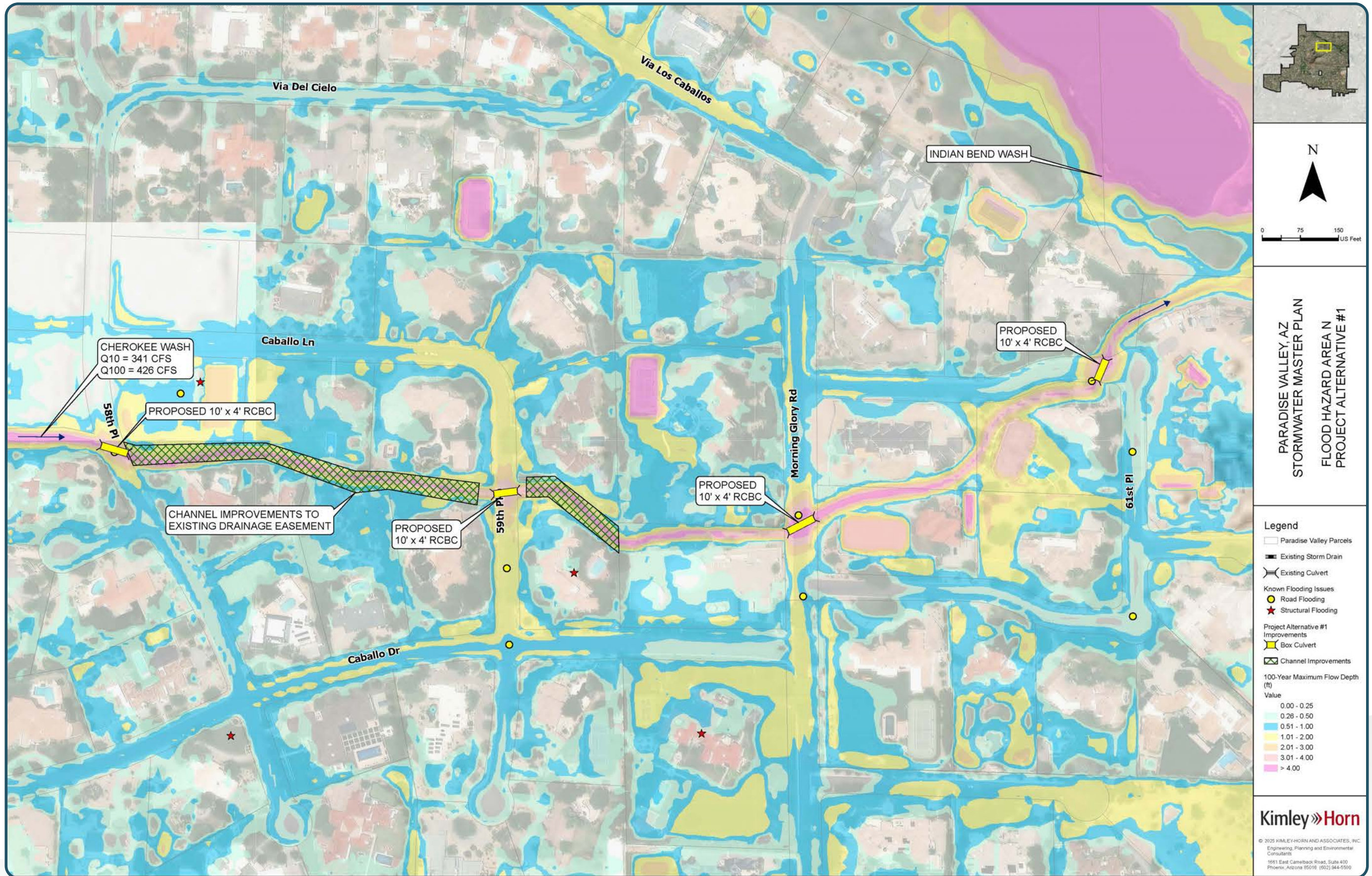
Alternative 2 for Area N consists of several small storm drain systems designed to reduce flooding on local streets. This flooding is mostly attributed to overflow from Cherokee Wash or runoff from Mummy Mountain as it flows towards Cherokee Wash. Storm drains would likely range in size from 36" to 48". Outfalls would further downstream along Cherokee Wash from breakout points, or at existing drainage corridors. This alternative would also include channel conveyance improvements along Cherokee Wash where existing ROW or improvements are in place. Refer to the Area N Alternative #2 exhibit on the following. The design and construction cost of Alternative 2 is estimated to be **3,956,897 USD**. See **Appendix E** for a detailed cost estimate of the project.

Table 24: Alternative 2 Opportunities and Constraints

Alternative 2 Opportunities	Alternative 2 Constraints
Larger overall area of flood mitigation in comparison to Alternative 1	More expensive alternative
Reduces flood hazards to residents, passenger vehicles, and emergency vehicles	Road crossings at Cherokee Wash may still be impassable during storm events
	Utility conflicts likely



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H. Flood Hazard Area O – Lincoln Drive

Summary and Description

The source of flooding in Area O is the runoff from the south side of Mummy Mountain contributing runoff to the upstream reach of Cudia City Wash (CCW). Runoff flows southwest from Mummy Mountain, through existing development, towards Lincoln Drive. Once the water reaches Lincoln Drive from the north, it flows under the road through existing culverts. Some culverts along Lincoln Drive do not have the required capacity to contain discharge, and the road overtops at 52nd Place with depths greater than 1 foot during the 100-year storm per the FLO-2D modeling results from this study. South of Lincoln Drive, water flows west across private parcels and under 51st Place through an existing culvert. This culvert is undersized and a maximum water depth of 4 feet occurs per modeling results. The crossing poses a hazard to passenger vehicles and impacts emergency vehicle access. Town residents and staff have reported flooding issues in this area. The CCW Area Drainage Master Study/Plan (ADMS/P) has also identified flood hazards in this area.

Alternative 1 (Large)

The first alternative proposed for Area O consists of improvements to existing roadway drainage infrastructure on Lincoln Drive. The existing culvert at Lincoln Drive and 52nd Place lacks the capacity required to prevent roadway flooding during a 100-year event. This alternative proposes a new storm drain along Lincoln Drive at 52nd Place to the outfall of three existing culverts just east of the Omni Resort on the south side of Lincoln Drive. The storm drain inlet would be adjacent to the existing culvert's inlet north of Lincoln Drive and 52nd Place, and would redirect a portion of the discharge to a separate outfall. Curb and gutter inlets would also be placed at this location to capture discharge coming from the east along Lincoln Drive. At the outfall, discharges would be captured by an existing culvert and routed south to ultimately outfall to Cudia City Wash. The design and construction cost of Alternative 1 is estimated to be **2,321,033 USD**. See **Appendix E** for a detailed cost estimate of the project.

Table 25: Alternative 1 Opportunities and Constraints

Alternative 1 Opportunities	Alternative 1 Constraints
Improves existing roadway drainage infrastructure	Major roadway impacts to Lincoln Drive during construction
Reduces discharge for undersized portions of Cudia City Wash	Utility conflicts likely
	More expensive alternative

Alternative 2 (Medium, Recommended)

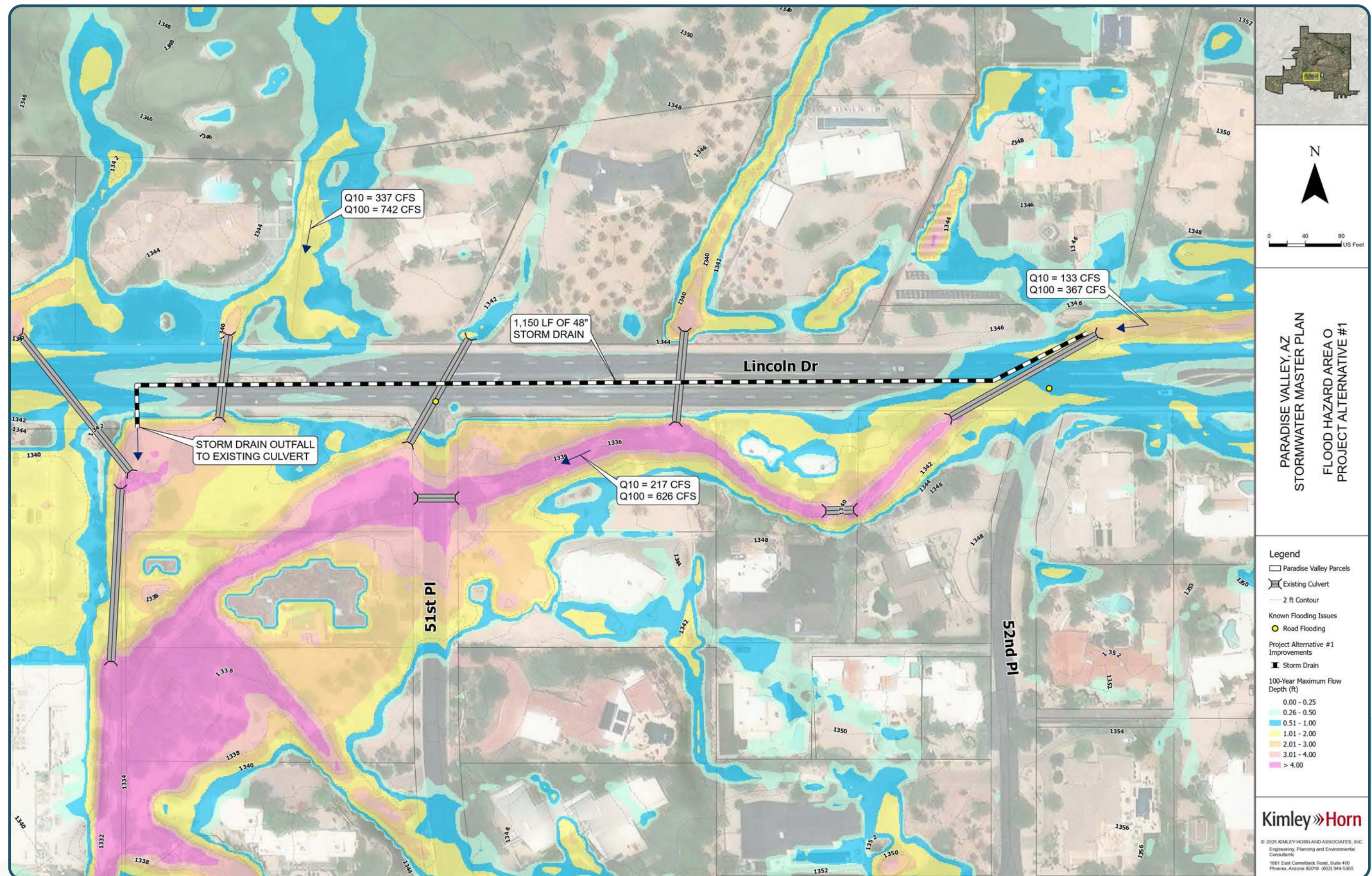
The second alternative proposed is the increase in existing culvert capacity at flood prone locations. Three culvert expansions or replacements are proposed upstream and downstream of Lincoln Drive. At Desert Fairways Drive, the existing box culvert would be removed and replaced with a 10' by 4' reinforced concrete box culvert (RCBC). Flows passing through this box culvert continue west and cross Lincoln Drive at the existing culvert at 52nd Place. This culvert would be replaced with a three barrel 48" reinforced concrete pipe culvert to mitigate roadway overtopping. The culvert at 51st Place is particularly undersized and would be replaced with a two barrel 10' by 4' RCBC. The proposed configuration at 51st Place is a 2 barrel 10' by 4' RCBC. Road improvements would also be required to accommodate the increased height of the new culverts. The design and construction cost of Alternative 2 is estimated to be **1,159,731 USD**. See **Appendix E** for a detailed cost estimate of the project.

Table 26: Alternative 2 Opportunities and Constraints

Alternative 2 Opportunities	Alternative 2 Constraints
Less expensive alternative	Utility conflicts likely
Improves emergency vehicle access on 51st Place	Major roadway impacts to Lincoln Drive during construction
Improvements maintain current flow paths	Would not reduce flows on parcels adjacent to Lincoln Drive
	Smaller area of flooding mitigation



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I. Flood Hazard Area P – Tatum Boulevard and McDonald Drive

Summary and Description

The source of flooding in this area is Cudia City Wash (CCW). The wash flows across private parcels and overtops Tatum Boulevard and McDonald Drive as it flows southeast through Area P. At Tatum Boulevard, a maximum water depth over the road of 2.9 feet occurs during the 100-year storm per FLO-2D modeling results from this study. This poses safety hazards to passenger vehicles and sediment and debris deposition on the road, requiring frequent maintenance. The existing culverts under McDonald Drive are also undersized resulting in road overtopping during the 100-year storm. Residents have reported property and roadway flooding at both crossings. This area has also been identified as a flooding hazard by the CCW Area Drainage Master Study/Plan (ADMS/P) and the CCW Design Concept Report (DCR). Two alternatives were developed as described below, each divided into three phases for flexibility with cost allocations. The CCW DCR also recommended the establishment of an improvement district as a funding source for construction and maintenance. The DCR also recommended acquiring a drainage easement along the wash corridor between Tatum Boulevard and McDonald Drive. A drainage easement would facilitate more regular maintenance of the channel improving the overall function of the wash.

Alternative 1 (Large/Medium/Maintenance, Recommended)

Alternative 1, Phase 1 proposed for Area P is a segment of storm drain along Tatum Boulevard and McDonald Road. The storm drain would capture flows from CCW from an inlet on the east side of Tatum Boulevard. The water would be routed south and west along the road where it would discharge back into CCW just north of McDonald Road. This would reduce the overall flow in the wash between the two road crossings. The design and construction cost of Alternative 1 is estimated to be **6,848,094 USD**. See **Appendix E** for a detailed cost estimate of Alternative 1.

Alternative 1, Phase 2 consists of increasing the existing culvert capacity at McDonald Drive. At McDonald Drive, a three barrel 10' by 4' culvert conveys CCW south under the road. This configuration does not convey the full capacity of the wash during the 100-year storm, and roadway overtopping occurs. This alternative proposes constructing an additional barrel to the culvert. The design and construction cost of Alternative 1, Phase 2 is estimated to be **789,801 USD**.

Alternative 1, Phase 3 proposes drainage improvements to mitigate the roadway overtopping that occurs on Valley Vista Lane. Flows from the north that converge at CCW overtop Valley Vista Lane prior to entering the wash. Placing a culvert under the road at the location of the wash crossing would reduce the erosion and

sediment deposition in this area. The design and construction cost of Alternative 1 is estimated to be **55,823 USD**.

Table 27: Alternative 1 Opportunities and Constraints

Alternative 1, Phase 1 Opportunities	Alternative 1, Phase 1 Constraints
No large land acquisition required	Utility conflicts likely
Improvements reduce discharge for undersized portions of Cudia City Wash	High cost alternative in comparison to Alternative 2, Phase 1
	Major roadway impacts to Tatum Blvd during construction
Alternative 1, Phase 2 Opportunities	Alternative 1, Phase 2 Constraints
Creates a road crossing that reduces road overtopping frequency	Major roadway impacts to Tatum Blvd during construction
More cost-effective Alternative in comparison to Alternative 2, Phase 2	Does not reduce discharge entering the wash
No large land acquisition required	Utility conflicts likely
Alternative 1, Phase 3 Opportunities	Alternative 1, Phase 3 Constraints
Slightly more effective cost alternative in comparison to Alternative 2, Phase 3	Construction would be disruptive for residents
Improvements reduce safety hazards and maintain requirements	



Alternative 2 (Large/Medium/Maintenance)

Alternative 2, Phase 1 proposes a reinforced concrete box culvert under Tatum Boulevard. The existing road crossing on Tatum Boulevard would be replaced with a four barrel 10' by 4' box culvert to mitigate roadway flooding. Road improvements would be required to accommodate the height of the culverts. The design and construction cost of Alternative 2 is estimated to be **1,974,030 USD**. See **Appendix E** for a detailed cost estimate of Alternative 2.

Alternative 2, Phase 2 replaces existing infrastructure. The existing box culvert under McDonald Drive would and be removed entirely replaced with a bridge, allowing the wash to flow without obstruction. This would reduce backwater effects and the water surface elevation north of the culvert. This area has been known to flood residential properties; therefore this improvement may not only improve roadway conditions, but also property conditions along the wash. The design and construction cost of Alternative 2 is estimated to be **3,341,890 USD**.

Alternative 2, Phase 3 utilizes Green Stormwater Infrastructure as a tool to reduce flooding. At the location where flows cross Valley Vista Lane, it is proposed that a low water crossing be implemented. The low water crossing would consist of concrete and grouted riprap to prevent erosion and sediment deposition on the road. It is also proposed that permeable pavement span 150 feet on either side of the crossing to help reduce the local ponding on the road. The design and construction cost of Alternative 2 is estimated to be **57,020 USD**.

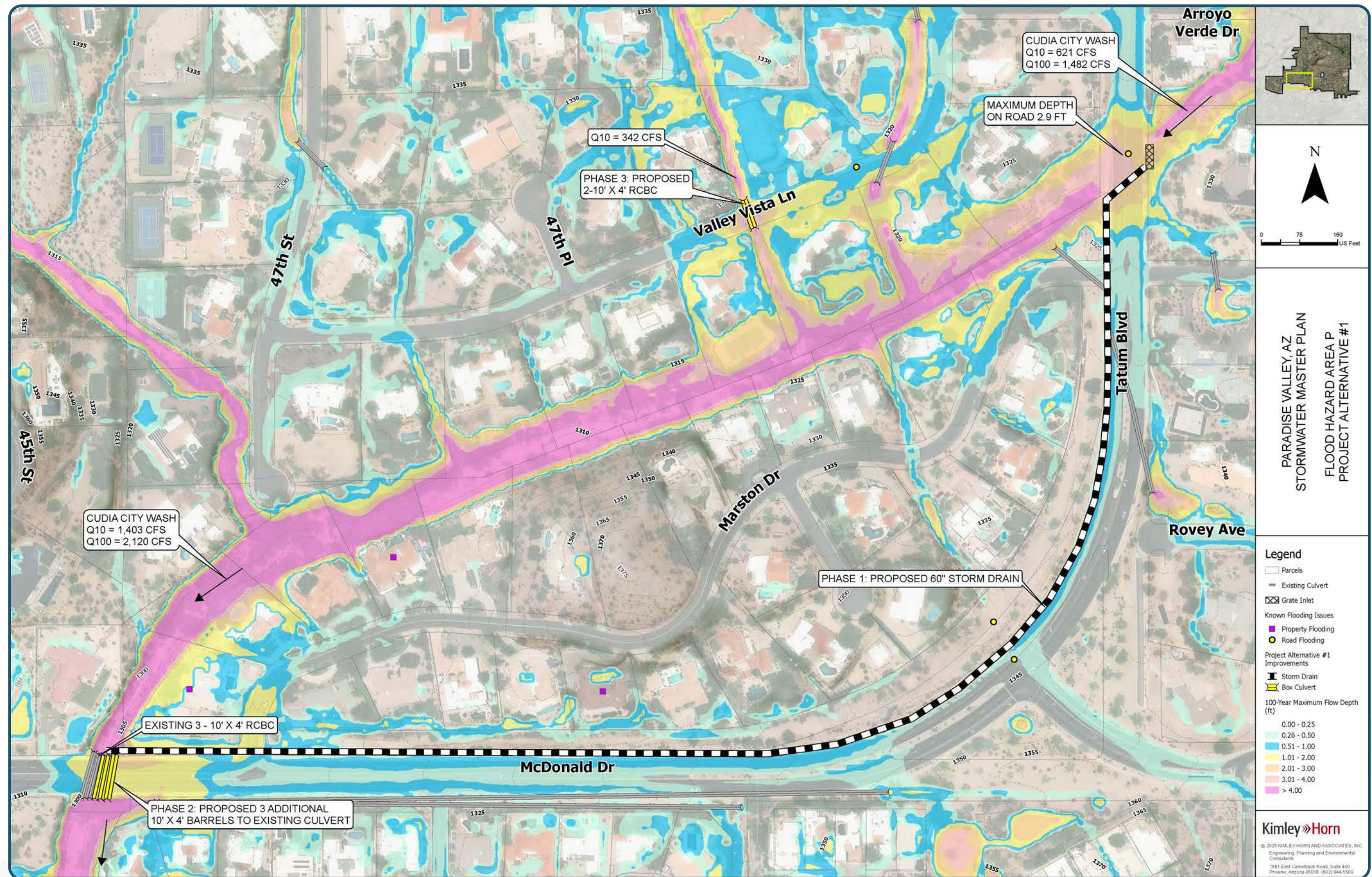
CCW overtop Valley Vista Lane prior to entering the wash. Placing a culvert under the road at the location of the wash crossing would reduce the erosion and sediment deposition in this area. The design and construction cost of Alternative 1 is estimated to be **55,823 USD**.

Table 28: Alternative 2 Opportunities and Constraints

Alternative 2, Phase 1 Opportunities	Alternative 2, Phase 1 Constraints
More cost-effective alternative in comparison to Alternative 1, Phase 1	Major roadway impacts to McDonald Drive during construction
Improvement to existing infrastructure	Utility conflicts likely
Improvements would reduce roadway flooding on McDonald Drive	
Alternative 2, Phase 2 Opportunities	Alternative 2, Phase 2 Constraints
Improvements would mitigate roadway flooding on McDonald Drive	Higher cost alternative in comparison to Alternative 1, Phase 2
May reduce backwater issues north of McDonald Drive	Major roadway impacts to McDonald Drive during construction
No large land acquisition required	Utility conflicts likely
Alternative 2, Phase 3 Opportunities	Alternative 2, Phase 3 Constraints
Improvements include GSI benefits	Construction would be disruptive for residents
Improvements reduce safety hazards and maintenance requirements	Higher cost alternative in comparison to Alternative 1, Phase 3

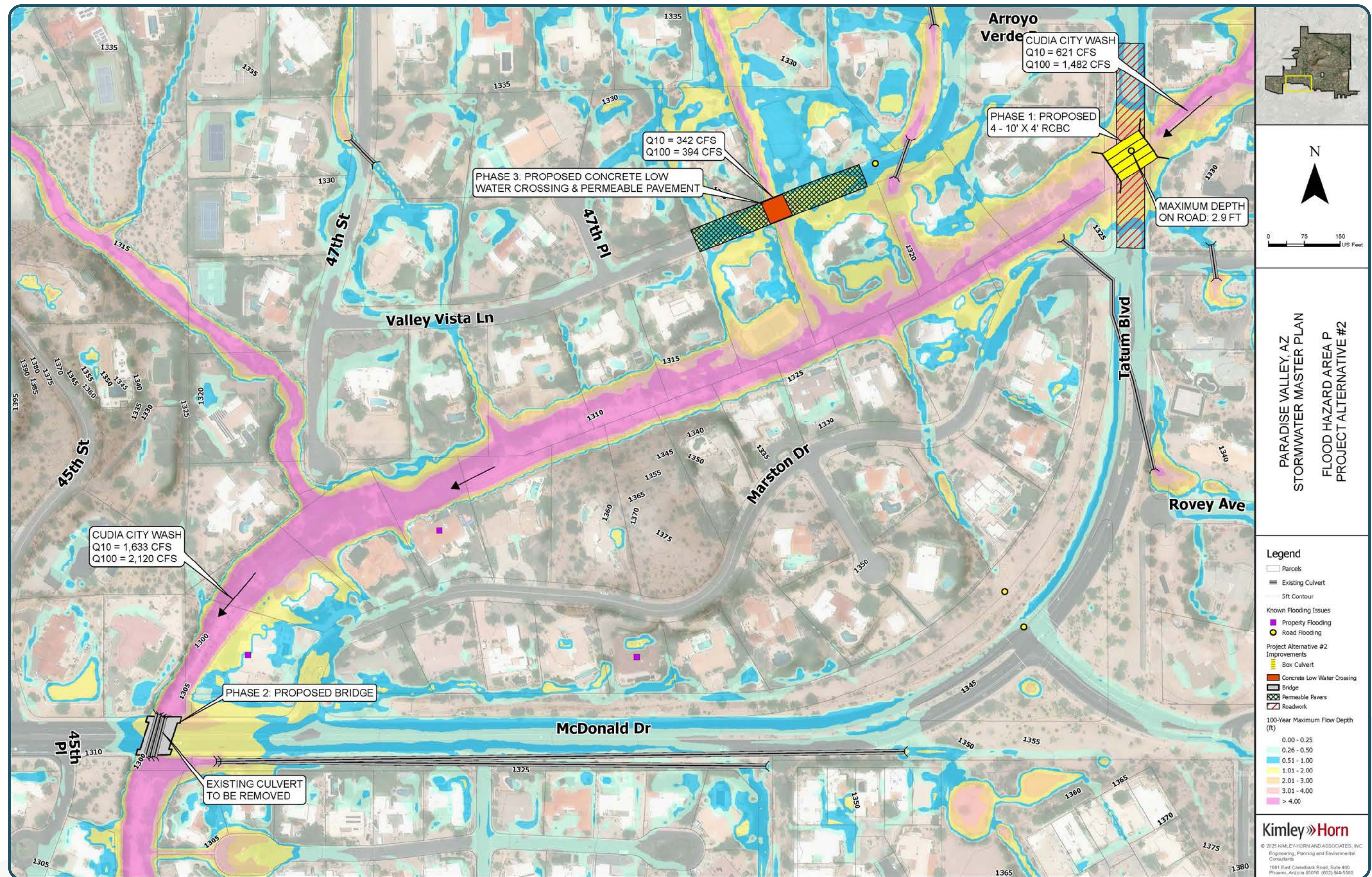


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VIII. HIGHEST PRIORITY ALTERNATIVES – BENEFIT COST ANALYSIS

The selected alternatives for the six highest ranking flooding issue areas were further developed into 15% plans and detailed conceptual cost estimates. Pages 78-113 contain a further description of each area, cost/benefit analysis results, conceptual plans, and figures depicting 10-year pre-project, post-project, and depth-difference results. The detailed conceptual cost estimates can be found in **Appendix G**. Projects were developed using constraints and preferences provided by Town Council. Constraints included restricting projects to available right-of-way. Projects were designed to provide protection from the 10-year storm. Pre-project, post-project, and depth-difference maps for other storm events are included in **Appendix F**.

The selected alternative(s) and ranking score for each of the nine flood hazard areas is summarized in **Table 29**. Of these, the top six were developed for the Master Plan per Town project development requirements. Analyses were split into two methodologies based on the project type and flood reduction impacts. The benefits for Areas A and K were determined by incorporating the proposed drainage improvements into proposed conditions FLO-2D modeling and comparing the pre- and post-project flow depth conditions adjacent to the impacted buildings. By using the U.S. Army Corps of Engineers (USACE) depth-damage curves for the building structures and building contents, a damage reduction or benefit per building was determined for the 10- and 100-year storms. Areas A and K have the biggest positive impacts on potential residential structure flooding. The USACE depth-damage curve and the corresponding calculations for the two areas are provided in **Appendix I**. For Areas H, L, N, and O, benefits were determined by evaluating the total reduction of water surface elevation from road crossings and the potential for improving emergency vehicle access. Projects in these areas mainly benefit transportation corridors and ingress/egress.

Table 29: Prioritized Projects Summary

Top Ranking Six	Area Identification	Selected Alternative	Ranking Score
	N	Alternative 1	49
	A	Alternative 1	45
	O	Alternative 2	45
	K	Alternative 2	43
	L	Alternative 1 & 2	41
	H	Alternative 2	40
	P	Alternative 1	39
	C	Alternative 2	39
	E	Alternative 3	38



A. Flood Hazard Area A – Invergordon and Mockingbird Lane

Description

Alternative 1 was selected from the project decision matrix. This project includes storm drain lines from 18” laterals up to a 12’ x 3’ storm drain box at the outfall. The storm drain upstream at Northern Avenue starts as a 36” pipe and transitions to a 42” storm drain downstream. Due to a sewer line crossing in Invergordon Road, a 2-30” pipe system was designed to provide clearance over the sewer line. This is an existing shallow sewer line crossing north of Maverick Road that is unavoidable. This sewer line is proposed to be rerouted by 300 feet to the north and tie into the adjacent system to avoid the conflict with the proposed storm drain box culvert. The sewer line reroute ultimately goes to the same location but the proposed realigned sewer to the north is lower allowing the storm drain to clear the existing sewer line. The Maverick Road storm drain trunk line is a 54” pipe that connects to the Invergordon trunk line. This project is estimated to cost 11,616,355 USD. Conceptual plans are shown on the following pages with the detailed cost estimate included in **Appendix G**.

Benefits

The potential benefits for the 10-year and 100-year storms were developed for the project and are shown in **Table 30**. The benefits were determined by incorporating the proposed drainage improvements into the FLO-2D model and comparing the pre and post project flow depth conditions adjacent to the impacted buildings. By using the U.S. Army Corps of Engineers (USACE) depth-damage curves for the building structures and building contents, a damage reduction or benefit per building was determined for the 10- and 100-year storms. The USACE depth damage curves can be seen in **Appendix H**. If the storm drain system is built, it is expected to have a life cycle of 75-years, and total benefits of about 23 million USD when assuming seven 10-year storms and one 100-year storm occurring during the infrastructure life span.

Table 30: Area A Benefit Cost Ratio Summary

Number of Properties Impacted		220
Approximate Population ¹		550
Benefit with Drainage Improvements in Place (\$)	Damage Reduction	21,394,816
	Social Benefits	1,978,900
	Total	23,293,796
Construction Cost		11,616,355
Benefit-Cost Ratio (BCR)		2.01

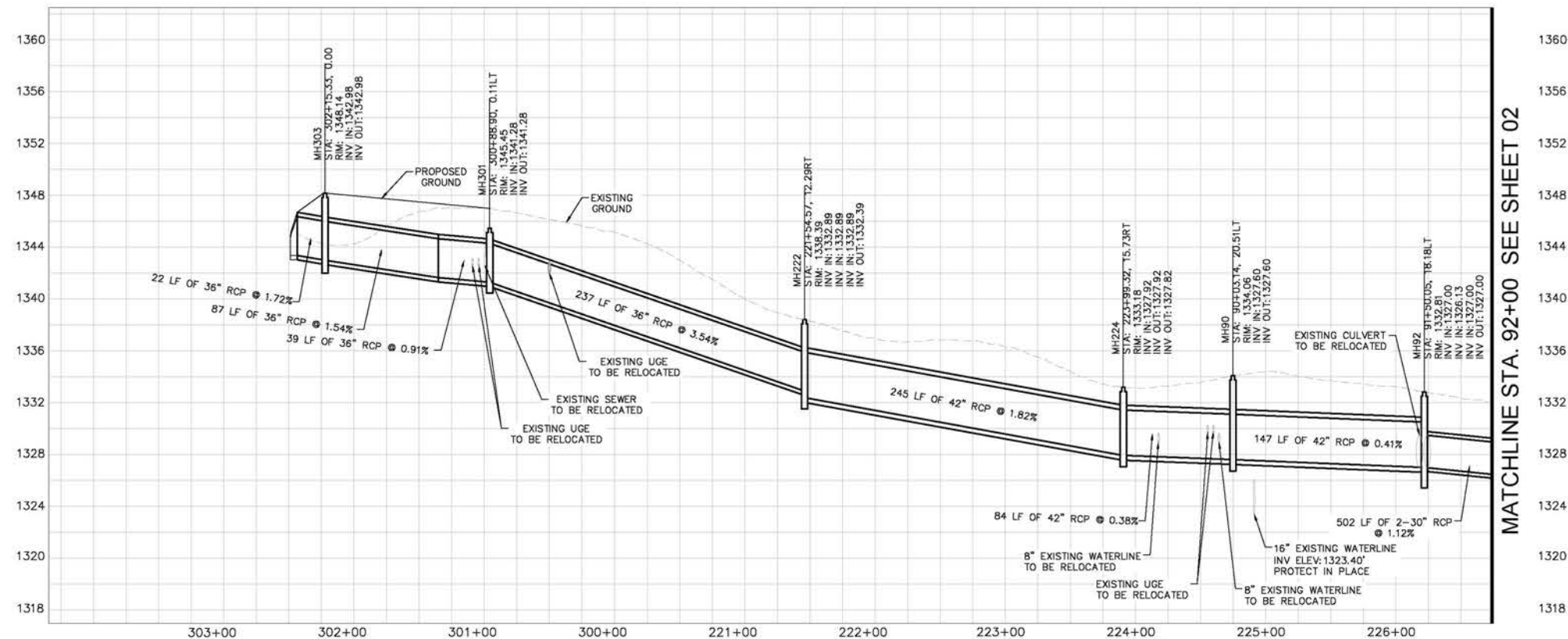
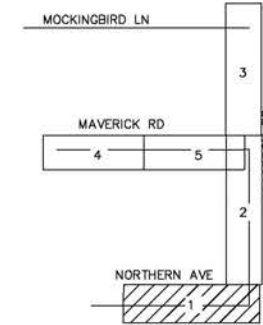
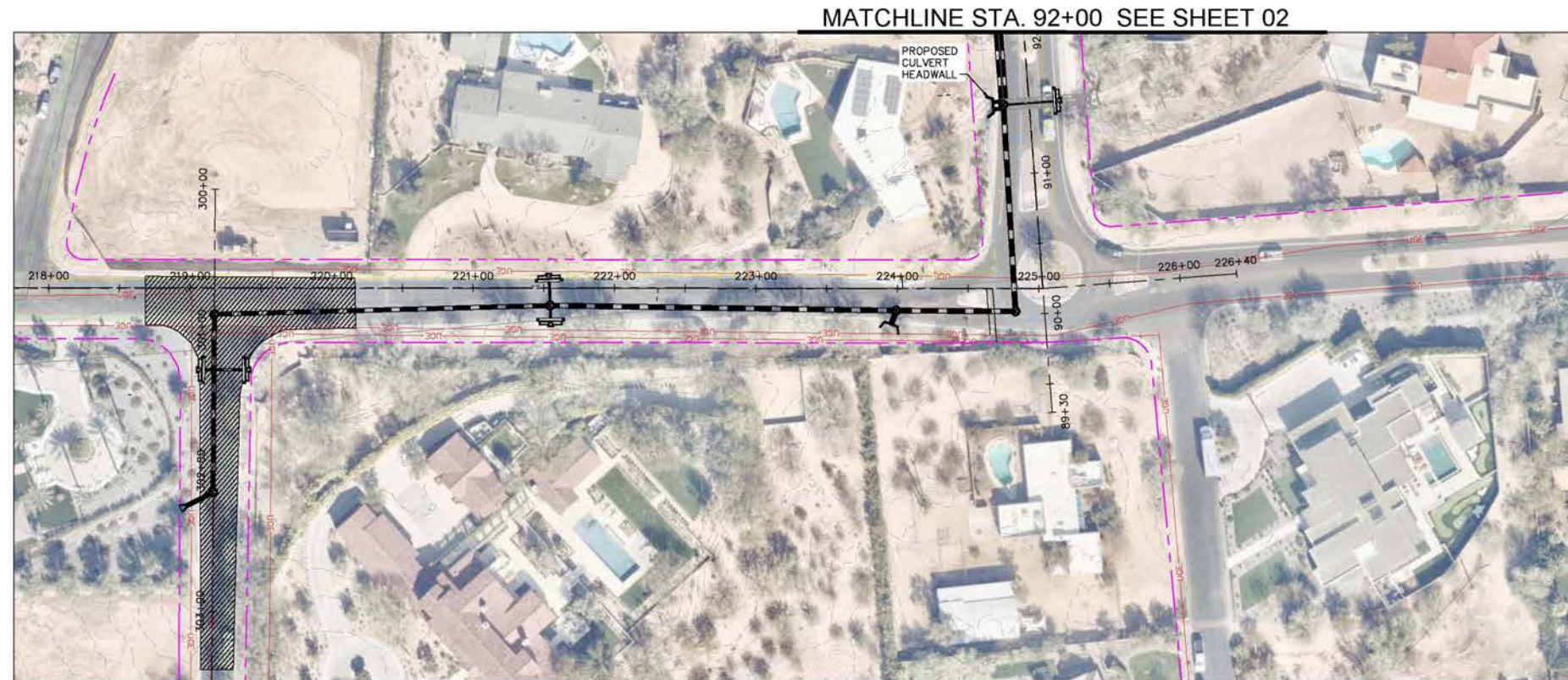
¹Assumed 2.5 people per household from U.S. Census for the Town of Paradise Valley.

²Social benefits are based on the number of residents impacted and are calculated using FEMA’s Benefit Cost Analysis toolkit. This would account for traffic closures, interruptions to work, etc.

³Assumed at least seven 10-year storms and one 100- year storm occur during the 75-year life span of the improvements.



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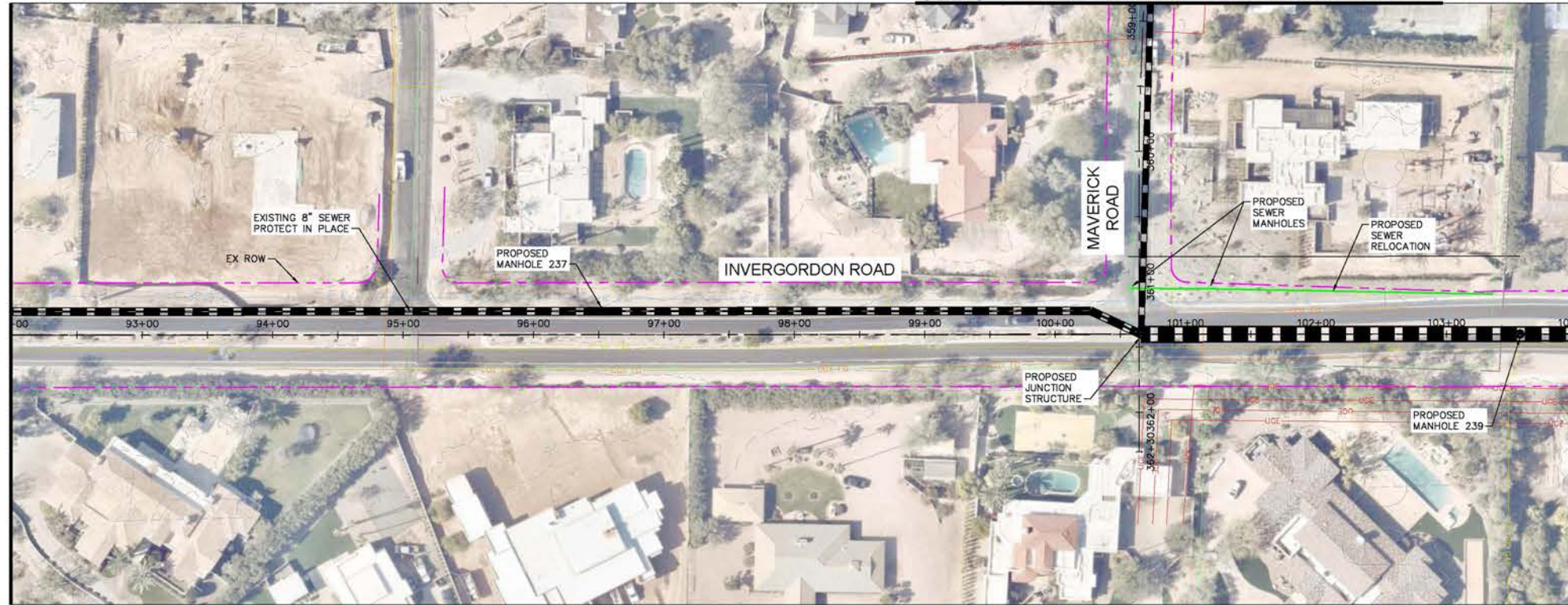


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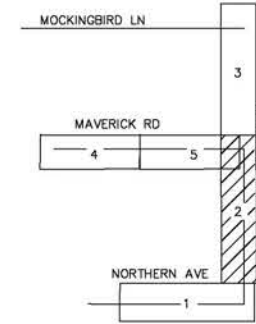


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MATCHLINE STA. 92+00 SEE SHEET 01



MATCHLINE STA. 104+00 SEE SHEET 03



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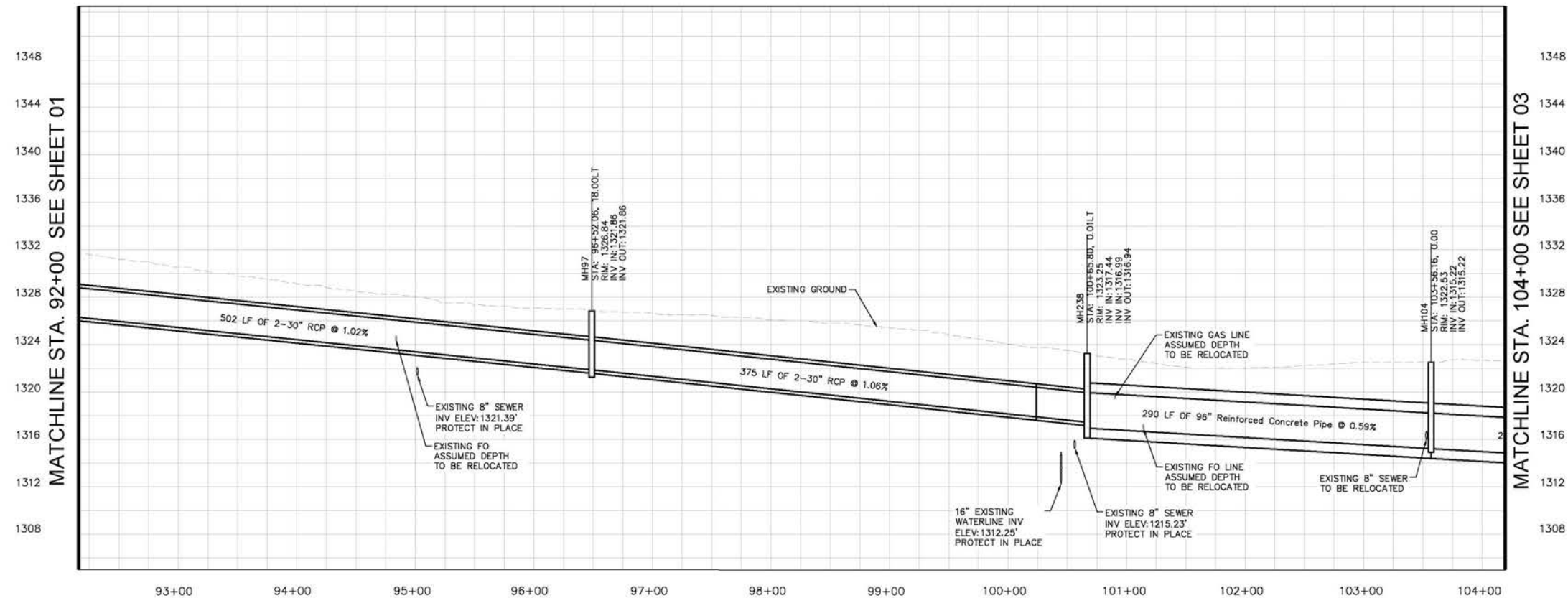


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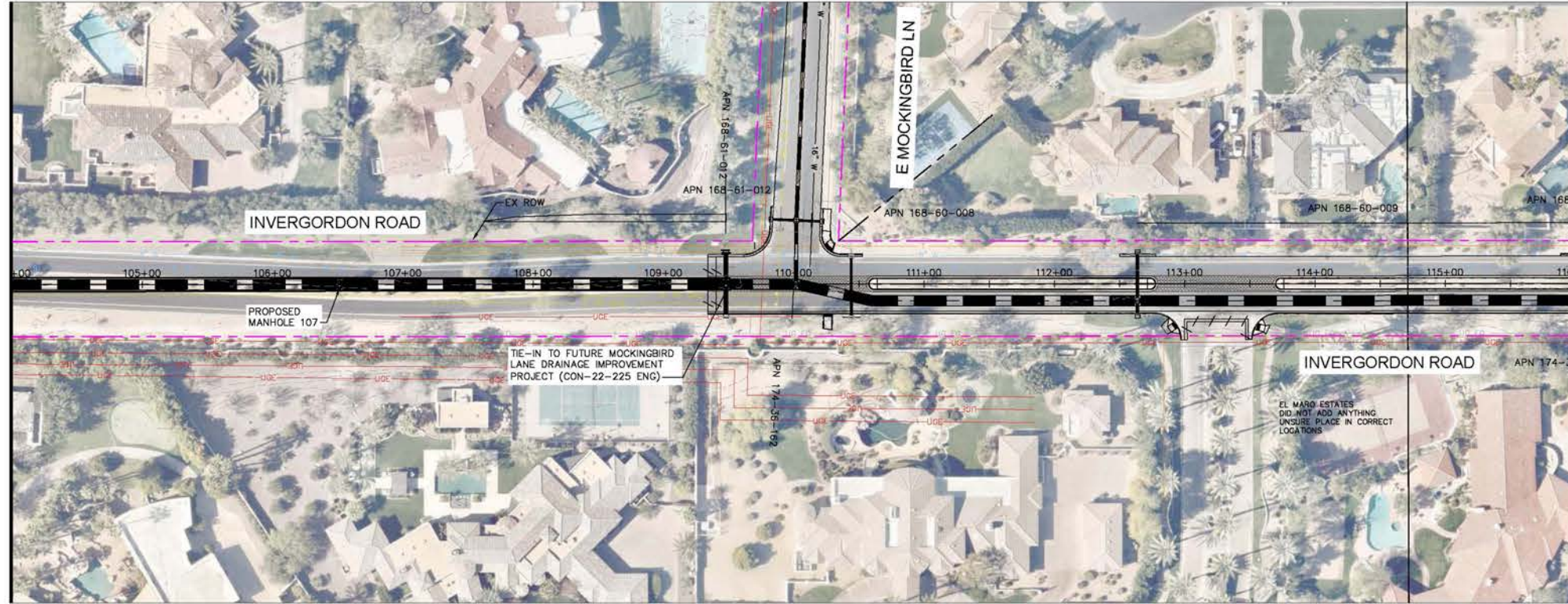


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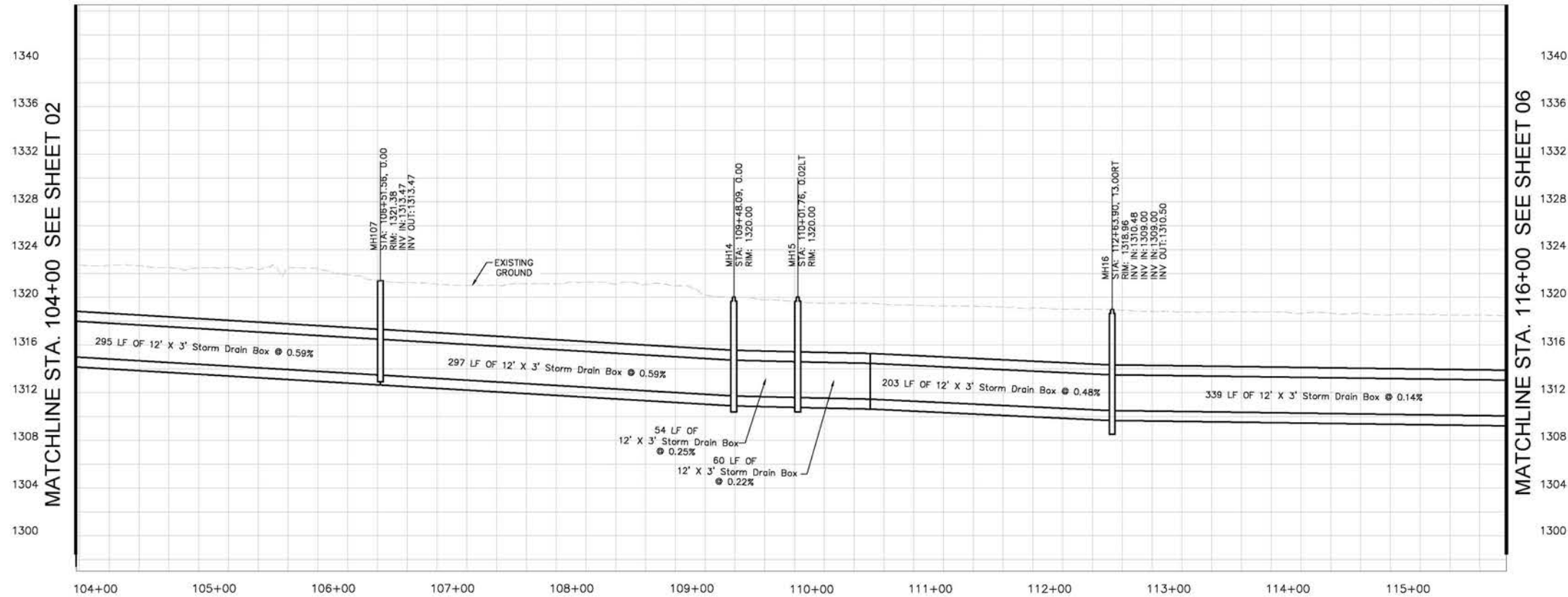
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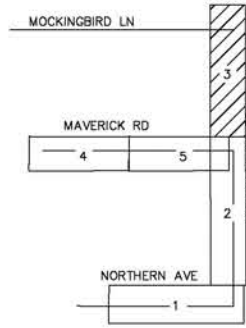


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MATCHLINE STA. 104+00 SEE SHEET 02



MATCHLINE STA. 116+00 SEE SHEET 06



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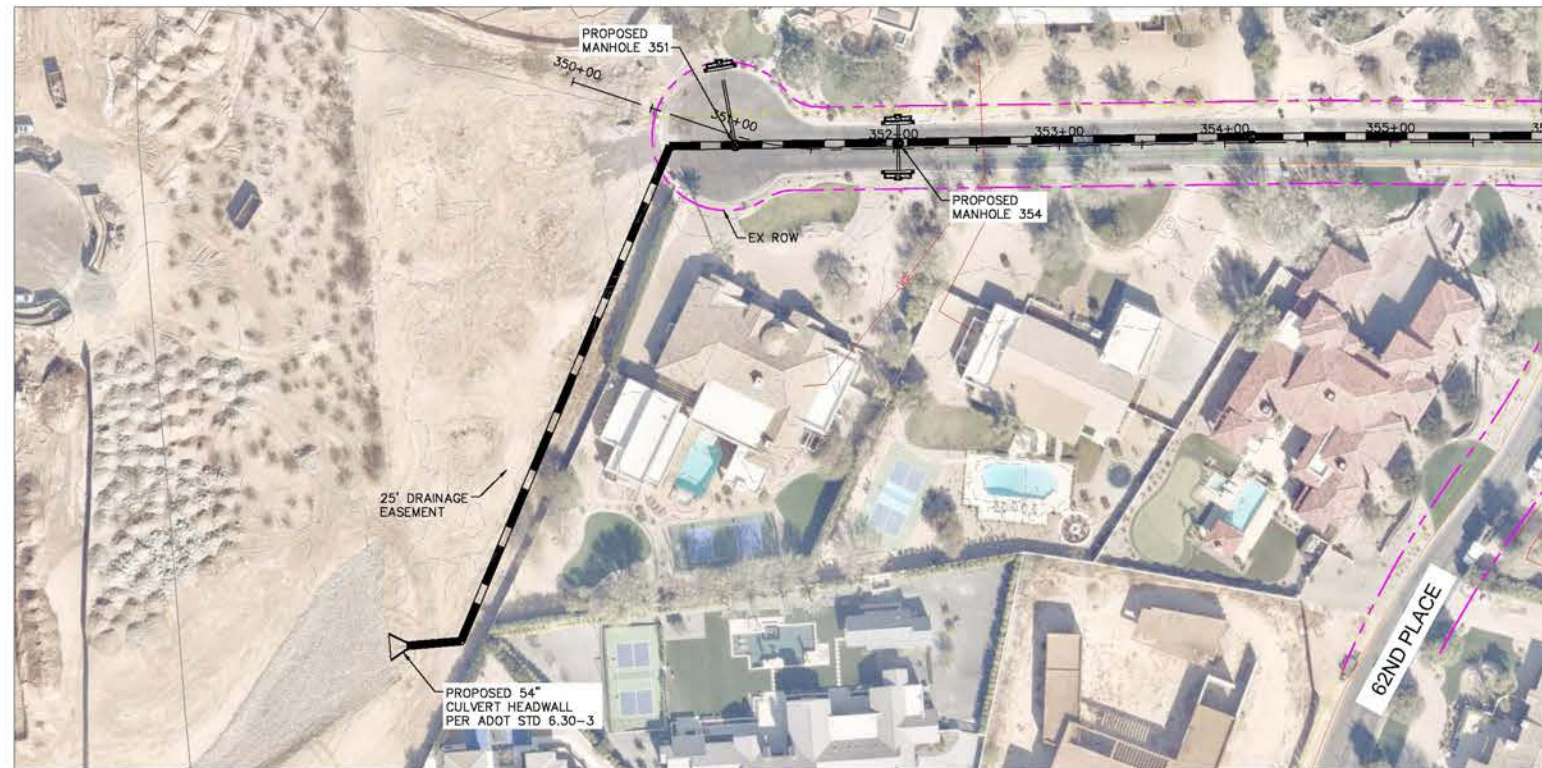


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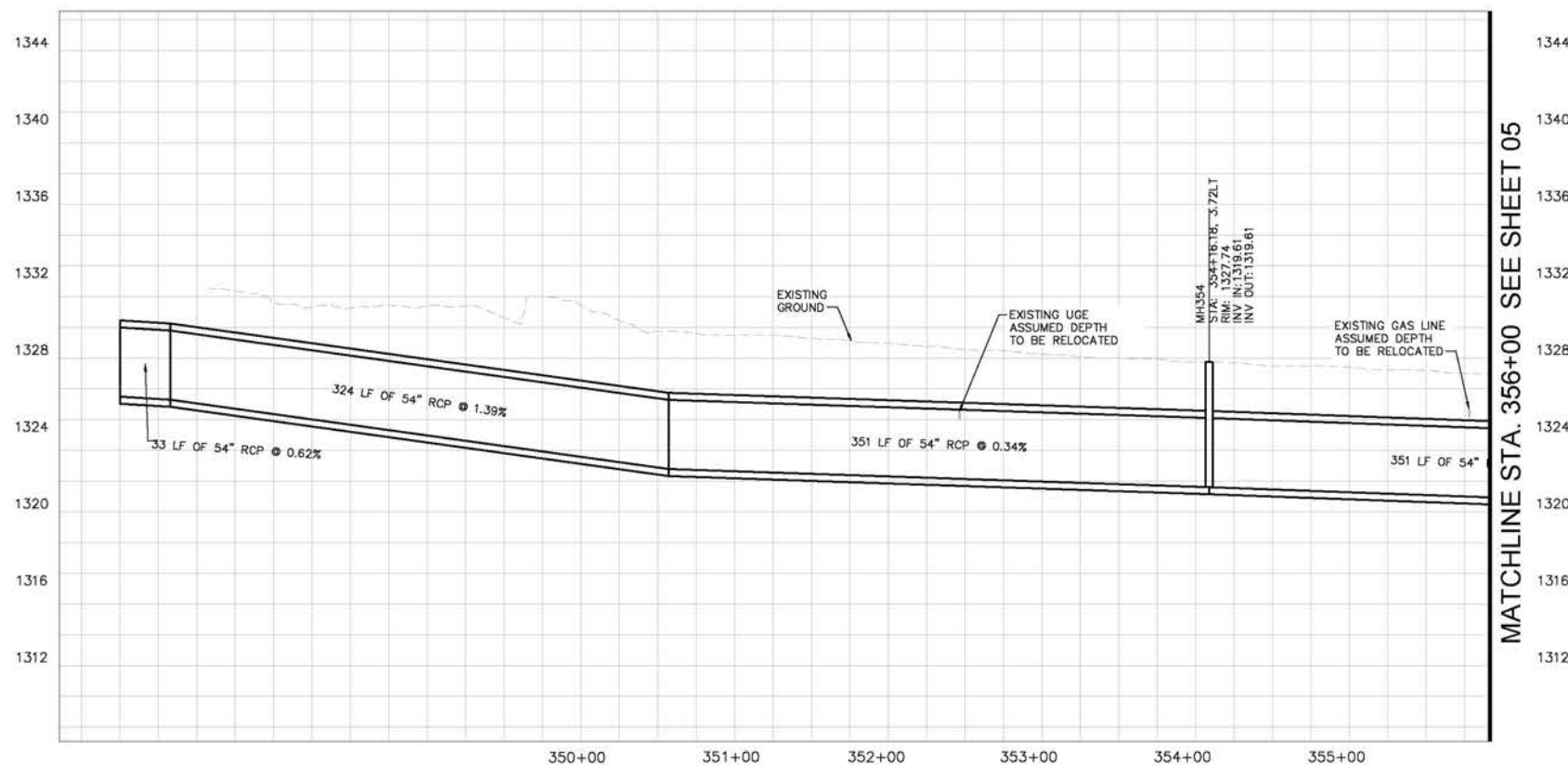
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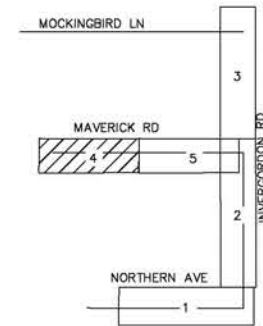
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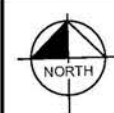
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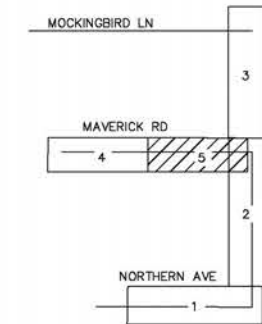
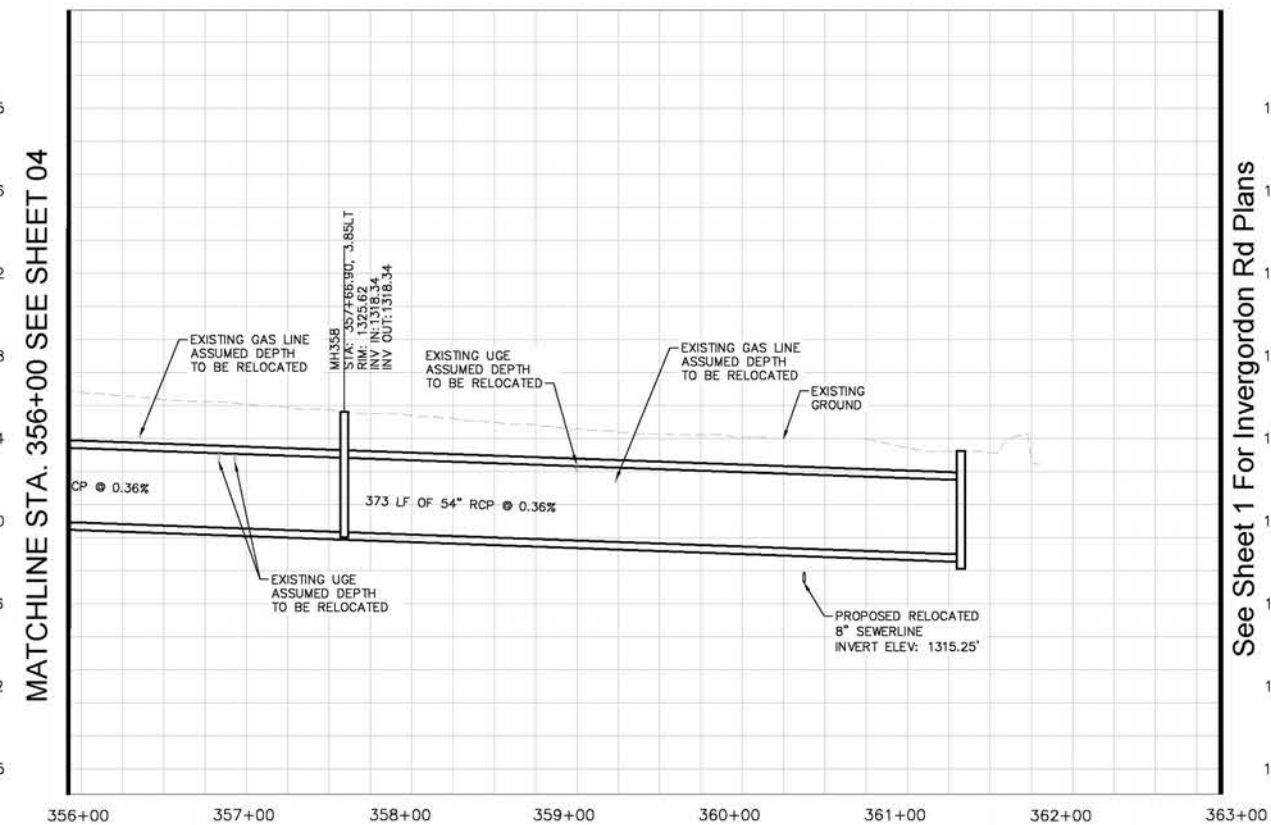
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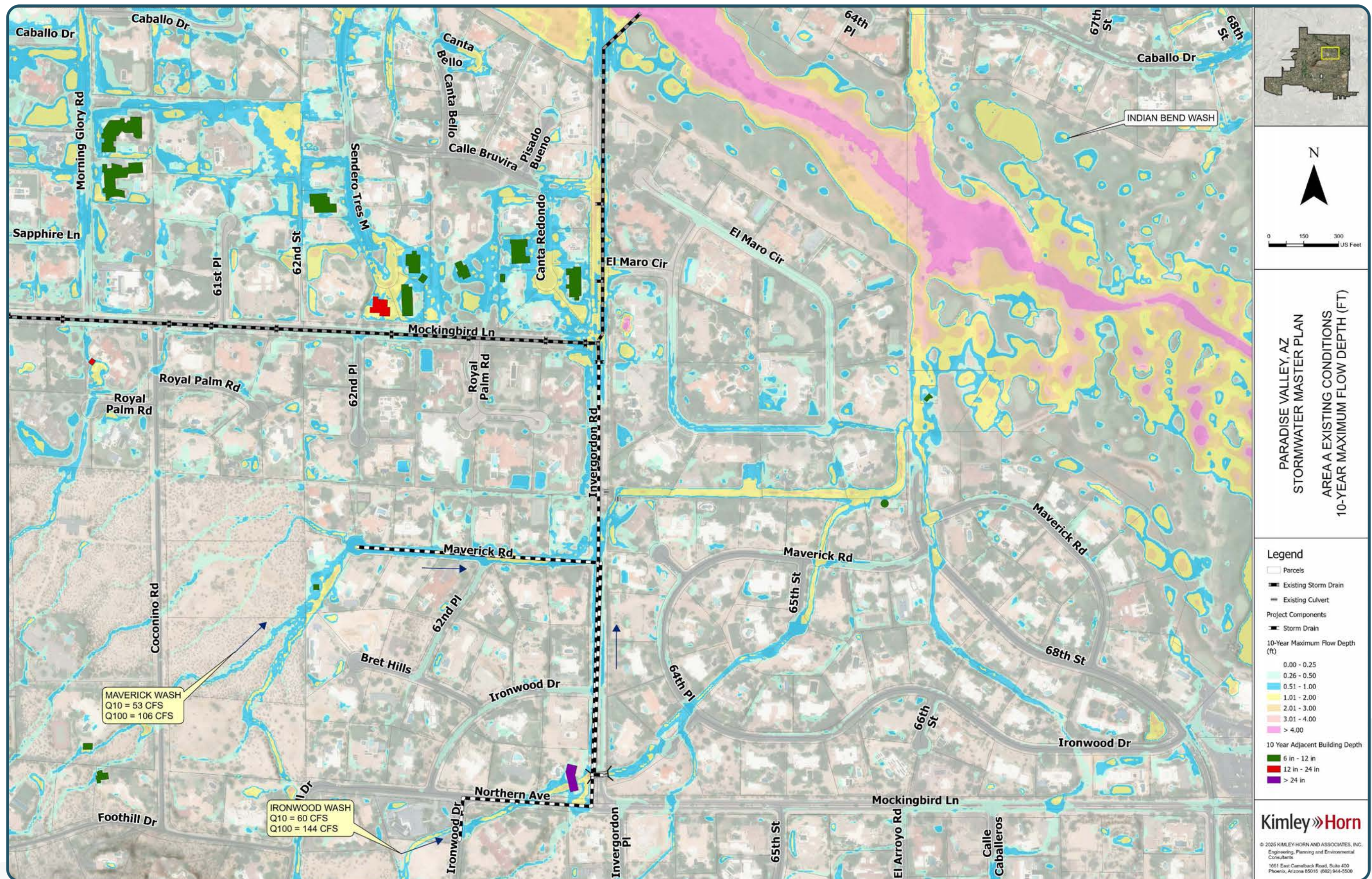


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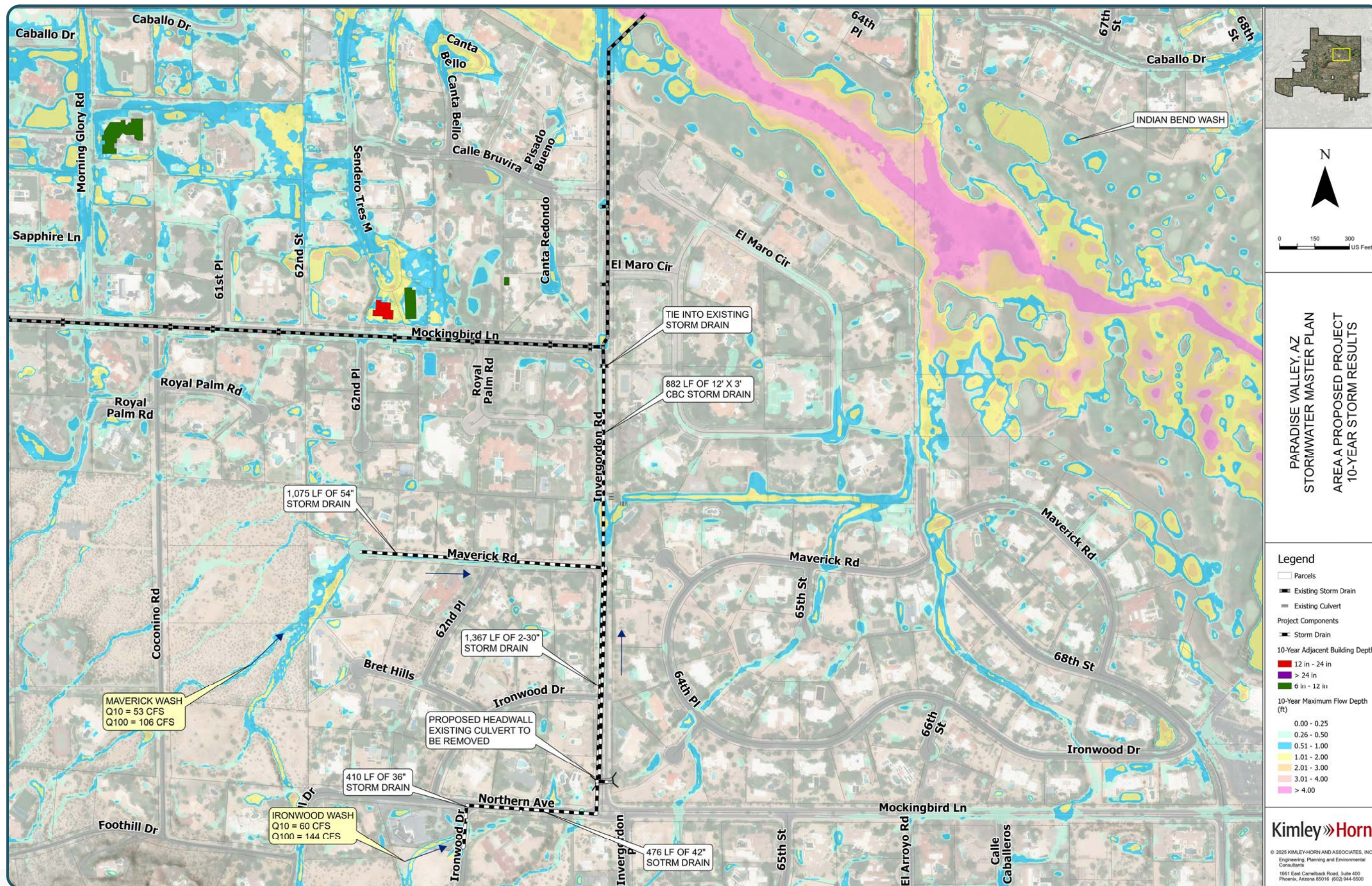


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B. Flood Hazard Area H – 40th Street and Stanford Drive

Description

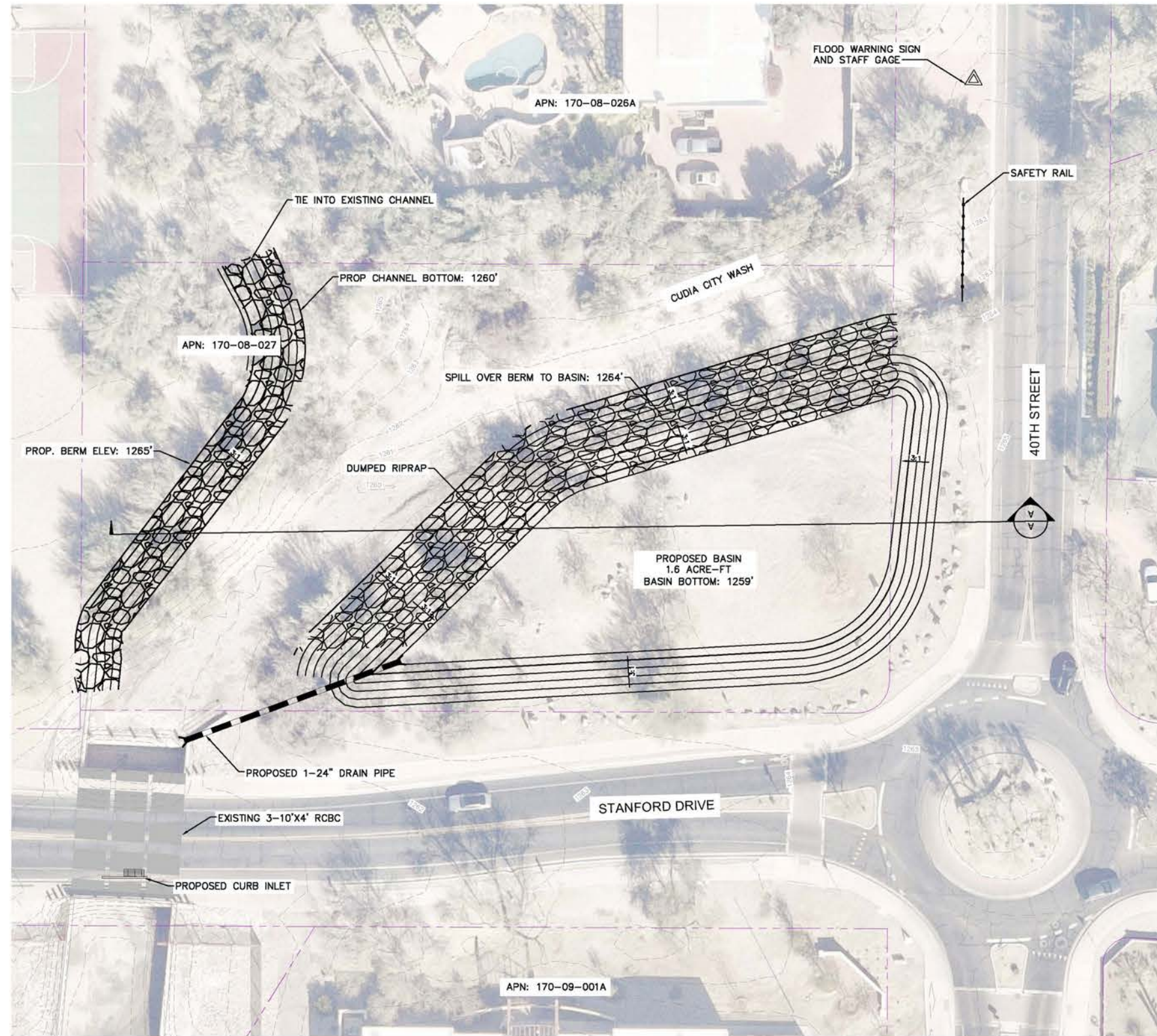
Alternative 2 was selected from the three alternatives evaluated in the project matrix. This alternative involved making 2-year storm improvements to the existing wash running through 40th Street and Stanford Drive, the inclusion of a flood control basin, and the expansion of the curb inlet on Stanford Drive. The proposed channel was further refined with the following improvements: the channel bottom would be lowered to an elevation of 1260', and the side slopes would be graded at 3 to 1 to an elevation of 1265' on the north side of the channel. The south side of the channel would only be graded to an elevation of 1264' and would function as a spill over to the adjacent flood control basin. The basin was designed to use as much space as possible within the parcel and ROW. It would have 3 to 1 side slopes and a bottom elevation of 1259'. This would give the basin a height of 5 ft and provide a storage volume of 1.6 acre-ft. A 24" drain pipe located at the southeast corner of the basin would drain water to the existing culvert inlet on the north side of Stanford Drive. To reduce flooding along Stanford Drive, the existing curb inlet would be expanded to increase its capacity to drain water from the road. Safety measures including a staff gage, flood warning signage, and safety rails would be placed on 40th Street. This project is estimated to cost 1,039,500 USD. Conceptual plans are shown on the following pages with the detailed cost estimate include in **Appendix G**.

Benefits

The implementation of this project would allow for decreased frequency of road closures at this intersection. In existing conditions, the entire intersection must typically be shut down for the 2-year storm. Stanford Drive becomes inundated with 1 to 3 feet of water and 40th Street with up to 5 feet of water according to modeling results. Recorded instances of the intersection being shut down have been confirmed and recorded by Town Staff. In 2-year and 10-year storm proposed conditions, Stanford Drive could remain open with closures being limited to the 40th Street wash crossing. This project would improve emergency and passenger vehicle access. A cost/benefit ratio was not calculated for this project as the benefits are entirely improved transportation function and emergency vehicle access improvement. 10-year existing conditions, proposed conditions, and depth difference maps, along with conceptual plans, are shown on the following pages. Additional storm events results are included in **Appendix F**.

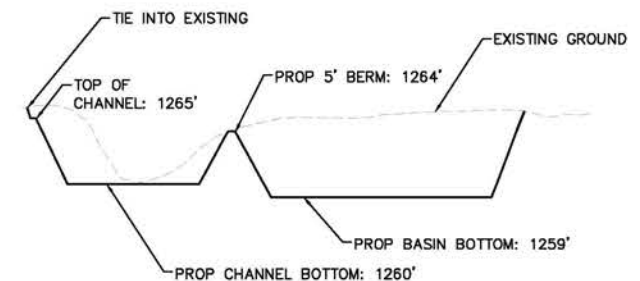


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SECTION A-A

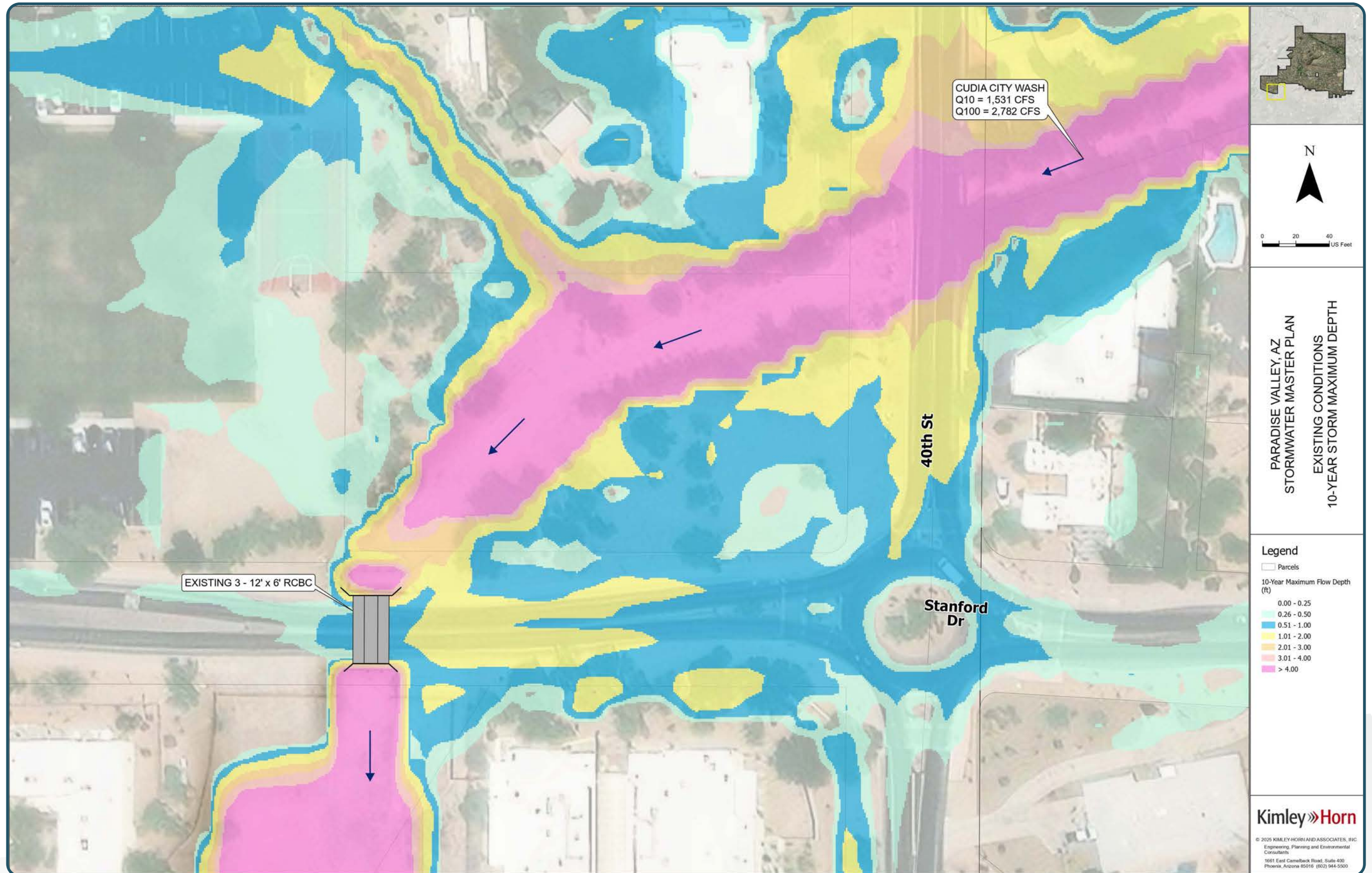
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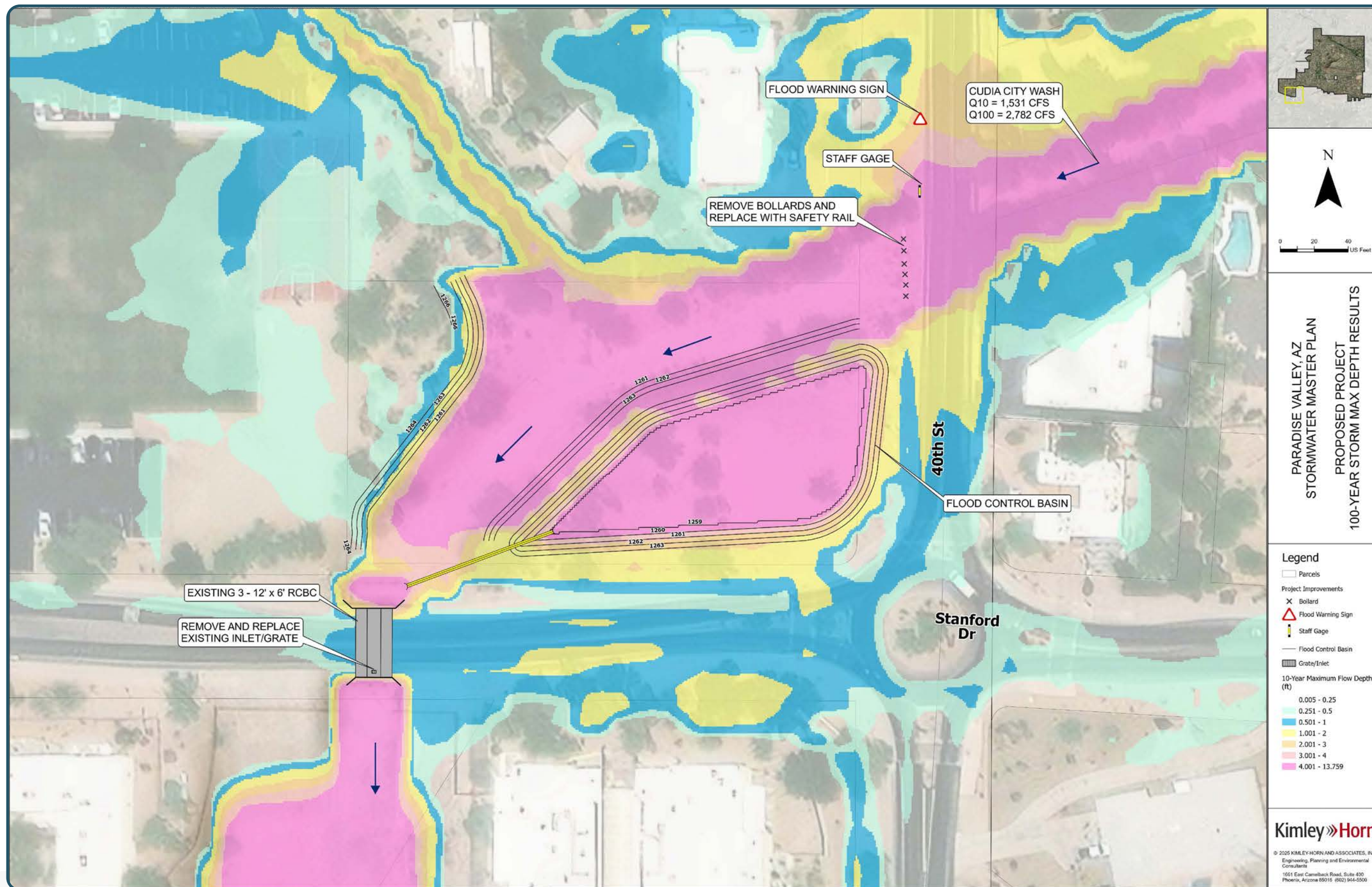


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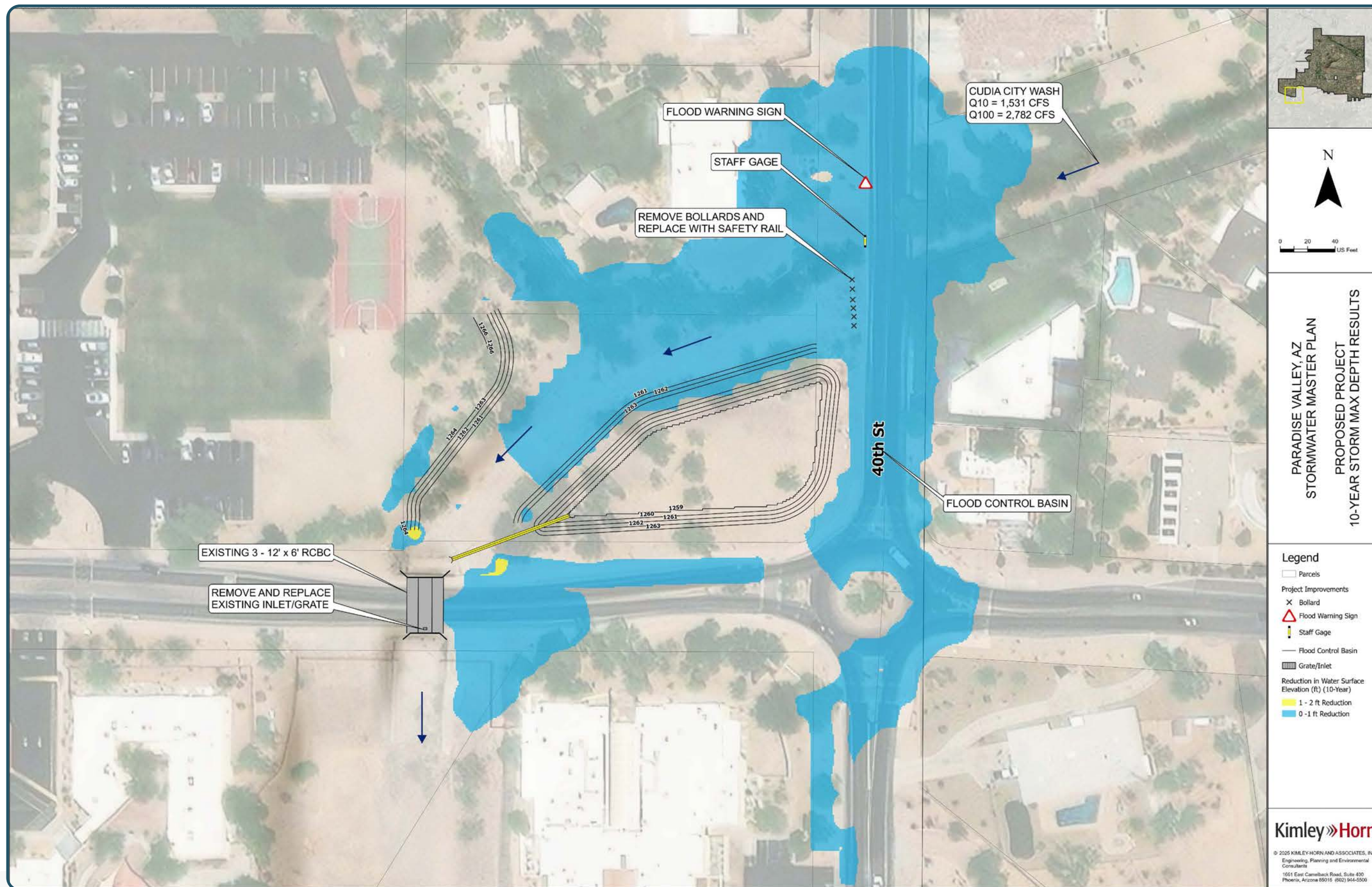


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C. Flood Hazard Area K – Mountain View Road

Description

Alternative 2 was selected from the two alternatives evaluated in the project matrix. This alternative involves constructing a retention basin upstream of Mountain View Road. The basin was sized with 3 to 1 slopes, a top elevation of 1396, and a bottom of elevation of 1388. This configuration provides 32.6 acre-ft of water storage, containing the 10-year hydrograph. The basin outfalls to a spillover weir on the west side of Tatum Boulevard. This project is estimated to cost 6,072,476 USD. Conceptual plans are shown on the following pages with the detailed cost estimate included in **Appendix G**.

Benefits

The potential benefits for the 10-year and 100-year storms were developed for the project and are shown in **Table 31**. The benefits were determined by incorporating the proposed drainage improvements into the FLO-2D model and comparing the pre and post project flow depth conditions adjacent to the impacted buildings. By using the U.S. Army Corps of Engineers (USACE) depth-damage curves for the building structures and building contents, a damage reduction or benefit per building was determined for the 10- and 100-year storms. The USACE depth damage curves can be seen in **Appendix H**. If the detention basin is built, it is expected to have a life cycle of 75-years, and total benefits of about 18.7 million USD when assuming seven 10-year storms and one 100-year storm occurring during the infrastructure life span

Table 31: Area K Benefit Cost Ratio Summary

Number of Properties Impacted		220
Approximate Population ¹		550
Benefit with Drainage Improvements in Place (\$)	Damage Reduction	21,394,816
	Social Benefits	1,978,900
	Total	23,293,796
Construction Cost		11,616,355
Benefit-Cost Ratio (BCR)		2.01

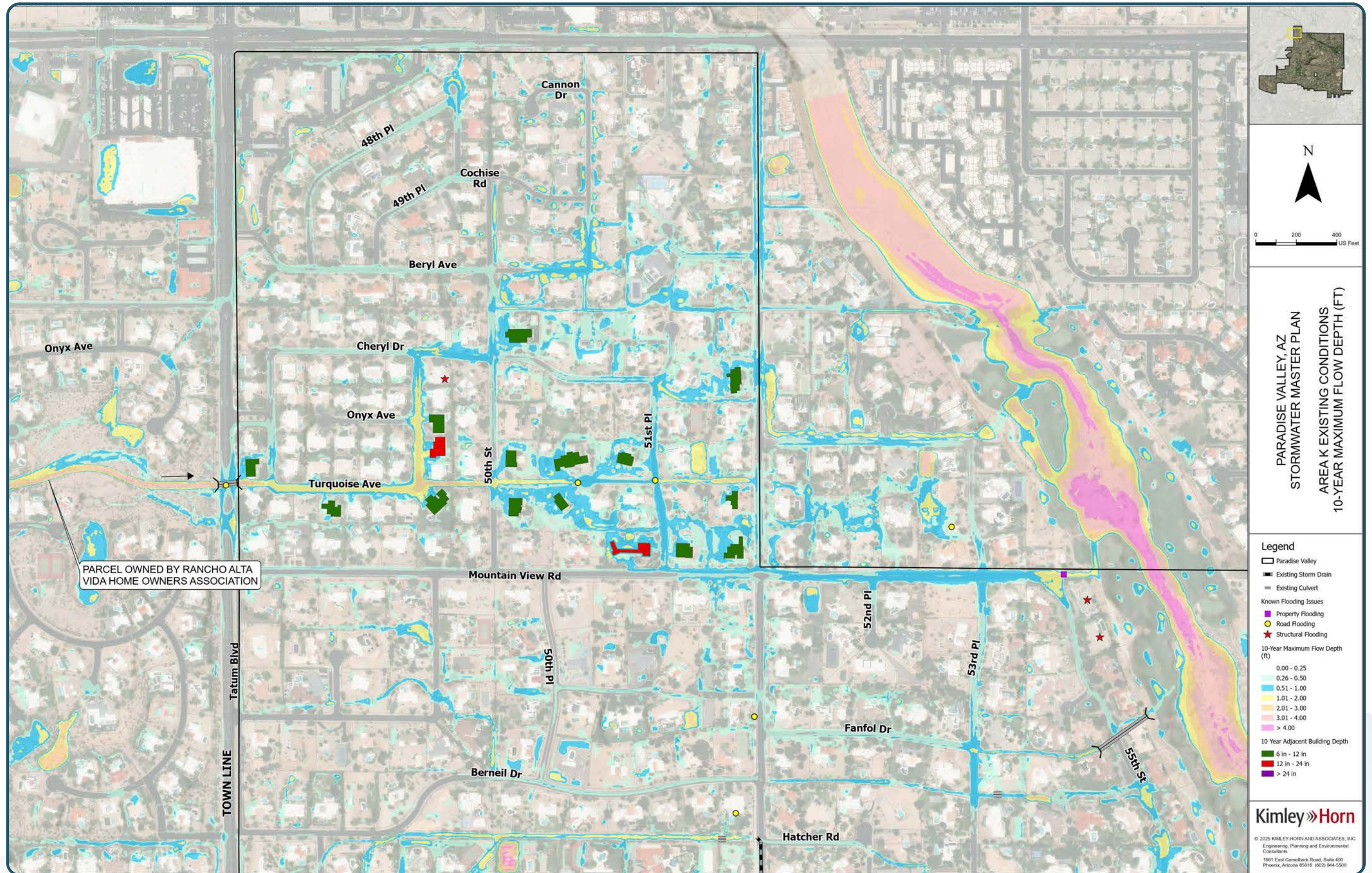
¹Assumed 2.5 people per household from U.S. Census for the Town of Paradise Valley.

²Social benefits are based on the number of residents impacted and are calculated using FEMA's Benefit Cost Analysis toolkit. This would account for traffic closures, interruptions to work, etc.

³Assumed at least seven 10-year storms and one 100- year storm occur during the 75-year life span of the improvements.

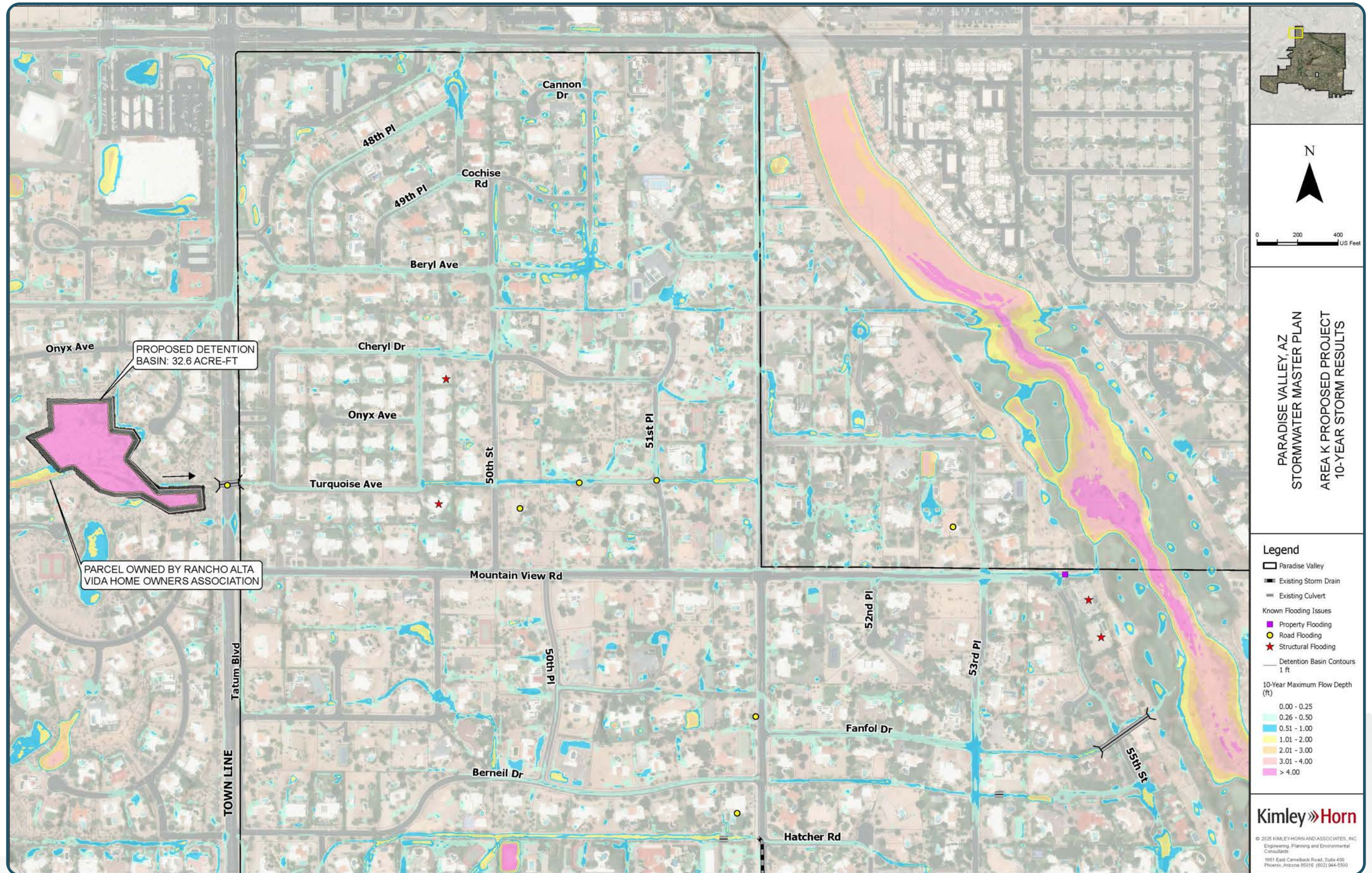


PARADISE VALLEY STORM WATER MASTER PLAN



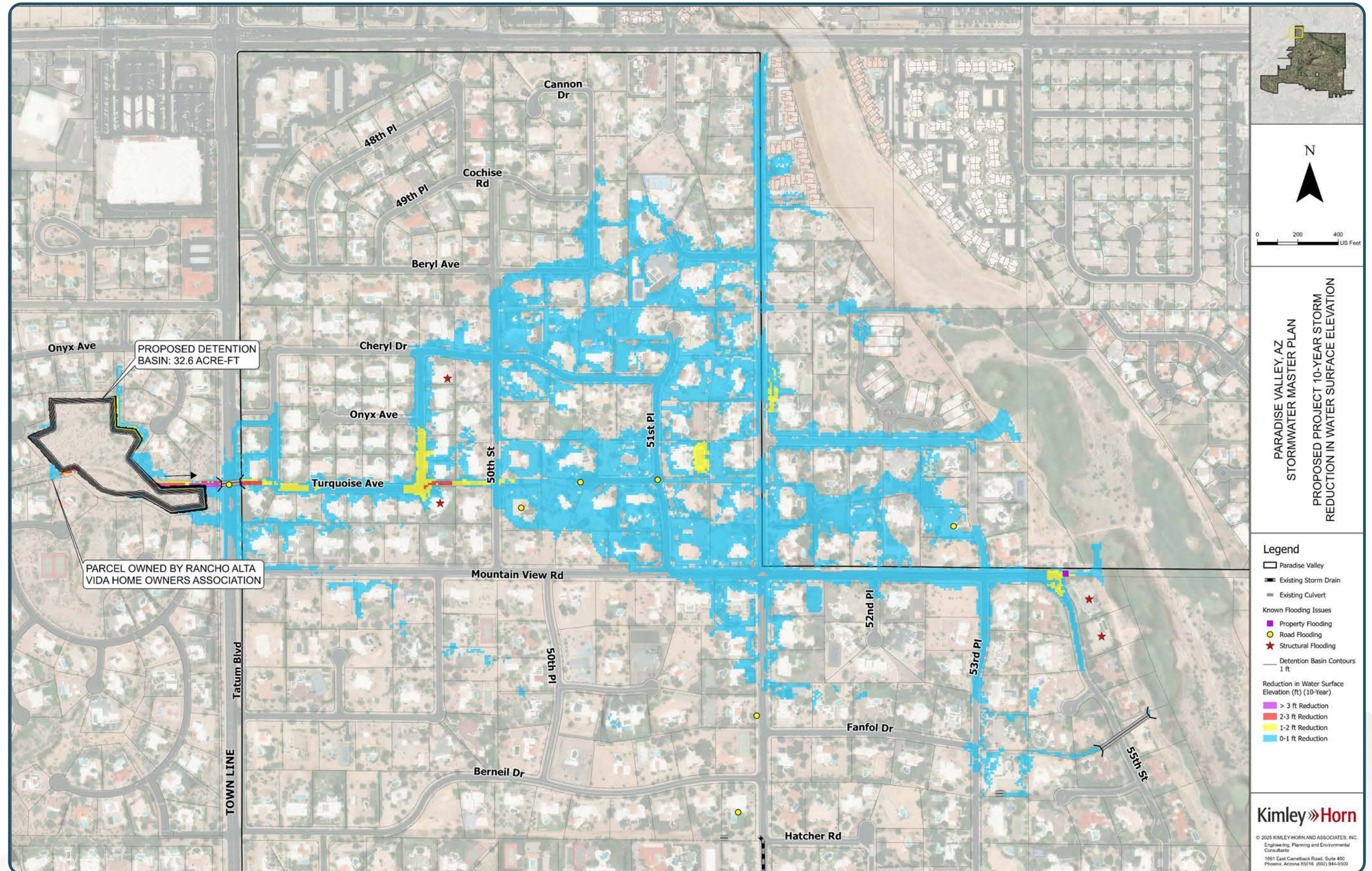


PARADISE VALLEY STORM WATER MASTER PLAN





PARADISE VALLEY STORM WATER MASTER PLAN





D. Flood Hazard Area L – Upstream Cherokee Wash

Description

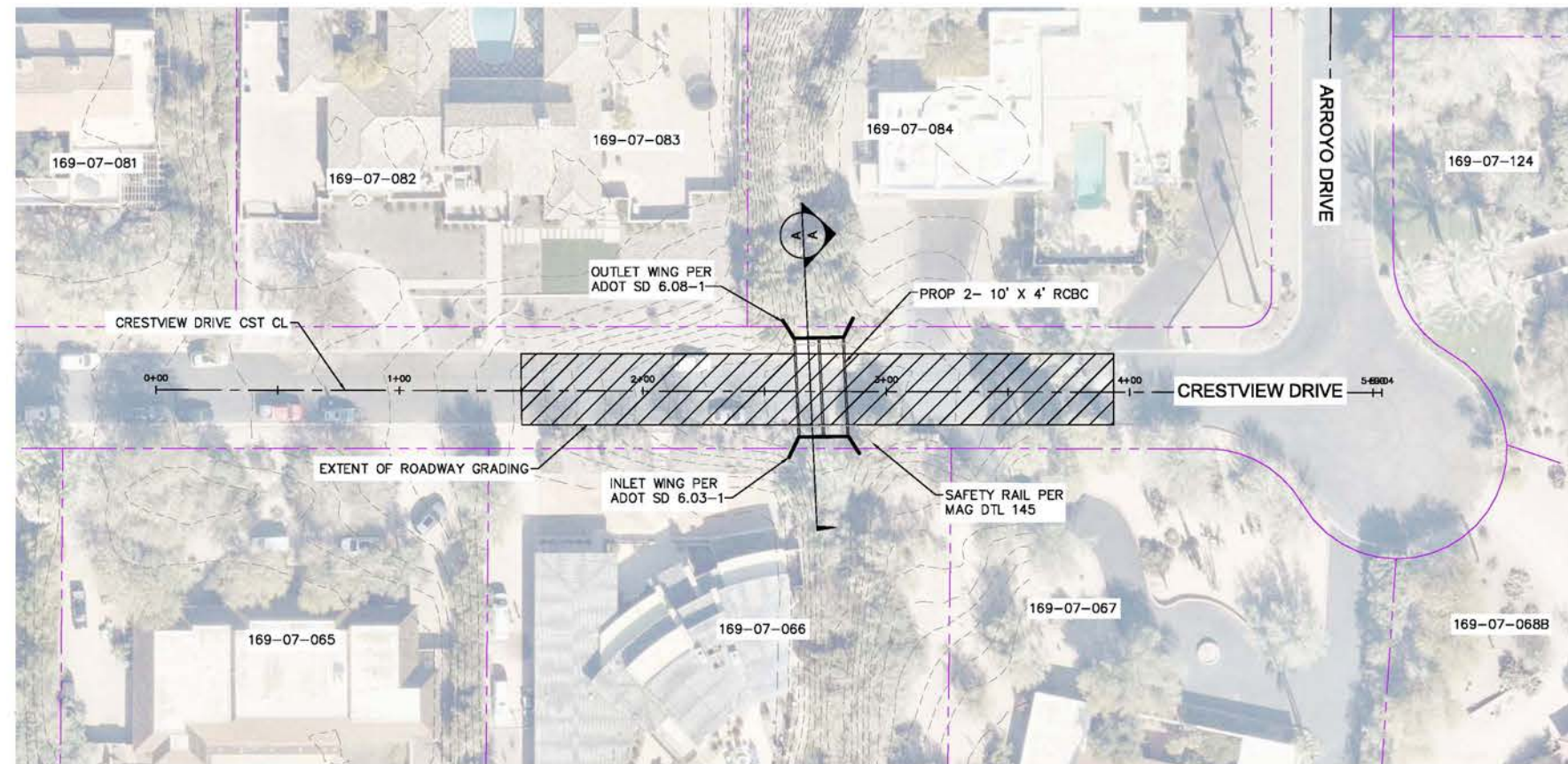
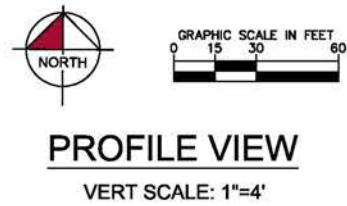
Alternative 2 was selected from the two alternatives evaluated in the project decision matrix. The alternative involves replacing three low water crossings with culverts. This alternative requires raising the road to accommodate the culvert configuration. The proposed culverts were developed with the following improvements: the extent of roadway grading necessary for the construction of the culverts was determined and optimized by creating a 3D profile. The profiles provided the required length, invert elevations, and road elevation of the proposed culverts. Using these variables, the 10-year storm water surface elevation passing through the culvert was determined by normal depth calculations. The culvert profiles are included in **Appendix H**. The final configuration for the culverts is 2-10' x 4' on Crestview Drive and Arroyo Drive and a 3-10'x4' on Desert Jewel Drive. Safety rails based on MAG Standard Detail 145 were included in conceptual design. This project is estimated to cost 6,113,214 USD. See **Appendix G** for the associated conceptual cost estimate.

Benefits

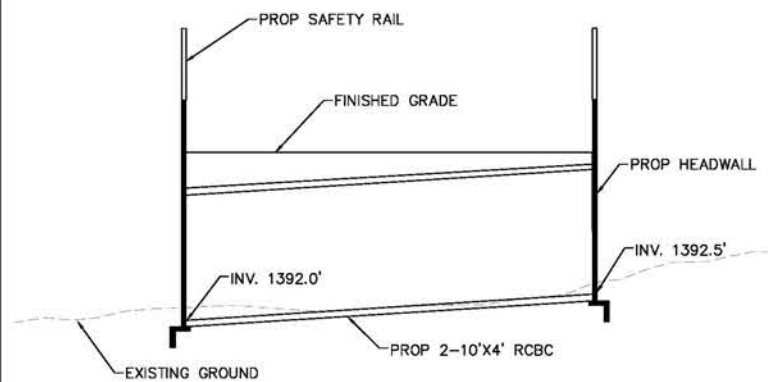
The completion of this project would improve public safety and reduce obstruction to emergency vehicle access. In 10-year existing conditions, the maximum flow depths through Crestview Drive, Arroyo Drive, and Desert Jewel Drive are 6 ft, 6.1 ft, and 4.2 ft, respectively per modeling results. These water crossings are hazards to emergency vehicle access and the traveling public. The culvert configuration contains the 2-year storm, and obstructions to emergency vehicles are reduced in the 10-year storm. A cost/benefit ratio was not calculated for this project as the benefits are entirely improved transportation function and emergency access improvement. 10-year existing condition, proposed condition, and depth difference maps, along with conceptual plans, are shown on the following pages. Additional storm event results are included in **Appendix F**.



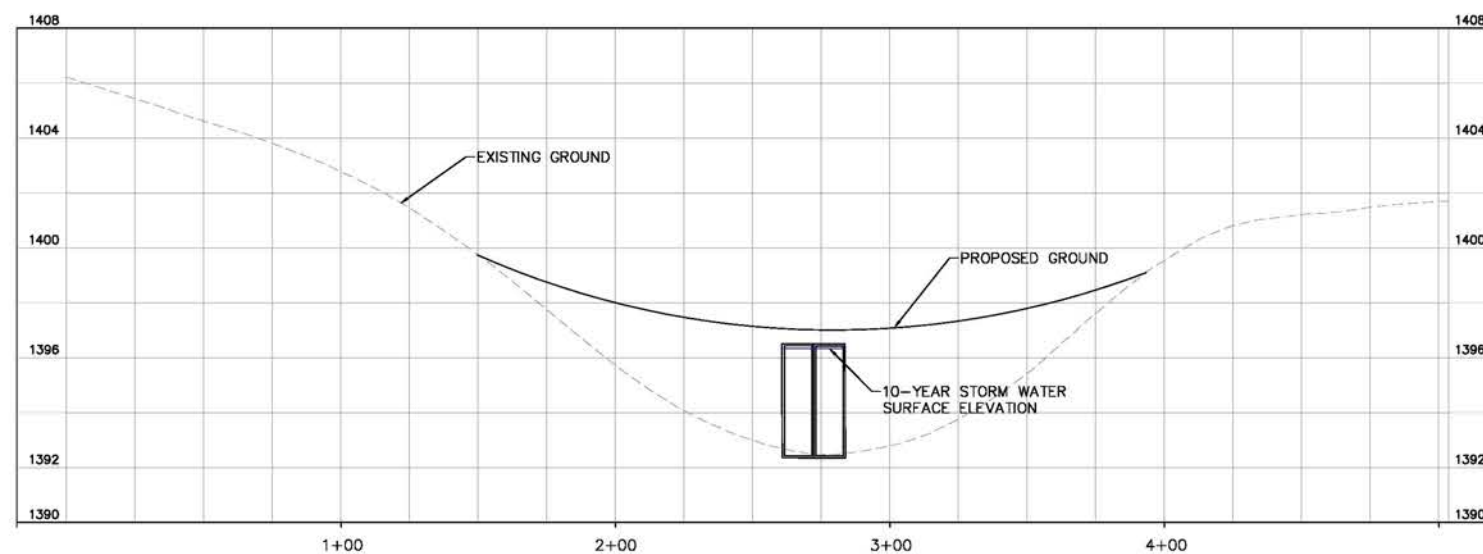
PARADISE VALLEY STORM WATER MASTER PLAN



SECTION A-A
SCALE: 1"=15'



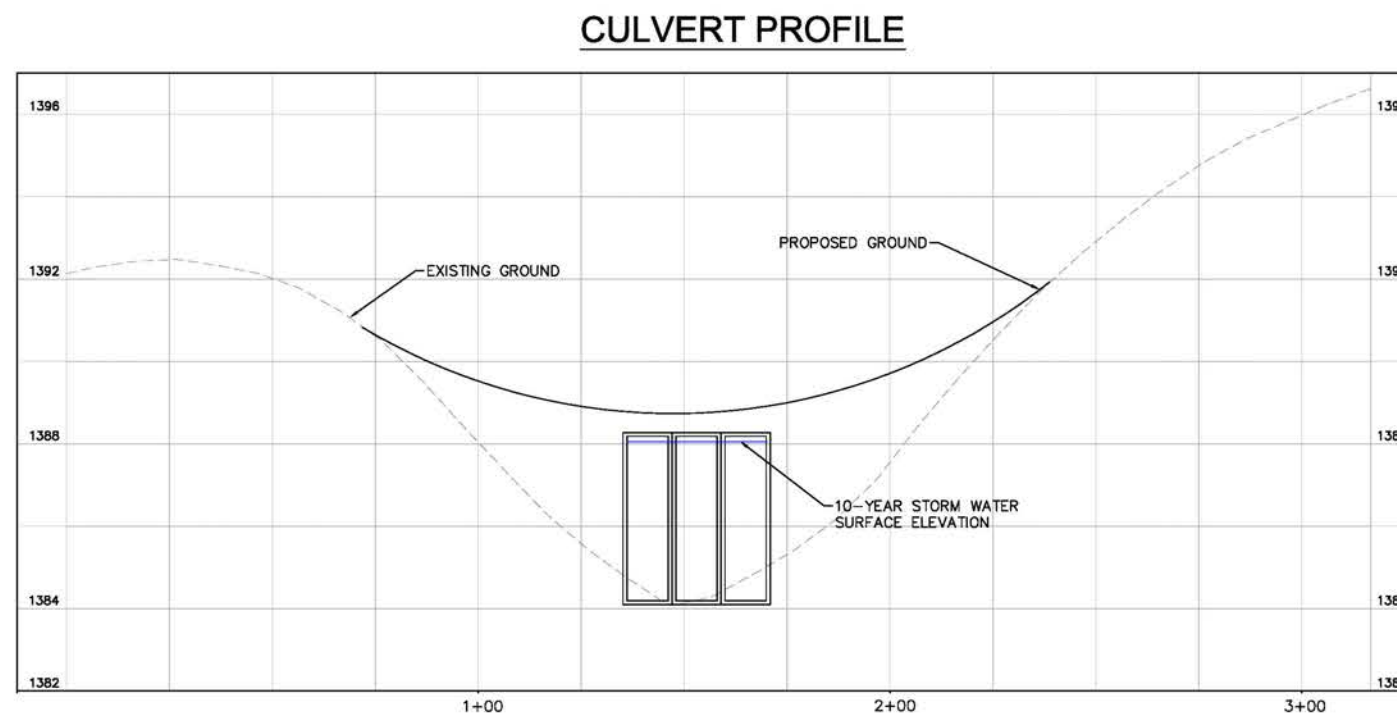
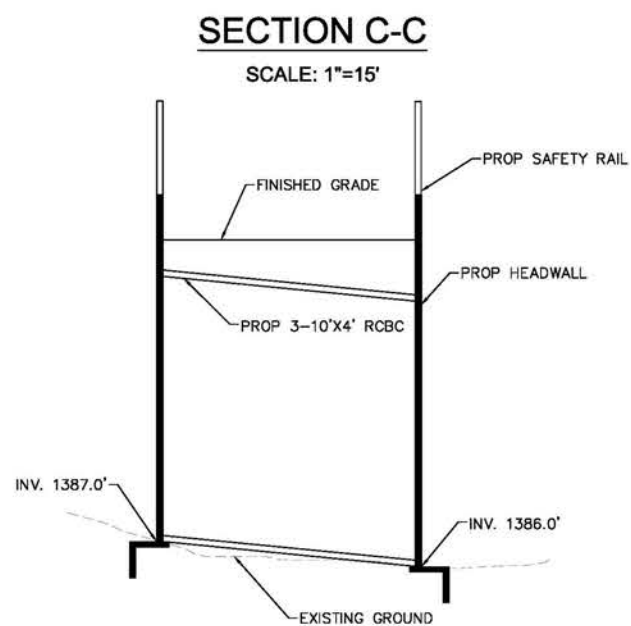
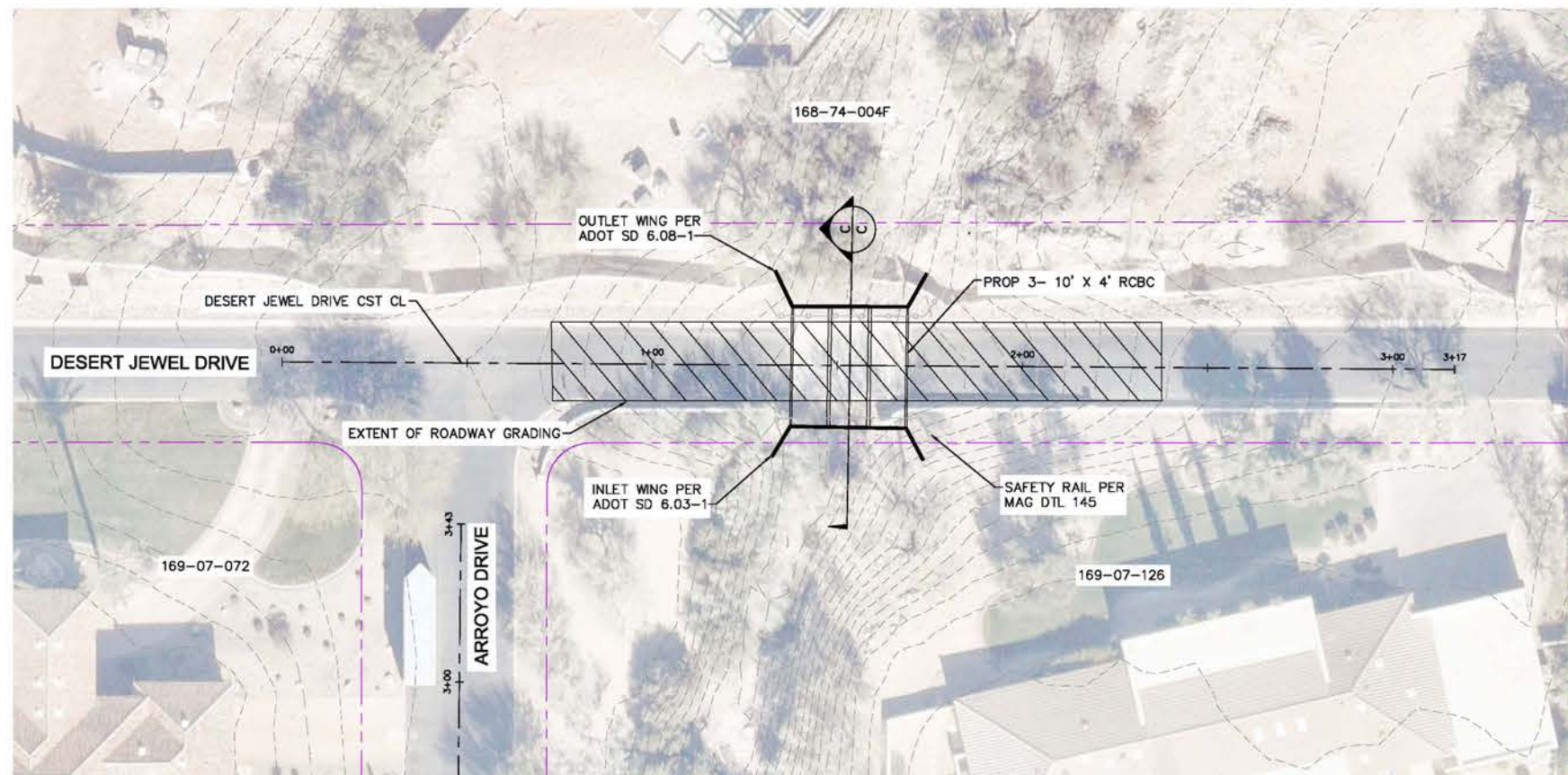
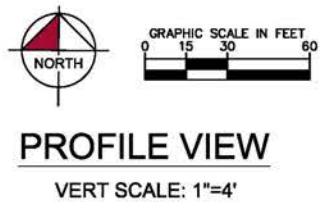
CULVERT PROFILE



Kimley»Horn	
© 2025 KIMLEY-HORN AND ASSOCIATES, INC. 1891 E. CAMELBACK RD. # 400 PHOENIX, ARIZONA 85016 (602) 944-5500	
SCALE (H): 1"=30'	SCALE (V): 1"=4'
DESIGNED BY: PTB	DRAWN BY: PTB
CHECKED BY: GSB	DATE: 03/2025
PARADISE VALLEY SWMP AREA L SELECTED ALTERNATIVE 15% PLANS	
PROJECT NO. 091054031	
DRAWING NAME AREA L	
1 OF 3	



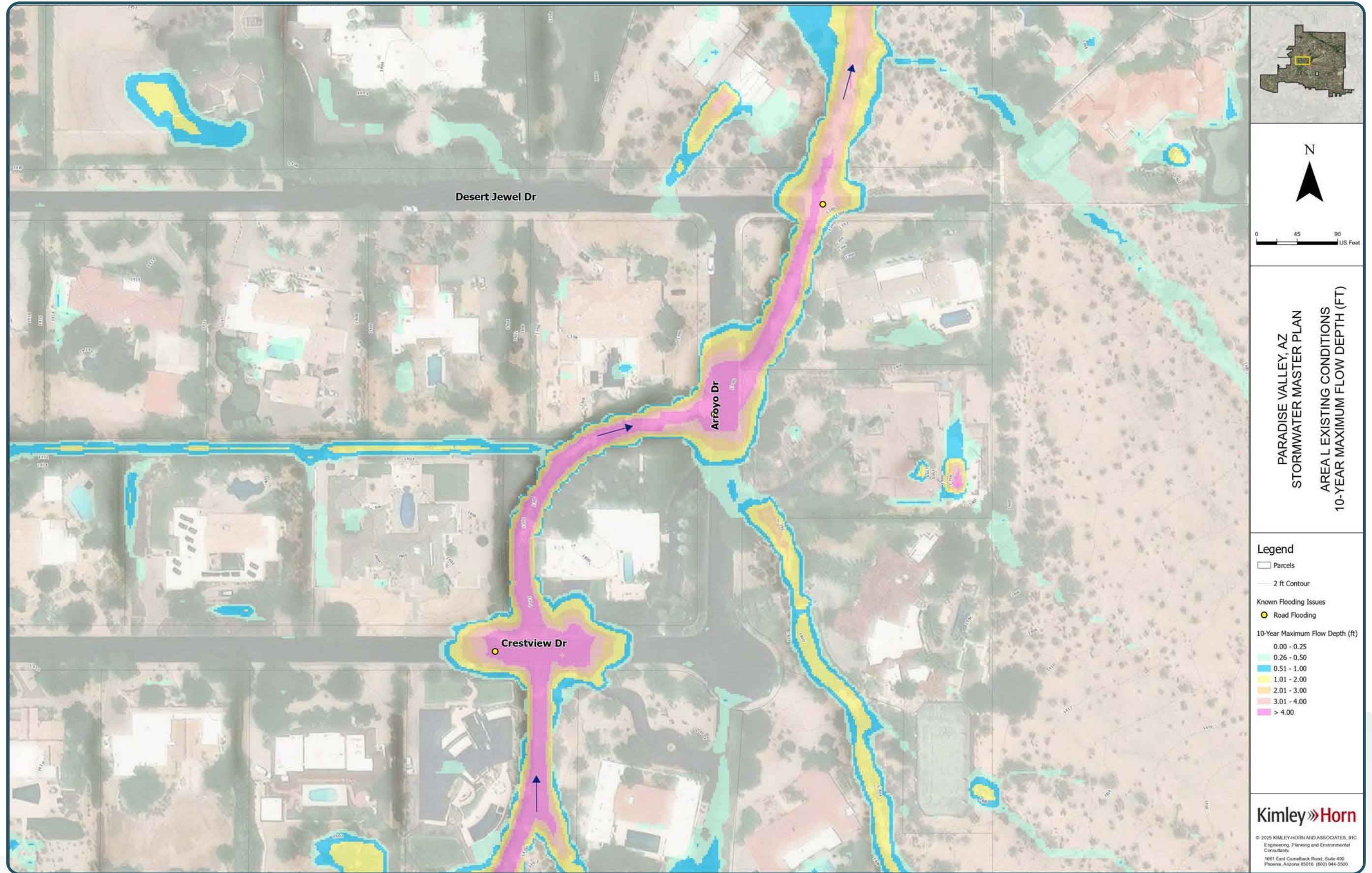
PARADISE VALLEY STORM WATER MASTER PLAN



PROJECT NO. 091054031		PARADISE VALLEY SWMP		SCALE (H): 1"=30'		Kimley»Horn			
DRAWING NAME AREA L		AREA L SELECTED ALTERNATIVE 15% PLANS		SCALE (V): 1"=4'		DESIGNED BY: PTB DRAWN BY: PTB CHECKED BY: USB			
3 OF 3				DATE: 03/2025		© 2025 KIMLEY-HORN AND ASSOCIATES, INC. 1661 E. CAMELBACK RD. # 400 PHOENIX, ARIZONA 85016 (602) 944-5500			
								NO. REVISION DATE	

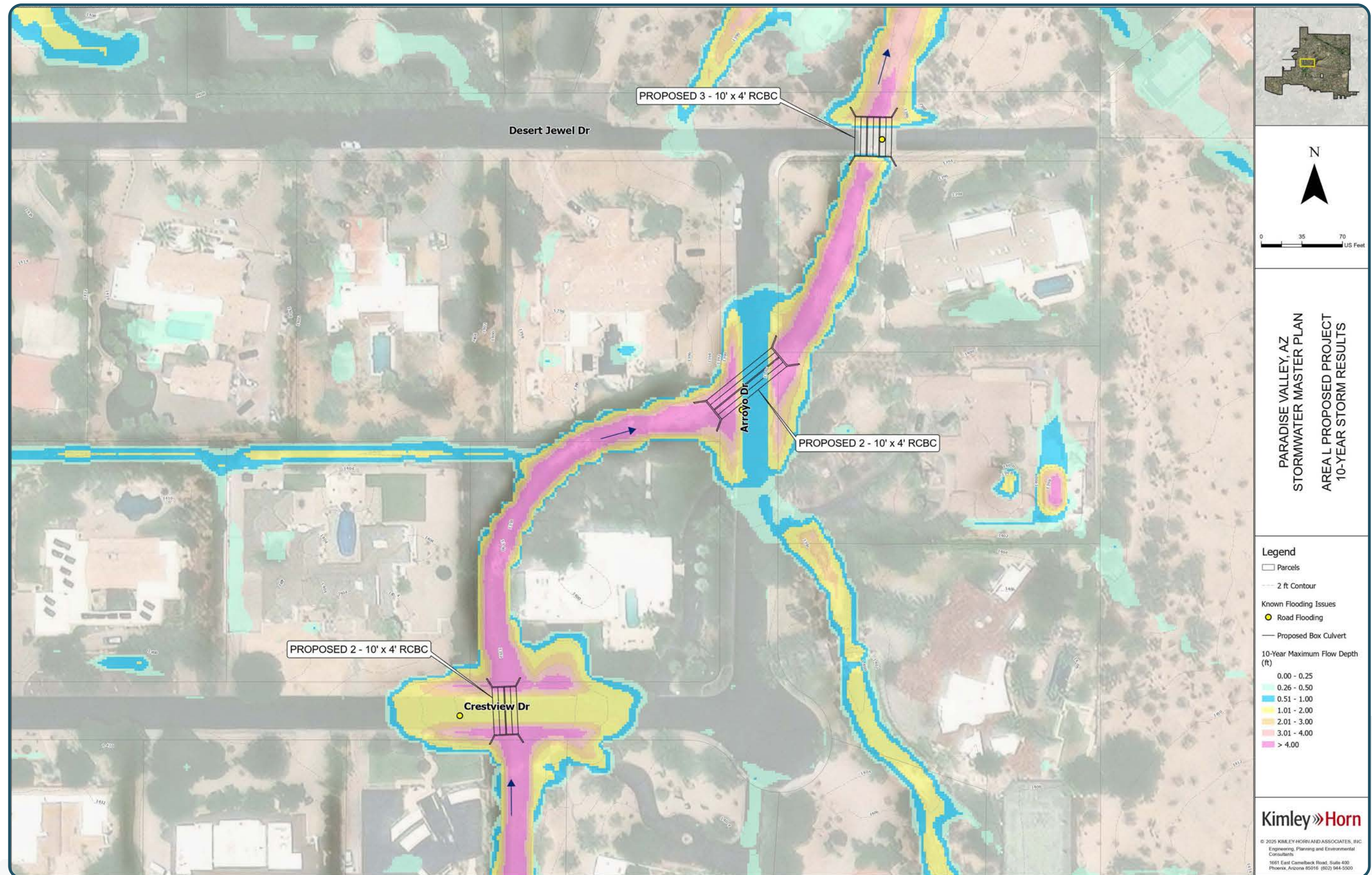


PARADISE VALLEY STORM WATER MASTER PLAN



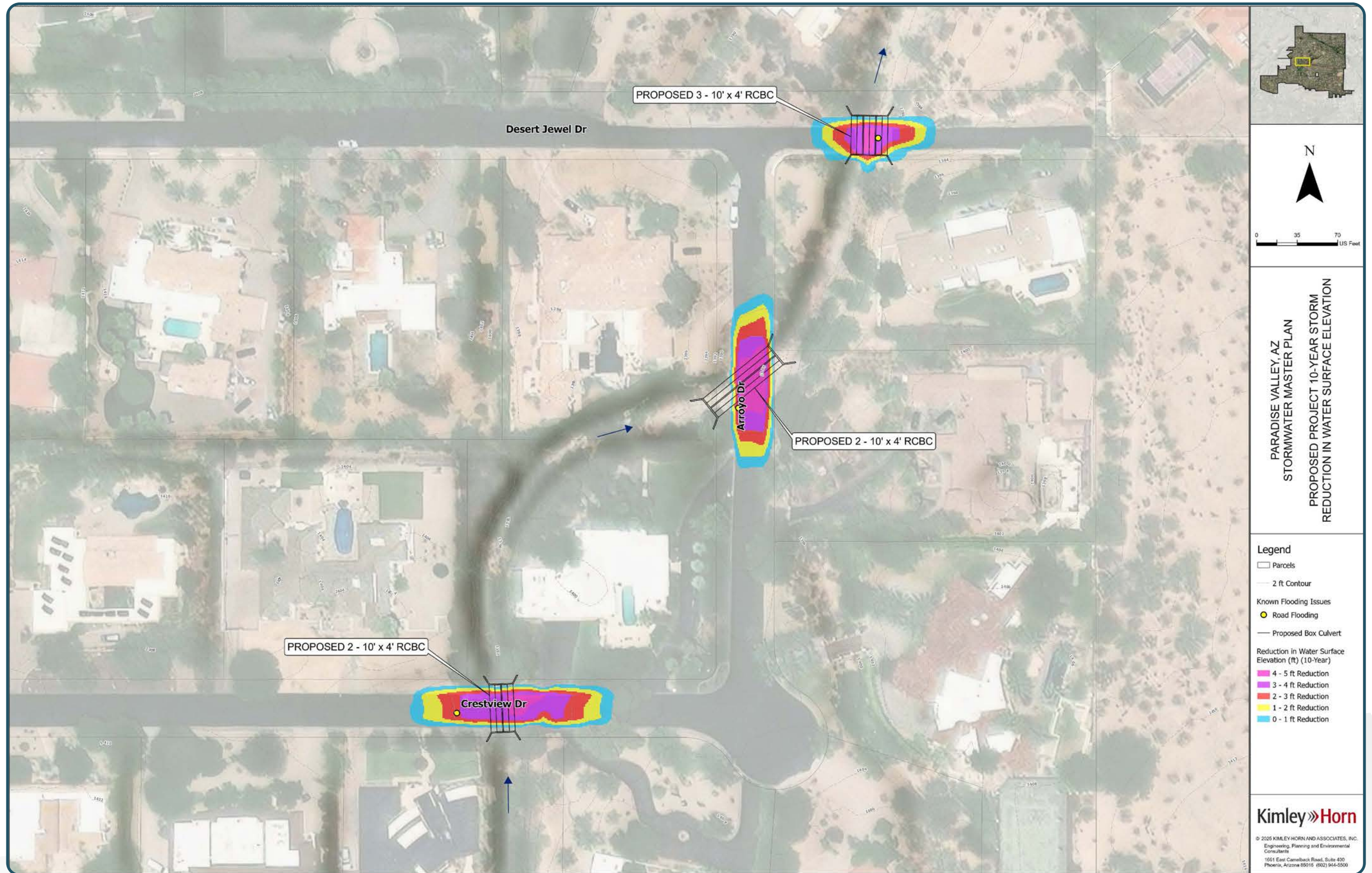


PARADISE VALLEY STORM WATER MASTER PLAN





PARADISE VALLEY STORM WATER MASTER PLAN





E. Flood Hazard Area N – Downstream Cherokee Wash

Description

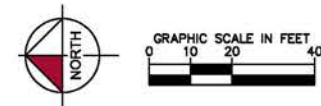
Alternative 1 was selected from the two alternatives evaluated in the project decision matrix. The alternative involves replacing four low water crossings with culverts. This alternative requires raising the road to accommodate the culvert configuration. The proposed culverts were developed with the following improvements: the extent of roadway grading necessary for the construction of the culverts was determined and optimized by creating a 3D profile. The profiles provided the required length, invert elevations, and road elevation of the proposed culverts. Using these variables, the 10-year storm water surface elevation passing through the culvert was obtained by performing normal depth calculations. The culvert configuration has the capacity for the 10-year storm. The culvert profiles are included in **Appendix F**. The final configuration for the culverts is a 10-year storm design and consisted of 2-10' x 4' for each culvert location. This project is estimated to cost 1,989,729 USD. See **Appendix G** for the associated conceptual cost estimate

Benefits

The completion of this project would improve public safety and reduce obstruction to emergency vehicle access. In 10-year existing conditions, the maximum flow depths through 58th Place, 59th Place, Morning Glory Rd, and Caballo Lane are 3.9 ft, 3.5 ft, 4.7, and 4.4 ft, respectively per modeling results. In 10-year proposed conditions, maximum flow depths are 0.1 ft, 0.6 ft, 0.6 ft, and 0.2 ft, respectively. A cost/benefit ratio was not calculated for this project as the benefits are entirely improved transportation function and emergency access improvement. 10-year existing condition, proposed condition, and depth difference maps, along with conceptual plans, are shown on the following pages. Additional storm event results are included in **Appendix F**.

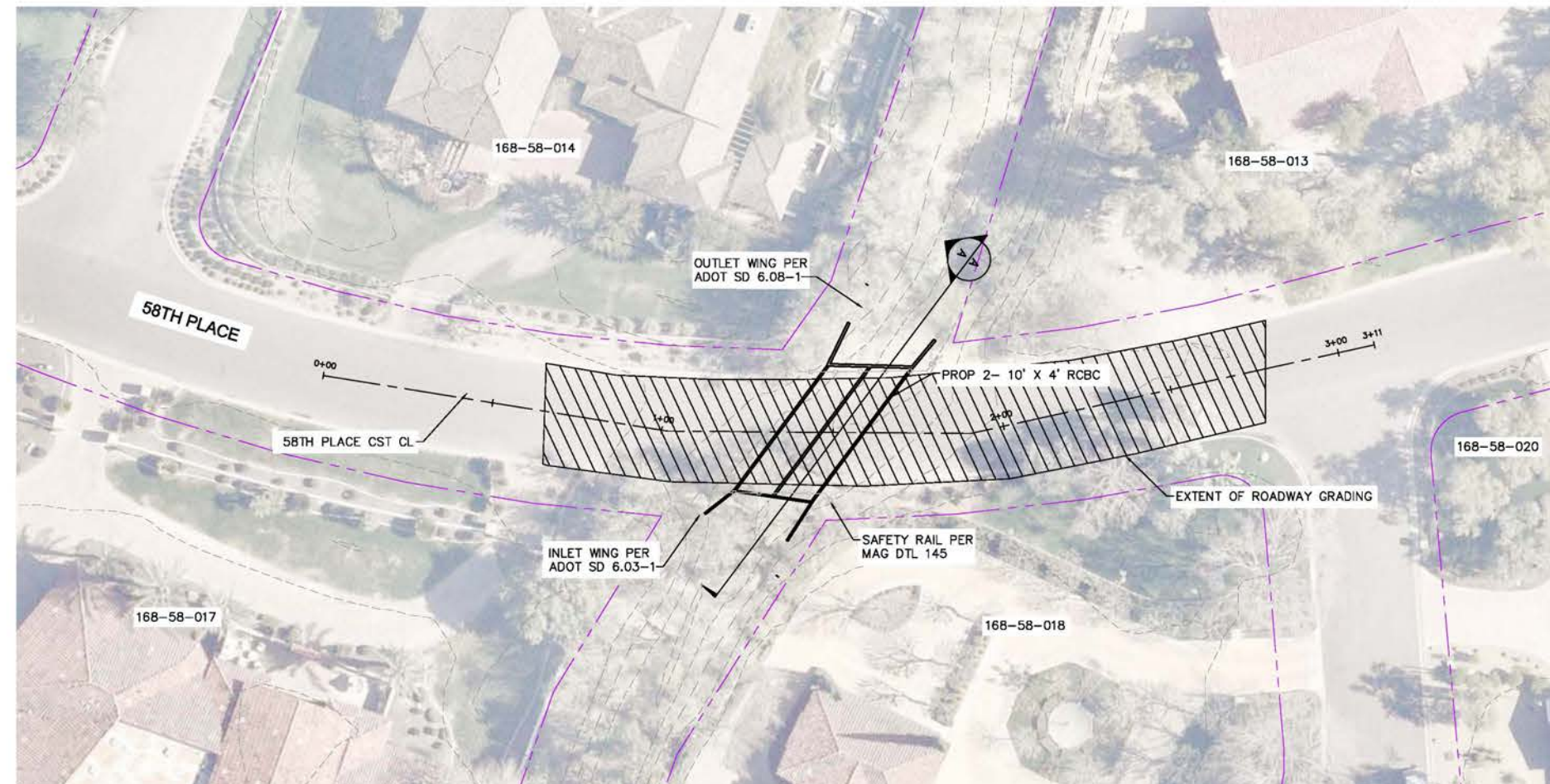


PARADISE VALLEY STORM WATER MASTER PLAN



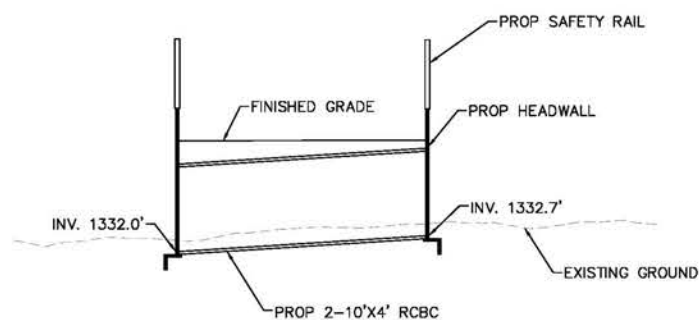
PROFILE VIEW

VERT SCALE: 1"=4'



SECTION A-A

SCALE: 1"=15'



CULVERT PROFILE

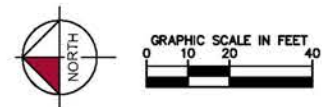


PROJECT NO. 091054031		SCALE (H): 1"=20'		Kimley»Horn © 2025 KIMLEY-HORN AND ASSOCIATES, INC. 1661 E CAMELBACK RD # 400 PHOENIX, ARIZONA 85016 (602) 944-5500		NO.		REVISION		DATE	
DRAWING NAME AREA N		SCALE (V): 1"=4'									
1 OF 4		DESIGNED BY: PTB									
		DRAWN BY: PTB									
		CHECKED BY: OSB									
		DATE: 03/2025									
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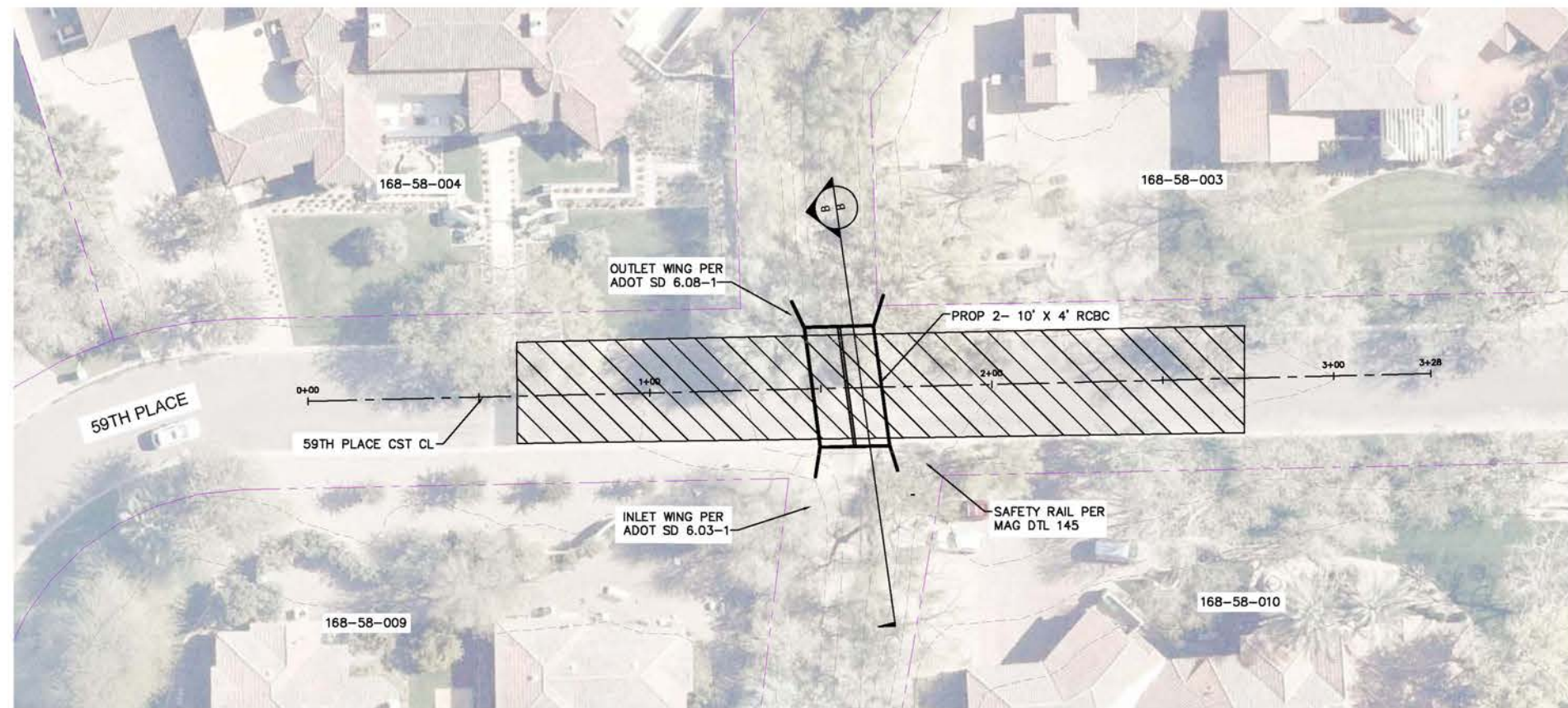


PARADISE VALLEY STORM WATER MASTER PLAN



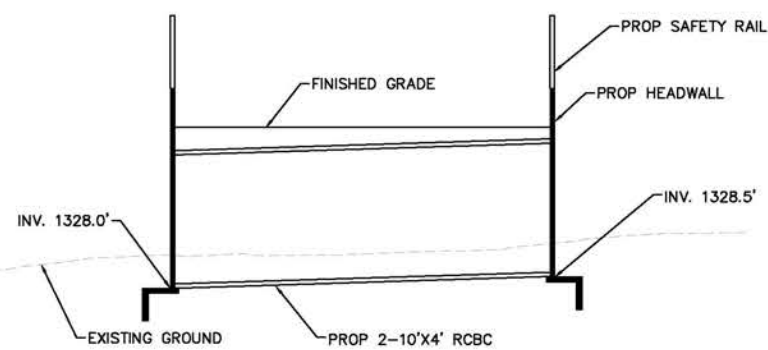
PROFILE VIEW

VERT SCALE: 1"=4'

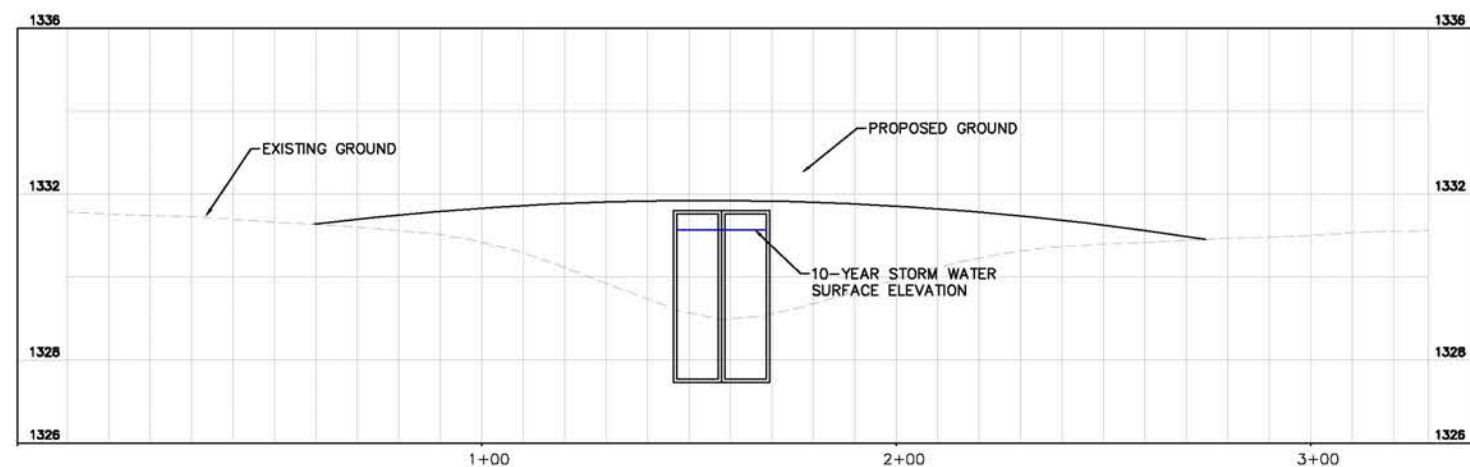


SECTION B-B

SCALE: 1"=10'



CULVERT PROFILE



Kimley»Horn

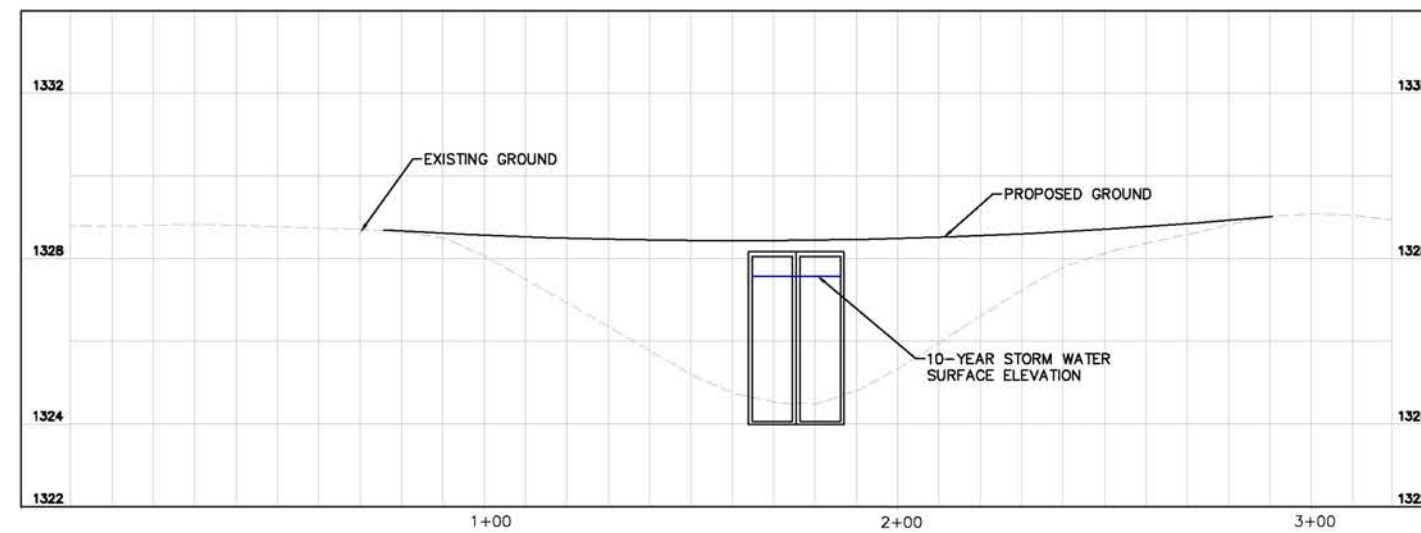
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PHOENIX, ARIZONA 85016 (602) 944-5500

SCALE (H): 1"=20'
SCALE (V): 1"=4'
DESIGNED BY: PTB
DRAWN BY: PTB
CHECKED BY: GSB
DATE: 03/2025

PARADISE VALLEY SWMP
AREA N SELECTED ALTERNATIVE 15% PLANS

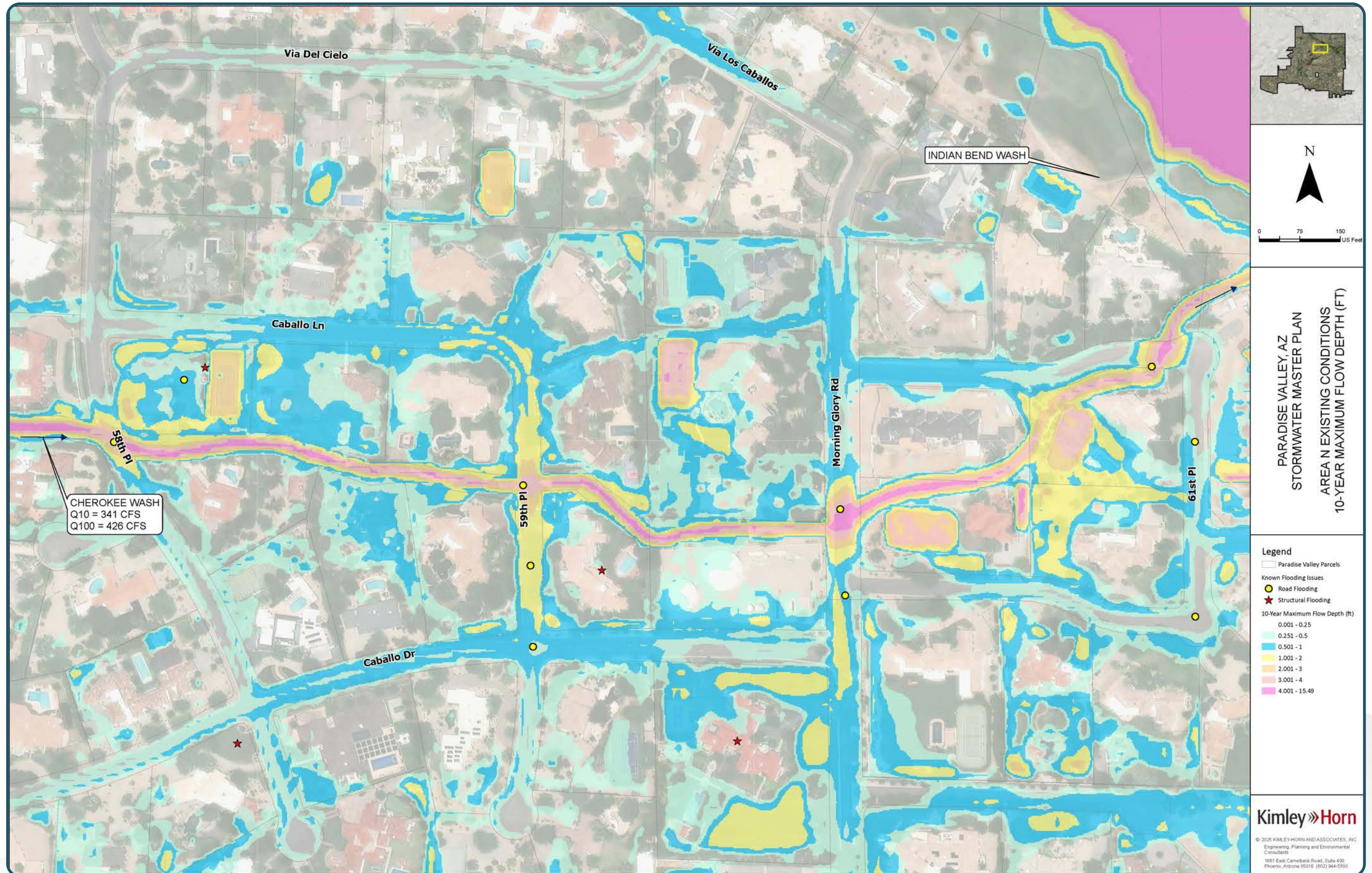
PROJECT NO.
091054031
DRAWING NAME
AREA N
2 OF 4

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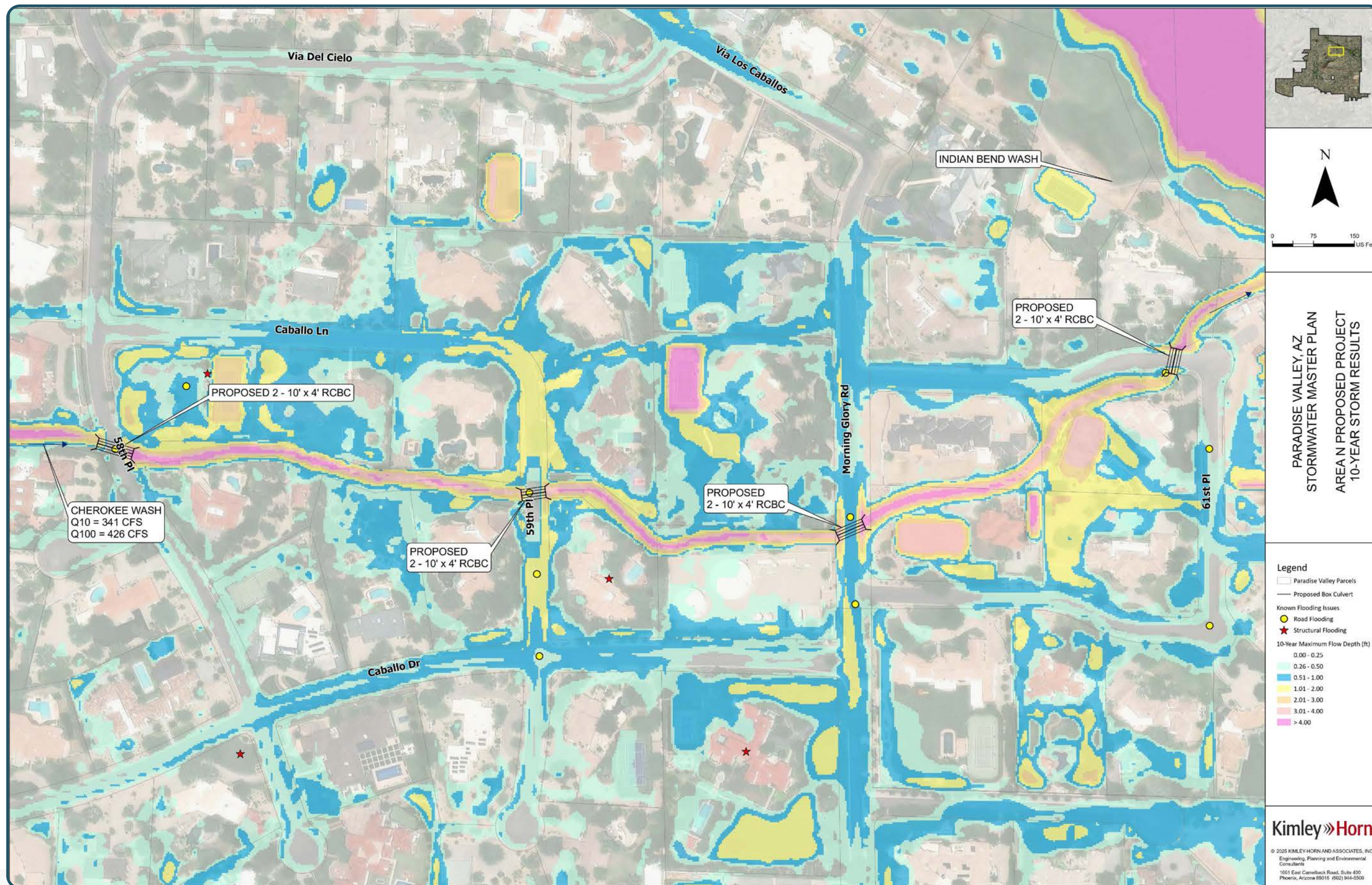


PARADISE VALLEY STORM WATER MASTER PLAN





PARADISE VALLEY STORM WATER MASTER PLAN





PARADISE VALLEY STORM WATER MASTER PLAN





F. Flood Hazard Area O – Lincoln Drive

Description

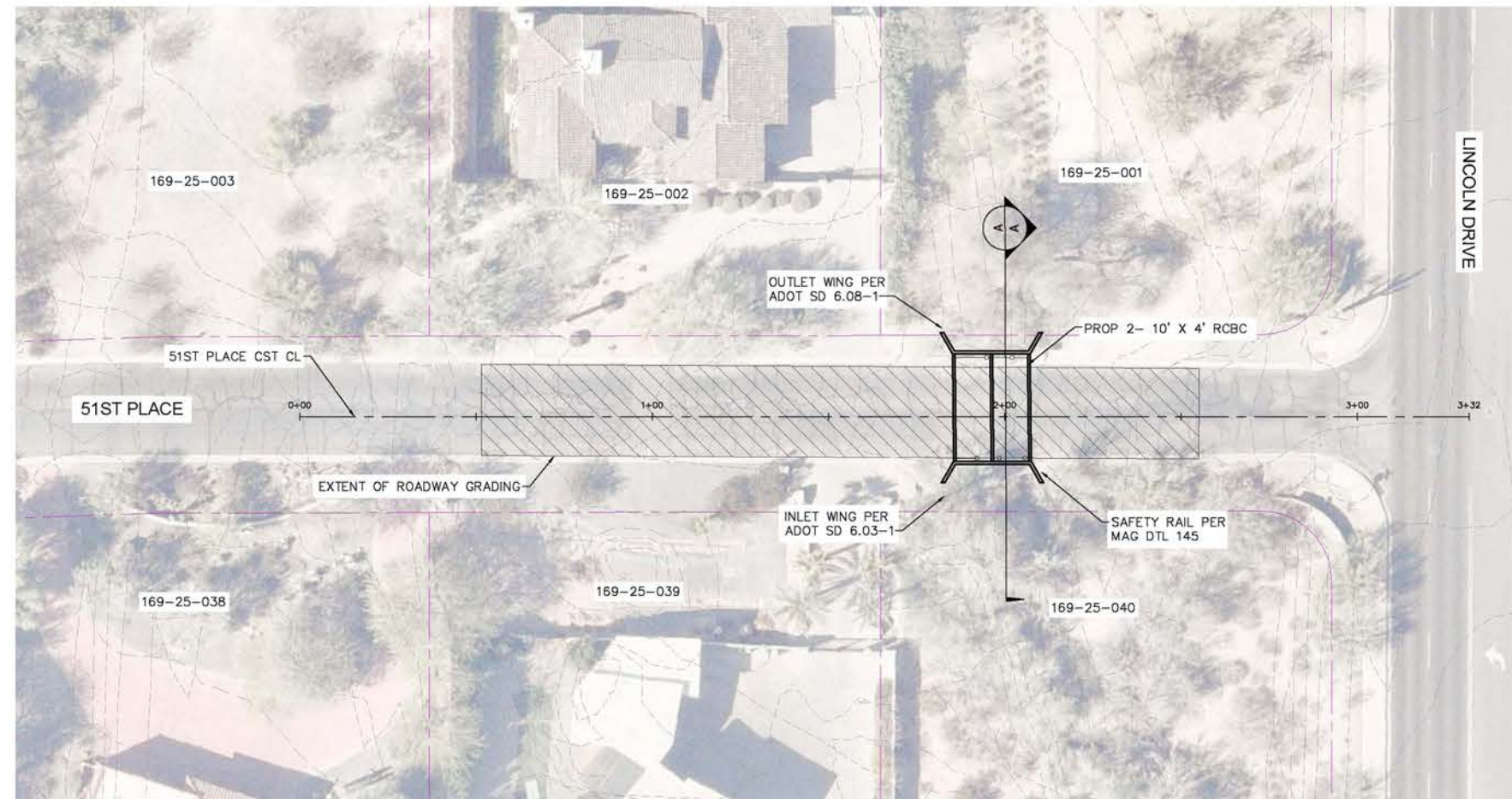
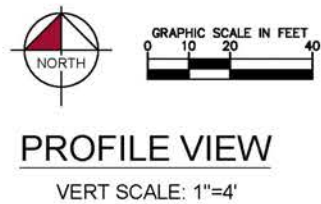
Alternative 2 was selected from the two alternatives evaluated in the project decision matrix. The alternative involves replacing three undersized culverts at 51st Place, Lincoln Drive, and Desert Fairways Drive. This alternative requires raising the road to accommodate the culvert configuration at two of the locations, 51st Street and Desert Fairways Drive. The proposed culverts were developed with the following improvements: the extent of roadway grading necessary for the construction of the culverts was determined and optimized by creating a 3D profile. The profiles provided the required length, invert elevations, and road elevation of the proposed culverts. Using these variables, the 10-year storm water surface elevation passing through the culvert was determined by performing normal depth calculations. The culvert configurations has the capacity for the 10-year storm. The culvert profiles are included in **Appendix F**. The final configuration for the culverts is a 10-year storm design and consisted of 2-10' x 4' at 51st Place and a 12'x3' culvert at both Lincoln Drive and Desert Fairways Drive. The culvert profiles and 15% plans are included in **Appendix H**. This project is estimated to cost 1,979,147 USD. See **Appendix G** for the associated conceptual cost estimate.

Benefits

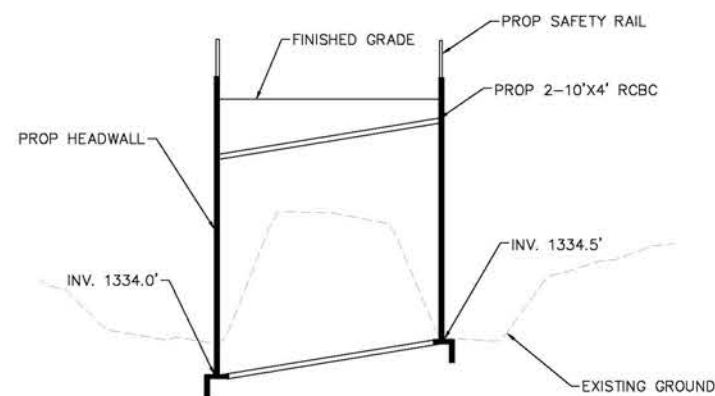
The completion of this project would improve public safety and reduce obstructions to emergency vehicle access. In 10-year existing conditions, the maximum flow depths through 51st Place, Lincoln Drive, and Desert Fairways Drive are 3 ft, 0.9 ft, and 1.3 ft, respectively per modeling results. In 10-year proposed conditions, maximum flow depths are 0.8 ft, 0.6 ft, and 0.8 ft, respectively. In the 2-year storm there is no overtopping of the culverts. A cost/benefit ratio was not calculated for this project as the benefits are entirely improved transportation function and emergency access improvement. 10-year existing condition, proposed condition, and depth difference maps, along with conceptual plans, are shown on the following pages. Additional storm event results are included in **Appendix F**.



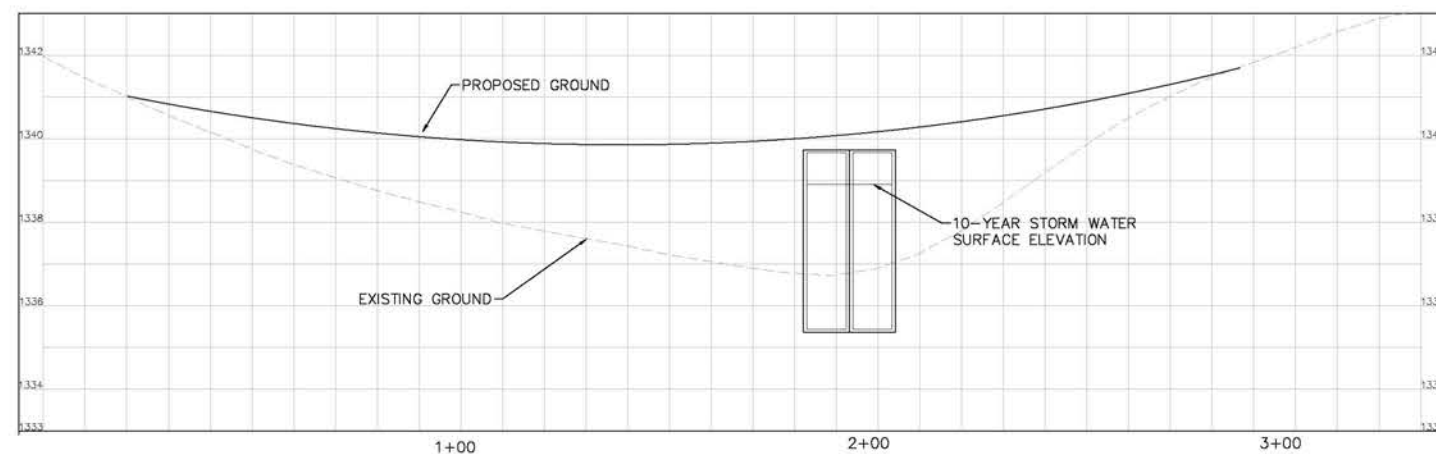
PARADISE VALLEY STORM WATER MASTER PLAN



SECTION A-A
SCALE: 1"=15'



CULVERT PROFILE

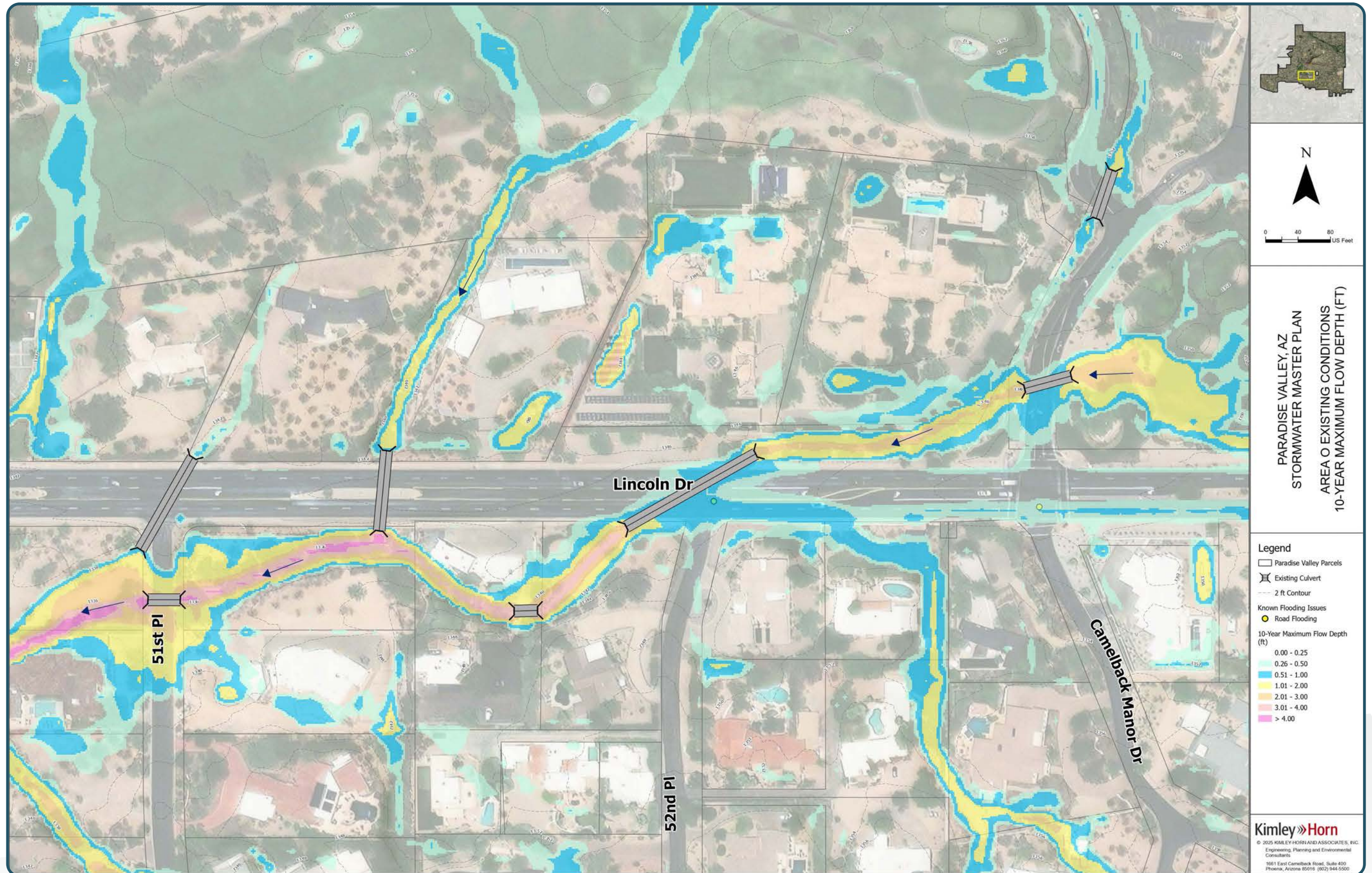


Kimley»Horn		NO.	REVISION	DATE
PARADISE VALLEY SWMP AREA O SELECTED ALTERNATIVE 15% PLANS		PROJECT NO. 091054031		
		DRAWING NAME AREA O		
		1 of 3		
		DESIGNED BY: PTB DRAWN BY: PTB CHECKED BY: OSB DATE: 03/2025		

\\pva\waterresources\091054031\15%_Stormwater_Master_Plan\040\Utilities\AreaO_project_profile.dwg May 16, 2025 mcaabaci
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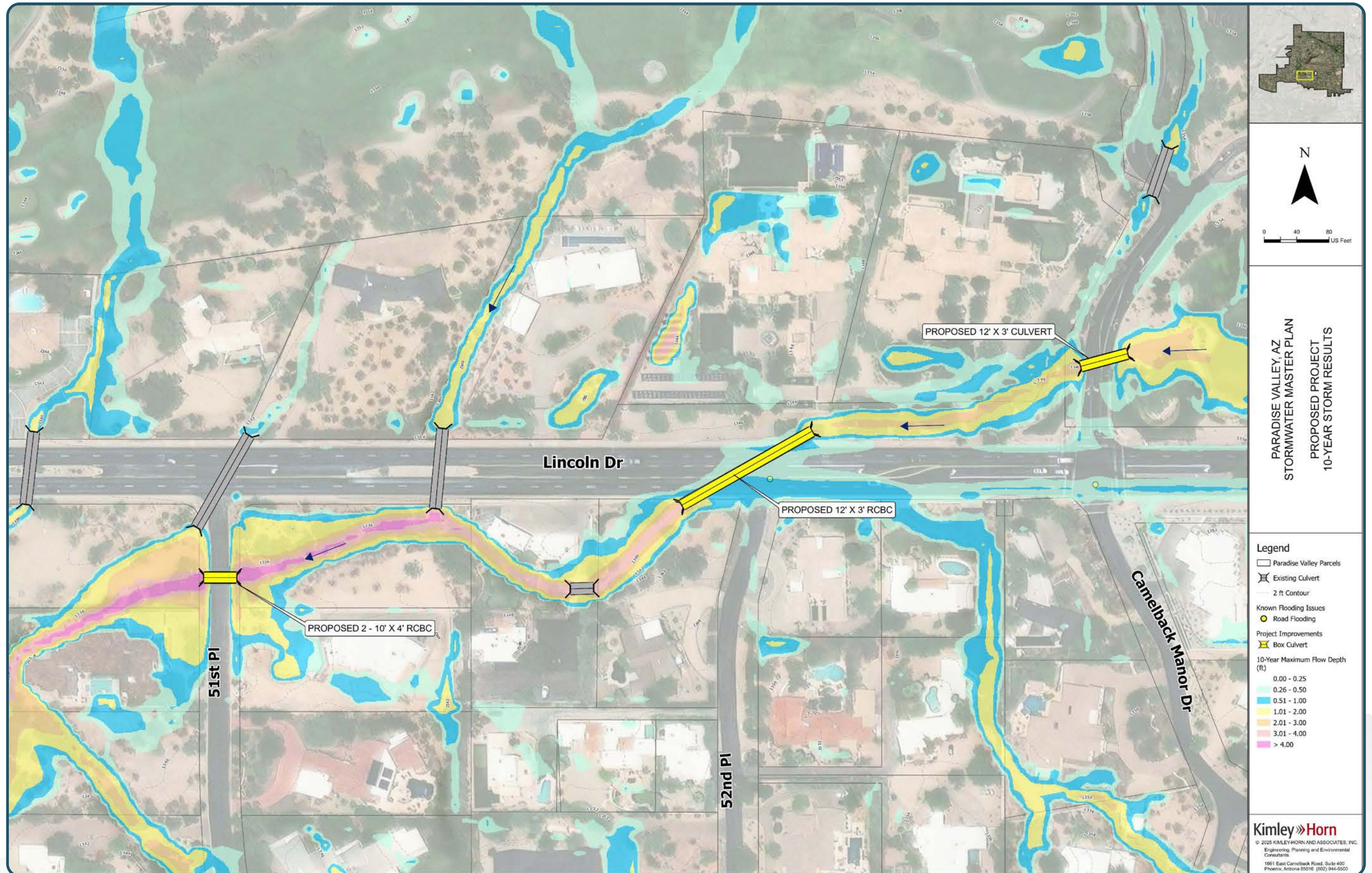


PARADISE VALLEY STORM WATER MASTER PLAN





PARADISE VALLEY STORM WATER MASTER PLAN





PARADISE VALLEY STORM WATER MASTER PLAN





IX. GRANT FUNDING OPPORTUNITY

The most accessible grant funding opportunities, both of which the Town has utilized in the past are the Flood Control District of Maricopa County's Small Project Assistance Program (SPAP) and Capital Improvement Project (CIP) cost shares. These programs have limits and are structures as follows:

SPAP

- 75/25 cost share between FCDMC and agency
- \$1M limit for design and construction (with some flexibility up to \$1.3M)
- Less than 24-month duration for design and construction
- Agency lead

CIP

- 65/35 cost share between FCDMC and agency
- Larger projects (>\$1.3M)
- Longer duration for design and construction (>24 months)
- Can be FCDMC lead

In addition to these County sponsored programs, grant funding opportunities are also available at the state and federal level. While programs are constantly evolving and changing, **Table 32** lists opportunities available as of the date of this report, with some of the parameters, due dates, funding levels etc. included.



Table 32: Summary of Grant Funding Opportunities

Grant Name	Agency	Funding Maximum	Required Match	Priorities	Types of Projects
Hazard Pre-Disaster Mitigation Grant Program	FEMA	Up to 10 M USD	75% grant, 25% match	Implementation of sustainable cost-effective measures designed to reduce the risk to individuals and property from future natural hazards.	Hazard mitigation projects and management costs
Hazard Mitigation Grant Program	FEMA	Varies	75% grant, 25% match	Development of hazard mitigation plans and rebuilding in a way that reduces, or mitigates, future disaster losses.	Flood mitigation planning and projects
Safeguarding Tomorrow Revolving Loan Fund Program	FEMA	25% of project total	n/a	Empowerment of entities. Innovative funding solutions.	Hazard mitigation from natural disasters
Flood Mitigation Assistance Program	FEMA	300,000 USD for individual projects and 900,000 USD for community projects	75% grant, 25% match	Reduce or mitigate the risk of repetitive flood damage to buildings ensured by the National Flood Insurance Program	Localized flood control, floodwater storage and diversion, stream restoration, stormwater management
Community Development Block Grant Program	U.S. Department of Housing and Urban Development	Up to 450,000 USD	No Match Required	Assisting under privileged communities	Acquisition, relocation/ demolition, rehabilitation of structures, construction of public facilities, renewable energy resources
Water Infrastructure Finance and Innovation Act Program	EPA	Varies	n/a	Supporting water infrastructure projects	Mitigate impacts of drought, manage stormwater, updating aging infrastructure, PFAS water mitigation



PARADISE VALLEY STORM WATER MASTER PLAN

Grant Name	Agency	Funding Maximum	Required Match	Priorities	Types of Projects
Corps Water Infrastructure Financing Program	U.S. Army Corps of Engineers	Provide loans of up 49%	n/a	Supporting water infrastructure projects	Dam safety projects
Public Works and Economic Adjustment Assistance Application Submission and Program	U.S. Economic Development Administration	49% of total project costs	49% grant, 51% match	promoting innovation and competitiveness, preparing American regions for economic growth and success in the worldwide economy	Water and sewer improvements
Sewer Overflow and Stormwater Reuse Municipal Grants program	EPA	344,000 USD	80% grant, 20% match	Facilitating the development of infrastructure capable of coping with the changing climate's impacts, such as precipitation events	Construction of critical stormwater infrastructure, combined sewer overflows, sanitary sewer overflows
Defense Community Infrastructure Program	Department of Defense	Between 250,000 and 20 Million USD	70% grant, 30% match	Addressing deficiencies in community infrastructure supportive of a military installation	Utility Infrastructure, transportation



X. PRIORITIZATION

Prioritization of projects can consider several factors. Project costs can determine which grant funding opportunities may be available. Benefit/cost ratios can determine eligibility for federal opportunities. Mitigation impacts can also influence Town priorities. Give these factors, **Table 33** lists each of the six projects where conceptual plans and cost were developed as part of this Master Plan, with prioritization considerations listed.

Table 33: Project Prioritization

Flood Hazard Area Designation	Project Size (Medium or Large)	Primary Benefit	Cost	BCR	Project Considerations
K	Large	Residential Structures	~ \$6.1 M	3.08	The recommended project alternative for Area K has the highest BCR for the projects that primarily benefit residential structures. It is also potentially more cost effective than the Area A project. Because of this, it is ranked as the highest priority large project benefiting private property.
A	Large	Residential Structures	~ \$11.6M	2.01	recommended project alternative ties into the ongoing Mockingbird Lane drainage improvements, creating an overall flood mitigation project for the area.
H	Medium	Arterial Roadways	~ \$1M	n/a	Area H recommended project alternative may fall within the SPAP cost criteria, making it eligible for a 75% cost share with FCDMC. Because of this, Area H was ranked as the highest priority roadway-oriented project.
O	Large	Arterial and Residential Roadways	~ \$2M	n/a	Area O recommended project alternative benefits both an arterial roadway (Lincoln Drive) and residential streets. Because of this, it was ranked higher than Areas L and N.
N	Large	Residential Roadways	~ \$2M	n/a	Area N was ranked higher than Area L because of the lower cost for construction.
L	Large	Residential Roadways	~ \$6.1M	n/a	Area L benefits residential streets only.



XI. CONCLUSION

The Paradise Valley Master Plan has identified and assessed areas vulnerable to flooding within the Town of Paradise Valley. By using records of flooding from residents and Town staff, previous studies, and comprehensive two-dimensional hydrologic and hydraulic modeling, this report provides detailed insights into flood risks and mitigation strategies for the entire 15-square-mile area.

Based on data collection and flood hazard analyses, the Master Plan identifies nineteen flood hazard areas, with nine prioritized for mitigation based on severity, impact on structures, streets, and emergency access. The nine were designated as the highest-ranking via a decision matrix ranking process. Recommended alternatives have been developed for each of these areas, ensuring efficient use of resources and strategic mitigation of flood hazards.

The six highest-ranking of the nine areas were designated as high-priority, with the recommended alternative for these areas further developed into 15% conceptual plans with an EOPC and cost/benefit analysis. The high-priority areas include Invergordon Road and Mockingbird Lane, 40th Street and Stanford Drive, Mountain View Road, upstream Cherokee Wash, downstream Cherokee Wash, and Lincoln Drive.

The benefit-cost analysis, prioritization, and thorough planning realized in this report offer Paradise Valley a robust framework for flood mitigation. Utilization of grant funding opportunities from local, state, and federal programs can significantly support the implementation of these projects.

In conclusion, this Master Plan sets the stage for Paradise Valley to strategically address flooding issues, assuring community resilience and safety through well-informed, high-priority flood mitigation projects. The Town's commitment to proactive flood hazard management will reduce risks, safeguard property, improve emergency access, and enhance the overall quality of life for its residents.



XII. REFERENCES

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