MEMO

TO: Joellen Meitl, Project Manager
Transportation and Drainage Operations, Houston Public Works

FROM: Kristen Hennings, PE, CFM, LEED® Green Associate

DATE: June 3, 2020

RE: Shepherd, Durham, and Selected Cross Streets Reconstruction in Memorial Heights Redevelopment Authority/TIRZ5
WBS No. N-T05000-0007-7

6/3/2020

Texas Department of Transportation

JONES | CARTER
Texas Board of Professional Engineers Registration No. F-439

MEMORIAL HEIGHTS
REDEVELOPMENT AUTHORITY

HOUSTON PUBLIC WORKS

ES Executive Summary

ES.1 Background & Area Characteristics

Shepherd Drive and Durham Drive are a couplet of one-way major thoroughfares that serve the western portion of the inner loop area in the City of Houston. Shepherd Drive and Durham Drive are primarily focused on automobile traffic but have needs to accommodate bicycle and pedestrian traffic. Memorial Heights Redevelopment Authority (TIRZ 5) and Houston Public Works (HPW) have both considered improvements to the Shepherd Drive and Durham Drive for several years. Both entities conducted traffic studies of the corridor and came to the same conclusion – with improvements at the intersections, the number of traffic lanes can be reduced to allow for the installation of accessible sidewalks and bicycle facilities.

ES.2 Need & Purpose

Shepherd Drive and Durham Drive serve as not only a pair of major thoroughfares connecting areas within Interstate 610, but as vital connections to the destinations adjacent to the project corridor. This corridor has a safety issue evidenced by a crash rate approximately four (4) times the Texas average for 4-lane, urban divided roadways. The trend line for crash frequency has been consistent year-over-year without significant fluctuation. Traffic volumes are significant ranging between 19,000 and 30,000 ADT dependent upon corridor location. In April 2019, a crash along this corridor attracted regional and statewide attention when a person in a wheelchair and a pedestrian were both killed struggling to cross a 4-lane section of Shepherd Drive.

The condition of the pavement has continued to decline through the years, making the drive on Shepherd Drive and Durham Drive more difficult. This roadway has not been significantly rehabilitated since the 1950's and has now outlived its useful life. The City of Houston has assigned the pavement condition, "impacting the ability to drive at posted speeds," for portions of the roadway. This project will significantly improve the functionality of the roadway by reconstructing or installing concrete pavement, curbs, gutters, striping, and signalization. Furthermore, reconstruction will decrease maintenance and related user costs (travel delay, vehicle wear/tear) within the project limits. Additionally, the sidewalks are not continuous through the corridor, the condition is deteriorating, and sections of sidewalk are disappearing with redevelopment or repurposing of tract adjacent to the project. Improvements to the roadway and pedestrian realm are greatly needed to provide adequate mobility and a safe environment for those who utilize Shepherd Drive and Durham Drive.

ES.3 Existing Conditions

Shepherd Drive and Durham Drive are primarily asphalt roadways with concrete curb and gutter. Pavement conditions are relatively poor. Existing sidewalks, where present, are narrow and incomplete. The existing traffic signals do not meet the current HPW standards. Water lines, sanitary

sewers, and storm sewers are aging and do not provide adequate service for the project area. The properties along the corridor are a mix of commercial, light industrial, residential, and educational. Redevelopment is occurring throughout the corridor with a mix of multi-family residential and commercial uses.

ES.4 Alternatives Evaluated

TIRZ 5 and the Jones|Carter Team evaluated five (5) alternatives for the improvement of the Shepherd Drive and Durham Drive corridor:

- No Build Alternative: No improvements
- Alternative 1: Cycle Track on Shepherd Drive
- Alternative 2: Bicycle Lanes on the Outsides of Shepherd Drive and Durham Drive
- Alternative 3: Bicycle Lanes on the Insides of Shepherd Drive and Durham Drive
- Alternative 4: Bicycle Lanes on the East Sides of Shepherd Drive and Durham Drive

ES.5 Preferred Alternative

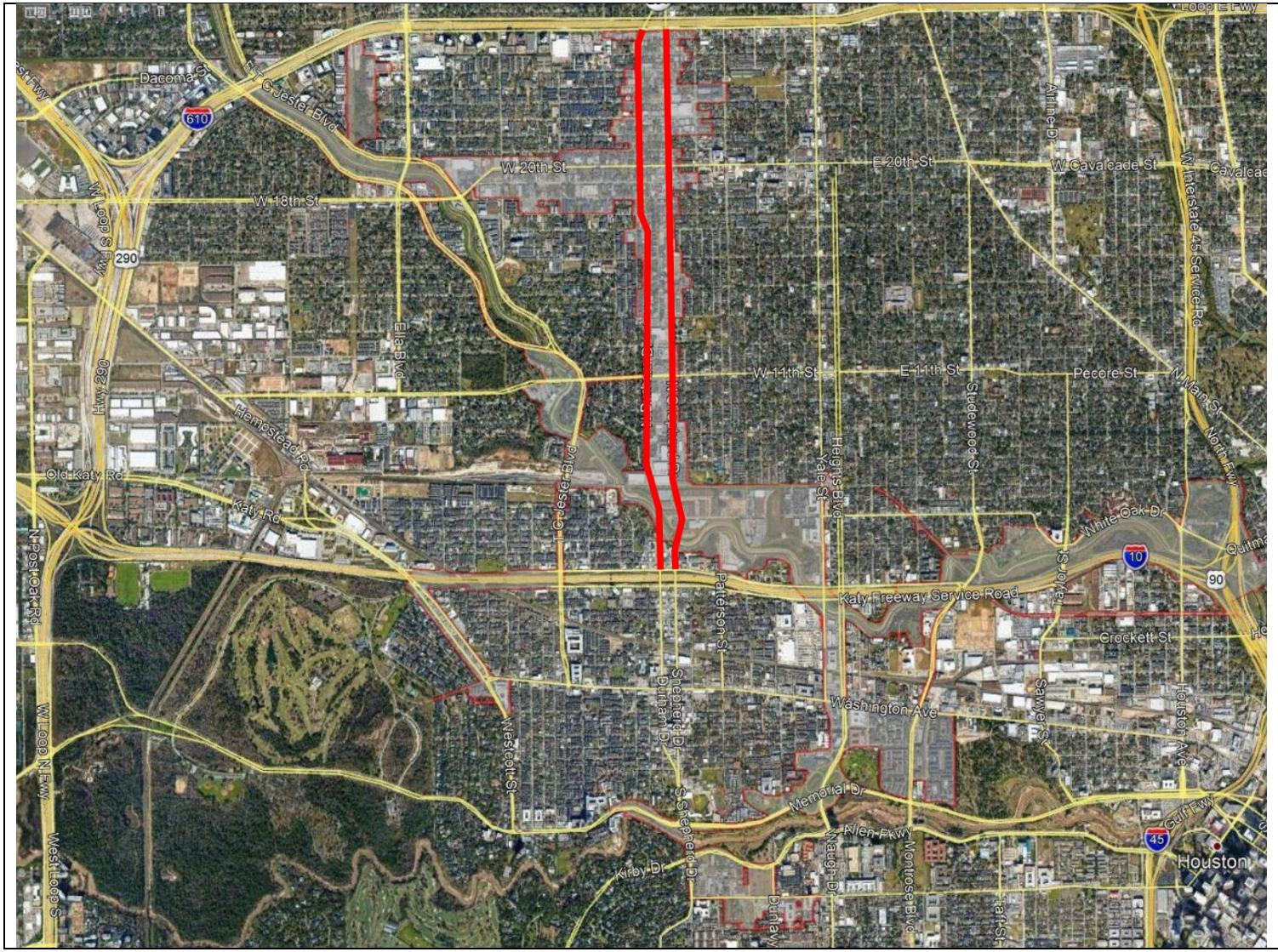
The preferred alternative is Alternative 4 which allows for the full reconstruction of Shepherd Drive, Durham Drive, and selected cross streets to improve the paving, traffic signals, sidewalks, and underground public utilities and for the construction of bicycle facilities on both Shepherd Drive and Durham Drive. The estimated cost of the proposed improvements is $100,000,000. Improvements will be designed and constructed in the following two (2) phases:

- Phase 1: Shepherd Drive and Durham Drive between Interstate 610 and West 15th Street, West 24th Street, West 20th Street, West 19th Street, West 18th Street, West 16th Street, and West 15th Street
- Phase 2: Shepherd Drive and Durham Drive between West 15th Street and Interstate 10, West 14th Street, West 13th Street, and West 11th Street

Phase 1 improvements will be funded through a combination of funds from TIRZ 5 Capital Improvements Plan, HPW, and a BUILD Grant. TIRZ 5 is currently pursuing additional funding for Phase 2 improvements.

Design of Phase 1 improvements is scheduled to be completed by June 2021 with construction starting in late summer 2021 and be completed within three (3) years. Design of Phase 2 improvements is scheduled to begin following the completion of Phase 1 design so that construction for Phase 2 can begin following Phase 1 and be completed within the following two (2) years.

1 Introduction



Neighborhood: Memorial Heights Redevelopment Authority/TIRZ No. 5

Annexed/Developed: Development Prior to 1944

Residential: 44%
Commercial: 32%

Recent Development Activity: Actively Redeveloping Parcels through the project Area

Watershed: White Oak Bayou

Water/Wastewater Facilities: City of Houston

Major Transportation Facilities: *Freeways:* Interstate 610, Interstate 10 *Major Thoroughfares:* Shepherd Drive, Durham Drive, West 20th Street, West 11th Street

Population Demographics: Urban

2 Existing Conditions

2.1 Land Use & Environmental

The Shepherd Drive and Durham Drive corridor is a vibrant mix of residential, commercial, and light industrial land uses with a few educational facilities located within the project limits.

Item	Data	Source	Format	Exhibit
Residential Land Use	415 Single family residential structures 3 Multi-family residential structures	HPW GIS; HCAD data; Topographic survey; physical observation	Map	Exhibit 2.1A
Commercial Land Use	231 commercial structures	HPW GIS; HCAD data; Topographic survey; physical observation	Map	Exhibit 2.1A
Vacant Property	51 vacant lots (4.61 acres)	HPW GIS; HCAD data; Topographic survey; physical observation	Map	Exhibit 2.1A
Permits	City Engineer (8 Roadway Obstruction; 3 Sidewalk Obstruction) Planning and Development Department (49 Plats)	HPW GIS	Map	Exhibit 2.1B
Parks	Love Park Lawrence Park	Houston Parks and Recreation Department	Map	Exhibit 2.1A
Cultural/Historical Resources	David A. Carden House, 718 West 17th St. Oriental Textile Mill, 2201 Lawrence St. Kronenberger House, 612 W. 26th St.	National Historic Register	Map	Exhibit 2.1A
Geotechnical/ESAs	Phase I Environmental Site Assessment	*Final Phase I Environmental Site Assessment: Shepherd Drive and Durham Drive from IH-610 to Larkin Street*, prepared by The Goodman Corporation, dated April 5, 2018	Report	Appendix A

Item	Data	Source	Format	Exhibit
Trees	Approximately 41 trees on Durham Drive, 122 trees on Shepherd Drive. 14 trees on West 24th Street; 16 trees on West 20th Street, 8 trees on West 19th Street, 10 trees on West 18th Street, 11 trees on West 16th Street, 12 trees on West 15th Street, 5 trees on West 14th Street, 7 trees on West 12th Street, and 46 trees on West 11th Street	Topographic Survey; Aerial photography; physical observation	Map	Exhibit 2.1C
Back of curb amenities	Sidewalks, business signs, plantings	Topographic Survey; Aerial photography; physical observation	Map	Exhibit 2.1C
Right-of-Way	Shepherd Drive: 70 feet to 80 feet Durham Drive: 65 feet to 70 feet West 27th Street through West 17th Street: 70 feet West 15th Street through West 13th Street: 50 feet West 12th Street: varies West 11th Street: 100 feet	Topographic Survey; Harris County data	Map	Exhibit 2.1D
Other	None	N/A	N/A	N/A

2.2 Utilities

Public utilities along the Shepherd Drive and Durham Drive corridor include water lines, sanitary sewers, and storm sewers that range from approximately 12 years to 67 years in service. Underground private gas lines are located throughout the project corridor. Other private utilities include electric and telecommunications lines that are primarily aerial and located on poles owned by CenterPoint Energy.

Item	Data/Format	Source	Format	Exhibit
Water	Shepherd Drive: 12-inch cast iron and asbestos concrete; 28 to 41 years	Topographic Survey; Record Drawings; HPW GIMS Database	Map	Exhibit 2.2A

Item	Data/Format	Source	Format	Exhibit
	Durham Drive: 8-inch and 12-inch cast iron and asbestos concrete; 12 to 37 years West 18th Street: 8-inch asbestos concrete; 24 years West 16th Street: 8-inch cast iron; unknown age West 14th Street: 8-inch; 45 years			
Wastewater	Shepherd Drive: 8-inch from West 16th to West 12th, unknown age; 54-inch from West 11th to West 10th, 67 years; 6-inch force main south of West 6th, 67 years Durham Drive: 8-inch from West 16th to West 12th, unknown age; 10-inch force main from West 7th to West 6th, 54 years West 16th Street: 8-inch, unknown age	Topographic Survey; Record Drawings; HPW GIMS Database	Map	Exhibit 2.2A
Storm	Shepherd Drive: 12-inch to 42-inch concrete, unknown ages Durham Drive: 15-inch to 48-inch concrete, unknown ages West 24th Street: open ditches West 20th Street: open ditches between Shepherd Drive and Durham Drive, 60-inch MRC west of Durham Drive, unknown age West 19th Street: open ditches West 18th Street: 24-inch to Shepherd Drive, open ditches West 16th Street: 90-inch MRC, unknown age West 15th Street: 84-inch MRC, unknown age West 14th Street: 36-inch to 42-inch concrete, unknown age	Topographic Survey; Record Drawings; HPW GIMS Database	Map	Exhibit 2.2A

Item	Data/Format	Source	Format	Exhibit
	West 12th Street: 36-inch MRC, unknown age West 11th Street: open ditches between Shepherd Drive and Durham Drive, 24-inch concrete west of Durham Drive, unknown age			
Electric	CenterPoint Energy – Electric Aerial facilities along or adjacent to all roadways and alleys within the project limits	Topographic Survey; Record Drawings; CenterPoint Maps	Map	Exhibit 2.2B
Gas	CenterPoint Energy – Gas, 2-inch to 12-inch gas lines	Topographic Survey; Record Drawings; CenterPoint Maps	Map	Exhibit 2.2B
Telecommunications	AT&T (overhead fiber and buried cable), Zayo (overhead fiber); Crown Castle (overhead fiber); Comcast	Topographic Survey; Record Drawings; AT&T Drawings; Zayo Drawings; Crown Castle map; Comcast Drawings	Map	Exhibit 2.2B
Pipelines	None	N/A	N/A	Exhibit 2.2B
Transmission corridors	CenterPoint Energy West 12th Street and West 13th Street	Topographic Survey; Record Drawings; CenterPoint Maps	Map	Exhibit 2.2B
Other	None	N/A	N/A	N/A

2.3 Transportation

Both Shepherd Drive and Durham Drive are part of the Houston Major Thoroughfare Plan as major thoroughfares. West 20th Street and West 11th Street are also listed as major thoroughfares. West 24th Street, West 19th Street, and West 14th Street are identified as major collectors. All other streets within the project limits are designated as local streets.

Item	Data/Format	Source	Format	Exhibit
TXDOT Facilities	Interstate 610 – 320 feet to 330 feet ROW Interstate 10 – 430 feet ROW	Topographic Survey; Record Drawings; HCAD Maps	Map	Exhibit 2.3A
METRO	Route 026 – Longpoint/Cavalcade Route 027 – Shepherd Route 030 – Clinton/Ella Route 066 - Quitman Route 283 – Kuykendahl/Greenway-Uptown P&R Route 298 – Kingsland/Addicks/NWTC/TMC P&R	www.Ridemetro.org	Map	Exhibit 2.3B
HCTRA	N/A	N/A	N/A	N/A
Railroads	N/A	N/A	N/A	N/A
County Facilities	N/A	N/A	N/A	N/A
Airport Facilities	N/A	N/A	N/A	N/A
Port Facilities	N/A	N/A	N/A	N/A
PCI	Shepherd Drive: 4 lanes, PCIs poor to fair Durham Drive: 4 lanes, PCIs poor to fair West 24th Street: 2 lanes, PCI fair West 20th Street: 2 lanes, PCI poor West 19th Street: 2 lanes, PCI fair West 18th Street: 2 lanes, PCI poor West 16th Street: 2 lanes, PCI poor West 14th Street: 2 lanes, PCI fair to good West 12th Street: 2 lanes, PCI poor	HPW GIMS Database	Map	Exhibit 2.3C

Item	Data/Format	Source	Format	Exhibit
	West 11th Street; 4 lanes, PCI fair to good			
311	A mix of potholes, water main complaints, sewer odor complaints, and traffic signal complaints consistent with the surrounding area	HPW GIMS Database	Map	Exhibit 2.3D
ADT	Shepherd Drive: Interstate 10 to West 11th Street – 21,949 West 11th Street to West 20th Street – 32,077 West 20th Street to Interstate 610 – 21,438 Durham Drive: Interstate 10 to West 11th Street – 22,592 West 11th Street to West 20th Street – 31,646 West 20th Street to Interstate 610 – 17,138	Traffic Counts; HPW GIMS Database	Map	Exhibit 2.3E
Bike Plan	Designated routes on Shepherd Drive, Durham Drive, West 24th Street, West 18th Street, West 14th Street, and West 11th Street; Trail connections to MKT at West 7th Street and White Oak Bayou at Larkin Street	Houston Bike Plan	Map	Exhibit 2.3F
Pedestrian infrastructure	Sidewalks are located on both sides of each street, but are not continuous and do not meet minimum HPW width requirements Signalized intersections include pedestrian push buttons and pedestrian signal heads	Topographic Survey, Record Drawings, Physical Observation	Map	Exhibit 2.1C

Item	Data/Format	Source	Format	Exhibit
As-builts	Listing of Existing HPW as-built drawings	City of Houston Records	Table	Table 2.3
Bridge/Bridge Condition	Bridge #22: Shepherd Drive over White Oak Bayou Bridge #149: Durham Drive over White Oak Bayou	Topographic survey; Record Drawings; BRINSAP Reports	Map	Table 2.3G Appendix B
Signalized Intersections	Approaches include four (4) lanes Pedestrian heads and pushbuttons are included at each signalized intersection	Topographic survey; Record Drawings; Physical Observation	Map	Table 2.3H Exhibit 2.3H Appendix C

2.4 Drainage

Shepherd Drive and Durham Drive are served by a network of storm sewers that empty into Turkey Gully and White Oak Bayou through seven (7) different outfall locations. The area has not flooded in recent severe weather events, including Hurricane Harvey and Tropical Storm Imelda, but analysis indicates that the storm sewers do not meet current HPW requirements.

Item	Data/Format	Source	Format	Exhibit
Losses	None within project limits	N/A	N/A	N/A
Structures in Flood Plain	3 commercial structures in Floodway, 5 commercial structures in 100-year floodplain, 5 commercial structures in 500-year floodplain	FEMA Map Panel 48201C0670M, dated 1/6/2017	Map	Exhibit 2.4A
Larger storm system/Outfall area	*System A:* less than 2-year capacity *System B:* between 2-year ATLAS 14 and 100-year ATLAS 14 capacity *System C:* less than 2-year capacity *System D:* 100-year ATLAS 14 capacity *System E:* 100-year ATLAS 14 capacity *System F:* between 2-year ATLAS 14 and 100-year ATLAS 14 capacity *System G:* 2-year capacity	Preliminary 2D Modeling	Map	Exhibit 2.4B

Item	Data/Format	Source	Format	Exhibit
Related Improvements /Improvements in Watershed	No adjacent HCFCD, USACE projects		N/A	N/A
H&H Model – XP SWMM	Existing 2D model	Preliminary 2D Modeling	Model output	Appendix D
Watershed	White Oak Bayou, 91.899 acres Turkey Gully, 707.476 acres	Harris County Flood Control, HPW GIMS Database	Map	Exhibit 2.4B
Ponding	*2-year ponding depth of* 100-year ponding depth of Shepherd Drive and Durham Drive passable during Hurricane Harvey	Preliminary 2D Modeling Anecdotal Evidence	Map	Exhibit 2.4C Exhibit 2.4D
Survey	LiDAR and topographic survey	N/A	N/A	N/A
HCFCD	Turkey Gully (HCFCD E106-00-00 White Oak Bayou (HCFCD E100-00-00)	HCFCD Website HPW GIMS	Map	Exhibit 2.4B
COH	None	N/A	N/A	N/A
Water/River Authority	None	N/A	N/A	N/A
MUDs	None	N/A	N/A	N/A
Existing Drainage Agreements	*None*	N/A	N/A	

2.5 Previous Studies

Item	Data/Format	Source	Format	Exhibit
HCFCD	Proposed or planned improvements to outfalls or watershed – CI-030: Turkey	HCFCD Website; Watershed Coordinators	Map	Exhibit 2.5A

Item	Data/Format	Source	Format	Exhibit
	Gulley; Lower White Oak Bayou Channel Restoration Study; North Canal			
COH PROCOH	Planned: Drainage, Paving, and Wastewater Improvements in Cottage Grove (East), M-410039-0001; Wastewater Improvements on Dorothy, R-002011-0095; Asphalt overlays on West 11th Street, West 14th Street, West 15th Street, West 16th Street, and Laird Street Completed sidewalks, traffic signals, water, and asphalt overlays	HPW GIMS	Map	Exhibit 2.5B
METRO	METRONext, Universal Accessibility	METRO	Map	Exhibit 2.5C
Counties	N/A	N/A	N/A	N/A
TxDOT	N/A	N/A	N/A	N/A
HGAC	N/A	N/A	N/A	N/A
TIRZ/MD/BID	MHRA/TIRZ 5 CIP	MHRA/TIRZ 5 CIP	Map	Exhibit 2.5D
Associated projects	N/A	N/A	N/A	N/A
COH Programs (i.e. Complete Communities, Walkable Centers)	Hogan/Lorraine Walkable Centers Pilot Area Near Northside Complete Communities Area	COH Website	Map	Exhibit 2.5E

3 Alternatives Analysis

3.1 Alternatives

Shepherd Drive and Durham Drive are both on the City's Major Thoroughfare Plan and the Houston Bike Plan with dedicated on-street bicycle facilities. The current pavement conditions dictate full reconstruction of the vehicle lanes. HPW has requested the replacement of the existing water lines along both Shepherd Drive and Durham Drive, the replacement of existing sanitary sewers crossing the project corridors and in back-lot easements, and the installation of new sanitary sewers south of West 12th Street to accommodate redirection of sanitary sewer flows and the abandonment of existing lift stations near White Oak Bayou.

With a focus on safety and mobility, METRO has also requested significant modifications to the locations of their bus stops along Shepherd Drive and Durham Drive. The MHRA team has coordinated with METRO on the consolidation and relocation of bus stops within the project corridor to reduce the number of stops by approximately one-half.

The existing storm sewers are of inadequate capacity to meet current City requirements. While the area did not experience significant flooding during Hurricane Harvey, Tropical Storm Imelda, or other recent severe weather events, it is important to plan for severe weather events in the future and to provide a level of service within the storm system that is above standard requirements where possible. The proposed storm improvements included in this project have been designed with the rainfall intensities of ATLAS14 in mind. These improvements will help keep Shepherd Drive and Durham Drive open as major thoroughfares in times of need.

MHRA considered several alternatives for the reconstruction of Shepherd Drive, Durham Drive, and Selected Cross Streets as summarized below.

No-Build Alternative (Option 0): *No Build Alternative – no improvements will be made*			
Estimated Property Impacts:	None	**Estimated Total Construction Cost:**	$0
Estimated ROW Cost:	$0	**Estimated Construction Time:**	None
Estimated Mitigation Required:	None	**Exhibit:**	None

Alternatives 1 through 4 focus on mobility and safety. Traffic analysis indicates that the number of travel lanes may be reduced to three (3) lanes each on Shepherd Drive and Durham Drive with appropriate improvements provided at signalized intersections to improve the levels of service throughout the corridor. Alternatives 1 through 4 also focus on the safety of cyclists and pedestrians and place dedicated bicycle facilities at sidewalk level and widen sidewalks to maximize spaces for pedestrians throughout the project corridor. Improvements behind the curb will include low impact development techniques such as permeable pavement for the bicycle and pedestrian facilities, vegetative strips, and filtration in tree wells to help minimize increases in impervious cover and the associated mitigation within the storm sewer system.

Alternative 1 (Option 1) – Cycletrack on Shepherd Drive: *Reconstruction Shepherd Drive, Durham Drive, and Selected Cross Streets to appropriate number of lanes of three (3) vehicle lanes on Shepherd Drive and Durham Drive and two (2) vehicle lanes on the selected cross streets. Dedicated cycle track at sidewalk level will be provided on the west side of Shepherd Drive and the east side of Durham Drive to meet the Houston Bike Plan. Other improvements necessary to meet or exceed current criteria include installation of new sidewalks, traffic signals, street lighting, storm sewers, water lines, and sanitary sewers.*			
Estimated Property Impacts:	Property acquisitions at West 20th Street, West 19th Street, and West 11th Street	**Estimated Total Construction Cost:**	$117,984,211
Estimated ROW Cost:	$300,000	**Estimated Construction Time:**	5 years over 2 phases
Estimated Mitigation Required:	Significant upgrades are required to meet current City criteria	**Exhibit:**	Exhibit 3.1

Alternative 2 (Option 2) – Bike Lanes on Outside of Shepherd Drive and Durham Drive: *Reconstruction Shepherd Drive, Durham Drive, and Selected Cross Streets to appropriate number of lanes of three (3) vehicle lanes on Shepherd Drive and Durham Drive and two (2) vehicle lanes on the selected cross streets. Dedicated bicycle lanes at sidewalk level will be provided on the east side of Shepherd Drive and the west side of Durham Drive to meet the Houston Bike Plan. Other improvements necessary to meet or exceed current criteria include installation of new sidewalks, traffic signals, street lighting, storm sewers, water lines, and sanitary sewers.*			
Estimated Property Impacts:	Property acquisitions at West 20th Street, West 19th Street, and West 11th Street	**Estimated Total Construction Cost:**	$115,868,715
Estimated ROW Cost:	$300,000	**Estimated Construction Time:**	5 years
Estimated Mitigation Required:	Significant upgrades are required to meet current City criteria	**Exhibit:**	Exhibit 3.2

Alternative 3 (Option 3) – Bike Lanes on Inside of Shepherd Drive and Durham Drive: *Reconstruction Shepherd Drive, Durham Drive, and Selected Cross Streets to appropriate number of lanes of three (3) vehicle lanes on Shepherd Drive and Durham Drive and two (2) vehicle lanes on the selected cross streets. Dedicated bicycle lanes at sidewalk level will be provided on the west side of Shepherd Drive and the east side of Durham Drive to meet the Houston Bike Plan. Other improvements necessary to meet or exceed current criteria include installation of new sidewalks, traffic signals, street lighting, storm sewers, water lines, and sanitary sewers.*			
Estimated Property Impacts:	Property acquisitions at West 20th Street, West 19th Street, and West 11th Street	**Estimated Total Cost:**	$115,868,715
Estimated ROW Cost:	$300,000	**Estimated Construction Time:**	5 years
Estimated Mitigation Required:	Significant upgrades are required to meet current City criteria	**Exhibit:**	Exhibit 3.3

Alternative 4 (Option 4) – Bike Lanes on the east side of Shepherd Drive and Durham Drive: *Reconstruction Shepherd Drive, Durham Drive, and Selected Cross Streets to appropriate number of lanes of three (3) vehicle lanes on Shepherd Drive and Durham Drive and two (2) vehicle lanes on the selected cross streets. Dedicated bicycle lanes at sidewalk level will be provided on the east side of Shepherd Drive and the east side of Durham Drive to meet the Houston Bike Plan. Other improvements necessary to meet or exceed current criteria include installation of new sidewalks, traffic signals, street lighting, storm sewers, water lines, and sanitary sewers.*			
Estimated Property Impacts:	Property acquisitions at West 20th Street, West 19th Street, and West 11th Street	**Estimated Total Cost:**	$115,868,715
Estimated ROW Cost:	$300,000	**Estimated Construction Time:**	5 years
Estimated Mitigation Required:	Significant upgrades are required to meet current City criteria	**Exhibit:**	Exhibit 3.4

3.2 Comparison of Alternatives

Many of the improvements included in Alternatives 1 through 4 share the same benefits and risks regardless of the alternative selected.

Criteria	Benefit(s)	Risk(s)
Crossing Distances	Reduction is crossing distances with the reduction in the number of lanes	Perceived loss of mobility with reduction in lanes

Criteria	Benefit(s)	Risk(s)
Detention	Mitigation provided to meet or exceed HPW requirements	Additional costs for storm sewer upgrades Construction disruption
Driveways	Opportunities to reduce or consolidate the number of driveways along the corridor	Perceived loss of access by property owners
Parking	Eliminate illegal street parking on Shepherd Drive and Durham Drive	Perceived loss of parking by property owners
Pedestrians	Dedicated/improved pedestrian space provided	
Potential for Redevelopment	Improved multi-modal access on Shepherd Drive and Durham Drive	Lag time in redevelopment due to construction
Private Utilities	Potential relocation of poles to right-of-way	Potential consolidation or reduction in number of poles may not be feasible
Rights-of-Way	Utilization of existing rights-of-way and limited acquisitions	Improvements potentially limited by the existing right-of-way widths
Risk to Existing Development	Improved multi-modal access	Construction disruption
Safety	Dedicated spaces for bicycles, pedestrian, buses, and other vehicles	Potential for bicycles to be located in unexpected locations
Storm Sewers and Drainage	Replace aging infrastructure to meet or exceed HPW requirements	Construction disruption
Street Lighting	Improved lighting through the project corridor	Additional costs for pedestrian/bicycle facility lighting
Traffic Signals	Replacement of existing traffic signals to meet or exceed HPW requirements Improved levels of service	Longer cycle times for left turns for some bicycle facilities
Wastewater	Replace aging infrastructure Reduce odor and stoppage complaints	Additional costs for sanitary sewers; Construction disruption
Water Lines	Replace aging infrastructure	Additional costs for water lines; Construction disruption

Benefits and risks for the individual alternatives:

Alternative 0: No Build			
Criteria	**Benefit(s)**	**Risk(s)**	**Notes**
Connectivity	No construction disruption	No improvement	No improvements to inadequate/ dangerous intersections; No improvements to address high crash rates Opportunities to connect to facilities to the north and south may be missed.
Bicycles	No construction disruption	No bicycle facility	No designated bicycle facility now
Transit	No construction disruption	No improvement	
Urban Design/Landscape	None	None	

Alternative 1: Cycletrack on Shepherd Drive			
Criteria	**Benefit(s)**	**Risk(s)**	**Notes**
Connectivity	Fewer conflicts for connection to the MKT Trail and White Oak Bayou Trail	No dedicated bicycle facility on Durham Drive; No sidewalk south of West 11th Street on Durham Bridge; May not be the most direct route for cyclists	Potential to provide connectivity with the repurposing of the lift station access road on Durham Drive; Contra-flow cycletrack may be a concern on a one-way road
Bicycles	Bicycles separated from buses	No dedicated bicycle facility on Durham Drive; Potential for bicycles to be located in unexpected locations and conflicts with turning vehicles; Potential future closures of cycletrack due to construction on adjacent properties	
Transit	Fewer conflicts between buses and bicycles	Connections between buses and bicycles may not be the most direct	
Urban Design/Landscape	Cycletrack may be more conducive to a mixed-use environment on Shepherd Drive;	Less space in some locations for shade;	

Alternative 1: Cycletrack on Shepherd Drive			
Criteria	**Benefit(s)**	**Risk(s)**	**Notes**
	Includes more space for landscaping on Durham Drive	Less multi-modal connectivity to mixed-use development on Durham Drive	

Alternative 2: Bike Lanes on Outside of Shepherd Drive and Durham Drive			
Criteria	**Benefit(s)**	**Risk(s)**	**Notes**
Connectivity	Access between buses, bicycles, and pedestrians is more direct; Access to adjacent neighborhoods is more direct	No sidewalk south of West 11th Street on Durham Bridge; Right-of-way on Durham Drive limits the installation of floating bus stops and could increase conflict potential	Potential to provide connectivity with the repurposing of the lift station access road on Durham Drive; Focus on the connections to the cross streets and neighborhoods is key
Bicycles	No left turn conflict with bicycles on Shepherd Drive and Durham Drive; Bicycles are located where drivers expect them to be	Limited inner-corridor connectivity between Shepherd Drive and Durham Drive; Potential conflicts between bicycles and right turns, especially right turns on red	
Transit	Access between buses, bicycles, and pedestrians is more direct	Potential for conflicts between buses and bicycles; Limited space for bicycles within Durham Drive right-of-way	
Urban Design/Landscape	Potential opportunities to work with redevelopment on the edges of the corridor	Potential conflicts with existing developments along the edges of the corridor	

Alternative 3: Bike Lanes on Inside of Shepherd Drive and Durham Drive			
Criteria	**Benefit(s)**	**Risk(s)**	**Notes**
Connectivity	Access to the interior of the project corridor is better	No sidewalk south of West 11th Street on Durham Bridge; Access to adjacent neighborhoods is not the most direct	Consider visibility for bicycles on the left of turning vehicles and appropriate turning speeds

Alternative 3: Bike Lanes on Inside of Shepherd Drive and Durham Drive			
Criteria	**Benefit(s)**	**Risk(s)**	**Notes**
Bicycles	Inner-corridor access between Shepherd Drive and Durham Drive; Better placement of bicycle lane on Durham Drive	Potential conflicts between bicycles and left turns on Durham Drive	Conflicts could be managed with signal phasing
Transit	Fewer conflicts between buses and bicycles	Connections between buses and bicycles limited to signalized intersections	
Urban Design/Landscape	Potential opportunities to work with redevelopment between Shepherd Drive and Durham Drive	Potential conflicts with existing developments between Shepherd Drive and Durham Drive	

Alternative 4: Bike Lanes on the east side of Shepherd Drive and Durham Drive			
Criteria	**Benefit(s)**	**Risk(s)**	**Notes**
Connectivity	Access between buses, bicycles, and pedestrians is more direct on Shepherd Drive; Access to adjacent neighborhoods is more direct from Shepherd Drive; Most direct and most legible connections to MKT Trail and White Oak Bayou Trail; Easier connection crossing Interstate 610; Easier connections on Shepherd Drive to facilities south of Interstate 10	No sidewalk south of West 11th Street on Durham Bridge; Access from Durham Drive to adjacent neighborhoods is not the most direct	
Bicycles	No left turn conflict with bicycles on Shepherd Drive; Bicycles are located where drivers expect them to be on Shepherd Drive	Limited inner-corridor connectivity between Shepherd Drive and Durham Drive; Potential conflicts between bicycles and left turns on Durham Drive	

Alternative 4: Bike Lanes on the east side of Shepherd Drive and Durham Drive			
Criteria	**Benefit(s)**	**Risk(s)**	**Notes**
Transit	Access between buses, bicycles, and pedestrians is more direct on Shepherd Drive	Connections between buses and bicycles limited to signalized intersections on Durham Drive	
Urban Design/Landscape	Potential opportunities to work with redevelopment on the edges of Shepherd Drive and the interior of Durham Drive	Potential conflicts with existing developments along the edges and interior of the corridor	

3.3 Preferred Alternative

Alternative 4 is recommended. Alternative 4 includes the reconstruction of Shepherd Drive and Durham Drive with three (3) traffic lanes each and sidewalk-level bicycle lanes on the east sides of Shepherd Drive and Durham Drive. Alternative 4 is configured to utilize the space within the existing rights-of-way in a way that provides safe environments for pedestrians, bicycles, transit, and vehicles while minimizing conflicts between the different modes of travel. Alternative 4 allows for the installation for floating bus stops along Shepherd Drive where there is adequate right-of-way width and separates bicycles from buses on Durham Drive where there is less room within the right-of-way.

Alternative 0 does not provide any improvements within the project corridor and allows potentially dangerous conflicts to continue.

Alternative 1 meets the goal of the project but does not provide multi-modal access along Durham Drive, provides less opportunities for shade through the project corridor, and does not directly connect with developments along Durham Drive.

Alternative 2 meets the goal of the project but does not reduce conflicts between bicycles and buses along Durham Drive or conflicts between bicycles and right turns on Durham Drive, and has limited connection with developments between Shepherd Drive and Durham Drive.

Alternative 3 meets the goal of the project but provides less opportunities to connect with the developments adjacent to the project corridor, does not reduce potential conflicts between bicycles and left turns at Shepherd Drive and Durham Drive, and does not limits connections between bicycles and buses to signalized intersections.

4 Preferred Alternative

4.1 Main Design Features

Transportation
The standard applicable to the reconstruction of Shepherd Drive, Durham Drive, and Selected cross streets are contained within the Houston Public Works Infrastructure Design Manual (HPW IDM), dated July 2019. The proposed roadway, bicycle, and pedestrian improvements are shown in Exhibit 3.4.

At Interstate 610 and Interstate 10, Shepherd Drive and Durham Drive will transition from four (4) vehicle lanes to three (3) vehicle lanes to accommodate the addition of bicycle and pedestrian facilities. At Interstate 10 and Shepherd Drive, this transition already occurs with the dedicated left turn lane for northbound traffic to the westbound service road. The through lanes will be slightly shifted to convert the east lane to a buffered bicycle lane. Similarly at Interstate 610 and Durham Drive, this transition already occurs with the dedicated left turn lane for southbound traffic to the eastbound service road. No lane shifting will be required as the eastern curb will be pushed out to accommodate a sidewalk level bicycle lane.

At Interstate 10, the continuation of bicycle facilities will be coordinated with the proposed METRO BRT route and transit center planned between Shepherd Drive and Durham Drive.

Continuation of bicycle facilities at Interstate 610 poses more of a challenge with the left turn and U-turn lanes and the structure of the Interstate 610 overpass. It appears that there may be sufficient room to provide sidewalk-level bicycle lanes along the east sides of Shepherd Drive and Durham Drive under Interstate 610. A full survey and dimensions of both Shepherd Drive and Durham Drive under Interstate 610 is needed to confirm that sufficient space is available to continue the facilities.

Connection of the proposed bicycle improvements on Shepherd Drive and Durham Drive to the MKT Trail near West 7th Street is critical to the bicycle network. A connection from Shepherd Drive can be made relatively easily as shown in Exhibit 3.4 by utilizing the Shepherd Drive service road. Connection from Durham Drive is a little more challenging. The City is working to abandon the Durham Lift Station. The service drive to the lift station can be repurposed and extended within the Durham Drive right-of-way under the bridge to connect to the MKT Trail as shown in Exhibit 3.4. Coordination with the properties that utilize the area under the bridge for parking will be required.

Shepherd Drive, Interstate 610 to Interstate 10					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Typical Section					
- Number of Lanes	4	4	3	Traffic Analysis	No
- Lane Width(s)	11	11	11	HPW IDM	No
- Median Width & Type	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder or Border Area Width	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder Slope	N/A	N/A	N/A	N/A	N/A
- Inside Shoulder Width	N/A	N/A	N/A	N/A	N/A
- Sidewalks	0 to 5 feet	5 to 6 feet	6 feet minimum	HPW IDM	No
- Auxiliary Lanes	N/A	N/A	N/A	N/A	N/A
- Bike Lanes	N/A	5 feet with 3-foot buffer	6 feet behind the curb	HPW IDM/ NACTO	No
Posted Speed	35	35	35	No change	N/A
Design Speed	40	40	40	No change	N/A
Min Horizontal Curve Radius	N/A	500 feet	N/A	HPW IDM	No
Maximum Superelevation Rate	N/A	N/A	N/A	HPW IDM	No
Maximum Grade	0.30%	3.5%	0.30%	HPW IDM	No
Access Control	N/A	N/A	N/A	N/A	N/A
Pavement Type	Concrete, asphalt	Concrete	Concrete	HPW IDM	No
Additional Items as warranted					

Durham Drive, Interstate 610 to Interstate 10					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Typical Section					
- Number of Lanes	4	4	3	Traffic Analysis	No
- Lane Width(s)	11	11	11	HPW IDM	No
- Median Width & Type	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder or Border Area Width	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder Slope	N/A	N/A	N/A	N/A	N/A
- Inside Shoulder Width	N/A	N/A	N/A	N/A	N/A
- Sidewalks	0 to 5 feet	5 to 6 feet	6 feet minimum	HPW IDM	No
- Auxiliary Lanes	N/A	N/A	N/A	N/A	N/A
- Bike Lanes	N/A	5 feet with 3-foot buffer	6 feet behind the curb	HPW IDM/ NACTO	No
Posted Speed	35	35	35	No change	N/A
Design Speed	40	40	40	No change	N/A
Min Horizontal Curve Radius	800’	500 feet	800’	HPW IDM	No
Maximum Superelevation Rate	N/A	N/A	N/A	HPW IDM	No
Maximum Grade	0.30%	3.5%	0.30%	HPW IDM	No
Access Control	N/A	N/A	N/A	N/A	N/A
Pavement Type	Concrete, asphalt	Concrete	Concrete	HPW IDM	No
Additional Items as warranted					

West 24th Street, Durham Drive to Shepherd Drive					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Typical Section					
- Number of Lanes	2	2	2	HPW IDM	No
- Lane Width(s)	11	11	11	HPW IDM	No
- Median Width & Type	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder or Border Area Width	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder Slope	N/A	N/A	N/A	N/A	N/A
- Inside Shoulder Width	N/A	N/A	N/A	N/A	N/A
- Sidewalks	0 to 5 feet	5 to 6 feet	6 feet	HPW IDM	No
- Auxiliary Lanes	N/A	N/A	N/A	N/A	N/A
- Bike Lanes	N/A	5 feet with 3-foot buffer	5 feet with 3-foot buffer	HPW IDM/ NACTO	No
Posted Speed	30	30	30	No change	N/A
Design Speed	40	40	40	No change	N/A
Min Horizontal Curve Radius	N/A	500 feet	N/A	HPW IDM	No
Maximum Superelevation Rate	N/A	N/A	N/A	HPW IDM	No
Maximum Grade	0.30%	3.5%	0.30%	HPW IDM	No
Access Control	N/A	N/A	N/A	N/A	N/A
Pavement Type	Concrete, asphalt	Concrete	Concrete	HPW IDM	No
Additional Items as warranted					

West 20th Street, 1,100 feet west of Durham Drive to Shepherd Drive					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Typical Section					
- Number of Lanes	2	2	4	Traffic Analysis	No
- Lane Width(s)	11	11	11	HPW IDM	No
- Median Width & Type	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder or Border Area Width	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder Slope	N/A	N/A	N/A	N/A	N/A
- Inside Shoulder Width	N/A	N/A	N/A	N/A	N/A
- Sidewalks	0 to 5 feet	5 to 6 feet	6 feet	HPW IDM	No
- Auxiliary Lanes	N/A	N/A	N/A	N/A	N/A
- Bike Lanes	N/A	5 feet with 3-foot buffer	N/A	HPW IDM/ NACTO	No
Posted Speed	35	35	35	No change	N/A
Design Speed	40	40	40	No change	N/A
Min Horizontal Curve Radius	N/A	500 feet	N/A	HPW IDM	No
Maximum Superelevation Rate	N/A	N/A	N/A	HPW IDM	No
Maximum Grade	0.30%	3.5%	0.30%	HPW IDM	No
Access Control	N/A	N/A	N/A	N/A	N/A
Pavement Type	Concrete, asphalt	Concrete	Concrete	HPW IDM	No
Additional Items as warranted					

West 19th Street, 800 feet west of Durham Drive to Shepherd Drive					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Typical Section					
- Number of Lanes	2	2	2	HPW IDM	No
- Lane Width(s)	11	11	11	HPW IDM	No
- Median Width & Type	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder or Border Area Width	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder Slope	N/A	N/A	N/A	N/A	N/A
- Inside Shoulder Width	N/A	N/A	N/A	N/A	N/A
- Sidewalks	0 to 5 feet	5 to 6 feet	6 feet	HPW IDM	No
- Auxiliary Lanes	N/A	N/A	N/A	N/A	N/A
- Bike Lanes	N/A	5 feet with 3-foot buffer	N/A	HPW IDM/ NACTO	No
Posted Speed	30	30	30	No change	N/A
Design Speed	40	40	40	No change	N/A
Min Horizontal Curve Radius	N/A	500 feet	N/A	HPW IDM	No
Maximum Superelevation Rate	N/A	N/A	N/A	HPW IDM	No
Maximum Grade	0.30%	3.5%	0.30%	HPW IDM	No
Access Control	N/A	N/A	N/A	N/A	N/A
Pavement Type	Concrete, asphalt	Concrete	Concrete	HPW IDM	No
Additional Items as warranted					

West 18th Street, 800 feet west of Durham Drive to Shepherd Drive					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Typical Section					
- Number of Lanes	2	2	2	HPW IDM	No
- Lane Width(s)	11	11	11	HPW IDM	No
- Median Width & Type	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder or Border Area Width	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder Slope	N/A	N/A	N/A	N/A	N/A
- Inside Shoulder Width	N/A	N/A	N/A	N/A	N/A
- Sidewalks	0 to 5 feet	5 to 6 feet	6 feet	HPW IDM	No
- Auxiliary Lanes	N/A	N/A	N/A	N/A	N/A
- Bike Lanes	N/A	5 feet with 3-foot buffer	N/A	HPW IDM/ NACTO	No
Posted Speed	30	30	30	No change	N/A
Design Speed	40	40	40	No change	N/A
Min Horizontal Curve Radius	N/A	500 feet	N/A	HPW IDM	No
Maximum Superelevation Rate	N/A	N/A	N/A	HPW IDM	No
Maximum Grade	0.30%	3.5%	0.30%	HPW IDM	No
Access Control	N/A	N/A	N/A	N/A	N/A
Pavement Type	Concrete, asphalt	Concrete	Concrete	HPW IDM	No
Additional Items as warranted					

West 16th Street, Durham Drive to Shepherd Drive					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Typical Section					
- Number of Lanes	2	2	2	HPW IDM	No
- Lane Width(s)	11	11	11	HPW IDM	No
- Median Width & Type	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder or Border Area Width	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder Slope	N/A	N/A	N/A	N/A	N/A
- Inside Shoulder Width	N/A	N/A	N/A	N/A	N/A
- Sidewalks	0 to 5 feet	5 to 6 feet	6 feet	HPW IDM	No
- Auxiliary Lanes	N/A	N/A	N/A	N/A	N/A
- Bike Lanes	N/A	5 feet with 3-foot buffer	5 feet with 3-foot buffer	HPW IDM/ NACTO	No
Posted Speed	30	30	30	No change	N/A
Design Speed	40	40	40	No change	N/A
Min Horizontal Curve Radius	N/A	500 feet	N/A	HPW IDM	No
Maximum Superelevation Rate	N/A	N/A	N/A	HPW IDM	No
Maximum Grade	0.30%	3.5%	0.30%	HPW IDM	No
Access Control	N/A	N/A	N/A	N/A	N/A
Pavement Type	Concrete, asphalt	Concrete	Concrete	HPW IDM	No
Additional Items as warranted					

West 15th Street, Prince Street to Dorothy Street					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Typical Section					
- Number of Lanes	2	2	2	HPW IDM	No
- Lane Width(s)	11	11	11	HPW IDM	No
- Median Width & Type	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder or Border Area Width	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder Slope	N/A	N/A	N/A	N/A	N/A
- Inside Shoulder Width	N/A	N/A	N/A	N/A	N/A
- Sidewalks	0 to 5 feet	5 to 6 feet	6 feet	HPW IDM	No
- Auxiliary Lanes	N/A	N/A	N/A	N/A	N/A
- Bike Lanes	N/A	5 feet with 3-foot buffer	N/A	HPW IDM/ NACTO	No
Posted Speed	30	30	30	No change	N/A
Design Speed	40	40	40	No change	N/A
Min Horizontal Curve Radius	N/A	500 feet	N/A	HPW IDM	No
Maximum Superelevation Rate	N/A	N/A	N/A	HPW IDM	No
Maximum Grade	0.30%	3.5%	0.30%	HPW IDM	No
Access Control	N/A	N/A	N/A	N/A	N/A
Pavement Type	Concrete, asphalt	Concrete	Concrete	HPW IDM	No
Additional Items as warranted					

West 14th Street, Durham Drive to Shepherd Drive					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Typical Section					
- Number of Lanes	2	2	2	HPW IDM	No
- Lane Width(s)	11	11	11	HPW IDM	No
- Median Width & Type	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder or Border Area Width	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder Slope	N/A	N/A	N/A	N/A	N/A
- Inside Shoulder Width	N/A	N/A	N/A	N/A	N/A
- Sidewalks	0 to 5 feet	5 to 6 feet	6 feet	HPW IDM	No
- Auxiliary Lanes	N/A	N/A	N/A	N/A	N/A
- Bike Lanes	N/A	5 feet with 3-foot buffer	5 feet with 3-foot buffer	HPW IDM/ NACTO	No
Posted Speed	30	30	30	No change	N/A
Design Speed	40	40	40	No change	N/A
Min Horizontal Curve Radius	N/A	500 feet	N/A	HPW IDM	No
Maximum Superelevation Rate	N/A	N/A	N/A	HPW IDM	No
Maximum Grade	0.30%	3.5%	0.30%	HPW IDM	No
Access Control	N/A	N/A	N/A	N/A	N/A
Pavement Type	Concrete, asphalt	Concrete	Concrete	HPW IDM	No
Additional Items as warranted					

West 12th Street, Durham Drive to Shepherd Drive					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Typical Section					
- Number of Lanes	2	2	2	HPW IDM	No
- Lane Width(s)	11	11	11	HPW IDM	No
- Median Width & Type	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder or Border Area Width	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder Slope	N/A	N/A	N/A	N/A	N/A
- Inside Shoulder Width	N/A	N/A	N/A	N/A	N/A
- Sidewalks	0 to 5 feet	5 to 6 feet	6 feet	HPW IDM	No
- Auxiliary Lanes	N/A	N/A	N/A	N/A	N/A
- Bike Lanes	N/A	5 feet with 3-foot buffer	N/A	HPW IDM/ NACTO	No
Posted Speed	30	30	30	No change	N/A
Design Speed	40	40	40	No change	N/A
Min Horizontal Curve Radius	N/A	500 feet	N/A	HPW IDM	No
Maximum Superelevation Rate	N/A	N/A	N/A	HPW IDM	No
Maximum Grade	0.30%	3.5%	0.30%	HPW IDM	No
Access Control	N/A	N/A	N/A	N/A	N/A
Pavement Type	Concrete, asphalt	Concrete	Concrete	HPW IDM	No
Additional Items as warranted					

West 11th Street, Nashua Street to Shepherd Drive					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Typical Section					
- Number of Lanes	4	4	4-5	Traffic Analysis	No
- Lane Width(s)	11	11	11	HPW IDM	No
- Median Width & Type	13 feet west of Durham Drive	14 feet, 4 feet minimum	14 feet	HPW IDM	No
- Outside Shoulder or Border Area Width	N/A	N/A	N/A	N/A	N/A
- Outside Shoulder Slope	N/A	N/A	N/A	N/A	N/A
- Inside Shoulder Width	N/A	N/A	N/A	N/A	N/A
- Sidewalks	0 to 5 feet	5 to 6 feet	6 feet	HPW IDM	No
- Auxiliary Lanes	N/A	N/A	N/A	N/A	N/A
- Bike Lanes	N/A	5 feet with 3-foot buffer	5 feet with 3-foot buffer	HPW IDM/ NACTO	No
Posted Speed	30	30	30	No change	N/A
Design Speed	40	40	40	No change	N/A
Min Horizontal Curve Radius		500 feet		HPW IDM	No
Maximum Superelevation Rate	N/A	N/A	N/A	HPW IDM	No
Maximum Grade	0.30%	3.5%	0.30%	HPW IDM	No
Access Control	N/A	N/A	N/A	N/A	N/A
Pavement Type	Concrete, asphalt	Concrete	Concrete	HPW IDM	No
Additional Items as warranted					

Major Intersections and Structures		
Intersection/Structure	**Existing**	**Proposed**
Durham Drive at Interstate 610 Service Road	Mast arm signal with pedestrian push buttons and crosswalks	No proposed improvements
Durham Drive at West 24th Street	Mast arm traffic signal with pedestrian signal heads, pedestrian push buttons and standard striping crosswalks.	Remove existing traffic signal and install new ADA compliant wheelchair ramps, crosswalks and mast arm type traffic signal with 340 ITS cabinet, vehicle signal heads, bike signal heads, loop detectors, countdown pedestrian signal heads, APS, WiMAX and pre-empt. Construct a westbound left turn lane.
Durham Drive at West 20th Street	Mast arm traffic signal with button crosswalks and no pedestrian push buttons or pedestrian signal heads.	Remove existing traffic signal and install new ADA compliant wheelchair ramps, crosswalks and mast arm type traffic signal with 340 ITS cabinet, vehicle signal heads, bike signal heads, loop detectors, countdown pedestrian signal heads, APS, WiMAX and pre-empt. Construct a westbound left turn lane and restripe the eastbound right turn lane to a shared through/right turn lane. Widen 20th St to 4 lanes with 2 lines in each direction.
Durham Drive at West 19th Street	Mast arm traffic signal with pedestrian signal heads, pedestrian push buttons and crosswalks.	Remove existing traffic signal and install new ADA compliant wheelchair ramps, crosswalks and mast arm type traffic signal with 340 ITS cabinet, vehicle signal heads, bike signal heads, loop detectors, countdown pedestrian signal heads, APS, WiMAX and pre-empt. Install a southbound left turn lane and a westbound left turn lane.
Durham Drive at West 14th Street	Mast arm/span wire traffic signal with pedestrian signal heads, pedestrian push buttons and crosswalks.	Remove existing traffic signal and install new ADA compliant wheelchair ramps, crosswalks and mast arm type traffic signal with 340 ITS cabinet, vehicle signal heads, bike signal heads, loop detectors, countdown pedestrian signal heads, APS, WiMAX and pre-empt.

Major Intersections and Structures		
Intersection/Structure	**Existing**	**Proposed**
Durham Drive at West 11th Street	Mast arm traffic signal with pedestrian signal heads, pedestrian push buttons and crosswalks.	Remove existing traffic signal and install new ADA compliant wheelchair ramps, crosswalks and mast arm type traffic signal with 340 ITS cabinet, vehicle signal heads, bike signal heads, loop detectors, countdown pedestrian signal heads, APS, WiMAX and pre-empt. Restripe the eastbound shared through/right turn lane to through only. Construct a southbound left turn lane with 50' of storage.
Durham Drive at Interstate 10 Service Road	Not included in analysis	Not included in analysis
Shepherd Drive at Interstate 610 Service Road	Mast arm traffic signal with pedestrian signal heads, pedestrian push buttons and crosswalks.	No proposed improvements
Shepherd Drive at West 24th Street	Mast arm traffic signal with pedestrian signal heads, pedestrian push buttons and crosswalks.	Remove existing traffic signal and install new ADA compliant wheelchair ramps, crosswalks and mast arm type traffic signal with 340 ITS cabinet, vehicle signal heads, bike signal heads, loop detectors, countdown pedestrian signal heads, APS, WiMAX and pre-empt. Construct an eastbound left turn lane and westbound right turn lane.
Shepherd Drive at West 20th Street	Span wire traffic signal with pedestrian signal heads, pedestrian push buttons and continental/standard crosswalk striping.	Remove existing traffic signal and install new ADA compliant wheelchair ramps, crosswalks and mast arm type traffic signal with 340 ITS cabinet, vehicle signal heads, bike signal heads, loop detectors, countdown pedestrian signal heads, APS, WiMAX and pre-empt. Widen 20th St to 4 lanes with 2 lines in each direction. Construct a northbound left turn lane on Shepherd Dr.
Shepherd Drive at West 19th Street	Mast arm traffic signal with pedestrian signal heads, pedestrian push buttons and crosswalks.	Remove existing traffic signal and install new ADA compliant wheelchair ramps, crosswalks and mast arm type traffic signal with 340 ITS cabinet, vehicle signal heads, bike signal heads, loop detectors,

Major Intersections and Structures		
Intersection/Structure	**Existing**	**Proposed**
		countdown pedestrian signal heads, APS, WiMAX and pre-empt.
Shepherd Drive at West 14th Street	Span wire traffic signal with pedestrian signal heads, pedestrian push buttons and crosswalks.	Remove existing traffic signal and install new ADA compliant wheelchair ramps, crosswalks and mast arm type traffic signal with 340 ITS cabinet, vehicle signal heads, bike signal heads, loop detectors, countdown pedestrian signal heads, APS, WiMAX and pre-empt.
Shepherd Drive at West 11th Street	Mast arm traffic signal with pedestrian signal heads, pedestrian push buttons and crosswalks.	Remove existing traffic signal and install new ADA compliant wheelchair ramps, crosswalks and mast arm type traffic signal with 340 ITS cabinet, vehicle signal heads, bike signal heads, loop detectors, countdown pedestrian signal heads, APS, WiMAX and pre-empt. Install a northbound left turn lane with 100' of storage.
Shepherd Drive at West 10th Street	HAWK signal to the south.	HAWK signal to remain.
Shepherd Drive at Interstate 10 Service Road	Not included in analysis	Not included in analysis

Drainage

Reconstruction within the Shepherd Drive and Durham Drive corridors allows for the replacement of outdated storm sewers and inlets. We also address the increased rainfall intensities in ATLAS 14. The recommended drainage improvements are shown in Exhibit 4.1A. Inundation mapping is provided in Exhibit 4.1B. J|C utilized InfoWorks ICM as an advanced design tool to help calculate ponding depths and outfall flows. This analysis is not intended to be viewed as a drainage impact analysis. The information provided is intended to inform design software (HouStorm) used for design and regulatory purposes. The standard applicable to the reconstruction of Shepherd Drive, Durham Drive, and Selected cross streets are contained within the Houston Public Works Infrastructure Design Manual (HPW IDM), dated July 2019.

Drainage Facilities – System A					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Storm drain LOS (sewer or open ditch)	Less than 2-year	ATLAS 14 2-year and 100-year	ATLAS 14 2-year and 100-year	HPW IDM, Preliminary 2D Modeling	N/A
- Minimum flow velocity, pipe	2.52 fps	3 fps	1.72 fps	HPW IDM, Preliminary 2D Modeling	No – velocity reduced due to mitigation
- Maximum flow velocity, pipe	16.33 fps	12 fps	11.12 fps	HPW IDM, Preliminary 2D Modeling	No
- Maximum flow velocity, outfall	12.87 fps	8 fps	13.67 fps	HPW IDM, Preliminary 2D Modeling	No
- Minimum flow velocity, open ditch	N/A	<1 fps	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Maximum flow velocity, open ditch	N/A	3 fps	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Ditch depth	N/A	4 feet max.	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Storm sewer diameter	24-inch to 48-inch	24-inch min.	24-inch to 10-foot by 10-foot RCB	HPW IDM, Preliminary 2D Modeling	No
- Inlet lead diameter	15-inch min.	24-inch min.	24-inch min.	HPW IDM, Preliminary 2D Modeling	No

Drainage Facilities – System A					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
- Storm sewer inlet type	A min.	BB min.	BB, C-2A	HPW IDM, Preliminary 2D Modeling	No
2-year ponding elevation, maximum	1.63 feet	0.5 feet	1.02 feet	HPW IDM, Preliminary 2D Modeling	No – improvement over existing
100-year ponding elevation, maximum	2.77 feet	1.5 feet	2.23 feet	HPW IDM, Preliminary 2D Modeling	No – improvement over existing
Mitigation volume	N/A		N/A	HPW IDM, Preliminary 2D Modeling	N/A
Flow Restrictor	N/A		42-inch	Preliminary 2d Modeling	No
Additional Items as warranted	N/A		N/A	N/A	N/A

Drainage Facilities – System B					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Storm drain LOS (sewer or open ditch)	Greater than 2-year, less than 100-year ATLAS 14	ATLAS 14 2-year and 100-year	ATLAS 14 2-year and 100-year	HPW IDM, Preliminary 2D Modeling	N/A

Drainage Facilities – System B					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
- Minimum flow velocity, pipe	3.59 fps	3 fps	0.91 fps	HPW IDM, Preliminary 2D Modeling	No
- Maximum flow velocity, pipe	17.53 fps	12 fps	17.56 fps	HPW IDM, Preliminary 2D Modeling	No
- Maximum flow velocity, outfall	7.55 fps	8 fps	7.87 fps	HPW IDM, Preliminary 2D Modeling	No
- Minimum flow velocity, open ditch	N/A	<1 fps	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Maximum flow velocity, open ditch	N/A	3 fps	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Ditch depth	N/A	4 feet max.	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Storm sewer diameter	24-inch to 42-inch	24-inch min.	24-inch to 7-foot by 7-foot RCB	HPW IDM, Preliminary 2D Modeling	No
- Inlet lead diameter	15-inch min.	24-inch min.	24-inch min.	HPW IDM, Preliminary 2D Modeling	No
- Storm sewer inlet type	B min.	BB min.	BB, C-2A	HPW IDM, Preliminary 2D Modeling	No

Drainage Facilities – System B					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
2-year ponding elevation, maximum	0.89 feet	0.5 feet	0.91 feet	HPW IDM, Preliminary 2D Modeling	No – 2D Mesh Comparison
100-year ponding elevation, maximum	2.14 feet	1.5 feet	2.15 feet	HPW IDM, Preliminary 2D Modeling	No – 2D Mesh Comparison
Mitigation volume	N/A		N/A	HPW IDM, Preliminary 2D Modeling	N/A
Flow Restrictor	N/A		N/A	N/A	N/A
Additional Items as warranted	N/A		N/A	N/A	N/A

Drainage Facilities – System C					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Storm drain LOS (sewer or open ditch)	Less than 2-year	ATLAS 14 2-year and 100-year	ATLAS 14 2-year and 100-year	HPW IDM, Preliminary 2D Modeling	N/A
- Minimum flow velocity, pipe	1.53 fps	3 fps	0.84 fps	HPW IDM, Preliminary 2D Modeling	No
- Maximum flow velocity, pipe	8.81 fps	12 fps	9.93 fps	HPW IDM, Preliminary 2D Modeling	No

Drainage Facilities – System C					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
- Maximum flow velocity, outfall	8.47 fps	8 fps	9.89 fps	HPW IDM, Preliminary 2D Modeling	No
- Minimum flow velocity, open ditch	N/A	<1 fps	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Maximum flow velocity, open ditch	N/A	3 fps	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Ditch depth	N/A	4 feet max.	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Storm sewer diameter	18-inch to 90-inch	24-inch min.	5-foot by 5-foot to 12-foot by 12-foot RCB	HPW IDM, Preliminary 2D Modeling	No
- Inlet lead diameter	15-inch min.	24-inch min.	24-inch min.	HPW IDM, Preliminary 2D Modeling	No
- Storm sewer inlet type	B min.	BB min.	BB, C-2A	HPW IDM, Preliminary 2D Modeling	No
2-year ponding elevation, maximum	1.65 feet	0.5 feet	1.05 feet	HPW IDM, Preliminary 2D Modeling	No – improvement over existing
100-year ponding elevation, maximum	2.17 feet	1.5 feet	1.99 feet	HPW IDM, Preliminary 2D Modeling	No – improvement over existing

Drainage Facilities – System C					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Mitigation volume	N/A		N/A	HPW IDM, Preliminary 2D Modeling	N/A
Flow Restrictor	N/A		N/A	N/A	N/A
Additional Items as warranted	N/A		N/A	N/A	N/A

Drainage Facilities – System D					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Storm drain LOS (sewer or open ditch)	100-year ATLAS 14	ATLAS 14 2-year and 100-year	ATLAS 14 2-year and 100-year	HPW IDM, Preliminary 2D Modeling	N/A
- Minimum flow velocity, pipe	4.84 fps	3 fps	5.14 fps	HPW IDM, Preliminary 2D Modeling	No
- Maximum flow velocity, pipe	5.91 fps	12 fps	6.83 fps	HPW IDM, Preliminary 2D Modeling	No
- Maximum flow velocity, outfall	5.89 fps	8 fps	6.82 fps	HPW IDM, Preliminary 2D Modeling	No
- Minimum flow velocity, open ditch	N/A	<1 fps	N/A	HPW IDM, Preliminary 2D Modeling	N/A

Drainage Facilities – System D					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
- Maximum flow velocity, open ditch	N/A	3 fps	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Ditch depth	N/A	4 feet max.	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Storm sewer diameter	7-foot by 6-foot RCB	24-inch min.	7-foot by 6-foot RCB (existing)	HPW IDM, Preliminary 2D Modeling	No
- Inlet lead diameter	18-inch min.	24-inch min.	24-inch min.	HPW IDM, Preliminary 2D Modeling	No
- Storm sewer inlet type	BB min.	BB min.	BB min.	HPW IDM, Preliminary 2D Modeling	No
2-year ponding elevation, maximum	0.59 feet	0.5 feet	0.54 feet	HPW IDM, Preliminary 2D Modeling	No – improvement over existing
100-year ponding elevation, maximum	0.76 feet	1.5 feet	0.67 feet	HPW IDM, Preliminary 2D Modeling	No
Mitigation volume	N/A		N/A	HPW IDM, Preliminary 2D Modeling	N/A
Flow Restrictor	N/A		N/A	N/A	N/A
Additional Items as warranted	N/A		N/A	N/A	N/A

Drainage Facilities – System E					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Storm drain LOS (sewer or open ditch)	100-year ATLAS 14, except inlets	ATLAS 14 2-year and 100-year	ATLAS 14 2-year and 100-year	HPW IDM, Preliminary 2D Modeling	N/A
- Minimum flow velocity, pipe	1.27 fps	3 fps	0.48 fps	HPW IDM, Preliminary 2D Modeling	No
- Maximum flow velocity, pipe	5.71 fps	12 fps	8.38 fps	HPW IDM, Preliminary 2D Modeling	No
- Maximum flow velocity, outfall	4.01 fps	8 fps	4.96 fps	HPW IDM, Preliminary 2D Modeling	No
- Minimum flow velocity, open ditch	N/A	<1 fps	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Maximum flow velocity, open ditch	N/A	3 fps	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Ditch depth	N/A	4 feet max.	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Storm sewer diameter	18-inch to 30-inch	24-inch min.	24-inch to 36-inch	HPW IDM, Preliminary 2D Modeling	No
- Inlet lead diameter	N/A	24-inch min.	N/A	HPW IDM, Preliminary 2D Modeling	No

Drainage Facilities – System E					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
- Storm sewer inlet type	B min.	BB min.	BB	HPW IDM, Preliminary 2D Modeling	No
2-year ponding elevation, maximum	1.56 feet	0.5 feet	1.62 feet	HPW IDM, Preliminary 2D Modeling	No – additional survey needed
100-year ponding elevation, maximum	1.89 feet	1.5 feet	1.95 feet	HPW IDM, Preliminary 2D Modeling	No – additional survey needed
Mitigation volume	N/A		N/A	HPW IDM, Preliminary 2D Modeling	N/A
Flow Restrictor	N/A		N/A	N/A	N/A
Additional Items as warranted	N/A		N/A	N/A	N/A

Drainage Facilities – System F					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Storm drain LOS (sewer or open ditch)	Greater than 2-year, Less than 100-year ATLAS 14	ATLAS 14 2-year and 100-year	ATLAS 14 2-year and 100-year	HPW IDM, Preliminary 2D Modeling	N/A
- Minimum flow velocity, pipe	3.18 fps	3 fps	4.97 fps	HPW IDM, Preliminary 2D Modeling	No

Drainage Facilities – System F					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
- Maximum flow velocity, pipe	10.74 fps	12 fps	12.16 fps	HPW IDM, Preliminary 2D Modeling	No
- Maximum flow velocity, outfall	8.24 fps	8 fps	9.76 fps	HPW IDM, Preliminary 2D Modeling	No
- Minimum flow velocity, open ditch	N/A	<1 fps	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Maximum flow velocity, open ditch	N/A	3 fps	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Ditch depth	N/A	4 feet max.	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Storm sewer diameter	24-inch	24-inch min.	24-inch	HPW IDM, Preliminary 2D Modeling	No
- Inlet lead diameter	18-inch min.	24-inch min.	24-inch min.	HPW IDM, Preliminary 2D Modeling	No
- Storm sewer inlet type	B min.	BB min.	BB	HPW IDM, Preliminary 2D Modeling	No
2-year ponding elevation, maximum	0.79 feet	0.5 feet	0.80 feet	HPW IDM, Preliminary 2D Modeling	No – 2D Mesh Comparison

Drainage Facilities – System F					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
100-year ponding elevation, maximum	1.15 feet	1.5 feet	1.15 feet	HPW IDM, Preliminary 2D Modeling	No
Mitigation volume	N/A		N/A	HPW IDM, Preliminary 2D Modeling	N/A
Flow Restrictor	N/A		N/A	N/A	N/A
Additional Items as warranted	N/A		N/A	N/A	N/A

Drainage Facilities – System G					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Storm drain LOS (sewer or open ditch)	2-year	ATLAS 14 2-year and 100-year	ATLAS 14 2-year and 100-year	HPW IDM, Preliminary 2D Modeling	N/A
- Minimum flow velocity, pipe	1.41 fps	3 fps	1.47 fps	HPW IDM, Preliminary 2D Modeling	No
- Maximum flow velocity, pipe	15.39 fps	12 fps	15.19 fps	HPW IDM, Preliminary 2D Modeling	No – improvement over existing
- Maximum flow velocity, outfall	9.61 fps	8 fps	9.08 fps	HPW IDM, Preliminary 2D Modeling	No – improvement over existing

Drainage Facilities – System G					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
- Minimum flow velocity, open ditch	N/A	<1 fps	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Maximum flow velocity, open ditch	N/A	3 fps	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Ditch depth	N/A	4 feet max.	N/A	HPW IDM, Preliminary 2D Modeling	N/A
- Storm sewer diameter	18-inch to 60-inch	24-inch min.	5-foot by 3-foot to 10-foot by 10-foot RCB	HPW IDM, Preliminary 2D Modeling	No
- Inlet lead diameter	18-inch min.	24-inch min.	24-inch min.	HPW IDM, Preliminary 2D Modeling	No
- Storm sewer inlet type	B min.	BB min.	BB, E	HPW IDM, Preliminary 2D Modeling	No
2-year ponding elevation, maximum	1.28 feet	0.5 feet	1.04 feet	HPW IDM, Preliminary 2D Modeling	No – improvement over existing
100-year ponding elevation, maximum	1.65 feet	1.5 feet	1.64 feet	HPW IDM, Preliminary 2D Modeling	No – improvement over existing
Mitigation volume	N/A		N/A	HPW IDM, Preliminary 2D Modeling	N/A

Drainage Facilities – System G					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Flow Restrictor	N/A		48-inch	Preliminary 2D Modeling	No
Additional Items as warranted	N/A		N/A	N/A	N/A

Water and Wastewater Facilities

With the reconstruction of Shepherd Drive and Durham Drive, HPW has requested the replacement of the existing water lines within the project corridor and the installation of sanitary sewers along Durham Drive south of West 11th Street to allow for lift station consolidation in the area. HPW has also asked for the replacement of existing sanitary sewers located within backlot easements and alleys north of West 16th Street.

Water Facilities					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Shepherd Drive					
- Interstate 610 to West 18th Street	12-inch	8-inch min.	12-inch	HPW Request	No
- West 18th Street to West 8th Street	12-inch	8-inch min.	12-inch	HPW Request	No
- West 8th Street to Interstate 10	12-inch	8-inch min.	12-inch	HPW Request	No
Durham Drive					
- Interstate 610 to West 21st Street	8-inch	8-inch min.	8-inch	HPW Request	No
- West 21st Street to West 17th Street	8-inch	8-inch min.	8-inch	HPW Request	No
- West 17th Street to West 11th Street	12-inch	8-inch min.	12-inch	HPW Request	No
- West 11th Street to West 9th Street	8-inch	8-inch min.	8-inch	HPW Request	No
West 18th Street					
- Durham Drive to west	8-inch	8-inch min.	8-inch	HPW Request	No
West 16th Street					
- Shepherd Drive to Durham Drive	2-inch 8-inch	8-inch min.	8-inch	HPW Request	No

Water Facilities					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
West 14th Street					
- Shepherd Drive to Durham Drive	8-inch	8-inch min.	8-inch	HPW Request	No

Wastewater Facilities					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Shepherd Drive					
- West 28th Street to West 26th Street	8-inch	8-inch min.	8-inch	HPW Request	No
- West 24th Street to West 23rd Street	8-inch	8-inch min.	8-inch	HPW Request	No
- West 16th Street to West 15th Street	8-inch	8-inch min.	8-inch	HPW Request	No
- West 15th Street to West 13th Street	8-inch	8-inch min.	8-inch	HPW Request	No
- West 13th Street to West 12th Street	8-inch 15-inch	8-inch min.	8-inch 15-inch	HPW Request	No
- West 11th Street to West 10th Street	54-inch	8-inch min.	N/A	N/A	No
- West 6th Street to Interstate 10	21-inch	8-inch min.	N/A	N/A	No
Durham Drive					
- Interstate 610 to West 27th Street	8-inch	8-inch min.	8-inch	HPW Request	No
- West 24th Street to West 23rd Street	8-inch	8-inch min.	8-inch	HPW Request	No
- West 16th Street to West 14th Street	6-inch	8-inch min.	6-inch	HPW Request	No
- West 14th Street to West 12th Street	8-inch	8-inch min.	8-inch	HPW Request	No
- West 11th Street to Durham Lift Station	N/A	8-inch min.	36-inch	HPW Request	No
Backlot: West 28th Street/ West 27th Street	8-inch	8-inch min.	8-inch	HPW Request	No
Backlot: West 27th Street/ West 26th Street	8-inch	8-inch min.	8-inch	HPW Request	No

Wastewater Facilities					
Feature	Existing	Standard	Proposed	Justification/ Methodology	Variance Required?
Backlot: West 26th Street/ West 25th Street	8-inch	8-inch min.	8-inch	HPW Request	No
Backlot: West 25th Street/ West 24th Street	8-inch	8-inch min.	8-inch	HPW Request	No
Backlot: West 24th Street/ West 23rd Street	8-inch	8-inch min.	8-inch	HPW Request	No
Backlot: West 23rd Street/ West 22nd Street	8-inch	8-inch min.	8-inch	HPW Request	No
Backlot: West 22nd Street/ West 21st Street	8-inch	8-inch min.	8-inch	HPW Request	No
Backlot: West 21st Street/ West 20th Street	8-inch	8-inch min.	8-inch	HPW Request	No
Backlot: West 20th Street/West 19th Street	8-inch	8-inch min.	8-inch	HPW Request	No
Backlot: West 19th Street/ West 18th Street	8-inch	8-inch min.	8-inch	HPW Request	No
Backlot: West 18th Street/West 17th Street	8-inch	8-inch min.	8-inch	HPW Request	No
Backlot: West 17th Street/West 16th Street	8-inch	8-inch min.	8-inch	HPW Request	No
West 16th Street					
- Shepherd Drive to Laird Street	8-inch	8-inch min.	8-inch	HPW Request	No
West 13th Street					
- Shepherd Drive to Durham Drive	8-inch 12-inch	8-inch min.	8-inch 12-inch	HPW Request	No
West 12th Street					
- Shepherd Drive to Durham Drive	8-inch 84-inch	8-inch min.	8-inch N/A	HPW Request	No

Due to the challenges of accessing sanitary sewers located within backlot easements and alleys, replacement of these sewers is not recommended with this project.

Street Lighting

As part of the reconstruction of the Shepherd and Durham corridors, street lighting will be updated. There are a few options available that consider the limitations of the grant funding and not having a management district to handle ongoing maintenance costs.

Option 1: New CNP Fixtures on Existing CNP Poles – Cobra fixture arm brackets are placed on existing CenterPoint (CNP) overhead electric wooden/metal poles within the roadway right-of-way, whether these poles are existing to remain in place along the corridors, relocated per project needs, or added to meet streetlight spacing standards (spaced every 180 to 200 feet). The overhead brackets can be powder coated as desired. This option is furnished, installed, and maintained by CNP at no cost to the TIRZ; however, an electricity/maintenance fee per streetlight is paid by the City of Houston (the City).

Option 2: New CNP Poles and Fixtures – Standard Cobra pole assemblies (fixture arm bracket and pole) are spaced every 180 to 220 feet separate from the overhead electric poles, typically between the curb and sidewalk. These pole assemblies can be powder coated as desired. The TIRZ pays a per street light cost for CNP to furnish and install the pole and pays for the installation of the underground infrastructure. This option is maintained by CNP with the City paying an electricity/maintenance fee per streetlight. Another standard pole assembly type is the Constellation pole assembly; however, this type is not recommended due to the higher TIRZ cost per pole. Both pole types have the ability to provide a double-arm configuration to shed light on the roadway and on the sidewalk-level bicycle and pedestrian facilities as needed (if the street-side fixture alone does not provide sufficient lighting for this purpose); however, this involves additional installation and maintenance costs that go beyond typical TIRZ capabilities.

Option 3: New City Poles and Fixtures – City/TIRZ agreed-upon streetlight poles are spaced as frequently as needed, with or without the double-arm configuration, and are equipped with sensors and advanced lighting controls programmed to allow lighting levels to be dimmed for energy savings and increased for pedestrian safety crossing. Other unique features include the ability to expand existing Wi-fi, monitor air quality, and manage streetlight assets. This option would meet the City's Smart City Streetlight Initiative and would be maintained by the City. Since this is a recent initiative, coordination would be required between the City and TIRZ to understand installation costs and features.

The recommendation for the Shepherd Drive and Durham Drive corridors moving into final design is to consider all options with the intent to enhance street lighting beyond standard spacing to ensure light levels are high-comfort for vehicles, cyclists, and pedestrians.

4.2 Real Estate/ROW Assessment and Parcel Survey

With the installation of dedicated turn lanes, acquisitions may be required at the following locations:

- Shepherd Drive at West 20th Street (southwest corner): 810 square feet
- Durham Drive at West 19th Street (northeast corner): 460 square feet
- Durham Drive at West 11th Street (northeast corner): 730 square feet

These locations are shown for reference on Exhibit 3.1E.

4.3 Permits, Commitments, Coordination, and Agreements

Entity	Item	Description
HPW	Permit, Commitment, Coordination, Agreement	Permits for construction (lane closure, sidewalk closure, excavation, etc.) Coordination and approval of design Commitment and Interlocal Agreement for reimbursement of water and wastewater improvement costs
HCFCD	Coordination	Connection to existing outfall structures
TxDOT	Permit, Coordination	Lane closure permits during construction Coordination of future bicycle facilities under Interstate 610
FHWA	Coordination	Coordination of plans under the BUILD Grant

4.4 Timeline and Phasing

The recommended improvements will be constructed in two (2) phases as shown in Exhibit 4.3:

- Phase 1: Interstate 610 to West 15th Street
- Phase 2: West 15th Street to Interstate 10

Under the terms of the Federal grant received, design plans for the recommended improvements for Phase 1 must be completed and ready for construction in June 2021. Construction of Phase 1 will be completed within three (3) years. The design of the recommended improvements for

Phase 2 will commence once construction of Phase 1 has started. Construction of Phase 2 is estimated to be completed within two (2) years. The entire project is expected to be completed within five (5) years.

4.5 Cost Estimate

Detailed estimates of probable construction costs are provided in Appendix E. A summary of the probable construction cost estimates by Phase follows:

Item	Phase 1	Phase 2	Total
General	$5,965,627	$6,796,873	$12,762,500
Landscape and LID	$4,588,026	$4,884,974	$9,473,000
Water Lines	$1,857,870	$1,888,000	$3,745,870
Sanitary Sewer (within ROW only)	$370,530	$4,783,749	$5,154,279
Storm Sewer	$11,960,608	$8,503,580	$20,464,188
Paving	$15,277,369	$13,919,708	$29,197,077
Subtotal	$40,020,030	$40,776,884	$80,769,914
Contingencies	$8,004,006	$8,155,377	$16,159,383
CM/CA/MTS	$6,243,125	$6,361,194	$12,604,319
Total Construction	**$54,267,161**	**$55,293,455**	**$109,560,615**

A summary of Total Implementation costs including Design and Right-of-Way Costs by Phase follows:

Costs	Phase 1	Phase 2	Total
Total Construction	$54,267,161	$55,293,455	$109,560,615
Design	$3,008,100	$3,000,000	$6,008,100
Right-of-Way Acquisition	$190,500	$109,500	$300,000
Total Implementation Costs	**$57,465,761**	**$58,402,955**	**$115,868,715**

4.6 Funding

MHRA/TIRZ No. 5 will fund the design of the Phase 1 improvements through their Capital Improvements Plan (CIP). The construction of Phase 1 improvements will be funded by a Federal BUILD Grant awarded to MHRA/TIRZ No. 5 in November 2019. An interlocal agreement with HPW will provide reimbursement to MHRA/TIRZ No. 5 for water line and sanitary sewer improvements.