

FMP 033000007 - Spring Meadows Estates Detention Pond Design

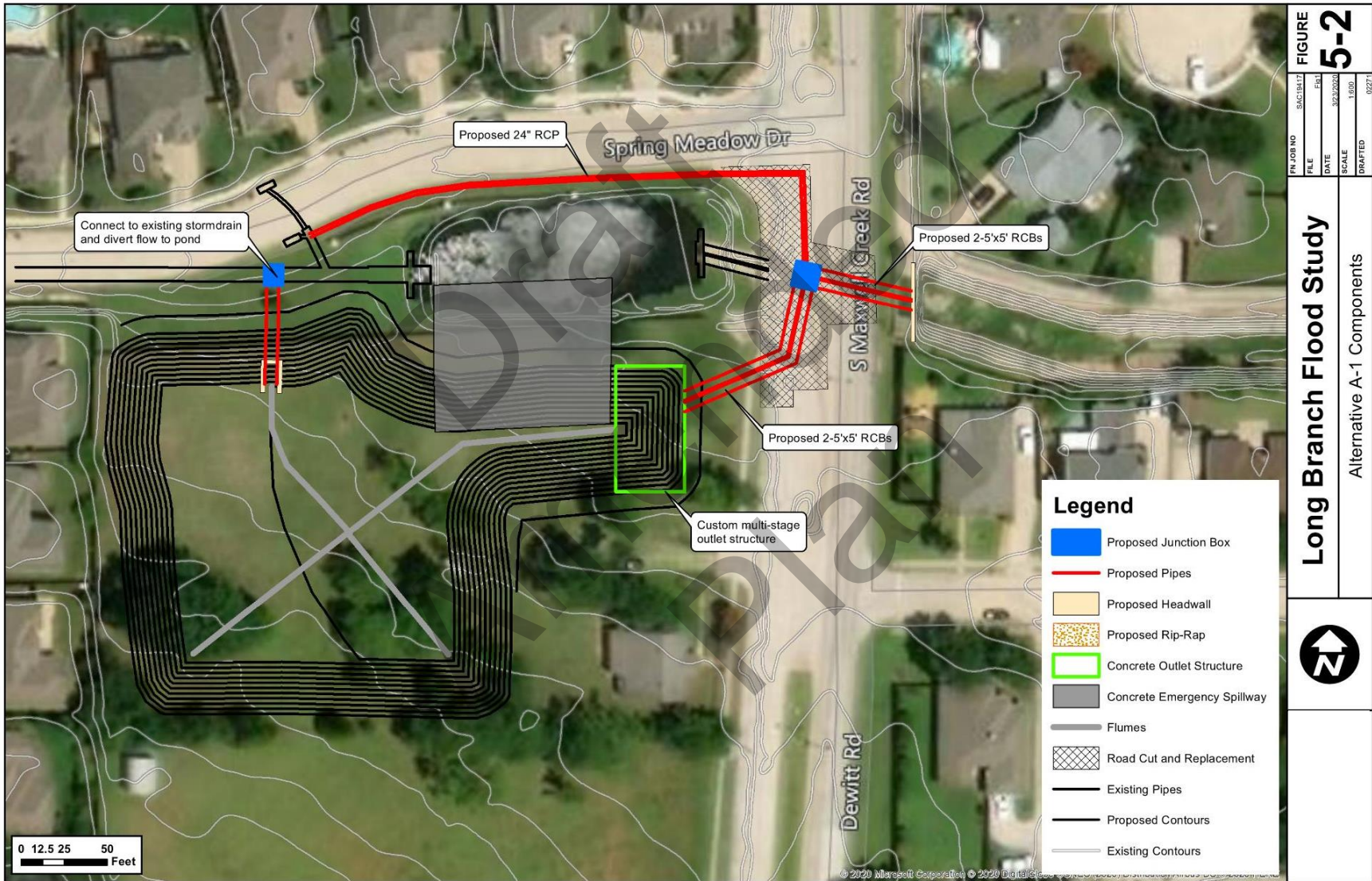
The Spring Meadows Estates Detention Pond Design project was generated from the Long Branch Flood Study¹. The proposed project aims to mitigate flooding along the intersection of Spring Meadow Dr and Dewitt Rd in the City of Sachse. This area experiences frequent flooding and creates a considerable safety concern. The primary source of flooding for this area is the overflow from the existing Spring Meadows Estates retention pond. This pond was originally designed as a dry detention pond, but it is currently functioning as a wet pond which effectively eliminates its ability to store floodwaters.

A HEC-RAS 2D model was created for this study to evaluate existing and proposed conditions. The main component of this project is the design and construction of an off-line dry detention pond next to the existing pond that will provide a 100-year LOS (see **Figure F.1**). A diversion structure would be required to redirect runoff from the existing storm drain system into the new pond. The new pond would be approximately 12 ft deep and would provide approximately 10 ac-ft of storage. Pond outlet works would be designed to control the 2-year and 100-year design storm events and would discharge to an existing concrete lined channel via 2-5'x5' RCBs. An additional 24-in RCP is required to reroute runoff from two inlets on Spring Meadows Dr and connect them to the proposed 2-5'x5' RCB's downstream. This project will require acquisition of a portion of the parcel south of the existing pond. The project cost is \$1,868,000.

Following the implementation of the proposed improvements, an estimated 0.34 miles of roadway and 9 residential structures would be completely removed from the 100-year floodplain. This correlates to an estimated 18 individuals removed from the 100-year flood risk. Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements (see Error! Reference source not found.).

¹ Long Branch Flood Study, Freese and Nichols, 2020

Figure F.1. Spring Meadows Estates Detention Pond Design - Project Components (FMP 033000007)



FMP 033000008 - West Irving Creek Phases 2, 3, and 4

The West Irving Creek FMP was generated from the Flood Infrastructure Fund application #13792. The City of Irving experiences significant flooding within the West Irving Creek watershed. This project identifies several elements to alleviate the flooding in the area.

A HEC-RAS 1D/2D model was created to analyze existing flooding conditions, develop flood mitigation alternatives, and evaluate the impacts of the proposed improvements. The West Irving Creek channel improvements project consists of reconstruction of over 2.5 miles of shallow trapezoidal concrete channel as deeper vertical walled channel to increase capacity and relieve historical flooding issues (see Figure F.2). The vertical walled channels allow the project to remain within a similar footprint as the existing channel to minimize easement needs and impacts to private properties while meeting the flood carrying capacity goals of the project. The channel improvements will also require the reconstruction of 15 road crossings and several miles of wastewater main. In conjunction with the channel improvements, upstream detention improvements will be made as well as the implementation of water quality ponds to reduce pollutant load in the channel and to provide amenity to the adjoining neighborhoods. These improvements will mitigate flood events associated with the 1% annual chance flood (100-year LOS).

The estimated flood risk reduction benefits following the implementation of West Irving Creek FMP include the removal of an estimated 5 miles of roadway and 252 structures from the 100-year floodplain, 230 of which are residential structures. This correlates to an estimated 1,151 individuals removed from the 100-year flood risk. Additionally, 6 structures would have reduced area within the 100-year floodplain but would not be fully removed from flood risk following these improvements. One critical facility and 1 low water crossing would also be removed from the 100-year floodplain.

Based on the comparative assessment performed for this FMP, the proposed project does not meet all no negative impacts requirements as established in the *TWDB Technical Guidance (Exhibit C Section 3.6.A)*. However, the Trinity RFPG considers that the West Irving Creek FMP conforms to the no negative impacts requirements based on professional engineering judgment (see Error! Reference source not found.).

Increases in peak discharge are expected at the downstream areas of the improved channel due to the significant increase in channel capacity. However, these increases are fully contained within the proposed channel and do not cause any adverse impact to adjacent properties. There is one area within the project's zone of influence that would experience an increase of approximately 1 foot in water surface elevation, but this is a public park area with no insurable structures (see **Figure F.2** and **Figure F.3**). Based on these factors, the RFPG considers that the West Irving Creek FMP conforms to the no negative impacts requirements.

The park areas within the project limits include Shady Grove Trail Park, Markwood Park, and Wyche Park, as well the Dallas College Irving Center, a college campus with a large open space along the channel alignment. Under Existing Conditions, the flooding seen between Tipton Road and Rogers Road is controlled by backwater from Markwood Park and the Dallas College Irving Center campus. While the proposed channel was designed to have 100-year capacity, this area will continue to flood unless the backwater is mitigated. In addition to the backwater, thirteen structures near the Markwood Park and Dallas College Irving Center are within the existing 100-year floodplain limits.

The West Irving Creek Drainage Improvements Comprehensive Planning Study (FNI, 2022) describes the alternatives that were considered for this public park area as part of the project design (Section 3.3.1). Multiple grading alternatives were presented to the City Parks Department, and after discussion it was decided that some alternatives would not be feasible for construction while others would be investigated further during the design phase of the project.

The first alternative involved grading out a bench above the Ordinary High Water Mark (OHWM). This option resulted in the greatest WSE decreases, but grading would result in the removal of Markwood Park and it would no longer be usable as a park area. The second alternative involved deepening the channel. This option would cause moderate impact to Markwood Park, but it would conflict with existing sewer lines in the park and require more extensive environmental permitting as grading would occur below the OHWM. Both alternatives were discarded by the City since they would cause negative impacts on Markwood Park.

Three additional alternatives were investigated in order to find solutions that would not have negative impacts on the park areas. These alternatives investigated options for grading out a bench in the Dallas College Irving Center Campus above the OHWM. These would provide greater capacity and storage and would also allow the majority of the existing open space in the Dallas College Irving Center campus to remain in use. In Markwood Park, various levels of grading and modifications were considered. Through evaluation of these alternatives, it was determined that grading in the Dallas College Irving Center campus provides significant benefits and is necessary in order for any changes within Markwood Park to be beneficial. Coordination and communication with Dallas College Irving Center on the proposed grading along the natural channel will be required in order to address concerns and ensure agreement on the proposed improvements.

After discussion with the City, it was decided that a decision regarding the potential alternatives for improvements in Markwood Park would be made at a later point in the design. The improvements in the Dallas College Irving Center campus will remove six structures from the 100-year floodplain, and the finalized Markwood Park improvements will not impact the design of the upstream channel. Further evaluation of the Markwood Park alternatives will be performed and discussed with the City and the US Army Corps of Engineers (USACE), and the final alternative will be selected as part of the detailed design phase of the project. The project cost is \$80,066,000.

Figure F.2. West Irving Creek Phases 2, 3, and 4 - Project Components (FMP 033000008)

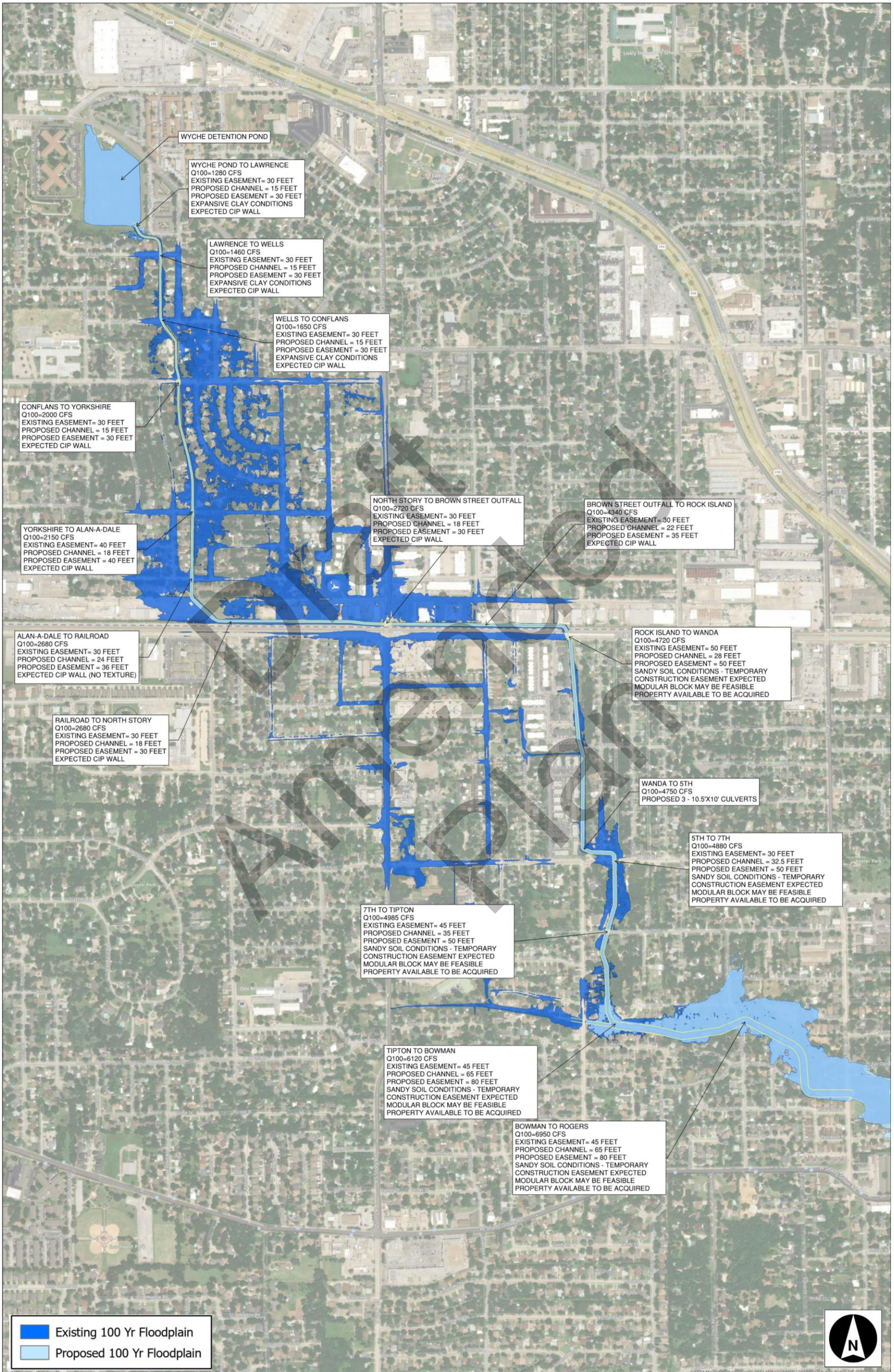


Figure F.3. Existing and Post-Project Floodplain in affected Parks Areas (FMP 033000008)



FMP 033000016 - Arlington VC(A)-1

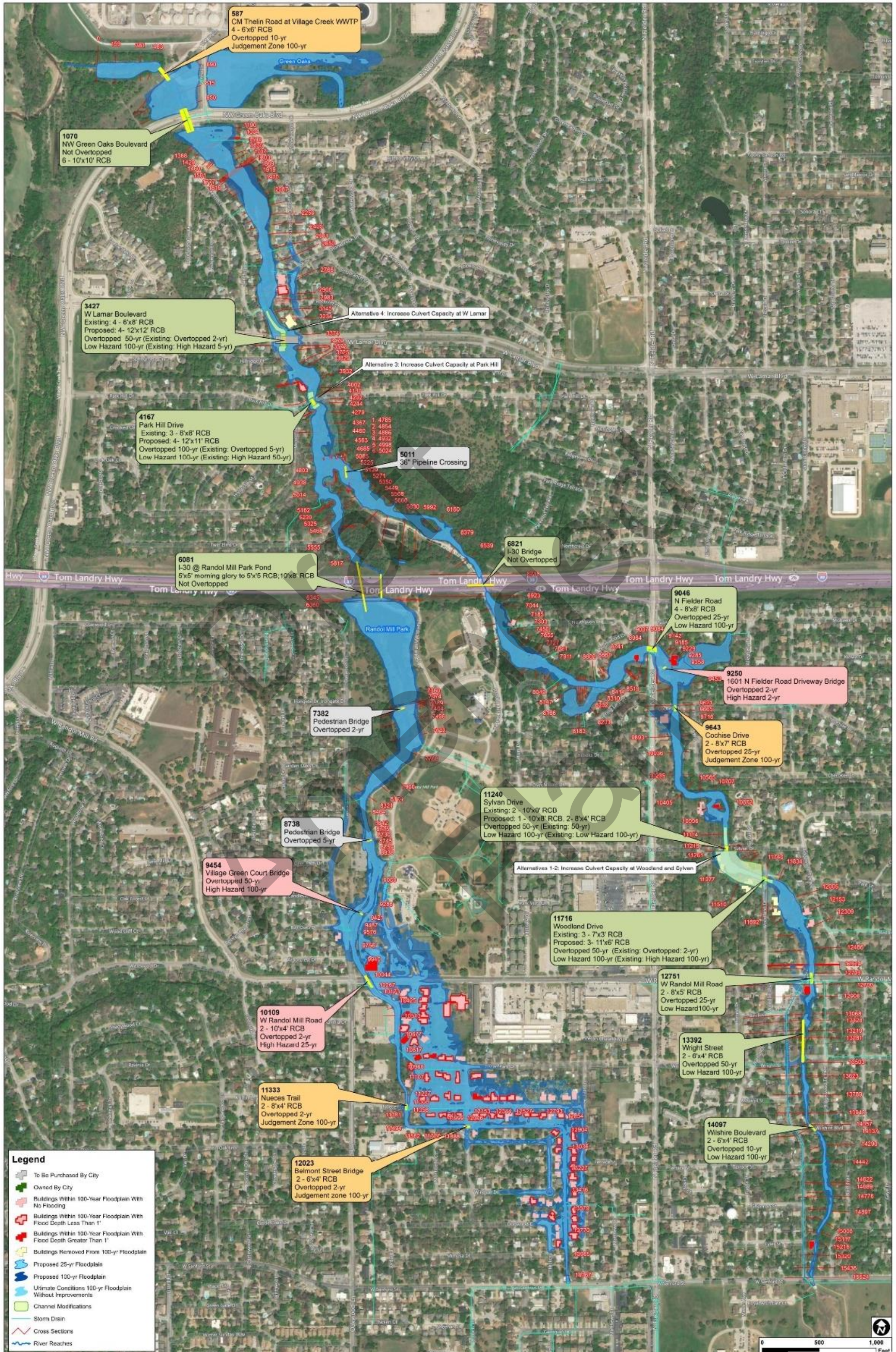
The Arlington VC(A)-1 FMP, developed from the unfunded Flood Infrastructure Fund application #13646, proposes options for drainage and erosion improvements. The proposed project includes improvements to four low-capacity crossings at Woodland Drive, Sylvan Drive, Park Hill Drive, and West Lamar Boulevard (see **Figure F.4**). HEC-HMS and HEC-RAS models were created to analyze the impact that the proposed improvements would have based on ultimate land use conditions. A stream assessment was also performed and identified erosion risk alternatives to improve the stability of the stream bed and banks.

The proposed project will provide a minimum of a 25-year LOS (4% annual chance flood event). The LOS for the four crossings mentioned above range from 25-year to 100-year. However, flood risk reduction benefits are expected for all crossings up to the 100-year event. The project cost is \$2,601,000.

Following the implementation of these drainage and erosion improvements, an estimated 0.16 mile of roadway and 9 structures would be removed from the 100-year floodplain, 3 of which are residential structures. This correlates to an estimated 24 individuals removed from the 100-year flood risk. Additionally, 29 structures would have reduced area within the 100-year floodplain but would not be fully removed from flood risk following these improvements.

Based on the comparative assessment performed for this FMP, the proposed project does not meet all no negative impacts requirements as established in the *TWDB Technical Guidance (Exhibit C Section 3.6.A)*. However, the Trinity RFPG considers that the Arlington VC(A)-1 FMP conforms to the no negative impacts requirements based on professional engineering judgment (see Error! Reference source not found.). Model results show a 0.31 ft rise at the Sylvan Dr crossing, but this minor rise is fully contained within the roadway right-of-way and does not impact insurable structures such as residential and commercial buildings

Figure F.4. Arlington VC(A)-1 – Project Components (FMP 033000016)



Stream VC(A)-1 Watershed Study Alternatives Workmap

FMP 033000030 - Linwood-Lancaster/Foch

The Linwood-Lancaster/Foch FMP is sponsored by the City of Fort Worth. Alternatives were evaluated to provide storm drain relief along Norwood Street between West 7th Street and Lancaster Avenue, at the Lancaster Avenue/Bledsoe Street intersection, and the Lancaster Avenue/Currie Street intersection. This is primarily a commercial area in downtown Fort Worth.

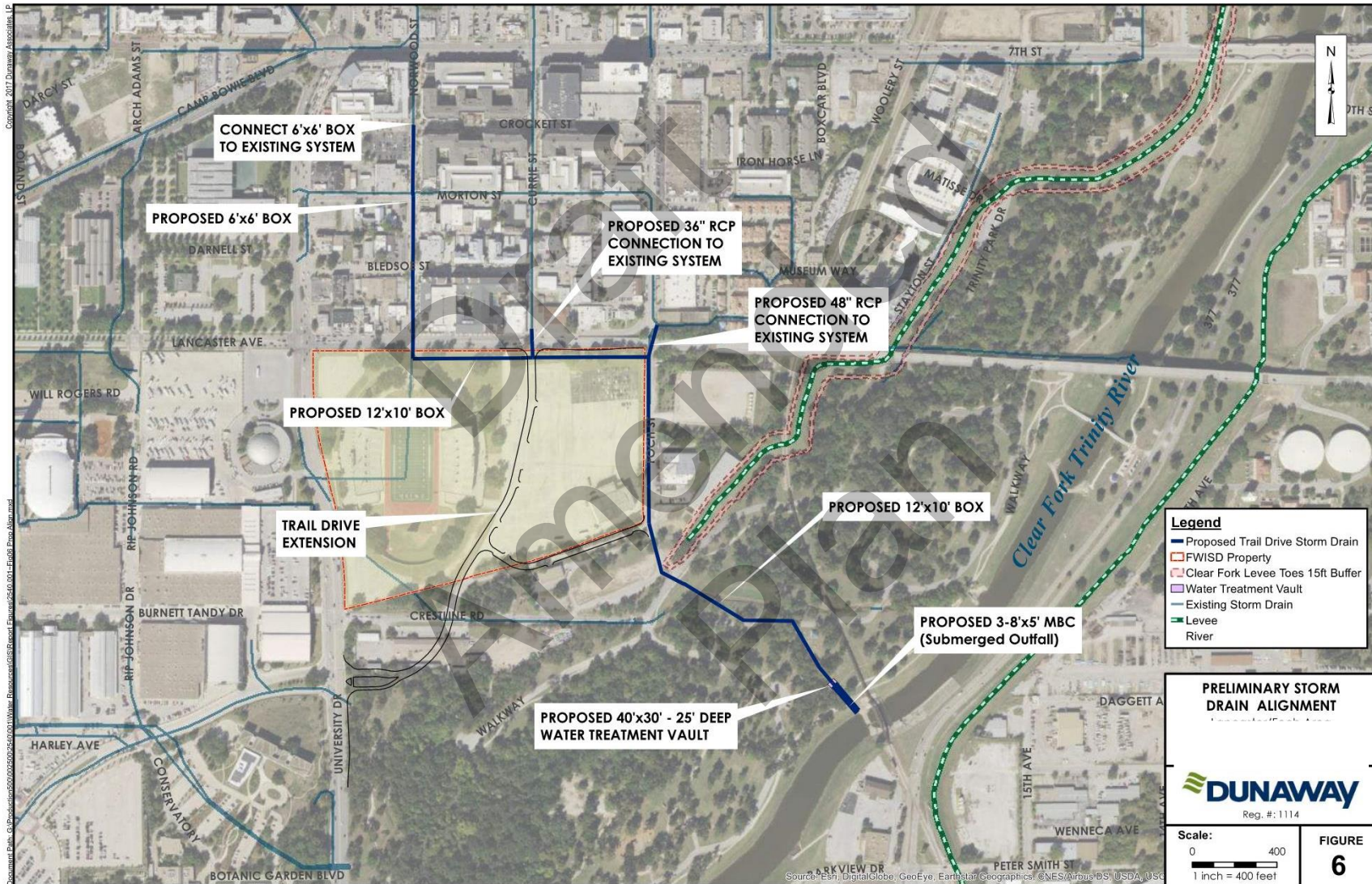
A 2D ICM model was developed to analyze the storm drain trunk lines and identify the deficiencies in the system. The proposed project includes a 6'x6' box section along Norwood Street north of Lancaster Avenue and a 12'x10' box section along the remainder of the relief system length to convey the 100-year discharge (see **Figure F.5**). The project cost is \$26,528,000.

Following the implementation of these mitigation measures, an estimated 0.49 mile of roadway and 10 structures (commercial and public properties) would be removed from the 100-year floodplain. This correlates to an estimated 3,272 individuals removed from the 100-year flood risk. Additionally, 23 structures would have reduced area within the 100-year floodplain but would not be fully removed from flood risk following these improvements.

Based on the comparative assessment performed for this FMP, the proposed project does not meet all no negative impacts requirements as established in the *TWDB Technical Guidance (Exhibit C Section 3.6.A)*. However, the Trinity RFPG considers that the Lancaster/Foch Area Mitigation FMP conforms to the no negative impacts requirements based on professional engineering judgment (see Error! Reference source not found.).

The proposed project would connect to the existing storm drain system and reduce the overall flow across the project study area. However, this improvement results in an increase (approx. 620 cfs) in peak discharge at the outfall into the Clear Fork Trinity River. The Lancaster/Foch FMP area of interest is less than 0.25 square miles, but the contributing drainage area is close to 3 square miles, which is a small fraction of the overall 90 square mile watershed of the Clear Fork Trinity River. With such a large difference between contributing areas, it is unlikely that there will be peak-on-peak conditions for the flood hydrographs of the Clear Fork Trinity River and the proposed storm drain system (see page 6 of the *SWS 081 - Task Order 1 Lancaster/Foch Area Flood Mitigation* report). Therefore, it is anticipated that this increase in peak discharge would not have a significant impact on the peak water surface elevations for the Clear Fork Trinity River. A timing analysis (i.e. hydrologic analysis) may be required to ultimately determine if there is an increase to the 100-year peak discharge and water surface elevations at the Clear Fork Trinity River.

Figure F.5. Linwood-Lancaster/Foch - Project Components (FMP 033000030)



FMP 033000031 - Linwood-University Drive

The City of Fort Worth completed a flood mitigation study for the Linwood Park area in 2017². This study identified approximately 2,000 cfs of stormwater generated by the area west of University Drive. Therefore, storm drain improvements west of University Drive are necessary to reduce the amount of runoff that reaches the Linwood Park area. Alternatives were identified to reduce the potential for inundation during the 100-year storm event.

An ICM model was created to evaluate the existing storm drain network and potential mitigation alternatives for multiple storm events. One branch of the proposed storm drain system would begin at Belle Place and run along West 7th Street, following three residential streets before turning east on Bristol Road and intersecting the line on University Drive. The storm drain would then run along University Drive to the West Fork Trinity River. A second feeder system would extend east from University Drive along Bristol Road, then turn south on Templeton Drive and extend south along Norwood Street to just north of West 7th Street (see **Figure F.6**). The project cost is \$73,277,000.

Following the implementation of these improvements, an estimated 3.32 miles of roadway and 204 structures would be removed from the 100-year floodplain, 123 of which are residential structures. Additionally, 239 structures would have reduced area within the 100-year floodplain but would not be fully removed from flood risk following these improvements. This correlates to an estimated 6,882 individuals removed from the 100-year flood risk.

Based on the comparative assessment performed for this FMP, the proposed project does not meet all no negative impacts requirements as established in the *TWDB Technical Guidance (Exhibit C Section 3.6.A)*. However, the Trinity RFPG considers that the Linwood Park Flood Mitigation FMP conforms to the no negative impacts requirements based on professional engineering judgment (see Error! Reference source not found.).

The proposed project would intercept the existing storm drain system and reduce flow across University Drive from 2,000 cfs to 200 cfs (90% reduction). However, this improvement results in a significant increase (approx. 1,853 cfs) in peak discharge at the outfall to the West Fork of the Trinity River. This increase is due to the timing in which flow arrives to the outfall location. The stormwater volume discharging to the West Fork of the Trinity remains the same. The observed increase in peak discharge will not necessarily coincide with the 100-year peak flow at the West Fork of the Trinity at this outfall. A timing analysis (i.e. hydrologic analysis) may be required to ultimately determine if there is an increase to the 100-year peak discharge and water surface elevations at the West Fork.

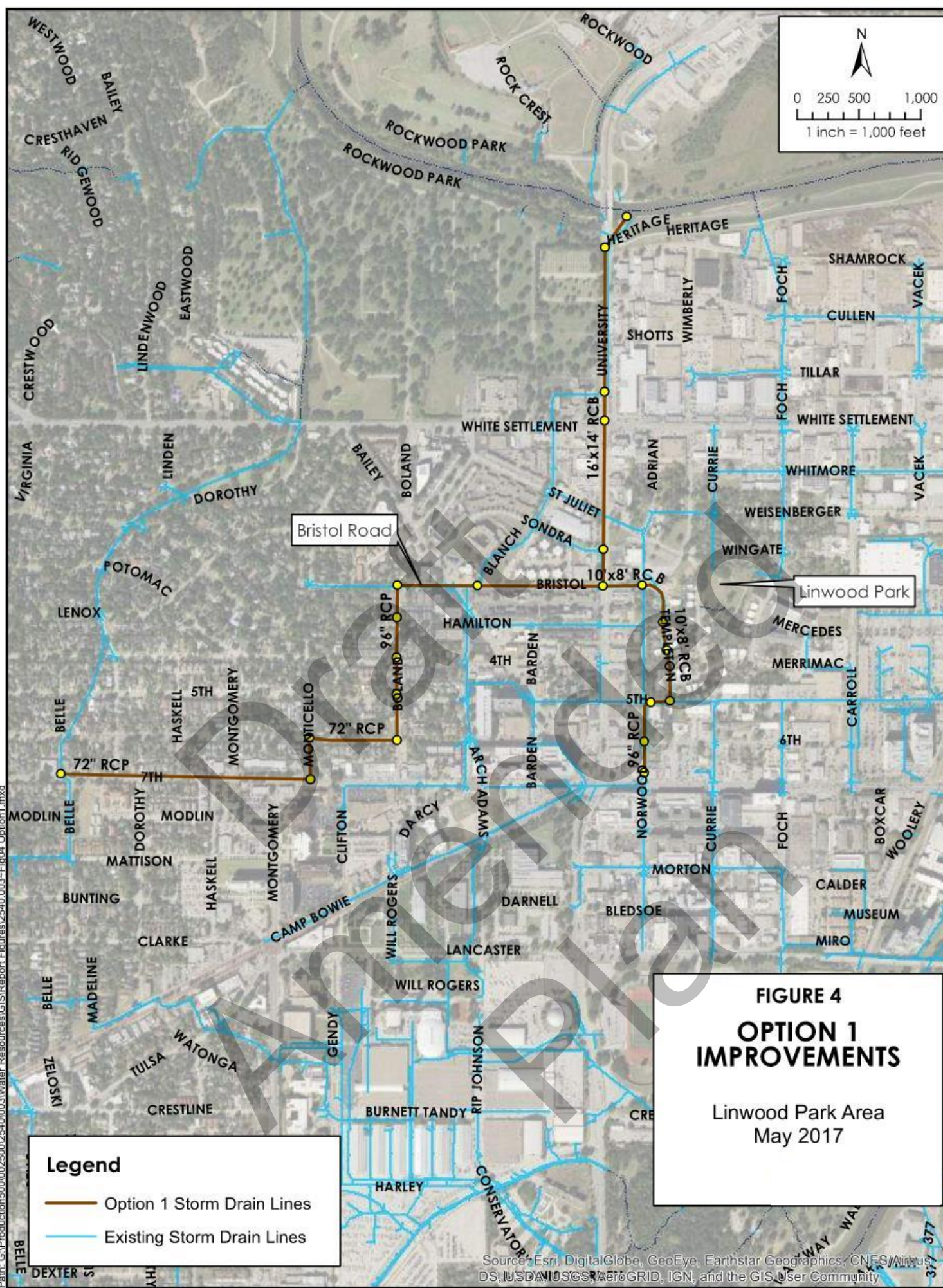
To that effect, the Linwood Park Flood Mitigation report indicates that although the new relief storm drain would replace the existing, smaller storm drain at the outfall point, there will likely need to be coordination with the US Army Corps of Engineers (USACE) regarding discharge into the West Fork as the river is controlled by the levee system (potential Section 408 permitting). The discharge will also

² SWS 081 - Task Order 3 Linwood Park Flood Mitigation, Dunaway, August 2017.

need to be coordinated with the Tarrant Regional Water District (TRWD) (page 5 of Linwood Area Final Report Compiled 2017-0808).

Draft
Amended
Plan

Figure F.6. Linwood-University Drive - Project Components (FMP 033000031)



FMP 033000032 - Zoo Creek Storm Drain Flood Mitigation (Sandage)

The City of Fort Worth performed a study to map flood risk and evaluate flood mitigation for the Zoo Creek watershed in the city. Zoo Creek has a drainage area of 1.27 square miles. This area of the city was developed over 50 years ago, prior to the current drainage standards. Undersized storm drainage infrastructure and a lack of overflow conveyance have contributed to a history of street and structure flooding. This flooding has damaged properties, hindered mobility, and complicated future development planning.

The Zoo Creek Storm Drain Flood Mitigation Study³ entails the development of a detailed InfoWorks ICM (v.8) Model was developed to assess the performance of the existing storm drain system and assist in identifying features to reduce flood risk and frequent flooding in the area. The Conveyance – Sandage Relief Line – Overall is the recommended alternative.

“The majority of the relief line is proposed within the Sandage Ave. and Devitt St. right of way which varies in width from 50 to 60 feet. The 10’x10’ RCB relief line begins at Forest Park, just south of Robert St., near the McPherson outfall. The park outfall will be protected from erosion by a 90’x120’ riprap basin. The 10’x10’ RCB will follow Sandage Ave. south to the existing 72-inch storm drain crossing at Sandage Ave. approximately 300 feet south of Berry St. At this point, the relief line will transition to an 8’x8’ RCB. The 8’x8’ RCB will follow Sandage Ave. to Devitt St. where it will continue east to Cleburne Rd. At Cleburne Rd. the relief line will connect to the existing 48-inch storm drain.”

This alternative will be broken into two phases. Phase 1 encompasses the storm drain upsizing to a 10’x10’ RCB from Forest Park to Berry Street. Phase 2 constructs the remainder of the recommended improvements including extending the relief line to Cleburn Road. (See **Figure F.7.**)

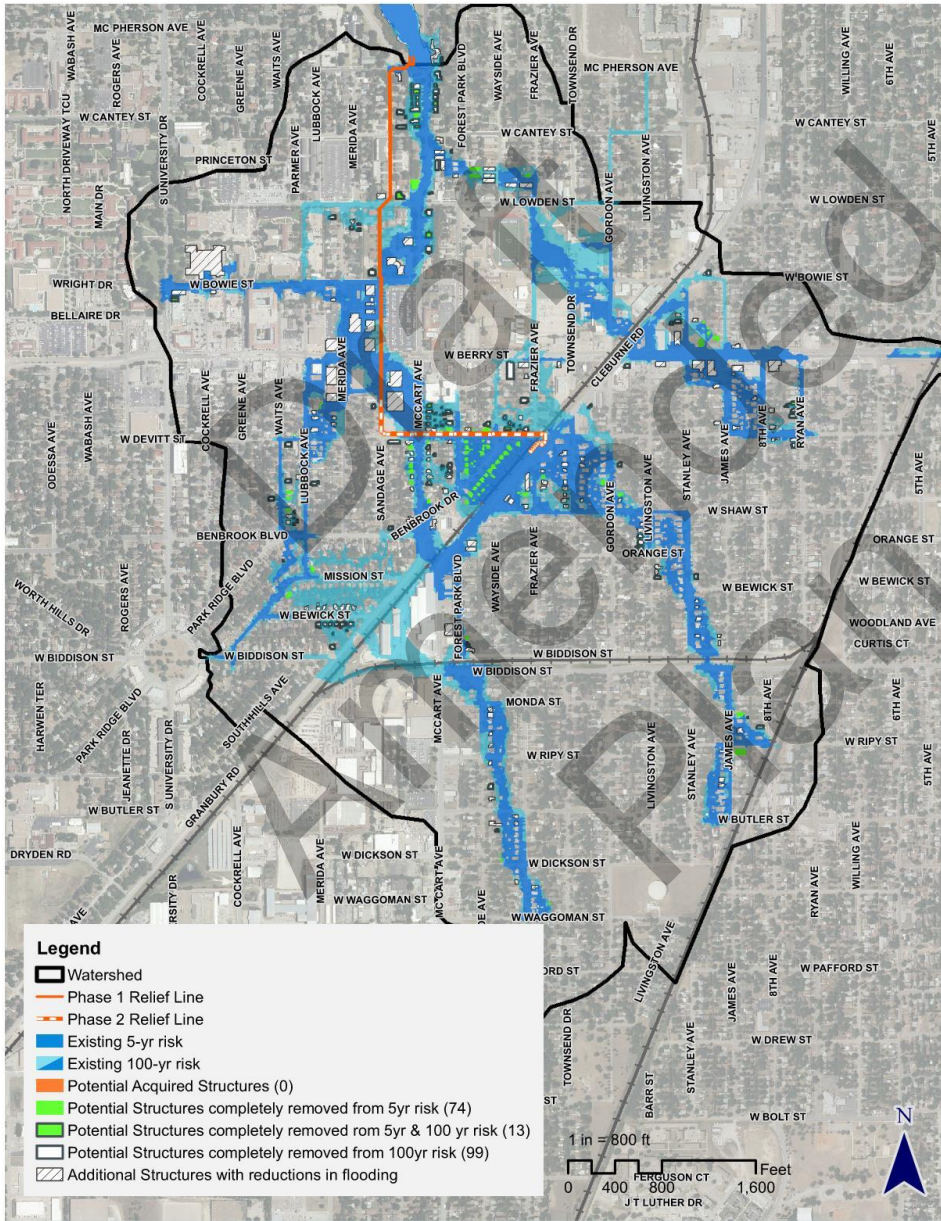
The proposed project will provide a minimum of a 100-year LOS (1% annual chance flood event). The implementation of these drainage improvements will remove an estimated 17 miles of roadway and 153 structures from the 100-year floodplain, 148 of which are residential structures. This correlates to approximately 391 individuals removed from the 100-year flood risk. Additionally, 421 structures would have reduced area within the 100-year floodplain but would not be fully removed from flood risk following these improvements. The estimated project cost is \$23,751,000.

Based on the comparative assessment performed for this FMP, the proposed project does not meet all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A). However, there are negative impact mitigation measures implemented in the design (see **Table F.1.**)

³ Zoo Creek Storm Drain Flood Mitigation Study, Halff Associates, November 2018

Figure F.7. Zoo Creek Storm Drain Flood Mitigation (Sandage) (FMP 033000032)

Project Details	Reduction in Road Hazard	Reduction in Risk of Structures	Cost / Phasing	Support / Opposition
- 3400 LF 10'x10' RCB across Berry St -1680 LF 8'x8' RCB to Cleburne Rd - Additional 120 LF inlets	Berry at Sandage - 2.80 ft reduction (5YR) - 3.58 ft reduction (100YR)	-90 Parcels with reductions in structural flooding	- \$23M - 2 Phase opportunity \$18.5M/\$4.6M	- Existing partnership with Parks Dept. for outfall in Forest Park - Potential Opportunity to work with TCU Master Plan



CONVEYANCE - SANDAGE RELIEF LINE - OVERALL

ZOO CREEK STORM DRAIN WATERSHED | FORT WORTH, TEXAS

SMS-054 AS.3.1

FMP 033000033 - Sunnyvale Urban Flooding Reduction Improvements – Area 1

The City of Sunnyvale completed a stormwater masterplan for the Long Creek watershed in 2018⁴. This study identified alternatives for local area improvements to reduce the potential for inundation during the ultimate conditions 100-year storm event. This FMP pertains to Area 1, which includes the Sunnyvale Middle and High School, portions of the Deer Creek neighborhood, and the ditch and culvert system along Tripp Road from Collins Street to East Fork Road. The ditch and culvert system along Tripp Road is undersized for the 100-year event, causing potential flooding to the road and neighboring structures. Causes for flooding along Tripp Road include not only the size of the culverts and ditches, but also the grades. Some of the systems have negative slopes or are filled with sediment. Portions of Tripp Road experience significant flooding, with upwards of 3 feet of inundation at the cross culvert from the Deer Creek detention pond.

An ICM model was created to model the performance of existing stormwater infrastructure, identify areas of inundation, and develop alternatives to mitigate flooding risks. The proposed improvements for Area 1 include an alternative ditch and culvert system for Tripp Road, which was sized to contain the 100-year ultimate flows within the right-of-way and under the driveways. Proposed improvements also include increasing existing ditch, culvert, and pipe sizes, adjusting inlet sizes and parameters for inlets receiving runoff from the school, and adjusting flowlines to establish a positive slope for the system. Channel geometry was selected to fit within the estimated right-of-way. Where capacity issues necessitated culvert sizes larger than 24-in, a multiple-barrel culvert or wider box culvert was proposed to avoid constructability issues related to the residential driveways (see **Figure F.8**). The project cost is \$4,560,000.

Following the implementation of these local area improvements, an estimated 0.32 mile of roadway and 14 structures would be removed from the 100-year floodplain, 9 of which are residential structures. This correlates to an estimated 56 individuals removed from the 100-year flood risk.

Based on the comparative assessment performed for this FMP, the proposed project does not meet all no negative impacts requirements as established in the *TWDB Technical Guidance (Exhibit C Section 3.6.A)*. However, the Trinity RFPG considers that the Sunnyvale Urban Flooding Reduction Improvements – Area 1 FMP conforms to the no negative impacts requirements based on professional engineering judgment (see Error! Reference source not found.).

Although there are noticeable increases in peak flow at the downstream outfall of the project, the increases to the 100-year inundation boundary are minimal and do not affect any structures downstream. In most areas, the inundation has been reduced due to proposed drainage infrastructure and building inundation has been greatly reduced. Sheet flow that used to leave Tribb Road and flow south, has been concentrated to flow in the proposed channels.

⁴ *Town of Sunnyvale Stormwater Masterplan*, Freese and Nichols, Inc., November 2018.

Figure F.8. Urban Flooding Reduction Improvements – Area 1 – Project Components (FMP 033000033)

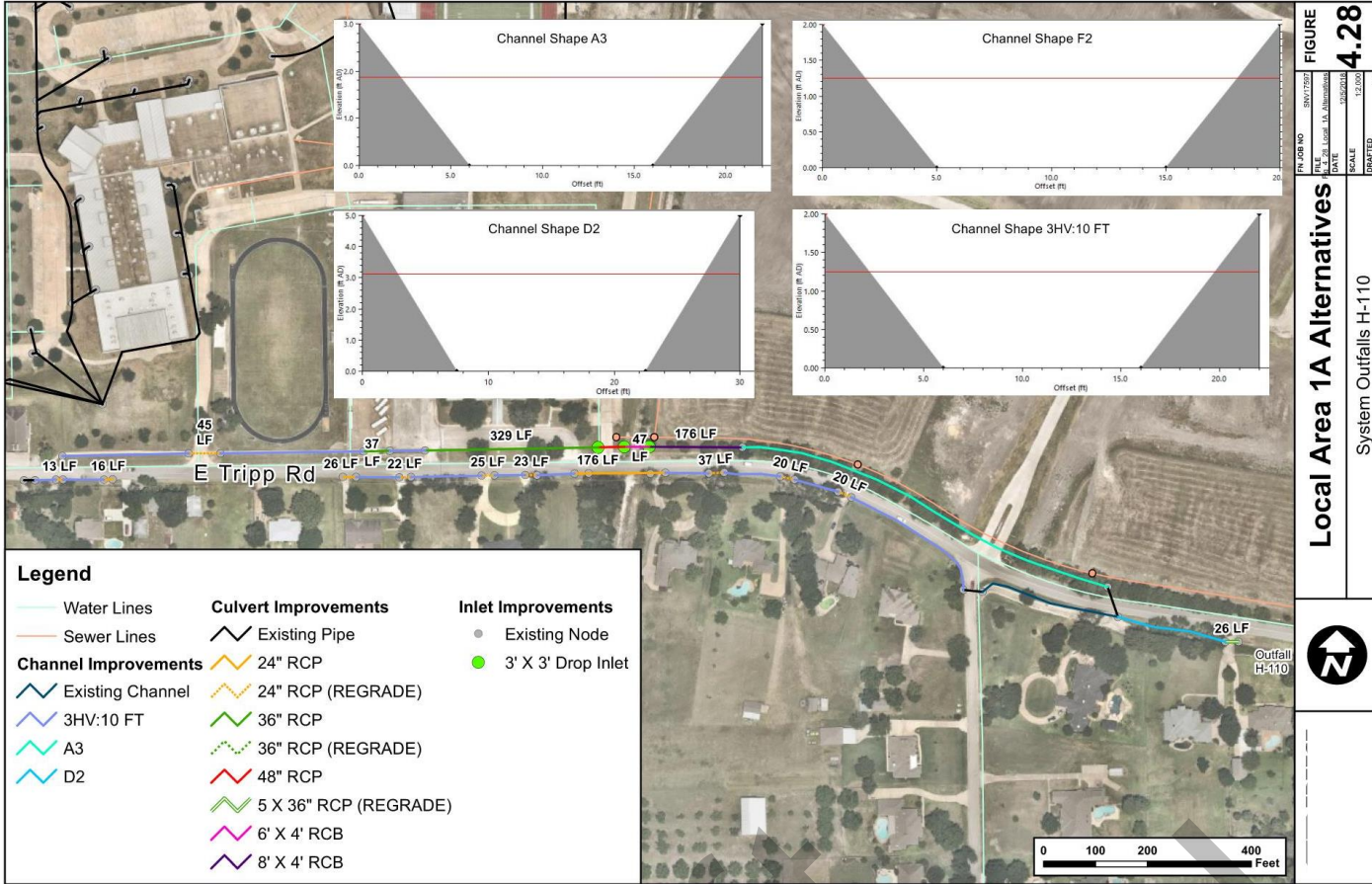


FIGURE 4.28

Local Area 1A Alternatives

System Outfalls H-110

Scale: 1" = 100'

North Arrow



FIGURE 4.29

Local Area 1B Alternatives

System Outfalls H-052 & H-004

Scale: 1" = 100'

North Arrow



FIGURE 4.30

Local Area 1C Alternatives

System Outfalls H-119 and H-130

Scale: 1" = 100'

North Arrow

FMP 033000036 - Sunnyvale Urban Flooding Reduction Improvements – Area 2

The City of Sunnyvale completed a stormwater masterplan for the Long Creek watershed in 2018⁵. This study identified alternatives for local area improvements to reduce the potential for inundation during the ultimate conditions 100-year storm event. This FMP pertains to Area 2, which includes storm drainage infrastructure along Tripp Road and Jobson Road adjacent to and including Sunnyvale Estates neighborhood. The ditch and culvert system along Tripp Road is undersized for the 100-year event, causing structure inundation and road overtopping. Causes for flooding along Tripp Road include not only the size of the culverts and ditches, but also the grades. Some of the systems have negative slopes or have very flat slopes which greatly reduce the channel capacity.

An ICM model was created to model the performance of existing stormwater infrastructure, identify areas of inundation, and develop alternatives to mitigate flooding risks. Proposed improvements include increasing existing ditch, culvert, and pipe sizes, and adjusting flowlines to establish a positive slope for the system. Channel geometry was selected to fit within the estimated right-of-way. An additional parallel 60" RCP and an additional 42" RCP are proposed for the two existing culvert crossings at Jobson Road to reduce inundation depths at Jobson Road (see **Figure F.9**). The project cost is \$5,701,000.

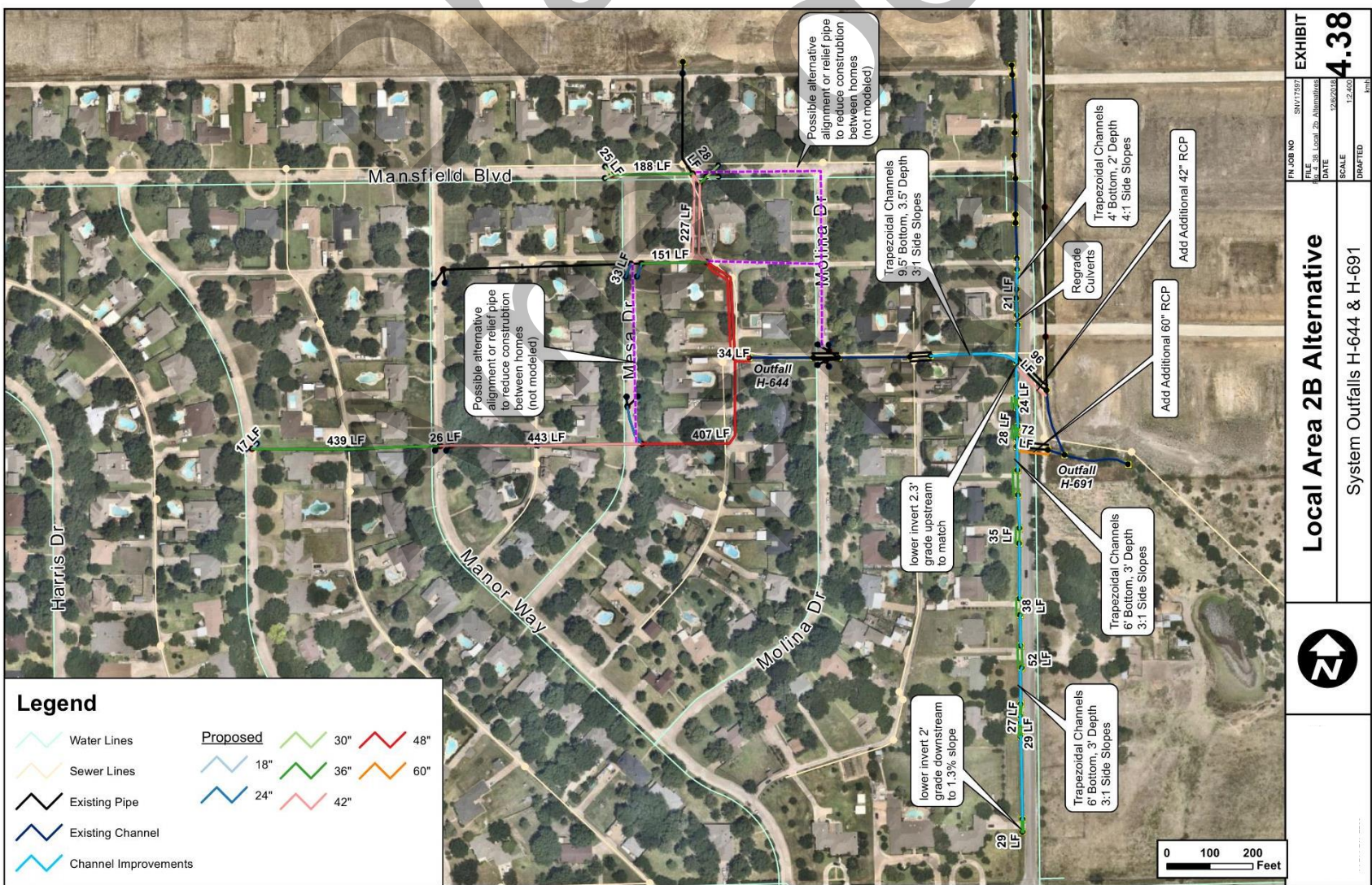
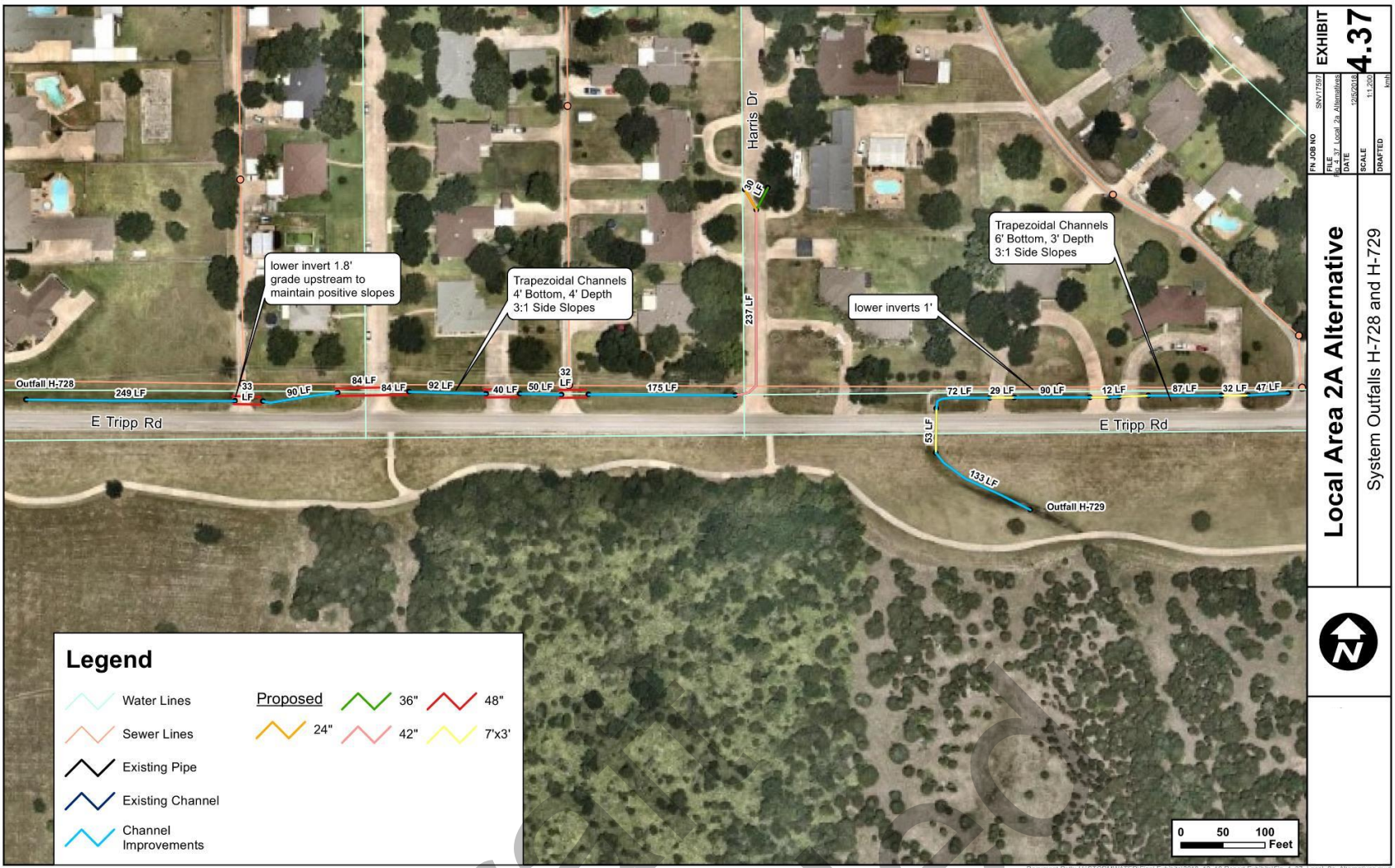
Following the implementation of these local area improvements, an estimated 0.8 mile of roadway and 32 structures would be removed from the 100-year floodplain, all of which are residential structures. This correlates to an estimated 113 individuals removed from the 100-year flood risk.

Based on the comparative assessment performed for this FMP, the proposed project does not meet all no negative impacts requirements as established in the *TWDB Technical Guidance (Exhibit C Section 3.6.A)*. However, the Trinity RFPG considers that the Sunnyvale Urban Flooding Reduction Improvements – Area 2 FMP conforms to the no negative impacts requirements based on professional engineering judgment (see Error! Reference source not found.).

Although there are noticeable increases in peak flow at the downstream outfall of the project, the increases to the 100-year inundation boundary are minimal and do not affect any structures downstream. In most areas, the inundation has been reduced due to proposed drainage infrastructure and building inundation has been greatly reduced. Flow is now concentrated to the east of Jobson Road and to the south of Tribb Road where there are no affected structures.

⁵ *Town of Sunnyvale Stormwater Masterplan*, Freese and Nichols, Inc., November 2018.

Figure F.9. Urban Flooding Reduction Improvements – Area 2 – Project Components (FMP 033000036)



FMP 033000037 - Project 1 - Point North Parkway System

The Point North Parkway System 1 FMP, from the Prairie Creek Watershed Study Capital Improvement Plan⁶, is located near the intersection of Synergy Park Boulevard. Roadway flooding reaches depths of 1.7 feet during the 100-year storm event in this area due to undersized storm sewer, high HGL in the downstream channel (backwater), and significant sedimentation in the culverts that extend under Synergy Park Boulevard, likely caused by low velocities through the channel. The result is a 10-year LOS (10% annual chance flood event).

Project 1 proposes a 100-year LOS (1% annual chance flood event) solution with approximately 450 feet of channel improvements to lower the HGL along with a storm sewer main crossing Point North Parkway and additional inlet capacity. Existing storm sewer will remain except for the inlet laterals which will be abandoned and/or diverted to the proposed storm sewer main. The proposed improvements will minimize sedimentation at the Synergy Park Boulevard culverts and will reduce the flood depths at Point North Parkway. Improvements of the storm sewer were evaluated in an XPSWMM model whereas proposed channel capacity was evaluated outside XPSWMM, using the total flow calculated from the model.

As part of the channelization of this alternative, 1,900 cubic yards downstream of Synergy Park Boulevard will be excavated. Improvements also include an additional 50 LF of 4-ft by 4-ft RCBC and 110 LF of 5-ft by 5-ft RCBC with wingwalls at the outfall into the channel. An additional 100 LF of curb inlets is also recommended. (See **Figure F.10**)

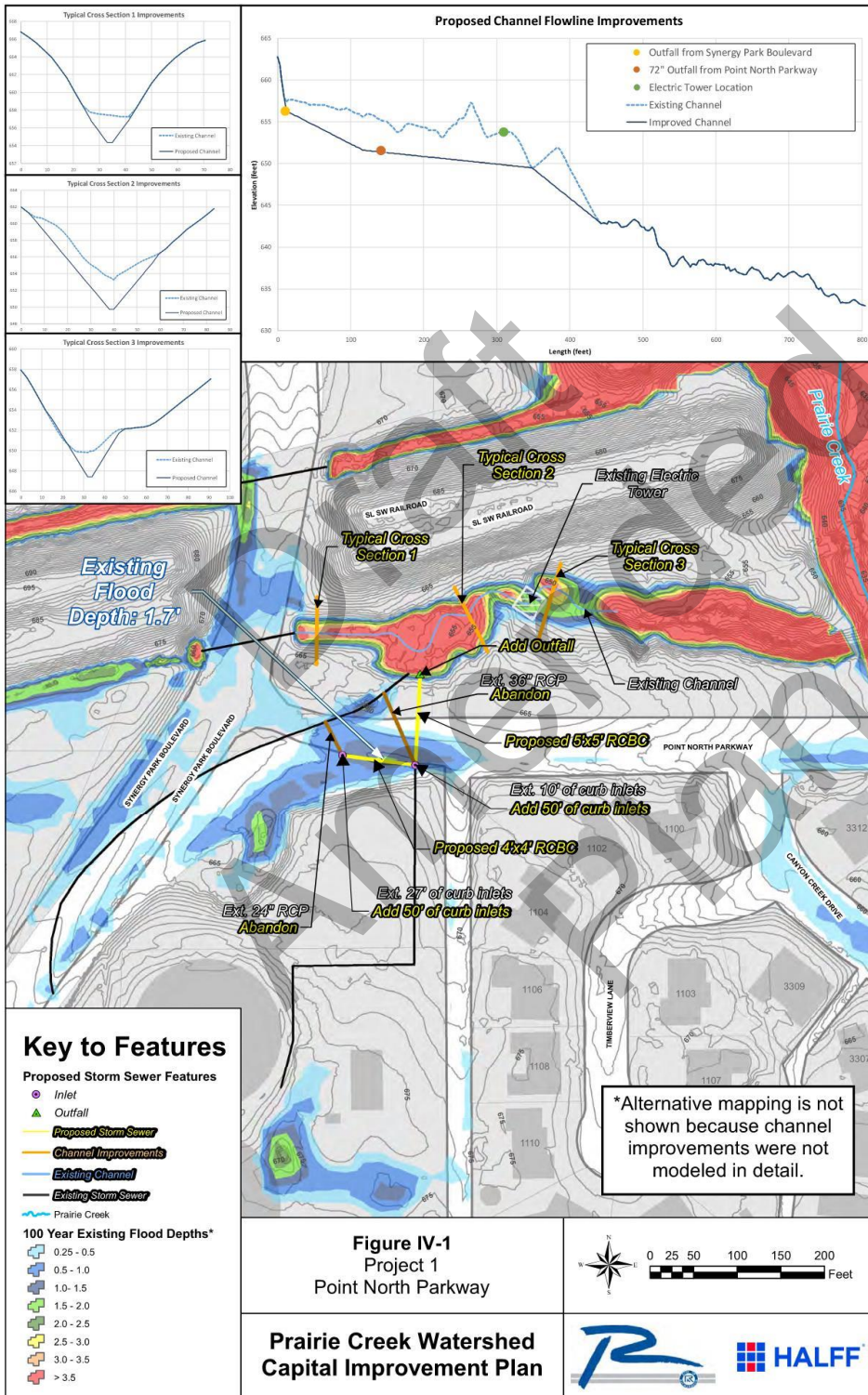
An implementation restriction is possible due to channel grading near an electric tower foundation in the area. Any additional precautions or restrictions have not been included in the cost estimate for this project.

Following the implementation of these drainage improvements, an estimated 0.96 miles of roadway will be removed from the 100-year floodplain. Moreover, 4 structures would have reduced risk during the 100-year storm event but would not be fully removed from the flood risk following these improvements. The project cost is \$946,000.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

⁶ *Prairie Creek Watershed Capital Improvement Plan*, Half Associates, March 2018

Figure F.10. Project 1 - Point North Parkway System (FMP 033000037)



FMP 033000038 - Project 4 - Big Horn Lane/Canyon Creek Drive System

The Big Horn Lane/Canyon Creek Drive System project, developed from the Prairie Creek Watershed Capital Improvement Plan⁷, has an existing storm sewer system between Big Horn Lane and Canyon Creek Drive that allows flood depths to reach 1.5 feet in the Big Horn Lane right-of-way, with 45 cfs spilling into adjacent properties during the 100-year storm event. Flooding along Canyon Creek Country Club is 2.5 feet, and flood water depths along Canyon Creek Drive reach 1.1 feet. This is primarily caused by undersized storm sewer main and limited inlet capacity. Due to these limitations, the area has a LOS of a 5-year event (20% annual chance flood event).

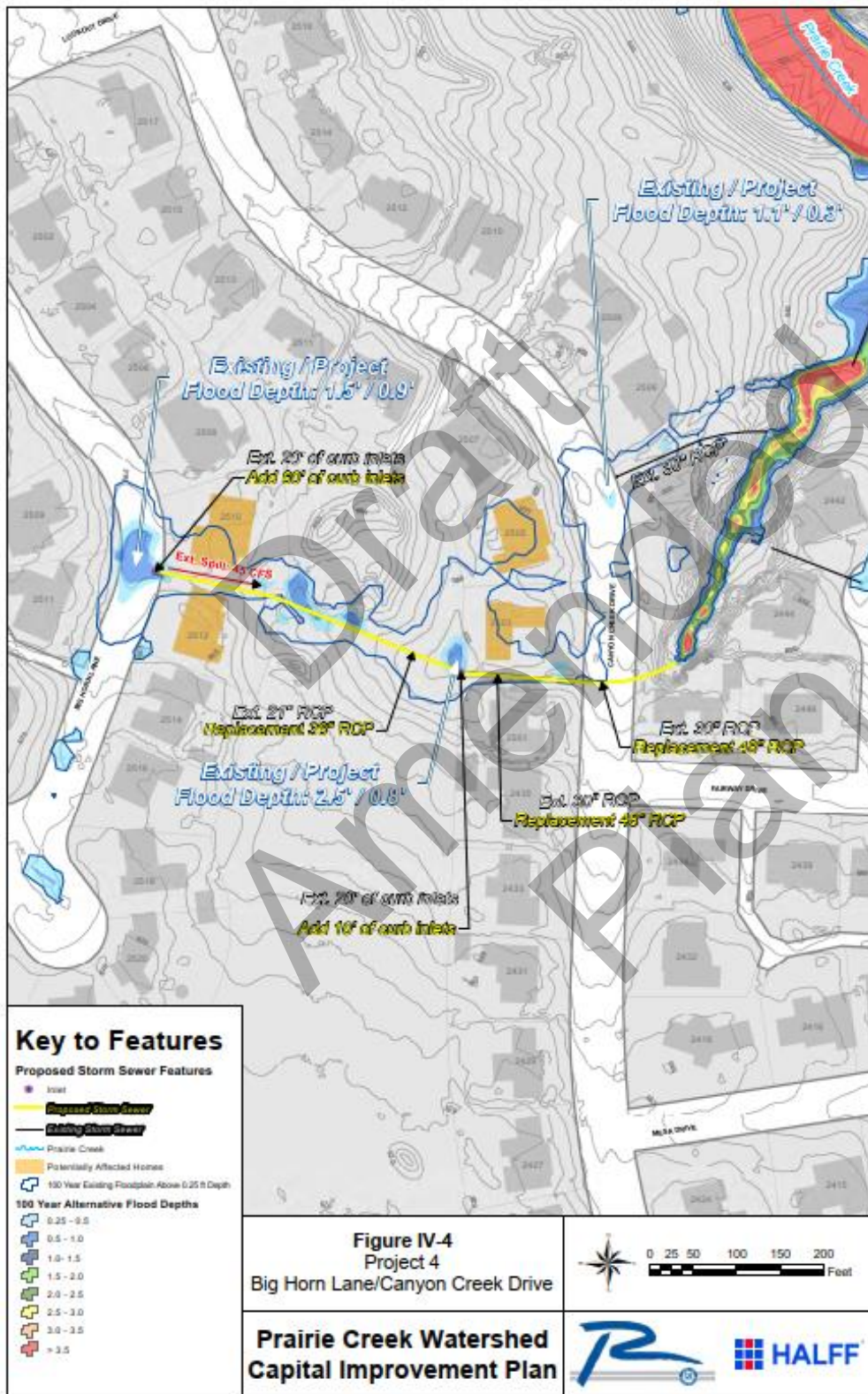
The proposed solution upsizes the existing storm sewer to reduce flooding. Specifically, 260 LF of 30-inch RCP will be replaced with 48-inch RCP. 360 LF of 21-inch RCP will be replaced with 36-inch RCP, and an additional 70 LF of curb inlets will be constructed. (See **Figure F.11.**)

Project implementation will result in the flood depth being reduced from 1.5 feet to 0.9 feet along Big Horn Lane, 2.5 feet to 0.8 feet in the Canyon Creek Country Club, and 1.1 feet to 0.3 feet along Canyon Creek Drive. Following the implementation of these drainage and erosion improvements, an estimated 0.16 miles of roadway and 3 structures would be removed from the 100-year floodplain, all of which are residential structures. This correlates to an estimated 8 individuals removed from the 100-year flood risk. Additionally, 10 structures would have reduced area within the 100-year floodplain but would not be fully removed from flood risk following these improvements. The estimated project cost is \$622,000.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

⁷ *Prairie Creek Watershed Capital Improvement Plan*, Half Associates, March 2018

Figure F.11. Project 4 - Big Horn Lane/Canyon Creek Drive system (FMP 033000038)



FMP 033000039 - Project 6 - Valley Forge Street System

The Valley Forge Street System project, developed from the Prairie Creek Watershed Capital Improvement Plan⁸, is located in the Valley Forge cul-de-sac near the Kansas City Southern (KCS) Railroad. 1.9 feet of depth occurs along the road and causes spilling into adjacent properties during the 100-year storm year. Additionally, Flat Creek Drive floods a maximum flood depth of 1.5 feet. The cause for this flooding problem is a combination of undersized storm sewer mains and a high hydraulic grade line (HGL) due to backwater from the railroad ditch. The area has a 10-year LOS (10% annual chance flood event) and the project is a high priority project due to the severity and extent of the flooding.

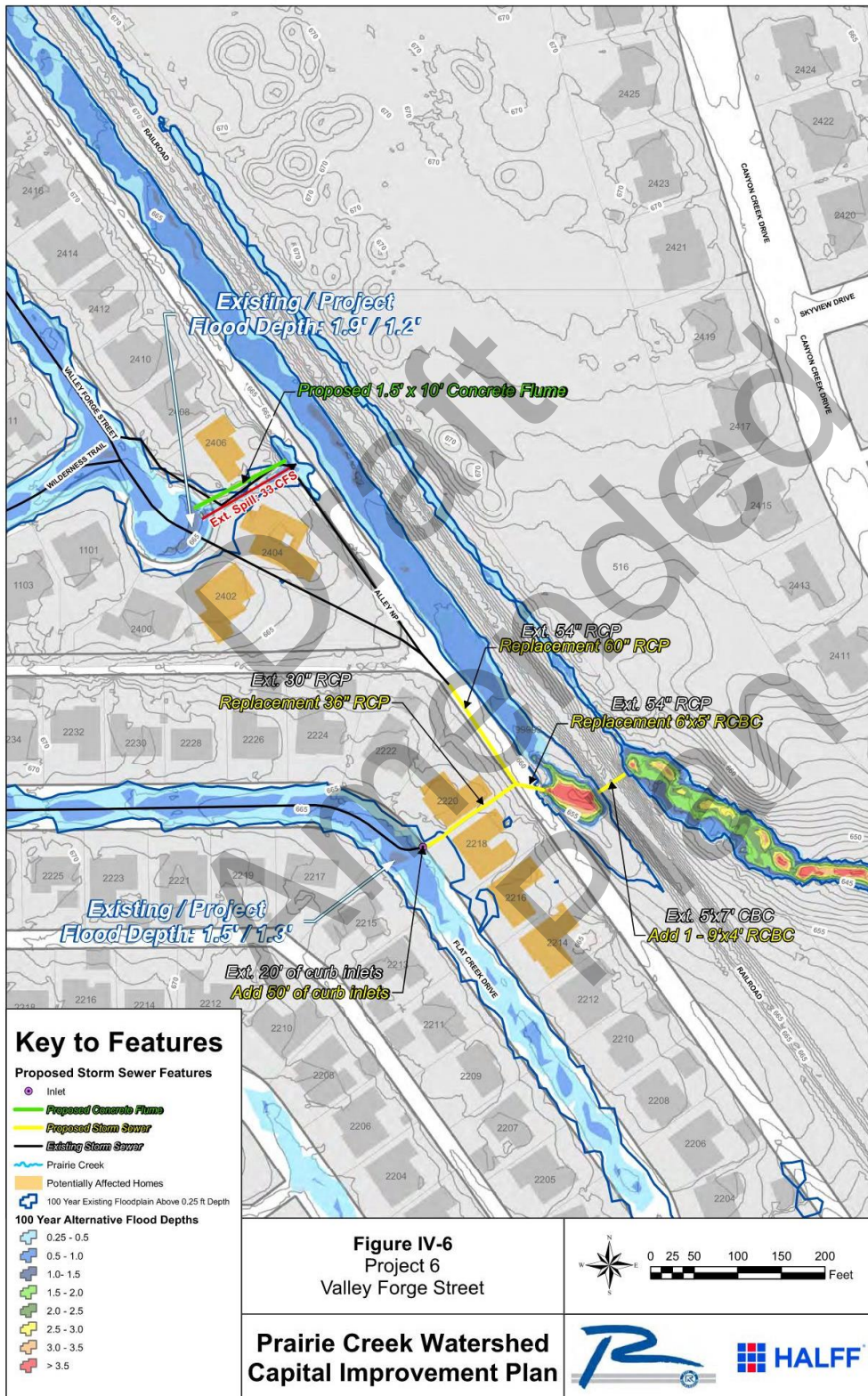
The proposed solution will provide a 100-year LOS (1% annual chance flood event) and consists of a parallel concrete flume culvert crossing the KCS Railroad that extends from the cul-de-sac to the alley parallel to the KCS Railroad. The replacement of the existing storm sewer main with larger storm sewer will also be necessary to keep floodwaters within the road ROW. To be specific the propose system entails the replacement of a 54-inch RCP with 6-ft by 5-ft RCBC, the replacement of a 30-inch RCP with 36-inch RCP, the replacement of a 53-inch RCP with 60-inch RCP, the construction of a 9-ft by 4-ft RCBC at KCS Railroad, the construction of a 1.5-ft high by 10-ft wide concrete flume, the construction of 50 LF of curb inlets, the construction of a 5-ft wingwalls at the 6-ft by 5-ft RCBC outfall, and the construction of two (2) 7-ft wingwalls at the KCS Railroad. (See **Figure F.12.**) The estimated project cost is \$755,000.

Following the implementation of these drainage improvements, an estimated 0.43 miles of roadway and 5 structures would be removed from the 100-year floodplain, 4 of which are residential structures. This correlates to an estimated 18 individuals removed from the 100-year flood risk. Additionally, 11 structures would have reduced area within the 100-year floodplain but would not be fully removed from flood risk following these improvements.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

⁸ *Prairie Creek Watershed Capital Improvement Plan*, Halff Associates, March 2018

Figure F.12. Project 6 - Valley Forge Street System (FMP 033000039)



FMP 033000040 - Project 8 - Lower Canyon Creek Drive System

The Lower Canyon Creek Drive System, which originates from the Prairie Creek Watershed Capital Improvement Plan⁹, has a flooding issue at the southern end of Canyon Creek Drive. The flood depths reach ¼ feet in the road with 75 cubic feet per second spilling into the adjacent properties during the 100-year storm event. The reason for this flooding is the undersized storm sewer and insufficient inlet capacity. The area currently has a LOS corresponding to a 25-year storm event (4% annual chance storm event) and the system improvements are categorized as a high priority project.

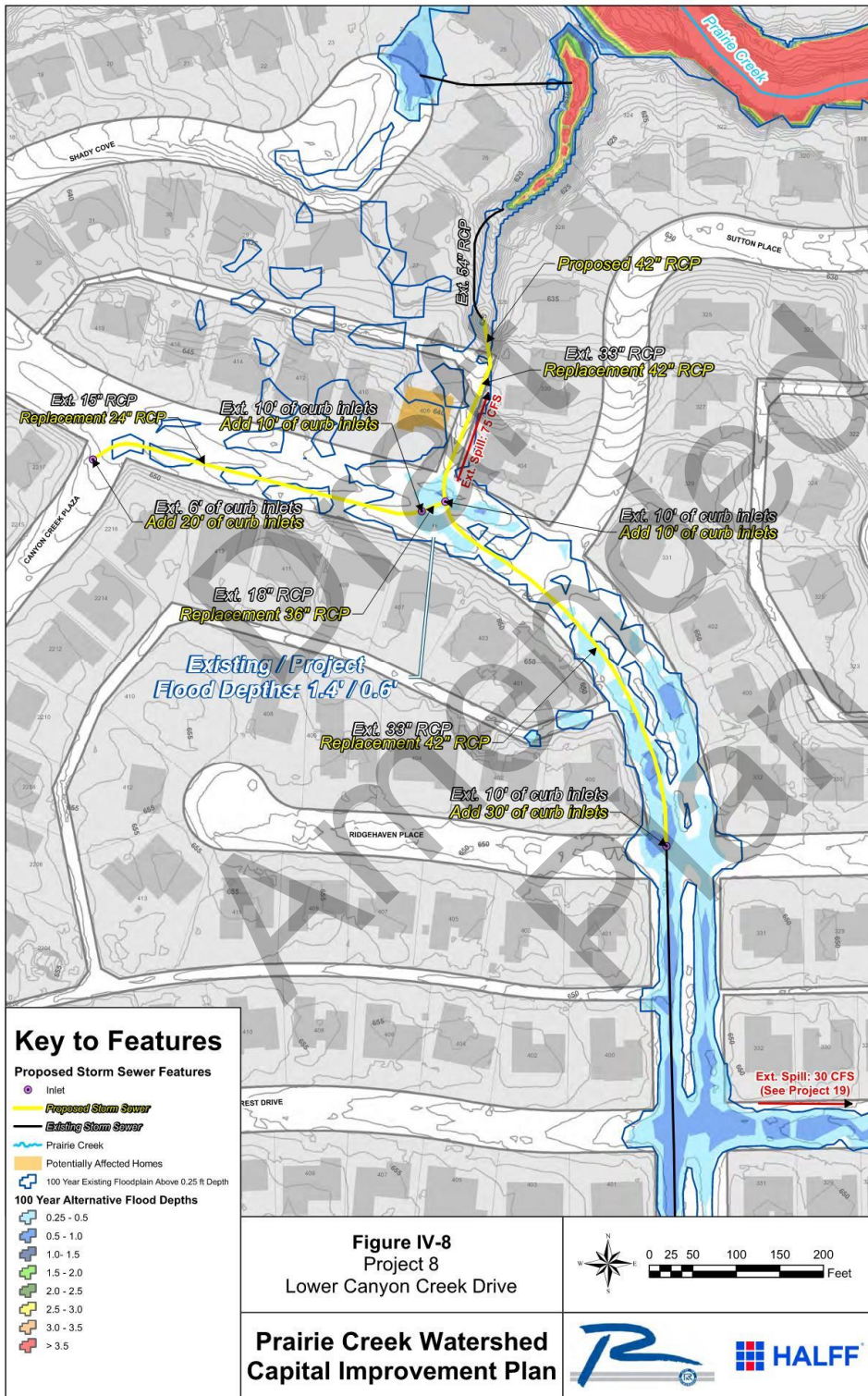
The proposed project model shows a LOS corresponding to a 100-year storm event (1% annual chance storm event). The improvements plan consists of replacing the existing storm sewer with a larger storm sewer to reduce the flooding. Specifically, the proposed solution includes replacing an 18-inch RCP with 36-inch RCP, replacing a 15-inch RCP with 24-inch RCP, and replacing a 33-inch RCP with a 42-inch RCP, as well as constructing 20 LF of new, 42-inch RCP to convey floodwaters from the roadway into the drainage ditch. The constructions of an additional 70 LF of curb inlets is also recommended. (See **Figure F.13**) The estimated project cost is \$1,502,000.

Following the implementation of these drainage improvements, an estimated 0.59 miles of roadway and 14 structures would be removed from the 100-year floodplain, all of which are residential structures. This correlates to an estimated 40 individuals removed from the 100-year flood risk. This solution would decrease the flood depths in the road from 1.4 feet to 0.6 feet, keeping floodwaters within the ROW and not overflowing to adjacent properties.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

⁹ *Prairie Creek Watershed Capital Improvement Plan*, Halff Associates, March 2018

Figure F.13. Project 8 - Lower Canyon Creek Drive System (FMP 033000040)



FMP 033000041 - Project 9 - Grandview Drive System

The Grandview Drive System originated from the Prairie Creek Watershed Capital Improvement Plan¹⁰ and is the location of a flooding issue along Grandview Drive near the intersection of Fall Creek Drive. Flood depths reach 2.2 feet in Fall Creek Drive and overtops into adjacent properties during the 100-year storm. Little Creek Drive reaches flood depths of 0.9 feet and overtops into adjacent properties during the 100-year storm. The reason for this flooding problem is the undersized storm sewer mains and lack of inlet capacity. This project is considered high priority because of high roadway flood depths, spills into residential properties, and currently has a LOS corresponding to a 5-year flood event (20% annual chance flood event).

The proposed solution for this project is to upsize the existing storm sewer. Upsizing the storm sewer will keep the floodwaters within the road ROW and not spill into adjacent properties. Specifically, the proposed solution consists of the following:

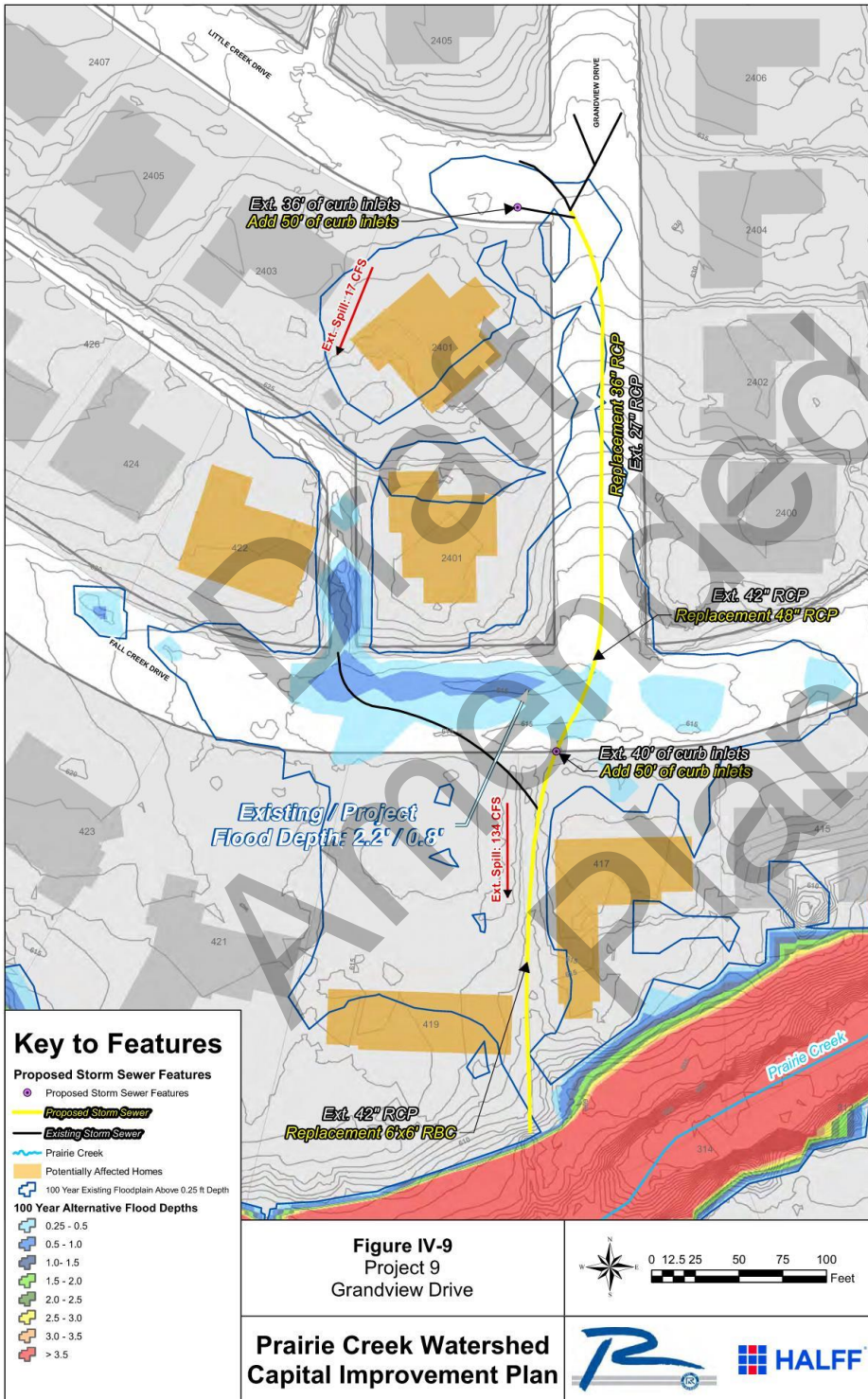
- Replace 90 LF of 42-inch RCP with a 48-inch RCP
- Replace 200 LF of 42-inch RCP with a 6-ft by 6-ft RCBC
- Replace 260 LF of 27-inch RCP with a 36-inch RCP,
- Construct an additional 100 LF of curb inlets, and
- Construct 6-ft wingwalls at the 6-ft by 6-ft RCBC outfall.

(See **Figure F.14**). The proposed project will provide a 100-Year LOS (1% annual chance flood event), and reduce the flood depths from 2.2 feet to 0.8 feet along Fall Creek Drive. The estimated project cost is \$750,000.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

¹⁰ *Prairie Creek Watershed Capital Improvement Plan*, Halff Associates, March 2018

Figure F.14. Project 9 - Grandview Drive System (FMP 033000041)



FMP 033000042 - Project 16 - Valley Glen Drive System

Project 16, Valley Glen Drive System, was developed from the Prairie Creek Watershed Capital Improvement Plan¹¹. The area is subject to flood depths that reach 2.3 feet in the roadway, subsequently flooding adjacent properties during the 100-year storm event. The cause of this flooding problem is primarily due to the undersized storm sewer mains and insufficient inlet capacity. The priority of this project is high as the current LOS corresponds to a 10-year storm event (10% annual chance storm event).

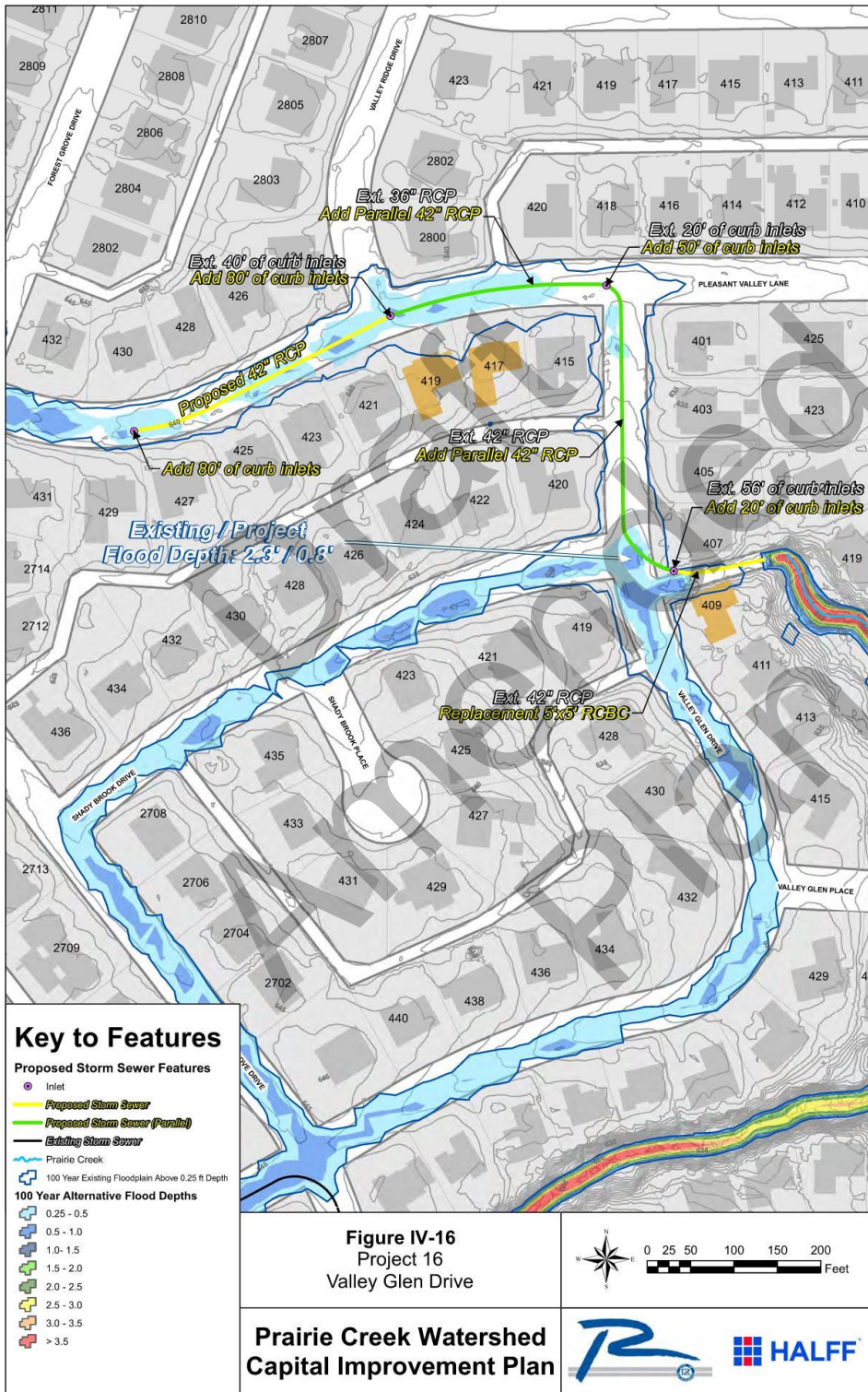
The proposed solution is to construct a parallel storm sewer along the existing storm sewer that extends further downstream. Specifically, the proposal entails the construction of new 42-inch RCP between Forest Grove Drive and Valley Ridge Drive along Pleasant Valley Lane. The parallel line will consist of 620 LF of 42-inch RCP along Pleasant Valley Lane from Valley Ridge Drive, turning south along Valley Glen Drive, and change into a single, 5-ft by 5-ft RCB before outfalling into the drainage ditch near the Shady Brook Drive intersection. (See **Figure F.15**)

Following the implementation of these improvements, an estimated 0.33 miles of roadway and 2 structures would be removed from the 100-year floodplain, all of which are residential structures. This correlates to an estimated 14 individuals removed from the 100-year flood risk. Additionally, 9 structures would have reduced area within the 100-year floodplain but would not be fully removed from flood risk following these improvements. The estimated cost of the project is \$1,513,000.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

¹¹ *Prairie Creek Watershed Capital Improvement Plan*, Halff Associates, March 2018

Figure F.15. Project 16 - Valley Glen Drive System (FMP 033000042)



FMP 033000043 - Project 19 – Pebblebrook Circle System

Project 19 stems from the Prairie Creek Watershed Capital Improvement Plan¹². The location of the flooding problem is near the intersection of Pebblebrook Circle and Prairie Creek Drive. Since the current site only has a LOS corresponding to the 25-year storm event (4% annual chance storm event), flood depths reach up to 1.2 feet in the roadway during the 100-year storm event. Uncontained floodwaters spill over to Robin Way and Ridge Crest Drive. The cause for this flooding is mainly undersized storm sewer main, which produces a high hydraulic grade line (HGL) that prevents runoff from entering the system. The flooding is contained within the ROW in existing conditions.

The proposed solution is to replace the existing storm sewer main with a larger storm sewer. The proposed improvements will reduce and continue to contain flooding in the ROW.

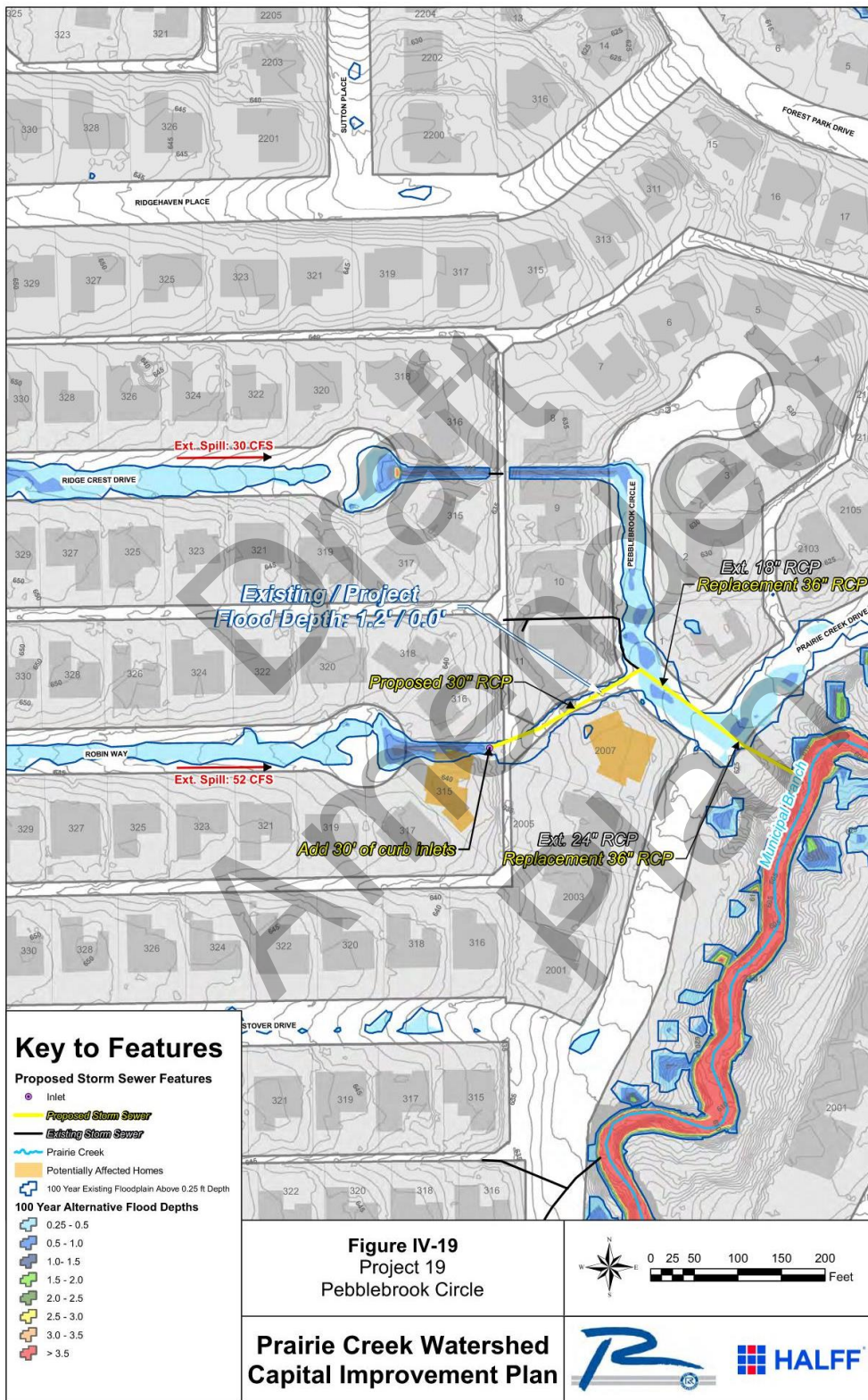
Specifically, the proposal entails replacing 180 LF of 24-inch RCP with 36-inch RCP, constructing 200 LF of new 30-inch RCP, constructing an additional 30 LF of curb inlets. (See **Figure F.16**)

Implementation of these improvements would lead to an estimated 0.15 miles of roadway and 1 residential structure removed from the 100-year floodplain. This correlates to an estimated 24 individuals removed from the 100-year flood risk. The estimated project cost is \$511,000 with a LOS corresponding to the 100-year storm event (1% annual chance storm event).

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

¹² *Prairie Creek Watershed Capital Improvement Plan*, Halff Associates, March 2018

Figure F.16. Project 19 – Pebblebrook Circle System (FMP 033000043)



FMP 033000044 - Project 2 – Campbell Road System

The Campbell Road System FMP, developed from the Cottonwood Creek Final Report¹³, proposes options for storm sewer improvements. . Presently, the storm sewer system between Campbell Road and Old Campbell Road causes flood depths of 2.1 feet during the 100-year storm event that inundates an adjacent commercial building. The current site has a LOS corresponding to the 10-year storm event (10% annual chance storm event).

The flooding in this area is primarily caused by an undersized storm sewer main and insufficient inlet capacity. This problem area is considered high priority due to the deep ponding at the commercial building located at 561 West Campbell Road.

The proposed project includes improvements to replace or construct portions of the existing Campbell Road storm sewer system. HEC-RAS, HEC-HMS, and XPSWMM models were used to model the fully developed hydraulics for the public drainage infrastructure within the watershed.

Project 2 replaces the existing storm sewer main with a larger storm sewer and includes the addition of a parallel storm sewer to reduce the flooding. Specifically, improvements include:

- Replacement of 62 LF of 18-inch RCP with a 30-inch RCP
- Construction of 170 LF of 36-inch RCP
- Construction of 890 LF of 42-inch RCP
- Construction of an additional 50 LF of curb inlets

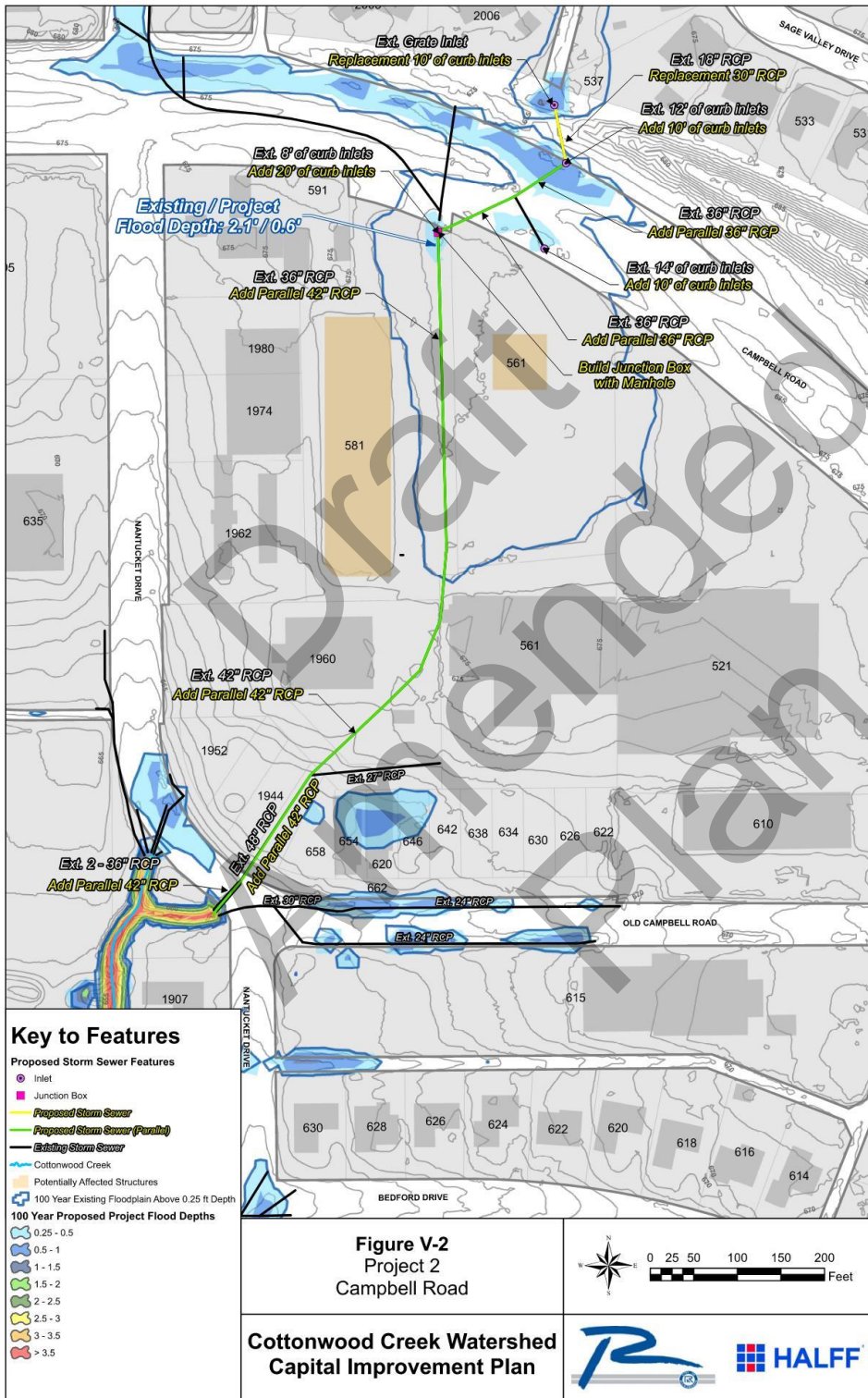
(See **Figure F.17**) The estimated project cost is \$1,349,000.

The proposed improvements will reduce the flood depth from 2.1 feet to 0.6 feet, keeping floodwaters within the road ROW and away from the adjacent properties. The proposed project removes 6 structures from the 100-year floodplain, one of which is residential. An LOS of a 100-year storm event is achieved through this project. An additional 10 structures have reduced flood depths during the 100-year event, though they are not entirely removed due to unrelated drainage issues.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

¹³ *Cottonwood Creek Watershed Capital Improvement Plan*, Halff Associates, December 2018

Figure F.17. Project 2 – Campbell Road System (FMP 033000044)



FMP 033000045 - Project 6 – Wisteria Way Circle at Timberlake Circle

Project 6 was developed from the Cottonwood Creek Watershed Capital Improvement Plan¹⁴. The location of the flooding problem is at the intersection of Wisteria Way with Timberlake Circle and 25 cubic feet per second spill through ten (10) properties along Wisteria Way from Maryland Drive to Timberlake Circle during the 100-year storm event. The cause for this flooding problem is an undersized storm sewer main. This is a high priority project because the current site only has a LOS corresponding to the 2-year storm event (50% annual chance storm event).

The proposed solution to this project is to replace a portion of the existing storm sewer system with a larger storm sewer and proposes an extensive storm sewer system connecting to the existing stub out adjacent to the Pinehurst Drive and Wisteria Way intersection to reduce flooding along the road.

Specifically, the proposal upsizing 50 LF of 24-inch RCP with 30-inch RCP, constructing an additional 450 LF of 42-inch RCP, 600 LF of 5-ft by 4-ft RCBC, 220 LF of 6-ft by 4-ft RCBC, and an additional 120 LF of curb inlets. Two junction boxes with manholes are also proposed for constructability and maintenance. (See **Figure F.18**)

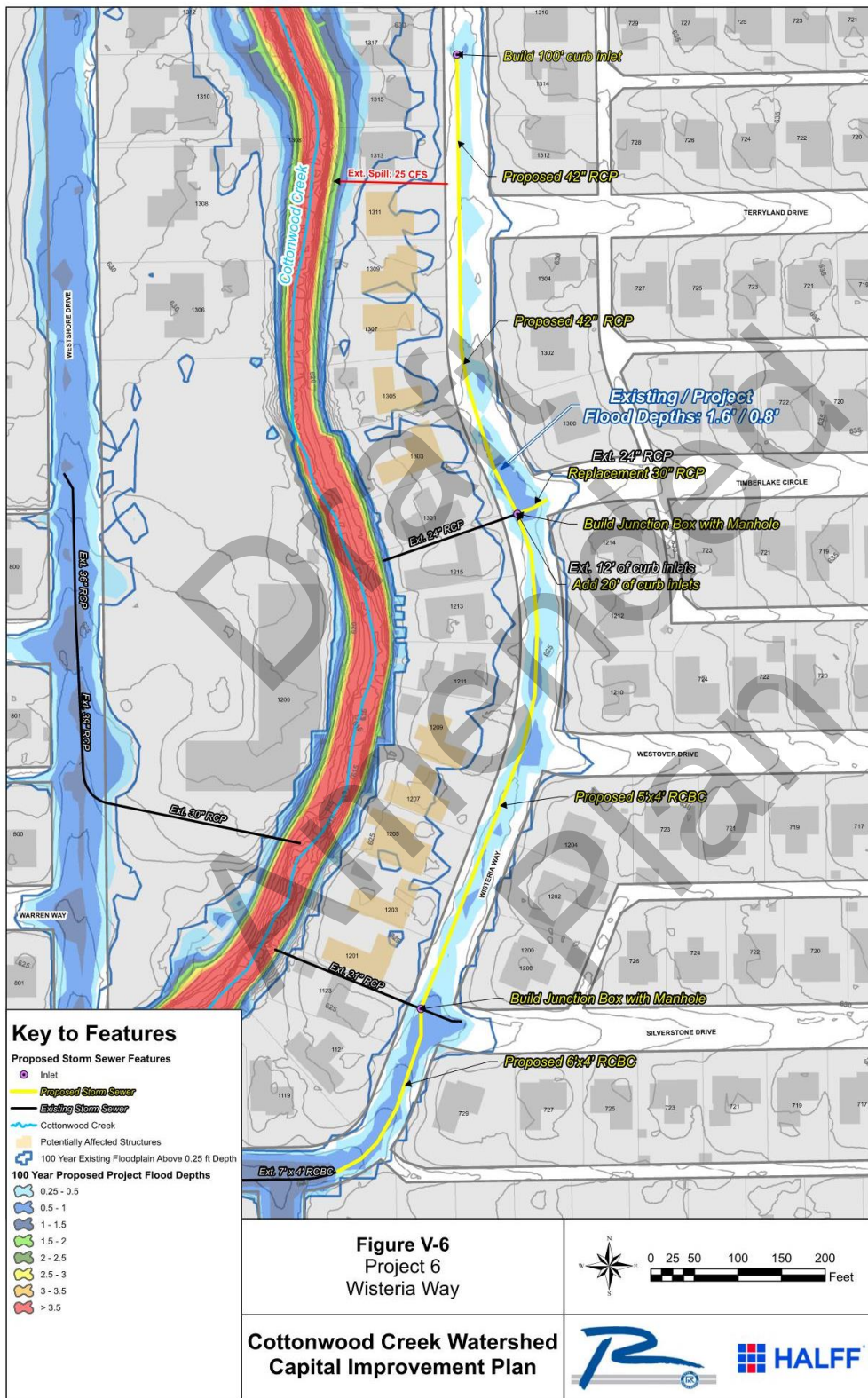
This proposal will reduce roadway flooding from 1.5 feet to 0.8 feet, keeping water within the ROW and not spilling into adjacent properties. Once the proposed project is implemented, an estimated 0.51 miles of roadway and 10 structures would be removed from the 100-year floodplain, 5 of which are residential structures. This correlates to an estimated 16 individuals removed from the 100-year flood risk. Additionally, 20 structures would have reduced flood depths within the 100-year floodplain but would not be fully removed from flood risk due to other flooding sources.

The estimated project cost is \$2,015,000 with a LOS corresponding to the 100-year storm event (1% annual chance storm event).

Based on the comparative assessment performed for this FMP, the proposed project does not meet all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

¹⁴ Cottonwood Creek Watershed Capital Improvement Plan, Halff Associates, December 2018

Figure F.18. Project 6 – Wisteria Way Circle at Timberlake Circle (FMP 033000045)



FMP 033000062 - Hickory Creek Flood Protection - Alternative 1

The Alternative 1 FMP was developed from the Hickory Creek Flood Protection Plan¹⁵. The Hickory Creek Watershed, within the City of Balch Springs, has led to frequent episodes of flooding through the city. During the 100-year, a total of 109 single-family and small multi-family dwellings and 15 commercial/public buildings are within flood risk. 26 structures are within 2-year flood risk, according to existing conditions simulations.

The proposed Alternative 1 includes the excavation of twelve detention areas located along Hickory Creek, Stream 4C6, and Stream 4C6 Tributary 2. These detention ponds add an additional storage volume of over 414 acre-feet to the Hickory Creek watershed. The proposed ponds have a 4:1 side slope and outfall structures sized to provide 1-foot of freeboard below the top of pond elevation. Detention ponds were graded to be less than 40 acre-feet in volume to be outside of TCEQ jurisdiction. (See **Figure F.19** through **Figure F.22**).

Alternative 1 should be the first of three projects to be completed as part of the overall Hickory Creek Flood Protection project. Alternative 2 and Alternative 3 can be implemented subsequently, and are included in this plan as FMP 033000063 and FMP 033000064, respectively.

At a cost of \$27,272,000, the Alternative 1 project alone will reduce damages along Lona Lane, Sheilah Drive and Dinah Drive and remove 29 homes and 2 business from the floodplain. This correlates to an estimated 90 people removed from the 100-year flood plain.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

¹⁵ *City of Balch Springs Hickory Creek Flood Protection Planning Study Update Report*, Halff Associates, July 2022

Figure F.19. Hickory Creek Flood Protection - Alternative 1 (FMP 033000062)

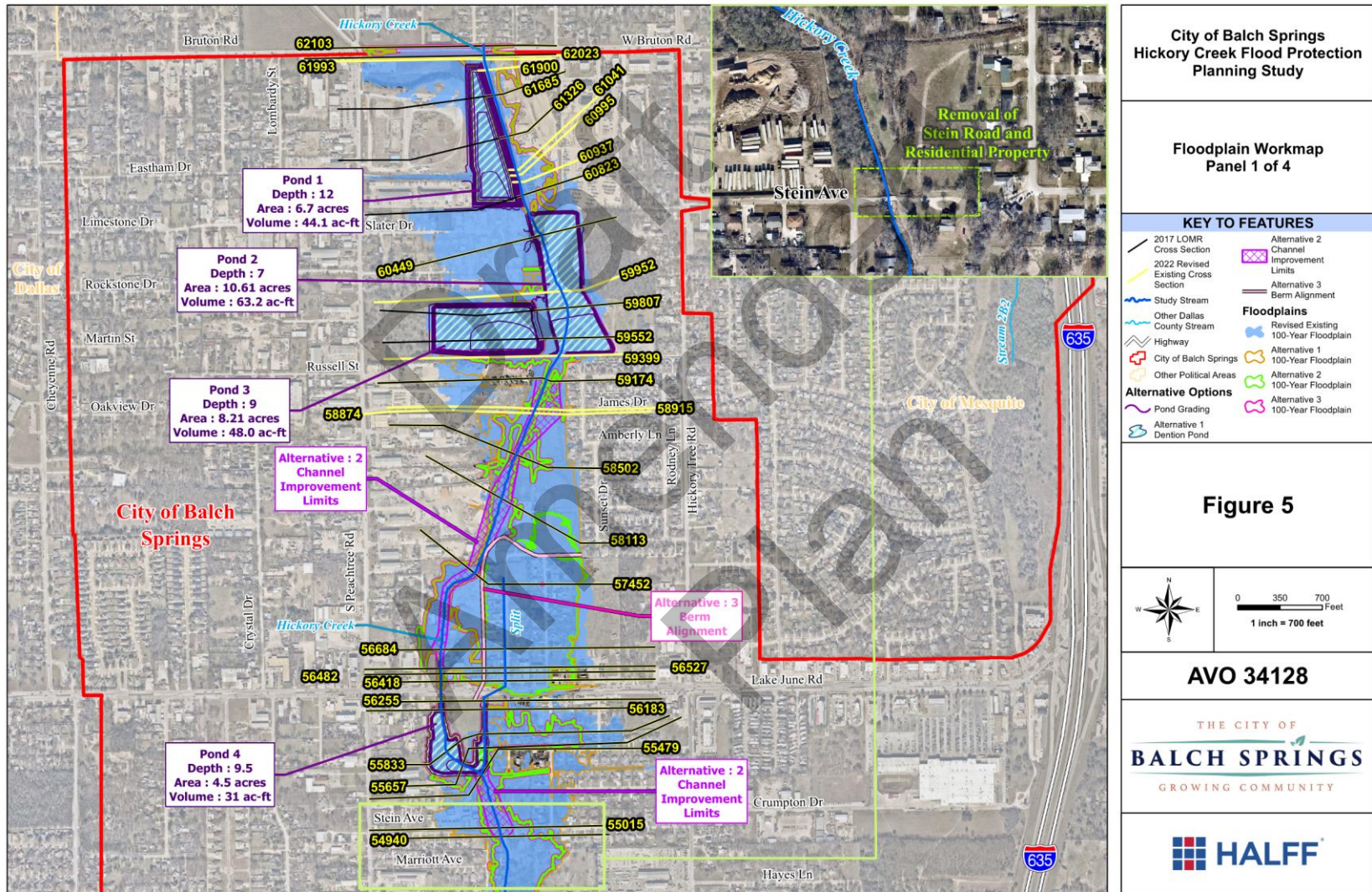


Figure F.20. Hickory Creek Flood Protection - Alternative 1 (FMP 033000062)

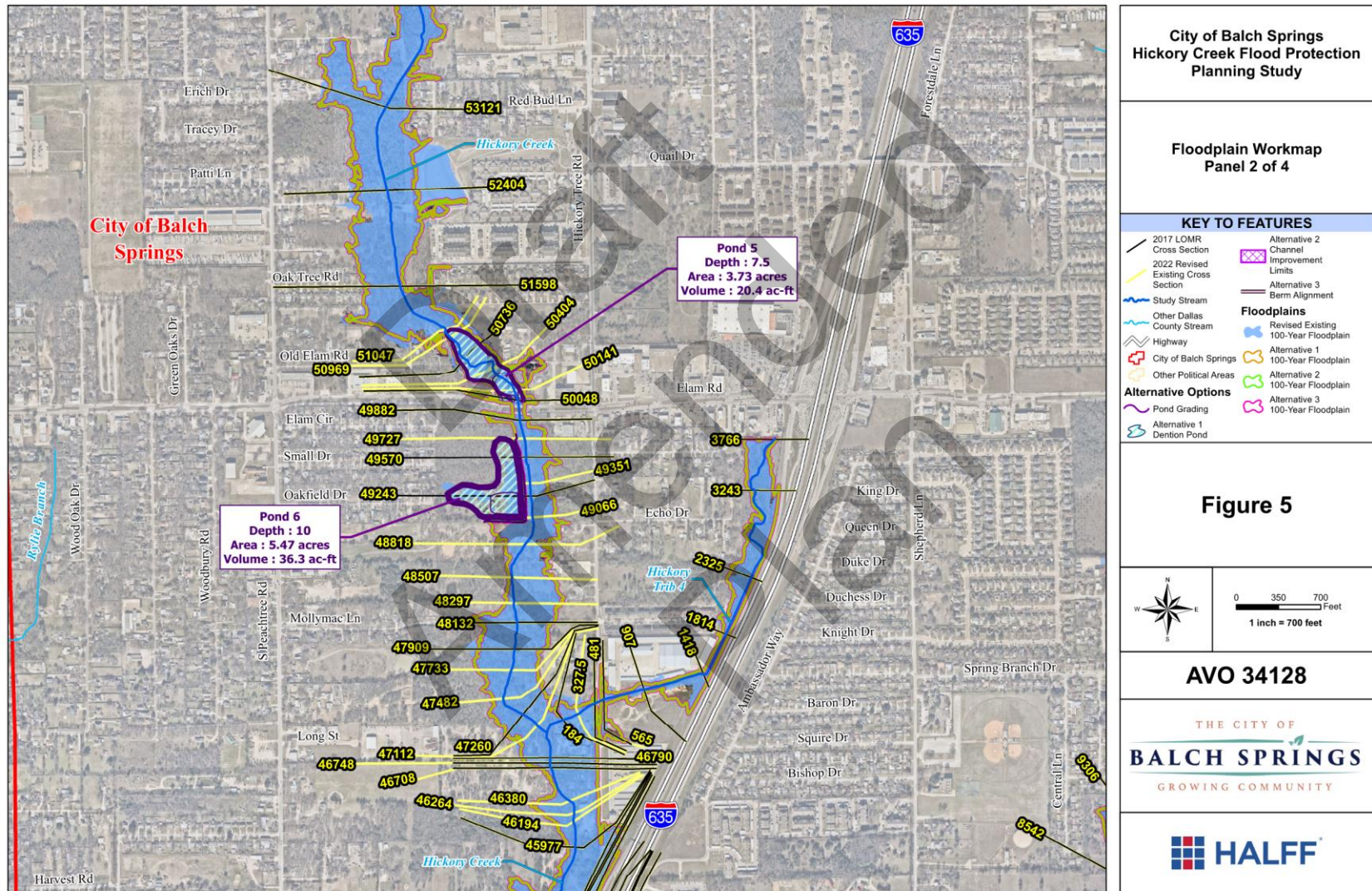


Figure F.21. Hickory Creek Flood Protection - Alternative 1 (FMP 033000062)

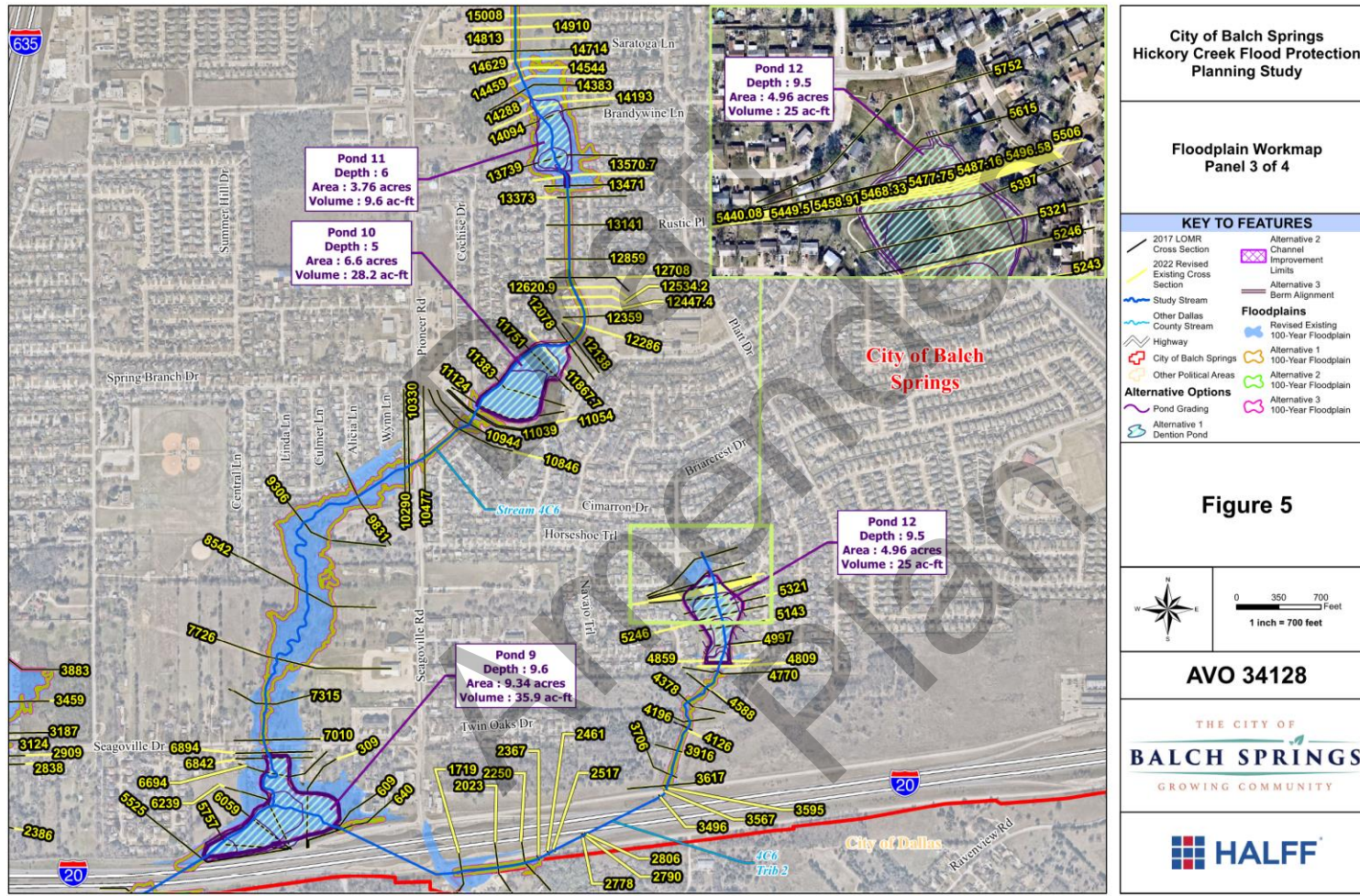
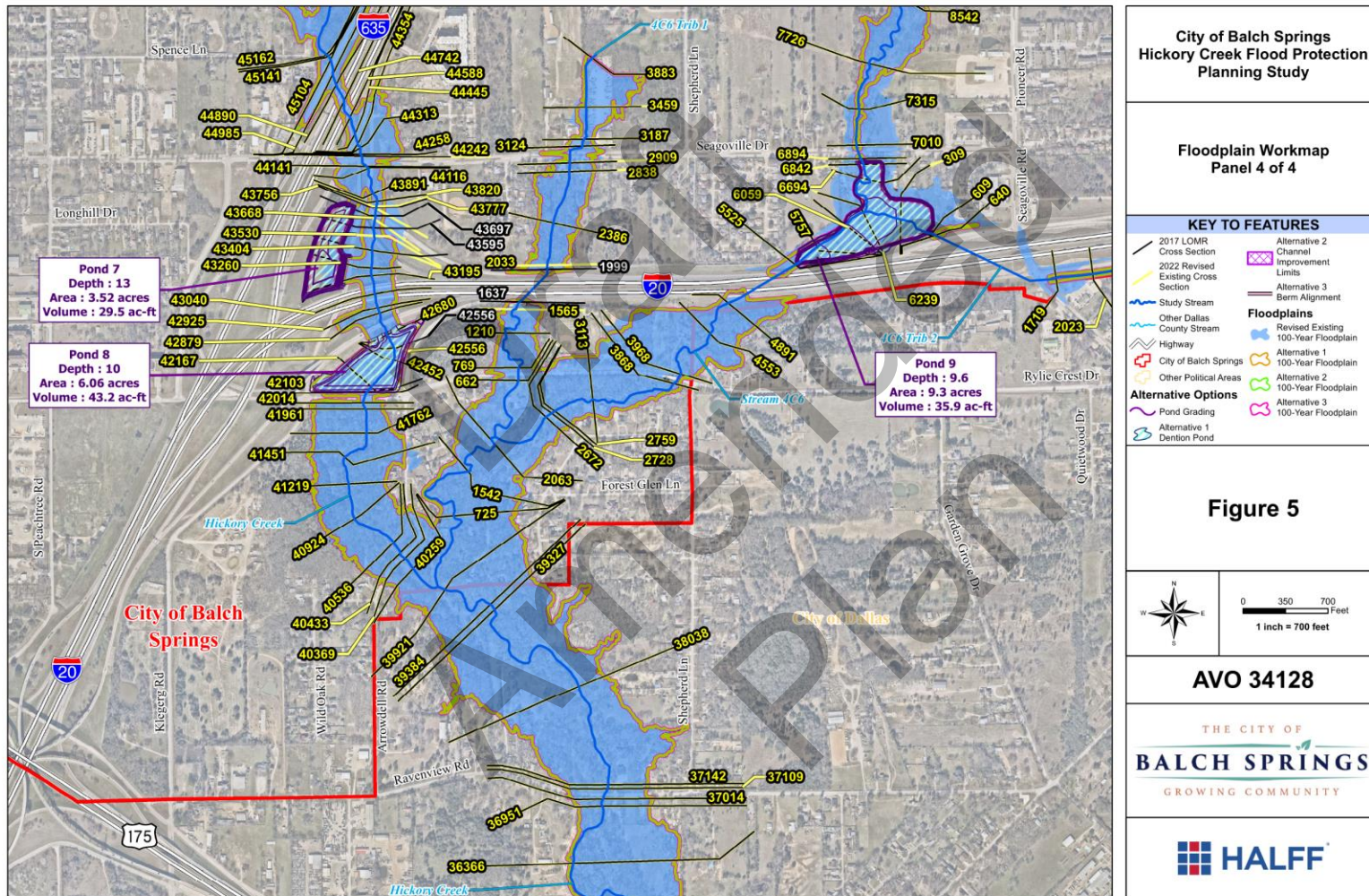


Figure F.22. Hickory Creek Flood Protection - Alternative 1 (FMP 033000062)



FMP 033000063 - Hickory Creek Flood Protection - Alternative 2

The Alternative 2 FMP was developed from the Hickory Creek Flood Protection Plan¹⁶. The Hickory Creek Watershed, within the City of Balch Springs, has led to frequent episodes of flooding through the city. Following the implementation of Alternative 1, 80 residential structures and 13 commercial or public structures would still be within 100-year flood risk.

Alternative 2 for the Hickory Creek project involves channel improvements in two locations along the creek, to be completed after Alternative 1. This alternative includes channelization along Hickory Creek at two locations, totaling an additional storage capacity of approximately 58 acre-feet in the Hickory Creek watershed. This will reduce peak discharges along Hickory Creek. (See **Figure F.23.**)

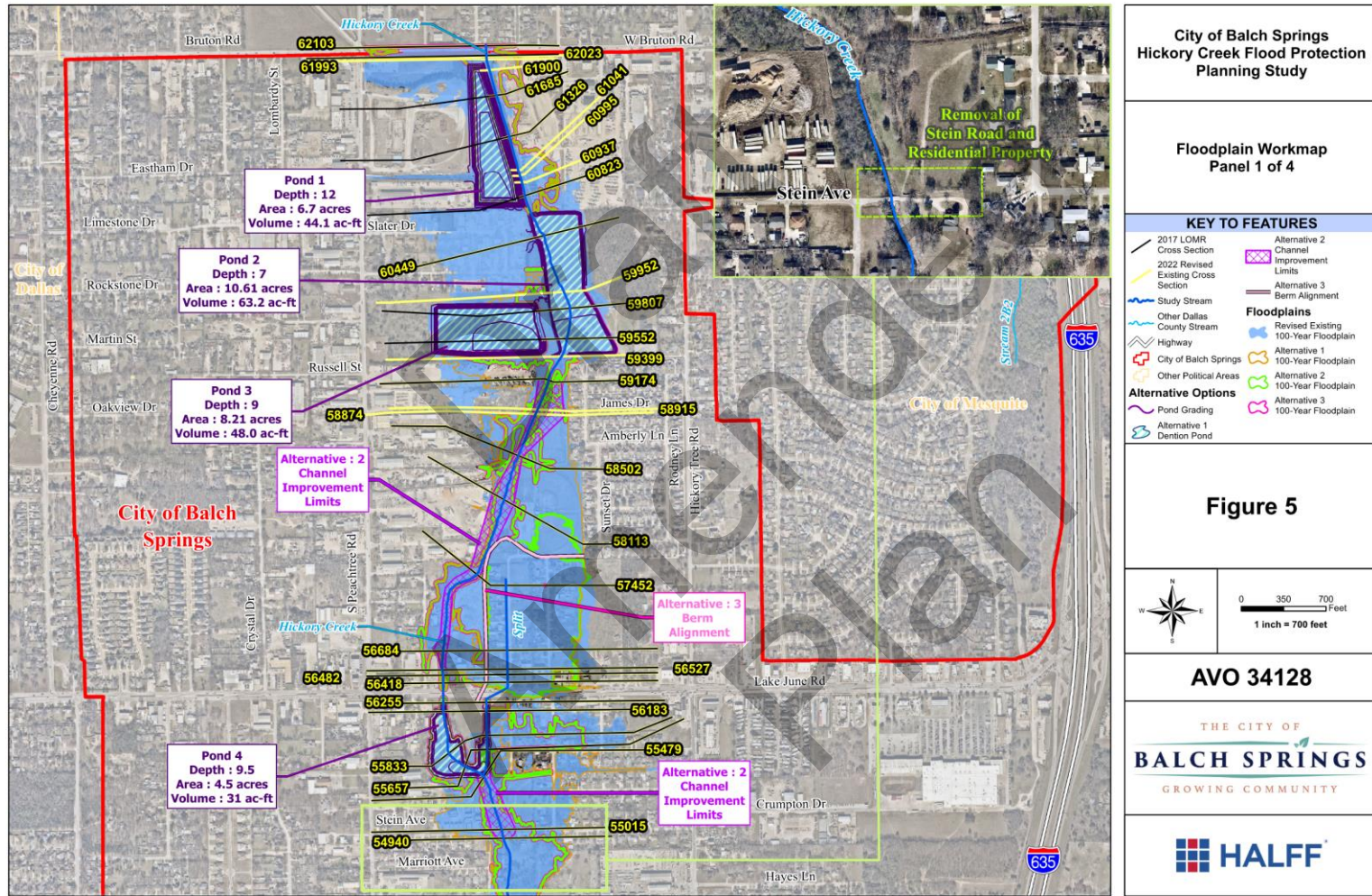
These improvements are necessary to mitigate the impacts of Alternative 3, which incorporates a levee to protect homes in the floodway near Lake June Road. It is not recommended to build Alternative 3 as a stand-alone project due to localized, negative impacts.

At a cost of \$30,531,000, Alternative 2 reduces water surface elevations enough to confine most of the flow in the existing channel. It removes 27 homes and 3 businesses from the 100-year floodplain. This means an estimated 90 people would be removed from 100-year floodplain.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

¹⁶ *City of Balch Springs Hickory Creek Flood Protection Planning Study Update Report*, Halff Associates, July 2022

Figure F.23. Hickory Creek Flood Protection – Alternative 2 (FMP 033000063)



FMP 033000064 – Hickory Creek Flood Protection – Alternative 3

The Alternative 3 FMP was developed from the Hickory Creek Flood Protection Plan¹⁷. The Hickory Creek Watershed, within the City of Balch Springs, has led to frequent episodes of flooding through the city. Following the implementation of Alternative 2, 78 residential structures and 12 commercial/public structures would still be within 100-year flood risk.

Alternative 3 involves building a protective levee along the western boundary of residential structures and turning east towards Lora Lane and terminating at Eloise Drive. This levee is designed to be completed after Alternatives 1 and 2.

The height of the levee is recommended to be constructed at the 500-year water surface elevation. (See **Figure F.24.**) However, it is not recommended to build this alternative without the previous projects, Alternative 1 and Alternative 2, due to potential adverse impacts downstream caused by the loss of channel conveyance.

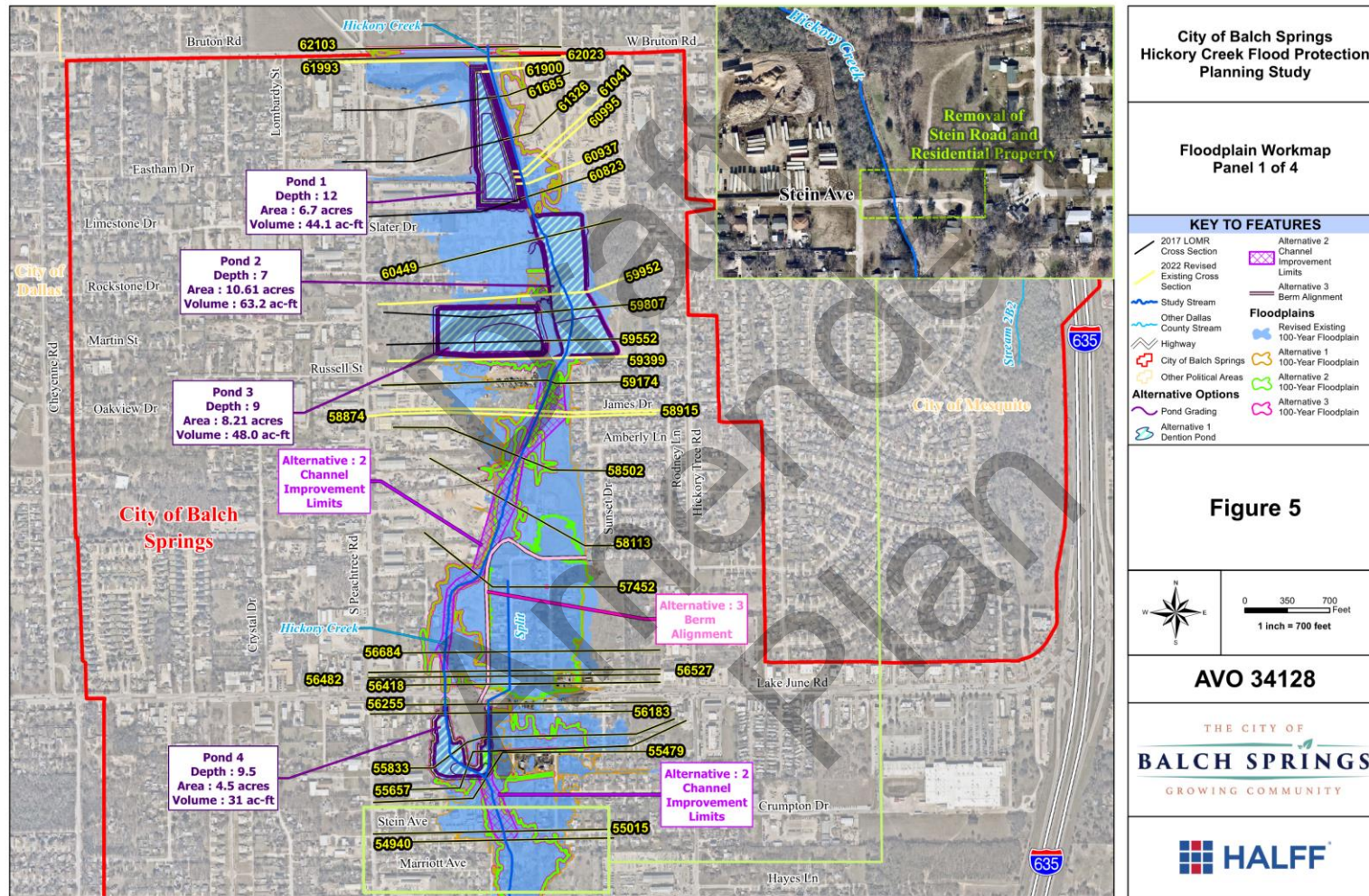
At a cost of \$30,671,000, Alternative 3 reduces water surface elevations enough to confine most of the flow in the existing channel. It removes 43 homes and 6 businesses from the 100-year floodplain. This correlates to an estimated 152 individuals removed from the 100-year floodplain.

The current levee alignment coincides with a trail running through the City. The intention is to keep the trail along the top of the levee, providing further social benefit to the proposed improvement.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

¹⁷ *City of Balch Springs Hickory Creek Flood Protection Planning Study Update Report*, Halff Associates, July 2022

Figure F.24. Hickory Creek Flood Protection - Alternative 3 (FMP 033000064)



FMP 033000065 - Town Creek [Tarrant Ave, Warren St, Johnson Ave, Newton Dr] Safety Improvement

The City of Burleson completed a stormwater masterplan for the Town Creek and Shannon Creek watersheds in 2004 and updated in 2021¹⁸. This study identified alternatives to improve street and structure flooding during the ultimate conditions 100-year storm event. This FMP pertains to Safety Improvements in the Town Creek watershed, which includes creek crossings at Tarrant Avenue, Warren Street, Johnson Avenue, and Newton Drive. These crossings are under-sized, with less than a 2-year level of service and experience the most flooding in the Town Creek watershed. This is due to the under-sized railroad crossing just downstream of N Warren Street. The railroad crossing causes a large amount of backwater and contributes to structure flooding upstream to Johnson Ave. In addition, the area is generally low lying with little topographical relief.

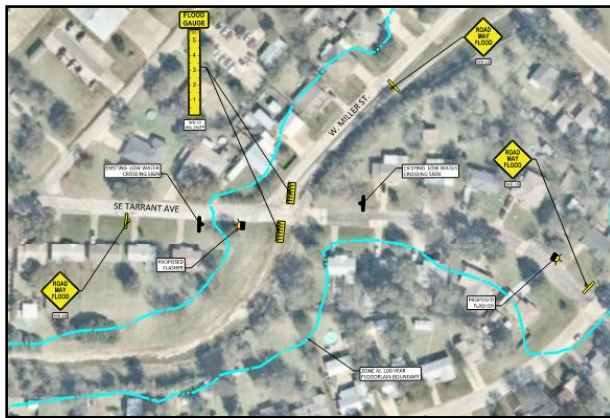
Road crossing alternatives were analyzed for this area. However, those alternatives were costly and provided little relief until the railroad crossing was improved. As a cost-effective, short-term solution, safety improvements are proposed for these four crossings. These safety improvements may include high-water warning flashers, staff gauges, flood hazard signs, and additional light fixtures (See **Figure F.25.**) The project cost is \$367,000.

No physical or quantifiable benefits would result from the implementation of these safety improvements. However, these improvements would be a prevention measure to help reduce the traffic on flooded roads.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the *TWDB Technical Guidance (Exhibit C Section 3.6.A)*. This FMP does not propose to alter the hydrology or hydraulics of the watershed. The proposed improvements are limited to minor disturbances to place signs or lights to increase visibility in the area. Therefore, no negative impacts are anticipated with the implementation of this FMP (see **Table F.1**).

¹⁸ *Town Creek and Shannon Creek Master Drainage Plan*, Freese and Nichols, Inc., 2021.

Figure F.25. Town Creek [Tarrant Ave, Warren St, Johnson Ave, Newton Dr] Safety Improvements



Tarrant Ave. Safety Improvements



Warren St. Safety Improvements



Johnson Ave. Safety Improvements



Newton Dr. Safety Improvements

FMP 033000067 - Ansley Dr. Storm Sewer System Improvements

The Ansley Dr. Storm Sewer System Improvements FMP was developed from City of Westworth Master Drainage Plan¹⁹. The current site has a LOS corresponding to the 1-year storm event (100% annual chance storm event).

The proposed improvements include replacing 1400 LF of existing concrete-lined drainage channel with a double-barrel, 7-ft by 7-ft RCB, as well as constructing 6 new storm sewer inlets to replace curb cuts on Ansley Dr. The existing junction box at the upstream end of the channel will also be upgraded to a 10-ft by 18-ft junction box to accommodate the new storm sewer. A headwall is also recommended at the channel outfall. PCSWMM models were created to analyze the impact that the proposed improvements would have based on ultimate land use. Peak flow rates and route hydrographs were also used to determine containment within the sewer system. (See **Figure F.26**)

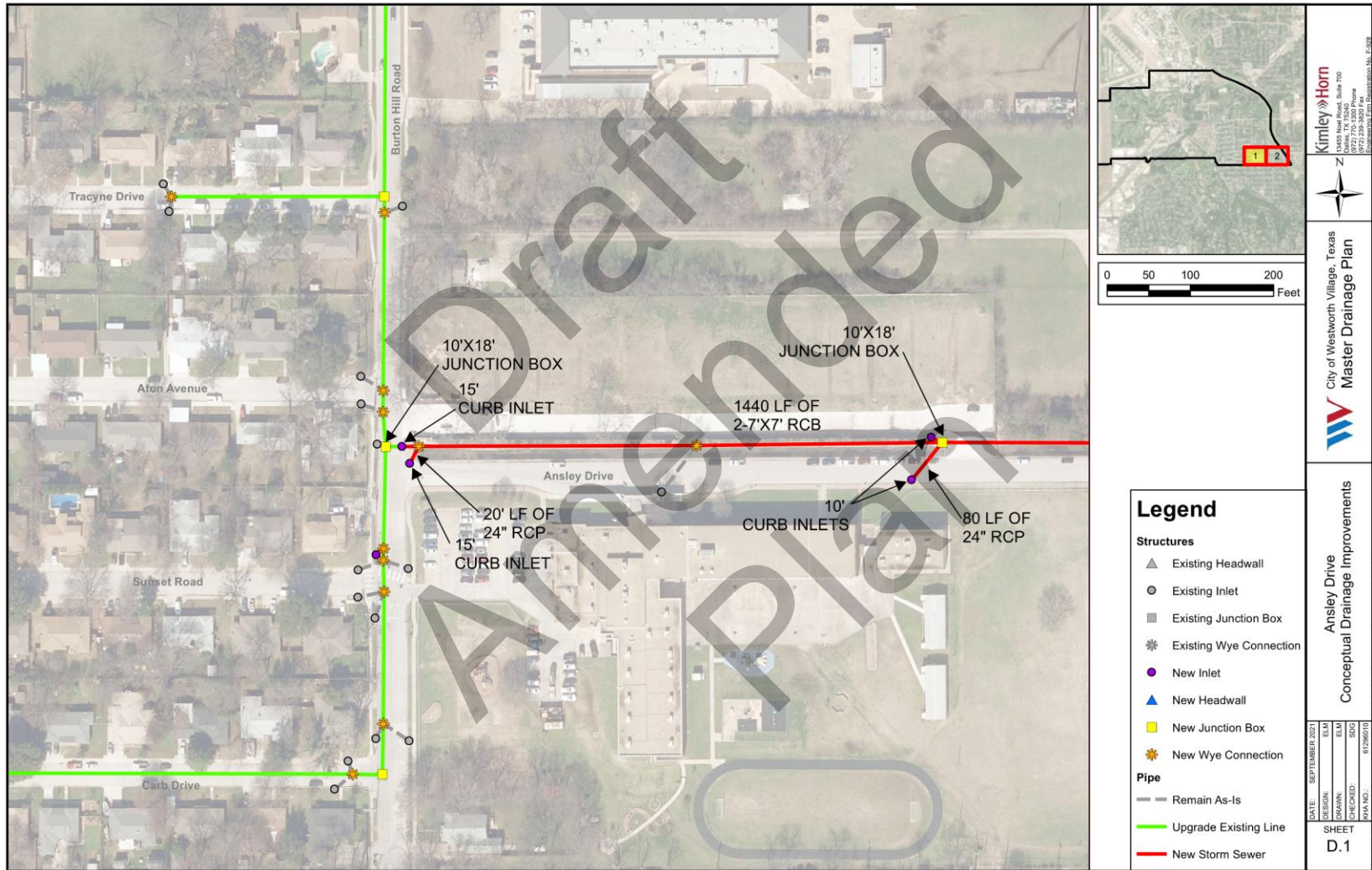
Following the implementation of these storm sewer system improvements, an estimated 0.14 miles of roadway and 1 structure will be removed from the 100-year floodplain. Additionally, there are 12 homes documented on Oaks Lane that have no road access in a 100-year storm event. While these homes are not in the 100-year floodplain, the proposed project will provide unflooded access.

At a cost of \$4,225,000, the proposed project will provide a 100-year storm event containment (1% annual chance flood event). The cost estimate also includes the installation of pavement above the proposed storm sewer between Burton Hill Road and Oaks Lane in support of a new bus lane.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

¹⁹ *City of Westworth Village Master Drainage Plan*, Kimley-Horn, September 2021

Figure F.26. Ansley Dr. Storm Sewer System Improvements (FMP 033000067)



FMP 033000068 - Main A Pump Station and Conveyance Improvements

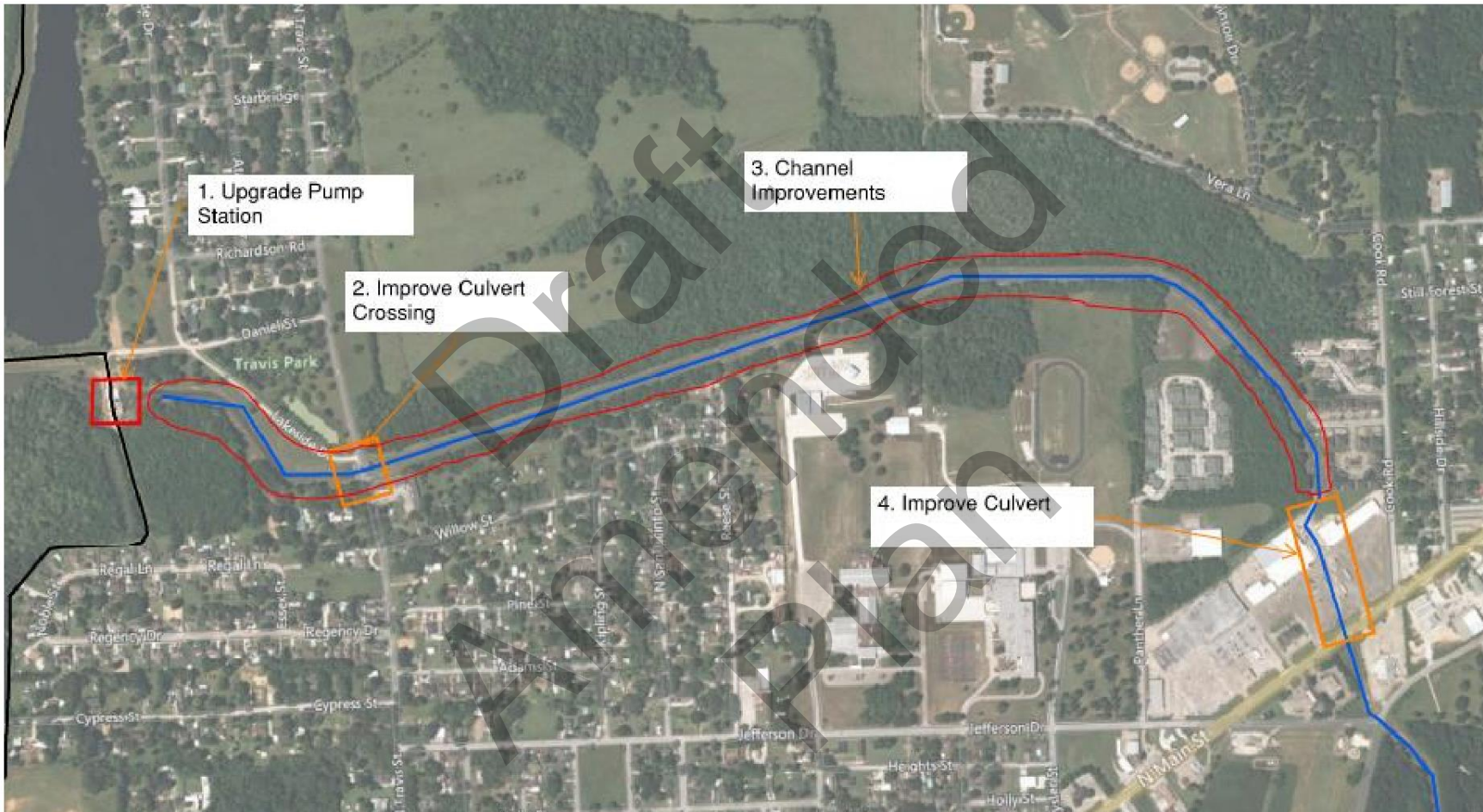
The City of Liberty has been subjected to numerous widespread flooding events. To protect the City from high stages on the Trinity River, a levee system was constructed around the northwestern side of the City. The levee has a number of gravity outfalls throughout its perimeter as well as three pump stations that are used to drain the City when the Trinity is in flood stage. In spite of the levee, the City remains at an elevated flood risk due to inadequate internal drainage systems that can efficiently convey water out of the City. The stage of the Trinity River is often elevated by releases from Lake Livingston, requiring that the pump stations are the only means of removing stormwater from the system. The local water control and improvement district, Liberty County WCID#5 is responsible for operating and maintaining the pump stations as well as the drainage channel infrastructure that feeds into the pump stations. The City is served by two primary drainage channels that lead to two pump stations operated and maintained by WCID#5 commonly referred to as Main A and Main B.

The proposed improvements consist of:

1. Rehabilitating and upsizing of Pump Station A. Currently the twin pumps have a maximum capacity of 60.6 cfs when operating together at full capacity. The pumped capacity is lower than the free flow out of the Main A system under gravity flow conditions by a factor of 2 (136 cfs). To increase the pumping capacity, it is proposed to replace the existing pumps with upgraded ones to match what is currently in place at the Main B pump station that are capable of pumping an approximate maximum capacity of 143 cfs. Included in the pump station upgrade are the necessary structural, electrical, and other necessary upgrades to serve the pump station.
2. Upsizing the North Travis Street Culverts from 2-54" and 2-48" pipe culverts to 5-8'x8' box culverts to remove restrictions on flow reaching pump station Main A.
3. Channel improvements along the Main A channel from the parking lot culvert outfall to the pump station. These improvements include approximately 1 mile of regrading the channel to include a 15' bottom width, 4:1 side slopes and resetting the channel slope to allow for consistent drainage. The channel improvements are modified downstream of North Travis Street to pump station Main A for approximately 1,400 feet to include a 30' bottom width while keeping 4:1 side slopes.
4. The culvert under the tractor supply parking lot will be upsized from 1-84" pipe to 2-84" pipes

(See **Figure F.27.**) Following the implementation of these local area improvements, 4 miles of road and an estimated 167 structures (including 1 critical facility) would be removed from the 100-year floodplain; 123 of these are residential structures, ultimately resulting in approximately 1,850 individuals removed from the 100-year flood risk. Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**). The project cost is \$7,639,000.

Figure F.27. Main A Pump Station and Conveyance Improvements (FMP 033000068)



FMP 033000069 – Highland Ave. Drainage Improvements

The City of Waxahachie developed a Drainage Master Plan to evaluate existing conditions and develop alternatives to address flooding concerns in five (5) specific areas – one of these areas is the Highland Avenue project area. The Highland Avenue project area includes the Highland Avenue storm drain, West Marvin Avenue storm drain, Union Pacific Railroad culvert, BNSF Railroad Bridge, BNSF Railroad culvert, West Main Street Culvert, and West Jefferson Street culvert connecting to Waxahachie Creek as shown in **Figure F.28**.

An ICM model was created to model the performance of existing stormwater infrastructure, identify buildings and roads at flood risk, and develop three alternatives to mitigate flood risks both upstream and downstream in accordance with the “Manual for Design of Storm Drainage Systems” criteria (May 2001). Each individual alternative proposes improvements to the Highland Avenue storm drain system; however, the alternatives were designed to work in unison together, with mitigation in one area corresponding to the increased conveyance in another area. The proposed improvements include:

- Major conveyance improvements by upsizing and installing additional inlets while simultaneously using the alleys between Highland Avenue and West University Avenue to deliver flow and tie into the Highland Avenue storm drain system at Martha Street and West Ross Street
- Implementing a regional detention pond to limit flows to the railroad capacity
- Downstream conveyance improvements by having additional storm drain to capture flow to West Main Street culvert and divert flow downstream towards West Jefferson Street.

The project cost is \$9,365,000, and following the implementation of these mitigation measures, an estimated 0.24 miles of roadway, 20 structures – all of which are residential buildings - and 33 people would be removed from the 100-year floodplain.

Based on the comparative assessment performed for this FMP, the proposed project does not meet all no negative impacts requirements as established in the *TWDB Technical Guidance (Exhibit C Section 3.6.A)*. However, the Trinity RFPG considers this project to conform to the no negative impacts requirements based on professional engineering judgment (see Error! Reference source not found.).

Although there are slight increases in peak flow at the upstream portion of the project, this is likely due to the increase in storm drain capacity. Additionally, the increases to the 100-year inundation boundary are minimal and do not affect any structures downstream. In most areas, the inundation has been reduced due to proposed drainage infrastructure and building inundation has also been reduced.

FMP 033000070 – Fairgrounds Detention Option 3

The Fairgrounds Detention FMP, developed from the Pecan North Pecan Watershed Study Report²⁰, proposes options for a detention pond upstream of Denton Center Shopping Mall along North Pecan Creek. The current system has a LOS corresponding to the 10-year storm event (10% annual chance storm event).

The proposed project includes mitigating structural flooding during the 100-year storm event (1% annual chance flood event) floodplain. HEC-HMS version 4.2 and HEC-RAS version 5.0.5. models were created to analyze the impact that the proposed improvements would have in the event of a 100-year storm event (1% annual chance storm event).

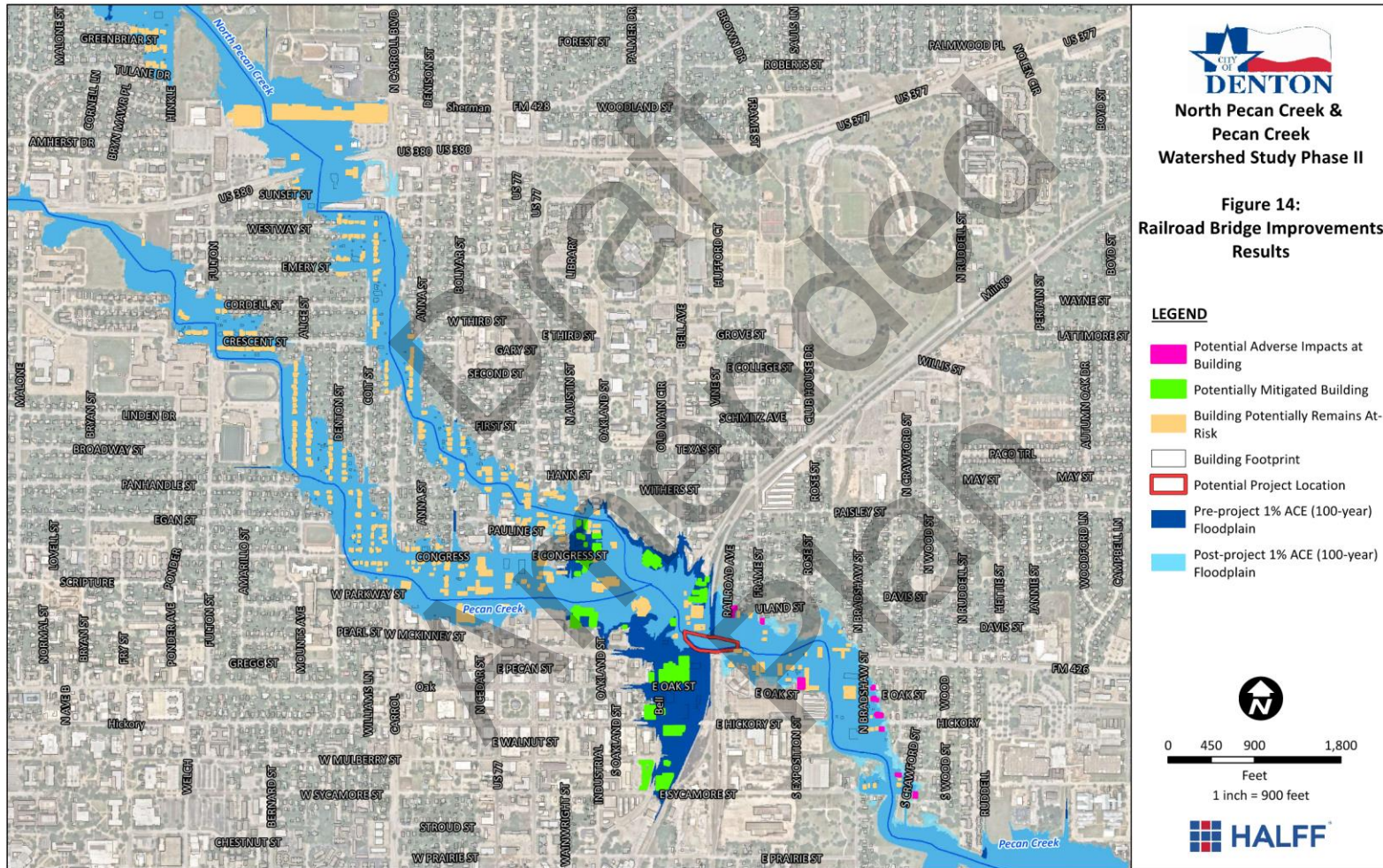
At a cost of \$24,234,000, the proposed project will provide a level of service (LOS) corresponding to the 100-year storm event (1% annual chance storm event). The pond will feature a surface area of 35 acres and a storage volume of 265 acre-feet, reducing 100-year flows to 76% of their previous magnitude. This pond would be an inline pond along North Pecan Creek. With a dam height above 6 feet, the location would be subject to TCEQ regulations. (See **Figure F.29.**)

Following the implementation of this detention pond, an estimated 2.51 miles of roadway and 58 structures, 37 of which are residential structures, would be removed from the 100-year floodplain. This correlates to an estimated 1228 individuals removed from the 100-year flood risk. This alternative also removes the Denton Center Shopping Mall downstream from 100-year flood risk.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1.**)

²⁰ *Pecan Creek and North Pecan Creek Watershed Study & Alternatives Analysis*, Halff Associates, February 2021

Figure F.29. Fairgrounds Detention (FMP 033000070)



FMP 033000071 – Design/Construction for Holland Lake Spillway

Holland Lake Dam is located on Holland Lake Creek in the Trinity River Basin, within the City of Weatherford, Texas in Parker County. The lake impounded by the dam, which is owned and operated by the City of Weatherford, serves as a recreational pond for the city-owned Holland Lake Park. The Design/Construction of Holland Lake Spillway project was initially conceptualized in the Holland Lake Dam (TX09628) Hydrologic Assessment & Breach Analysis study performed by Freese and Nichols, Inc. (FNI), in October 2012. This study included various dam safety analyses and associated project recommendations to achieve compliance with Texas Commission on Environmental Quality (TCEQ) dam safety standards. FNI was later retained to design the recommended dam improvements and a 90% design plan set was completed in July 2017. The 2012 study included a hydrologic assessment to approximate the Probable Maximum Flood (PMF) for Holland Lake Dam. The PMF analysis is necessary in order to determine the hydraulic adequacy of the dam in its current condition. A dam breach analysis was performed to determine the potential downstream hazards associated with a dam failure. The PMF and Breach Analyses were conducted following TCEQ's Hydrologic and Hydraulic Guidelines for Dams (2007).

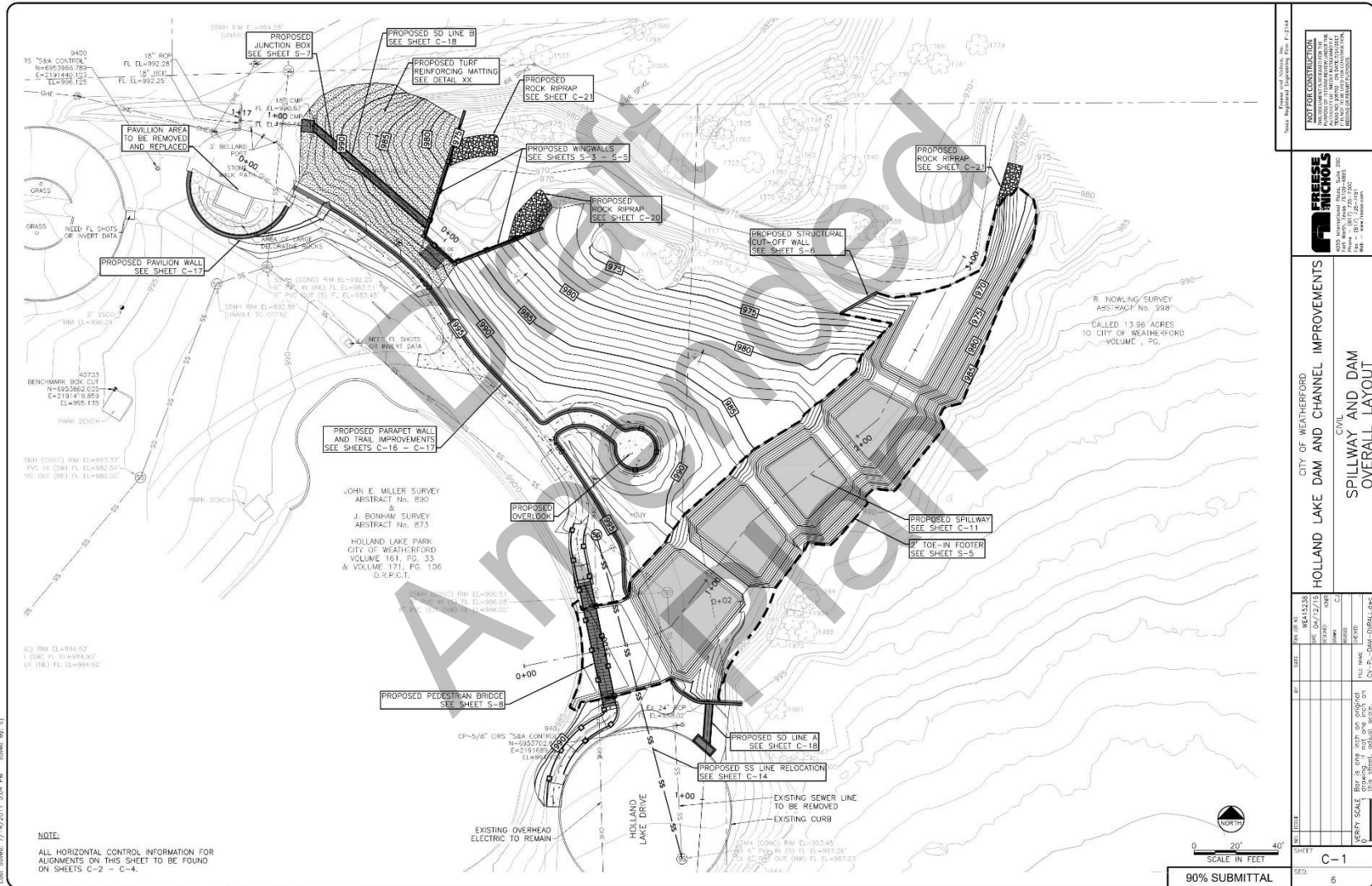
Holland Lake Dam falls under the jurisdiction of the TCEQ due to potential impacts in case of dam failure. As a small, low hazard dam, Holland Lake Dam is required to pass 25 percent of the PMF according to State criteria. The dam was found to be only capable of passing 5 percent of the PMF without overtopping. Holland Lake Dam is therefore considered hydraulically inadequate in its current condition.

Several modification alternatives were analyzed to upgrade the dam to be able to pass the 25 percent PMF, which would be the required design storm if the dam were able to maintain a low hazard classification. For the Holland Lake Dam watershed, the 25 percent PMF peak inflow roughly corresponds to the 100-year flood peak inflow, as developed in a previous study. The proposed modifications consist of a combination of adding an emergency spillway through the right abutment of the dam along with raising the top of dam elevation. The proposed emergency spillway will have a crest elevation of 989 feet, approximately 1.5 feet above the service spillway crest of 987.5 feet. (See **Figure F.30**.) The proposed top of dam would be raised approximately 5 feet from existing conditions to an elevation of 995.1 feet. The project cost is \$3,860,000.

Aerial imagery from 2012 was reviewed to identify structures that could potentially be impacted by outflows from Holland Lake Dam. If a dam break were to occur during the 25% PMF event (approximately a 100-yr event), one structure would experience flooding conditions (flood depth = 0.35 ft). The proposed dam modifications are intended to safely pass the 25% PMF event, and reduce the risk of dam failure. Furthermore, with these improvements, the potentially-impacted property would not experience flooding conditions during the 25% PMF event.

Based on this comparative assessment, this FMP meets all no negative impacts requirements (see Error! Reference source not found.).

Figure F.30. Design/Construction for Holland Lake Spillway (FMP 033000071)



FMP 033000072 - Elkins Lake Dam Rehabilitation

Elkins Lake Dam is located within the City of Dalworthington Gardens, Texas. The dam is situated in the Trinity River Basin and impounds water along an unnamed tributary of Rush Creek. The area located within the potential inundation area of a breach of Elkins Lake Dam only contains structures within City of Arlington. If a breach were to occur at Lake Elkins Dam, City of Arlington residents would be affected. Potential impacts of a breach contain several units (approximately 40 units) of the Cinnamon Park apartment complex, as well as Spanish Trail. The presence of habitable structures, with possible impacts to greater than seven lives, as well as the road, result in the classification of Elkins Lake Dam as a high hazard dam. According to Texas Administrative Code §299.15, a small size, high hazard structure is required to pass 75 percent of the Probable Maximum Flood (PMF) without being overtopped. The dam currently passes 31 percent of the PMF, well short of the required minimum.

The dam is hydraulically inadequate in its current condition. The City of Dalworthington Gardens determined that an evaluation of the dam and advancement of the design be performed, as necessary, to comply with TCEQ Dam Safety regulations. An alternatives analysis was completed in February 2020 which included additional modeling to evaluate alternatives for improvement and achieve compliance with TCEQ. The selected alternative consists of the addition of two 60-inch diameter culverts to the existing spillway and widening of the vegetated approach channel. In addition, the crest of the dam would be raised to a crest elevation of 569.5 ft, which is a maximum of 3.1 ft raise. (See **Figure F.31.**) The purpose of the modifications to the structure is to bring the dam into compliance with TCEQ criteria by adding discharge and storage capacity. The project cost is \$1,705,000.

Based on the comparative assessment performed for this FMP, the proposed project does not meet all no negative impacts requirements as established in the *TWDB Technical Guidance (Exhibit C Section 3.6.A)*. However, the Trinity RFPG considers that the Elkins Lake Dam Rehabilitation FMP conforms to the no negative impacts requirements based on professional engineering judgment (See Error! Reference source not found.).

Although there are increases in the 100-yr water surface elevations (WSE) and peak flows downstream of the dam, increases do not cause any adverse impacts to insurable structures or means of ingress/egress. Apartment buildings located along Spanish Trail are not flooded and maintain a freeboard of more than 5 ft in proposed conditions. More than 2.5 ft of freeboard to the bottom of the bridge deck remains at Spanish Trail in proposed conditions.

Conversations with various City staff including the Floodplain Manager is still needed, as well as coordination with the Natural Gas Drilling and Exploration Company.

FMP 033000073 - Arlington Bonneville/Greenbrook Drainage Improvements

The Bonneville/Greenbrook Drainage Improvements FMP was developed from the City of Arlington's Bonneville/Greenwood Neighborhood Drainage Study²¹. The current storm drain system surcharges during storm events as frequent as the 5-year storm, resulting in 0.25 miles of road flooding and 14 structures in the floodplain in the 100-year event. Several structures flood in more frequent events.

The proposed alternative realigns the 12-ft by 4-ft RCB storm drain through Greenbrook Dr. and the Huntwick Addition to outfall farther to the south along Rush Creek Tributary 5. The improvement includes upsizing of existing trunk lines including:

- Replacing 590 LF of 36-inch RCP with 8-ft by 3-ft RCB
- Replacing the Bonneville Drive 18-inch lateral with a 27-inch RCP.
- Replacing 470 LF of 48-inch RCP with 10-ft by 4-ft RCB
- Replacing 85 LF of 39-inch RCP to 10-ft by 4-ft RCB
- Constructing an additional 200 LF of 8-ft by 4-ft RCB
- Upsizing multiple 10-ft and 15-ft curb inlets to 20-ft curb inlets
- Upsizing multiple 5-ft curb inlets to 10-ft curb inlets

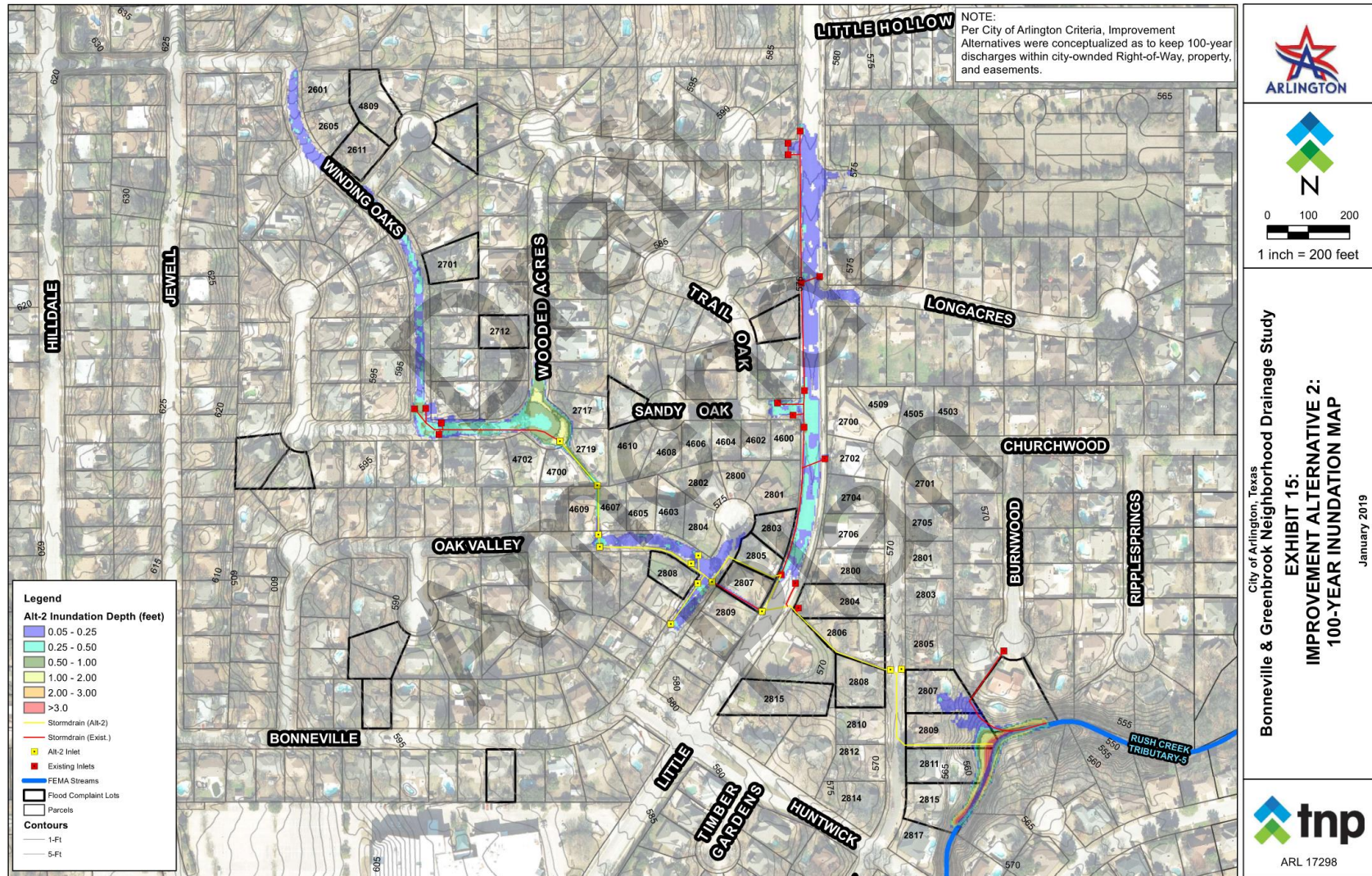
and addition of curb inlet capacity in several locations. The improvement also includes some acquisition of property to facilitate construction of improvements, reconstruction of a portion of Little Road and an alternative alignment for the proposed outfall line into the stream. (See **Figure F.32.**)

At a cost of \$4,939,000, the improvements mitigate flooding throughout the study area with the storm drain capacity improvements eliminating stormwater overflow in the 100-year storm event. This will remove 0.25 miles of road from the floodplain as well as all 14 structures. This correlates to an estimated 37 people removed from the 100-year floodplain. The alternative also allows for more feasible construction of the upsized pipes by utilizing Greenbrook drive and nearby driveways and drainage easements.

Based on the comparative assessment performed for this FMP, the proposed project does not meet all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A). However, the City of Arlington's Bonneville/Greenwood Neighborhood Drainage Study includes an adverse impacts mitigation solution at an additional cost. The proposed mitigation alternative mitigates downstream impacts from the proposed project alternative. This mitigation alternative also alleviates erosion downstream of Woodside Drive along the northern channel and extends a gabion or modular block, which will provide additional support to the channel bank that is currently eroding and prevent further erosion. The mitigation alternative is a separate improvement from the chosen project alternative but would need to be implemented to mitigate the downstream impacts created by the chosen project alternative (see **Table F.1**).

²¹ *Bonneville / Greenbrook Neighborhood Drainage Study*, Teague, Nall, and Perkins, June 2020

Figure F.32. Arlington Bonneville/Greenbrook Drainage Improvements (FMP 033000073)



FMP 033000074 - Lebow Flood Mitigation Project

Lebow Channel has an existing LOS less than 1-year storm event. The crossings along Lower Lebow are undergoing effort to achieve an LOS of the 100-year storm event except Schwartz Avenue, which requires channel modifications in order to meet the 100-year LOS.

The Upper Lebow portion encounters more flooded structures than Lower Lebow. Upper Lebow is a channel over 8,000 LF in length, crossing a total of nine roadways, all of which are overtopped during the 2-year event, except Terminal Road and Long Avenue. The channel generally has a 2-year capacity, with the 100-year floodplain averaging 400 to 500 feet wide.

In general, the Lower Lebow channel improvements consist of widening and regrading the channel to include benching and a naturally-aligned low-flow channel. Approximately 4,000 LF of the low-flow channel flowline will be lowered between one and seven feet. The overbank slopes are as steep as 4:1 (H:V) in some locations, but are less steep in most areas. Two bypass channels are proposed, one paralleling Hardy Street and one along Vera Cruz Street. Both bypass channels were selected and designed to minimize impacts to the tree canopy in the area.

Upper Lebow will need to be widened and lowered with 0.5:1 (H:V) sloped gabion-basket walls. The proposed bottom width averages between 32 and 38 feet, reaching as wide as 48 feet at culverts. Eight out of the nine crossings along Upper Lebow will be upgraded to pass the 100-year storm event and maintain one foot of freeboard. (See **Figure F.33.**) The Upper Lebow improvements also include a detention facility located north of Long Avenue, adjacent to the Diamond Hill Addition. The Upper Lebow Storm Water Detention Facility is proposed to maintain a 'no-rise' condition in the existing 100-year water surface elevation. (See **Figure F.34.**)

Significant utility coordination will need to take place to accommodate the Upper Lebow improvements. Right of way acquisition will be required for the capacity improvements, including easements along the entire alignment, some properties at crossings, and additional property for the detention pond at Long Avenue. The project requires a USACE Section 404 individual permit and will be subject to a strategically phased implementation plan based on factors including public safety, hydraulic dependency, FEMA permitting/mapping, environmental impact/mitigation, property acquisition/easement takings and funding availability. It is anticipated the improvements will provide 100-year level of service in both Upper and Lower Lebow. The total cost for the construction of the Lebow Channel improvements is estimated to be \$30,349,000.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

Figure F.33. Lebow Flood Mitigation Project [Lower End] (FMP 033000074)

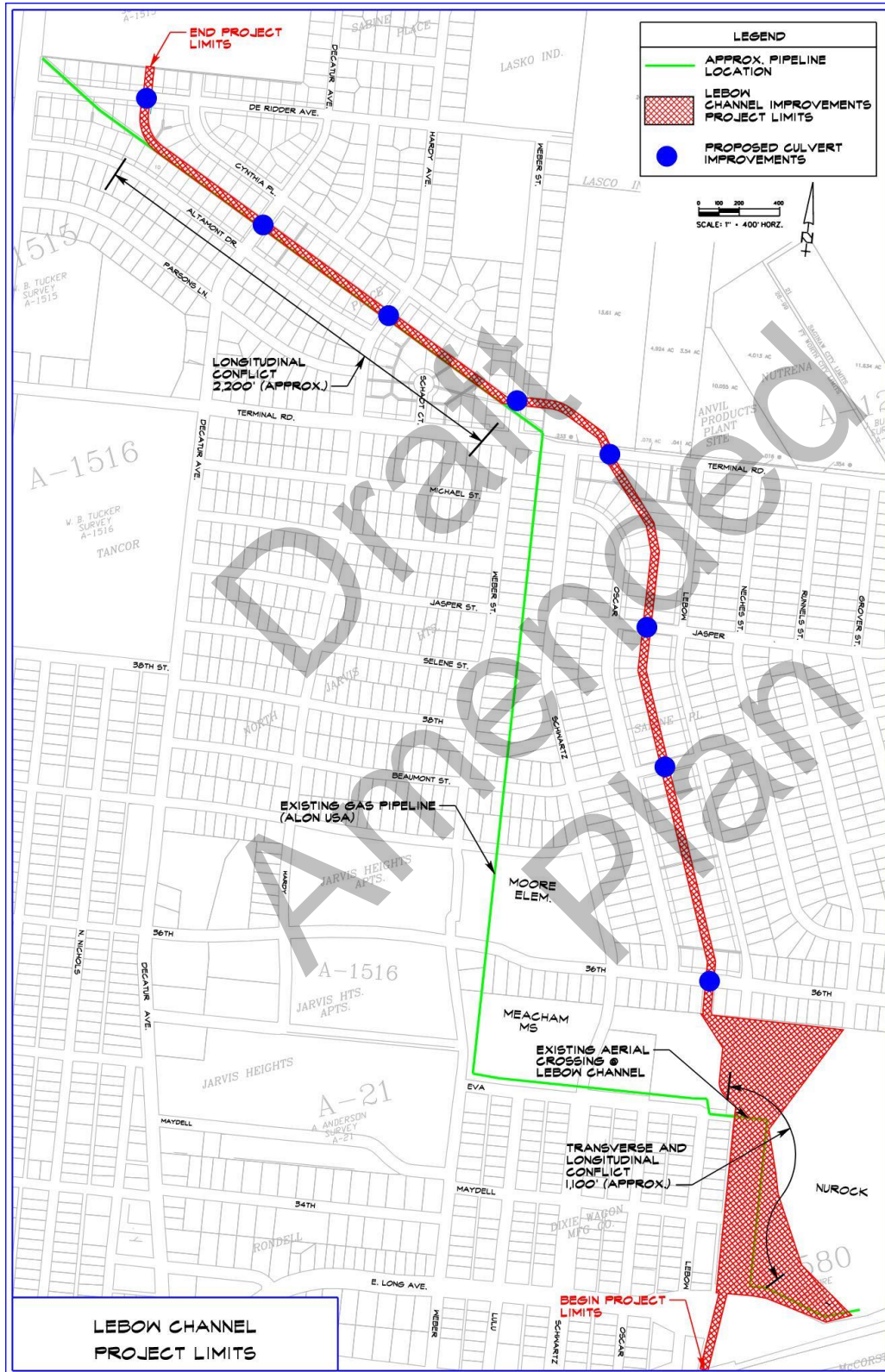


Figure F.34. Upper Lebow Storm Water Detention Facility



FMP 033000075 - Village Creek [Dobson St (CR 714)] Safety Improvements

The City of Burleson completed a stormwater masterplan for the Willow Creek and Village Creek watersheds in 2023²². This study identified alternatives to improve street and structure flooding during the ultimate conditions 100-year storm event. This FMP pertains to Safety Improvements in the Village Creek watershed, which includes a creek crossing at County Road 714.

Significant improvements are needed at this crossing as it currently has less than a 2-year level of service. Since those improvements would be costly, safety improvements are recommended for this crossing. These safety improvements may include high-water warning flashers, staff gauges, flood hazard signs, and additional light fixtures (See **Figure F.35**). The project cost is \$273,000.

No physical or quantifiable benefits would result from the implementation of these safety improvements. However, these improvements would be a prevention measure to help reduce the traffic on flooded roads.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the *TWDB Technical Guidance (Exhibit C Section 3.6.A)*. This FMP does not propose to alter the hydrology or hydraulics of the watershed. The proposed improvements are limited to minor disturbances to place signs or lights to increase visibility in the area. Therefore, no negative impacts are anticipated with the implementation of this FMP (see **Table F.1**).

²² *Willow Creek and Village Creek Master Drainage Plan*, Freese and Nichols, Inc., 2023.

Figure F.35. Village Creek [Dobson St (CR 714)] Safety Improvements (FMP 033000075)



FMP 033000077 - White Settlement Rd. Storm Sewer System Improvements

The White Settlement Rd FMP was developed from the Westworth Village Master Drainage Plan²³ for storm sewer improvements. The level of service for White Settlement Rd does not currently contain beyond the 1-Year storm event (100% annual chance storm event).

The proposed project improvements include upgrading the existing storm sewer, which consists of upsizing 1940 LF of existing storm sewer, 5 junction boxes and 2 headwalls from east of Burton Hill Road to west of Tanny Street, along with 5 new inlets and 5 new curb extensions. (See **Figure F.36** and **Figure F.37**.)

PCSWMM models were used to model the fully developed hydraulics for the public drainage infrastructure within the watershed. Peak runoff flow rates for multiple storm events in fully developed conditions within the City's watershed were determined via PCSWMM Method & Energy Step Method.

The proposed project will provide significant containment in the event of a 100-year storm (1% annual chance storm event) at a cost of \$1,904,000.

Following the implementation of these drainage and erosion improvements, an estimated 0.64 miles of roadway and 12 structures will be removed from the 100-year floodplain, 11 of which are residential structures. This correlates to an estimated 33 individuals removed from the 100-year flood risk. Additionally, 2.16 acres of farmland would have reduced area within the 100-year floodplain but would not be fully removed from flood risk following these improvements.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

²³ *Westworth Village Master Drainage Plan*, Kimley-Horn, September 2021

Figure F.36. White Settlement Rd. Storm Sewer System Improvements (FMP 033000077)

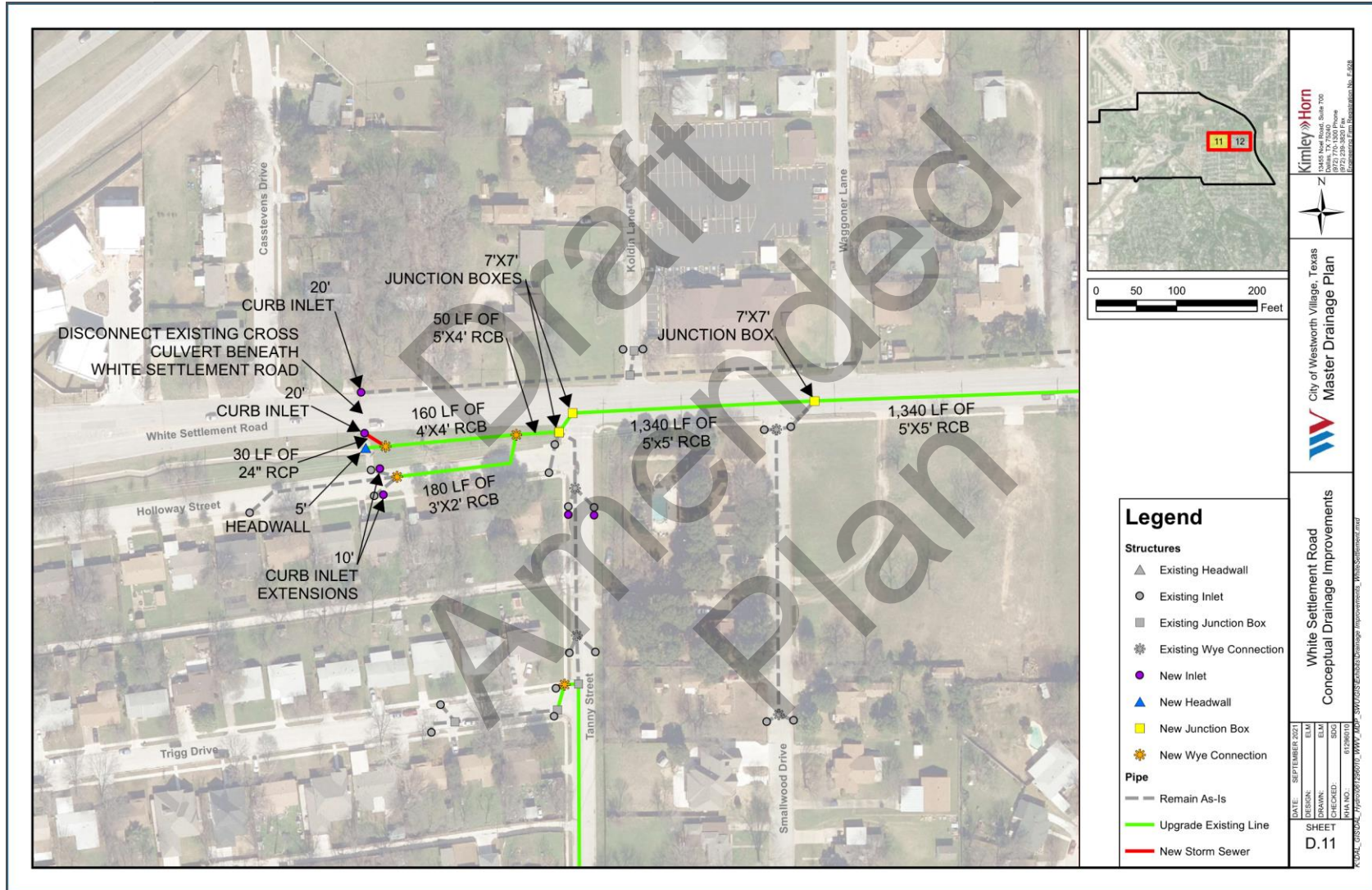
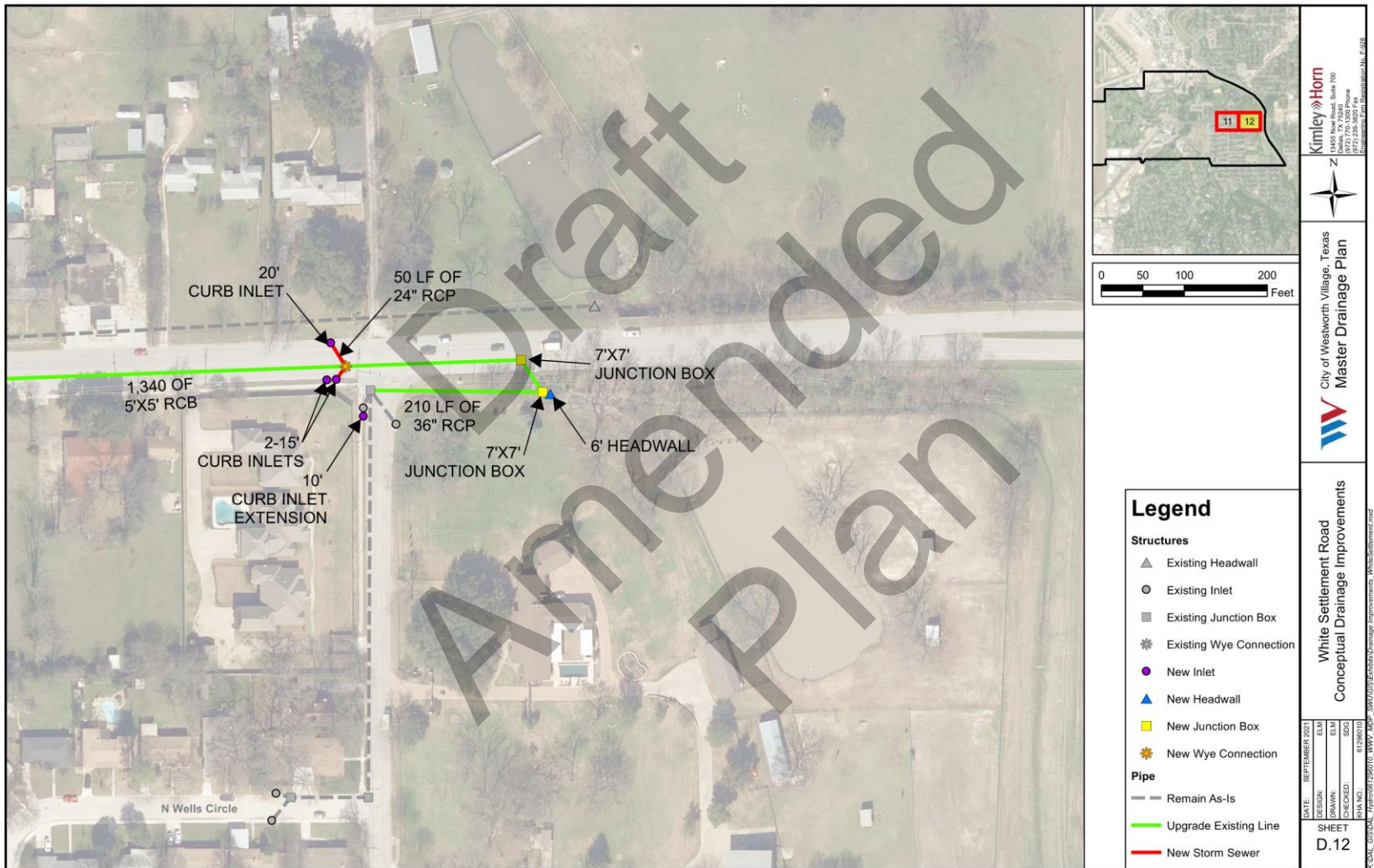


Figure F.37. White Settlement Rd. Storm Sewer System Improvements (FMP 033000077)



FMP 033000078 - Main B Pump Station, Detention, and Conveyance Improvements

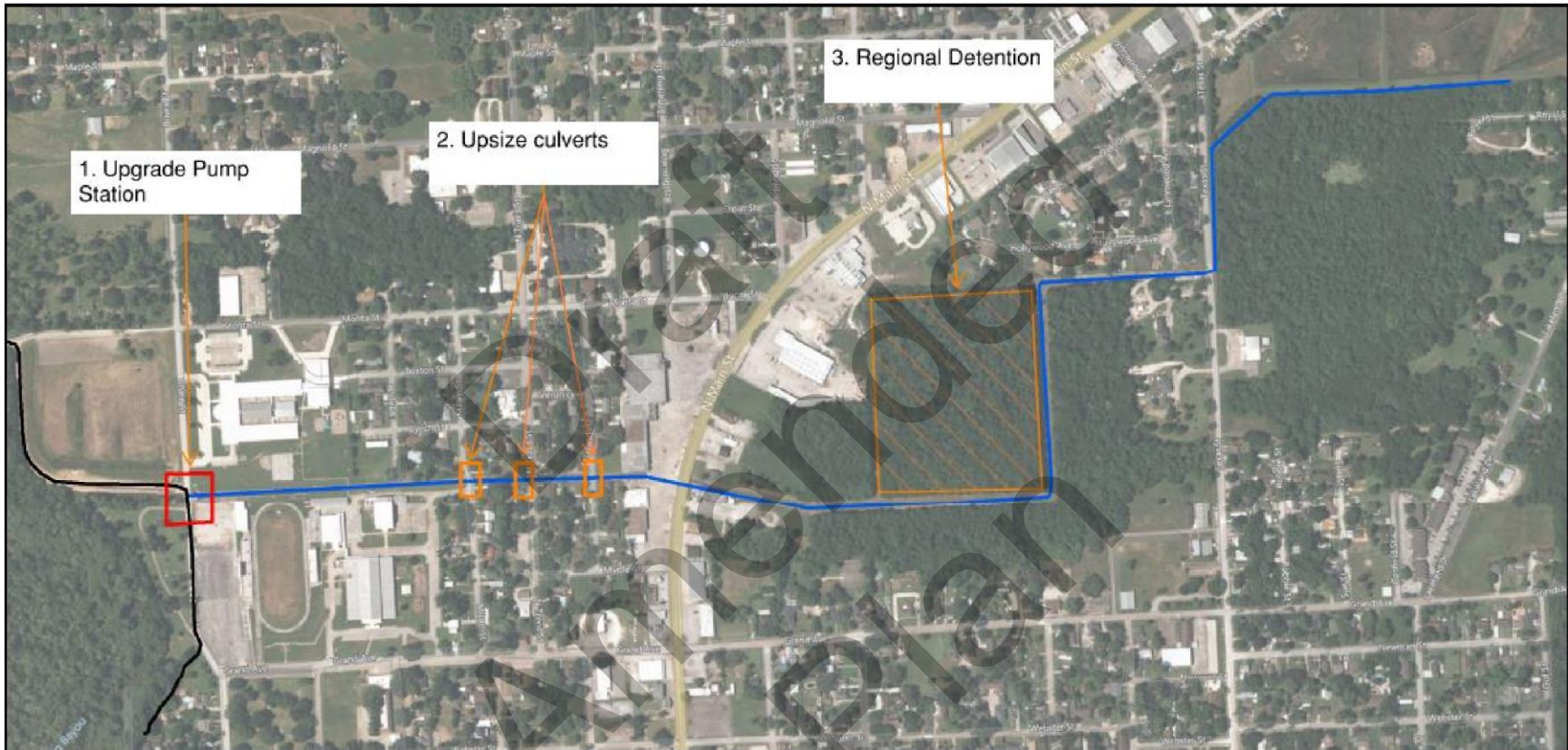
The City of Liberty has been subjected to numerous widespread flooding events. To protect the City from high stages on the Trinity River, a levee system was constructed around the northwestern side of the City. The levee has a number of gravity outfalls throughout its perimeter as well as 3 pump stations that are used to drain the City when the Trinity River is in flood stage. In spite of the levee, the City remains at an elevated flood risk due to inadequate internal drainage systems that can efficiently convey water out of the City. The stage of the Trinity River is often elevated by releases from Lake Livingston requiring that the pump stations are the only means of removing stormwater from the system. The local water control and improvement district, Liberty County WCID#5 is responsible for operating and maintaining the pump stations as well as the drainage channel infrastructure that feeds into the pump stations. The City is served by two primary drainage channels that lead to two pump stations operated and maintained by WCID#5 commonly referred to as Main A and Main B.

The proposed improvements consist of:

1. Rehabilitating and upsizing Pump Station B. Currently the twin pumps have a maximum capacity of 142.6 cfs when operating together at full capacity. It is proposed to upgrade the existing pumps and add a third pump of similar capacity to bring the total pumped capacity up to 213.9 cfs. Included in the pump station upgrade are the necessary structural, electrical, and other necessary upgrades to serve the pump station.
2. Upsizing the culverts on Main B to be a consistent size. The culverts at North Travis Street and Milam Street will be upsized from 1-6'x5' and 2-5'x5' to 3-6'x6' RCBs, and the culverts at Woods Drive will be upsized from 3-5'x5' to 3-6'x6' RCBs to reduce the flow restrictions on the Main B channel.
3. Regional detention basin upstream of Main Street to reduce peak flows traveling downstream into the Main B system where capacity is more limited. The proposed basin is approximately 12.5 acres adjacent to the channel and will be filled via a weir that allows the basin to function to shave off peak flows from the primary flood wave.

(See **Figure F.38.**) Following the implementation of these local area improvements, an estimated 3 structures would be removed from the 100-year floodplain, all of which are residential, ultimately resulting in approximately 12 individuals removed from the 100-year flood risk. Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (See **Table F.1.**) The project cost is \$14,433,000.

Figure F.38. Main B pump station, detention, and conveyance improvements (FMP 033000078)



FMP 033000079 - Cordell Detention Pond (Rayzor Elementary School Pond)

The Cordell Detention Pond project was developed from Pecan Creek and North Pecan Watershed Study & Alternatives Analysis²⁴. This project is located southeast of the intersection of West University Drive and Malone Street along Pecan Creek near Newton Rayzor Elementary School. The current LOS for the area is less than what could contain the 10 years storm event (<10% annual chance storm event).

This pond would be an inline pond that requires excavation and grading to maximize the storage. The construction of a dam across Pecan Creek would be required to detain the desired volume of floodwaters. The detention pond near the school would have approximately 90 acre-feet in capacity and a surface area of around 12 acres. (See **Figure F.39.**)

At a cost of \$15,497,000, the project reduces water surface elevations enough to remove 39 homes and 3 businesses from the 100-year floodplain. This correlates to an estimated 373 individuals removed from the 100-year floodplain. This project is anticipated to provide a LOS corresponding to the 100-year storm event.

This proposal results in a 1% ace peak flow reduction of 7% to 14% along Pecan Creek. The peak flow is also reduced 28% directly downstream of the pond. This project alternative will reduce the flood risks along Pecan Creek.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

²⁴ *Pecan Creek and North Pecan Creek Watershed Study & Alternatives Analysis*, Halff Associates, February 2021

Figure F.39. Cordell Detention Pond (Rayzor Elementary School Pond) (FMP 033000079)



FMP 033000081 - Town Creek Warren Park Extension

The City of Burleson completed a stormwater masterplan for the Town Creek and Shannon Creek watersheds in 2004 and updated in 2021²⁵. This study identified alternatives to improve street and structure flooding during the ultimate conditions 100-year storm event. This FMP pertains to property buyouts in the Town Creek watershed.

Significant improvements are needed at the railroad crossing downstream as it currently has a 10-year level of service and causes backwater effects to multiple roadway crossings upstream. Since those improvements would be costly, property buyouts in the area immediately upstream of the railroad would be a solution to decrease structural flooding in the area. This solution proposes the voluntary acquisition of structures that are at risk of flooding and extending the existing Warren Park (see **Figure F.40**). The project cost is \$10,346,000.

Project models reveal that 19 structures that were once inundated over one foot can be bought by the City and the property converted into a park. In total, 27 structures would be purchased and removed from the floodplain along with 0.1 miles of roadway. These 27 structures are all residential structures, which correlates to 65 individuals removed from the 100-year flood risk.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the *TWDB Technical Guidance (Exhibit C Section 3.6.A)*. This FMP would replace impervious area with pervious area, so a reduction in flows could occur. A reduction in peak flows would be a benefit to this community. No negative impacts are anticipated with the implementation of this FMP (see **Table F.1**).

²⁵ *Town Creek and Shannon Creek Master Drainage Plan*, Freese and Nichols, Inc., 2021.

FMP 033000082 - Project 18 - Waterview Dr. Re-route

Project 18 – Waterview Dr. Re-Route was developed from the West Fork of Cottonwood Creek Capital Improvement Projects Report²⁶. N. Waterview Drive drains by various isolated storm sewer systems that convey water to the main creek (West Fork of Cottonwood Creek). These systems do not have capacity to convey the 100-year storm event individually, causing the system to surcharge at different locations along N. Waterview Drive.

Project 18 proposes a 5,700 LF storm sewer diversion system that will redirect water from the main creek at approximately 520 feet downstream of Campbell Road and outfall back to the main creek just upstream of Arapaho Road. (See **Figure F.41**) Specifically, the project proposes:

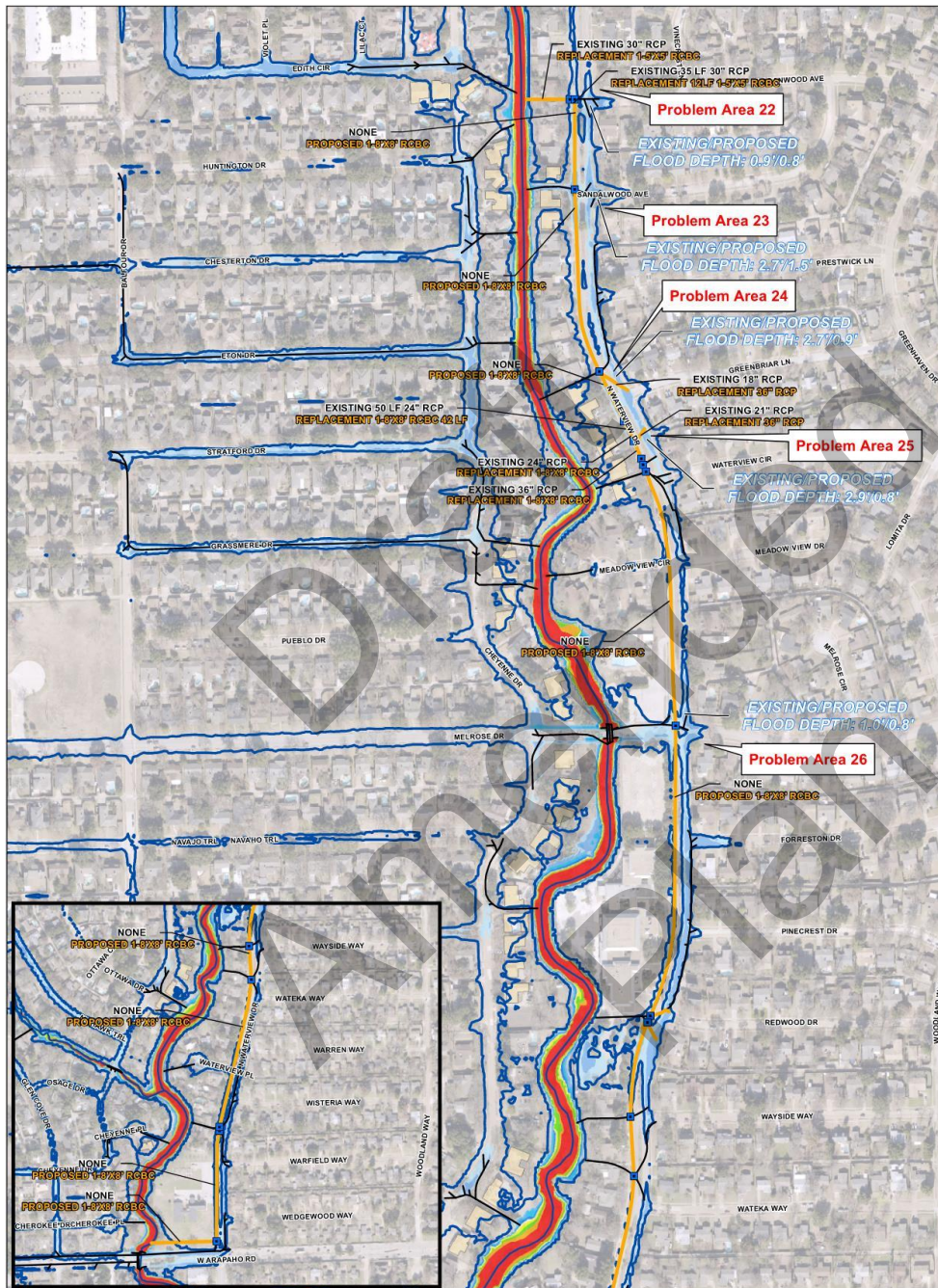
- Replace 12 LF of 15-inch RCP with a 30-inch RCP.
- Replace 29 LF of 15-inch RCP with a 36-inch RCP.
- Replace 110 LF of 18-inch RCP with a 36-inch RCP.
- Replace 134 LF of 21-inch RCP with a 36-inch RCP.
- Replace 45 LF of 27-inch RCP with a 30-inch RCP.
- Replace 73 LF of 24-inch RCP with an 8-ft by 8-ft RCBC.
- Replace 152 LF of 30-inch RCP with a 5-ft by 5-ft RCBC.
- Replace 83 LF of 36-inch RCP with an 8-ft by 8-ft RCBC.
- Construct 5,413 LF of 8-ft by 8-ft RCBC.
- Construct 10 LF of additional curb inlets
- Construct 18 junction boxes with manholes for constructability and maintenance

After implementation, the project will remove 33 homes from the 100-year floodplain. This correlates to an estimated 118 individuals removed from the 100-year floodplain. The estimated project cost is \$11,500,000 and a 100-year LOS (1% annual chance floodplain).

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

²⁶ *West Fork of Cottonwood Creek Capital Improvement Projects (CIPs)*, LJA Engineering, August 2022

Figure F.41. Project 18 - Waterview Dr. Re-route (FMP 033000082)



<p>Key to Features</p> <ul style="list-style-type: none"> Existing Storm Sewer Stream Centerline Potentially Affected Structures Existing 100-Year Floodplain Above 0.25 ft Depth <p>Proposed Features</p> <ul style="list-style-type: none"> Proposed Inlet Proposed Junction Box Proposed Storm Sewer 	<p>100-Year Proposed Project Flood Depths</p> <ul style="list-style-type: none"> 0.25 - 0.5 0.5 - 1 1 - 1.5 1.5 - 2 2 - 2.5 2.5 - 3 3 - 3.5 3.5 - 4 > 4 	<p>West Fork Watershed Capital Improvement Projects City of Richardson, Dallas County, Texas</p>	<p>Figure B25 Project No. 18 N. Waterview Drive (Diversion)</p>	<p>Source of Aerial Imagery: City of Richardson, 2019</p> <p>Project No. NTP852F</p>			<p>LJA ENGINEERING FRN - F - 1386</p>
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FMP 033000083 - Pumphrey Dr. Storm Sewer System Improvements

The Pumphrey Drive FMP was developed from the City of Westworth Village Master Development Plan²⁷ for storm sewer improvements. The site currently has less than a 1-year LOS (contains the 100% annual chance storm event), so the area floods frequently and severely.

The proposed project includes upgrading 280 LF of existing storm sewer, two existing inlets, and a headwall. (See **Figure F.42.**) Within the City's watersheds, fully developed conditions peak runoff flow rates for multiple storm events were determined via PCSWMM Method & Energy Step Method in PSCWMM.

At a cost of \$221,000, the proposed project will provide a minimum of a 100-year (1% annual chance) storm event level of service.

Following the implementation of these storm sewer improvements, approximately 300 ft of roadway and 2 structures would be removed from the 100-year floodplain, of which one is a residential structure. This correlates to an estimated 3 individuals removed from the 100-year flood risk.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

²⁷ *Westworth Village Master Drainage Plan*, Kimley-Horn, September 2021

Figure F.42. Pumphrey Dr. Storm Sewer System Improvements (FMP 033000083)



FMP 033000084 - Channel and Crossing Improvements on Redmond Creek south of the City of Ames

The City of Ames lies within the service of Liberty County Water Control and Improvement District #5 (WCID#5) and has been subjected to numerous widespread flooding events. Ames drains primarily through Redmond Creek and its tributaries, which face a restriction at the FM 160 crossing south of the City. A neighborhood along Redmond Creek is subject to street flooding and excessive street flow due to lack of localized drainage infrastructure and restrictions at FM 160 and Redmond Creek as well as a culvert restriction east of Redmond Creek that serves to collect local sheet flow. FM 160 itself is subject to flooding and overtopping in relatively minor storm events which can be remedied by the improvements proposed in this project.

The proposed improvements consist of:

1. Channel improvements to Redmond Creek to include widening the channel to have a 5' bottom width and a trapezoidal shape to include 4:1 side slopes and clearing out of overgrown heavy vegetation within the channel itself.
2. Upsizing the culverts at two locations on FM 160. The primary crossing of Redmond Creek will be upsized from 3 – 84" RCPs to 4-8'x7' RCBs. A crossing to the west will also be upsized from an estimated 1-24" RCP to 2-3'x2' RCBs to better conveyed roadside ditch drainage that collects sheet flow from a large area to the north and conveys Redmond Creek overflows to a channel south of FM 160.

(See **Figure F.43.**) While the proposed improvements do not remove any structures from the 100-year floodplain, the model shows that an estimated 3 structures will see a reduced 100-year flood risk. Based on the comparative assessment performed for this FMP, the proposed project does not meet all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A). There are minor increases to peak flows downstream of FM 160 in the 10-year and 100-year events, but these changes are merely 0.15% and 0.5% increases in peak flows. It is anticipated that as the design progresses these minor increases in flows can be removed by further refining the proposed improvements (see **Table F.1**). The project cost is \$1,255,000.

Figure F.43. Channel and Crossing Improvements on Redmond Creek south of the City of Ames (FMP 033000084)



FMP 033000085 - Arlington Harvest Hills Channel and Drainage Improvements

The Arlington Harvest Hills Channel and Drainage Improvements FMP, developed from the Harvest Hills and Briar Meadow Neighborhood Drainage Study²⁸, is an area currently impacted in events as minor as 2-year storms. During the 5-year storm, roadway flooding over 2 feet is seen along Wickersham Drive and Guinevere Street. Structure flooding up to one foot is seen during the 5-year storm for two residences. The 100-year storm causes flooding in up to 47 homes. This is primarily caused by undersized storm sewer in the neighborhood.

Proposed drainage system improvements were evaluated to protect homes from the 100-year storm event in the Harvest Hills and Briar Meadow neighborhoods in Arlington. Option 2 (Briar Meadow Diversion) with downstream channel improvements is recommended.

Option 2 involves the removal and replacement of the storm drain system from Coronado Street to the channel, along with required property buyouts. This option will also disconnect the existing 54-inch bypass from the storm drain main line and provide separate outfalls for the bypass and storm drain main. Option 2 will increase the capacity of the storm drainpipe system from approximately 270 cfs to 502 cfs, including the bypass system. (See **Figure F.44**)

The proposed storm drain improvement options causes an increase in flow from existing conditions of approximately 200 cfs to the channel and result in higher peak water surface elevations. Channel and culvert improvements were evaluated in HEC-RAS to reduce peak water surface elevations in the downstream channel system. The channel from Overbrook Drive to New York Avenue, New York Avenue to Mayfield Road, and from Mayfield to the confluence of North Fish Creek (a total of 2,965 linear feet) were modeled as a vertical wall channel with additional depth and top width than existing. In addition, the culvert crossings at New York Avenue and Mayfield Road require additional box culverts. Easements would be required for the channel widening and recommended maintenance access ramp.

Option 2 includes renewal of water, sanitary sewer, and pavement in the locations of proposed storm drain improvements and the acquisition of 6 properties. The anticipated cost of Option 2 with the downstream channel improvements and property acquisitions is \$15,063,000.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements when constructed with the channel improvements, as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

²⁸ *Harvest Hills and Briar Meadow Neighborhood Drainage Study*, Westra Consultants, April 2019

Figure F.44. Arlington Harvest Hills Channel and Drainage Improvements (FMP 033000085)

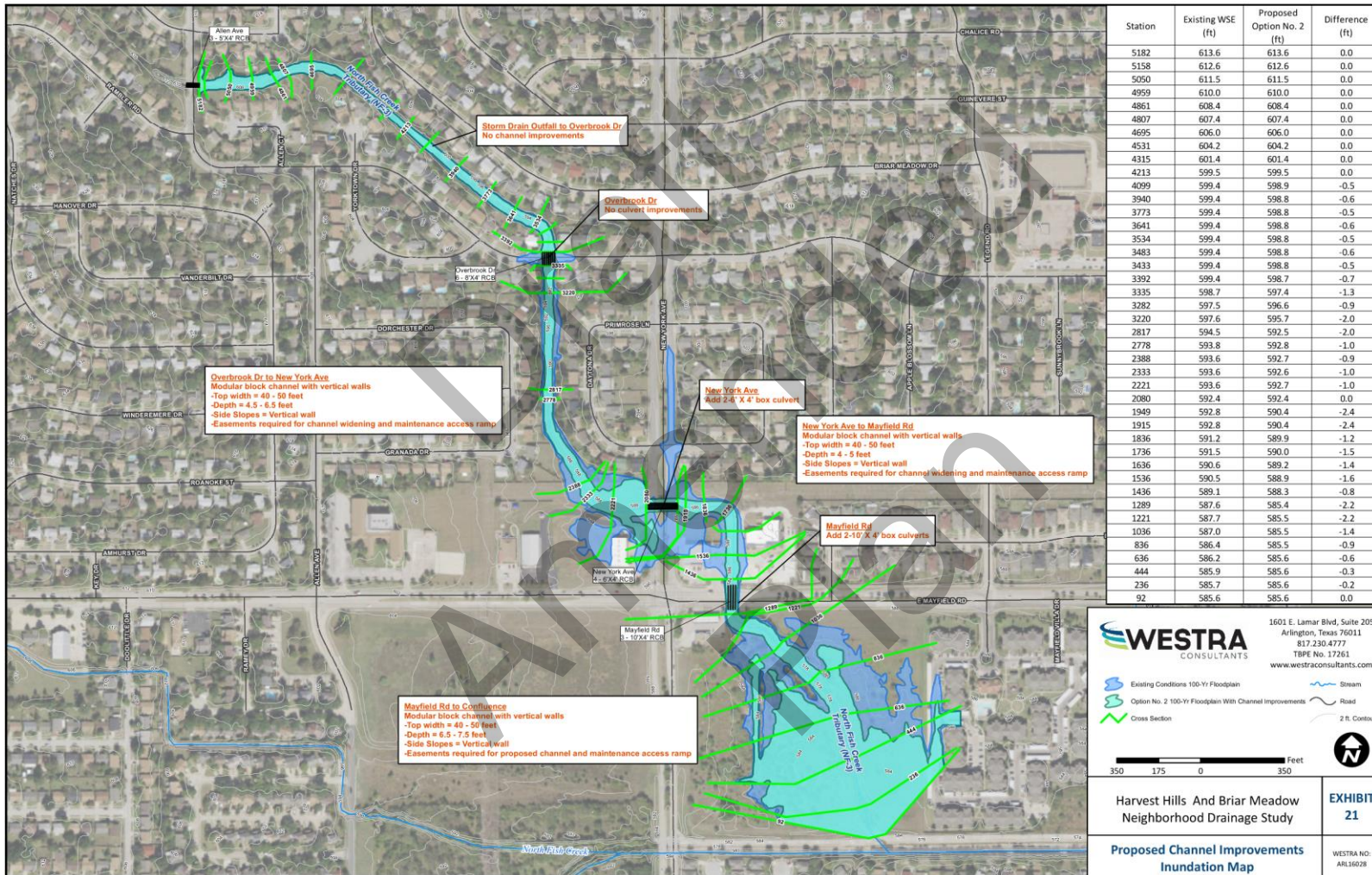
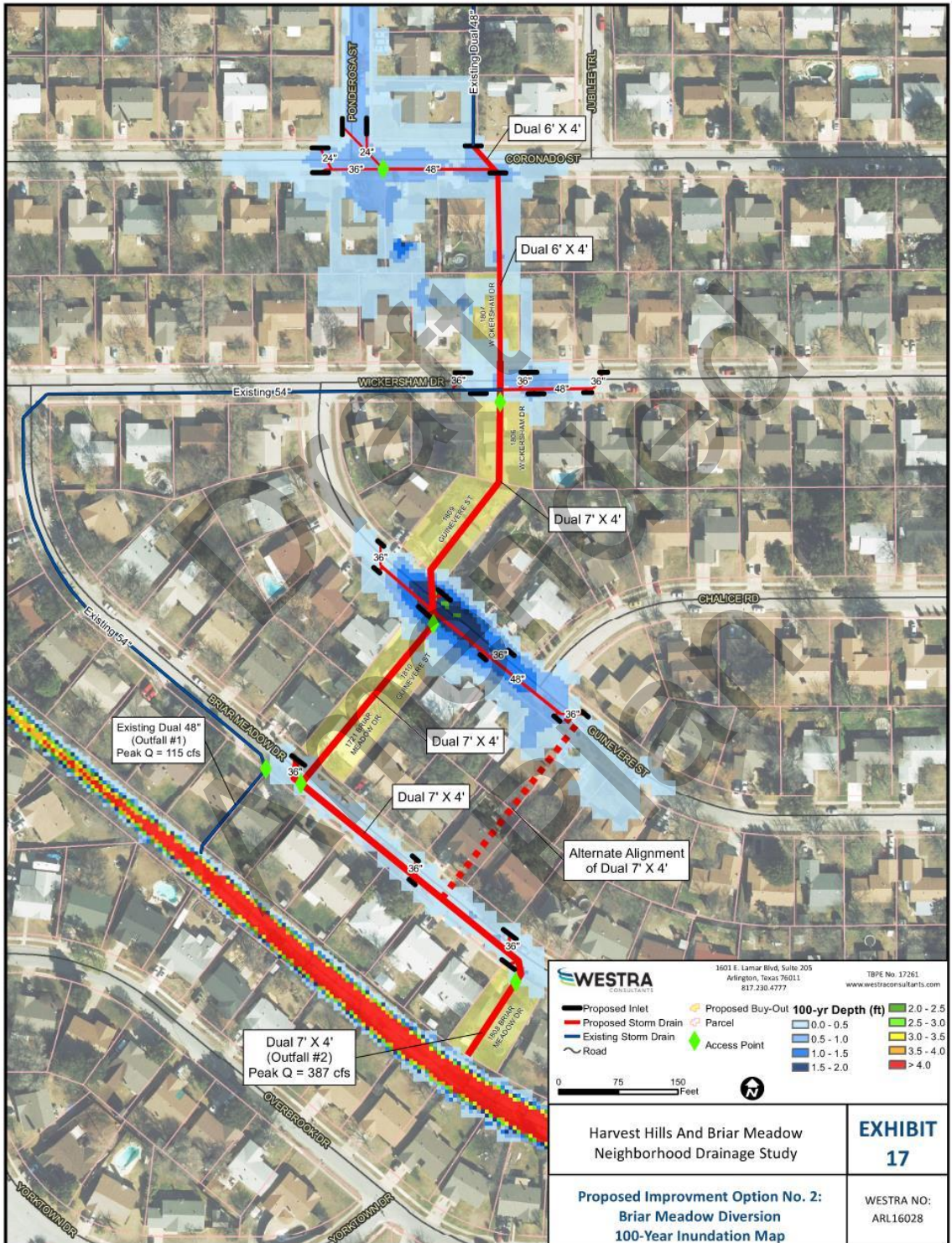


Figure F.45. Arlington Harvest Hills Channel and Drainage Improvements (FMP 033000085)



FMP 033000086 - Project 8a - Cheyenne Dr

As part of the larger West Fork of Cottonwood Creek Capital Improvements Projects Report²⁹, the current project area along Cheyenne Drive experiences ponding depths of up to 3.1 feet during the 100-year storm, primarily due to undersized storm sewer drainage. This ponding adversely affects nine properties in the immediate area.

Project 8a - Cheyenne Dr proposes upsizing the existing storm drain infrastructure on Cheyenne Dr. south of Melrose Dr. and increases the number of curb inlets to reducing flooding of Cheyenne Dr. and adjacent streets. (See **Figure F.46.**) Specifically, the improvement includes:

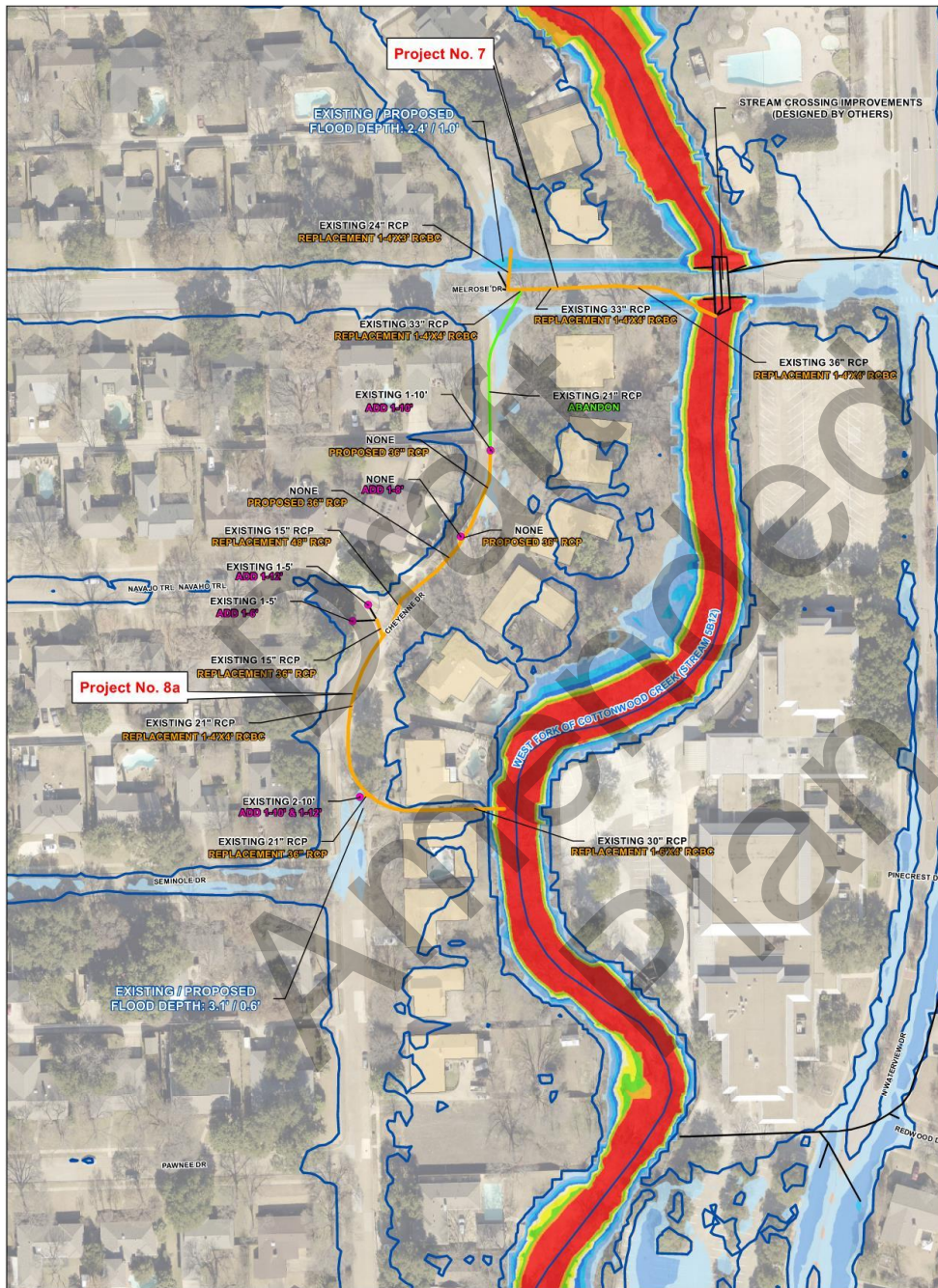
- Replace 19 LF of 15-inch RCP with a 36-inch RCP.
- Replace 45 LF of 15-inch RCP with a 48-inch RCP.
- Replace 9 LF of 21-inch RCP with 36-inch RCP.
- Replace 190 LF of 21-inch RCP with a 4-ft by 4-ft RCBC.
- Replace 180 LF of 30-inch RCP with a 6-ft by 4-ft RCBC.
- Construct 204 LF of 36-inch RCP.
- Construct 60 LF of additional curb inlets.

The proposed project will provide a 100-year LOS (1% annual chance storm event) and remove 7 residential structures, along with an estimated population of 20 individuals, from the floodplain. Proposed improvements will reduce the flood depth from 3.1 feet to 0.6 feet, keeping the floodwaters within the ROW and away from adjacent properties. The estimated cost for this project is \$792,000.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A).

²⁹ *West Fork of Cottonwood Creek Capital Improvement Projects*, LJA Engineering, August 2022

Figure F.46. Project 8a - Cheyenne Dr (FMP 033000086)



<p>Key to Features</p> <ul style="list-style-type: none"> Existing Storm Sewer Stream Centerline Potentially Affected Structures Existing 100-Year Floodplain Above 0.25 ft Depth <p>Proposed Features</p> <ul style="list-style-type: none"> Proposed Inlet Proposed Storm Sewer Abandon 	<p>100-Year Proposed Project Flood Depths</p> <ul style="list-style-type: none"> 0.25 - 0.5 0.5 - 1 1 - 1.5 1.5 - 2 2 - 2.5 2.5 - 3 3 - 3.5 3.5 - 4 > 4 	<p>West Fork Watershed Capital Improvement Projects</p> <p>City of Richardson, Dallas County, Texas</p>	<p>Source of Aerial Imagery: City of Richardson, 2019</p>	
		<p>Figure B9</p> <p>Project No. 7 & 8a</p> <p>N. Cheyenne Drive & Melrose Drive/Navajo Trail</p>	<p>Project No. NTP852F</p>	

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FMP 033000087 - Arlington Johnson Creek - Arkansas Lane and Pioneer Parkway Buyout at Johnson Creek

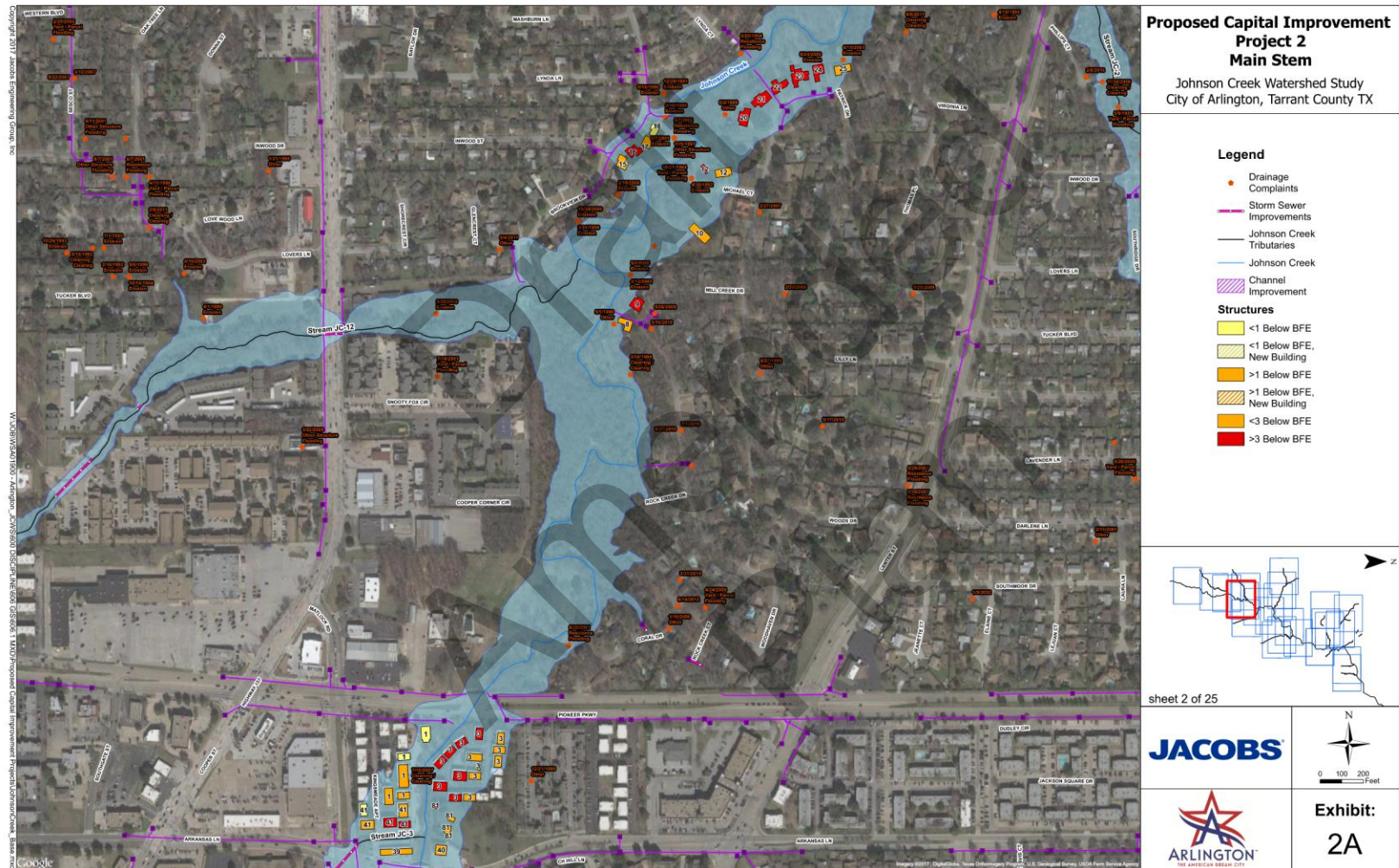
This project was developed from the Johnson Creek Watershed Study. The project is located between Arkansas Lane and Pioneer Parkway. The project area is currently predicted to have 24 residential structures in the 100-year floodplain (10% annual chance storm event), equating to 157 individuals currently in the 100-year floodplain.

The acquisition and demolition of approximately twenty-four (24) structures is what this project entails. No channel improvements or negative impacts will occur. To address the erosion and flooding concerns along Johnson Creek, these structures need to be bought out. (See **Figure F.47.**) Proposed improvements will remove all residential structures from the floodplain as well as provide 100-year LOS to the immediately surrounding area. The estimated buyout cost is \$7,675,000.

Based on the comparative assessment performed for this FMP, the proposed project does not meet all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

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Figure F.47. Arlington Johnson Creek - Arkansas Lane and Pioneer Parkway Buyout at Johnson Creek (FMP 033000087)



FMP 033000088 - Project 13 - Mimosa & Melrose Dr

The Mimosa Drive & Melrose Drive System FMP, developed from the West Fork of Cottonwood Creek Capital Improvement Projects Report³⁰, proposes options for storm sewer replacements and additions. The current location is subject to severe roadway flooding with 1.33 miles of roadway impacted in the 100-year storm (1% annual chance flood event). The existing conditions model shows 140 CFS of uncollected flow in the roadway which negatively impacts the intersection and surrounding properties.

The proposed project includes upsizing 790 linear feet of storm sewer mains and laterals with larger storm sewers, adding 665 linear feet of parallel storm sewer, constructing 81 linear feet of new storm sewer, and adding 244 linear feet of curb inlets to eliminate inlet overflow. (See **Figure F.48.**)

Specifically, the alternative includes:

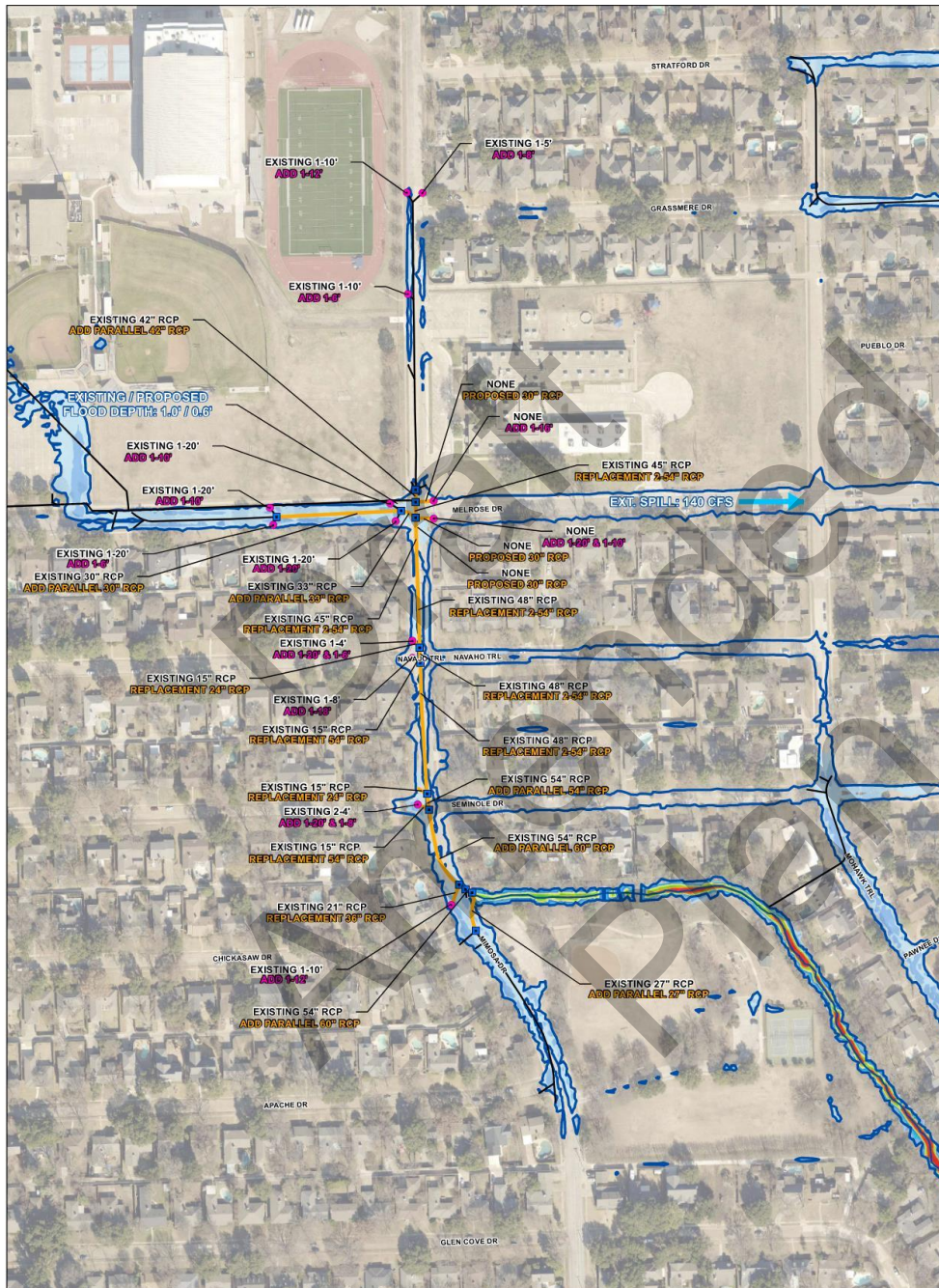
- Replace 43 LF of 15-inch RCP with a 24-inch RCP.
- Replace 48 LF of 21-inch RCP with a 36-inch RCP.
- Replace 48 LF of 15-inch RCP with a 54-inch RCP.
- Replace 173 LF of 42-inch RCP with two 54-inch RCP.
- Replace 152 LF of 45-inch RCP with two 54-inch RCP.
- Replace 326 LF of 48-inch RCP with two 54-inch RCP.
- Construct Parallel 73 LF of 27-inch RCP.
- Construct Parallel 270 LF of 30-inch RCP.
- Construct Parallel 35 LF of 33-inch RCP.
- Construct Parallel 27 LF of 42-inch RCP.
- Construct Parallel 35 LF of 54-inch RCP.
- Construct Parallel 225 LF of 60-inch RCP
- Construct 81 LF of 30-inch RCP.
- Construct 244 LF of additional curb inlets.
- Construct thirteen junction boxes with manholes.

HEC-RAS and XPSTORM models were created to analyze the impact that the proposed improvements would have. The structural LOS for this alternative is the 100-year storm event (1% chance of occurrence), as the 100-year storm is held to the right-of-way. Following the implementation of these storm sewer improvements, an estimated 0.74 miles of roadway would be removed from the 100-year floodplain. The project area population of 314 people would benefit from reduction in road closures. Additionally, some agricultural land would have reduced area within the 100-year floodplain but would not be fully removed from flood risk following these improvements. The project also supports other project areas within the City of Richardson.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

³⁰ *West Fork of Cottonwood Creek Capital Improvement Projects*, LJA Engineering, August 2022

Figure F.48. Project 13 - Mimosa & Merose Dr (FMP 033000088)



Key to Features	
Existing Storm Sewer	100-Year Proposed Project Flood Depths
Existing 100-Year Floodplain Above 0.25 ft Depth	0.25 - 0.5
Proposed Inlet	0.5 - 1
Proposed Junction Box	1 - 1.5
Proposed Storm Sewer	1.5 - 2
	2 - 2.5
	2.5 - 3
	3 - 3.5
	3.5 - 4
	>4

West Fork Watershed Capital Improvement Projects
City of Richardson, Dallas County, Texas

Figure B18
Project No. 13
Mimosa Drive & Melrose Drive

Source of Aerial Imagery:
City of Richardson, 2019

Project No. NTP852F

0 200 400 Feet
1 inch = 200 feet



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FMP 033000089 - Arlington Johnson Creek - Collins Street and Division Street Buyout

The Collins Street and Division Street Buyout was developed from the Johnson Creek Watershed Study. This project is located between Collins Street to the south and Division Street to the North along Johnson Creek. Currently, there are 76 residential structures, an estimated population of 640 individuals, currently impacted by the 100-year storm event (1% annual chance storm event).

The acquisition of approximately one hundred twenty-four (124) structures is what this project entails. No channel improvements or negative impacts will occur. These structures are recommended to be bought out to address the erosion and flooding concerns along Johnson Creek,. (See **Figure F.49.**)

At a cost of \$30,258,000, the project removes 76 homes, and the 640 residents, from the 100-year floodplain.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

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Figure F.49. Arlington Johnson Creek - Collins Street and Division Street Buyout (FMP 033000089)



FMP 033000090 - Town Creek Railroad and S. Warren Street Improvements

The City of Burleson completed a stormwater masterplan for the Town Creek and Shannon Creek watersheds in 2004 and updated in 2021³¹. This study identified alternatives to improve street and structure flooding during the ultimate conditions 100-year storm event. This FMP pertains to roadway crossing improvements to reduce structure and roadway flooding in the Town Creek watershed.

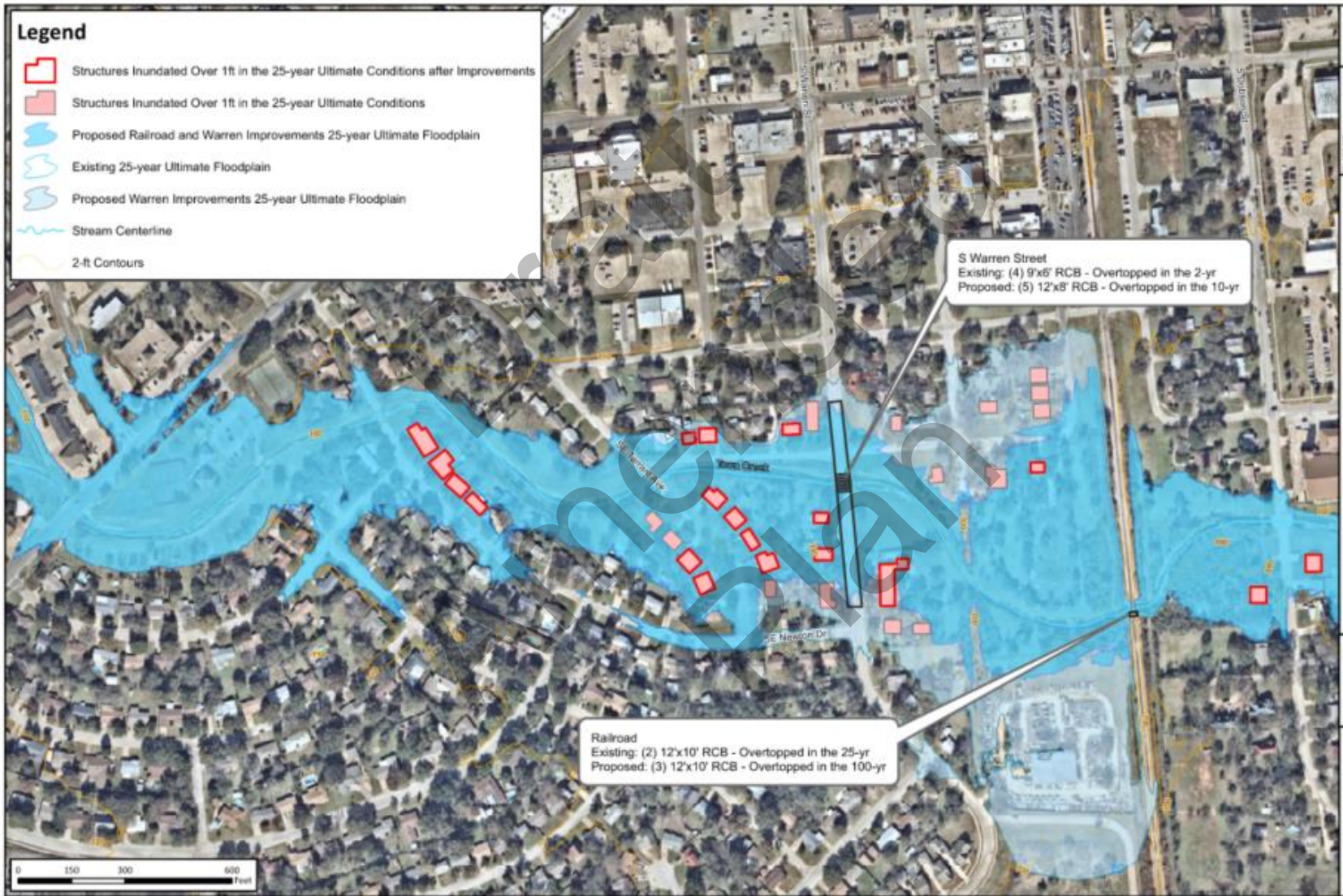
Significant improvements are needed at the railroad crossing as it currently has a 10-year level of service and causes backwater effects to multiple roadway crossings upstream, including S. Warren Street. The existing crossing contains two 12'x10' RCBs, and this project suggests an additional 12'x10' RCB be added to increase capacity. Additionally, the current S. Warren Street crossing is overtopped in the 2-year storm event. Therefore, this project also recommends raising the roadway elevation by 2.5' and replacing the existing four 9'x6' RCBs with five 12'x8' RCBs (see **Figure F.50**). These improvements bring the post-project level of service to 100-yr for the railroad crossing and 10-yr for the S. Warren Street crossing. The project cost is \$2,441,000.

Project models reveal that, while no structures are completely removed from the 100-yr floodplain, 20 structures show a reduced 100-yr flood risk.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the *TWDB Technical Guidance (Exhibit C Section 3.6.A)* (see **Table F.1**).

³¹ Town Creek and Shannon Creek Master Drainage Plan, Freese and Nichols, Inc., 2021.

Figure F.50. Town Creek Railroad and S. Warren Street Improvements (FMP 033000090)



FMP 033000091 - Saturn Springs Estates Drainage Improvements

The previous study for the Saturn Springs Estates neighborhood³² includes analysis of the residential street drainage and Stream 2C3 (also known as Ruperds Branch). The current storm sewer is undersized to cope with the current level of development and rainfall, which leads to flooding along roadways and residential properties in events as frequent as the 2-year (50% annual chance event).

Negative impacts from flooding are caused by the insufficient storm drainage at the 50% annual chance storm and riverine flooding at 10% annual chance storm event. The proposed solutions are Alternative Two for the channel improvements and Option Two for the storm drain improvements.

Alternative two focuses on protecting areas prone to erosion near Stream 2C3 by constructing gabions and retaining walls in areas of the channel prone to high velocity, as well as where structures are within 5 feet of the channel bank, where utilities are threatened by erosion, and around the Glenbrook Drive crossing. (See **Figure F.51**) Through alternative two, nine (9) habitable and two (2) accessory structures are removed from the 100-year floodplain.

Option two focuses on storm drain upgrades including upsizing multiple pipes along Briarwood, Glenbrook, Kynn, and Larry Drives; repairing and installing curb and gutter; and installing lateral lines for additional inlets. (See **Figure F.52**) Option two removes sixteen (16) habitable and thirty-one (31) accessory structures from the 100 year floodplain. Both Alternative Two and Option Two are recommended for implementation.

The estimated project cost is \$10,510,000.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

³² *Saturn Springs Estates Drainage Improvements*, O'Brien Engineering, Inc., October 2021

Figure F.51. Saturn Springs Estates Drainage Improvements (FMP 033000091)

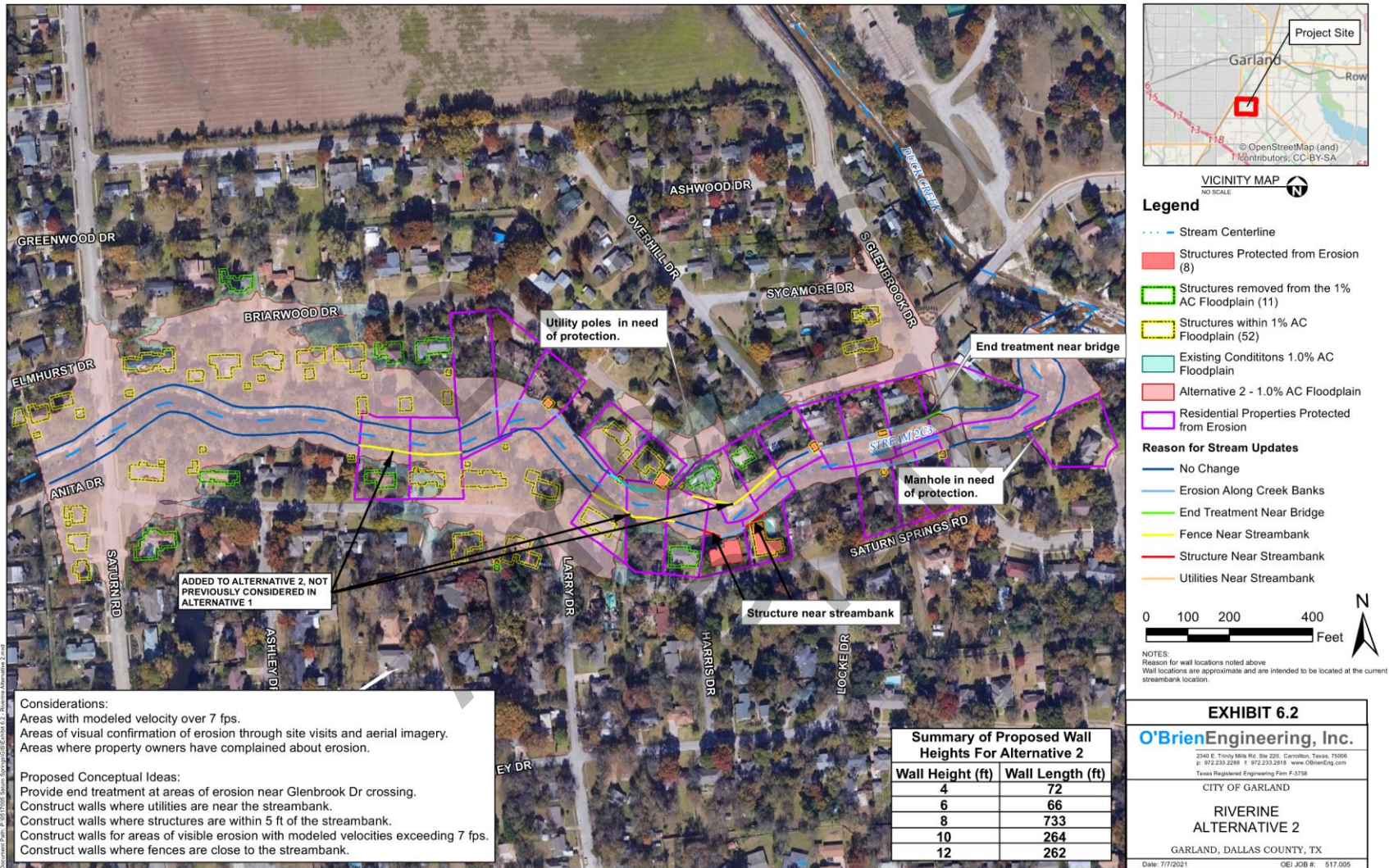
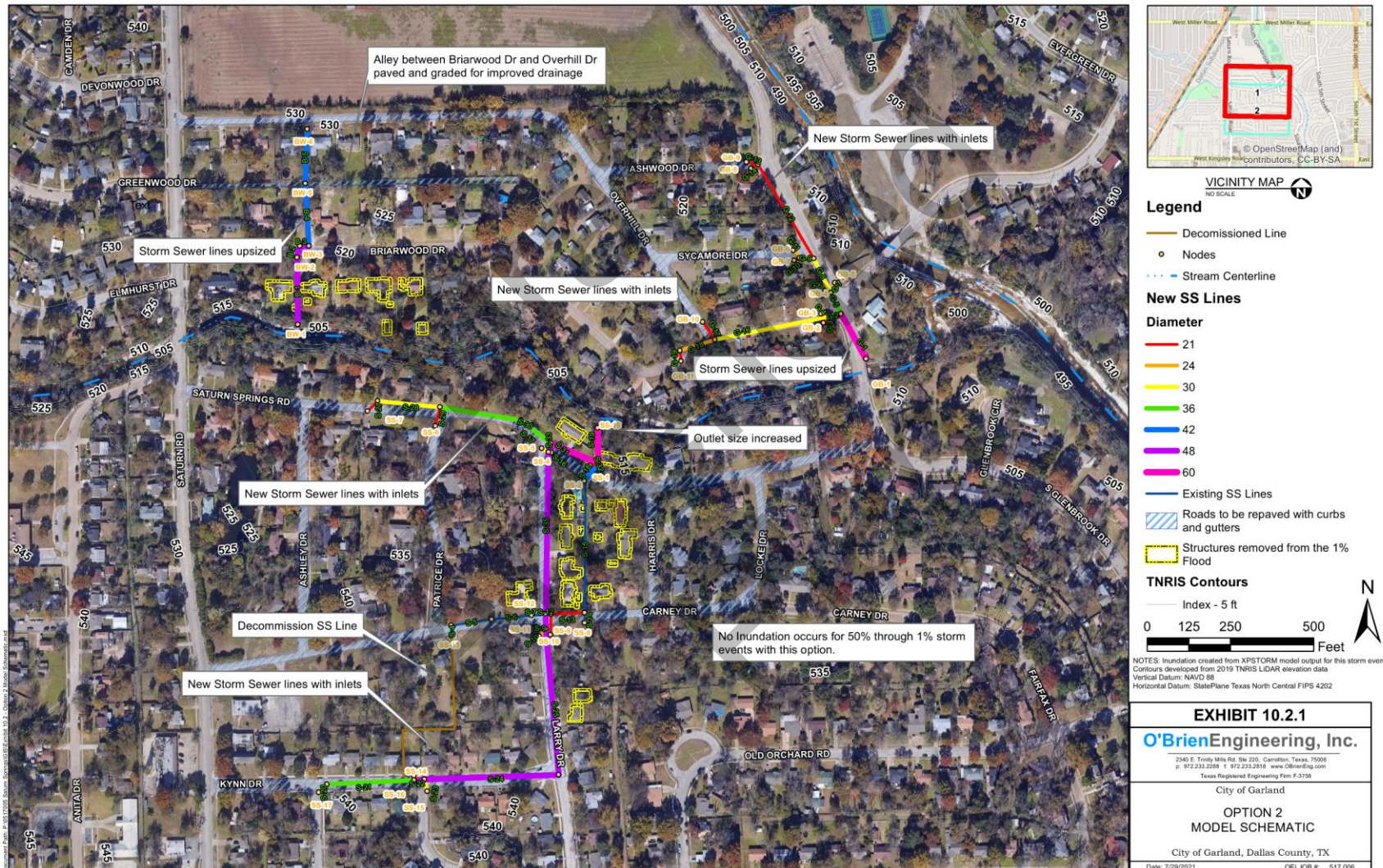


Figure F.52. Saturn Springs Estates Drainage Improvements (FMP 033000091)



FMP 033000092 - Terrell KC1 Watershed Drainage Improvements

The City of Terrell developed a Drainage Master Plan for the portion of the City between Kings Creek on the east and Bachelor Creek on the west. Study area KC1 is generally bounded on the north by Brin Street, the south by Rochester Street, the west by Pacific Avenue, and the east by Kings Creek. The confluence of the tributaries occurs slightly east of the Gardner Street crossing and flows between the railroad tracks and the Stalling's Addition subdivision. The existing storm drain systems vary in age and condition, though are generally in fair or better condition.

The upper watershed storm drains were modeled using ICM, with separate models north and south of US-80, called "Virginia" and "East" respectively. The lower watershed open channels were modeled using HEC-RAS to the confluence with Kings Creek. The H&H analysis demonstrates that storm drains are needed on Brin Street, College Street, Rochester Street, and Gardner Street with some slight differences in alignments and extents of existing storm drains. Doing so will allow the removal of the valley gutters and the hazard it poses to vehicles. The flow will be contained from Rockwall Avenue all the way to the outfall in the main channel, just downstream of Blanche Street. Additionally, a new drainage crossing at SH 34 is recommended at High Street to provide increased capacity that results in a slight reduction in depth at the High Street sag point during the 100-year storm and a significant reduction during the 2-year storm. Inlet pairs will be placed at every intersection to capture additional runoff along the alignment. Upsizing the Railroad Crossing and improving the channel adjacent reduces flood hazard and will lessen the probability of the railroad being overtopped.

The Gardner Street culvert and channel will remove the severe overtopping and improve the efficiency of flow through the area. The detention pond is included in the project to mitigate the increased flow rates. The combined effect of the proposed infrastructure improvements results is shown in **Figure F.53**. The overtopping across US 80 is significantly reduced and the flooding is better contained to the ROW in the Rochester, Downtown, and Gardner Street areas.

The combined improvements in this watershed are expected to increase discharges downstream, however; these flows are discharged to an engineered channel that has additional capacity. The area downstream of the engineered channel is generally undeveloped in existing conditions. Following the implementation of these mitigation measures, an estimated 2.5 miles of roadway, 61 structures – 19 of which are residential buildings, and 610 people would be removed from the 100-year floodplain.

Based on the comparative assessment performed for this FMP, this proposed project does *not meet all* no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A).] The combined improvements in this watershed are expected to increase discharges downstream; however, these flows are discharged to an engineered channel and detention pond that have the necessary additional capacity. Additionally, the area downstream of the engineered channels is generally undeveloped land in existing conditions.

FMP 033000094 - Lois Branch Main Channel Improvements

The Lois Branch Main Channel Improvements Project developed from the Floyd Branch Watershed Capital Improvement Plan³³. The study area is located between Polk Street and the confluence with Floyd Branch. The Lois Branch Existing Conditions Hydraulic Model was previously developed and shows 2 residential structures, nearly 4 miles of roadway, and 9 critical facilities are impacted by the 100-year event (1% annual chance flood event).

The recommended alternative modifies the channel geometry to include two drop structures of 3.0 and 3.5 feet to allow larger culverts to be implemented under Pittman Street and Highland Boulevard. The alternative recommends approximately 3,900 LF of channel modification along with these improvements. Most of the existing waterway would be reconstructed into a concrete, rectangular channel between 10 to 15 feet wide and the channel downstream of Spring Valley into a concrete-lined trapezoidal cross section with a base width of 20 feet. The Spring Valley crossing itself would be raised by 1.0 foot at the Lois Branch crossing. (See **Figure F.54** and **Figure F.55**.)

At a cost of \$2,598,000, the 2 residential structures, as well as the 4 miles of roadway, and 8 of the critical facilities will be removed from the 100-year floodplain.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

³³ *Floyd Branch Watershed Capital Improvement Plan*, Freese and Nichols, April 2010

Figure F.54. Lois Branch Main Channel Improvements (FMP 033000094)



FMP 033000095 - DMP Phase 1: Kirven Avenue (Project 1)

The City of Waxahachie prepared a Drainage Master Plan to assist in evaluating existing drainage conditions and developing conceptual solutions to address flooding concerns. The Master Plan is comprised of five (5) potential project areas that were identified through rain-on-mesh (ROM) analysis and local officials' knowledge of historical flooding issues. The Kirven Avenue (Project 1) area is one of those 5 project areas.

HEC-RAS was used to develop a 2D ROM model to identify areas of flooding concern. The hydraulic model captured approximately 148 square miles around the City of Waxahachie, Waxahachie Creek, and the surrounding tributaries of: Grove Creek, Mustang Creek, and South Prong Creek.

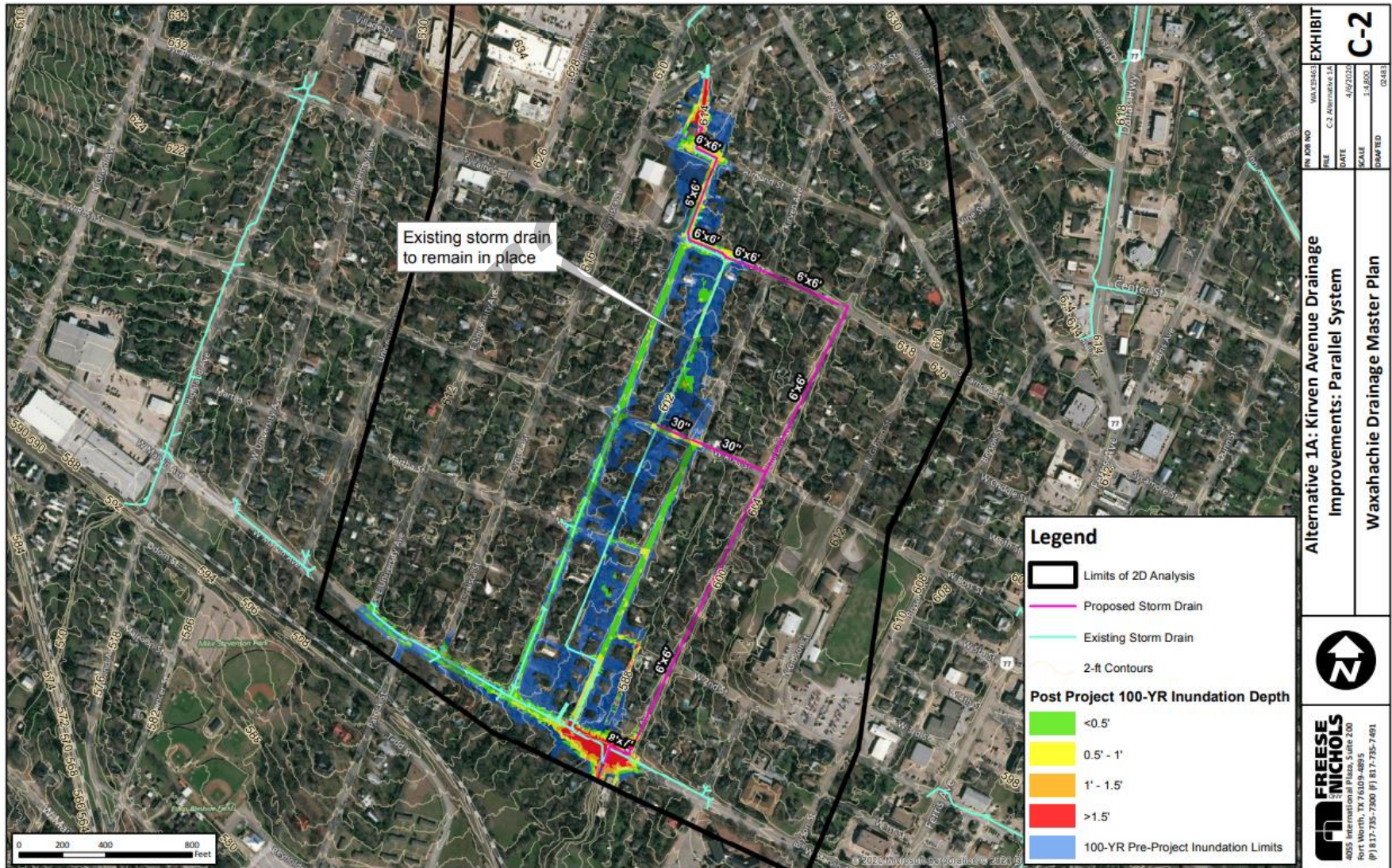
The results of a HEC-RAS 2D rain-on-mesh model indicated that properties located along Kirven Avenue and Virginia Avenue likely experience flooding due to insufficient capacity within the existing storm drain system and the right-of-way (ROW). The flooding generally occurs within the area bounded by Floyd Street in the north and Marvin Avenue in the south. An existing storm drain runs underneath the roadway from Almond Street to Sycamore Street and between properties from Sycamore Street to the existing 8'x4' RCB outfall at Marvin Avenue. An existing conditions model was developed in Infoworks ICM to analyze the existing conditions of this area in further detail by incorporating the overall storm drain capacity. The model results confirm that the existing storm drain is undersized, and as the capacity of this storm drain is exceeded, water overtops the roads and flows across private properties.

On the upstream end of the studied area, structures at Almond Street are at risk of flooding as early as a 5-year storm event, and similarly, Marvin Avenue begins to experience significant ponding in a 5-year event. In the 25-year storm event, the storm drain is overwhelmed, and additional runoff is conveyed along Kirven and Virginia Avenues as well as through the alley between the streets.

The recommended alternative proposes to address flooding by supplementing the existing storm drain system with an additional parallel system contained within the ROW. The upstream end of the proposed storm drain would begin near the intersection of Almond St. and Sycamore St. and would extend downstream along Harbin Ave. to the existing outfall at Marvin Ave. The existing 8'x4' RCB outfall on Marvin Avenue would be replaced with an 8'x7' RCB outfall as shown in **Figure F.56**. Following the implementation of these local area improvements, an estimated 14 structures would be removed from the 100-year floodplain, 12 of which are residential structures, ultimately resulting in approximately 37 individuals removed from the 100-year flood risk.

Based on the comparative assessment performed for this FMP, the proposed project does not meet all no negative impacts requirements as established in the *TWDB Technical Guidance (Exhibit C Section 3.6.A)*. The proposed improvements increase the water surface elevation at the outfall near the intersection of Marvin Ave and Harbin Ave. However, comparative analysis demonstrates that this increase does not affect any properties and/or structures and the proposed drainage infrastructure and building inundation have been greatly reduced. Furthermore, the proposed storm drain improvements both upstream and downstream are sized to contain the increases in peak discharge (see Error! Reference source not found.).

Figure F.56. DMP Phase 1: Kirven Avenue (Project 1) (FMP 033000095)



FMP 033000096 - Estates Dr. Bridge Replacement

The Estates Drive bridge crosses over Poindexter Branch in the City of Copper Canyon. The current LOS for the bridge is a 2-year event (50% annual chance flood event). As a result, flooding in the area occurs frequently and with severity.

The Estates Dr. Bridge Replacement³⁴ proposes replacing the existing bridge with an 80-ft span over Poindexter Creek. (See **Figure F.57.**) HEC-HMS and HEC-RAS models were created to analyze the impact that the proposed improvements would have.

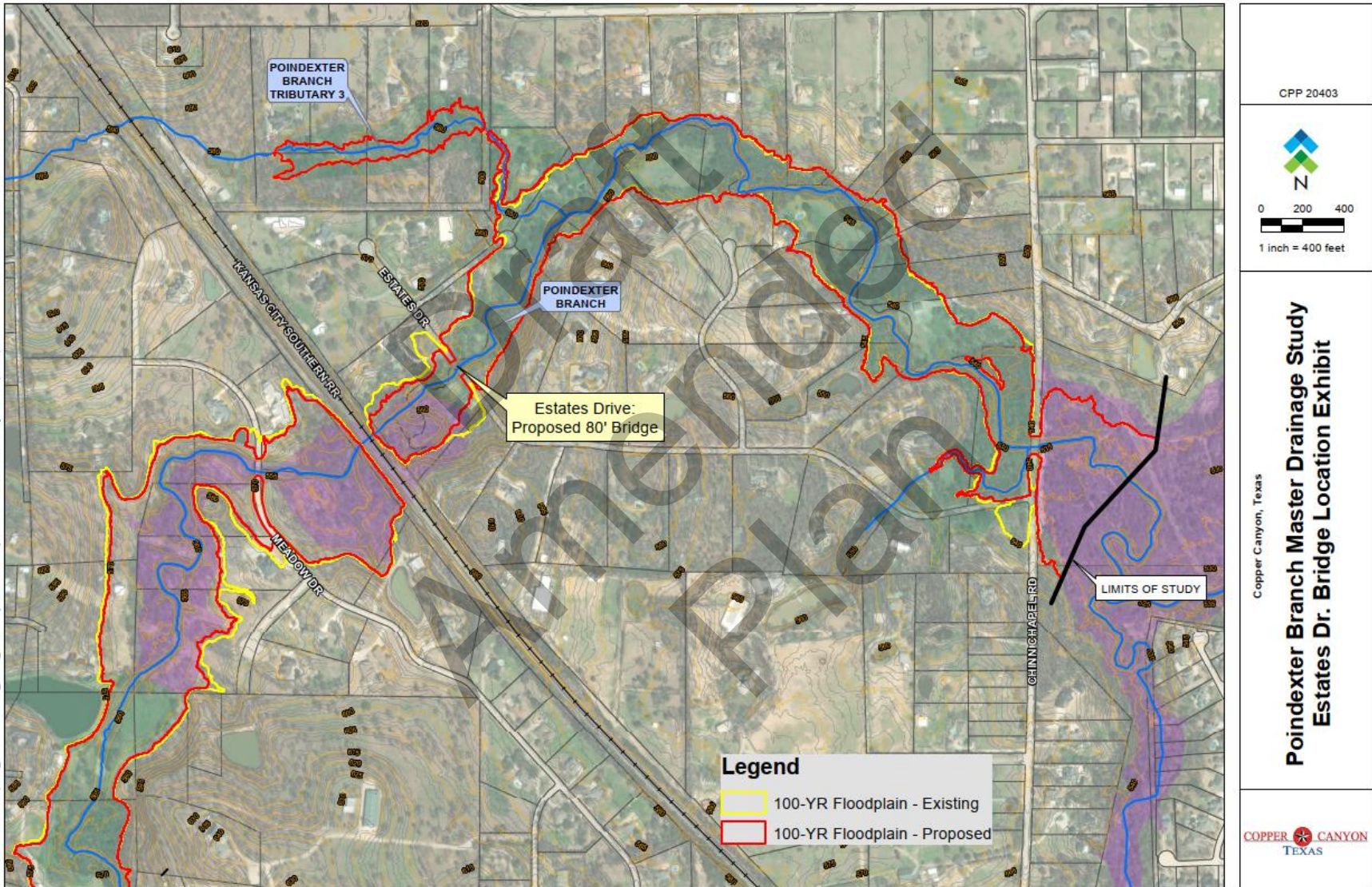
Following the implementation of these drainage and erosion improvements, an estimated 3.05 miles of roadway and 4 structures would be removed from the 100-year floodplain, 2 of which are residential structures. Additionally, 8 structures would have reduced area within the 100-year floodplain but would not be fully removed from flood risk following these improvements. The proposed project will provide a minimum of a 100-year LOS (1% annual chance flood event) for the crossing, at a cost of \$1,338,000.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1**).

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³⁴ *Poindexter Branch Master Drainage Study*, Teague, Nall, and Perkins, January 2023

Figure F.57. Estates Dr. Bridge Replacement (FMP 033000096)



FMP 033000097 - PEC-4 Phases 3 & 4

PEC-4 is located in central Denton, bounded by the University of North Texas and Bernard St on the West, along Hickory St to the North, South Bell Avenue to the East, and Highland St on the South. The contributing drainage area to the outlet of PEC-4 on the east side of Wainwright St encompasses 377 acres. Phases 1 and 2 have previously been designed and constructed and were implemented during modeling. The proposed Phases 3 and 4 will extend upstream north of Prairie St until the south side of the intersection of W Mulberry St and the existing open channel.

Runoff contributing to PEC-4 is collected largely by an underground storm drain network that routes water to the existing open channel that starts at Bernard St. The existing open channel contains 8 culvert crossings transitions underground for approximately 600 feet between Mulberry St and W Sycamore St before transitioning back to open channel. The channel continues downstream until outfalling into a larger open channel to the east of Wainwright St. The total length of the project extents along the main channel of PEC-4 is about 4,500 feet. The PEC-4 existing open channel consists of a rectangular shape with a rock-lined wall and a concrete-lined bottom.

The existing conditions simulations in XPSTORM 2021.3 show that channel banks are overtopped, and pipe systems are surcharged, resulting in surface overflow propagating from the northwest to the southeast towards the outlet, where it accumulates. All areas immediately surrounding the open channel are inundated, along with particularly high impacts along Carroll Blvd, S Locust St, and S Elm St. Inundation was observed for commercial and residential areas.

The proposed PEC-4 Phases 3 & 4 includes reinforced concrete boxes constructed in parallel with the existing open channel from Mulberry St to Bernard St. These boxes are sized to convey the 100-year storm in conjunction with the open channel: 16' x 8' boxes for Phase 3, and 9' x 8' boxes for Phase 4 (see **Figure F.58**). The storm sewer can provide additional capacity for larger storms while collecting the local drainage to the channel. The proposed FMP greatly reduces excess flow along Locust St and Elm St. and removes all buildings within the project extents. Flooding along Bernard St and near the intersection of Bernard St and Mulberry St is also eliminated. The project cost is \$15,973,000.

The estimated flood risk reduction benefits following the implementation of the PEC-4 Phases 3 & 4 FMP include the removal of an estimated 1 mile of roadway and 81 structures from the 100-year floodplain, 70 of which are residential structures. This correlates to an estimated 244 individuals removed from the 100-year flood risk. Additionally, seven structures would have reduced impacts within the 100-year floodplain but would not be fully removed from flood risk. Two critical facilities and one low water crossing would also be removed from the 100-year floodplain.

Based on the comparative assessment performed for this FMP, the proposed project does not meet all no negative impacts requirements as established in the *TWDB Technical Guidance (Exhibit C Section 3.6.A)* (see **Table F.1**). Proposed improvements cause the peak discharge at the outfall to increase. The 1D maximum flow rates were higher than in the existing scenario due to the higher capacity of the proposed system and reduction of spilling onto the surface. The report indicates that the channel and culvert capacities downstream of SH 183 are adequate to receive this increase in discharge. A conservative 100-yr tailwater condition was adopted for the design of Phases 1 and 2, which were designed with sufficient capacity to add Phases 3 and 4 in the future.

Figure F.58. PEC-4 Phases 3&4 (FMP 033000097)



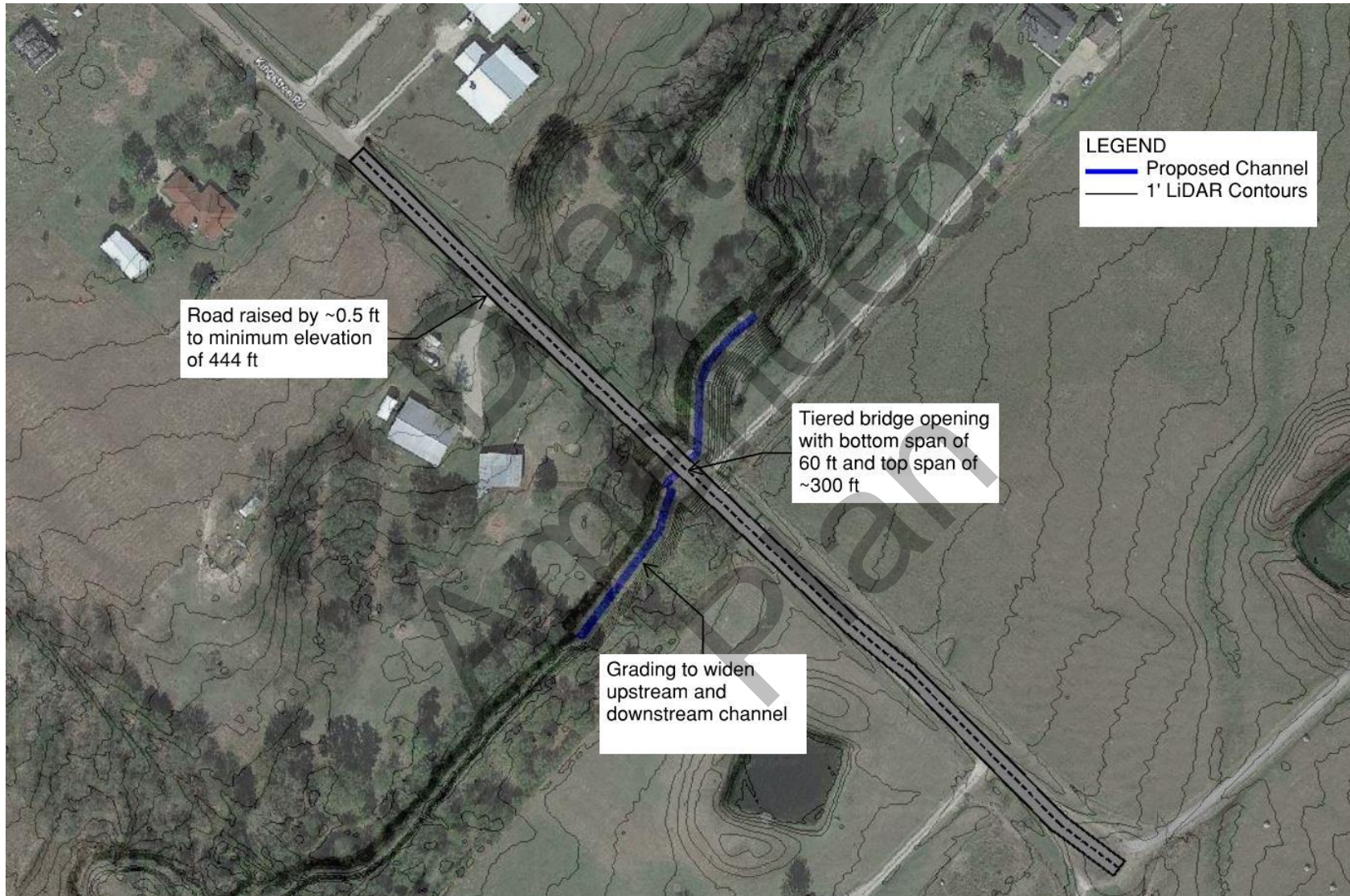
FMP 033000098 - Kingstree Rd Drainage Improvements

The Kingstree Road site is located in Precinct 1 of Kaufman County, approximately 5 miles northeast of the City of Kaufman. The site is located within the Kings Creek watershed in the Trinity River Basin. Kingstree Road is a dead-end road, and a crossing with Big Cottonwood Creek is located toward the end of the road. The existing drainage infrastructure at the crossing includes three 5-foot diameter corrugated metal culverts at the main creek channel, and another 2-foot diameter corrugated metal culvert located at a secondary crossing approximately 65 feet northwest of the main channel. The minimum road elevation over the crossing is approximately 442 feet. Existing drainage infrastructure appears to be significantly undersized and is unable to convey flow from a 2-year storm event. Model results show roadway overtopping and residential structures within the floodplain.

The proposed alternative for the Kingstree Road site includes installing a bridge, raising the road elevation, and upstream and downstream channel grading. The proposed bridge would have a total span of approximately 190 feet, with a bottom span of 40 feet at the main creek channel at elevation 433.5 feet, and two raised shelves at elevation 440 feet on either side with bottom spans of 40 feet each. The road over the crossing is proposed to be raised to an elevation of 444.5 feet for a total length of approximately 450 feet. Channel grading was added upstream and downstream of the crossing to tie in the existing channel to the widened channel at the base of the bridge. **Figure F.59** shows a summary of the proposed improvements, which achieve a 10-yr LOS. Project models reveal that, while no structures are completely removed from the 100-yr floodplain, 13 structures show a reduced 100-yr flood risk. The project cost is \$3,319,000.

Based on the comparative assessment performed for this alternative, the proposed project does not meet all no negative impacts requirements as established in *TWDB Technical Guidance (Exhibit C Section 3.6.A)* (see **Table F.1**). However, the WSE increases above 0.35 ft are contained within a small portion of the drainage ditch on the north side of the roadway. All other affected areas, including residential structures, experience decreases in WSE or an increase below 0.35 ft.

Figure F.59. Kingstree Rd Drainage Improvements (FMP 03300098)



FMP 033000100 - Arlington Upper Village VC(A)-5 Channel and Culvert Improvements

The Arlington VC(A)-5 FMP, developed from the Upper Village and Trinity Tributaries Report³⁵, proposes options for channel and culvert improvements. The current LOS for Bowman Springs Road is the 1-year event and the 2-year event for Crossgate Court.

HEC-HMS and HEC-RAS models were created to analyze the impact that the proposed improvements would have based on ultimate land use conditions. Channel improvements are recommended to the existing, concrete-lined trapezoidal channel, to reconstruct the cross section as a 20-ft wide, 7-ft deep rectangular channel between Bowman Springs Road and Crossgate Court. Appropriate channel cross section transitions are recommended at either end of the improvements. The culverts on Bowman Springs Road are further recommended to upsize to reinforced concrete boxes. (See **Figure F.60.**)

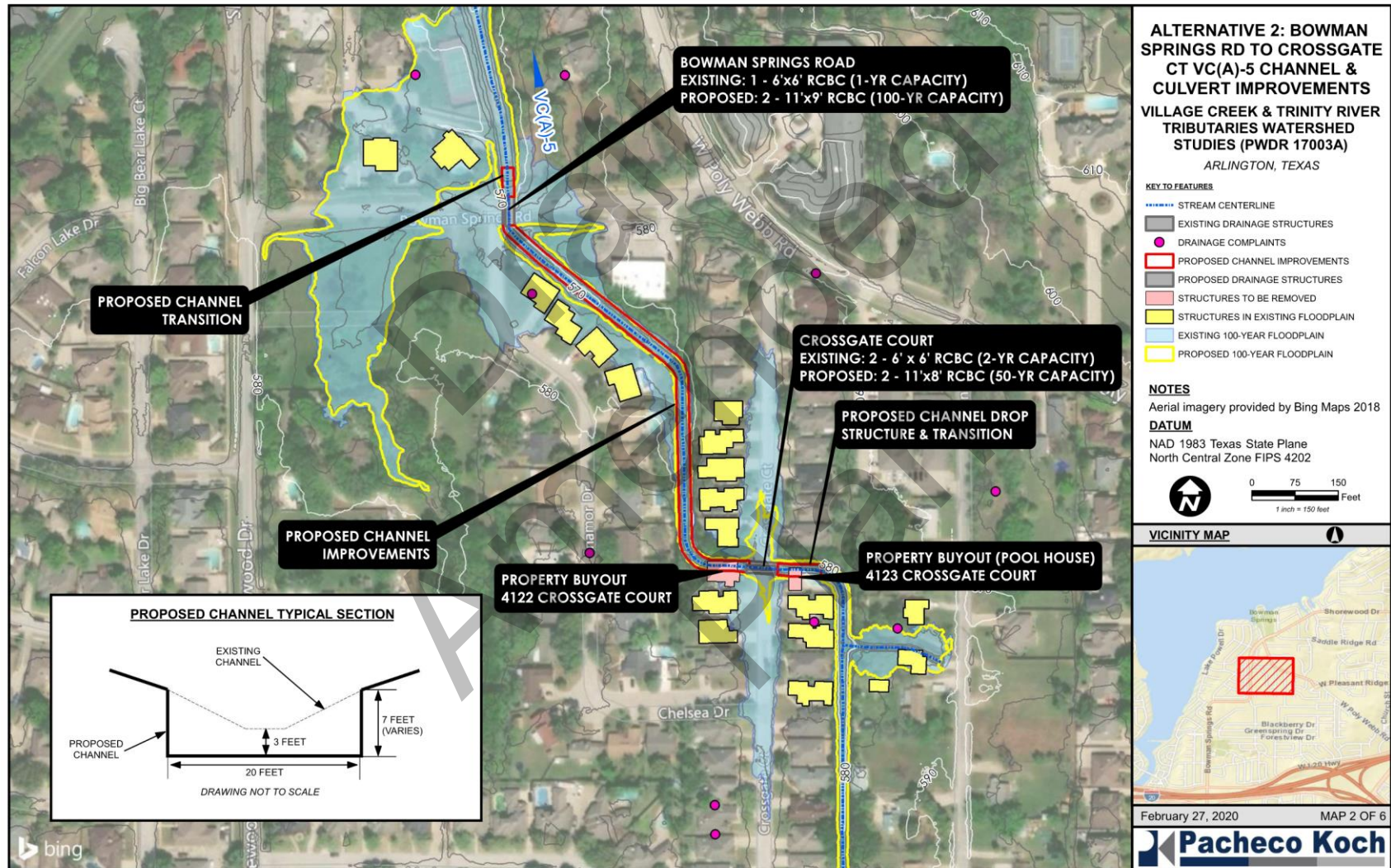
The proposed project will provide a minimum of a 100-year LOS (1% annual chance flood event). Flood risk reduction benefits are expected to bring the LOS for both crossings up to the 100-year event.

Following the implementation of these channel and culvert improvements, an estimated 0.08 miles of roadway and 13 structures would be removed from the 100-year floodplain, all of which are residential structures. This correlates to an estimated 28 individuals removed from the 100-year flood risk. Additionally, 3 structures would have reduced area within the 100-year floodplain but would not be fully removed from flood risk following these improvements. The estimated project cost is \$4,274,000.

Based on the comparative assessment performed for this FMP, the proposed project meets all no negative impacts requirements as established in the TWDB Technical Guidance (Exhibit C Section 3.6.A) (see **Table F.1.**)

³⁵ *Upper Village Creek & Trinity River Tributaries Watershed Studies*, Pacheco Koch, January 2021

Figure F.60. Arlington Upper Village VC(A)-5 Channel and Culvert Improvements (FMP 033000100)



FMP 033000101 - Channel Improvement on Brockbank Channel Basin north of SH 183

The purpose of the Brockbank Channel study³⁶ is to analyze the existing drainage infrastructure along Brockbank Channel and to provide alternative solutions to alleviate flooding of streets north of Brockbank Channel along Rochelle Road and Rochelle Point in the City of Irving. There are currently 43 structures at risk of flooding in the project area and signs of a continuation of flooding to the north.

One improvement alternative was developed for the open channel. This alternative consists of vertical cast-in-place concrete walls ranging from 20' to 18' bottom widths between Scotland Drive, with an average 7' wall height. The proposed channel footprint fits within the existing 30' ROW, however, temporary construction easements may be needed to brace the existing power poles. Most of the existing power poles near the channel are located at a sufficient distance to avoid relocation, but approximately 10 power poles will need to be relocated. Additionally, an 8-inch liquid petroleum pipeline is located approximately 6" below the existing channel floor north of Scotland Drive and will require relocation for open channel improvements.

An improvement alternative in two phases was developed for the closed storm drain system at Rochelle Road. The proposed alternative would mitigate the 50-year storm event and require removal of the existing 72" RCP that outfalls into Brockbank Channel. Phase 1 consists of installing approximately 625 LF of two, 8'x6' RCBs running from the outfall to Rochelle Road. Phase 2 consists of approximately 330 LF of 12'x4' RCB, 760 LF of 7'x4' RCB and 285 LF of 8'x4' RCB. The project extents are shown in the proposed improvements location map (see **Figure F.61**). The project cost is \$15,197,000.

Following the implementation of this FMP, an estimated 0.61 miles of roadway and 39 residential structures would be completely removed from the 100-year floodplain. This correlates to an estimated 60 individuals removed from the 100-year flood risk.

Based on the comparative assessment performed for this FMP, the proposed project does not meet all no negative impacts requirements as established in the *TWDB Technical Guidance (Exhibit C Section 3.6.A)*. However, the Trinity RFPG considers that the Channel improvement on Brockbank Channel Basin FMP conforms to the no negative impacts requirements based on professional engineering judgment (see Error! Reference source not found.). The open channel improvement causes peak flows to increase by 25.4%. This same increase (1420 to 1780 cfs) occurred at the six most downstream cross-sections of the model results. This increase is allowable, according to the Brockbank Channel Alignment Study.

"A downstream assessment was performed to verify sufficient channel and culvert capacity and potential adverse impacts for Brockbank Channel from SH 183 south to the confluence with Delaware Creek. The 100-year design discharge used for the Lower Brockbank Channel and culvert improvements was 1,830 cfs at SH 183. The more detailed hydrology performed for this study gave a 100-year design discharge of 1,780 cfs at SH 183. The downstream channel and culvert capacities were checked with the lower design discharge values and were verified to be adequate. There is sufficient channel and culvert capacity and no adverse impacts resulting from the proposed Brockbank Channel Improvements."

³⁶ Brockbank Channel Alignment Study, Pacheco Koch Consulting Engineers, 2022.

Figure F.61. Channel improvement on Brockbank Channel Basin north of SH 183 (FMP 0330000101)



FMP 033000107 - Plantation Ridge Channel Improvements

The Plantation Ridge site is in Precinct 1 of Kaufman County, just south of US Highway 80 between Forney and Terrell. The site is located within the Kings Creek watershed in the Trinity River Basin. The site is also located downstream of large commercial warehouse properties. It was noted that the County has installed upgrades to culvert infrastructure at Helms Trail in response to reports of structural flooding upstream. Because the culvert crossings at Helms Trail and Plantation Ridge are in close proximity, the County requested the two sites be combined into one FMP for the alternatives analysis. This allows for a more comprehensive solution to structural flooding in the area rather than only focusing on County roads.

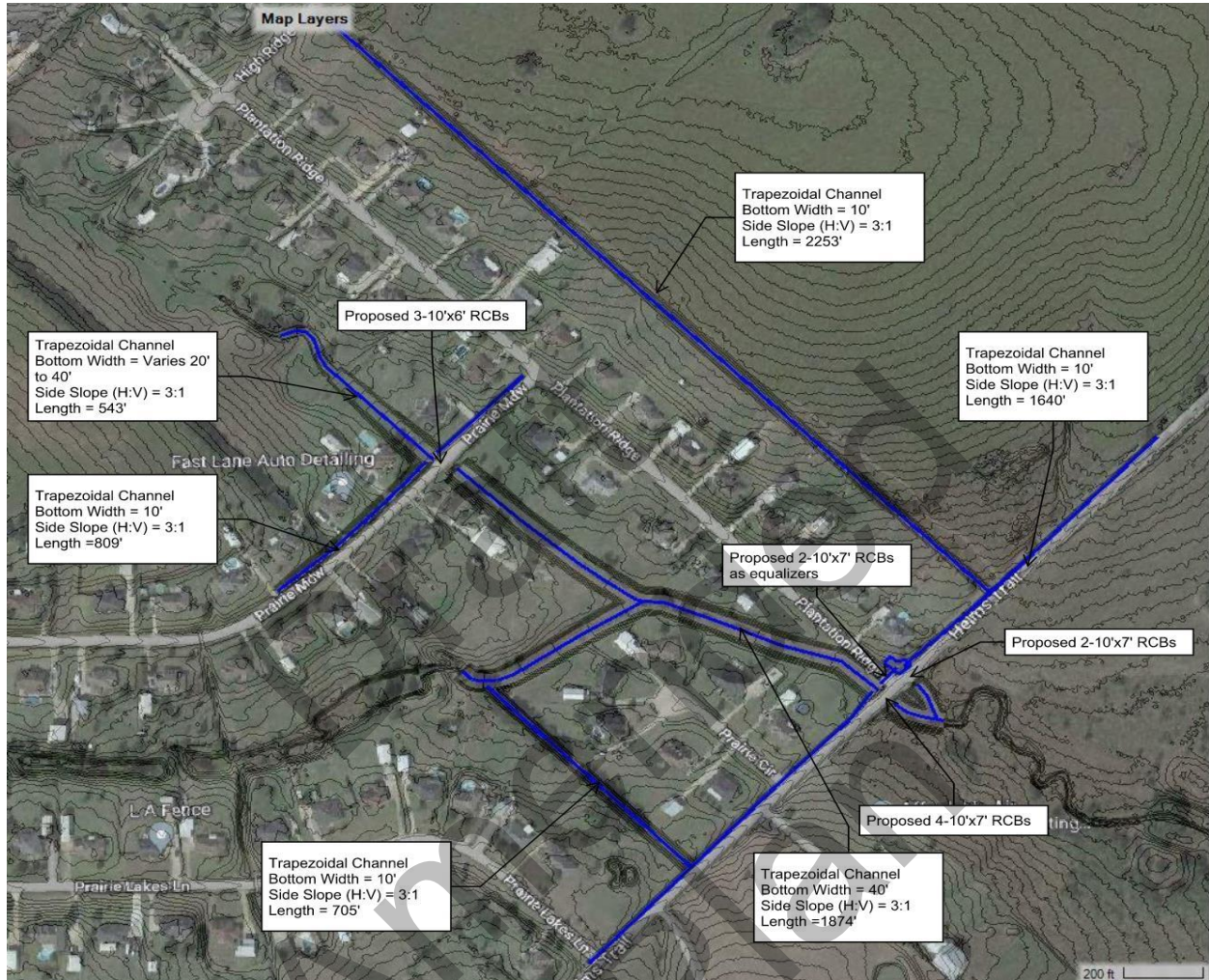
The proposed alternative includes upsizing the existing culverts, significant channel grading, and side ditch grading. Multiple 10'x7' RCBs are being proposed at the Plantation Ridge – Helms Trail intersection and multiple 10'x6' RCBs are being proposed at the Prairie Meadow intersection. The culverts have been sized in conjunction with channel grading to increase conveyance through the project area while not raising any residential road elevations. The proposed grading includes a main trapezoidal channel (40' bottom and 3:1 side slopes) running parallel to Plantation Ridge and through the Helms trail culvert crossing. It is expected that the channel will be vegetated with armoring added at locations of potential erosion. The proposed channel is placed behind existing residential properties in order to reduce infringement on private property. However, it is expected that a well-defined drainage easement will need to be obtained from the property owners. The channel grading effectively removes most of the properties from the 100-yr inundation boundary while not causing a significant rise on other properties.

In addition to the main trapezoidal channel previously mentioned, there are various side ditches proposed for this FMP. Although the side ditches are not as significant as the main channel, they aid in redirecting off site flows around existing structures. For example, there is currently a large open field to the northeast of Plantation Ridge that flows through residential backyards. The proposed 10' trapezoidal channel will redirect flows to the proposed culverts at Helms Trail. (See **Figure F.62.**)

These proposed improvements achieve a 10-yr LOS at the Plantation Ridge-Helms Trail crossing, and a 100-yr LOS at the Prairie Meadow crossing. Following the implementation of these local area improvements, an estimated 0.08 miles of road and 4 structures would be removed from the 100-year floodplain, 3 of which are residential structures; ultimately resulting in approximately 1 individual removed from the 100-year flood risk. The project cost is \$7,966,000.

Based on the comparative assessment performed for this alternative, the proposed project meets all no negative impacts requirements as established in *TWDB Technical Guidance (Exhibit C Section 3.6.A)* (see **Table F.1**).

Figure F.62. Plantation Ridge Channel Improvements (FMP 033000107)



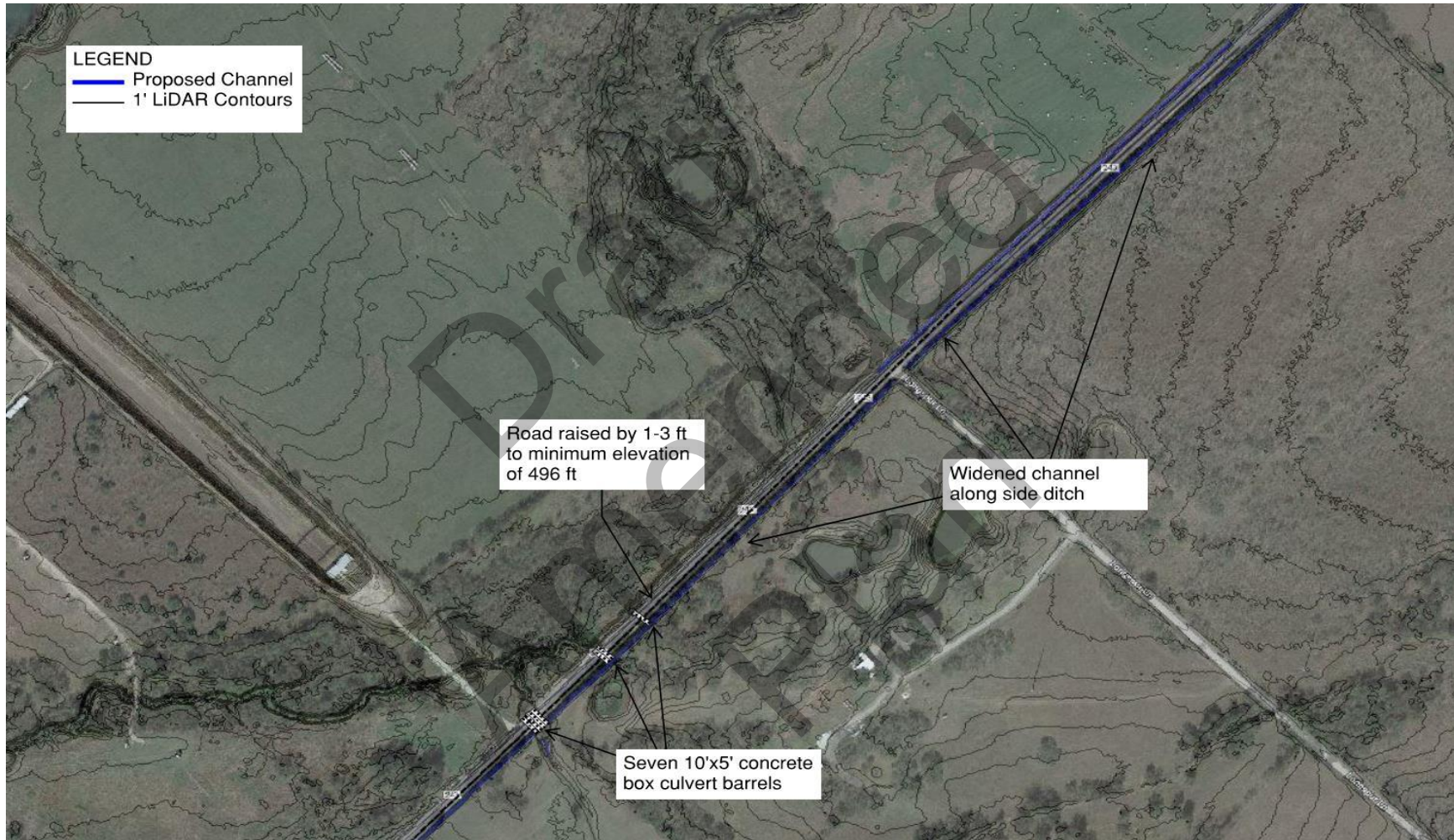
FMP 033000108 - CR-243 Drainage Improvements

The CR 243 site is located in Precinct 3 of Kaufman County, near the intersection of CR 243 and Longspur Lane and adjacent to a private gun range. The site is located within the Kings Creek watershed in the Trinity River Basin. The area receives floodwaters from two different directions. The main source of flow comes from Little High Point Creek, which flows south towards CR 243 before being redirected southwest after intersecting with the road embankment. The side ditch on the north side of CR 243 effectively becomes the main channel of flow for the creek for approximately 670 feet before flowing west away from the roadway. The other source of flow comes from two unnamed tributaries of Little High Point Creek which flow northwest and converge just before intersecting with CR 243, and eventually Little High Point Creek near the point where the creek begins to flow west away from the road. The combination of flow from these two sources creates significant flooding issues along this stretch of CR 243. During heavy storm events, the roadway effectively becomes an overflow channel for Little High Point Creek, carrying floodwaters southwest until it joins with the other tributaries.

The proposed alternative for the CR 243 site includes upgrading existing culverts to concrete box culverts, raising the road, upstream and downstream channel grading, side ditch grading, and grading around culvert entrances and exits. Seven 10'x5' concrete box culverts would be installed, four at the main channel crossing, two at the middle culvert group, and one where the existing culvert pair is located. The road would be raised to a minimum elevation of 496 feet, with most of the road being set to a higher elevation. Channel grading was added upstream and downstream of the main channel crossing. Side ditches were also widened along the south end of CR 243 to help direct flow into the culverts. Grading was added at the culvert entrances and exits as well. **Figure F.63** shows a summary of the proposed improvements, which achieve a 100-year LOS. Following the implementation of these local area improvements, an estimated 0.4 miles of road would be removed from the 100-year floodplain, and approximately 10 structures would show reduced 100-year flood risk. The project cost is \$4,767,000.

Based on the comparative assessment performed for this alternative, the proposed project does not meet all no negative impacts requirements as established in *TWDB Technical Guidance (Exhibit C Section 3.6.A)* (see **Table F.1**). However, all impacts are located upstream of the roadway and cause rises in WSE outside of the County easement. It is anticipated that nearby property owners will be notified of impacts prior to construction. There are no significant increases to WSE at upstream structures, and all increases at upstream structures are less than 0.35 ft.

Figure F.63. CR-243 Drainage Improvements (FMP 033000108)



FMP 033000109 - Valley View/Ravenhill-Devonshire Drainage Improvements

The Valley View/Ravenhill-Devonshire site is in Precinct 2 of Kaufman County, near the intersection of Valley View and Ranch Road and the Devonshire residential community. The site includes two different sites with two separate roadways and tributaries.

The Valley View crossing is located where an unnamed tributary of Buffalo Creek intersects the Valley View roadway. The crossing is unique because it is located just upstream of an SCS reservoir site. During heavy storm events, the roadway is first overtopped by flood waters flowing into the reservoir, then again by reservoir storage, which takes over 36 hours to fully recede in the case of the 50-year event and higher. Existing drainage infrastructure includes two 8-foot diameter metal tanker culvert barrels at the main channel crossing. The roadway has a minimum elevation of approximately 439 feet. Model results show roadway overtopping during the 10-year event and higher. The crossing is located downstream of several new residential areas, which could increase the potential flood risk even further once fully developed.

Existing drainage infrastructure at the Ranch Road crossing includes two 8'x4' half-circle metal tanker culvert barrels with upstream and downstream channel grading at the culvert entrance and exit. The roadway has a minimum elevation of approximately 458 feet. Model results show roadway overtopping during the 10-year, 50-year, and 100-year storm events. Existing drainage infrastructure appears to be undersized and is unable to convey flow from a 10-year storm event.

For the Valley View crossing, the proposed alternative includes installing five 10'x10' concrete box culverts, three at the main channel crossing, and two additional culverts north of the main crossing. Channel grading was added on the upstream side to the main channel and to a secondary channel to the north to help direct flow to the two additional culverts. Side ditch grading and grading at the culvert entrances and exits was added to help direct flow into the larger capacity culverts. The road was raised to a minimum elevation of 443 feet on the north end and 442 feet on the south end. **Figure F.64** shows a summary of the proposed improvements. A 100-year LOS is achieved with the proposed improvements at the Valley View crossing.

For the Ranch Road crossing, the proposed alternative includes installing two 10'x8' concrete box culverts at the main channel crossing. The culvert would be lowered to allow more flow to pass through the crossing. A minimum slope of 0.5% would be maintained for both culvert barrels. Upstream and downstream channel, side ditch, and culvert entrance and exit grading would also be included to help direct flow into the culverts and away from the roadway. The roadway would be raised to a minimum elevation of 460 feet on the north end and 462 feet on the south end. **Figure F.65** shows a summary of the proposed improvements. A 100-year LOS is achieved with the proposed improvements at the Ranch Road crossing. The project cost is \$6,691,000.

Following the implementation of these local area improvements, an estimated 0.28 miles of road would be removed from the 100-year floodplain. Based on the comparative assessment performed for this alternative, the proposed project meets all no negative impacts requirements as established in *TWDB Technical Guidance (Exhibit C Section 3.6.A)* (see **Table F.1**).

Figure F.64. Valley View/Ravenhill-Devonshire Drainage Improvements (FMP 033000109)

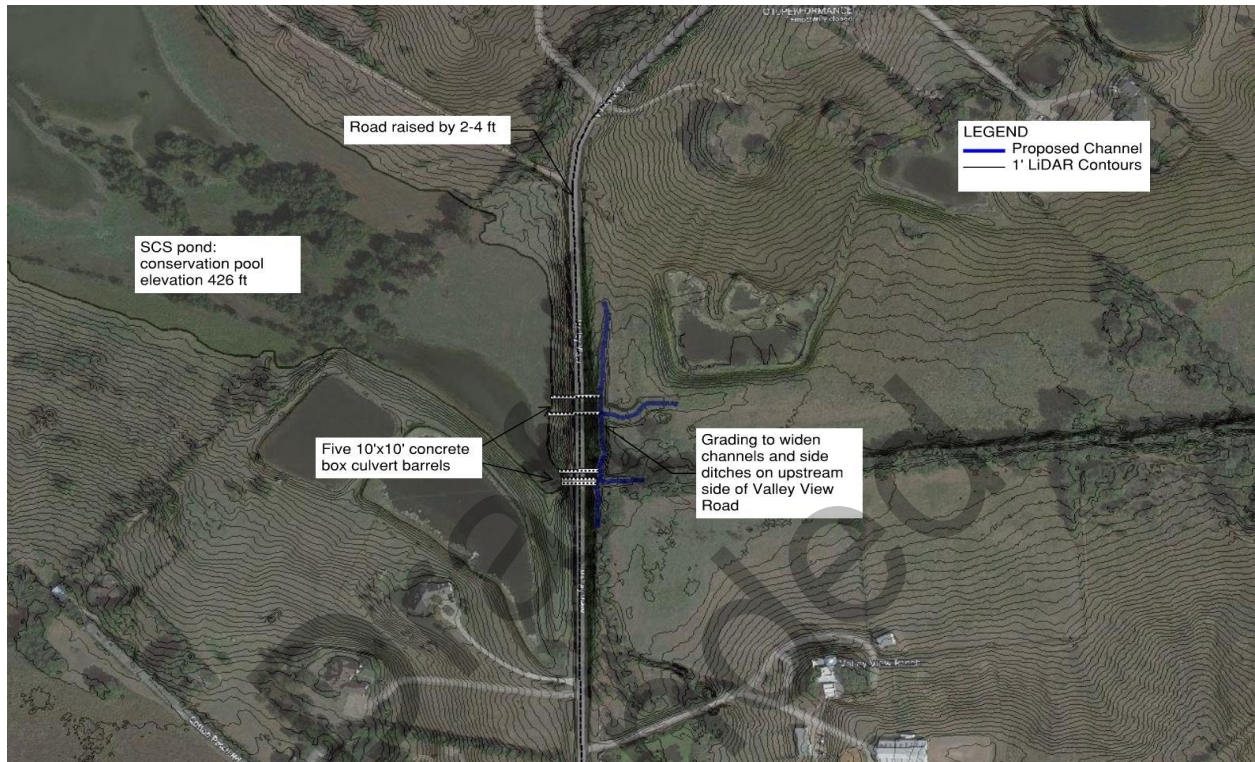
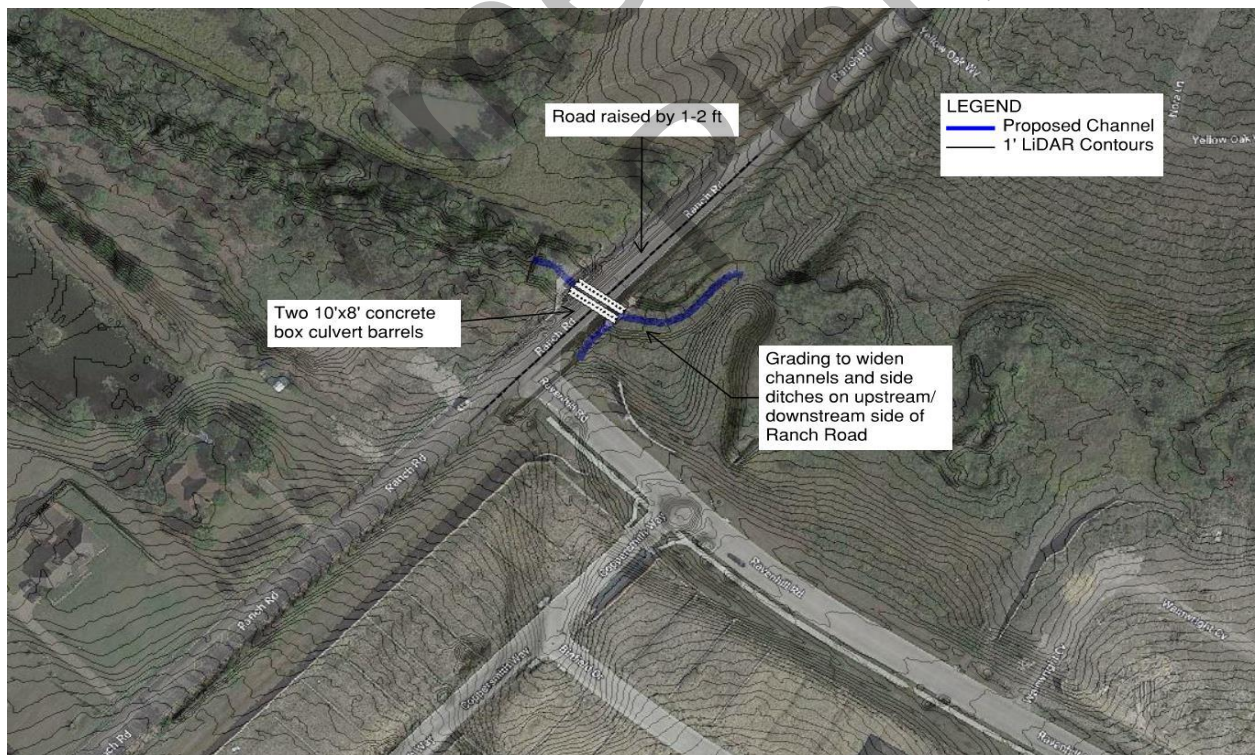


Figure F.65. Valley View/Ravenhill-Devonshire Drainage Improvements (FMP 033000109)



FMP 033000110 - CR-4116 Drainage Improvements

The CR 4116 site is located in Precinct 4 of Kaufman County approximately 1.7 miles south of Gastonia just east of the intersection of CR 4116 and CR 4101. The site is located within the Duck Creek – Trinity River watershed in the Trinity River Basin. The site is located next to the Cherokee Creek RV resort. Based on conversations with County staff there are known cases of residential flooding along County Road 4116. The existing drainage infrastructure consists of driveway culverts and side ditches running along CR 4116 on both sides of the road. The side ditch on the north side of CR 4116 outfalls to an existing culvert just south of the Cherokee Creek RV resort. The southern side ditch outfalls to the downstream side of the same culvert. It is important to note that since CR 4116 was not included in the site visits, all existing culvert dimensions have been estimated from LiDAR and aerial imagery. Additionally, the latest LiDAR for this site indicates that there is significant offsite flow coming from the south side of CR 4116. Historically, this offsite flow appears to have collected on the south side of CR 4116 and was conveyed by natural swales. The natural swales appear to have been disturbed by development and residential structures are at risk of flooding.

The proposed alternative includes a series of interceptor channels with their accompanying driveway culverts. The channels vary in dimension but reach a maximum bottom width of 10' at the most downstream point. In total, there are three proposed channels running parallel to CR 4116. Two of these channels are located immediately next to CR 4116 and also serve as road drainage. The remaining channel is located 350' to the south. The purpose of the southern channel is to intercept offsite flow before it reaches the residential properties. All the proposed channels running parallel to CR 4116 eventually outfall to the west and direct runoff away from structures. This system of channels is also interconnected at two locations to aid in intercepting runoff.

In addition to the proposed channel grading, a major component of the proposed alternative is the replacement of existing culverts. There are approximately 40 drive culverts to replace with 48" RCPs. Since the proposed channel grading will lower the elevation of the existing side ditches, it is necessary to replace these culverts so that all proposed pipe inverts match the new channel bottom. In addition, the existing culvert at the Cherokee Creek RV resort is also proposed to be upsized to a 7'x3' RCB. (See **Figure F.66.**)

A 100-year LOS is achieved with the proposed improvements. Project models also reveal that, while no structures are completely removed from the 100-year floodplain, 28 structures show a reduced 100-year flood risk. The project cost is \$8,019,000.

Based on the comparative assessment performed for this alternative, the proposed project meets all no negative impacts requirements as established in *TWDB Technical Guidance (Exhibit C Section 3.6.A)* (see **Table F.1**).

Figure F.66. CR-4116 Drainage Improvements (FMP 033000110)

