City of Houston

Design Manual

Chapter 6

UTILITY LOCATIONS

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UTILITY LOCATIONS

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6.1.02.B Typical utility locations within City rights-of-way.

~~3.~~6.1.03 DEFINITIONS

6.1.03.A Easements - Areas set aside for installation and maintenance of utilities by public and private utility companies.

6.1.03.B Private Utilities - Utilities belonging to, operated, and maintained by private entities.

6.1.03.C Public Utilities - Utilities belonging to, operated, and maintained by public entities

6.1.03.D Right-of-Way - Public property dedicated or deeded to a municipality for the purpose of public use.

6.1.03.E Storm Sewer Lines - Closed gravity (non-pressure) conduits designed to collect and transport storm water from inlet locations to an open conduit outfall, ditch, creek, stream, bayou, river, holding pond, or bay. Inlets are surface mounted basins designed to collect and funnel storm water to the collection system. Storm sewers from the inlets to the collection system are usually defined as inlet leads.

~~6.1.03.E~~6.1.03.F Type 1 Permanent Access Easement - A permanent access easement at least 50 -feet in width that is designed and constructed like a public street in accordance with the design manual and contains one or more public utilities in an unpaved portion of the easement. Refer to Chapter 42 of the Code of Ordinances.

~~6.1.03.F~~6.1.03.G Water Lines - Closed conduits designed to distribute potable water for human consumption and to provide fire protection. Line size and fire protection accessory locations are dependent on distance from primary source and quantity

demand.

6.1.03.H Wastewater Sewer Lines - Closed conduits designed to collect and transport wastewater from residential, commercial, and industrial sites to plants for treatment prior to discharge into open conduits. Wastewater lines may be designed as gravity (non-pressure) flow lines or force (pressure) mains. Gravity flow lines usually fall into three categories in ascending size from service line to lateral line to main line. Service lines (source of wastewater) may discharge into a lateral line or main line.

~~6.08~~SECTION 2 – UTLITY LOCATION DESIGN REQUIREMENTS

~~1.~~6.2.01 DESIGN REQUIREMENTS

6.2.01.A Whenever practical, locate public storm sewer, wastewater collection lines, water mains, and appurtenances within public rights-of-way in the manner described by this and corresponding subject-specific chapters in this manual, as well as related details and specifications.

6.2.01.B Research and resolve known conflicts of proposed utilities with existing utilities according to subject-specific criteria developed by the utility owner(s).

6.2.01.C Locate back lot utilities in compliance with UCC recommendations.

6.2.01.D Identify all existing and proposed utilities and related appurtenances in the manner established by the subject-specific chapters in this manual.

~~2.~~6.2.02 SUBMITTALS

6.2.02.A. Submittals are to be made according to the criteria established by the utility owner(s).

~~3.~~6.2.03 QUALITY ASSURANCE

6.2.03.A All existing utilities must be shown on project drawings. Sources of data include survey, record drawings, graphical information systems, and field visits. Field visits must be made to verify the project drawings accurately portray the existing conditions.

~~4.~~6.2.04 DESIGN

6.2.04.A Back Lot Utilities: Identify type of electrical service and select the appropriate width of the easement. For mixed overhead and underground service select the 14-foot-wide easement to provide versatility.

~~6.2.04.B No Utilities Lines on City of Houston Bridges~~

~~No Utility lines shall be placed on or attached to a City of Houston bridge without approval of the City Engineer. Approval shall be based on submittal of study of all alternatives resulting in no viable option.~~

~~6.2.04.C~~6.2.04.B Water Lines

1. Water lines may be located within a public right-of-way, within a Type 1 permanent access easement with overlapping public utility easements, within a dedicated easement adjacent to and contiguous with the right-of-way, or within separate dedicated water line easements, to meet the requirements of

this manual. Water lines and related appurtenances shall be as specified in the subject-specific chapter(s) in this manual, as well as related details and specifications.

2. Water lines shall not be located in combination easements without approval of Houston Public Works. Water line easements shall not be combined with wastewater sewer easements.

3. Water lines, with the exception of transmission lines, shall be located within the right-of-way between the property line and back of curb or in a dedicated easement adjacent to and contiguous with the right-of-way.

4. Water lines and fire hydrants shall not be located in State rights-of-way. Water lines and fire hydrants should be located outside of the right-of-way in a separate contiguous easement. Width of easements shall be as provided in Paragraph 5.07.A.1.d. Existing interagency utility agreements between the City and the State within State rights-of-way may supersede this requirement. Agreements shall be provided upon request for review and applicability.

~~6.2.04.D~~6.2.04.C Wastewater Lines

1. Wastewater lines shall be located in a public right-of-way, within a Type 1 permanent access easement with overlapping public utility easements or within a dedicated easement adjacent to the public right-of-way. Side lot easements may be used when required. Backlot easements shall not be utilized except in cases of pre-existing conditions and with approval of the City. Wastewater, force mains, and related appurtenances shall be as specified in the chapter (7, 8, and 9) in this manual, as well as related details and specifications.

2. Wastewater trunk or collector mains shall not be located inside lot easements without approval of the City.

3. Wastewater gravity sewer trunks, collector mains, and force mains shall be generally located on the opposite side of the right-of-way from the water main.

4. Wastewater force mains are generally located within the right-of-way between the property line and the back of curb, or in a dedicated easement adjacent and contiguous with the right-of-way.

5. When wastewater or force mains are parallel to the storm sewer, they shall not be constructed in the same theoretical trench widths.

6. Wastewater Sewer Lines shall not be located in State rights-of-way. Wastewater Sewer Lines should be located outside of the right-of-way in a separate contiguous easement. Width of easements shall be as provided in

6.2.04.E.4 continued

Paragraph 5.07.B.1. Existing interagency utility agreements between the City and the State within State rights-of-way may supersede this requirement. Agreements shall be provided upon request for review and applicability.

~~6.2.04.E~~6.2.04.D Storm Water Lines

1. Storm water lines shall be located within public rights-of-way, within a Type 1 permanent access easement with overlapping public utility easements or approved easements. Approval of the location for storm water lines should be obtained from Houston Public Works prior to plan preparation.

2. Coordinate the proposed storm sewer alignment with water line location and future pavement widening.

~~6.2.04.F~~6.2.04.E Private Utility Lines

1. Proposed work, location, and placement of utilities shall be submitted to the Office of the City Engineer for reviews and Permitting. A minimum separation distance of either three feet (or more as stated in other portions of this design manual and/or related specifications, standards, or details) of horizontal clearance when parallel, and two feet (or more as stated in other portions of this design manual and/or related specifications, standards, or details) vertical clearance when crossing, shall be maintained between the exterior of all private utilities and public utilities, unless dimensional limitations constraints are not sufficient to support these separation distances. ~~A minimum of three (3) feet horizontal clearance when parallel, and two (2) feet vertical clearance when crossing, shall be observed between the exterior of all private utilities and public utilities, unless a greater clearance is required as stated in other portions of this design manual and/or related specifications or details.~~

2. Structures shall not be imbedded within sidewalks.

3. All proposed work must be coordinated with the City of Houston Capital Improvement Program.

4. Above-ground utility structures and appurtenances shall have a minimum of three ~~(3) -~~ feet of horizontal clearance from the right-of-way, unless approved by the City Engineer. Utility poles should be placed within two feet of the ROW line, unless approved by the City Engineer. These clearances do not apply to wireless service facilities: See Chapter 16. In no case shall above ground utility infrastructure from one utility entity be located within a clear distance of other infrastructure (retaining wall, exterior wall, trees, planters, light poles, traffic signals, other utility entity's infrastructure, etc.) that prevents use / travel along the sidewalk's path by persons in wheelchairs.

SECTION 3 – UTILITY LINES ON CITY OF HOUSTON BRIDGES AND OTHER STRUCTURES

Utilities mounted to bridges that go over waterways that fall under the jurisdiction of the Army Corp of Engineers, must meet their requirements and are subject to their approval.

6.3.01 UTILITY LINES ON CITY BRIDGES OVERVIEW

6.3.01.A These criteria are not applicable when removing and replacing a utility in kind on a bridge structure.

6.3.01.B The following information is adapted from the Texas Department of Transportation Bridge Project Development Manual, Chapter 4: Advanced Planning, Section 4: Utility Attachments; March 2018 Edition.

6.3.01.C To every extent possible, do not attach utility lines to bridges and separation structures because the proliferation of such lines and their maintenance constitutes a hazard to traffic and complicates widening or repair. Attaching utility lines to a bridge structure can materially affect the structure, the safe operation of traffic, the efficiency of maintenance, and the overall appearance.

6.3.01.D Where other arrangements for a utility line to span an obstruction are not feasible, Houston Public Works may consider the attachment of such line to a bridge structure. Any exceptions that are permitted will be handled in accordance with the conditions set forth in Title 43 TAC, Section 21.35 and 21.37 (relating to utility structures) and other pertinent requirements contained therein. Each such attachment will be considered on an individual basis and permission to attach will not be considered as establishing a precedent for granting of subsequent requests for attachment.

6.3.01.E Written permission is required from TxDOT's Bridge Division Office for any utility attachments to on-system bridges. On-system bridges are Federal-Aid highway/roadway bridges. In addition, written permission is also required from the City of Houston (Houston Public Works – Street and Bridge Maintenance) for these any utility attachments to on-system bridges. The reason is that the City of Houston is a stakeholder in terms of taking over maintenance of the bridges, and these bridges, because they cross City of Houston water bodies, watersheds, roads, paths, etc. Permit requests to perform the attachment work to on-system bridges shall be submitted to Office of the City Engineer (see paragraph 6.3.06) as well as any other regulatory agency with jurisdiction.

6.3.01.F Written permission is required from Houston Public Works - Street and Bridge Maintenance for any utility attachments to off-system bridges within the City of Houston's jurisdiction. Off-system bridges are non-Federal-aid roadway bridges.

6.3.01.G Permit requests to perform the attachment work to off-system bridges shall be submitted to Office of the City Engineer (see paragraph 6.3.06).

6.3.01.H Considerations for allowing or rejecting attachment of utilities to bridges include, but are not limited to the following:

1. Painting of Steel Bridges: Utility attachments may limit the ability of Bridge Maintenance crews to sandblast (prep) and paint steel bridge components. Panting is critical in maintaining steel bridges and extending their useful service life.

2. Hazardous Liquid or Gas Utility Lines: Requests for such lines will be reviewed on a case by case basis. Shut off valves may be required on either side of the bridge.

3. Bridge Maintenance / Repair: Some bridge maintenance / repair work may require vertical displacement of the bridge deck. This work includes replacing bearing pads, repairing bridge columns, or other bridge repair work. Such displacements may damage rigid pipe utilities, used for transporting liquids or gas, or utility conduits, used for carrying cable utilities.

4. Added Cost: There may be added cost for incorporating utility attachment to a bridge. This cost may be comprised of design costs, material costs, construction costs, change orders, schedule delays, etc.

5. Proposed attachment details submitted by the utility owner and the impacts the details may have on the bridge/structure.

6.3.02 DECISION AND NOTIFICATION TO ALLOW ATTACHMENT

6.3.02.A If it is decided to allow utility attachment to a bridge, written permission (Letters of Decision or Issuance of No Objection) will be issued. The following terms and conditions are associated with allowing a utility line to be attached to a bridge or other structure: These terms are not an all-inclusive list, and additional site-specific additions may be required.

1. Maintenance of utility, including all conduit and attachment material for supporting the utility on the bridge (or other structure) shall be the responsibility and at the cost of the utility owner.

~~1.~~2. The City of Houston is not responsible for any damage or out-of-service losses associated with the utility, its conduit (if applicable), coatings, or attachment hardware resulting from any event, including but not limited to bridge repair and maintenance work, such as sand-blasting and painting, raising the deck to replace bearing pads, and any other bridge repair or maintenance activities.

6.3.02.A
continued

3. Utility owner shall remove its utility line, conduit, and attachments at the request of the City of Houston at any time. This includes, but is not limited to, shut down, disruption of service, de-inventory / evacuating of a liquid or gas utility pipeline, inerting a flammable liquid or gas utility pipeline, swabbing / cleaning a hazardous liquid pipeline, and traffic control for work areas and potential dropped object zones above roadways. Timing may be immediate if required to protect public safety or the environment. Timing may be urgent for bridge maintenance work. Removal shall be at the expense of the utility owner.

4. The utility owner shall reimburse (pay) the City of Houston Public Works all costs realized by the city to review and facilitate the supported utility on a bridge. The costs may include engineering / design services costs, material costs, and construction costs for new bridges/structures in the design process (not yet existing or being reconstructed) or for a third-party engineering contractor(s) or supplier(s) to review attachment details for existing bridges. The utility owner will still be responsible for reimbursement (payment) of costs realized by the city to review and facilitate the utility attachment if the utility owner ultimately decides not to attach its utility to the bridge for any reason.

5. Utility owner will be responsible for all costs associated with installation and attachment of the utility. This includes, but is not limited to, installation of the utility into pre-existing or pre-installed conduits if available, condition assessment of pre-existing conduits, attachment hardware for supporting the utility, tie-ins, materials not pre-installed by the City of Houston, electrical isolation and grounding of the utility as applicable, removal of existing conduit and attachments that may be inadequate, damaged, or corroded, work to install new conduit and attachment hardware, development and implementation of traffic control plans for the work, and installation execution plans.

6. Permits are required for performing the actual work of attaching the utility. Permit requests for the work shall be submitted to Office of the City Engineer (see paragraph 6.3.06).

~~1.~~6.3.03 OVERALL DESIGN GUIDELINES

6.3.03.A All requests for attachments to an existing City of Houston bridge/structure must be submitted to the City's Bridge Maintenance Office.

6.3.03.B All requests for attachments to a new City of Houston bridge/structure in the design process (not yet existing or being reconstructed) must be submitted to Houston Public Works – Street and Bridge Maintenance, / Interagency Coordinator in consultation with the Bridge Maintenance Office. Requests should be submitted (and addressed) as early as possible in the design process to minimize the cost to the City of Houston in the form of design changes, schedule delay, and change orders.

6.3.03.C All new bridge structures should include conduit for future utilities, per TxDOT's current design standards.

6.3.03.D Attachment Locations

1. Recommended attachment locations are on the overhang, as close as possible to the outside beam, or behind the outside beam. Behind the outside beam is preferred.

2. Hanging lines on the outside of the beams is not aesthetically pleasing and may be subject to vandalism. Attachments to water crossing structures should be placed on the downstream side where exposure to high water is less likely.

3. Bridge attachments shall not be made to any bridge rail or rail hardware, including anchor bolts. Bridge rails are the most susceptible to damage caused by motor vehicles, and hence are not a suitable location for utility placement. This will reduce the risk of damage to the utility, and it will reduce the need to get the utility owner involved when bridge rail repair is performed.

4. Do not hang lines from the bottom of beams. This decreases freeboard (water crossings) and clearance (road crossings), and hence increases the likelihood of damage

5. It may be beneficial to carry lines across an obstruction using a separate utility structure rather than an attachment to a City of Houston Public Works bridge / structure.

6.3.04 DESIGN GUIDELINES PER TYPE OF UTILITY

6.3.04.A Communication Lines

1. When it is impractical to carry a self-supporting communication line across a stream or other obstruction, Houston Public Works may permit the attachment of the line to its bridges. On existing bridges, Houston Public Works generally requires that the line be enclosed in conduits and located on structures such that it does not interfere with stream flow, traffic, or routine maintenance operations. When a request is made prior to construction of a bridge, suitable conduits will be provided in the structure if the utility company bears the cost of all additional work and materials involved.

6.3.04.B Gas or Fuel Utility Lines

1. No gas or liquid fuel lines may be attached to a bridge or grade separation structure without the specific permission from Houston Public Works. Note that attachment of US Department of Transportation (49 CFR 192 and 49 CFR 195) transmission pipelines and attachment of oil and gas production flowlines/pipelines to City of Houston bridges and other structures are strictly prohibited. Transmission pipelines and production flowlines/pipelines require their separate and dedicated ROW and bridge/crossing. The only exception is that consideration may be given to temporary water or saltwater pipelines (Paragraph 6.3.04.E). See paragraph 6.3.04.D regarding costs.

6.3.04.C Power Lines

1. Power lines are not permitted on bridges under any condition with the exception of low-voltage distribution lines where the cost of independent facilities to carry these lines would be prohibitive. For this requirement, low-voltage lines must carry 600 volts or less.

6.3.04.D Utility Pipelines

1. When a utility company requests permission to attach a pipeline to a proposed bridge prior to construction, and the added load is sufficient to require an increase in the strength of the structure or use of more costly materials or type of construction, the utility owner is required to pay for the increase in cost.

6.3.04.E Temporary Water Lines or Saltwater Pipelines

1. Temporary water lines are sometimes requested to be attached to bridges by companies in the oil and gas industry. If considered, special review and procedures will be required to assure that leaks during operation and an approved de-inventory, swabbing/cleaning/pigging, air-drying, and containment procedure(s) does not cause accelerated corrosion of the bridge/structure when a line is removed. See paragraph 6.3.04.D regarding costs.

6.3.05 REQUESTS TO ATTACH A UTILITY TO AN EXISTING BRIDGE

6.3.05.A All requests shall be sent to the Bridge Maintenance Office and each request may include the following as determined applicable by Bridge Maintenance Office:

1. Alternatives Study
2. Hydraulic Impact Analysis (stream analysis and/or scour analysis)
3. Stress analysis showing the effect of the added load on the structure.

6.3.06 PERMITTING OF UTILITY WORK ON THE CITY OF HOUSTON BRIDGES

6.3.06.A All third-party utility work shall be submitted to the Office of the City Engineer for reviews and permitting.

6.3.06.B Plans shall:

1. Show proposed location of attachment
2. Show specific detail for the attachment
3. Identify materials
4. Traffic Control Plans, including staging, for all work areas
5. Traffic Control Plans, including staging for all dropped object zones for roads being crossed by a bridge on which utility attachment work is being conducted.
6. Installation execution plans
7. Provide Letters of Decision/Issuance of No Objection from the Bridge Maintenance Office for off-system bridges and written permission from TxDOT, with additional written permission from City of Houston Public Works for flammable or hazardous liquid utility pipelines, for on-system bridges.

END OF CHAPTER

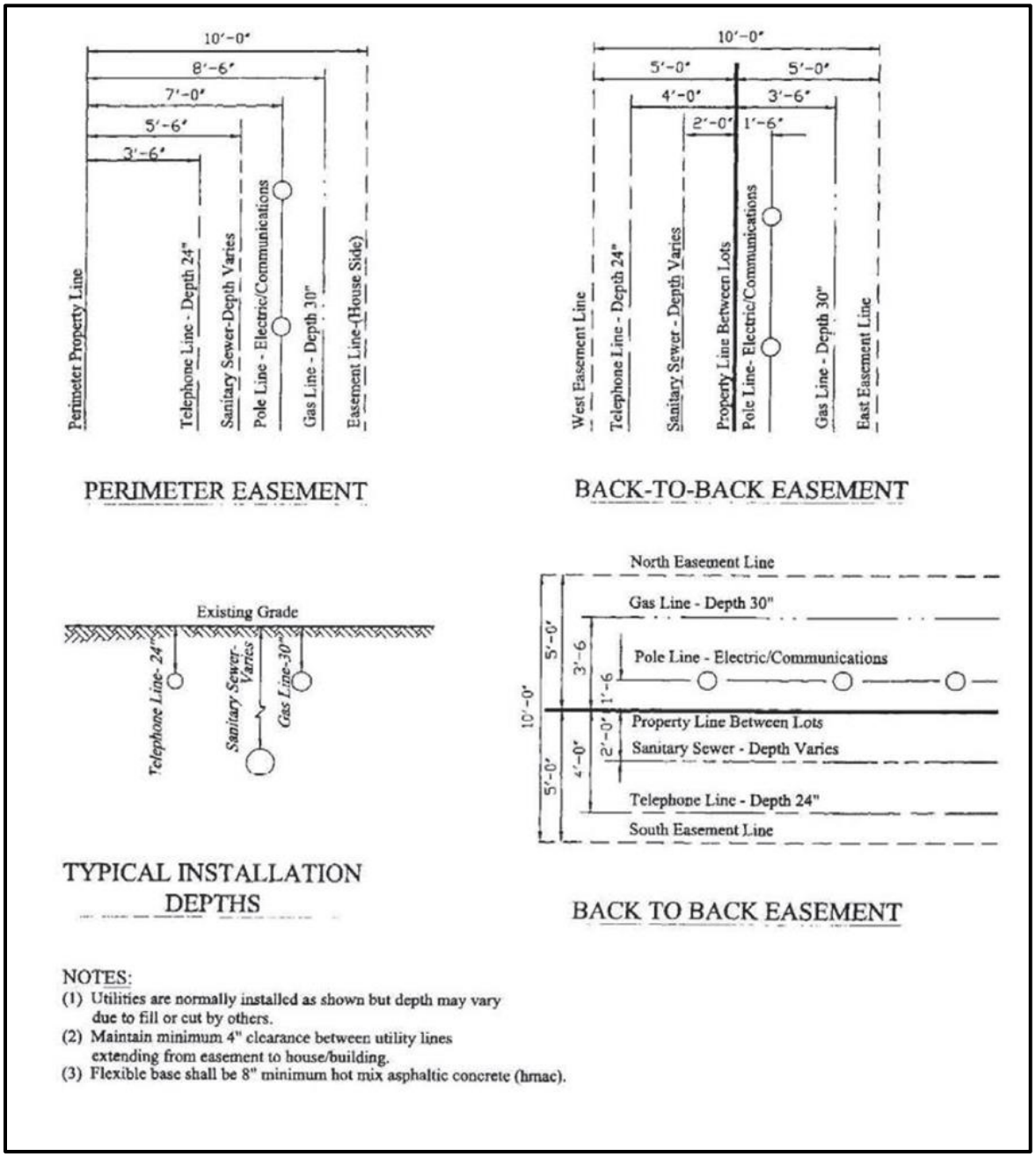

Figure 6.1 - TYPICAL UTILITY LOCATIONS IN 10-FOOT WIDE RESIDENTIAL EASEMENT

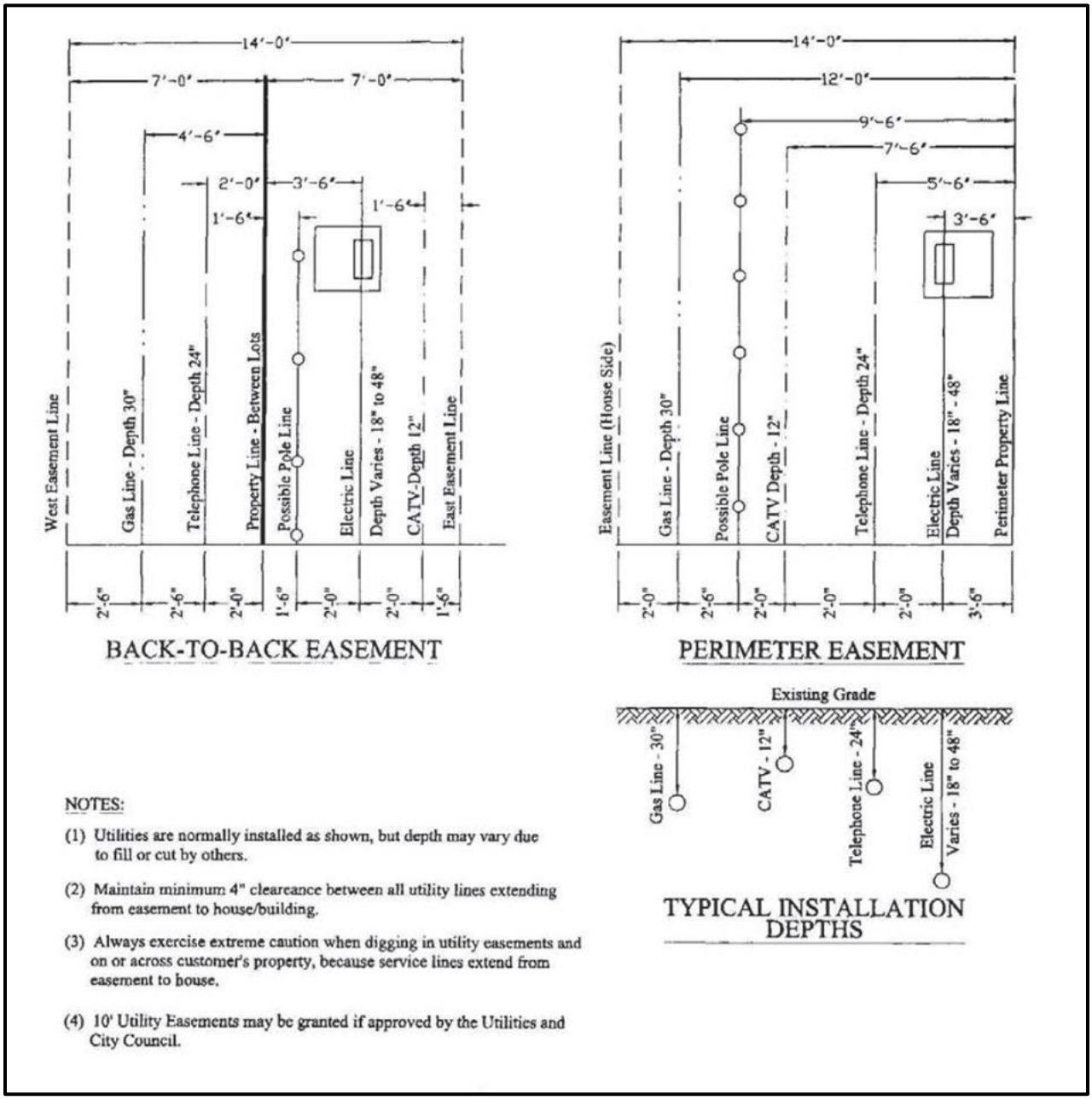

Figure 6.2 - TYPICAL UTILITY LOCATIONS IN 14-FOOT WIDE RESIDENTIAL EASEMENT (NO BACKLOT SEWER)

City of Houston

Design Manual

Chapter 10

STREET PAVING DESIGN REQUIREMENTS

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Chapter 10

STREET PAVING DESIGN REQUIREMENTS

SECTION 1 – STREET PAVING DESIGN OVERVIEW

10.1.01 CHAPTER INCLUDES

10.1.01.A Geometric design guidelines for streets, criteria for street paving, and standard paving notes for drawings.

10.1.02 POLICY

10.1.02.A The design of streets within the City of Houston shall consider all users.

10.1.02.B Roadway designs shall require the use of context sensitive design principles such as those included in the ITE Recommended Practice: Designing Walkable Urban Thoroughfares: A context Sensitive Approach.

10.1.02.C The design requirements set in this chapter are not intended to be the only values used for design. Where applicable, design requirements should be exceeded to enhance safety and comfort for all road users.

10.1.02.D Project designs shall consider roadway context, including adjacent land uses, nearby destinations and infrastructure and existing or potential bicycle, pedestrian or transit use.

10.1.02.E Designers are encouraged to consider the cross sections provided in Appendix 2 of this chapter to support the roadway context of the project. Additionally, information regarding potential enhanced pedestrian environments and bicycle or transit facilities can be found in Chapter 17.

10.1.02.F Designers are encouraged to consider alternate cross sections and design standards to meet the context sensitive needs of their projects. If they find that their proposed design conflicts with portions of this manual, they should meet with the Office of the City Engineer to discuss applicability and what, if any, variances might be needed.

10.1.03 REFERENCES

10.1.03.A Access Management Manual, TRB, current edition

10.1.03.B Houston Complete Streets and Transportation Plan (HCSTP)

10.1.03.C Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, ITE, current edition

10.1.03.D A Policy on Geometric Design of Highways and Streets ("The Green Book"), AASHTO, current edition

10.1.03.E Guide for the Development of Bicycle Facilities, AASHTO, current edition

10.1.03.F Guide for the Design of Pavement Structures, AASHTO, current edition

10.1.03.G Highway Capacity Manual (HCM), TRB, current edition

10.1.03.H Highway Safety Manual, AASHTO, current edition

10.1.03.I International Building Code (IBC), current edition

10.1.03.J Department of Houston Public Works Infrastructure Design Manual Chapter 1, General Requirements.

10.1.03.K Roadside Design Guide, AASHTO, current edition

10.1.03.L Scenic Houston Streetscape Resource Guide

10.1.03.M Texas Manual on Uniform Traffic Control Devices (TMUTCD), TXDOT, current edition

10.1.03.N Traffic Engineering Handbook, ITE, current edition

10.1.03.O Trip Generation, ITE, current edition

10.1.03.P Urban Bikeway Design Guide, NACTO, current edition

10.1.03.Q Urban Street Design Guide, NACTO, current edition

10.1.03.R Signalized Intersection Information Guide. Report No. FHWA-HRT-04-091, FHWA

10.1.03.S Roadway Design Manual, TxDOT, current edition

10.1.03.T Roundabouts: An Informational Guide, National Cooperative Highway Research Program (NCHRP) Report 672, current addition

10.1.04 DEFINITIONS

10.1.04.A AASHTO - American Association of State Highway and Transportation Officials

10.1.04.B AC - asphaltic concrete.

10.1.04.C ASTM - American Society for Testing and Materials

10.1.04.D CMP - The City Mobility Plan is joint initiative between Planning & Development Department and HPW to examine a range of land development and growth issues by evaluating multi-modal transportation network needs and adjacent land development in the city.

10.1.04.E Complete Streets - Complete streets are streets that are designed using context sensitive design principles.

10.1.04.F Context Sensitive Design - Context sensitive design takes into account all roadway users, their interactions with one another, and overall effect on the land uses and neighborhoods for which a corridor serves to move people in a safe, effective and predicable manner. Roadway users include people who are driving or riding in cars, using mass transit, riding bicycles, walking, using wheelchairs, driving or riding in trucks, driving or being transported by emergency vehicles, and being served at their residence or property by other users. Context sensitive design principles are flexible and sensitive to community values. Context sensitive design principles take the following variables in account:

1. People being served at their residence or property by other Right-of-Way users.

2. People of all ages and abilities, including children, older adults, and persons with disabilities.

3. The functional classification of the road (e.g. local, collector, and thoroughfare), the level of comfort for pedestrian and bicycle traffic, as well as vehicle volumes and speeds of the roadway.

4. Multi-Modal Classification Street Type - A public street type classification that takes into account the functional classification (MTFP designation) and land use context, inclusive of right-of-way width, number of lanes and traffic volume. The context of the land use adjacent to the road comprises population and job densities (present and future), projected land use types (residential, commercial community facility or industrial), and modes of operation (pedestrian, bicycle, transit, rail, freight and vehicle lanes) can be used as a determinant in identifying Multi-Modal Classifications.

10.1.04.F ~~5~~
continued

a. Complete Streets and Transportation Plan - A plan that, at a minimum, includes the Major Thoroughfare and Freeway Plan, Bikeway/Pedestrian Plan, Rail Plan, Multi-Modal Classification Street Type, Master Parking Plan, Bayou Greenway Initiative, Context Report and METRO's Transit Plan.

b. Major Thoroughfare - Divided into two classifications; Principal Thoroughfare and Thoroughfare. Major Thoroughfares are those streets designed for fast, heavy truck traffic, high traffic volumes and are intended to serve as traffic arteries of considerable length and continuity throughout the community. For definitions of principal thoroughfare and thoroughfare, see the latest version of the City of Houston Major Thoroughfare and Freeway Plan (MTFP) Policy Statement.

~~1) Principal Thoroughfare – Public streets that accumulate traffic from Collector streets and other Major Thoroughfares for distribution to the freeway system. They may be a highway and typically provide a high degree of mobility for long distance trips.~~

~~2) Thoroughfare – Public streets that accumulate traffic from Collector streets and local streets for distribution through the thoroughfare and freeway system. These streets distribute medium to high volume traffic and provide access to commercial, mixed use and residential areas.~~

c. Collector Streets - Public streets that accumulate traffic from local streets for distribution to the Major Thoroughfare streets. A Collector Street may be a Minor Collector or a Major Collector. For definitions of Minor collector and Major collector, see the latest version of the City of Houston Major Thoroughfare and Freeway Plan (MTFP) Policy Statement.

~~1) Major Collector – Public streets that accumulate traffic from local streets and Minor Collectors for distribution to the Major Thoroughfare. A Major Collector Street may have commercial, residential or have mixed uses abutting.~~

~~2) Minor Collector – A public street that accumulates traffic from local streets for distribution into a thoroughfare or major collector. A minor collector typically serves residential uses. Although in some circumstances, it may serve commercial or mixed uses.~~

d. Transit Corridor Streets - Rights-of-way or easements that METRO has proposed as a route for a guided rapid transit or fixed guide way transit system and that is included on the City's MTFP.

10.1.04.G Curb-and-gutter Sections - Full width concrete pavement with doweled on six ~~(6)~~ inch curbs or monolithic curb-and-gutter sections for asphaltic concrete pavement. Curb-and-gutter sections require inlets and underground storm sewers.

10.1.04.H Geotechnical Engineer - A licensed Professional Engineer in the State of Texas

who is practicing in the field of geotechnical engineering.

10.1.04.I Houston Complete Street and Transportation Plan- A plan that, at a minimum, includes the Major Thoroughfare and Freeway Plan, Bikeway/Pedestrian Plan, Rail Plan, Multi-Modal Classification Street Type and Master Parking Plan, Bayou Greenway Initiative, Context Report and METRO's Transit Plan.

10.1.04.J Intersection Sight Distance - Provides an unobstructed line of sight in each direction at intersections. The unobstructed line of sight allows for vehicles on side streets to observe approaching traffic on the main roadway and to safely enter an intersection from a side street. The unobstructed line of sight allows for vehicles on the main roadway sufficient distance to observe vehicles entering from side streets.

10.1.04.K ITE - Institute of Transportation Engineers

10.1.04.L Local Streets - Provide access to individual single-family residential lots, multifamily or commercial developments, provide entry and exit to the neighborhood, and provide connectivity to collectors and thoroughfares.

10.1.04.M MTFP - Major Thoroughfare and Freeway Plan

10.1.04.N NACTO - National Association of City Transportation Officials.

10.1.04.O Roadside Ditch Sections - Ditch sections adjacent to either full width reinforced concrete pavement or asphaltic concrete pavement. Roadside ditch sections do not require underground storm sewers; however, the ditch sections must be designed to accommodate storm runoff.

10.1.04.P Roadway Context - The roadway context includes adjacent land uses, traffic volumes, and multimodal components taken into consideration when determining roadway design features. Although each roadway will have a unique set of characteristics that define its specific context, five major categories of roadway context are defined: commercial, residential, mixed use, industrial and transit. Each category of roadway context has specific design features, standards, and cross sections that must be considered.

~~a.~~1. Commercial Street – The primary land uses adjacent to the street is commercial (with limited amounts of light industrial), and the Planning and Development Department has classified the roadway context as commercial.

~~b.~~2. Mixed-Use Street – The land use is a mix between commercial and residential (either single or multi-family), and the Planning and Development Department has classified the roadway context as mixed-use.

~~1.~~3. Residential Street - The primary land use is residential (typically single-family, potentially with some multi-family), and the Planning and Development Department has classified the roadway context as residential.

~~2.~~4. Industrial Street - The adjacent land uses are predominantly industrial with some commercial land uses, and the Planning and Development Department has classified the roadway context as industrial.

~~3.~~5. Transit Street - The typical adjacent land uses are those of a Mixed-Use Street with the addition of a fixed guideway or other high-capacity rapid transit system, and the Planning and Development Department has classified the roadway context as transit- related.

10.1.04.Q Soils

1. Cohesive Soils are those that have 50% or more (by weight) passing the No. 200 Sieve and Plasticity Index greater than seven ~~(7)~~.

2. Granular Soils are those that have 50% or more (by weight) retain on the No. 200 Sieve.

10.1.04.R TRB - Transportation Research Board

10.1.04.S Type 1 Permanent Access Easement - A permanent access easement at least 50 ~~-~~ feet in width that is designed and constructed like a public street in accordance with the design manual and contains one or more public utilities in an unpaved portion of the easement. Refer to Chapter 42 of the Code of Ordinances ~~No. 1999-262~~.

10.1.04.T Type 2 Permanent Access Easement - A permanent access easement at least 28~~-~~ feet in width that is designed and constructed like a private street serving a development that has no public utilities other than a public water line, connected to one or more fire hydrants, that provides no domestic water services. All private utilities within a Type 2 permanent access easement must be designed to public utility standards outlined in the Infrastructure Design Manual. Refer to Chapter 42 of the Code of Ordinances ~~No. 1999-262~~.

10.1.04.U Type A Street – A public street that intersects a transit corridor street and that abuts a blockface that is located within 1,320 feet walking distance of the end of an existing or proposed transit station platform.

SECTION 2 – PAVEMENT DESIGN REQUIREMENTS

10.2.01 ~~10.04~~ASPHALTIC CONCRETE PAVEMENT DESIGN REQUIREMENTS~~:~~

10.2.01.A AC Surface Minimum Thickness - Pavement design shall be prepared by a Professional Engineer based on current AASHTO design methodology (Guide for the Design of Pavement Structure). Minimum thickness shall be as shown on City of Houston Standard Detail 02741-01.

10.2.01.B Base Course Minimum Thickness - Pavement design shall be prepared by a Professional Engineer based on current AASHTO design methodology (Guide for the Design of Pavement Structure). Minimum thickness shall be as shown on City of Houston Standard Detail 02741-01. ~~Alternative design may be approved by HPW.~~

10.2.01.C Subgrade Treatment

1. Type, depth, and percentage of subgrade stabilization, stabilization design, and type of stabilization shall be determined by a geotechnical engineer.

2. For subgrade conditions of cohesive soils, subgrade treatment or stabilization shall be no less than eight ~~(~~8 ~~)~~ inches. ~~unless otherwise prescribed in this document or specified by a geotechnical engineer.~~

10.2.02 ~~10.05~~CONCRETE PAVEMENT DESIGN REQUIREMENTS

The following requirements are applicable to pavement within City street rights-of-way.

10.2.02.A Minimum Pavement Thickness, Reinforcing, and Subgrade Stabilization Requirements:

1. Pavement thickness and reinforcement shall be designed by a Professional Engineer based on a current soil~~s~~ analysis, roadway use, traffic loadings, and minimum 50 ~~-~~-year life span of proposed pavement. Pavement design shall be prepared by a Professional Engineer based on current AASHTO design methodology (Guide for the Design of Pavement Structure). However, in no event shall the pavement thickness be less than the minimums stated below.

2. For Residential Roadway Concrete Pavement:

   a. Minimum concrete slab thickness shall be six ~~(6)~~ inches.

   b. Minimum concrete strength shall be f'c = 4,000 psi.

   c. Minimum reinforcing steel strength shall be fy = 60,000 psi.

   d. Refer to City of Houston Standard Detail 02751-01 for concrete reinforcement details.

   e. Minimum stabilized subgrade thickness shall be six ~~(6)~~ inches for granular soils and eight ~~(8)~~ inches for cohesive soils.

   f. The type and depth of subgrade ~~and base~~ shall be as determined by a geotechnical engineer.

3. Collector Roadway with Concrete Pavement

   a. Minimum concrete slab thickness shall be nine ~~(9)~~ inches.

   b. Minimum concrete strength shall be f'c = 4,000 psi.

   c. Minimum reinforcing steel strength shall be fy = 60,000 psi.

   d. Refer to City of Houston Standard Detail 02751-01 for concrete reinforcement details.

   e. Minimum stabilized subgrade thickness shall be six ~~(6)~~ inches for granular soils and eight ~~(8)~~ inches for cohesive soils.

   f. The type and depth of subgrade ~~and base~~ shall be as determined by a geotechnical engineer.

4. For Major Thoroughfares Constructed with Concrete Pavement

   a. Minimum concrete slab thickness shall be ~~(~~11~~-)~~inches.

   b. Minimum concrete strength shall be f'c = 4,000 psi.

   c. Minimum reinforcing steel strength shall be fy = 60,000 psi.

   d. Refer to City of Houston Standard Detail 02751-01 for concrete reinforcement details.

e. Minimum stabilized subgrade thickness shall be eight ~~(8)~~ inches.

f. The type and depth of subgrade ~~and base~~ shall be as determined by a geotechnical engineer.

5. Paving headers shall be placed at the end of all concrete pavements.

10.2.02.B Curb Requirements

1. Six ~~(6)~~ inch Vertical Curb:

a. Six ~~(6)~~ inch vertical curb is the standard curb design and shall be in accordance with City Standard Details.

b. Collector streets and higher volume residential streets where traffic calming measures are in place require construction of six ~~(6)~~ inch vertical curb.

2. Laydown Curb~~:~~

a. Is only allowed as an option for street projects on single family residential streets within the City.

~~a.~~b. Laydown curb shall be in accordance with City Standard Details.

~~b.~~c. Shall be four ~~(4)~~ inches in height.

~~c.~~d. Laydown curb shall not be permitted if sidewalk is to be constructed immediately adjacent to the curb.

~~d.~~e. Laydown curb construction shall provide for necessary transition lengths at curb inlets to go from laydown curb to standard vertical curb section.

~~e.~~f. Transition from standard six ~~(6)~~ inch to four ~~(4)~~ inch vertical curb shall be extended a minimum of ~~ten (~~10~~)~~ feet beyond curb inlets before beginning transitions.

~~10.06~~SECTION 3 - GEOMETRIC DESIGN REQUIREMENTS~~:~~

10.3.01 OVERARCHING CONSIDERATIONS

~~10.3.01 Design Guidance~~

~~The design of streets within the City of Houston shall consider all users.~~

~~Roadway designs shall require context sensitive solutions such as those included in the ITE Recommended Practice: Designing Walkable Urban Thoroughfares: A Context Sensitive Approach; the NACTO Urban Bikeway Design Guide; AASHTO; or any other reference documents as defined in Chapter 17.~~

~~Minimum standards should be exceeded, to enhance safety and comfort for all roadway users. The minimum standards set in this chapter are not intended to be the only values used for design. The design values should be based on the context of the roadway and engineers may choose to use values that vary from the minimums set in this chapter. Use of the minimums shall be properly communicated and coordinated with Houston Public Works Staff.~~

~~Alternative Cross Section:~~

~~Project designs should consider roadway context, including adjacent land uses; nearby destination and infrastructure; and existing and potential bicycle, pedestrian, and transit traffic. Designers are encouraged to consider alternative cross sections as defined in Appendix 1 of this chapter to support the roadway context. Additional information regarding potential enhanced pedestrian environments and bicycle facilities can be found in Chapter 17.~~

10.3.01.A Roadway Classifications

~~a.~~1. ~~Principal~~ Major Thoroughfare
~~Thoroughfare~~
~~b.~~2. ~~Major~~ Collector
~~c. Minor Collector~~

~~1.~~3. Transit Corridor

~~d.~~4. Local Street Classifications (not applicable in the ETJ)

~~(1)~~a. Residential Standard Density - Provides access to individual lots equal to or greater than 40~~-~~-feet in width.

~~(2)~~b. Residential High Density - Provides access to individual lots less than 40~~-~~-feet in width.

~~a.~~c. Residential Main - Serves multiple streets and can be described as the "neighborhood feeder / collector."

~~(3)~~d. A summary of the design characteristics for the three local street classifications above is included in ~~Table 10.06-01~~Table 10.1~~Table 10.1101~~. Traffic volumes shown in column "Traffic ADT" are provided as general guidelines. These guidelines are provided to assist in the selection of context-sensitive street cross sections.

Table 10.1 - LOCAL STREET CLASSIFICATION FOR CURB AND GUTTERED STREETS

STREET CLASSIFICATION	GROSS DENSITY DU/AC (4)	TRAFFIC ADT (1)	MIN. PAVEMENT WIDTH (FEET)
Residential Standard Density (2)	0-6	250 - ~~5000~~350	26
Residential High Density (3)	6-27	350 - ~~5000~~1,500	32
Residential Main	0-27	≥ 1,500	36

Notes:
1. ADT - average dailytraffic.
2. Lot widths equal to or greater than 40~~-~~-feet.
3. Lot widths less than 40~~-~~-feet.
4. DU/AC - dwelling units (DU) per acre.

10.3.01.B Design Considerations

Critical design criteria shall be determined from performing a Traffic Engineering Study (See 15.05).

1. Context factors that may influence roadway design include, but are not limited to:

   a. Number of dwelling units per acre (density).

   b. Location of services within or near the neighborhood.

   c. Pedestrian and bicycle facilities within the neighborhood.

   d. Connectivity to the collector and thoroughfare network.

   e. Connectivity to pedestrian, bicycle, and transit networks.

   f. Traffic volume guidelines (ADT) are based on full development density.

   g. Level of Comfort for bicyclists and pedestrians, as defined in Chapter 17.

   h. Transit stations and bus stops~~stop locations~~, destinations, ridership and appropriate facility design for high comfort boarding and alighting, transitions and access to platforms.

2. Design Speed

   a. For purposes of design, design and target speed shall be synonymous.

   b. The design speed shall be set by City Ordinances regulating speed limits.

   c. The minimum design speed for a roadway shall be 30-mph.

3. ~~Design~~ Vehicles

   The geometric design of a roadway is dependent on the physical characteristics of the various anticipated vehicles using that roadway. To ensure economy and safety, two sub-classifications of vehicles are established.

   a. Design Vehicle

      (1) A vehicle that must be regularly accommodated and is expected to traverse an intersection under normal conditions without encroachment into opposing traffic lanes.

b. Control Vehicle

(1) A vehicle that infrequently must be accommodated, and is expected to traverse an intersection, but encroachment into opposing traffic lanes, multiple-point turns, or minor encroachment into the street side is acceptable.

c. The vehicles selected for the design of roadway intersections are provided in Table 10.2~~Table 10.2102~~.

Table 10.2 - VEHICLE REQUIREMENTS

STREET TYPE	DESIGN VEHICLE	CONTROL VEHICLE
Local	P	DL23[1]
Collector	DL23	BUS40
Major Thoroughfare	BUS40	WB40
Major Thoroughfare (Truck) [2]	WB40	WB62

Notes:
1. Local streets along designated transit routes shall use a minimum control vehicle of BUS40 in street design elements that impact the transit route.
2. Major Thoroughfares that have daily truck volumes exceeding 5% of ADT. Truck design/control vehicles shall only apply at intersections where both street truck volumes exceed 5% of ADT.

~~a. A WB-50 design vehicle shall be used for the following intersection types:~~
~~(1) Thoroughfare/Thoroughfare~~
~~(2) Thoroughfare/Major Collector~~
~~(3) Major Collector/Collectors~~

~~b. A B-40 (Bus 40-foot) design vehicle will be generally used for all other intersections.~~
~~(1) If the design engineer feels that a design vehicle larger than a B-40 is applicable for other intersections, they should use the appropriate larger vehicle.~~
~~(2) In no case shall a smaller design vehicle be used without a variance, from the City Engineer.~~

~~c. Where bicyclist and pedestrian needs must be considered, the following design vehicles shall apply.~~
~~(1) A DL-23 (Delivery Truck) shall be used at intersections involving only neighborhood/residential streets.~~
~~(2) A SU-30 shall be used at intersections on streets within Downtown or designated commercial districts.~~

4. Objects in Right-of-Way

a. Utilities (especially those above ground), trees, and other fixed objects ~~obstacles~~ shall not be placed within the sidewalk or otherwise ~~where they will~~ interfere with pedestrian movements or access to transit stops. Sidewalks may be gently shifted to avoid existing fixed objects that cannot be moved or to enable the installation of new fixed objects when

the shifting of said object is restricted; however, the designs of the sidewalk and the overall pedestrian realm must still satisfy all design requirements.~~on existing and future side walk location. Minimum of 5' clearance pedestrian.~~

b. Utility pole locations ~~s~~within right-of-way: See Chapter 6.~~shall be placed within two (2) feet of the ROW Lines unless approved the City Engineer.~~

10.3.02 INTERSECTION DESIGN

10.3.02.A Curb Radii

1. Cul-de-Sac Curb Radii

   a. For approved cul-de-sac curb radii, refer to ~~City of Houston Standard Drawing~~No. 10.06-09Figure 10.10~~Figure 10.10~~Figure ~~10~~10.

   b. Curb radii around cul-de-sacs shall be ~~42~~48~~-~~-feet for single family areas.

   c. Curb radii around cul-de-sacs shall be 50-~~-~~feet for cul-de-sacs in areas other than single family areas.

2. Street Intersection Curb Radii

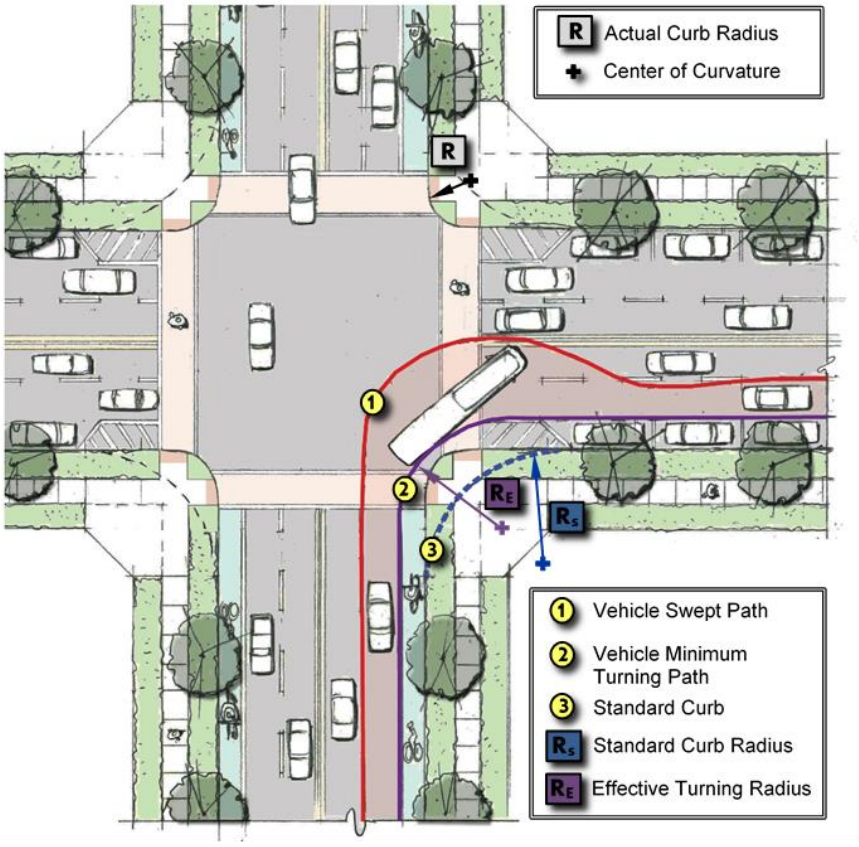


Figure 10.1 - CURB RADII

Smaller curb radii shorten the distance that pedestrians must cross at intersections. The occasional turn made by large trucks can be accommodated with slower speeds and some encroachment into the opposing traffic lanes. The existence of parking and bicycle lanes creates an "effective" turning radius that is greater than the curb-return radius Source: 10.1.03.C. NOTE: BUS40 used as control vehicle for this drawing.

10.3.02.A.2 continued

~~1. For approved street intersection curb radii, refer to City of Houston Standard Drawing No. 10.06-04.~~
~~2. Variances to the standard presented in Cityof Houston Standard Drawing No. 10.06-04 require approval by the City Engineer.~~
~~3. Street intersection curb radii are a composite of needs to serve pedestrian and vehicular traffic.~~
~~4. Bicycle/Pedestrian consideration: See Chapter 17.~~

a. The curb radius is the radius of curvature, measured from the center of curvature, of a physical curb-return at the corner of a street intersection. The selection of appropriate curb radii shall consider the needs of all roadway and pedestrian traffic.

b. For standard curb radii, refer to Table 10.3~~Table 10.3103~~.

Table 10.3 - INTERSECTION STANDARD CURB RADII

INTERSECTION TYPE	STANDARD CURB RADIUS (R_S) BY INTERSECTION ANGLE	
	90˚	80˚ - 90 ˚
Local / Local	15 ft	15 ft
Local / Collector	20 ft	20 ft
Local / Major Thoroughfare	20 ft	20 ft
Collector / Collector	25 ft	25 ft
Collector / Major Thoroughfare	25 ft	25 ft
Major Thoroughfare / Major Thoroughfare	30 ft	35 ft
Truck / Truck	45 ft	50 ft

Notes:

1. Curb radii have been selected based on the swept paths of design and control vehicles.
2. Truck/Truck radii should only be considered at intersections of streets that each have daily truck volumes exceeding 5% of ADT.
3. Other intersections experiencing heavy truck volumes shall utilize appropriate design vehicles and turning templates for curb radius design.
4. Intersections along designated transit routes shall use a minimum control vehicle of BUS40 for corners along the path of the transit route.
~~1.~~5. Intersecting angles smaller than 80-degrees shall require detailed engineering analysis and approval by HPW.

c. The design of curb radii is a critical component of intersection design. A curb radius that is too small for the design vehicle can be damaged and become a long-term maintenance liability. A curb radius that is too large encourages dangerous speeds, reduces pedestrian refuge areas, and increases pedestrian crossing distances as shown in Figure 10.1~~Figure 10.1101~~. In general, the smallest feasible curb radius should be chosen.

10.3.02.A.2 continued

d. Curb radii may vary from Table 10.3~~Table 10.3103~~ with adequate engineering justification, to be approved by Transportation & Drainage Operations (TDO). Justification shall include consideration of traffic counts or projection, pedestrian activity, vehicle classifications, turning template analysis, and any other documentation requested. Refer to "ITE. Designing Walkable Urban Thoroughfares: A Context Sensitive Approach" (10.1.03.C) for additional guidance on the use of smaller curb radii to encourage safe roadway operations and a pedestrian-friendly environment.

e. Street intersection curb radii shall be designed to facilitate turning and tracking requirements of the selected design vehicle anticipated to use the facility (i.e. P, DL-23, WB-40, etc.) (10.1.03.R) The curb radii design should allow for frequently turning vehicles to remain in their lane. Larger control vehicles that make the turn less frequently may have the option of encroaching into the adjacent lane to complete their turn (10.1.03.N). A one-foot buffer distance between the face of curb and the swept path of the vehicle should be retained for all turning vehicles. The selected radius of curvature for curb radii is to be rounded up to the nearest five feet.

f. The effective turning radius (R_E), as shown in Figure 10.1~~Figure 10.1101~~ is the radius of curvature of the minimum turning path of a turning vehicle when additional curb offset is provided by a parking lane, bicycle lane, or shoulder. The use of an effective radius is encouraged whenever appropriate. Use of an effective radius will not require a variance, but it will require an engineering analysis to justify adequacy.

10.3.02.B Right-of-Way Corner Cut-Backs

1. For approved right-of-way (ROW) corner cut-back dimensions, refer to ~~City of Houston Standard Drawing No. 10.06-04~~Figure 10.2~~Figure 10.2102~~ and Table 10.4~~Table 10.4104~~.

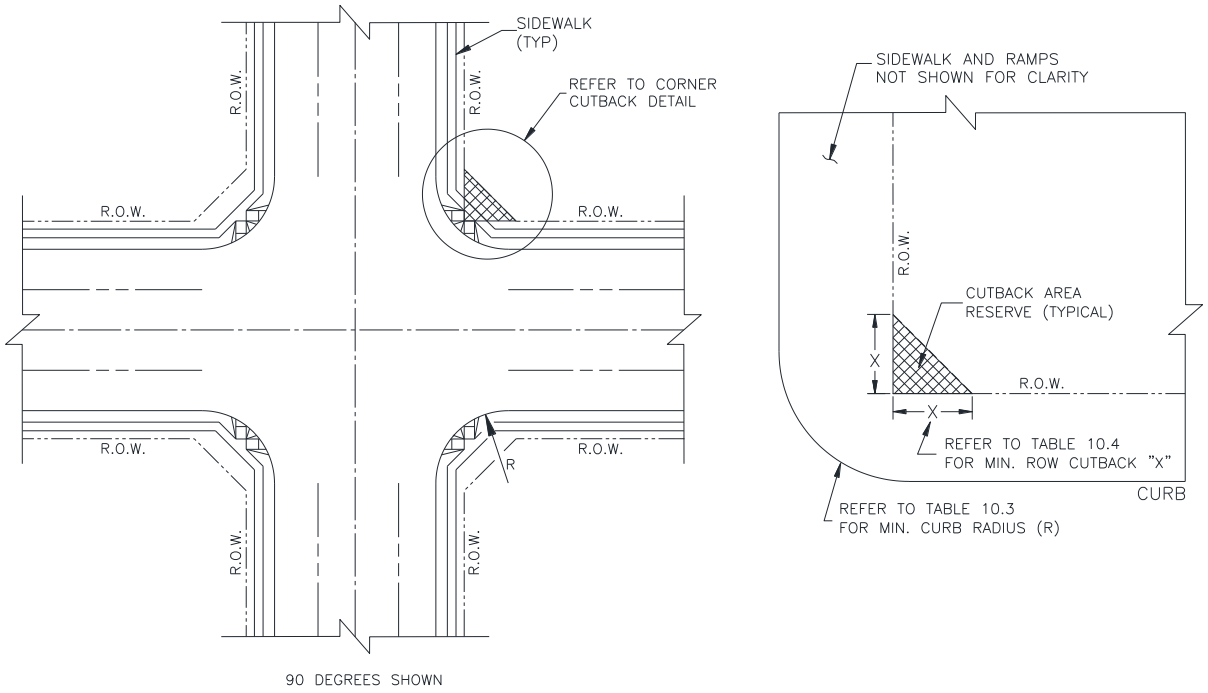


Figure 10.2~~10.2~~ - ROW CORNER CUTBACK

Table 10.4 - ROW CUTBACK REQUIREMENTS

CURB RADIUS (R) (feet)	MINIMUM R.O.W. CUTBACK "X" (feet)
25 or Less	15 x 15
30	20 x 20
35	25 x 25
40	30 x 30
45 or More	35 x 35

~~1.~~2. Right-of-way shall be dedicated for corner cut-backs on ~~principal thoroughfares,~~ major thoroughfares, transit corridor streets, ~~major collectors,~~ collectors and local streets as a requirement for subdivision platting of adjacent properties under Chapter 42 of the City of Houston Code of Ordinances.

~~4.~~3. Corner cut-backs of right-of-way at street intersections are necessary to provide sufficient public space for intersection visibility, pedestrian sidewalk facilities and ramps, ~~(compliant with Americans with Disabilities Act - ADA and Texas Accessibility Standards-TAS),~~ traffic control devices, street signs,

street lighting, traffic signal equipment, and all ~~surface~~ encroachments which could prevent the future installation of such equipment within the cut-back area.

4. When right-of-way corner cut-backs are not feasible ~~on local streets~~, visibility easements will be required. Visibility easements shall conform with Section 10.3.02.C Intersection Sight Distance.

5. In cases where the public ROW behind the curb is sufficient, corner cut-backs may not be needed to provide the required levels of visibility. The Engineer of Record (EOR) shall provide a sight triangle analysis to justify the lack of any corner cut-backs.

6. For intersections with Type 1 Permanent Access Easements, visibility easements shall be provided.

~~5. Bicycle/Pedestrian consideration: See Chapter 17.~~

10.3.02.C Intersection Sight Distance

1. Dedicated right-of-way or easements are required to meet the intersection sight distance triangle requirements.

2. Design Basis

   a. Design Vehicle - Passenger Car

   b. Design Standard – AASHTO "A Policy on Geometric Design of Highway and Streets".

   c. Lane Widths - ~~11-feet wide travel lanes; 10' may be considered based on engineering judgment and appropriate based on area context and multimodal use of a corridor inclusive of bicycles as defined in Chapter 17.~~See 10.3.03.C for requirements.

   d. Vertical obstructions and elevations must be considered for all users of the corridor including pedestrians and bicyclists.

   e. Sight Distance - Is measured to the center of the outside lane on main roadway approaching from the left and to the center of the inside lane of traffic on the main roadway approaching from the right.

   f. The intersection of local streets serving residential properties only, meeting at an angle of 85 ~~°~~ degrees or more. Within 250 ~~-~~-feet of the intersection, each of the uncontrolled approaches to the intersection of two local residential streets will have:

      (1) land uses adjacent to the street that are exclusively single~~-~~-family

residential lots (or unoccupied reserves of limited size, such as landscape reserves, drainage reserves or utility reserves).

(2) Residential lots with driveway access to the uncontrolled approach street.

(3) A posted (or prima facie) speed limit of 30 ~~-~~mph or less.

10.3.02.C ~~ign Requirements~~
continued

3. Design Procedures~~:~~

   a. Determine design speed of main roadway based on Section ~~10.06.C2~~10.3.01.B.2 of this chapter.~~For the appropriate design speed, determine the minimum sight distance from the following Table 10.6~~

   b. Develop a scaled drawing depicting the sight triangle based on the design criteria. For the appropriate design speed, determine the minimum sight distance from Table 1 on ~~Refer tothe City of Houston Standard Drawing~~No. 10.06-05Figure 10.6~~Figure 10.6~~~~Figure 106~~.

~~TABLE 10.6-02 Triangle Applicability~~

~~Highest classification/greater width street~~	~~Sight triangle driver's eye setback distance~~	~~Sight triangle dimension on uncontrolled street~~
~~High speed major thoroughfare (>45 mph posted speed)~~	~~25 feet~~	~~sight specific analysis~~
~~Major thoroughfare or major collector on MTFP map~~	~~25 feet~~	~~500 feet~~
~~Divided streets and 41 ft. streets~~	~~15 feet~~	~~500 feet~~
~~26 ft. local and collector streets~~	~~15 feet~~	~~390 feet~~
~~26 ft., single family residential frontage on both streets~~	~~N/A~~	~~N/A~~

4. Exceptions

   a. Replats and partial replats at the intersections of a local/local street, local/major collector street, and major collector/major collector street are exempt from providing intersection sight distance rights-of-way or easements where existing site conditions for abutting properties preclude compliance.

   b. Variances or deviations to these guidelines will be considered on a site-by-site basis. An engineering analysis should be prepared to support the proposed sight triangle dimensions, based on criteria in the AASHTO "Green Book", latest edition (10.1.03.D). Where the uncontrolled street is existing, design speeds should be based on an analysis of the 85th percentile operating speed.

10.3.02.D Left Turn Lanes

1. Left Turn Lanes are Required:

a. At all signalized intersection approaches.

b. At all median openings.

c. Overlaps between opposing and adjacent left turn tracking paths should be checked and shown in the intersection review design submittal.

2. Left Turn Lane Design Standards:

a. Refer to ~~City of Houston Standard Drawing No.10.06-07~~Figure 10.8~~Figure 10.8~~~~Figure 108~~ for left turn bay geometrics.

~~c.~~b. The volume of left turn movements shall be based on traffic studies approved by the City Engineer.~~projections developed in the City Mobility Plan or based on traffic studies reviewed and approved by the City Engineer.~~

~~d.~~c. At median openings; openings may be directional but whenever possible, left turn lanes should be provided for both directions.

3. Dual Left Turn Lanes~~:~~

a. Dual left turn lanes present challenges to people walking across the intersection. Other options for traffic mitigation should be assessed first.

~~a.~~b. Where other options are not feasible, dual left turn bays may be considered ~~Are required~~ when left turn movement exceeds 300 vehicles for the peak hour, or when traffic analysis of the intersection indicates existing or projected left turn storage space requires dual left turn lanes before the volume threshold is reached.

c. Where dual left turn lanes are required, right of way for the intersection shall be based on the width required for dual left turns, through lanes, a right turn lane, and minimum landscape/pedestrian zone ~~of ten (10) feet~~ (dimension S) as shown in ~~City of Houston Standard Drawing No.~~ Figure 10.4~~Figure 10.4~~10410410.06-02~~~~.

4. Special conditions or other constraints may require design criteria other than shown herein.

a. Exceptions to the requirements must be demonstrated by submittal of a traffic study encompassing AASHTO criteria.

b. Approval by City Engineer is required for all variances to standard.

10.3.02.E Roadway Offset Through Intersection

1. An intersection shall not be designed such that any through lane is offset more than three feet from the corresponding receiving lane. ~~The design of a left turn~~

~~lane shall not result in an offset greater than three (3) feet crossing the intersection for the adjacent through lanes.~~

2. The addition of auxiliary left- and right- turn lanes shall conform with this requirement.

~~10.3.02.E~~10.3.02.F Roundabout Intersections

~~1. Roundabouts are limited to collector-collector street intersections and four leg approaches without prior consideration and approval of the City Engineer and City Traffic Engineer.~~

~~2. No direct driveway access shall be allowed to the roundabout.~~

~~3. Roundabouts will have raised center island treatment.~~

~~4. Landscaping in the central island will conform to Chapter 15 visibility requirements.~~
~~5. For general layout of Roundabouts refer to details 10.06-15 and 10.06-16.~~

1. Roundabout Planning

a. Roundabouts shall be considered for all new or reconstructed intersections, especially signalized intersections and all-way stop intersections.

b. Lane configuration for all approaches shall be based on an approved capacity analysis. The number of lanes may vary by approach.

c. The analysis shall include considerations for existing traffic and for a 20-year horizon. Lane configurations should result in an overall LOS D or better for existing conditions.

d. If the 20-year horizon requires a different lane configuration to maintain LOS D or better, the design should include phasing considerations for future modifications to implement those changes when warranted. Constructing a roundabout with more capacity than is currently needed can decrease the safety of the intersection and is discouraged.

e. The design vehicles shall be consistent with the design vehicle on the approach roadways.

f. For additional design guidance, refer to reference 10.1.03.T.

~~1.~~2.Roundabout Design

Table ~~10.06.4~~10.5 - ROUNDABOUT DESIGN PARAMETERS

PARAMETERS	~~Local or Collector~~SINGLE LANE	~~Boulevard or Arterial~~MULTI LANE

Typical Capacity (all approaches)	< 20,000	< 40,000
Maximum Number of Entering Lanes	1	2
Maximum Entry Speed	20 mph	25 mph
~~Design Vehicle~~	~~B – 40~~	~~WB – 50~~
Typical Inscribed Circle Diameter (feet)	90 to 150 ~~FT~~	150 to 180 ~~FT~~
~~Roadway Type~~	~~Collectors or lower~~	~~Major Collectors and above~~
~~Median Treatment~~	~~Raised Curb with Truck Apron~~	~~Raised Curb with Truck Apron~~
Typical Entry Width (feet)	16 to 20	28 to 32
Typical Entry Radius (feet)	50 to 90	60 to 120
Typical Exit Radius (feet)	50 to 800	200 to 1000
Typical Circulatory Roadway Width (feet)	16 to 20	28 to 32
Minimum Splitter Island Length (feet)	50	50

a. Design drawings for roundabouts shall include roundabout-specific signage and pavement marking sheets that include the roundabout central island centered on one sheet.

b. Roundabout geometry shall be based on an analysis of fastest path for all through movements, left-turn movements, and right-turn movements. Fastest path speeds shall be analyzed and approved during preliminary design.

c. No roundabout will be approved for more than two entry lanes (not including right-turn lanes).

d. Physical splitter islands shall be utilized for all approaches.

~~a.~~e. Multilane roundabout shall be designed to minimize path overlap of adjacent entering vehicles.

f. No direct driveway access should be allowed to the roundabout.

g. Appropriate street lighting shall be provided to illuminate all conflict areas, especially entry conflicts and pedestrian conflicts.

h. The central island shall include a concrete curb and, where necessary, a truck apron. The central island shall include a minimum three feet sod mow strip.

i. Conduit for electrical wiring shall be installed to the central island even if no illumination or electrical features are currently planned.

j. All landscaping shall be designed to minimize roadside hazards and

maintain required stopping and intersection sight distance throughout the roundabout.

~~b.~~k. The conflicting leg sight triangle decision point is located 50-feet from the yield line. Safe stopping sight distances for the approach shall be evaluated from both the yield line and marked crosswalk.

3. Pedestrian/Bicycle Considerations

a. The crossing of pedestrians/bicycles and location of bus stops at roundabouts shall be carefully considered.

~~c.~~b. Splitter islands shall include a pedestrian cut through with a minimum width of 10-feet and minimum length (between roadways) of six feet. The cut through shall be fully ADA compliant.

c. Raised crosswalks may be used to further improve pedestrian safety and ensure roundabout-compatible vehicular speeds.

d. Roundabout design shall not permit pedestrians to access the central island.

e. Existing and proposed bicycle facilities shall be fully incorporated into the roundabout design. Bicycles should be brought up to the pedestrian grade, preferably in a dedicated space that is not shared with pedestrians.

~~d.~~f. Sidewalks shall be installed around the roundabout to maximize the buffer between the sidewalk and the edge of pavement, especially at the corners, where run-off-the-road crashes are most likely.

~~e.~~g. Design standards for Roundabouts are shown in Table 10.5~~Table 10.5Table 10.510.06.5~~.

~~Driveways shall not be located where vehicles must take direct access to a roundabout or splitter island. Fastest paths must be drawn for all approaches and all movements, including left-turn and right-turn movements. If required, unobstructed visibility easement(s) shall be provided to conform with required sight distances.~~

~~10.3.01~~

10.3.03 ~~All landscaping shall be designed to minimize roadside hazards and maintain required stopping and intersection sight distance throughout the roundabout.Conflicting leg sight triangle decision point is located 50 ft. from the yield line. Safe stopping sight distances for the approach shall be evaluated from both the yield line and marked crosswalk.~~CORRIDOR DESIGN

Table 10.6~~10.06-03~~ - ROADWAY GEOMETRIC DESIGN CRITERIA

~~Roadway Geometric Design Criteria~~		
ITEM	DESIRABLE	MINIMUM
Width of Travel Lanes (feet)	~~11~~10-11[4]	~~11~~10[4]
Width of Turn Lanes (feet)	~~11~~10-11[4]	~~11~~10[4]
Horizontal Curve Radii (feet)	Varies[5]	500
~~Non-Dedicated Bike Lane~~	~~*11-14~~	~~*11-14~~
~~Standard Bike Lane Width (ft)~~	~~*6~~	~~*5~~
Median Width at turn lanes (feet)	17[1]	15
Median Width face of the curb to the face of curb outside the turn lanes (feet)	~~*~~6-10[5]	4
Center Turn Lane Width (feet)	~~11~~10	~~11~~10
Non-Dedicated Bike Lane (feet)	~~15[3]~~	
Standard Bike Lane Width (feet)	~~10~~	
Pedestrian Realm Width[2] (feet)	~~6~~	
Total Buffer to Sidewalk with Tree Well[2] (feet)	~~4~~	
Total Buffer to Sidewalk w/o Tree Well[2] (feet)	~~4~~	
Sidewalk Width (feet)	~~2~~	
Transit Sidewalk Width ~~(ft)~~ By Transit Corridor Ordinance (feet)	~~*6-10~~	
Sidewalk adjacent to curb (feet)	~~5/6[5]~~	
Shared use path/trail (feet)	~~>6~~	
Shared use path/trail easement (feet)	~~6~~	
	~~>6~~	
	~~6~~	
	~~10~~	
	~~8~~	
	~~20~~	
	~~15~~See Chapter 17 for information	

Notes:

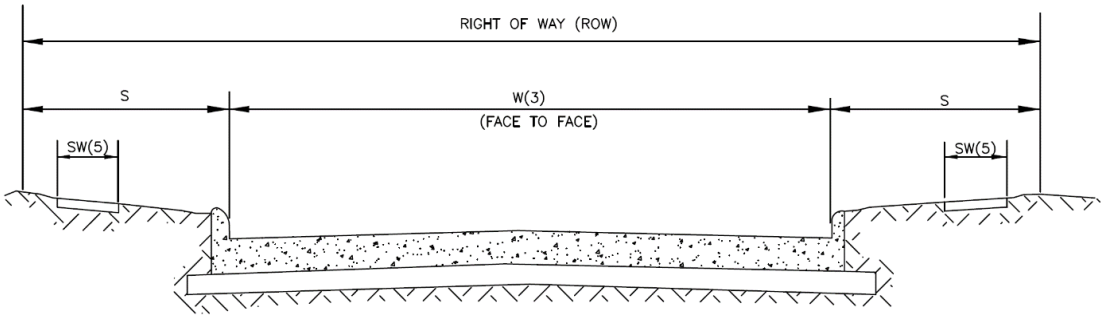
1. Median widths that exceed 17-feet require approval of Transportation and Drainage Operations (TDO). Engineer of Record shall notify TDO of any median widths that exceed 17-feet prior to preliminary design. ~~Desirable Median width may be higher based on available right-of-way, seedwg. 10.06-02~~
~~2. Buffer to sidewalk includes buffer to tree grate and tree grate width~~
~~3. Figure 10.06.02 show typical sections only, not minimum or desirable widths.~~
2. Curve design radii shall be based on the design speed of the roadway and any super- elevation that may be considered for the design. Where bicycle facility is present, curve radii should provide for highest visibility of a person on a bike by motor vehicle users.
~~4.~~3. For sidewalk design guidance, refer to 17.06: Pedestrian Design Requirements.

10.3.03.A.1 continued

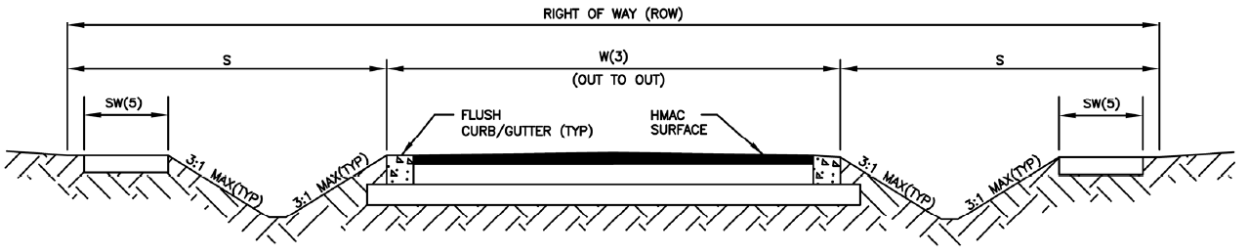
4. See paragraph 10.3.03.C for lane width requirements.
~~5. On thoroughfares and above.~~
5. ~~*~~See Chapter 17 for more information.

10.3.03.A Roadway Cross Sections

1. The City of Houston utilizes the basic roadway cross sections shown in ~~City of Houston Standard Drawing Numbers 10.06-01, 02~~Figure 10.3~~Figure 10.3~~103, Figure 10.4~~Figure 10.4~~104, ~~and 03~~Standard detail 02751-01~~, respectively~~. With the growing emphasis on Context Sensitive Design, roadway cross section variations are encouraged and will be considered by the Office of the City Engineer.



(a) - Raised Curb and Gutter



(b) - Flush Curb/Gutter with Ditch

Figure 10.3~~10.3~~ - UNDIVIDED STREET TYPICAL CROSS SECTION

Table 10.7 - UNDIVIDED STREET DIMENSIONS

LOCAL STREET SINGLE FAMILY RESIDENTIAL (SFR)						THOROUGHFARE/ COLLECTOR STREET		
	STANDARD DENSITY LOT		HIGH DENSITY LOT		RESIDENTIAL MAIN			
ADT	250 - 350		350 - 1,500		≥1,500	≥5,000		
ROW	50	60	55	60	60	60	70	80

10.3.03.A.1
continued

W[3]	26	26	32	36	36	-[1]		
S	12	17	11.5	12	12	≥10	≥13	≥18
# OF LANES	-	-	-	-	-	2-4[2]		

Notes:

1. Roadway width for thoroughfare and collector streets is based on the overall lane configuration and approved lane widths.
2. Number of lanes to be determined through Traffic Engineering Study (See 15.05). Any design or redesign of a major thoroughfare, collector, or any other classified street shall require a Traffic Engineering Study (see 15.05) or other approved traffic study to be reviewed and approved by TDO prior to design begins.
3. Width (W) does not include width for bicycle lanes. Refer to Appendix 2 for minimum requirements. Requires approval of the City Engineer. Width includes on street parallel parking where approved by City Engineer.
4. Requests for alternative street cross section shall be submitted to City Engineer for review.
5. For sidewalk design guidance, refer to Section 17.06: Pedestrian Design Requirements.

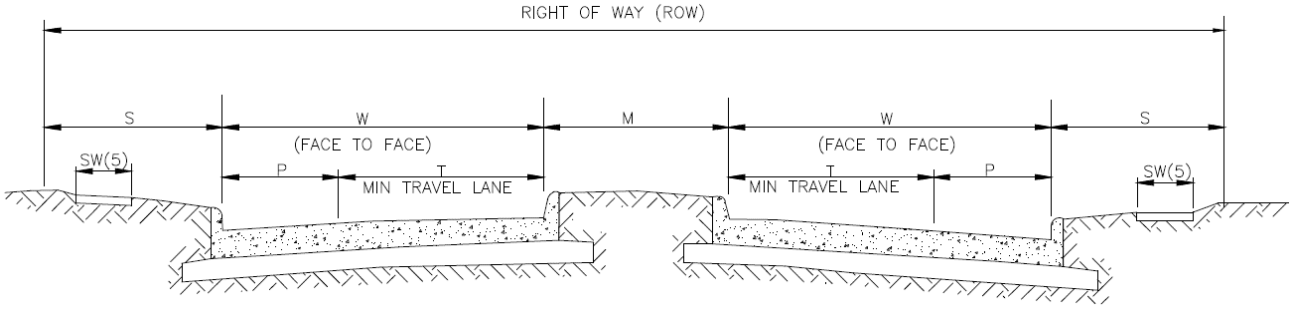


Figure 10.4~~10.4~~ - DIVIDED STREET TYPICAL CROSS SECTION

Table 10.8 - DIVIDED STREET DIMENSIONS (FEET)

LOCAL STREET SINGLE FAMILY RESIDENTIAL (SFR)			THOROUGHFARE/COLLECTOR STREET		
	RESIDENTIAL MAIN				
	STD SW	CENTER SW			
ADT	≥1,500	≥1,500	5,000+		
ROW	70	80	80	90	100
W	20	20	-[1]		
M	8	16	17	17	17
S	11	12	≥10	≥12	≥15
T	11	11	-[1]		
P	9	9	-[2]		
# OF LANES	-	-	4	4	4

Notes:

1. Any design or redesign of a major thoroughfare, collector, or any other classified street shall require a Traffic Engineering Study (see 15.05) or other approved traffic study to be reviewed and approved by TDO prior to design begins. This study shall determine the roadway width and travel way for the road.
2. Parking is generally not permitted along thoroughfares.
3. Any right-of-way dimensions different from those shown shall require special geometric design as determined by City Engineer.
4. Refer to Appendix 2 for optional designs to serve special mobility needs, pedestrian needs, bicycle lanes, or other requirements. Approval by City Engineer required.
5. For sidewalk design guidance, refer to Section 17.06: Pedestrian Design Requirements.

10.3.03.B Walking, Bicycling, and Transit Considerations

1. Transit Shelters

   a. Engineers shall coordinate with METRO or other Transit groups in regard to placement and design of Bus or other Transit Shelters when designing or rebuilding roadways for the placement of pads and other appurtenances. No bus stops, pads or shelters shall be removed from the ROW without METRO's approval. See this chapter ~~Chapter 17~~ for more information regarding transit and see Chapter 17 for more information regarding~~,~~ pedestrian and bicycle facilities.

2. Pedestrian Realm (Sidewalks, Accessibility Ramps, and Bus Pads)

   a. See Chapter 17 for pedestrian realm design requirements.

   ~~1. Minimum Sidewalk Width – five (5) feet and should be wider where appropriate. For Transit Streets see section 10.6.I.3. Minimum sidewalk width for Major Thoroughfares shall be six (6) feet.~~

   ~~2. Accessibility ramps shall be constructed at all intersections, when the right-of-ways leading to those intersections have existing sidewalks.~~

   ~~3. Sidewalks constructed along Type A Streets – for Transit Corridor Streets shall have a minimum width of six (6) feet. Ramps, approaches and sidewalks shall comply with ADA and TAS requirements. Sidewalks for Transit Corridor Street and Type A Streets:~~

   ~~a. Chapter 42, Article IV – Transit Corridor Development, of the Code of Ordinances regulates improvements constructed in the public right of way within 1,320 feet of each transit station (Ch. 42, Sec 401-406). Mandatory requirements are summarized below and shown in Standard Detail 02775-08. These requirements are required under IBC, Section 3110).~~

   ~~(1) Minimum Sidewalk Width – six (6) feet (must be located within the public right of way or sidewalk easement).~~

   ~~(2) Minimum Vertical Clear Zone, a continuous obstacle free path, for a minimum width of six (6) feet and a minimum height of seven and one-half (7 ½) feet.~~

   ~~b. Performance Standards - Refer to Chapter 42 Sections 401-406:~~

   ~~(1) Minimum Pedestrian Realm – 15 feet distance from back of curb to a building's facade or other improvements (can be entirely within public right of way or a combination of public right of way and public access easement).~~

   ~~(2) Maximum Softscape area in the pedestrian realm is 20% of the surface area of the pedestrian realm excluding any driveways and shall be located at least two (2) feet from the back-of-curb of any street area used for parking.~~

~~4. Sidewalks at intersections are to be provided with unobstructed areas as shown in Standard Drawing No. 10.06-04 and are to be free of obstructions and surface encroachments such as sign posts, power poles and down guy wires within that area.~~

~~5~~b. Approved sidewalk/ramp details are shown in the City's Standard Details. Use of these details are specific to certain field conditions such as ramp direction, driveway crossings, crosswalk locations and the location of the sidewalk with respect to the curb.

~~6. Where use of standard sidewalk/ramp details is not possible due to field conditions, engineer shall submit proposed design drawings to City Engineer for approval. Design drawings shall include site field survey conditions.~~

~~7. Accessibility ramps should cross street at 90 degrees to centerline of street.~~

~~8. All ramps constructed on an intersection corner should be interconnected for pedestrian access continuity.~~

~~9. Mid-block crosswalks shall be installed where appropriate based on area context and associated justification provided by the design engineer. Mid-block crossings for side paths, off-street trails as well as other considerations are discussed in Chapter 17.~~

~~10. Sidewalks traversing rail lines shall be at 0% slope for a distance of five (5) feet from the Center Line of the track.~~

~~11. Alternative methods of sidewalk construction may be used in places where tree preservation is of concern. Alternative materials may be but are not limited to decomposed granite and checkered plate.~~

~~12~~c. When right-of-way contains a Bus Stop, the engineer will contact METRO at busstops@ridemetro.org to determine the appropriate bus stop type~~use the following Bus Pad and Landing Design Guidance to appropriately integrate the bus landing pad with the sidewalk~~.

(1) Each bus stop area will be composed of three elements per Figure 10.14~~Figure 10.14~~~~1014~~~~City of Houston Drawing Number 10.~~:

i. Bus Pad (one): ~~15'6"~~17-feet (typical) by eight ~~(8)~~ feet (minimum) (all slopes maximum 2%)
ii. Bus Landing Area (two): Five ~~(5)~~ feet by eight ~~(8)~~ feet (minimum) (front door landing), and seven ~~(7)~~ feet (recommended) by eight ~~(8)~~ feet (minimum) (back door landing) (all slopes maximum 2%)
iii. Transitions (two): Five ~~(5)~~ feet (minimum) by eight ~~(8)~~ feet aligning with the landing and tapering to the sidewalk width (maximum longitudinal slope of 5%)

(2) As additional right-of-way is available beyond the minimum nine ~~(9)~~ feet S-dimension:

i. Pad will shift back, maintaining a one-foot distance to the edge of right-of-way.
ii. Landings may extend in width from the curb to one foot from the right-of- way. The width will be extended in order to always maintain an ADA and TAS accessible route between the pad and landing.
iii. Engineer will use their judgement to specify the proposed surface of the remaining portion between the pad and curb (ex. paving, grass, etc.).

(3) Context factors that may influence the design of Standard Bus Pad and Landings.

i. Distance from the curb to the right-of-way (or bus pad easement) is less than nine ~~(9)~~ feet.
ii. Location of bus pad longitudinally along the roadway will need to account for the Critical Shelter Obstruction (as identified in City of Houston Figure 10.14~~Figure 10.141014~~) ~~Drawing Number 10.06~~ when verifying safe Intersection Sight Distances (as prescribed by per City of Houston ~~Drawing Number 10.06-05~~Figure 10.6~~Figure 10.6~~~~Figure 106~~). If the stop location needs to change due to sight distance requirements, the engineer will contact METRO at busstops@ridemetro.org~~713-615-6195~~ for coordination and approval.

(4) Where use of standard bus pad and landings details is not possible due to field conditions (ex. driveways, trees, etc.), engineer shall contact METRO at ~~713-615-6195~~ busstops@ridemetro.org for proposed variations and approval.

10.3.03.C Lane Widths

Local street travel way width is dictated by the required cross section width provided in tables 10.7 & 10.8. Lane width standards apply to lanes on major thoroughfares and collectors that are designated by pavement markings, are intended primarily for through movements, and can only accommodate one use at a time (e.g. movement or parking). For more information, refer to paragraph 10.3.03.A Roadway Cross Sections.

1. Inside Interstate 610

a. The standard lane width on a City street ~~will be~~is ~~11~~10~~--~~feet.

b. On thoroughfares with heavy truck traffic documented (daily truck volumes exceeding 5% of ADT~~greater than 5% of total volume~~)~~or transit~~

~~agencies designated bus routes~~, the use of an ~~12~~11-~~-~~foot outside lane ~~is recommended~~may be used based on engineering judgement.

c. On thoroughfares with transit agency designated bus routes, the outside lane may be 11-feet.

~~d. If a permanent parking lane is provided, an outside lane width of 20-feet is recommended.~~

~~e. Lane widths other than 11-feet shall require a variance signed by both the City Engineer and the City Traffic Engineer, unless otherwise specified within this chapter.~~

2. Outside Interstate 610

a. The minimum lane width on a City street is 10-feet. The maximum lane width is 11-feet.

b. The lane width shall be determined based on engineering judgment. The engineer of record shall make a recommendation for the lane width by considering the following:

(1) Truck traffic

(2) Transit agency designated bus routes

(3) Pedestrian/bicycle activity

(4) Design Speed

(5) Roadway capacity

~~b.~~c. On thoroughfares with heavy truck traffic documented (daily truck volumes exceeding 5% of ADT), the use of an 11-foot outside lane may be used based on engineering judgement.

d. On thoroughfares with transit agency designated bus routes, the outside lane width may be 11-feet.

3. Lane widths other than what is specified above, shall require a variance signed by both the City Engineer and the City Traffic Engineer, unless otherwise specified within this chapter.

10.3.03.D Curve Radii

1. (1) Curve radii design shall be based on the design speed of the roadway and any super-elevation that may be considered for the design.

   (2) Minimum curve radii for ~~major~~ collectors/major thoroughfares is 500-~~-~~ feet.

   (3) Minimum curve radii for local streets and minor collectors is 300-~~-~~feet.

2. Reverse curves for roadways should have a minimum 100-~~-~~feet tangent between curves excluding turn lane transitions.

3. Maximum super elevation rate will be 4%.

4. Reverse super elevations shall not be allowed on any city roadways.

~~5. For super elevation design criteria, refer to City of Houston Standard Drawing 10.06-12.~~

10.3.03.E Median Design

Median design should accommodate bicycle and pedestrian movements across a street where the need has been established. Midblock crossing standards for bicycle and pedestrian access are defined in Chapter 17.

1. Minimum Median Width

10.3.03.E.1 continued

a. For local streets, refer to~~City of Houston Standard Table No. 10.06-04~~Figure 10.4~~Figure 10.4104~~.

b. Paved medians shall be at least four ~~4-~~feet (face to face) in width.

c. The desired width of reverse median is six ~~6-~~feet (face to face).

2. Minimum Median Length

a. Median lengths are based on functional street classification of the main roadway and intersecting street. Median Openings should only be installed where the need for an opening exists. Before a median opening is closed, the need to continue pedestrian and bicycle movements across the corridor shall be evaluated per Chapter 17 guidance.

b. Refer to ~~City of Houston Standard DrawingNo. 10.06-06~~Figure 10.7~~Figure 10.7~~Figure 107 for minimum median length requirements. ~~The minimum median spacing is 660 feet. Designs should adhere to the desirable spacing when in the vicinity of major signalized intersections.~~

3. Median Geometry - Refer to ~~City of Houston Standard DrawingNo. 10.06-07.~~Figure 10.8~~Figure 10.8~~Figure 108.

4. Street Taper Geometry - Refer to Figure 10.9~~Figure 10.9~~Figure 109 ~~City of Houston Standard Drawing No 10.0~~for subdivision street taper geometrics.

10.3.03.F Vertical Geometric Requirements

1. For ~~Curb and Gutter~~ Pavement Sections:

a. Minimum grade line shall be 0.30 percent.

b. Minimum grade line shall be 1.00 percent for radii of 35~~-~~feet or less around intersection turnouts. Grades for larger radii shall be determined on an individual basis.

c. Superelevation - Major thoroughfares shall be super elevated in accordance with AASHTO requirements.

d. Vertical Curves

(1) Shall be installed when the algebraic difference in grades exceeds 1.00 percent.

(2) Elevations shall be shown at 10~~-~~foot intervals through vertical curves.

(3) Maintain a minimum of 0.03 ~~-~~foot elevation change at 10~~-~~foot intervals by altering calculated elevations.

(4) Determine minimum vertical curve lengths based on AASHTO design criteria (minimum shall not be less than 3 times design speed).

e. Minimum grade line around a cul-de-sac shall be 0.70 percent.

f. Pavement Cross Slopes:

(1) Cross slopes for pavement shall be a minimum of 1/4-inch per foot.

(2) Cross slopes for left-turn lanes and esplanade openings shall be 1/8-inch per foot minimum.

2. Railroad Crossings

a. Maximum Tangent Grade to Vertical Curves at Railroad Crossings:

(1) 8.0 percent for local streets

(2) 3.5 percent for major thoroughfares

b. Roadway grades at railroad crossings shall be zero percent from centerline of the track to ~~ten (~~10~~)~~ feet either side of the track's centerline, and should not cause a drop of more than six ~~(~~6~~)~~ inches from the top-of-rail elevation at a distance of 30 feet either side of the track's centerline.

c. For concrete roadways, the roadway shall terminate at a railroad header, six ~~(~~6~~)~~ feet from the centerline of the track and the roadway cross slope shall be zero ~~(0)~~ from the railroad header to four ~~(4)~~ feet before the railroad header.

d. Railroad crossings are shown in ~~Standard Drawing~~No.~~10.06-13~~Figure 10.13~~Figure 10.13~~Figure ~~1013~~.

e. All roadway crossings of a railroad shall include a minimum six ~~(6)~~ feet pedestrian walkway. See ~~Standard Drawing~~No. ~~10.06-13~~Figure 10.13~~Figure 10.13~~Figure ~~1013~~.

f. At railroad track approaches, decrease curbs from ~~six (~~6~~)~~ inches to zero ~~(0)~~ inches in two ~~(~~2~~)~~ feet, at a distance of ten ~~(10)~~feet from the nearest track centerline.

g. All roadway crossings of a railroad that involve bicycle facilities shall include appropriate crossing angles and signage for bicyclists as defined in Chapter 17.

10.3.03.G Alleys

1. Definitions

   a. Public Use Alley Means a mid-block right use or right-of-way that is open and available for vehicular use and travel by the general public and has been formally accepted for maintenance by the City of Houston (City). An inventory of these alleys is maintained by the Office of the City engineer (OCE) of Houston Public Works and can be found on the City's website.

   b. Private Rights of Access Alley shall mean a mid-block right-of-way utilized for right of ingress and egress for property adjacent to and authorized access by reference to map or plat showing alleys abutting such real property, and that have not been accepted for maintenance by the City.

   c. Applicant shall mean a person who owns real property abutting an alley and seeks to improve such alley for motorized vehicular traffic use either by the public or pursuant to private rights if access.

   d. Application shall be the plans for the proposed improvements from the Applicant's property to the public street submitted with the Applicants construction plans for the improvement to personal property. No separate application is required.

2. Access

   a. Public Use Alley

      (1) Alley is on the most current list of approved alleys.

      (2) Applicant is responsible for providing photos that the existing alley meets the criteria stated in the Private Rights of Access section of this chapter.

      (3) Alley access can be approved for residential and commercial properties.

      (4) A commercial property shall only connect to a Public Use Alley.

   b. Private Rights of Access Alley

      (1) Residential use only.

      (2) Applicant has the right to access a Private Rights Access Alley. The City is not responsible for maintaining these alleys.

      (3) The City's driveway requirements shall apply to the portion of the alley along the Private Rights Access Alley from the right-of-way (ROW) line to the public street.

(4) The portion of the alley from the City's ROW line (of public street) to the applicant's property being developed shall be designed and constructed in accordance with the City of Houston, Houston Public Works detail as shown on Figure 10.12~~Figure 10.12~~~~Figure 1012~~.

~~Design standards for a Public Use Alley are shown in City of Houston Standard Drawing No. 10.06-10.~~

~~All Public Use Alleys should not drain across sidewalks without approval by City Engineer.~~

~~An offer of dedication of right of way to the public is required for a Public Use Alley and such offer must be formally accepted by the City for implementation of public maintenance services.~~

~~The minimum design standards for a Private Use Alley are shown in City of Houston Standard Drawing No. 10.06-11.~~

~~The right of way for a Private Use Alley is owned and maintained by the abutting property owners.~~

~~Signs shall be erected by the developer at the entrance to the alley (or by the abutting property owners for existing alleys) which state "PRIVATE ALLEY – NOT A PUBLIC WAY". See City of Houston Standard Drawing 10.06-11 for sign detai~~

10.3.03.H Street Terminations

1. Where cul-de-sac streets are approved, design geometrics shall comply with ~~City of Houston Standard Drawing No. 10.06-09~~Figure 10.10~~Figure 10.10~~~~Figure 1010~~. Bicycle and pedestrian access to nearby existing or proposed bicycle facility or trail shall be provided where feasible.

10.3.03.H
continued

2. Where termination of a private street or Type 2 Permanent Access Easement is approved, design geometrics shall comply with ~~City of Houston Standard Drawing No.~~ ~~10.06-09~~Figure 10.10~~Figure 10.10~~~~Figure 1010~~. Bicycle and pedestrian access to nearby existing or proposed bicycle facility or trail shall be provided where feasible.

3. Dead-End Streets - Standard City of Houston barricades shall be placed at the end of dead-end streets not terminating in cul-de-sacs. Refer to City of Houston Standard Detail No. 01580-01. Bicycle and pedestrian access to nearby existing or proposed bicycle facility or trail shall be provided where feasible.

~~3.~~4. Street terminations shall consider impacts to bicycle and pedestrian access. Where feasible, bicycle and pedestrian access across street terminations points should be considered, especially when connecting between neighborhoods; to destinations such as commercial districts, parks, and schools; or to existing or proposed bicycle facilities and trails.

~~4.~~5. Temporary Street Termination - Temporary termination of streets (for future extension into adjacent development) shall include construction of street barricades as shown in City of Houston Standard Detail No. 01580-01.

10.3.03.I On-Street Parking and Cutback Parking

1. General Requirements

a. At the discretion of the City Traffic Engineer, parking may be allowed in a traffic lane if current traffic volume do not warrant the need for the additional lane. The City Traffic Engineer may allow this parking to occur all day or may restrict it to certain times of the day as needed for mobility purposes. All parking allowed to occur within a traffic lane shall be considered to be temporary and can be removed at any time.

b. Designated on-street parking can be approved provided that sufficient right-of-way exists. When a designated parking lane is provided, it shall be at least nine feet in width. Where on-street ADA accessible parking is provided, the minimum required width is 13-feet.

c. As required by the City of Houston Code of Ordinances, all on-street parking shall be parallel to the curb or edge of pavement unless approved by the City Traffic engineer. Lateral parking shall be treated on a case by case basis.

d. As required by the City of Houston Code of Ordinances, all parking within the public right-of way behind the curb (curb cutback parking) requires the approval of the Director of Houston Public Works. Parking behind the curb shall be considered on a case by case basis.

~~c.~~e. Figure 10.5~~Figure 10.5105~~ applies to all on-street parking and curb cutback parking.

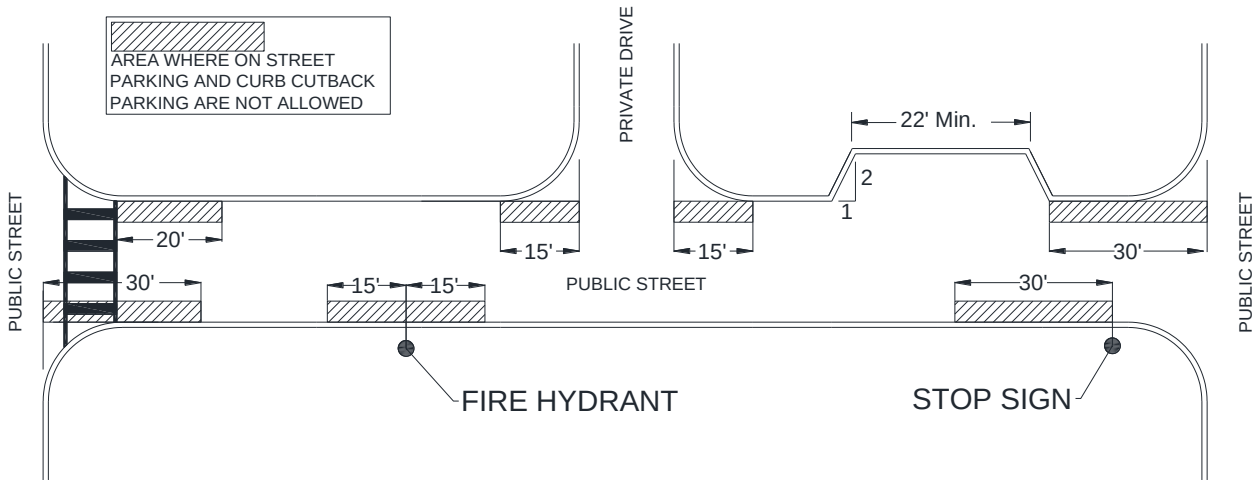


Figure 10.5~~10.5~~ - ON-STREET PARKING

10.3.03.I continued

2. On-Street Parking for Existing Roadways

~~d.~~a. Roadway width less than 20-feet

(1) No parking allowed on the street.

~~e.~~b. Roadway width equal to or greater than 20-feet but less than 26-feet

(1) Parking will be allowed on one side, if parking restrictions do not exist.

(2) If on street parking already exists on one side of the street, parking on the opposite side of the street will not be allowed.

~~f.~~c. Roadways width equal to or greater than 26-feet

(1) On-Street Parking will be allowed on both sides of the street, if parking restrictions do not exist.

~~2.~~3. On-Street Parking for Roadways that Require Widening

a. Widening performed for parking must be per the requirements outlined in this manual.

b. To allow for parking, the roadway must be widened along the entire property frontage.

~~a.~~c. The roadway widening must also include transitions outside of the property frontage.

d. The required transition must follow the requirements outlined in the Manual.

e. Transition requirements apply to both concrete and asphalt roadways.

f. For cases where the required transition starts less than 100-feet from the nearest intersection, the street must be widened along the entire property frontage and extend all the way through the nearest intersection.

4. Curb cutback parking

~~b.~~a. Curb cutback parking is defined as all parking within the public right-of-way:

(1) Behind the curb (Refer to 10.3.03.I.1.d) or

(2) Adjacent to the edge of the pavement for non-curbed streets.

b. Curb cutback parking will not be considered for roadway widths less than 20-feet.

c. Curb cutback parking must be nine feet wide by 22-feet long per parking space.

~~c.~~d. All curb cutback parking must have a curb with appropriate drainage.

(1) Curbed roadways – proposed curb must tie into the existing curb.

(2) Non-curbed roadways – proposed curb is only required along the edge parallel to the roadway.

e. All curb cutback parking shall be confined within the property frontage.

~~d.~~f. Cut back criteria

(1) Transitions into a cutback parking shall taper 2:1.

(2) Cut back area shall conform to all sight distance, distance to intersection and all other existing design criteria.

g. These criteria shall also apply for parking within the public right of way on streets without curb.

~~1. Permanent on-street parking cannot occur in a traffic lane.~~

~~(1) At the discretion of the City Traffic Engineer, parking may be allowed in a traffic lane if current traffic volumes do not warrant the need for the additional lane. The City Traffic Engineer may allow this parking to occur all day or may restrict it to certain times of the day as needed for mobility purposes. All parking allowed to occur within a traffic lane shall be considered to be temporary and can be removed at any time.~~

~~2. Permanent on-street parking can be provided assuming that sufficient right-of-way exists. When a permanent parking lane is provided, it shall be at least eight (8) feet in width. Where on-street ADA accessible parking is provided, the minimum required width is (13) feet.~~

~~3. As required by the City of Houston Code of Ordinances, all on-street parking shall be parallel to the curb or edge of pavement unless approved by the City Traffic Engineer. Lateral parking shall be treated on a case by case basis.~~

~~4. As required by the City of Houston Code of Ordinances, all parking within the public right-of-way behind the curb (curb cutback parking) requires the approval of the Director of Houston Public Works. Parking behind the curb shall be considered on a case by case basis.~~

SECTION 4 – STREET CONNECTIONS AND TRANSITIONS

10.4.01 STREET CONNECTIONS

10.4.01.A Where a new street or driveway is proposed to connect to an existing signalized intersection, refer to Chapter 15 Traffic and Signal Design Requirements.

10.4.02 STREET TRANSITION REQUIREMENTS

10.4.02.A Concrete Streets

1. When transitioning from a proposed concrete street to an existing concrete street, the transition shall consist of concrete, and shall equal the existing concrete pavement thickness with a minimum thickness of eight ~~(8)~~ inches.

2. Refer to City of Houston Standard Detail 02751-01.

10.4.02.B Streets Other Than Concrete Pavement

1. When transitioning from a proposed street to an existing street constructed of material other than concrete, the transition shall consist of asphaltic concrete paving.

2. Refer to City of Houston Standard Detail 02741-01~~Drawing No. 10.06-03~~.

10.4.02.C Pavement Transition Length

1. The standard transition length for all street types shall be calculated as follows:

$$L = \frac{WS^2}{60}$$

Where:

L = Transition length (feet)
S = Posted speed (mph)
W = width of offset (feet)
(Source: See 10.1.03.M)

~~1. Proposed Curb and Gutter Street Connecting to an Existing Roadside Ditch Street:~~

2. Minimum transition length shall be:~~The standard transition length for meeting a roadside ditch street is:~~

   a. 50-feet for street widths less than or equal to 26~~-~~-feet F-F (face to face of curb).

   b. 75-feet for street widths greater than ~~equal 36~~26~~-~~-feet and less than 36-feet

F-F (face to face of curb).

c. 100~~-~~feet for street widths greater than ~~equal to 40~~36~~-~~feet and less than or equal to 40-feet F-F (face to face of curb).

10.4.03 PROPOSED CURB AND GUTTER STREET CONNECTING TO AN EXISTING CURB AND GUTTER STREET

10.4.02.A When meeting an existing curb-and-gutter street, top-of-curb elevations shall be designed to meet an elevation six ~~(6)~~ inches above the existing gutter.

10.4.02.B At existing inlets, top-of-curb elevations shall be designed to match existing top-of- curb elevations.

10.4.04 CONSTRUCTION REQUIREMENTS FOR CONNECTING A PROPOSED CONCRETE STREET WITH AN EXISTING CONCRETE STREET

10.4.03.A When meeting existing concrete streets at right angles, the existing street should be saw cut in a V-shape extending from the curb returns to a point where the centerline of the proposed pavement intersects the quarter point of the existing concrete street to create a crowned intersection. In the event this construction creates a situation in which traffic on the existing street, at design speed, will bottom out when crossing the proposed street intersection, a special design will be allowed to eliminate this potentially dangerous condition.

10.4.03.B Remove concrete either to an existing joint or a sawed joint. The groove of the sawed joint shall be cut to a minimum depth of two ~~(2)~~ inches along the line designated by the Professional Engineer.

10.4.03.C When meeting existing concrete pavement, horizontal dowels shall be used if no exposed reinforcing steel exists. Horizontal dowels shall be Grade 60 bars, 24 inches long, drilled and embedded 12~~-~~inches into the center of the existing slab with PO ROC, or approved equal. Dowels shall be 12~~-~~inches center-to-center, unless otherwise specified.

10.4.03.D When concrete is removed for connection with proposed concrete pavement, the pavement shall be saw cut and existing concrete removed to expose a minimum of 15~~-~~inches of reinforcing steel. If no reinforcing steel exists, use horizontal dowels per Paragraph ~~10.07 D.3~~10.4.03.C.

10.4.05 PAVEMENT CONNECTION SPECIAL REQUIREMENTS

10.4.04.A At a T-intersection with a street that has not been improved to its ultimate width, concrete shall be stopped either at the right-of-way line or the end of the curb return. The option that will require the least concrete removal at a future date should be chosen.

10.4.04.B For roadway turnouts placed at an existing cross street intersection, the turnout should be designed to fit the ultimate pavement width of the intersecting cross street and then transitioned to the existing roadway.

10.4.06 L - TYPE STREET

The minimum grade line around the longest radius on an L-type street shall be 0.40 percent.

SECTION 5 – BICYCLE FACILITIES

See Chapter 17 - Bicycle, Transit and Pedestrian Design Requirements.

~~Bicycle Master Plan~~

~~All City of Houston maintained bicycle facilities shall be shown on the City's Bikeway Plan.~~

~~On-Street bicycle facilities will not be provided on roadways having a posted speed limit above 35 mph.~~

~~If an On-Street Bike Lane is provided, the minimum width of the Bike Lane shall be five (5) feet with a desired width of six (6) feet.~~

~~Types of Bicycle Facilities~~

~~Bike Routes are signed routes primarily along collector streets, local streets, and occasionally along thoroughfares. They consist of Bike Route signs (D11-1) only with no pavement markings or reserved area for bicycles. Bike routes typically require a minimum lane width of 11-feet.~~

~~Buffered Bike Lanes can be provided on collectors and major thoroughfares assuming that sufficient right-of-way exists for these facilities. A Buffered Bike Lane is simply a Bike Lane that is separated from the adjacent traffic while still existing as a part of the roadway. The buffer can be provided through the use of either a raised or painted median. If painted the buffer shall be a minimum of three (3) feet in width and shall consist of two six (6) inch solid white lines with six (6) inch diagonal white cross-hatching. If a raised median is provided, it will follow the minimum guidelines for raised medians found elsewhere in this manual. Bicycle pavement markings will be provided in the bike lanes and Bike Lane signs (R3-17) will be provided along the route.~~

~~Cycle Tracks can be provided on collectors and major thoroughfares assuming that sufficient right-of-way exists for these facilities. Cycle tracks can be one or two way and are similar in nature to Buffered Bike Lanes. Cycle Tracks will be treated on a case by case basis and additional information can be found in the NACTO Urban Bikeway Design Guide. For Cycle Tracks design criteria, refer to City of Houston Standard Drawing 10.06-13.~~

~~Off-Street facilities within the right-of-way can be provided along any facility and the speed of adjacent traffic is not of concern. Due to maintenance issues associated with off-street facilities, they will be considered on a case by case basis to determine the best design standards for the project. Typically, off-street facilities will be two-way and will be at least eight (8) feet in width and shall be at least five (5) feet from the back of curb.~~

~~Bicycle Parking or "Corrals" can be provided; however, they must occur within a~~

~~permanent parking space, not in a travel or mobility lane or within the sidewalk. If the sidewalk exceeds ten (10) feet in width, bicycle parking may be considered within the pedestrian realm.~~

~~Bike Trails~~

~~Bike trails should be designed using AASHTO Guidelines for Development of Bicycle Facilities, current edition or alternate with approval of the City Engineer.~~

SECTION 6 – SPECIAL REQUIREMENTS

10.6.01.A Pavement Crossing Pipelines - A Letter of agreement between the City and pipeline company is required when paving is placed over a transmission pipeline.

10.6.01.B Bridge design should include a high comfort bicycle facility where a bicycle facility exists or is proposed. See Chapter 17 for details on high comfort bicycle facilities. ~~Bridges: attaching utilities to bridges shall be prohibited whenever practical, unless all other ways have been explored.~~

~~a. Design Requirement~~

~~(1) Research and resolve known conflicts of proposed utilities before establishing design to structure. Any exceptions that are permitted will be handled per the design conditions. These exceptions will be considered on an individual basis and does not set a precedent for granting subsequent requests.~~
~~(2) It may be beneficial to carry lines across an obstruction using a utility structure rather than an attachment to a structure.~~
~~(3) The City Engineer's Office and the Bridge Maintenance Office will conduct a structural review and review of the details of the design. Exhibits submitted should include the following:~~

~~1. Details on how the line is attached to the bridge.~~
~~a. Show proposed location of the attachment on elevation view of bridge layout.~~
~~b. Show specific detail of attachment to bridge with appropriate notes to contractor.~~
~~c. The Utility Attachment Exhibit must be signed and sealed by a licensed professional engineer.~~
~~2. Copies of bridge layout and pertinent details of existing bridge as-built plans (if available).~~

~~(4) .~~

~~Note: All requirements can be referenced from The Texas Department of Transportation Bridge Project Development Manual; Chapter 4: Advanced Planning, Section 4: Utility Attachments; December 2012 Edition~~

~~b. Design Guidelines~~

~~(1) No gas or liquid fuel line may be attached to a bridge structure without approval from Public Works.~~
~~(2) Power lines are not permitted on bridges under any condition with the exception of low voltage distribution lines, lines that carry 600 volts or less.~~
~~(3) When a utility company request permission to attach a utility to an existing bridge, sufficient information should be furnished to allow a stress analysis to determine the effect of the added load on the structure. Other details of the proposed attachment as they affect safety and maintenance should also be presented. If the bridge structure is not of adequate strength to carry the increased~~

~~weight or forces with safety, permission will not be granted.~~

~~(4) Bridge attachments should not be made to any bridge rail or rail hardware, including anchor bolts.~~
~~(5) Do not hang lines from the bottom of beams.~~
~~(6) Maintenance of utility attachments to a bridge is the responsibility of the utility.~~

10.6.01.C Thoroughfare Construction Considerations

1. When the full section of a thoroughfare is located within the city limits and is dedicated on a final plat, the esplanade and all lanes of the thoroughfare shall be constructed at the time of initial construction of the roadway.

2. If approved by the City Engineer, lanes contained within a plat, left-turn lanes, bicycle facilities, and the esplanade to the centerline of the right-of-way shall be constructed at the time of initial construction of the roadway when only one side of a thoroughfare is located on a final plat. The remaining lanes, left-turn lanes, bicycle facilities and esplanade shall be constructed at the time the final plat containing the opposite side of the thoroughfare is approved.

10.6.01.D Inlets and Manholes

1. The inlet spacing and the maximum allowable curb run to an inlet shall be provided in accordance with Chapter 9.

2. City approved inlets shall be used on all curbs and gutter sections within the city limits and in the ETJ.

3. Keep proposed inlets away from esplanade opening and out of major thoroughfare intersections. For intersections between a major thoroughfare and minor street, locate inlets at the end of return (E/R) of the side street.

4. Inlets shall be placed at the end of pavement in order to eliminate drainage from the pavement gutter into a road ditch.

5. When curb and gutter streets connects to roadside ditches street, place inlets at end of curb and gutter street with reinforced concrete pipe stubs with rings to collect ditch storm water. See standard detail 02632-11- Side Street Ditch Reception.

6. Use only City standard grates for curb inlets.

7. Adjust existing manhole frames and covers within the limits of the proposed pavement to meet the proposed top-of-slab elevation.

8. Adjust existing manhole frames and covers outside the limits of pavement to conform to the final grading plan.

10.6.01.E When a curb and gutter street intersects a drainage ditch, the gutter elevation shall be above the designed water surface elevation of the ditch.

10.6.01.F Fill/Cut for Proposed Pavement

1. Fill Placement for Curb and Gutter Pavement Sections:

   a. Fill shall be placed to ensure a minimum of 3/8-inches per foot transverse slope toward the curb from the property line. Fill shall be placed between the curb and a point two ~~2~~ feet outside of the right-of-way.

   b. Where fill as described above is required, and the pavement is adjacent to a nonparticipating property owner, fill easements shall be obtained, filed, and a copy of the easement shall accompany the final drawings.

   c. Construction of this nature will require back-slope drainage design to prevent trapping storm runoff.

   d. When pavement or curb grades are established below natural ground, slopelines shall be shown on the drawings.

10.6.01.G Drawings

1. Construction drawings shall be prepared in accordance with Chapter 3, Graphic Requirements.

2. Top-of-curb grade for the outside lanes shall be labeled except at railroad crossings where gutter grades shall be labeled. Centerline grades are acceptable for sheets with roadside ditch sections.

3. For proposed driveways, call out centerline stations, widths, and radii.

END OF CHAPTER

APPENDIX ~~2~~ 1: DESIGN FIGURES

~~CHAPTER 10~~

GEOMETRIC DESIGN GUIDELINES FOR SUBDIVISION STREETS

CITY OF HOUSTON

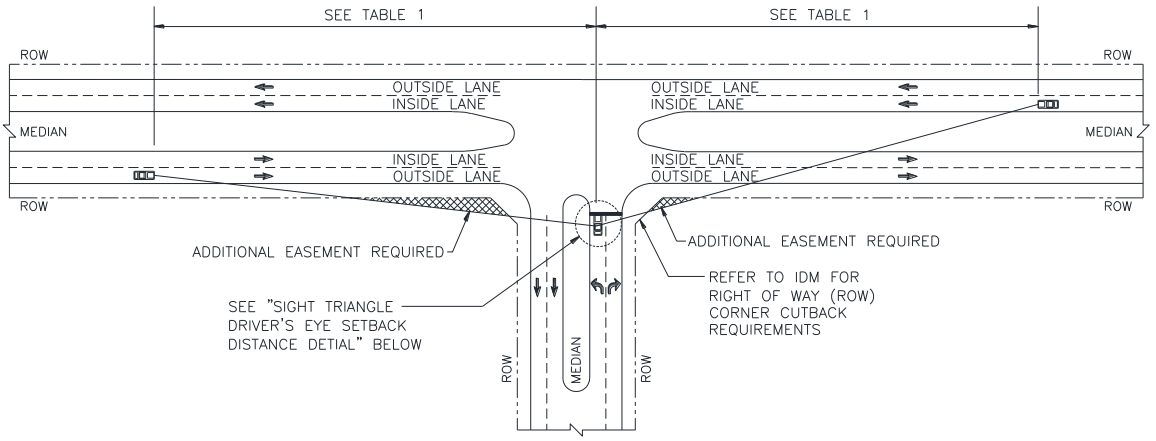
The Guidelines presented in Appendix ~~2~~ 1 include the most often requested information regarding geometric design of subdivision streets. All streets within the City of Houston shall be considered for special design features such as presented in Appendix ~~1~~ 2 of this Chapter. Design features not shown in Appendix ~~2~~ 1 should be considered special design features. Agency Engineer as used throughout this section shall mean City Engineer for the City of Houston. The average daily traffic volumes presented in~~Standard Drawing No. 10.06-01, 02,~~ Table 10.7~~Table 10.7107~~, Table 10.8~~Table 10.8108~~, and Appendix ~~1~~ 2 Figure 1 are provided as general guidelines to define each street classification. Professional engineering experience and judgment should be used in application of the guidelines to a specific project.

It is advisable to consult with the City and review the most recent edition of the following publications to determine adequate thoroughfare requirements and special design features.

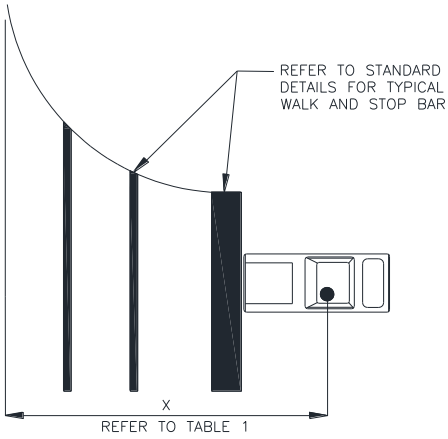
- Recommended Guidelines for Subdivision Streets, Institute of Transportation Engineers
- Guidelines for Urban Major Streets Design, Institute of Transportation Engineers
- A Policy on Geometric Design of Highways and Streets, American Associations of State Highway and Transportation Officials (AASHTO)
- Texas Manual on Uniform Traffic Control Devices (TMUTCD), Texas Department of Transportation
- Urban Street Design Guide, National Association of City Transportation Officials (NACTO)
- Urban Bikeway Design Guide, National Association of City Transportation Officials

THE GUIDELINES IN THIS APPENDIX ARE HEREBY APPROVED AS BASIC REQUIREMENTS FOR FUTURE STREET PLANNING AND DEVELOPMENT

JULY ~~2015~~2020



INTERSECTION GEOMETRY SIGHT DISTANCE TRIANGLE PLAN



SIGHT TRIANGLE DRIVER'S EYE SETBACK DISTANCE DETAIL

TABLE 1: TRIANGLE APPLICABILITY

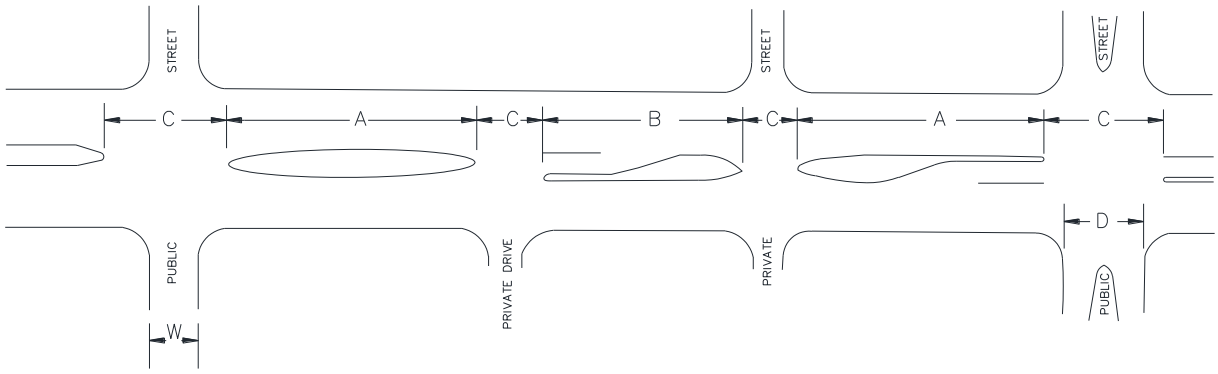
HIGHEST CLASSIFICATION/GREATER WIDTH STREET	SIGHT TRIANGLE DRIVER'S EYE SETBACK DISTANCE "X"	SIGHT TRIANGLE DIMENSION ON UNCONTROLLED STREET (DESIGN SPEED)
HIGH SPEED MAJOR THOROUGHFARE (≥45 MPH POSTED SPEED)	25 FT	SIGHT–SPECIFIC ANALYSIS
MAJOR THOROUGHFARE OR MAJOR COLLECTOR ON MTFP MAP	25 FT	500 FT (45 MPH)*
DIVIDED STREETS AND 41 FT STREETS	15 FT	500 FT (45 MPH)*
26 FT LOCAL AND COLLECTOR STREETS	15 FT	390 FT (35 MPH)*
26 FT SINGLE FAMILY RESIDENTIAL FRONTAGE ON BOTH STREETS (1)	N/A	N/A

*BASED ON A PASSENGER CAR TIME GAP

NOTES:

1. INTERSECTION SIGHT DISTANCES ARE BASED ON AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO) CRITERIA FOR INTERSECTION SIGHT DISTANCE.
2. IF ROADWAY BEING CROSSED OR TURNED INTO HAS A MEDIAN THAT IS 25 FEET OR GREATER, SIGHT DISTANCE TO THE RIGHT MAY BE MEASURED FROM THE POINT AT WHICH A VEHICLE CAN SAFELY STOP WITHIN THE MEDIAN OPENING.

Figure 10.6~~10.6~~ - INTERSECTION GEOMETRY SIGHT DISTANCE TRIANGLE



TYPICAL MEDIAN OPENING C

MEDIAN INTERRUPTION FOR	(1) 1 LTB	(1) 2 LTB
PRIVATE DRIVE OR PRIVATE STREET	52.5'	60'
UNDIVIDED STREET W ≤ 40' W = 44'	52.5' (2) 55' (2)	60' 80'
DIVIDED STREET ALL	D+22' (3)	D+22' (3)

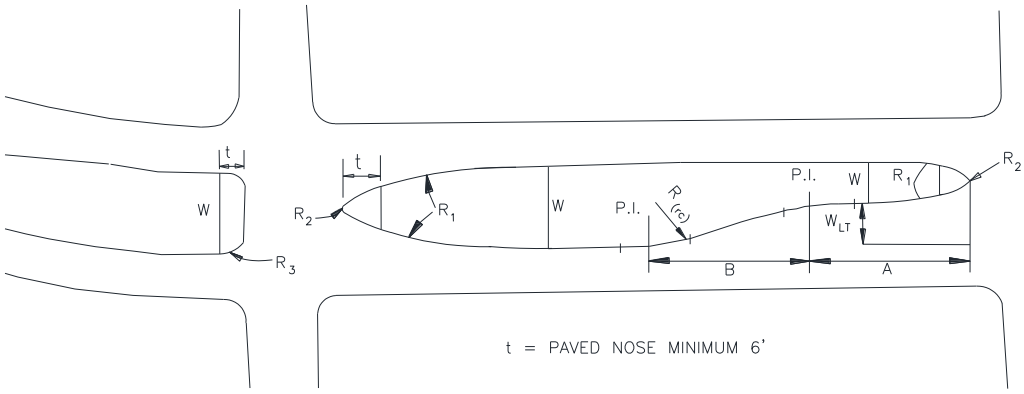
MINIMUM MEDIAN LENGTH A, B

IF DIVIDED STREET IS:	INTERSECTING STREET CLASSIFICATION			
	MAJOR THOROUGHFARE/ MAJOR THOROUGHFARE (A)	COLLECTOR STREET (A)	LOCAL STREET (A)	PRIVATE STREET OR DRIVEWAY (B)
MAJOR THOROUGHFARE/ MAJOR THOROUGHFARE	660'	660'	660'	660'
COLLECTOR STREET	660'	500'	350'	350'
LOCAL STREET	300'	300'	300'	300'

NOTE:

(1) LTB–LEFT TURN BAY.
(2) DISTANCE FROM CENTERLINE OF OPENING TO MEDIAN NOSE WITH LEFT TURN LANE IS 30' FOR RIGHT ANGLE INTERSECTIONS. FOR INTERSECTIONS OTHER THAN 90°, APPLY DESIGN VEHICLE TURNING TEMPLATE TO DETERMINE DIMENSION TO MEDIAN NOSE CUT OFF.
(3) "W" AND "D" DENOTE THE PAVEMENT WIDTH MEASURED FROM FACE OF CURB TO FACE OF CURB

Figure 10.7~~10.7~~ - MEDIAN LENGTH AND OPENING



LEFT TURN BAY PLAN

MEDIAN DIMENSIONS

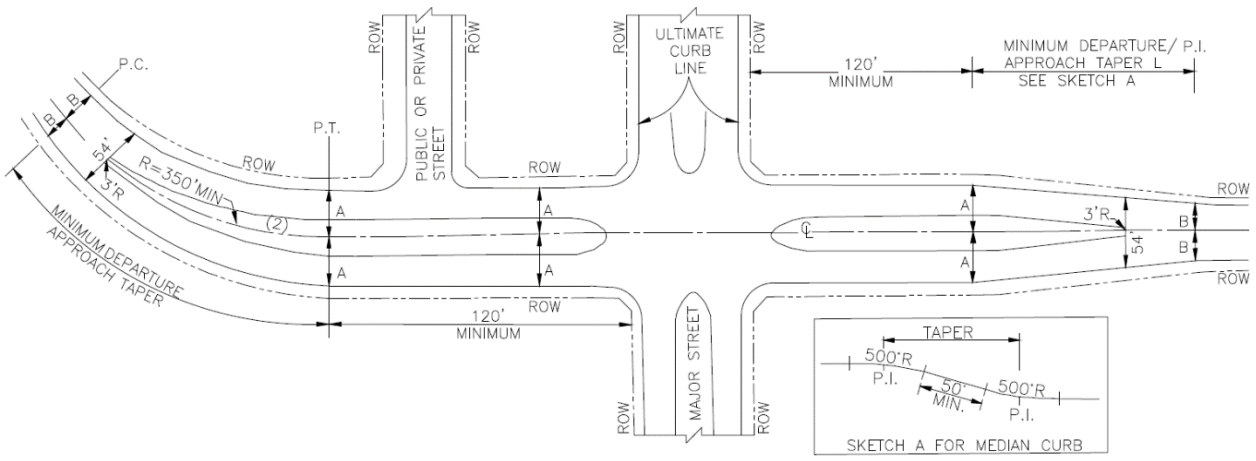
W	R_1	R_2	R_3
≤10'	NONE	$\frac{W}{2}$	NONE
>10'≤40'	90	2'	NONE
>40'	NONE	NONE	15

LEFT TURN BAY DIMENSIONS

INTERSECTION TYPE	DESIGN SPEED	A	B	$R_{(rc)}$	$W_{(LT)}$
MAJOR THOROUGHFARE – MAJOR THOROUGHFARE	≤35 MPH ≥35 MPH	150' 150'	86' 118'	150' 300'	10'/11' 10'/11'
MAJOR THOROUGHFARE – MAJOR COLLECTOR	≤35 MPH ≥35 MPH	150' 150'	86' 118'	150' 300'	10'/11' 10'/11'
ALL OTHER	≤35 MPH ≥35 MPH	100' 100'	86' 118'	150' 300'	10'/11' 10'/11'

TABLE NOTES:
1) $R_{(rc)}$ – REVERSE CURVE RADIUS
2) LEFT TURN BAY LANE WIDTH (W_{LT}) TO CONFORM TO LANE WIDTH REQUIREMENTS SPECIFIED IN SECTION 10.3.03: CORRIDOR DESIGN

Figure 10.8~~10.8~~ - MEDIAN NOSE AND LEFT TURN BAY



NOTES:

1) APPROACH AND DEPARTURE TAPER REQUIREMENT:

$L = \frac{WS^2}{60}$ WHERE L = LENGTH IN FEET
S = SPEED IN M.P.H.
W = LATERAL OFFSET IN FEET

S = 30 M.P.H. MINIMUM DESIGN SPEED FOR SUBDIVISION STREETS

W = A–B

2) 300' MINIMUM CENTERLINE RADIUS FOR HORIZONTAL CURVE WITH APPROACH OR DEPARTURE TAPERS.

3) REFER TO STANDARD DRAWING NO. 10.8 FOR MEDIAN LENGTHS AND MEDIAN OPENING.

Figure 10.9~~10.9~~ - ROADWAY TAPERS FOR MEDIAN DESIGN (LOCAL STREETS

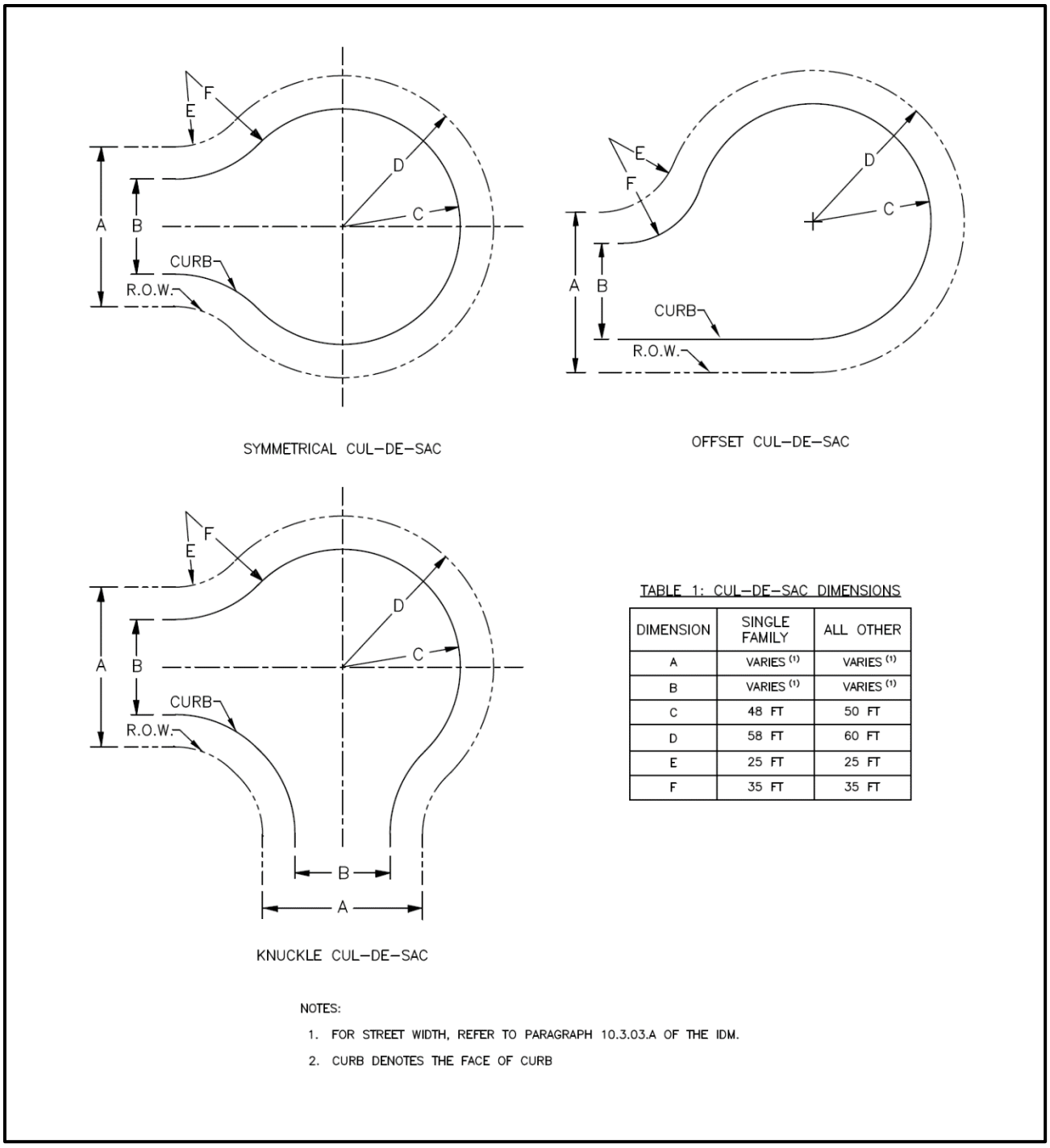


TABLE 1: CUL–DE–SAC DIMENSIONS

DIMENSION	SINGLE FAMILY	ALL OTHER
A	VARIES (1)	VARIES (1)
B	VARIES (1)	VARIES (1)
C	48 FT	50 FT
D	58 FT	60 FT
E	25 FT	25 FT
F	35 FT	35 FT

NOTES:

1. FOR STREET WIDTH, REFER TO PARAGRAPH 10.3.03.A OF THE IDM.
2. CURB DENOTES THE FACE OF CURB

Figure 10.10~~10.10~~ - STREET TERMINATION CUL-DE-SAC ~~AND TYPE 2 PAE~~

PUBLIC USE ALLEY REMOVED

ANY PUBLIC USE ALLEY ROW SHOULD MEET CITY ROADWAY STANDARDS

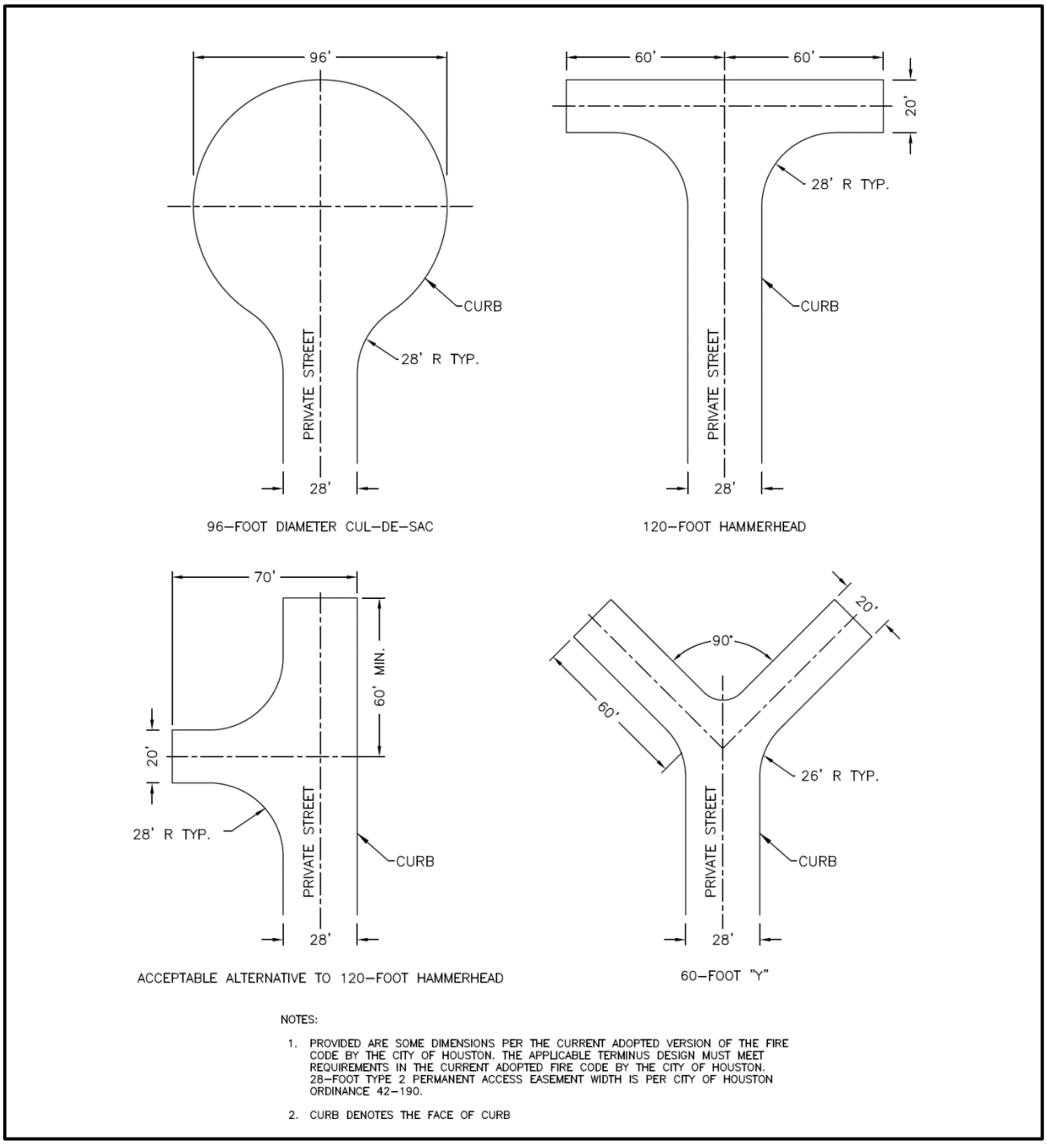


Figure 10.11~~10.11~~ - ~~PRIVATE USE ALLEY~~TYPE 2 PERMANENT ACCESS EASEMENT

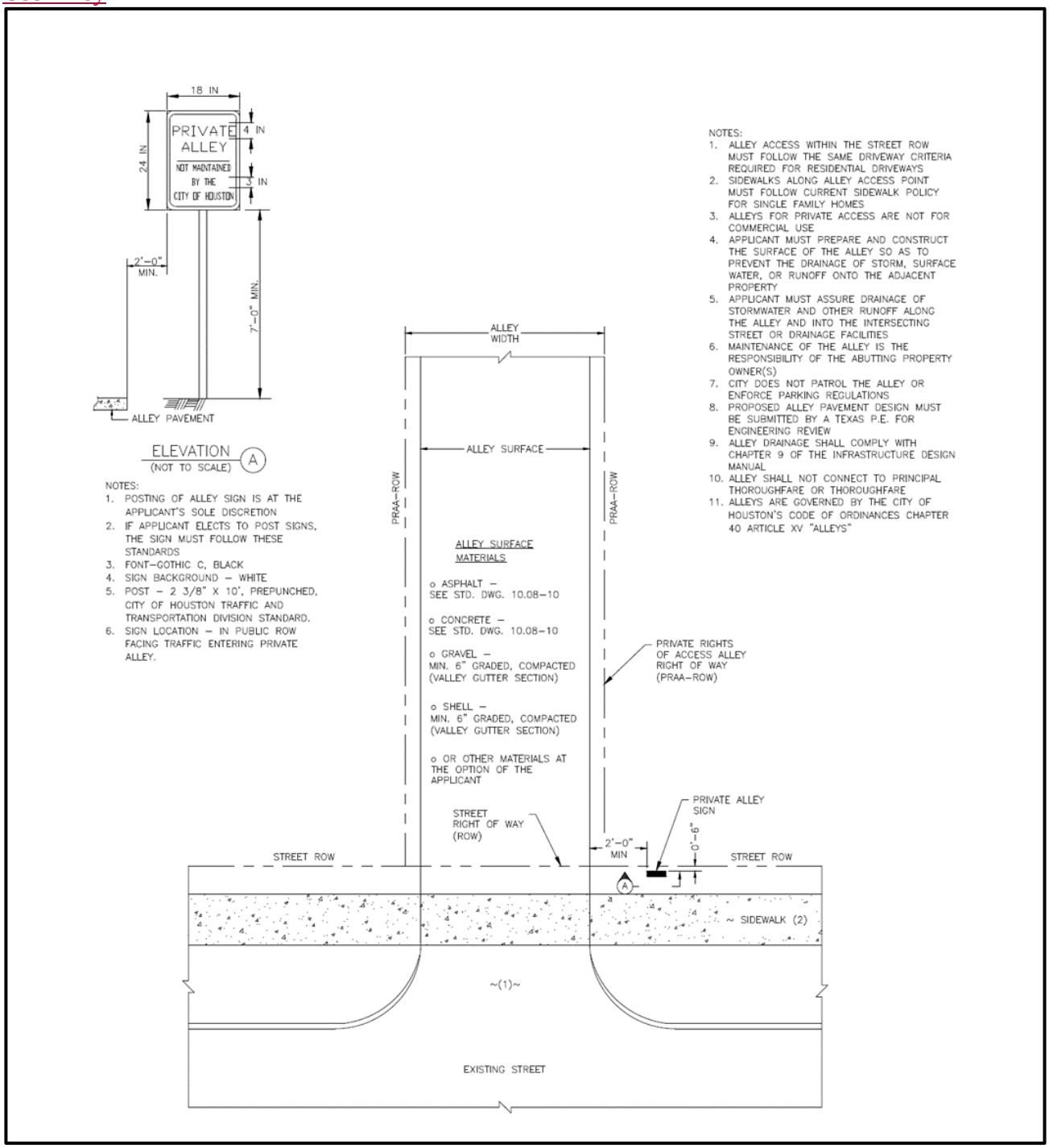


Figure 10.12~~10.12~~ - ~~RAILROAD CROSSING~~PRIVATE USE ALLEY

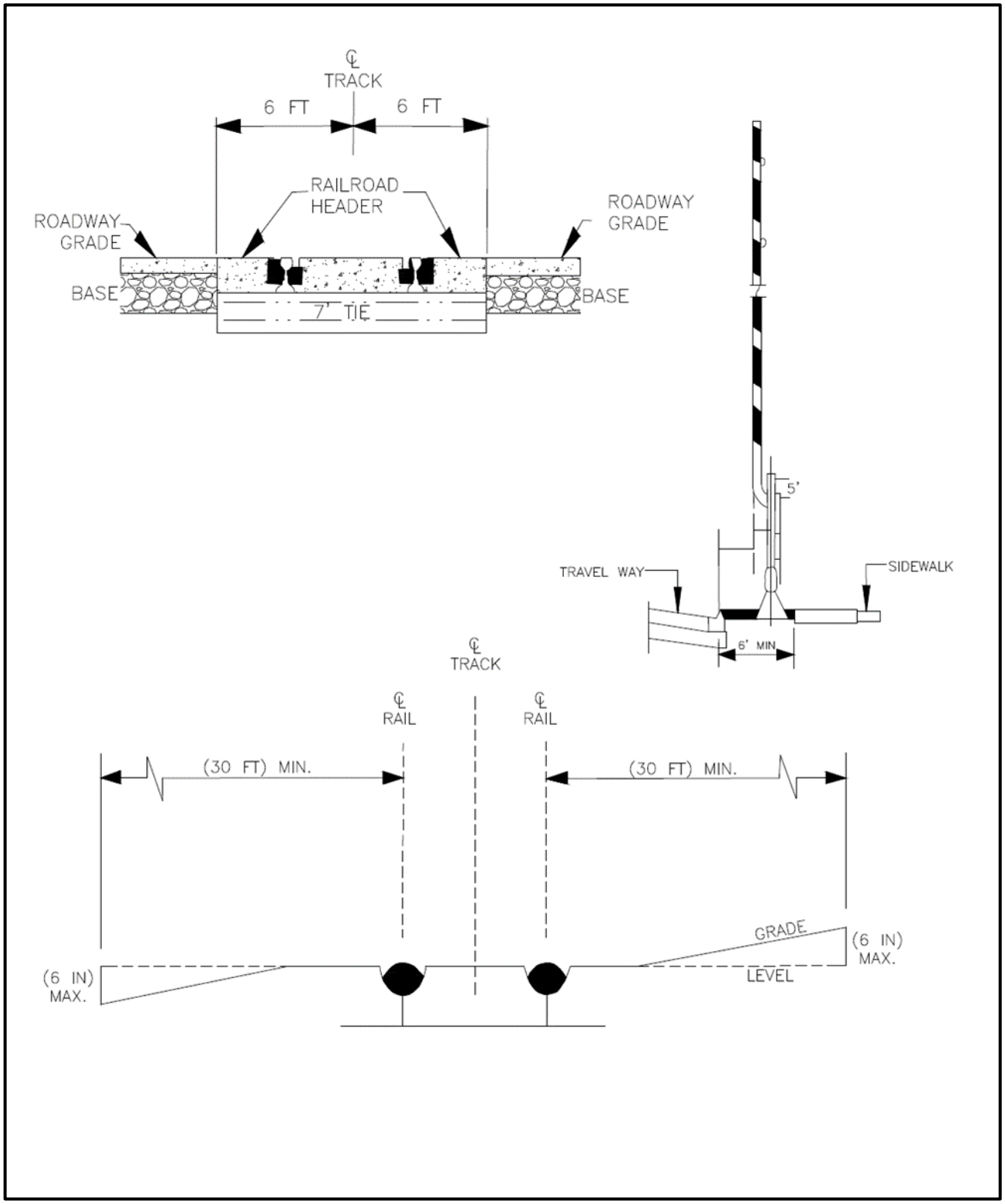


Figure 10.13~~10.13~~ - ~~STANDARD BUS PAD AND LANDINGS~~RAILROAD CROSSING

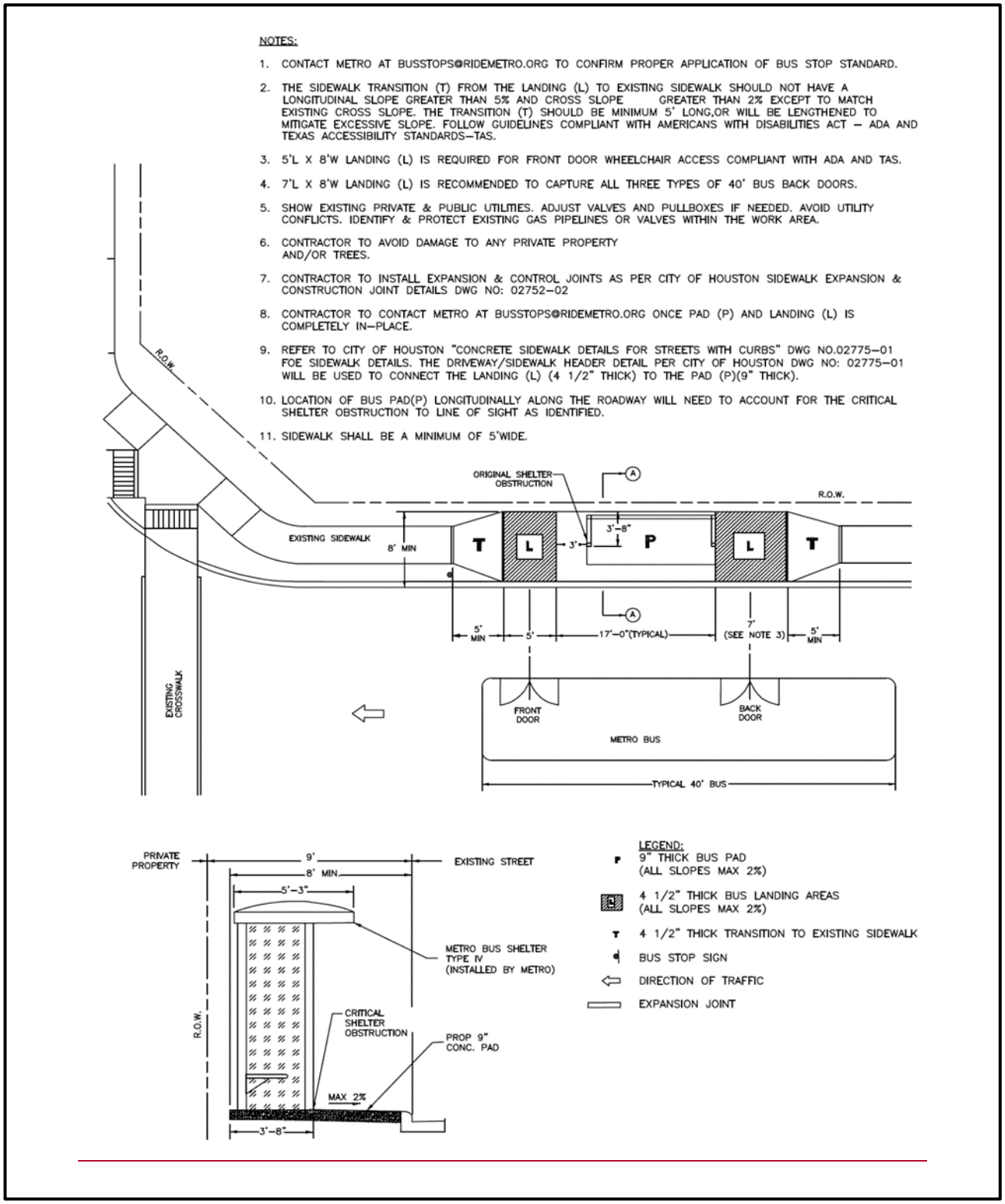


Figure 10.14 - STANDARD BUS PAD AND LANDINGS

APPENDIX ~~1~~2: STREET DESIGN MENU

~~CHAPTER 10~~

Appendix ~~1~~2 presents a "Street Design Menu" with examples of optional roadway corridor sections that are a result of the 2009 City of Houston Mobility Planning Study. Figure 1 is provided to cross reference the street classifications in the Major Thoroughfare and Freeway Plan to the corridor sections within the City Mobility Plan. These corridor sections can be utilized for development of roadway systems within the City limit of Houston. These roadway sections are not applicable in the ETJ of the City. The tables identify the right-of-way requirements and element dimensions associated with each corridor section.

The design engineer, in consultation with the City, shall determine the appropriate Multimodal Street Classification is applicable for each street using context sensitive design principles. While full right-of-way dedication may not be required under Chapter 42 of the City of Houston Code of Ordinances, it is expected that developer's utilizing these alternative sections will make available the necessary public right-of-way dimensions at no cost to the City of Houston.

NOTES

1. Sidewalk dimensions shown are options. Minimum sidewalk dimension for Transit Street designations and Major Thoroughfare is six ~~(6)~~ feet and five ~~(5)~~ feet for all others.

2. TW - Tree Wells will be considered for use in lieu of a green space dimension where shown in Tables.

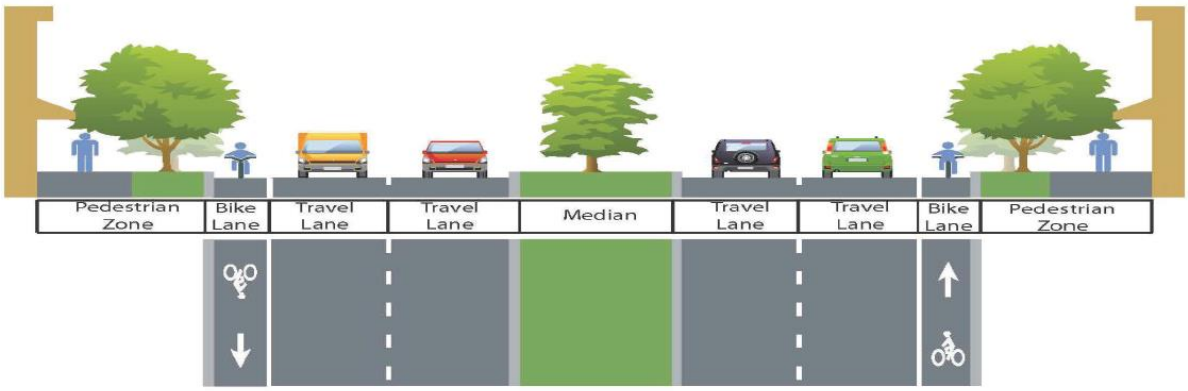
CITY MOBILITY PLAN (CMP)				MAJOR THOROUGHFARE AND FREEWAY PLAN (MTFP)				
MULTIMODAL STREET CLASSIFICATION				EXISTING CLASSIFICATION				
	Proposed Right-of-Way	Number of Lanes	Typical Design Avg Daily Traffic Vol (vpd)	Principal Thoroughfare	Thoroughfare	Major Collector	Minor Collector	Local Street
BOULEVARD								
Commercial	80' - 140'	4 - 8	15,000 - 80,000					
Mixed Use	80' - 140'	4 - 6	15,000 - 50,000					
Residential	80' - 120'	2 - 6	15,000 - 30,000					
Transit	120'	4 - 6	15,000 - 30,000					
Industrial	80' - 140'	4 - 6	15,000 - 50,000					
AVENUE								
Commercial	80' - 100'	2 - 4	1,500 - 30,000					
Mixed Use	80' - 100'	2 - 4	1,500 - 30,000					
Residential	80' - 100'	2 - 4	1,000 - 20,000					
Transit	100'	2	1,500 - 15,000					
Industrial	80' - 100'	3 - 5	5,000 - 35,000					
COUPLET								
Commercial	60' - 100'	2 - 5	1,000 - 45,000					
Mixed Use	60' - 100'	2 -5	1,000 - 45,000					
Residential	60' - 100'	2 -3	1,000 - 25,000					
Transit	60' - 100'	2 - 4	1,000 - 35,000					
Industrial	60' - 100'	2 - 5	1,000 - 45,000					
STREET								
Commercial	60'	2	1,000 -15,000					
Mixed Use	60'	2	1,000 - 15,000					
Residential	60'	2	500 - 5,000					
LOCAL STREET								
Residential Main	60' - 70'	2	≥ 1,500					
Residential High Density	55' - 65'	2	350 - 5,000					
Residential Std. Density	50' - 65'	2	250 - 5,000					

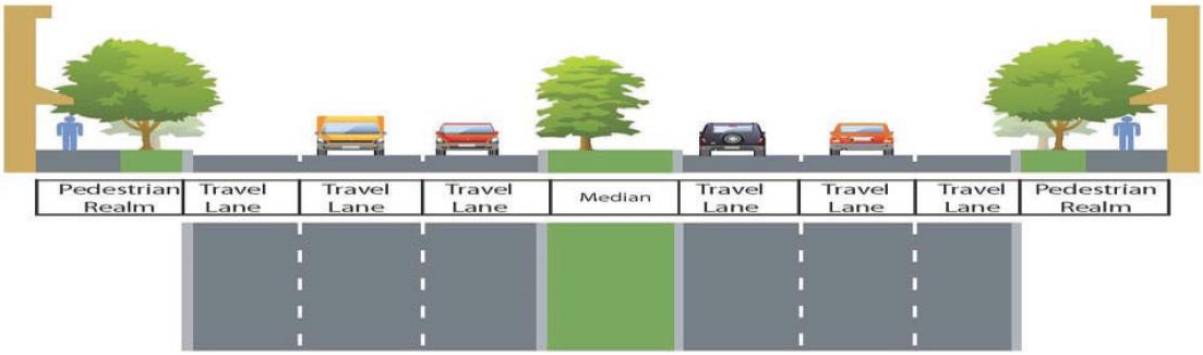
Indicates Shared Classification

Figure 1

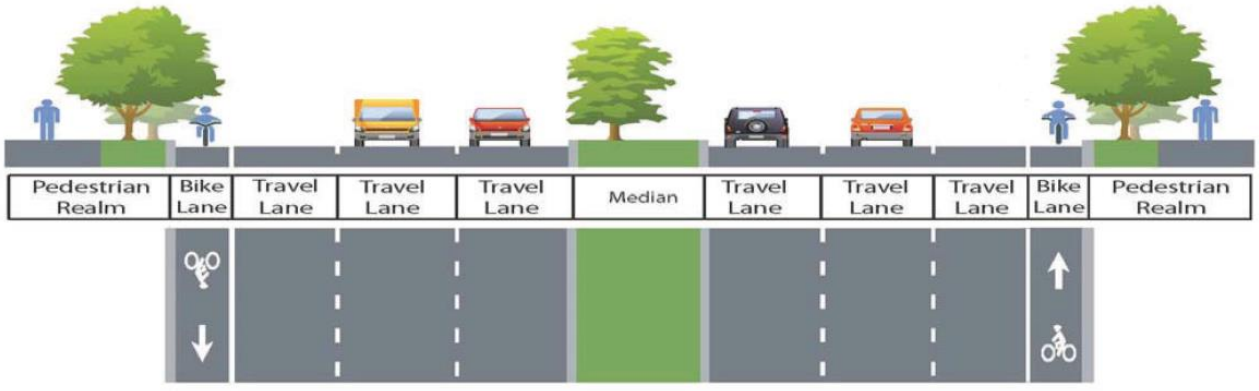
Commercial/Mixed Use Boulevard Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
80	2 x 10 = 20	TW	N/A	N/A	16	4 x 11 = 44	15,000 - 30,000
100	2 x 18 = 36	TW	N/A	N/A	20	4 x 11 = 44	15,000 - 30,000
	2 x 12 = 24	TW	N/A	2 x 6 = 12	20	4 x 11 = 44	15,000 - 30,000
	2 x 10 = 20	TW	2 x 8 = 16	N/A	20	4 x 11 = 44	15,000 - 30,000
	2 x 13.5 = 27	TW	N/A	2 x 6 = 12	17	4 x 11 = 44	15,000 - 30,000
	2 x 10 = 20	TW	N/A	N/A	14**	6 x 11 = 66	15,000 - 40,000
120	2 x 17 = 34	TW	N/A	N/A	20	6 x 11 = 66	15,000 - 30,000
	2 x 11 = 22	TW	N/A	2 x 6 = 12	20	6 x 11 = 66	15,000 - 30,000
	2 x 12.5 = 25	TW	N/A	2 x 6 = 12	17	6 x 11 = 66	15,000 - 30,000
	2 x 10.5 = 21	TW	2 x 8 = 16	N/A	17	6 x 11 = 66	15,000 - 30,000
140	2 x 16 = 32	TW	N/A	N/A	20	8 x 11 = 88	20,000 - 50,000
	2 x 11.5 = 23	TW	N/A	2 x 6 = 12	17	8 x 11 = 88	20,000 - 50,000

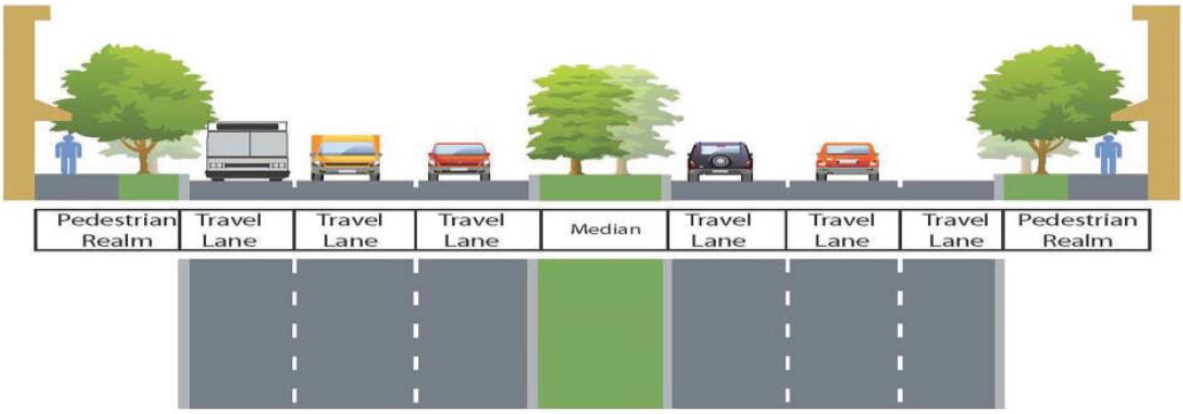
* - Minimum Sidewalk width is a minimum of 5 feet.
** - Not recommended. Requires the concurrence of the City Engineer and the City Traffic Engineer.



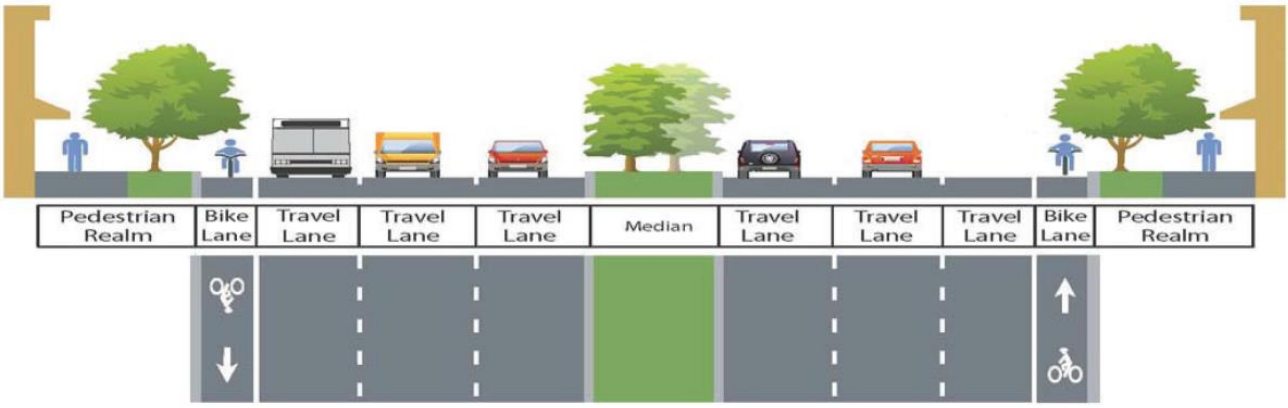


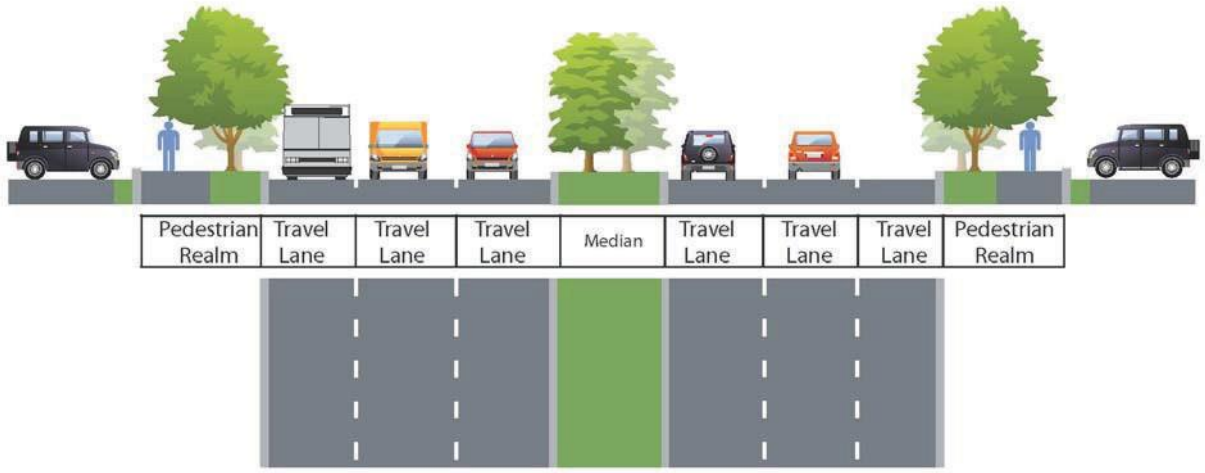
Residential Boulevard Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
80	2 x 11 = 22	TW	2 x 8 = 16	N/A	20	2 x 11 = 22	5,000 - 15,000
	2 x 13 = 26	TW	N/A	2 x 6 = 12	20	2 x 11 = 22	5,000 - 15,000
	2 x 10 = 20	TW	N/A	N/A	16	4 x 11 = 44	15,000 - 30,000
100	2 x 10 = 20	2 x 12.5 = 25	2 x 8 = 16	N/A	17	2 x 11 = 22	5,000 - 15,000
	2 x 10 = 20	2 x 14.5 = 29	N/A	2 x 6 = 12	17	2 x 11 = 22	5,000 - 15,000
	2 x 12 = 24	TW	N/A	2 x 6 = 12	20	4 x 11 = 44	15,000 - 30,000
	2 x 11.5 = 23	TW	2 x 8 = 16	N/A	17	4 x 11 = 44	15,000 - 30,000
120	2 x 10 = 20	2 x 12 = 24	N/A	2 x 6 = 12	20	4 x 11 = 44	15,000 - 30,000
	2 x 12.5 = 25	TW	N/A	2 x 6 = 12	17	6 x 11 = 66	15,000 - 50,000
	2 x 10 = 20	2 x 7 = 14	N/A	N/A	20	6 x 11 = 66	15,000 - 50,000
* - Minimum Sidewalk width is a minimum of 5 feet.							



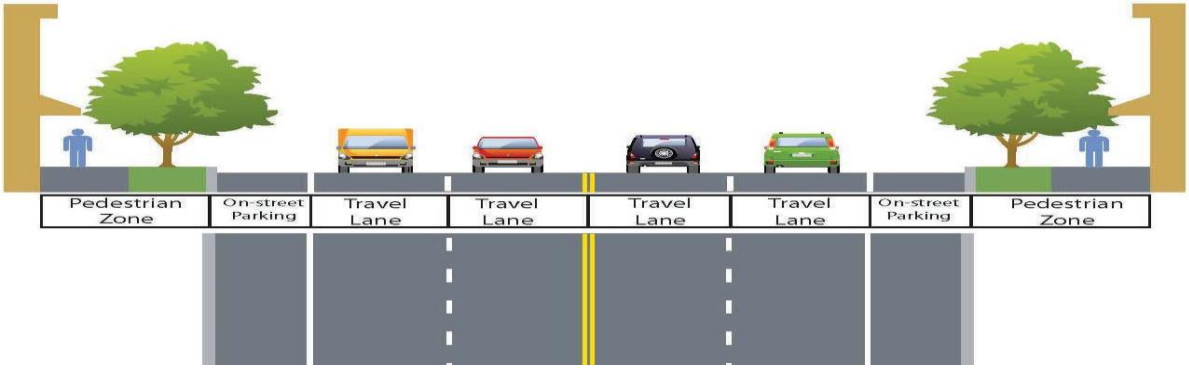


Transit Boulevard Designation							
Minimum R.O.W (feet)	**Pedestrian Realm* (feet)**	**Tree Well or Swale**	**On-Street Parking (feet)**	**Bike Lane (feet)**	**Median Width (ft)**	**Lane Widths (feet)**	**ADT (vpd)**
100	2 x 13 = 26	TW	N/A	N/A	28	2 x 12 = 24 2 x 11 = 22	15,000 - 30,000
110	2 x 18 = 36	TW	N/A	N/A	28	2 x 12 = 24 2 x 11 = 22	15,000 - 30,000
120	2 x 17 = 34	TW	N/A	2 x 6 = 12	28	2 x 12 = 24 2 x 11 = 22	15,000 - 30,000
	2 x 16 = 32	TW	N/A	N/A	20	2 x 12 = 24 4 x 11 = 44	15,000 - 40,000
* - Minimum Sidewalk width is a minimum of 6 feet.							

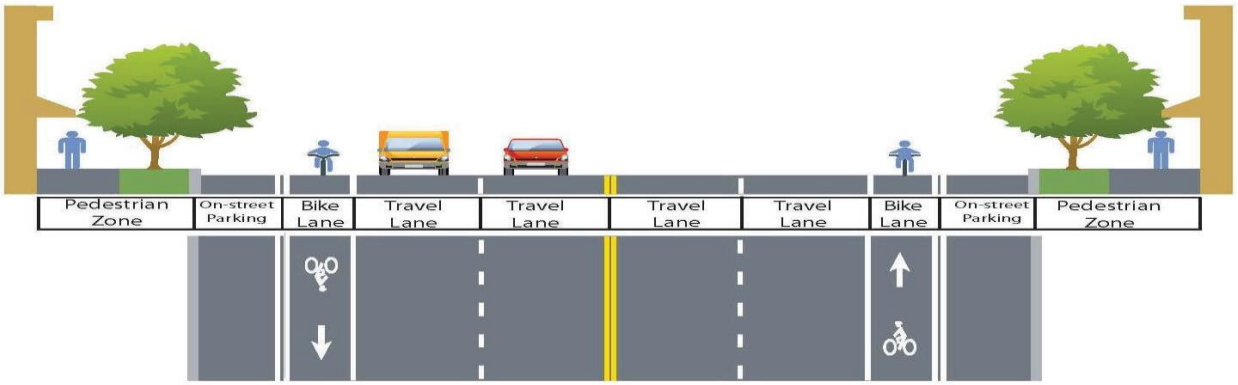


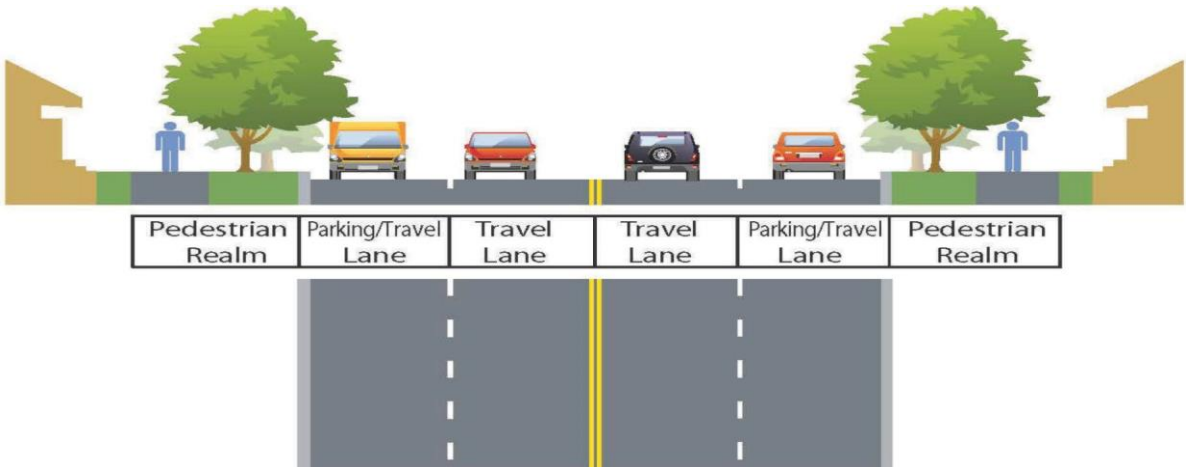


Industrial Boulevard Designation							
Minimum R.O.W (feet)	**Pedestrian Realm* (feet)**	**Tree Well or Swale**	**On-Street Parking (feet)**	**Bike Lane (feet)**	**Median Width (ft)**	**Lane Widths (feet)**	**ADT (vpd)**
100	2 X 17 = 34	TW	N/A	N/A	20	2 X 11 = 22 2 X 12 = 24	15,000 - 30,000
	2 X 11 = 22	TW	N/A	2 X 6 = 12	20	2 X 11 = 22 2 X 12 = 24	15,000 - 30,000
	2 X 10.5 = 21	TW	2 X 8 = 16	N/A	17	2 X 11 = 22 2 X 12 = 24	15,000 - 30,000
120	2 X 16 = 32	TW	N/A	N/A	20	4 X 11 = 44 2 X 12 = 24	15,000 - 50,000
	2 X 10 = 20	TW	N/A	2 X 6 = 12	20	4 X 11 = 44 2 X 12 = 24	15,000 - 50,000
* - Minimum Sidewalk width is a minimum of 5 feet.							



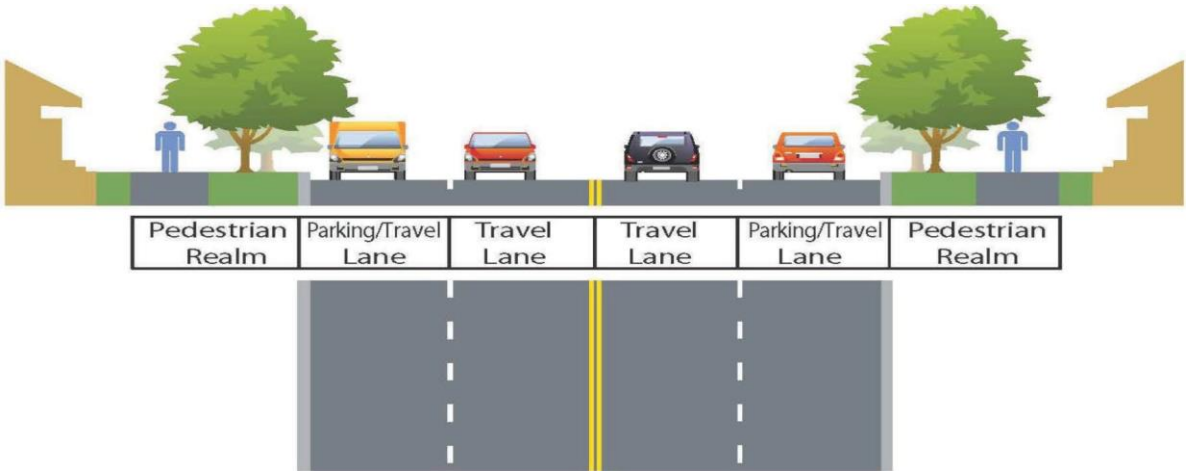
Commercial/Mixed Use Avenue Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
80	2 X 21 = 42	TW	2 X 8 = 16	N/A	N/A	2 X 11 = 22	1,500 - 15,000
	2 X 11 = 22	TW	2 X 18 = 36**	N/A	N/A	2 X 11 = 22	1,500 - 15,000
	2 X 15 = 30	TW	2 X 8 = 16	2 X 6 = 12	N/A	2 X 11 = 22	1,500 - 15,000
	2 X 15 = 30	TW	N/A	2 X 6 = 12	N/A	2 X 11 = 22	1,500 - 15,000
	2 X 22 = 44	TW	N/A	N/A	N/A	2 X 11 = 22 + 1 X 14 (CLTL***) = 36	5,000 - 20,000
	2 X 14 = 28	TW	2 X 8 = 16	N/A	N/A	2 X 11 = 22 + 1 X 14 (CLTL***) = 36	5,000 - 20,000
	2 X 16 = 32	TW	N/A	2 X 6 = 12	N/A	2 X 11 = 22 + 1 X 14 (CLTL***) = 36	5,000 - 20,000
	2 X 18 = 36	TW	N/A	N/A	N/A	4 x 11 = 44	10,000 - 30,000
	2 X 10 =20	TW	2 X 8 = 16	N/A	N/A	4 x 11 = 44	10,000 - 30,000
	2 X 12 = 24	TW	N/A	2 X 6 = 12	N/A	4 x 11 = 44	10,000 - 30,000
100	2 x 28 = 56	TW	N/A	N/A	N/A	4 x 11 = 44	10,000 - 30,000
	2 x 22 = 44	TW	N/A	2 x 6 = 12	N/A	4 x 11 = 44	10,000 - 30,000
	2 x 20 = 40	TW	2 x 8 = 16	N/A	N/A	4 x 11 = 44	10,000 - 30,000
	2 x 10 = 20	TW	2 x 18 = 36**	N/A	N/A	4 x 11 = 44	10,000 - 30,000
	2 x 14 = 28	TW	2 x 8 = 16	2 x 6 = 12	N/A	4 x 11 = 44	10,000 - 30,000
	2 x 17 = 34	TW	N/A	N/A	N/A	6 x 11 = 66	10,000 - 30,000
	2 x 11 = 22	TW	N/A	2 x 6 = 12	N/A	6 x 11 = 66	10,000 - 30,000
* - Minimum Sidewalk width is a minimum of 5 feet.							
** - Angle Parking. Requires permission from the City Traffic Engineer.							
*** - CLTL = Continuous Two-Way Left Turn Lane.							





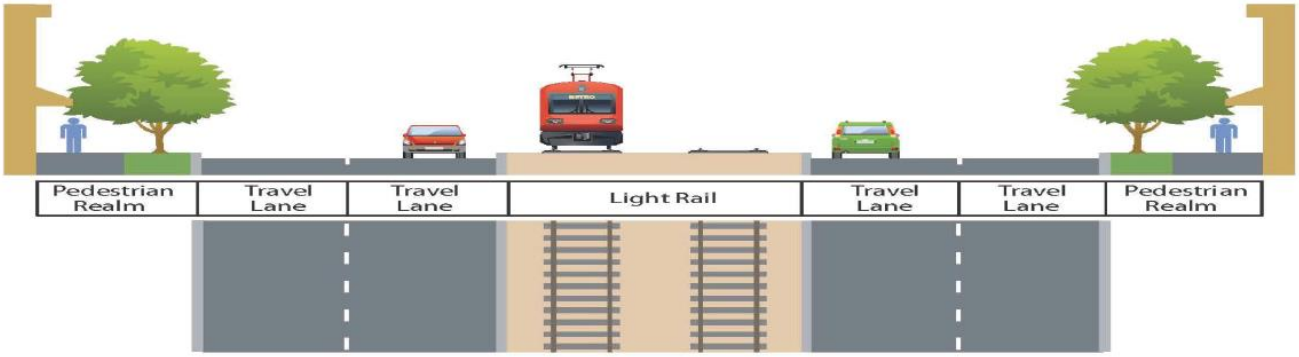
Transit Avenue Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
80	2 x 11 = 22	2 x 10 =20	2 X 8 = 16	N/A	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 8 = 16	2 x 7 = 14	2 X 8 = 16	2 X 6 = 12	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 13 = 26	2 x 10 = 20	N/A	2 X 6 = 12	N/A	2 X 11 = 22	1,000 - 10,000
	2 X 8 = 16	2 x 10 = 20	N/A	N/A	N/A	4 x 11 = 44	5,000 - 20,000
	2 X 10 =20	TW	2 X 8 = 16	N/A	N/A	4 x 11 = 44	5,000 - 20,000
	2 X 12 = 24	TW	N/A	2 X 6 = 12	N/A	4 x 11 = 44	5,000 - 20,000
100	2 x 18 = 36	2 x 10 = 20	N/A	N/A	N/A	4 x 11 = 44	5,000 - 20,000
	2 x 12 = 24	2 x 10 = 20	N/A	2 x 6 = 12	N/A	4 x 11 = 44	5,000 - 20,000
	2 x 10 = 20	2 x 10 = 20	2 x 8 = 16	N/A	N/A	4 x 11 = 44	5,000 - 20,000
	2 x 14 = 28	TW	2 x 8 = 16	2 x 6 = 12	N/A	4 x 11 = 44	5,000 - 20,000

* - Minimum Sidewalk width is a minimum of 5 feet.



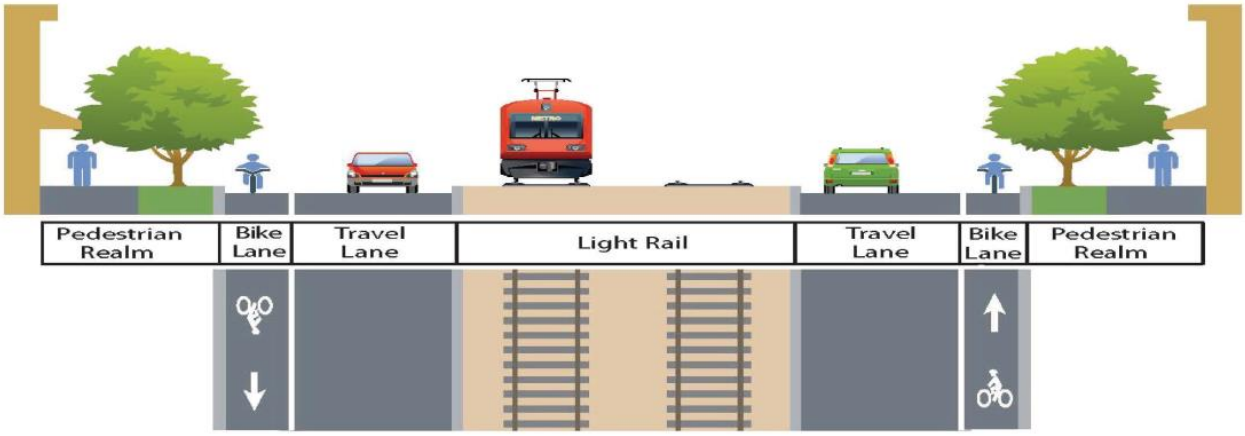
Residential Avenue Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
80	2 x 11 = 22	2 x 10 =20	2 X 8 = 16	N/A	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 8 = 16	2 x 7 = 14	2 X 8 = 16	2 X 6 = 12	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 13 = 26	2 x 10 = 20	N/A	2 X 6 = 12	N/A	2 X 11 = 22	1,000 - 10,000
	2 X 8 = 16	2 x 10 = 20	N/A	N/A	N/A	4 x 11 = 44	5,000 - 20,000
	2 X 10 =20	TW	2 X 8 = 16	N/A	N/A	4 x 11 = 44	5,000 - 20,000
	2 X 12 = 24	TW	N/A	2 X 6 = 12	N/A	4 x 11 = 44	5,000 - 20,000
100	2 x 18 = 36	2 x 10 = 20	N/A	N/A	N/A	4 x 11 = 44	5,000 - 20,000
	2 x 12 = 24	2 x 10 = 20	N/A	2 x 6 = 12	N/A	4 x 11 = 44	5,000 - 20,000
	2 x 10 = 20	2 x 10 = 20	2 x 8 = 16	N/A	N/A	4 x 11 = 44	5,000 - 20,000
	2 x 14 = 28	TW	2 x 8 = 16	2 x 6 = 12	N/A	4 x 11 = 44	5,000 - 20,000

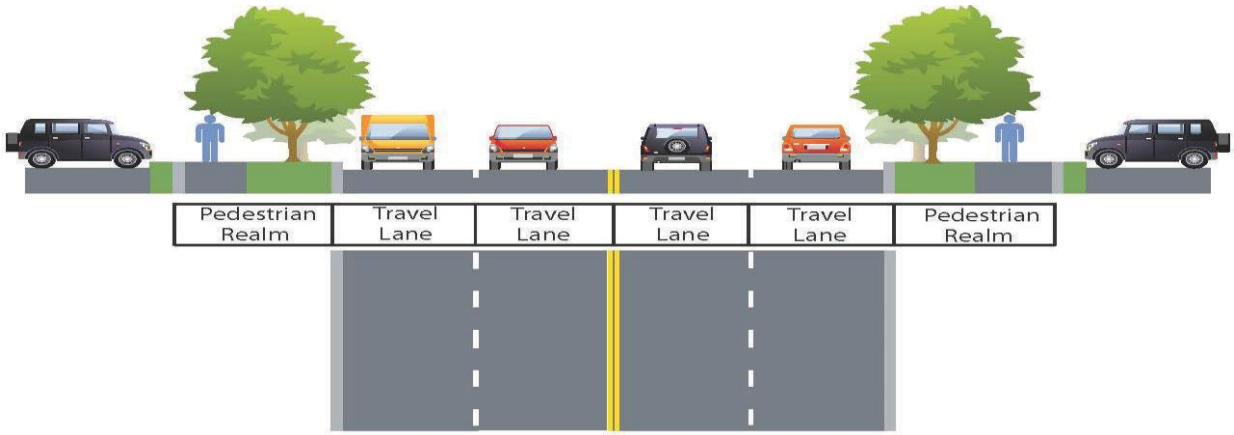
* - Minimum Sidewalk width is a minimum of 5 feet.



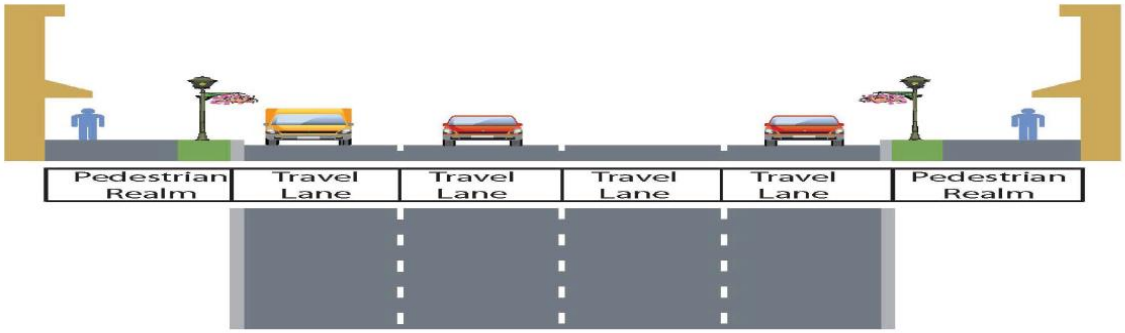
Transit Avenue Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Transit Lanes** (ft)	Lane Widths (feet)	ADT (vpd)
100	2 x 27 = 54	TW	N/A	N/A	2 x 12 = 24	2 x 11 = 22	1,000 - 15,000
	2 x 21 = 42	TW	N/A	2 x 6 = 12	2 x 12 = 24	2 x 11 = 22	1,000 - 15,000
	2 x 19 = 38	TW	2 x 8 = 16	N/A	2 x 12 = 24	2 x 11 = 22	1,000 - 15,000
	2 x 13 = 26	TW	2 x 8 = 16	2 x 6 = 12	2 x 12 =24	2 x 11 = 22	1,000 - 15,000

* - Minimum Sidewalk width is a minimum of 6 feet.
** - Transit lanes may be tranist vehicle onl or allow for mixed traffic.



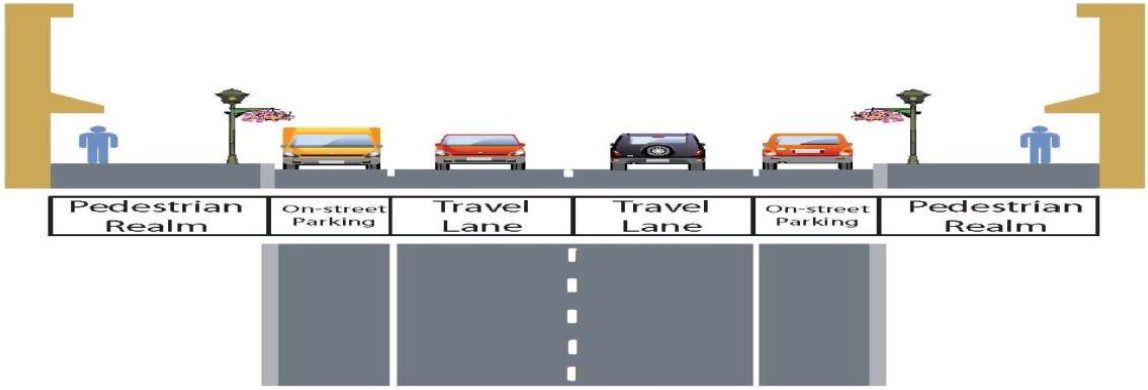


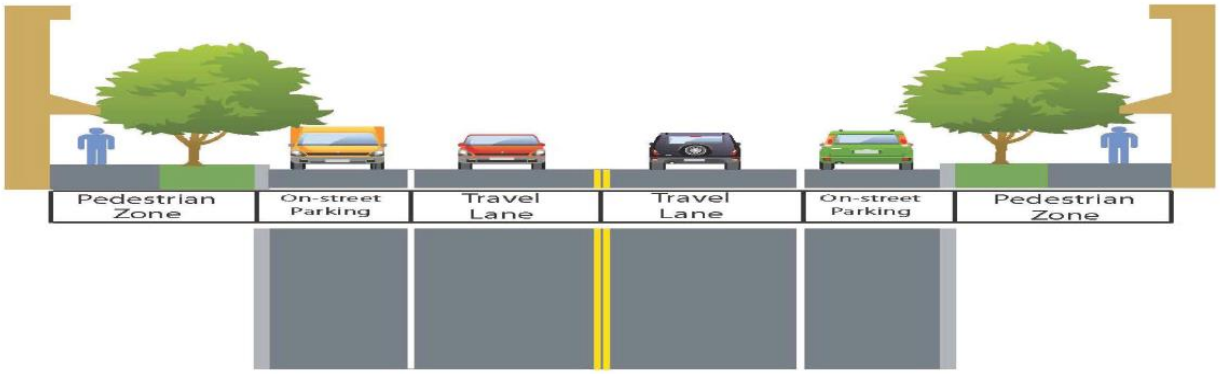
Industrial Avenue Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
80	2 x 10 = 20	2 x 7 = 14	N/A	N/A	N/A	2 x 11 + 2 x 12 = 46	10,000 - 25,000
	2 x 11 = 22	2 x 10 = 20	N/A	N/A	N/A	1 x 14(CLTL**) + 2 x 12 = 38	5,000 - 15,000
90	2 x 18 = 36	TW	2 x 8 = 16	N/A	N/A	1 x 14(CLTL**) + 2 x 12 = 38	5,000 - 15,000
100	2 x 10 = 20	2 x 10 =20	N/A	N/A	N/A	1x14(CLTL**)+ 2x12+2x11= 60	10,000 - 35,000
* - Minimum Sidewalk width is a minimum of 5 feet.							
** - CLTL = Continuous Two-Way Left Turn Lane.							



Commercial/Mixed Use Couplet Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
60	2 x 11 = 22	TW	2 X 8 = 16	N/A	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 13 = 26	TW	N/A	1 x 6 = 6	N/A	2 X 11 = 22	1,000 - 10,000
80	2 x 21 = 42	TW	2 X 8 = 16	N/A	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 23 = 46	TW	N/A	1 X 6 = 6	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 15 = 30	TW	2 x 8 = 16	1 X 6 = 6	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 15.5 = 31	TW	2 X 8 = 16	N/A	N/A	3 x 11 = 33	1,500 - 15,000
	2 x 17.5 = 35	TW	N/A	1 X 6 = 6	N/A	3 x 11 = 33	1,500 - 15,000
	2 x 9.5 = 19	TW	2 X 8 = 16	1 X 6 = 6	N/A	3 x 11 = 33	1,500 - 15,000
	2 x 10 = 20	TW	2 X 8 = 16	N/A	N/A	4 x 11 = 44	5,000 - 20,000
	2 X 12 = 24	TW	N/A	1 X 6 = 6	N/A	4 x 11 = 44	5,000 - 20,000
	2 x 12.5 = 25	TW	N/A	N/A	N/A	5 x 11 = 55	10,000 - 25,000
100	2 x 14 = 28	TW	2 x 8 = 16	1 x 6 = 6	N/A	4 x 11 = 44	5,000 - 20,000
	2 x 14.5 = 29	TW	2 x 8 = 16	N/A	N/A	5 x 11 = 55	10,000 - 25,000
	2 x 15.5 = 31	TW	N/A	1 x 6 = 6	N/A	5 x 11 = 55	10,000 - 25,000
	2 x 9.5 = 19	TW	2 x 8 = 16	1 x 5 = 5	N/A	5 x 11 = 55	10,000 - 25,000

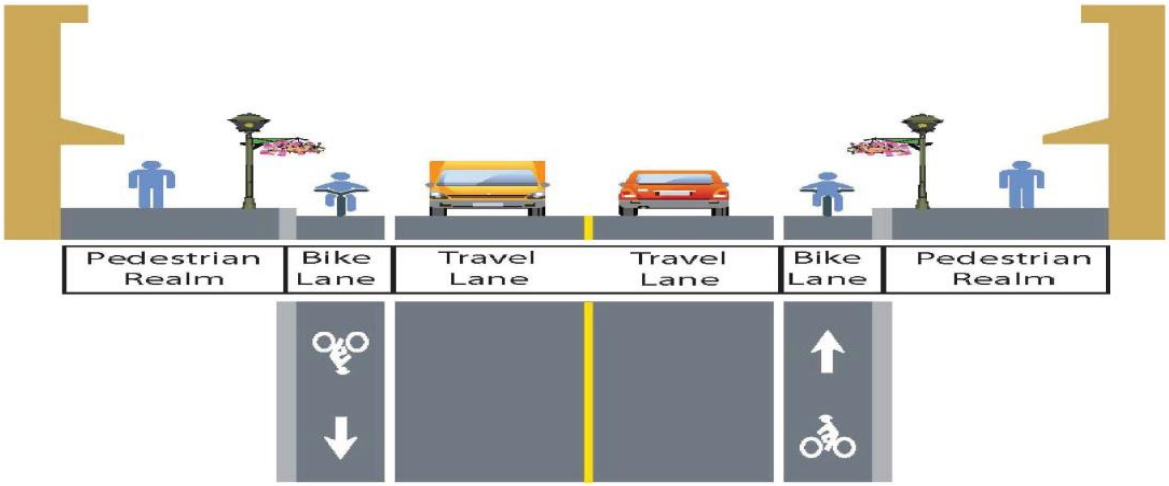
* - Minimum Sidewalk width is a minimum of 5 feet.

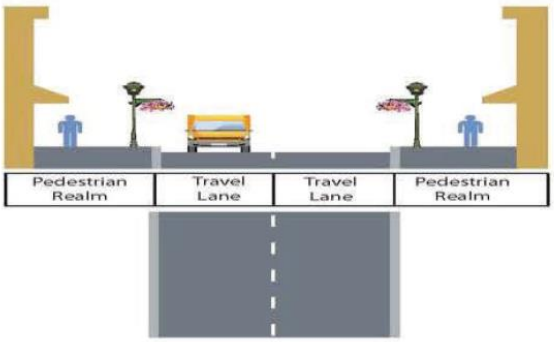


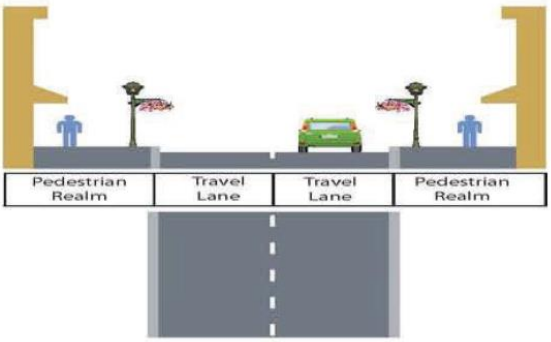


Commercial/Mixed Use Street Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
	2 x 19 = 38	TW	N/A	N/A	N/A	2 X 11 = 22	1,000 - 10,000
60	2 x 11 = 22	TW	2 X 8 = 16	N/A	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 13 = 26	TW	N/A	2 X 6 = 12	N/A	2 X 11 = 22	1,000 - 10,000
	2 X 12 = 24	TW	N/A	N/A	N/A	2 X 11 = 22 + 1 X 14 (CLTL**) = 36	1,000 - 15,000

* - Minimum Sidewalk width is a minimum of 5 feet.
** - CLTL = Continuous Two-Way Left Turn Lane.

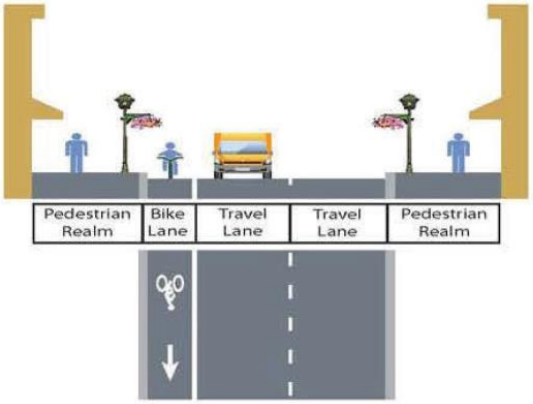


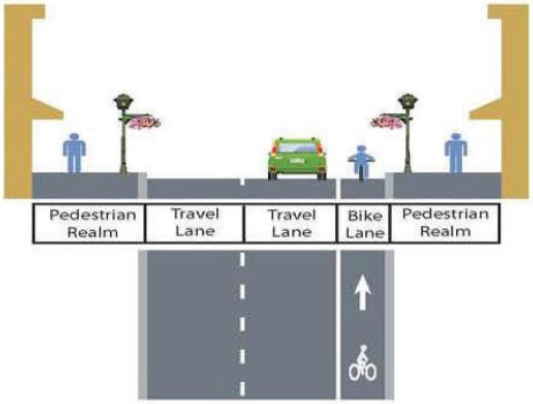


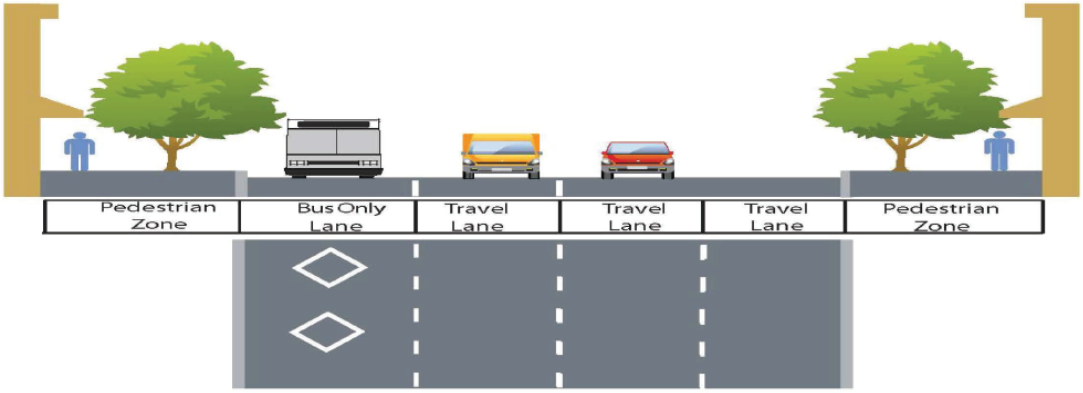


Residential Couplet Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
60	2 x 11 = 22	TW	2 X 8 = 16	N/A	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 13 = 26	TW	N/A	1 x 6 = 6	N/A	2 X 11 = 22	1,000 - 10,000
80	2 x 10 = 20	2 x 10.5 = 21	2 X 8 = 16	N/A	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 10 = 20	2 x 13 = 26	N/A	1 X 6 = 6	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 15 = 30	TW	2 x 8 = 16	1 X 6 = 6	N/A	2 X 11 = 22	1,000 - 10,000
	2 x 15.5 = 31	TW	2 X 8 = 16	N/A	N/A	3 x 11 = 33	1,500 - 15,000
	2 x 17.5 = 35	TW	N/A	1 X 6 = 6	N/A	3 x 11 = 33	1,500 - 15,000
	2 x 9.5 = 19	TW	2 X 8 = 16	1 X 6 = 6	N/A	3 x 11 = 33	1,500 - 15,000
	2 x 9.5 = 19	TW	2 X 8 = 16	1 X 6 = 6	N/A	3 x 11 = 33	1,500 - 15,000

* - Minimum Sidewalk width is a minimum of 5 feet.

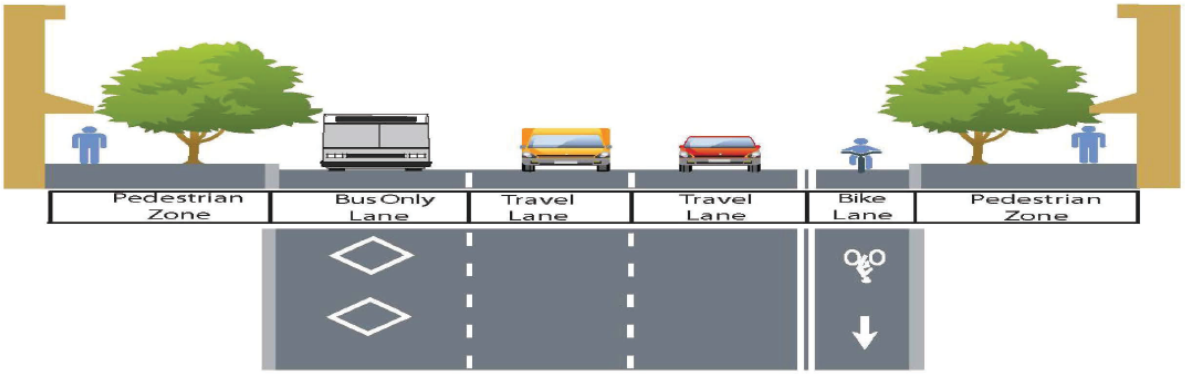


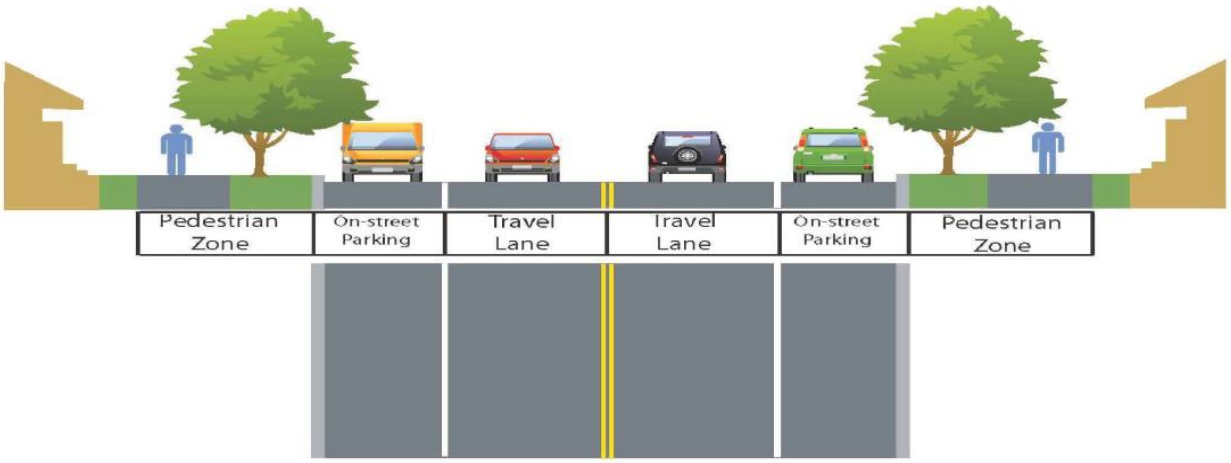




Transit Couplet Designation							
Minimum R.O.W (feet)	**Pedestrian Realm* (feet)**	**Tree Well or Swale**	**On-Street Parking (feet)**	**Bike Lane (feet)**	**Median Width (ft)**	**Lane Widths (feet)**	**ADT (vpd)**
60	2 x 10.5 = 21	TW	2 X 8 = 16	N/A	N/A	1 x 12 + 1 X 11 = 23	1,000 - 10,000
	2 x 12.5 = 25	TW	N/A	1 x 6 = 6	N/A	1 x 12 + 1 X 11 = 23	1,000 - 10,000
80	2 x 20.5 = 41	TW	2 X 8 = 16	N/A	N/A	1 x 12 + 1 X 11 = 23	1,000 - 10,000
	2 x 22.5 = 45	TW	N/A	1 X 6 = 6	N/A	1 x 12 + 1 X 11 = 23	1,000 - 10,000
	2 x 14.5 = 29	TW	2 x 8 = 16	1 X 6 = 6	N/A	1 x 12 + 1 X 11 = 23	1,000 - 10,000
	2 x 15 = 30	TW	2 X 8 = 16	N/A	N/A	1 x 12 + 2 x 11 = 34	1,500 - 15,000
	2 x 17 = 34	TW	N/A	1 X 6 = 6	N/A	1 x 12 + 2 x 11 = 34	1,500 - 15,000
	2 X 11.5 = 23	TW	N/A	1 X 6 = 6	N/A	1 x 12 + 3 x 11 = 45	5,000 - 20,000
	2 x 12 = 24	TW	N/A	N/A	N/A	5 x 11 = 55	10,000 - 25,000
100	2 x 13.5 = 27	TW	2 x 8 = 16	1 x 6 = 6	N/A	1 x 12 + 3 x 11 = 45	5,000 - 20,000
	2 x 14 = 28	TW	2 x 8 = 16	N/A	N/A	1 x 12 + 4 x 11 = 56	10,000 - 25,000

* - Minimum Sidewalk width is a minimum of 6 feet.

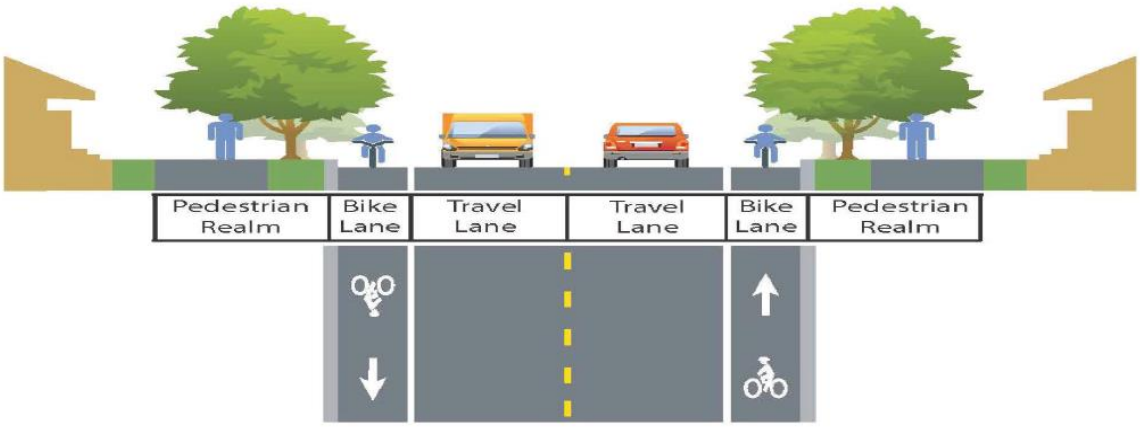




Residential Street Designation							
Minimum R.O.W (feet)	Pedestrian Realm* (feet)	Tree Well or Swale	On-Street Parking (feet)	Bike Lane (feet)	Median Width (ft)	Lane Widths (feet)	ADT (vpd)
50	2 x 12 = 24	TW	N/A **	N/A	N/A	2 x 13 = 26	500 - 5,000
60	2 x 9 = 18	2 x 8 = 16	N/A **	N/A	N/A	2 X 13 = 26	500 - 5,000
	2 x 11 = 22	TW	2 X 8 = 16	N/A	N/A	2 X 11 = 22	500 - 5,000
	2 x 13 = 26	TW	N/A	2 X 6 = 12	N/A	2 X 11 = 22	500 - 5,000

* - Minimum Sidewalk width is a minimum of 5 feet.

** - While space is not specifically set aside for parking, parking may be allowed on a 26' wide residential street.



City of Houston

Design Manual

Chapter 12

STREET CUT REQUIREMENTS

Chapter 12
Table of Contents

Street Cut Requirements

SECTIONS PAGE

Chapter 12

STREET CUT REQUIREMENTS

SECTION 1 – STREET CUT REQUIREMENTS OVERVIEW

~~12.01~~12.1.01 CHAPTER INCLUDES

12.1.01.A Criteria for street pavement cuts, excavation, backfill, and pavement restoration in Public Ways.

12.1.01.B This chapter applies to excavation ~~under paved surfaces~~ in Public Ways which have been improved for street, sidewalk, surface drainage, or related public transportation infrastructure.

~~12.02~~12.1.02 REFERENCES

12.1.02.A Refer to the list of references in Chapter 1, General Requirements.

12.1.02.B Rules and Regulations for Excavation in Public Way~~City of Houston Procedural Guidelines for Planning and Permitting of Excavations in Public Ways, latest revision.~~

12.1.02.C City of Houston

12.1.02.D City of Houston Street Cut Ordinance

12.1.02.E City of Houston Standard Details

~~12.05.L.~~

~~12.03~~12.1.03 DEFINITIONS

~~A.~~12.1.03.A Excavation - An activity that disturbs, alters, or penetrates any portion of the public way that has been improved for street, driveway, sidewalk, surface drainage, or related public transportation infrastructure purposes. The term includes but is not limited to cutting, tunneling, jacking and boring, backfilling, restoring, and repairing the public way. The term does not include a transportation improvement or maintenance of publicly owned utility systems, such as water and wastewater lines and facilities.

~~B.~~12.1.03.B Backfill - Excavation fill material that meets city specified quality requirements or the placement thereof.

~~C.~~12.1.03.C Facility - Any structure device ~~or other thing whatsoever~~improvements that may be installed or maintained in, or, within, under, over or above a public way by an excavation.

~~D.~~12.1.03.D Five - Year CIP - Street improvement projects included in a Capital

Improvement Program by the City of Houston, Harris County, METRO, TxDOT, or other organization for construction.

~~E.~~12.1.03.E Hole - Excavation in the Public Way with the excavation having a length less than the width of the pavement.

~~A.~~12.1.03.F Patch - Method of pavement replacement that is temporary in nature. A patch consists of: (1) the compaction of the subbase and aggregate base, and (2) the replacement, in kind, of the existing pavement for a minimum of two feet beyond the edges of the excavation in all directions. ~~A patch is full restoration only when the pavement is included in the City of Houston's Five Year Capital Improvement Plan.~~

~~B.~~12.1.03.G Public Way - Any public street right-of-way located in the city, including the entire area between the boundary lines of every way (including but not limited to roads., streets, alleys, highways, boulevards, bridges, tunnels, or similar thoroughfares), whether acquired by purchase, grant, or dedication and acceptance by the ~~city~~ City or by the public that has been opened to use of the public for purpose of vehicular travel.

~~C.~~12.1.03.H Restoration - The process by which an excavated public way and surrounding area, including pavement and foundation, is returned to the same condition or better that existed before excavation.

~~D.~~12.1.03.I Trench - An excavation in the pavement with the excavation having length equal to or greater than the width of the pavement.

SECTION 2 – STREET CUT DESIGN REQUIREMENTS

~~12.04~~12.2.01 DESIGN REQUIREMENTS

12.2.01.A ~~1.~~ Design project so that restoration returns public way to the same or better condition that existed prior to excavation. ~~Base minimum limits and methods required for restoration on City Standard Details.~~Minimum limits and methods for pavement restoration shall be in accordance with City Standard Details 02951-01, 02951-02, 02951-03, 02902-01, and 02902-02.

12.2.01.B Comply with requirements ~~of 6.08A, Open Cut Construction in Street Pavement,~~ for all open-cut construction including excavation for auger or directional drilling insertion pits.

1. Saw cut existing pavements along lines parallel to and perpendicular to traveled way center lines unless otherwise approved by the City Engineer.

2. For concrete pavements and for Hot Mix Asphaltic Concrete (HMAC), conform to requirements of the City of Houston Infrastructure Design Manual, Chapter 10 – Street Paving Design, paragraph 10.2.02 and Section 3 – Geometric Design Requirements. ~~, conform to requirements of Paragraphs 10.04, K., 5., 10., and 11.~~

3. Construction documents shall require that one lane of traffic be open at all times with a flagman and work zone signage at both ends of the construction unless otherwise provided on an approved traffic control plan.

~~2.~~4. For open-cut construction in street pavement, the drawings shall call for secured steel plate to be placed over open-cut sections whenever the contractor is not working within the open-cut area so that traffic will have full use of the roadway.

12.2.01.C Prepare plan view drawings for all excavations that identify and locate existing underground facilities. The drawings, or verification statements, shall confirm that the underground facilities have been identified, located, and marked by the following organizations:

1. Texas Underground Facility Notification Corporation,

2. City of Houston Public Utilities ~~(water and sewer),~~Division and

3. City of Houston Traffic ~~Signal Section~~Operations Division.

12.2.01.D The City may require Plan and Profile drawings for complex projects or when the constructing agency has demonstrated previous non-compliance with underground facility location procedures.

12.2.01.E Plan view drawings shall be in accordance with Chapter 3 – Graphic

Requirements in the City of Houston Infrastructure Design Manual.~~show, at a minimum, the following information for the project area:~~

~~0. Topographical features.~~
~~0. Existing public and private utilities.~~
~~0. Significant landscaping or other structures which might impact construction or construction related activities.~~
~~0. Location and dimensions of proposed surface cuts.~~
~~0. Location and depth of existing and proposed mains, cables, conduits, switches, and related equipment and facilities.~~
~~0. Use baseline offsets from property lines, centerline of the public way, or curb lines; or a coordinate system acceptable to the City.~~

~~12.2.01.L~~12.2.01.F Final drawings shall include a list of City of Houston Standard Specifications and related standard details for excavation, bedding, backfilling, and pavement repair and resurfacing.

~~12.05~~12.2.02 QUALITY ASSURANCE

12.2.02.A For projects which include conduits, duct banks or pipelines over one~~1",~~ inch, have final design drawings sealed, signed, and dated by the Professional Engineer responsible for development of the drawings.

END OF CHAPTER

City of Houston

Design Manual

Chapter 15

TRAFFIC AND SIGNAL DESIGN REQUIREMENTS

Chapter 15

TRAFFIC AND SIGNAL DESIGN REQUIREMENTS

15.01 CHAPTER INCLUDES

A. Criteria for the design of traffic and signal requirements.

15.02 REFERENCES

A. Refer to the reference lists in Chapter 1 - General Requirements and Chapter 10 – Street Paving Design Requirements

B. Roundabout Informational Guide, Current Edition

C. Signal Timing Manual, Current Edition

D. Trip Generation, Current Edition (An ITE Informational Report, Institute of Transportation Engineers, Washington, D.C.)

E. TxDOT Traffic Signal Manual, Current Edition

F. City of Houston, Standard Details, Current Edition

G. City of Houston, Standard Specifications, Current Edition

15.03 DEFINITIONS

A. **Access Management** is the systematic control of the location, spacing, design and operation of driveways, median openings, intersections, bike lanes, and auxiliary lanes.

B. **ADT** is the average daily traffic volume. It represents the total two-way traffic on a street for some period less than a year, divided by the total number of days it represents, and includes both weekday and weekend traffic. Usually, ADT is adjusted for day of the week, seasonal variations, and/or vehicle classifications.

C. **Auxiliary Lane** is a lane striped for use as an acceleration lane, deceleration lane, right-turn lane, or left-turn lane, but not for through traffic use.

D. **Central Business District** shall mean the area bounded by Interstate Highway 45, United States Highway 59, and Interstate Highway 10.

E. **Connection Spacing** is the distance between connections, which is measured along the edge of the traveled way from the closest edge of pavement of the first access connection to the closest edge of pavement of the second access connection.

F. **Corner Clearance** is the distance along the edge of the traveled way from the closest edge of pavement of the intersecting public or private street to the closet edge of pavement of the nearest driveway.

G. **Design Exception** shall mean any City Engineer approved variation from the design requirements listed in this chapter.

H. **Driveway** is an access connection constructed within the public right-of-way, used to connect a public or private street with adjacent property.

I. **Driveway Permit** - Permit issued by the Building Official based upon Section 3110.4 of the Houston Amendments to the 2006 International Building Code or latest revisions. Driveway permits for access to Freeways, Highways, Frontage Roads, Tollways and Farm to Market Roads are not under the jurisdiction of the City of Houston. Driveway approvals from the appropriate agency with jurisdiction is required with building permit application.

J. **Intersection Limits** shall mean the functional portion of the intersection and shall be defined as the extent or limit of turning bays unless otherwise defined by the City Engineer.

K. **Joint Access** See "Shared Access"

L. **Major Activity Center** shall mean those areas designated as Major Activity Centers pursuant to Section 42-274 of the Code of Ordinances of the City of Houston, Texas.

M. **Median** is the portion of a divided street separating opposing traffic flows. A median may be traversable or nontraversable.

N. **Shared Access** is a single connection serving two or more adjoining lots or parcels.

O. **Sight Distance** is the distance visible to the driver of a passenger vehicle measured along the normal travel path of a street from a designated vehicle location and to a specified height above the street when the view is unobstructed by traffic. Refer to AASHTO, Geometric Design of Highways and Streets (Current Edition), for application to specific design needs such as stopping sight distance, other sight requirements.

P. **Storage Lane Length** is the portion of an auxiliary lane required to store the number of vehicles expected to accumulate in the lane.

Q. **Transit Corridor** is a road along a rail corridor (non-freight) designated on the Major Thoroughfare and Freeway Plan with definition defined in Chapter 42, Code of Ordinances.

15.04 TRAFFIC STUDIES FOR SITE DEVELOPMENT

A. APPLICABILITY

1. Two levels of traffic studies are identified and are dependent upon specific site location conditions, adjacent street configurations/capacities and traffic generation rates for proposed development. These studies are referred to as "Access Management Data" and "Traffic Impact Studies (TIA)". Figure 15.04.01 provides an overview of the submittal and review process.

2. For each proposed development or redevelopment, an Access Management Data Summary Form must be submitted.
Access Management Form provides general property information and an initial estimate of traffic volumes associated with the property.

3. Exceptions to the requirements for the submittal of Access Management Data Summary Form include:

   a. Construction, reconstruction, remodel or additions to a single family residence.

   b. Remodel of commercial developments with no change in use and/or size.

4. In addition to filing the Access Management Date Form, a Traffic Impact Analysis may be required.

   a. If the proposed development or redevelopment generates 100 or more new peak hour trips (PHT), the Analysis Engineer should meet with the City to determine the requirement for a Traffic Impact Study.

   b. If after discussion with the City, a Traffic Impact Study is required, the extent of the area to be studied will be determined.

   c. If an applicant submits a development plat application or building permit application for new development or redevelopment, the applicant may voluntarily submit a TIA to support the trip generation rates and access management needs to the adjacent street system for the proposed project.

5. The City may ask for a technical memorandum in lieu of a full Traffic Impact Analysis (TIA). The technical memo shall be submitted when the proposed development generates 80 vph -120 vph during AM or PM peak hours, utilizing the trip generation rates in the latest edition of the Traffic Generation Manual. The technical memo shall address the immediate intersection(s) to the proposed development. The intersection(s) to be included in the technical memorandum shall be decided by the City. The memorandum shall address the studies intersection(s) in terms of:

   a. Existing traffic counts (turning movements and 24-hour counts)

b. Existing signal timing

c. The Intersection geometric layout including:
   (1) Number of lanes for each approach
   (2) Lane width
   (3) Medians widths and median openings locations
   (4) Existing driveways location near the proposed development
   (5) Signage and lane marking

d. Existing operation performance using SYNCHRO or HCM compatible software packages

e. Number of trips generated by the proposed development

f. The impact of the proposed development on the intersection(s) traffic operation performance under the existing conditions (using SYNCHRO or HCM compatible software packages)

g. The proposed mitigation measures including but not limited to:
   (1) Changing lane usage and marking
   (2) Changing geometric and/or layout
   (3) Changing traffic control type
   (4) Adding lanes

h. The impact of the proposed mitigation measures on the intersection traffic operation performance (using SYNCHRO or HCM compatible software packages).

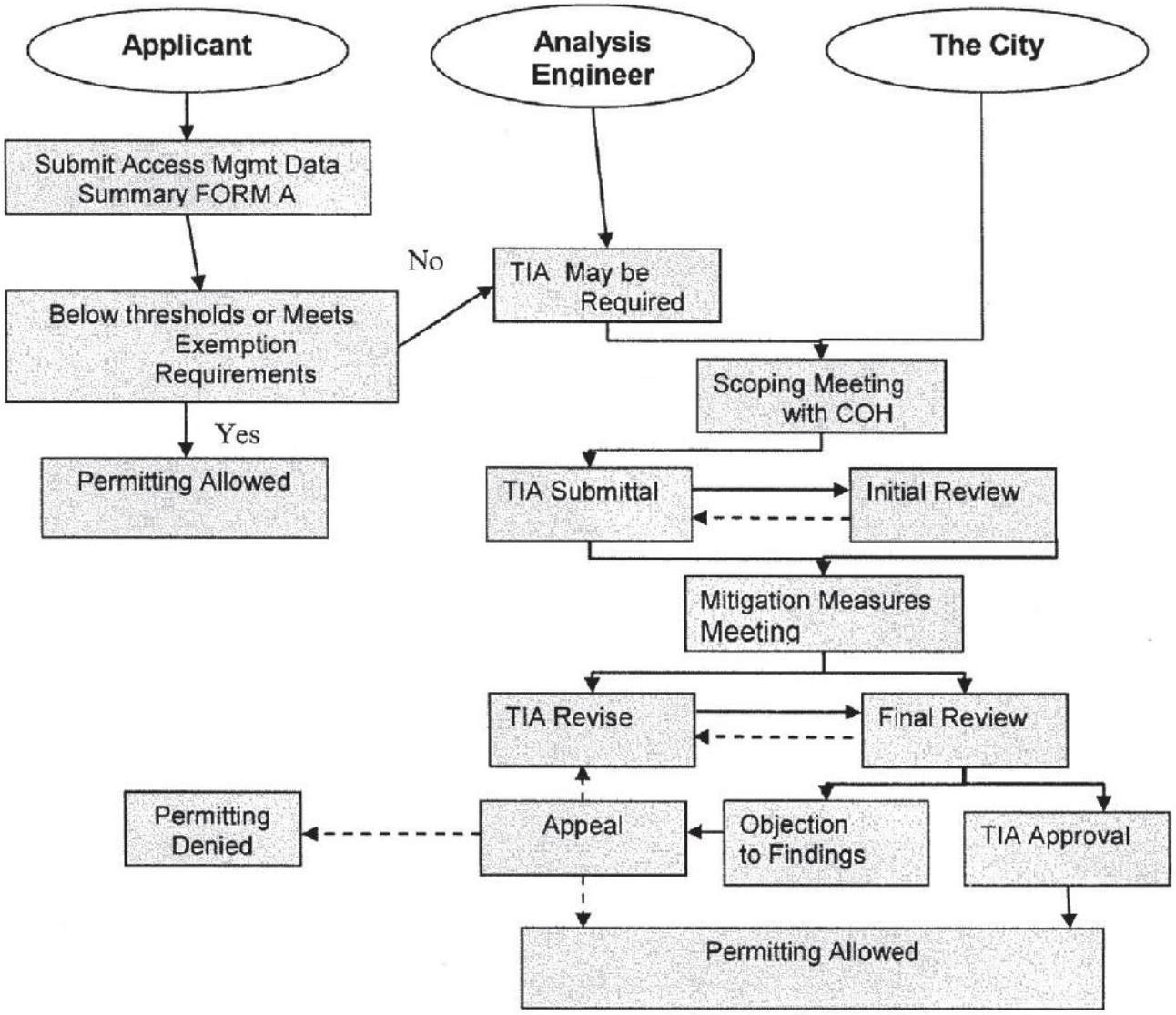


Figure 15.04.01 Overview of Traffic Impact Analysis Process

HOUSTON PUBLIC WORKS

City of Houston
Access Form

Project Name: _____ **Project Number:** _____

Critical Item:

An Access Form is required for all commercial developments with the exception of developments with no change in use and/or size. Alterations to roadway access points **may result in significant site plan revisions.** For this reason, Access Forms should be submitted prior to or during plat submittal. If platting is not required, this form shall be approved prior to submitting plans for permitting.

Background:

This Access Form provides general property information and initial estimates of traffic volumes associated with the property. Chapter 15 of the City of Houston Infrastructure Design Manual (IDM) requires all commercial properties to submit an Access Form and a Traffic Impact Analysis (TIA) (if applicable). Exceptions to the submittal of an Access Form are:

a) Construction, reconstruction, remodel or additions to a single family residence.
b) Remodel of commercial developments with no change in use and/or size.

Furthermore, existing driveways in the right of way are not grandfathered.

Instructions:

This Access Form must be completely filled and submitted to PWEACCESSFORM@HOUSTONTX.GOV for review. It **must** be accompanied by a dimensioned site plan layout with driveway locations indicating the extent of the access which the commercial property has or (is planned) to access public streets. On-site traffic related features (loading docks, emergency lanes, and driveway entrance/exits) must be depicted on the site plan.

CESS MANAGEMENT DATA FORM

Access Form

Project Name: _____ **Project Number:** _____

Project Address: _____

Applicant: _____

Telephone: _____ Email: _____

☐ **I have read and understand all items on page 1 of this Access Form (Check mark and initials are required to start review)**	**Initials:** _____

EXISTING DEVELOPMENT (IF FUNCTIONAL):

Tract Number: _____ Tract Size: _____

Building Sq. Ft.	Land Use Description & I.T.E Code	Trip Rate		Peak Hour Trips		Average Daily Traffic Rate	Average Daily Traffic
		AM	PM	AM	PM		
Total							

PROPOSED DEVELOPMENT (NEW ADDED TRIPS):

Tract Number: _____ Tract Size: _____

NET NEW ADDED TRIPS:	

Building Sq. Ft.	Land Use Description & I.T.E Code	Trip Rate		Peak Hour Trips		Average Daily Traffic Rate	Average Daily Traffic
		AM	PM	AM	PM		
Total							

ABUTTING ROADWAYS:

Street Name	Number of Driveways	R.O.W Width	Pavement Width

Access Form

Project Name: _____ **Project Number:** _____

FOR OFFICE USE ONLY:

☐ The Office of City Engineer (OCE) has reviewed the Access Form provided for this project. At this time, the OCE has no objection to permitting for driveway access on the basis of vehicle trips generated by this development. **(Please provide a copy of this form with your permit documents.)**

However, this statement of no objection does not supersede requirements to comply with geometric design standards, codes and ordinances pertaining to median opening/modifications, driveways, auxiliary lane and other roadway improvements. All geometric design modifications must be approved by the Office of the City Engineer.

Reviewed by: _____ Date: _____

☐ At this time, a Technical Memorandum is required in lieu of a full Traffic Impact Analysis (TIA). The technical memo shall be submitted when the proposed development generates 80 vph -120 vph during AM or PM peak hours, utilizing the trip generation rates in the latest edition of the Traffic Generation Manual.

(If additional concerns arise through the review of a Technical Memorandum, the City of Houston may request a full Traffic Impact Study.)

☐ A Traffic Impact Analysis is required. The Analysis Engineer should meet with the City to determine the scope for a Traffic Impact study and the extent of the study area.

	Traffic Impact Category	Site Traffic Thresholds New Peak Hour Trips (PHT) On Adjacent Street
○	Category I	PHT < 100
○	Category II	100 to 499
○	Category III	500 to 999
○	Category IV	PHT ≥ 1000

B. TRAFFIC IMPACT ANALYSIS GUIDELINES (TIA)

1. General

a. Authorization to Perform a TIA

A TIA shall be prepared by an individual, group, firm, or corporation having demonstrated professional emphasis and experience in traffic engineering, and the preparation of similar analysis, hereinafter referred to as the "Analysis Engineer". The TIA document shall bear the seal and signature of a Texas Licensed Professional Engineer specializing in the branch of civil engineering. The responsibility for assessing the traffic impacts associated with a proposed development/redevelopment, hereinafter referred to as the "Development," rests with the Applicant and the Analysis Engineer, while the City shall serve as the review and approval authority.

b. Purpose and Intent of TIA Guidelines

The purpose of the TIA is to identify the adequacy of the existing street right of way to accommodate any changes in trips generated from a proposed development/redevelopment (as a stand-alone development or a stage of a master plan). If impacts are identified, potential mitigation measures (on-site or off-site) can be proposed and evaluated. The traffic impact analysis will be used to make a determination as to whether driveway(s) being considered are necessary to provide reasonable access to the private property consistent with the safety and convenience of the public.

c. Goals of a TIA Completed Within the City of Houston

(1) To identify any and all potential adverse traffic impacts to the existing area street system, the surrounding community and to additional proposed developments.
(2) To identify transportation improvements with an aim to cost effectively mitigate identified adverse traffic impacts to mobility within the study area/analysis area.
(3) To assist public and private sector entities in identifying and resolving issues related to the location of driveways, median openings, turn lanes, traffic signals, and other transportation facilities.

d. Document Limitations

While this section (15.04) contains guidelines and requirements necessary to complete a TIA for the City, the City does not intend this section to be a sole reference for the preparation of a TIA. For more specific information regarding the various aspects of TIA preparation, the City suggests that the reader obtain and refer to the Institute of Transportation Engineer's (ITE) current edition of Transportation Impact Analyses for Site Development (An

ITE Proposed Recommended Practice).

2. The Traffic Impact Analysis Process

a. The TIA report shall bear the seal and signature of a Texas Licensed Professional Engineer specializing in the branch of civil engineering. The responsibility for assessing the traffic impacts associated with a proposed development or redevelopment rests with the applicant and the Analysis Engineer, while the City shall serve as the review and approval authority.

b. A TIA determines traffic impacts of a development/redevelopment on the surrounding street system. The City will use this information to assist in establishing immediate transportation infrastructure needs and potential transportation improvements. If the development/redevelopment is a stage of a future larger development (master plan), the TIA should include the impact of the overall development (all stages).

c. It is a goal of the City that these guidelines will allow for the maximization of efficiency and safety associated with area development/redevelopment. The City emphasizes that the TIA process can begin when the Applicant initiates development planning (i.e. prior to plat preparation).

d. If a TIA is required or the applicant chooses to prepare a TIA, the completed TIA may be submitted at any time prior to or during the plat submittal. If platting is not required, a TIA shall be approved prior to submitting plans for permitting. TIA review may result in significant site plan revisions~~between the preliminary plat submittal and before the final site plan approval~~. The final site plan approval shall not be issued without the TIA approval.

e. Prior to submitting an application for development platting or a building permit the Applicant may be required to submit a revised TIA and obtain approval by the City if any changes have been made to the development (site plan) or original TIA assumptions related to:

(1) Land-use (revisions required only for an increase in trips),
(2) Increase in the trip generation variable(s) (revisions required only for an increase in trips),
(3) Intersection and street design, and
(4) Access connections placement and design assumptions.

3. The Proposal of Scope and Initial Trip Generation Estimate

a. Using proposed development ~~or~~ redevelopment, or master plan attributes (type, size, etc.), determine a corresponding traffic impact category for the Development by calculating the highest number of estimated new peak hour trips generated for an adjacent street (See Table 15.04.01).

Table 15.04.01 Traffic Impact Categories

Traffic Impact Category	Site Traffic Thresholds New Peak Hour Trips (PHT) on Adjacent Street
Category I	PHT < 100
Category II	100 to 499
Category III	500 to 999
Category IV	PHT ≥ 1000

b. The City requires that the Analysis Engineer generate site traffic using the methodologies found in the current edition of the ITE publication. This includes following the "Recommended Procedure for Estimating Trip Generation", as shown in Figure 15.04.02.

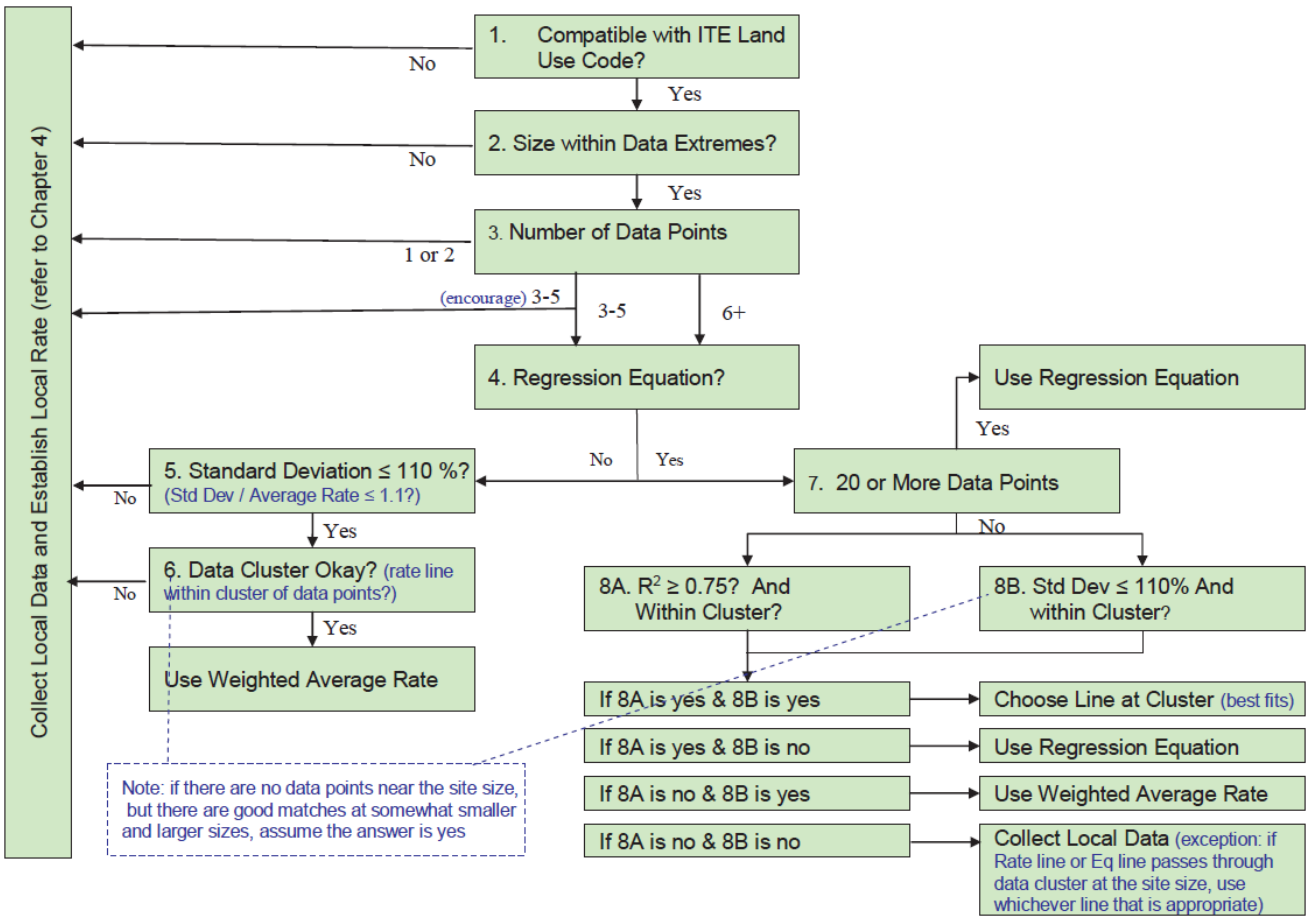


Figure 15.04.02 Recommended Procedure for Estimating Trip Generation

c. Using the resulting traffic impact category and the Boundaries and Horizons Guidelines in Table 15.04.02, the Analysis Engineer shall prepare and submit to the City Engineer a proposed scope for the TIA.

d. It is also a goal of the proposed scope to minimize deliverables. It is mandatory that, regardless of traffic impact category (II, III, or IV), the Analysis Engineer holds a preliminary scoping meeting with the City Traffic Engineer.

e. An approved proposal of scope ensures that the submittal of a TIA will allow the City to evaluate the overall traffic impact of the development on area transportation infrastructure.

4. Preparing the TIA

The TIA shall be prepared according to the requirements detailed in the Traffic Impact Analysis Preparation Overview Figure 15.04.03.

Table 15.04.02 Boundaries and Horizons Guidelines

	Requirements	Category I	Category II	Category III	Category IV
General	Access Management Data Summary Form	X	X	X	X
	Scoping Meeting with the City Traffic Engineer		X	X	X
	Proposed Scope		X	X	X
Horizon	Opening Year		X	X	X
	Full Build-Out Year(1)			X	X
Limits(3)	Analysis Area (From boundaries of development)(2)		¼ Mile	½ Mile	½ or 1 Mile
	All Site Access Driveways		X	X	X
	All Site Access Private Street Intersections		X	X	X
	All Adjacent Signalized Intersections		X	X	X
	All Adjacent Major Unsignalized Intersections		X	X	X
	All Analysis Area Signalized Intersections			X	X
	All Analysis Area Major Unsignalized Intersections			X	X

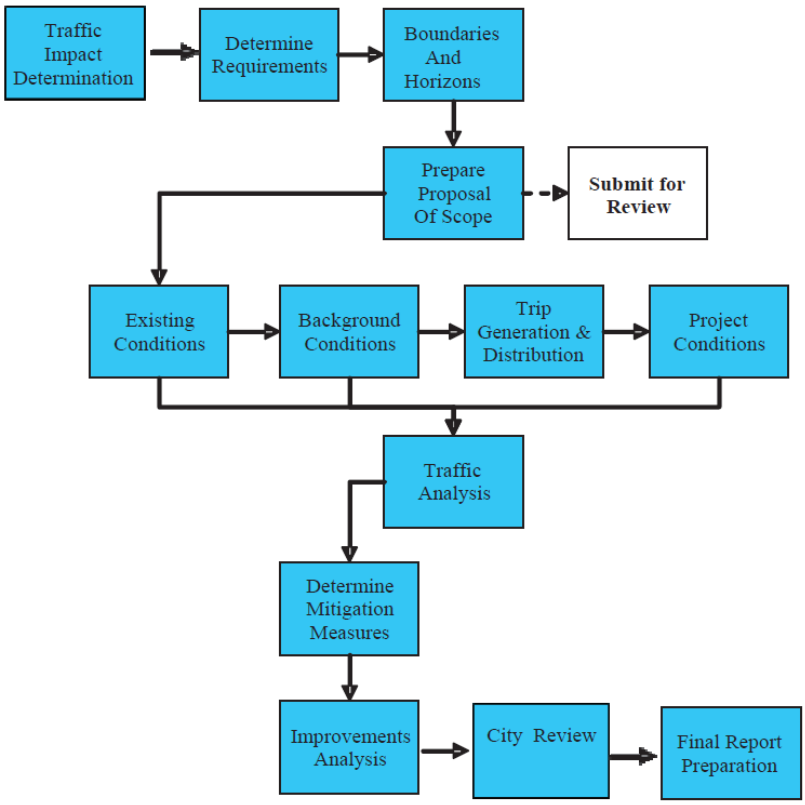
(1) Including the full implementation of master plan.
(2) Category II, III and IV studies should extend to first signalized intersection (minimum) even if outside of Boundary and include any critical intersections as defined by the City.
(3) Shall be defined as the limits of the master plan.

5. TIA Submission and Review

a. All TIA submittals should be addressed to the Office of the City Engineer. Paper copies should be submitted through the Office of the City Engineer, 2nd floor of 1002 Washington Avenue, Houston, TX. Electronic copies should be emailed directly to the Office of the City Engineer.

b. The Applicant shall submit to the City two (2) paper copies and one electronic copy. In addition, one electronic version of the TIA appendix is required (paper copies of the appendix are not necessary unless requested by the City).

Figure 15.04.03 Traffic Impact Analysis Preparation Overview



c. The City will make an initial review of the TIA to determine if the Analysis Engineer completed the TIA in accordance with the technical requirements and within the submission requirements of the analysis as outlined in this manual or as established at the preliminary scoping meeting or proposal of scope. If the City finds deviations from the technical requirements and/or the submission requirements of the study, the City will terminate the initial review until the Analysis Engineer has addressed said deficiencies. At such a time when the City identifies deficiencies, the City will send a notice of deficiencies to the Analysis Engineer and Applicant. Submittal should include, if available, electronics copies of traffic counts (in Excel and pdf formats) and other collected data (i.e., queuing, delay studies, etc.) as well as any traffic analysis models used and reference in the TIA.

d. All TIA submittals should include either an interim seal or a final seal, which is signed by a Licensed Professional Engineer in the State of Texas.

e. When the Applicant submits a final TIA that meets the technical and submission requirements established in this document or at the preliminary scoping meeting or proposal of scope, the City will conduct a final review of the TIA.

f. Following the City's completion of the final review, the City will provide to the Analysis Engineer and Applicant written objection to the findings or adequacy of the proposed mitigation measures to address impacts. If no objections are noted, the City will interpose no objection to permitting for the proposed development. If the Applicant disagrees with the objections made by the City, the Applicant may write an appeal to the Director of Public Works.

g. Approval of a TIA will remain valid for a maximum of three years (from date of final TIA approval). Validity of an approved TIA beyond three years will be allowed by the City Engineer so long as the phased development is proceeding according to the approved plan and the schedule contained within such approved plan. The applicant may be required to update traffic impact data to address changes within the area and will meet with the City Engineer prior to the expiration of the three-year period to determine if an updated TIA is required.

6. Mitigation Measures Requirements

a. The TIA shall have identified significant adverse traffic impacts in order to trigger the need for mitigation. The need for mitigation is determined by using the qualitative measure Level-of-Service (LOS). The threshold of significance for transportation facilities on the area street system is LOS D.

City of Houston

Design Manual

Chapter 17

BICYCLE, TRANSIT AND PEDESTRIAN DESIGN REQIIREMENTS

Chapter 17

BICYCLE, TRANSIT AND PEDESTRIAN DESIGN REQIIREMENTS

17.01 CHAPTER INCLUDES

A. Geometric design guidelines for bicycle, pedestrian, and transit facilities.

17.02 REFERENCES

A. Bicycle Master Plan (Houston Bike Plan), current edition

B. Bicycle Parking Guidelines, Association of Pedestrian and Bicycle Professionals (APBP), current edition

C. Designing for All Ages and Abilities - Contextual Guidance for High-Comfort Bicycle Facilities, NACTO, current edition

D. Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, ITE, current edition

E. Houston Complete Streets and Transportation Plan

F. Implementing Context Sensitive Design on Multimodal Thoroughfares, ITE, current edition

G. A Policy on Geometric Design of Highways and Streets ("The Green Book"), AASHTO, current edition

H. Guide for the Development of Bicycle Facilities, AASHTO, current edition

I. Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations, FHWA, current edition

J. Parks Master Plan, current edition

K. Roadside Design Guide, AASHTO, current edition

L. Scenic Houston Streetscape Resource Guide

M. Separated Bike Lane Planning and Design Guide, Federal Highway Administration Bicycle and Pedestrian Program, current edition

N. Texas Manual on Uniform Traffic Control Devices (TMUTCD), TXDOT, current edition

O. Transit Street Design Guide, NACTO, current edition

P. Trail Sponsor Guidance Document, Harris County Flood Control District (HCFCD), current edition

Q. Urban Bikeway Design Guide, NACTO, current edition

R. Urban Street Design Guide, NACTO, current edition

S. Accessibility Guidelines for Pedestrian Facilities in the Public Right Of Way (PROWAG)

17.03 DEFINITIONS

A. Bicycle Master Plan - Also called the Houston Bike Plan, this is a planning document that outlines the City's vision for bicycling in the City and associated goals for achieving the stated vision.

B. Bike Routes - A bicycle route can be designated along any bikeway type with signing and can provide guidance along a series of different styles of bicycle facilities.

C. Bicycle Facility - parts of a bikeway which may be dedicated, non-dedicated or off-street.

1. Dedicated On-Street Bicycle Facilities provide dedicated space for bicyclists separate from vehicle lanes within the roadway. These facilities can be located on the right side or left side of the road as appropriate based on engineering judgment to accommodate roadway conflicts such as transit vehicles, driveways, and turn movements. Examples include Standard Bike Lane, Buffered Bike Lane, Separated Bike Lane, and Side Path.

2. Non-Dedicated On-Street Bicycle Facilities are on-street are on-street bikeways where bicyclists share the street with motor vehicle traffic. They can be high-comfort facilities on roadway with certain characteristics such as low traffic volumes and speeds.

3. Off-Street Bicycle Facilities provide dedicated space for bicyclists separate from vehicle lanes outside of the roadway.

a. Trail: A facility for bicyclists and pedestrians outside of street right-of-way. For trails in Harris County Flood Control District rights-of-way, refer to the HCFCD "Trail Sponsor Guidance Document."

b. Side Path: A facility for bicyclists and pedestrians within the street right-of-way but outside the roadway. May consist of a sidewalk widened sufficiently to also support bicycle travel.

D. Bicycle Parking:

1. Bicycle Parking Station: An area on or projecting on any public right-of-way upon which one or more bicycle racks may be affixed. Amenities may include bicycle fixit stations, bicycle lockers, etc.

2. Bike Rack: A fixture upon which one or more bicycles may be parked.

3. Specifications and guidelines for bike racks and their installation are provided in the Houston Bike Racks Application.

E. Cycle Track - see Separated Bike Lane

F. Conflict Zone - Space where one mode's primary path crosses another, and can occur at points of transition such as at intersections, bus stop, primary commercial driveways, etc. Pavement markings and signage should be used to define the space and communicate proper use by facility user whether a pedestrian, bicycle, car, or bus.

G. Contraflow Bike Lanes - are typically separated bike lanes that flow against vehicle traffic on a one-way street. They can be used where the contraflow path closes an important gap in the network and other alternatives are not feasible. They can be installed in conjunction with a separated bicycle facility or non-dedicated bicycle facility on the opposite side of the road that flows in the same direction as vehicle traffic. Contraflow Bike Lanes may be located on the left side of a corridor.

H. Delineator - treatment or object used to physically separate a bike facility from vehicular traffic or bike traffic from pedestrian traffic. They provide the comfort and safety that make separated bike lanes attractive facilities. The selection of separation type(s) should be based on the presence of on-street parking, overall street and buffer width, cost, durability, aesthetics, traffic speeds, emergency vehicle and service access, and maintenance. Example of delineators include but are not limited to:

1. Armadillo: Oblong low delineator that creates the physical separation for separated bike lanes.

2. Raised curb buffer: Precast or concrete unit raised and spaced appropriately for continued maintenance and drainage that creates the physical separation for separated bike lanes.

I. Desired Bicycle Width - Desirable width of a bicycle facility, based the facility's bicycle level of comfort as it relates to roadway traffic volumes, posted speeds and number of vehicular lanes.

J. Houston Bike Plan Map - Map of all existing and planned City of Houston maintained bicycle facilities. The primary purpose of the map is to define a connected network of bicycle facilities that is updated on a regular basis. Additional facilities may be proposed based on individual project, neighborhood, and connectivity needs.

K. Level of Comfort - A qualitative measure of the ability of a bicycle facility to provide an experience that the target user considers safe and comfortable. Elements that impact the level of comfort include volume and speed of adjacent automobile traffic, width of bicycle facility, number of driveway and intersection crossings, quality of pavement, and type and width of buffer provided between the bicycle facility and adjacent vehicle travel and parking lanes.

L. Minimum Width - Alternative width to be considered where ROW is constrained. Values lower than the provided minimum result in a Low-Comfort facility and require review and approval of Houston Public Works staff.

M. Transit Lane Configurations - Special roadway configurations that dedicate lanes/space to specific modes of transportation.

1. Transit Only Lane - Roadway lanes dedicated to transit vehicles, typically using signs and pavement markings. Vehicles and bicycles may use said lanes if necessary to make a turn or reach a business front or curbside parking (aka Business Access/Transit (BAT) lanes).

2. Transit and Bicycle Shared Lane - Roadway lanes dedicated to bicycles and transit, ideal for low speed, low traffic roadways.

3. Bus Turn Radii - Buses require more space on roadway infrastructure due to larger turning radii (20-40 ft). This factor must be considered when designing intersections and station/stop areas as well as the route alignment.

N. Transit Stations/Stops - A designated location for boarding/alighting of a transit vehicle. Stations/stops may also provide transit users shelter to wait for vehicles.

1. Bus Stop - Any location designated as a boarding/alighting zone within a bus transit route.

a. Far Side Stop - A bus stop located beyond an intersection. It requires that buses cross the intersection before stopping to serve passengers.

b. Near Side Stop - A bus stop located on the approach side of an intersection. The buses stop to serve passengers before crossing the intersection.

c. Mid-Block Stop - A bus stop located between two intersections. Traditionally, these stops are located next to a mid-block pedestrian crossing for safe crossing.

2. Bypass Lane - Transit only lane or right turn lane at the near side of an intersection that allows transit vehicles to pass queued automobiles without a specific transit only signal.

3. Transit Shelter - Infrastructure installed at transit stop locations to provide protection from the weather.

4. Bus Boarding Pad - A rectangular slip resistant concrete pad connected to adjacent sidewalks and sidewalk ramps and provide access to transit vehicles.

5. Bus Pullout - A dedicated space adjacent to roadway infrastructure that brings transit vehicles completely out of traffic into a dedicated space. Provides increased safety during the boarding/alighting process.

6. Floating Bus Stop - A bus stop whose specific layout allows pedestrian and bicycle right-of-way to locate behind the bus boarding pad, safely separating different modes of transportation. Generally used when a dedicated/protected bike lane travels through a bus stop area.

7. BRT Station - A transit station for bus rapid transit and its passengers.

8. Rail Station - A transit station for trains. It is typically an off-street facility where passengers wait for, board, alight, or transfer between transit units (vehicles or trains). A station usually provides information and a waiting area and may have boarding and alighting platforms, ticket or farecard sales, fare collection, and other related facilities Rail stations can be both at-grade or grade separated (for elevated guideways).

O. Pedestrian Clear Zone - The primary, accessible area along a roadway where pedestrian travel is prioritized. Additional pedestrian clear zone widths are required within transit areas.

P. Public Transit - Any form of publicly provided passenger transportation containing fixed/non-fixed routes and an established fare system.

1. Bus Transit - A form of public transit that uses bus fleets to provide fixed route and non-fixed route service.

2. Bus Rapid Transit (BRT) - High capacity bus service with dedicated lanes and upgraded stations. BRT systems are characterized by several of the following components: exclusive transitways, enhanced stations, easily identified vehicles,

high frequency, all-day service, simple route structures, simplified fare collection, and ITS technologies.

3. Light Rail Transit (LRT) - A metropolitan electric railway system characterized by its ability to operate single cars or short trains along exclusive rights-of-way at ground level, on aerial structures, in subways, or occasionally, in streets, and to board and discharge passengers at track or car floor level.

Q. Retrofit Bicycle Facility - A bicycle facility provided through the reallocation of existing roadway pavement by reducing the width or number of existing vehicle or parking lanes or by using excess, unused pavement. Retrofits typically do not require the roadway widening or median reduction.

R. Separated Bike Lane - Dedicated on-street space for bikes separated from vehicle traffic with a buffer and a physical delineation device. Facilities can be one or two-way where a one-way facility is similar in nature to buffered bike lanes. Sometimes called a "Cycle Track."

S. Wayfinding - Directional signage to certain destinations such as libraries, parks, schools, trail entry points, and other attractions.

17.04 BICYCLE GEOMETRIC DESIGN REQUIREMENTS

A. General Design Guidance

1. The design of streets within the City of Houston shall consider options for high-comfort bicycle design solutions to improve bikeway connectivity and expansion of the planned bicycle network.

2. Low-comfort bicycle facilities should be avoided wherever possible. Proposed design of any facilities that would be considered low-comfort shall require prior approval from the Transportation and Drainage Operations.

3. The design of bicycle facilities shall accommodate the design bicyclist. The dimensions of a bicycle and associated operating space are summarized in Figure 17.1 and interpreted from the Guide for the Development of Bicycle Facilities, AASHTO.

4. Bicycling is an increasing component of multimodal thoroughfares. Bicycle facilities may be placed at sidewalk level, between sidewalk and pavement level, against the curb, between the curb and the parking lane, or between the parking lane and the vehicle travel lane. Bicycling facilities can benefit pedestrians by providing a buffer between the walking area and the vehicle traveled way.

5. Bicycle design speed for bicycle facilities is 12 mph.

6. Visibility of bicycle crossings may be emphasized by the use of bicycle-green pavement markings.

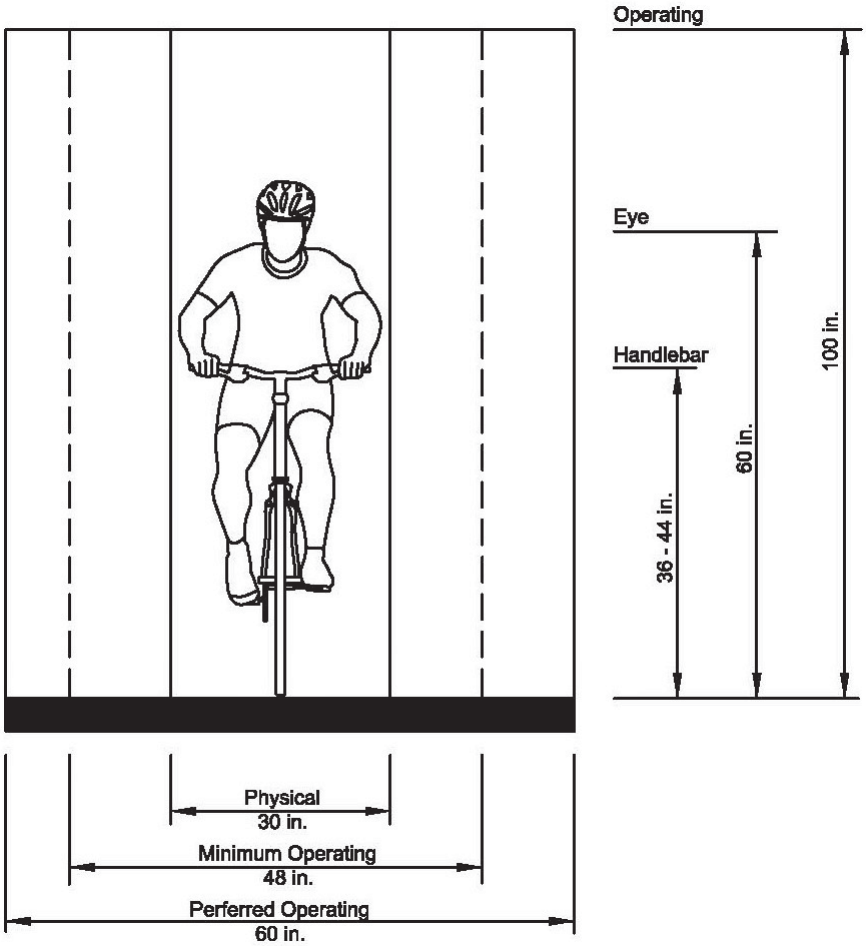


Figure 17.1 Design Bicyclist

B. Design Considerations

1. Bikeway facilities can be implemented as part of roadway reconstruction projects, through retrofit projects, or in the case of facilities outside of the roadway pavement, through special capital projects or other.

2. Bicycle Retrofit Projects: In some cases, retrofit bicycle facilities can be provided by reallocating existing pavement or by utilizing unused, excess pavement. A traffic study shall be required to determine the impact to other modes of travel on the roadway where an existing vehicular lane of traffic is removed. The traffic study shall be reviewed and approved by Houston Public Works staff before the retrofit can proceed. Houston Public Works may require a public meeting to gauge the public input on a proposed retrofit project. The flowchart below outlines the questions to be addressed by the traffic study.

3. Where delineator is being considered, the designer should evaluate its impacts on accessibility for other road users such as a bus accessing a bus stop, driveway ingress and egress, street sweeper, garbage collection truck, etc.

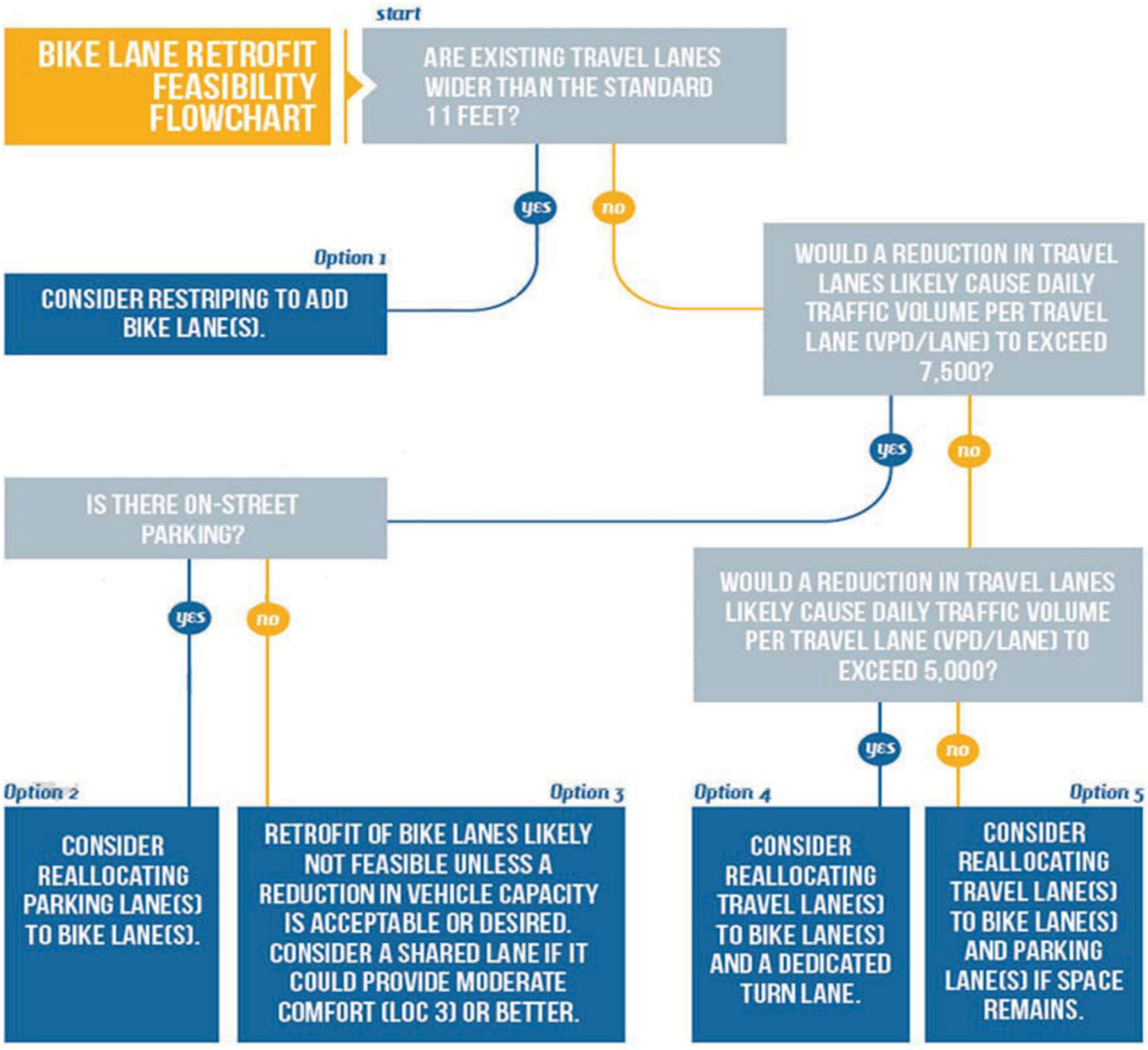


Figure 17.2 Bike Lane Retrofit

C. Selection of Bicycle Facility Type

New bicycle facilities shall provide as high a level of comfort for bicycle traffic as possible within the constraints of a given project. The flowchart below can be used to determine what type of bicycle facility may be appropriate for achieving a desired level of comfort with the specific roadway and traffic characteristics of a given project.

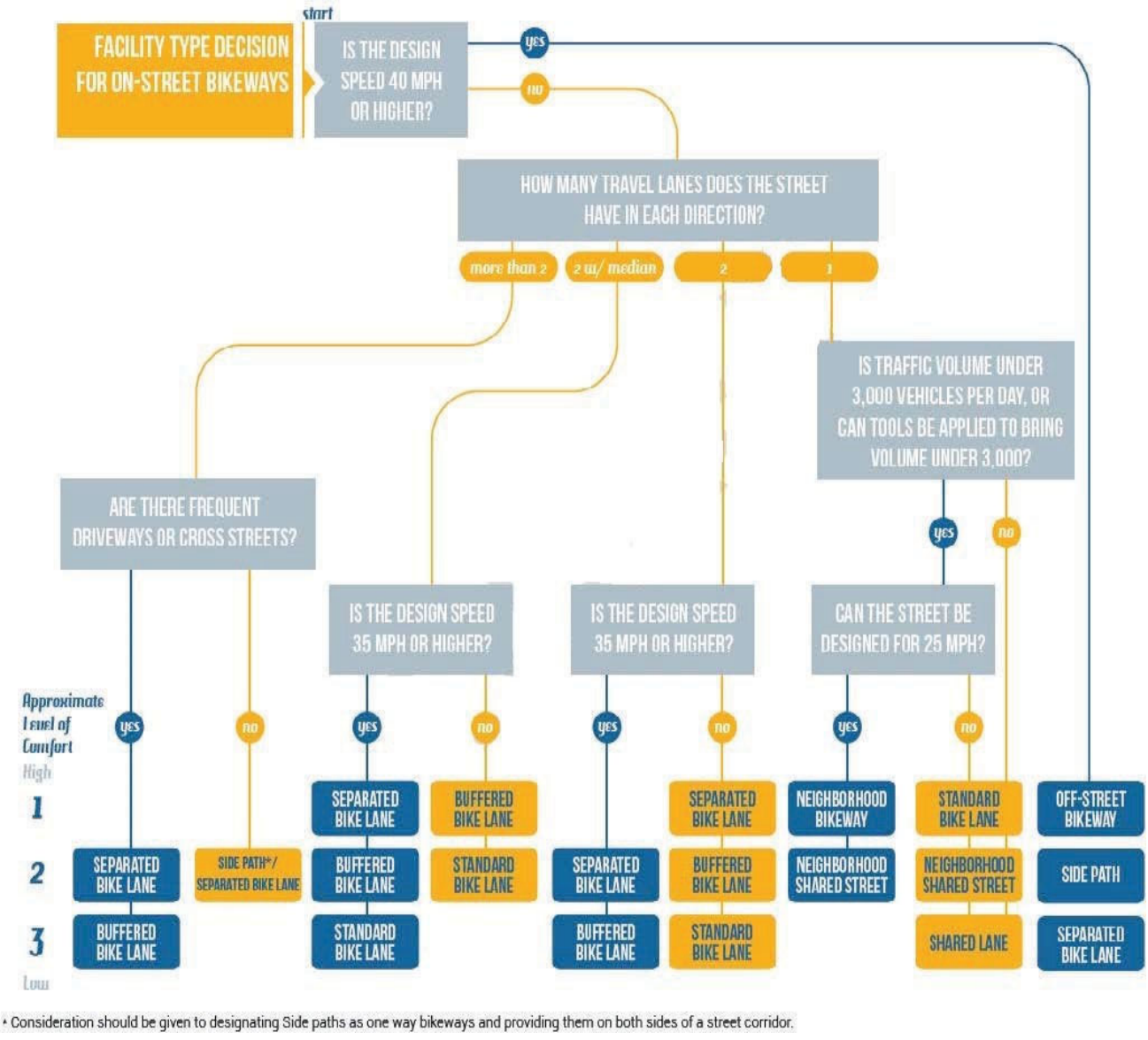


Figure 17.3 Bicycle Facility Type

D. Facility Type Standards and Guidelines

1. Dedicated Bicycle Facilities

a. Standard Bike Lanes are delineated from vehicular traffic with pavement markings and do not provide a buffer.
   i. Dimensions: Standard width is six (6)-ft (minimum five (5)-ft).
   ii. Pavement Markings (Longitudinal): A six (6) inch solid white stripe shall be used to separate the bicycle lane from the adjacent vehicle lane.
   iii. Pavement Marking (Symbols): In accordance with the Texas MUTCD Section 9c.04, a bicycle symbol and arrow markings shall be used to define bicycle lanes and should be placed at the beginning of a bike lane facility and the start of every block or at regular intervals as necessary to reinforce the intended use. See Standard Detail 01510-04 for pavement marking details.
   iv. Signage: Bike lane signs (R3-17) and plaques (R3-17aP and R3-17bP) are required and should be placed at the beginning of a bike lane facility and at the start of every block or at regular intervals as necessary to reinforce the intended use.

For standard bike lanes design criteria, refer to City of Houston Standard Detail 01510-09.

b. Buffered Bike Lanes can be provided on local streets, collectors and major thoroughfares. They are standard bike lanes with additional striped, delineated space separating the bicycle lane from the adjacent vehicle travel lane and/or parking lane. Buffered bike lanes can provide a higher level of comfort in given traffic conditions than standard bike lanes. Buffered bike lanes are generally preferred over of standard bike lanes for increased bicyclist comfort where ROW is sufficient.
   i. Dimensions: The lane and buffer together shall be at least eight (8)-ft wide. Buffer may be reduced if a raised delineator is provided as approved by Houston Public Works. The minimum bicycle lane width is five (5)-ft.
   ii. Pavement Markings (Buffer): The buffer shall consist of two six (6)-inch solid white lines, with six (6)-inch diagonal white hatching if three (3) -ft in width or wider. Spacing of hatching should be between 10 and 40 -ft as determined by the engineer to increase motorist compliance.
   iii. Delineator: A raised, physical delineator shall be provided where buffer space is less than 2-ft between vehicles and bicycles and should be used for increased comfort based on engineering judgment. Examples include armadillos and raised curb buffer. Delineator selection should consider impacts on drainage, bus stops, street

sweeping and where not specified here shall require approval from Houston Public Works.

iv. Pavement Marking (Symbols): In accordance with the Texas MUTCD Section 9c.04, a bicycle symbol and arrow markings shall be used to define bicycle lanes and should be placed at the beginning of a bike lane facility and at the start of every block or at regular intervals as necessary to reinforce the intended use. See Standard Detail 01510-04 for pavement marking details.

v. Signage: Bike lane signs (R3-17) and plaques (R3-17aP and R3-17bP) are required and should be placed at the beginning of a bike lane facility and at the start of every block or at regular intervals as necessary to reinforce the intended use.

For buffered bike lanes design criteria, refer to City of Houston Standard Detail 01510-09.

c. Separated One-way Bike Lanes can be provided on collectors and major thoroughfares. It is a dedicated on-street space for bikes, wide enough to allow for one-way bicycle traffic, separated from vehicle traffic with a buffer and, where applicable, a physical delineation device.

i. Dimensions: The buffer shall be designed to accommodate and complement the selected delineator device but should typically be at least three (3) -ft. Buffer may be reduced if raised delineators are provided as approved by Houston Public Works staff. The minimum bicycle lane width is five (5) -ft.

ii. Delineator: A raised, physical delineator shall be provided where the bike lane runs against the vehicular traffic (contra flow) or buffer space is less than 2-ft between vehicles and bicycles and should be used for increased comfort based on engineering judgment. Examples include armadillos and raised curb buffer. Delineator selection should consider impacts on drainage and street sweeping and where not specified here shall require approval from Houston Public Works staff.

iii. Pavement Markings (Buffer): Should complement the delineator type selected. For delineators utilizing a series of discrete elements (e.g. armadillos), a striped buffer shall be utilized and shall consist of two six (6)-in solid white lines, with six (6)-inch diagonal white hatching if three (3)-ft in width or wider. Spacing of hatching should be between 10 and 40-ft as determined by the engineer to increase motorist compliance.

iv. Pavement Marking (Symbols): In accordance with the Texas MUTCD Section 9c.04, a bicycle symbol and arrow markings shall be used to define bicycle lanes and should be placed at the beginning of a bike lane facility and at the start of every block or at regular intervals as necessary to reinforce the intended use. See Standard Detail 01510-04 for pavement marking details.

v. Signage: Bike lane signs (R3-17) and plaques (R3-17aP and R3-17bP) are required and should be spaced at the beginning of a bike lane facility and at the start of every block or at regular intervals as necessary to reinforce the intended use.

For one-way separated bike lanes design criteria, refer to City of Houston Standard Detail 01510-09.

d. Separated Two-way Bike Lanes: can be provided on collectors and major thoroughfares. It is a dedicated on-street space for bikes separated from vehicle traffic with a buffer and a physical delineation device wide enough to allow for two-way bicycle traffic.
   i. Dimensions: The buffer shall be designed to accommodate and complement the selected delineator device but should typically be at least three (3)-ft. The minimum bidirectional bicycle lane width is ten (10)-ft.
   ii. Delineator: A raised physical delineator shall be provided as additional buffer. Examples include armadillo and raised curb buffer. Delineator selection should consider impacts on drainage and street sweeping and shall require approval from Houston Public Works staff.
   iii. Pavement Markings (Buffer): Should complement the delineator type selected. A striped buffer shall be utilized and shall consist of two six (6)-inch solid white (or yellow if contra flow) lines, with six (6)-inch diagonal white (or yellow) cross-hatching if three (3) -ft in width or wider. Spacing of hatching should be between 10 and 40 -ft as determined by the engineer to increase motorist compliance. Delineators are generally placed in the center of the striped buffer.
   iv. Pavement Markings (Longitudinal): A dashed yellow line should be used to separate two-way bicycle traffic.
   v. Pavement Marking (Symbols): In accordance with the Texas MUTCD Section 9c.04, a bicycle symbol and arrow markings shall be used to define bicycle lanes and should be placed at the beginning of a bike lane facility and at the start of every block or at regular intervals as necessary to reinforce the intended use. See Standard Detail 01510-04 for pavement marking details.
   vi. Signage: Bike lane signs (R3-17) and plaques (R3-17aP and R3-17bP) are required and should be placed at the beginning of a bike lane facility and at the start of every block or at regular intervals as necessary to reinforce the intended use.
   vii. If physical delineators are used, access should be considered for driveways, solid waste collection, bus stops, and mail delivery.

For two-way separated bike lanes design criteria, refer to City of Houston Standard Detail 01510-09.

e. Side Paths are bike facilities that run alongside a roadway within the ROW. Side paths may be slightly raised from the street level or at the same grade as the sidewalk. Side paths may provide single or bidirectional bicycle traffic flow. Side paths may be designed as shared use space for bicycles and pedestrians or as dedicated single or double lane bicycle facilities separate from both pedestrian and vehicular traffic. Bicycle-dedicated side paths can be separated from pedestrian traffic physically with a buffer or simply with contrasting pavement materials or colors. Maintenance responsibilities for side paths should be determined before implementation. Side paths can be provided along any roadway regardless of the speed of adjacent traffic. However, they can present challenges when there are an abundance of driveways, intersections, and other conflict points.

i. Dimensions.

1. A two-way, bidirectional side path should maintain a standard width of ten (10)-ft (minimum eight (8)-ft), and can be more if separated pedestrian traffic is desired.
2. A buffer of at least three (3)-ft should be provided between the side path and the adjacent motor vehicle lane, and tree plantings incorporated for increased shading.
3. Where pedestrian traffic and bicycle traffic are both heavy, a portion of the side path cross section should be designated for exclusive bicycle use. Designation may include unique pavement texture and/or colors, bike lane pavement markings, and/or signage. For two-way bicycle travel the width of this area is ten (10)-ft; minimum eight (8)-ft. For one-way bicycle travel the width of this area is six (6)-ft; minimum five (5)-ft. This is in addition to the width of the pedestrian travel area.

ii. Pavement Markings (Longitudinal): A dashed yellow line may be used to separate two-way bicycle traffic on bidirectional side paths.

iii. Pavement Marking (Symbols): For bicycle-exclusive side paths, a bicycle symbol and arrow markings may be used to define bicycle lanes and, if used, should be placed at the beginning of a bike lane facility and every block or at regular intervals as necessary to reinforce the intended use. See Standard Detail 01510-04.

iv. Signage: Signage should be provided to designate intended use of the side path. At a minimum, "Bike Route" signs should be provided at the start of the facility and at regular intervals.

v. Access Drives: Shall incorporate design considerations for enhanced visibility of the bicycle facility to motorized vehicle users. Prioritized mode at crossing should be clearly defined by signage and/or pavement markings. See E. CORRIDOR DESIGN CONSIDERATIONS of this section.

vi. Ramps: Width of curb ramps that incorporate pedestrian and bicycle movements shall be equal to the width of the shared use path. Detectable warning surfaces shall extend the full width of the ramp run (excluding any flared sides).

For side path design criteria, refer to City of Houston Standard Detail 01510-09.

2. Non-Dedicated Bikeway Facilities

a. Neighborhood Shared Streets are low speed, low volume, and typically residential streets shared by motor vehicles and bikes and marked with "Bike Route" signs and potentially wayfinding signage. This designation does not include additional treatments to manage vehicle speed or volume.

i. Pavement Markings: No special pavement markings are required. Shared Lane Markings may be used if the shared nature of the roadway should be emphasized to encourage driver compliance.

ii. Signage: Bike Route signs (D11-1) should be placed at regular intervals based on engineering judgment to inform bicyclists of bicycle route direction changes and to confirm route direction. Bikes May Use Full Lane signs (R4-11) may be used. Wayfinding can be used to provide direction to other high comfort bicycle facilities, trails, or neighborhood destinations and amenities such as schools.

b. Neighborhood Bikeway: also known as "Bicycle Boulevards," are similar to Neighborhood Shared Streets but provide a more regional connector and may be provided on local streets or collectors where the speed limit does not exceed 30 mph. They have three essential elements:

1. Street design elements that enhance bicycle and pedestrian safety and comfort while maintaining vehicle traffic speeds at levels appropriate to the neighborhood context.
2. Intersection treatments to assist bicyclists crossing roadways with high traffic volumes and/or speeds.
3. Bicycle signage and wayfinding

i. Pavement Markings: Shared Lane Markings should be used to emphasize the shared nature of the roadway. See Standard Detail 01510-04. for shared lane marking placement and design consideration. On-street parking may but is not required to be delineated. Parking delineation may be appropriate in dense urban or commercial contexts.

ii. Signage: Bike Route signs (D11-1) should be placed at regular intervals based on engineering judgment to inform bicyclists of bicycle route direction changes and to confirm route direction. Bikes May Use Full lane signs (R4-11) shall be used to emphasize the shared nature of the roadway. Wayfinding should be used to provide direction to other

high comfort bicycle facilities, trails, or neighborhood destinations and amenities such as schools. Stop sign placement and direction should provide priority to the bikeway over intersecting local streets to minimize bicycle stops.

iii. Optional Treatments: Bicycle safety enhancements, such as speed cushions, neighborhood traffic circles, chicanes, and bike-only through movements at intersections can be considered based on engineering judgment and shall require Houston Public Works approval.

c. Shared Lanes can be located on minor collector, major collector and certain major thoroughfares where there is insufficient ROW for dedicated facilities. They represent roadway travel lanes shared by vehicles and bicyclists on thoroughfares. They do not provide the highest level of comfort for bikes and are appropriate only where ROW is insufficient to provide a dedicated bikeway. They may be used in combination with higher-quality bike facilities to accommodate ROW pinch points. Shared lanes are restricted to roadways with posted speed limits 35 mph or less. Shared Lanes should not exceed 12-ft where no on-street parking is present. Signage and pavement markings are used to provide a visual indicator to vehicle traffic of the dual use and nature of the roadway

i. Pavement Markings: Shared Lane Markings shall be used to encourage bicycle travel in the middle or most visible portion of the travel lane. If on-street vehicular parking is not present, pavement markings should be placed far enough from the curb to direct bicyclists away from gutters, seams, and other obstacles. Minimum Placement:

1. Shared Use Vehicular Lane Defined: 6-ft from the lane line of the shared use lane
2. Shared Use Lane Not Defined: 6-ft from the center of the roadway where roadway lines do not exist.

ii. Signage: Bike Route signs (D11-1) should be placed at regular intervals based on engineering judgment to inform bicyclists of bicycle route direction changes and to confirm route direction. Bikes May Use Full lane signs (R4-11) shall be used to emphasize the shared nature of the roadway.

E. CORRIDOR DESIGN CONSIDERATIONS:

1. Overview: Bicycle facilities should provide a safe, high-comfort experience for the user as it traverses a corridor from intersection to intersection. Elements along a corridor may present unintended obstacles for bicyclists if not properly designed.

Design considerations presented in this section are not exhaustive. Additional considerations for review should be raised based on engineering judgment and approved by Houston Public Works.

2. General:

a. Gutter seams, drainage inlets, and utility covers should be flush with the pavement and oriented to prevent conflicts with bikes. Bicycle facility width should not include the gutter pan because people on bikes are typically unable to use this space.

b. Bicycle facilities are intended to be flexible to maximize comfort and can transition between facility types to accommodate corridor elements. Bicycle facility transitions (e.g., a bike lane to an off-street side path) should be logical and smooth. Abrupt facility transitions can be confusing, decrease bicycle predictability and increase vehicle conflicts.

c. Where possible, bicycle facilities should connect to other bicycle facilities, and facility termination should be minimized. Where bicycle facilities terminate, clear signing and striping shall be provided to communicate the termination to bikeway users and other roadway users. Where appropriate, on-street bicycle facilities may transition to a shared space with pedestrians (i.e. side path/trail) or to a non-dedicated bicycle facility type. Bicycle facilities should not terminate in areas that abruptly force bicyclists to merge with high-speed or high-volume vehicular traffic or heavy pedestrian activity.

d. Ramps may be used to transition bicycles on and off the street and shall not compromise pedestrian realm minimum standard widths.

e. All signs, signals, and markings related to bicycle facilities shall have maintenance responsibilities established and, if relevant, approved by Houston Public Works.

f. The design of bicycle facilities and associated physical delineation shall not restrict curbside access for solid waste trucks on streets with curbside trash and/or recycling pickup.

g. The design of bicycle facilities and associated physical delineation shall not restrict curbside access for transit vehicles at designated transit stops. Physical delineators should be stopped prior to transit stops. On streets where frequent breaks in physical delineation would be required, alternative bicycle facility designs that do not require physical delineation should be considered.

3. On-Street Parking:

   a. Bike lanes may be provided between the parking lane and the curb or between the parking lane and travel lane.

   b. Where on-street parallel parking would otherwise be allowed, No Parking in Bike Lane signs (R7-9) may be considered.

   c. A 3-ft buffer should be provided between a bike lane and an adjacent parking lane to accommodate the door zone when high parking turnover is expected.

4. Railroad Crossings:

   a. General: Bicycle tires can become stuck in rail flanges when they cross tracks at a small angle. Where bicycle facilities cross a street-surface rail track, bicyclists should be directed to cross tracks at a safe angle (60 degrees minimum, 90 degrees desirable).

   b. If desired crossing angle is not possible, a warning sign (W10-1 or W10-12) shall be placed in advance of the rail crossing alerting bicyclist of skewed railroad crossing.

   c. In presence of uneven railroad tracks warning sign (W10-6) should be installed.

5. Bridge Crossings and Tunnels:

   a. Bridges and tunnels shall accommodate multimodal transportation usage.

   b. When the approach roadway has an existing or planned bicycle facility, the quality and comfort of bicycle facility on the bridge/tunnel shall equal or exceed that of the facility on the approach roadways.

   c. When the approach roadway does not have an existing or planned bicycle facility, 10-ft or greater sidewalks should be considered for multimodal consideration on the bridge/tunnel. The absence of an existing bicycle facility on the approach roadway does not justify failure to accommodate bicyclists on the bridge or tunnel.

   d. Bridge sidewalks and shared-use paths shall be raised above the vehicular pavement level.

e. Railing/Delineator:
   i. Exterior bridge railings adjacent to a pedestrian/bicycle facility:
      1. Minimum height: 42 inches.
      2. Height of 48 inches should be considered in the following cases:
         - Speed of adjacent traffic exceeds 35 mph
         - Width of pedestrian/bicycle facility is less than 10-ft
      3. The railing design should minimize opportunities for bicycle handle bars to get caught in the railing.
   ii. A railing may be used to separate bicycle traffic from pedestrian traffic to improve bicycle/pedestrian safety and comfort where appropriate.

6. Loading/Commercial Zones:

   a. Dedicated loading/commercial zones shall not impede bicycle traffic or encroach on a bicycle facility. Where possible, dedicated bicycle facilities should be placed behind loading zones and adjacent to the pedestrian zone whether on or off-street.

   b. To avoid conflicts with loading/commercial zones bicycle facility may be transitioned to the adjacent sidewalk where a minimum 10-ft separate pedestrian realm is maintained.

   c. A painted crosswalk may be provided across the bikeway facility to accommodate loading and unloading of commercial vehicles.

7. Midblock Crossings

   a. General: Midblock crossings are legal pedestrian and bicycle street crossing locations that are not located at roadway intersections. Intersection crossings are generally preferred, but occasionally midblock crossing locations are acceptable. Examples of potentially acceptable midblock crossing locations include a trail in a utility easement that crosses a street at a distance that is farther from the nearest signalized intersection than a trail user would be expected to traverse.

   b. Midblock crossings shall require Houston Public Works approval.

   c. Midblock crossings shall be designed at minimum with the following considerations:
      i. Midblock crossings shall be located at least 100-ft from adjacent intersections.
      ii. Street name signs should be placed at Major Thoroughfare crossings and should be considered on Collector and Local Street crossings.

iii. The width of curb ramps serving a midblock crossing shall be equal to the width of the approaching pedestrian or bicycle facility. Detectable warning surfaces shall extend the full width of the ramp.

iv. Pavement markings shall be used to define all midblock crossing locations.

1. For pedestrian-only midblock crossing, white high visibility crosswalk markings shall be used.
2. For shared-use midblock crossings, Dual Use Markings shall be used, consisting of a series of white stripes flanked by square bicycle-green pavement markings (see Standard Detail 01510-09A).

d. Midblock Enhancements: Additional treatments should be considered for increased visibility and refuge at midblock crossings. Enhancements shall require justification per engineering judgment and approval by Houston Public Works. Potential enhancements may include:

i. Raised crossing (a.k.a. raised crosswalk). Raised crossings elevate people in the crossing above the road level, thereby increasing their visibility. Raised crossings are not permitted on corridors with design speeds greater than 35 miles per hour.

ii. Curb extensions. Curb extension reduce crossing distance and increase visibility of people in the crossing. This treatment can be used when on-street parking exists or where excess pavement exists such that a curb extension can be constructed without decreasing roadway capacity.

iii. Median refuge islands. Median refuge islands are located in the center of the roadway to permit a two-stage crossing of the roadway. Median refuges should be considered where center turn lanes are present and are encouraged on corridor with 4 or more lanes, or where roadway configuration is reconfigured from a 4-lane corridor to a 3-lane corridor.

iv. Street lighting at midblock trail crossings where feasible and approved by Houston Public Works.

e. Selection of Midblock Treatments:

Midblock treatments shall be selected to maximize safety of people crossing the street at the midblock location. Selection of treatments should consider the corridor speed, number of lanes and average daily traffic in addition to area context. Several levels of treatment based on these factors are presented below. Standard treatments are required for each level. Optional treatments may be used based on engineering judgment and with Houston Public Works approval. **Table 1-B** provides guidance for the selection of treatment level.

Table 1-B Criteria for Midblock Crosswalk
(Levels A, B, C, D are defined below)

ADT	Speed Limit	4 lanes with median	2 lanes without median	4 lanes without median
≤ 5,000	≤ 30 mph	A	A	A
	> 30 mph	A	B	C
5,000 - 15,000	≤ 30 mph	B	B	B
	> 30 mph	C	C	D
>15,000	≤ 30 mph	C	D	D
	> 30 mph	D	D	D

Level A: Midblock crossing pavement markings

1. Standard: Install, as appropriate, white high-visibility crosswalk markings (pedestrian-only crossing) or Dual Use Markings (shared-use crossing).

2. Optional:

   a. Install W11-2 pedestrian warning sign (pedestrian-only crossing) or W11-15 pedestrian/bicycle warning sign (shared-use crossing) with W16-9P AHEAD (plaque) mounted on the side of the roadway in advance of the crossing.
   b. Install W11-2 pedestrian warning sign (pedestrian-only crossing) or W11-15 pedestrian/bicycle warning sign (shared-use crossing) with W16-7PL diagonal downward arrow plaque mounted on the side of the roadway at the crossing.

Level B: Level A + advance warning signage

1. Standard:

   a. Install, as appropriate, white high-visibility crosswalk markings (pedestrian-only crossing) or Dual Use Markings (shared-use crossing).
   b. Install W11-2 pedestrian warning sign (pedestrian-only crossing) or W11-15 pedestrian/bicycle warning sign (shared-use crossing) with W16-9P AHEAD (plaque) mounted on the side of the roadway in advance of the crossing.

c. Install W11-2 pedestrian warning sign (pedestrian-only crossing) or W11-15 pedestrian/bicycle warning sign (shared-use crossing) with W16-7PL diagonal downward arrow plaque mounted on the side of the roadway at the crossing.

2. Optional:

a. Install "PED XING" (pedestrian-only crossing) or "BIKE XING" (shared-use crossing) advanced pavement marking.

Level C: Level B + additional pavement markings

1. Standard:

a. Install, as appropriate, white high-visibility crosswalk markings (pedestrian-only crossing) or Dual Use Markings (shared-use crossing).
b. Install W11-2 pedestrian warning sign (pedestrian-only crossing) or W11-15 pedestrian/bicycle warning sign (shared-use crossing) with W16-9P AHEAD (plaque) mounted on the side of the roadway in advance of the crossing.
c. Install W11-2 pedestrian warning sign (pedestrian-only crossing) or W11-15 pedestrian/bicycle warning sign (shared-use crossing) with W16-7PL diagonal downward arrow (plaque) mounted on the side of the roadway at the crossing.
d. Install "PED XING" (pedestrian-only crossing) or "BIKE XING" (shared-use crossing) advanced pavement marking.
e. On four-lane roadways, install R1-5 "Yield Here to Pedestrians" (pedestrian-only crossing) or R1-5PB "Yield Here to Pedestrians and Bicyclists" (shared-use crossing) signage and yield lines consisting of isosceles triangles pointing toward oncoming vehicles (see Standard Detail 01510-09A).

2. Optional:

a. Raised crossing
b. Curb extension
c. Median refuge island

Level D: Level C + crossing enhancements

1. Standard:

    a. Install, as appropriate, white high-visibility crosswalk markings (pedestrian-only crossing) or Dual Use Markings (shared-use crossing).
    b. Install W11-2 pedestrian warning sign (pedestrian-only crossing) or W11-15 pedestrian/bicycle warning sign (shared-use crossing) with W16-9P AHEAD (plaque) mounted on the side of the roadway in advance of the crossing.
    c. Install W11-2 pedestrian warning sign (pedestrian-only crossing) or W11-15 pedestrian/bicycle warning sign (shared-use crossing) with W16-7PL diagonal downward arrow plaque mounted on the side of the roadway at the crossing.
    d. Install "PED XING" (pedestrian-only crossing) or "BIKE XING" (shared-use crossing) advanced pavement marking.
    e. On four-lane roadways, install R1-5 "Yield Here to Pedestrians" (pedestrian-only crossing) or R1-5PB "Yield Here to Pedestrians and Bicyclists" (shared-use crossing) signage and yield lines consisting of isosceles triangles pointing toward oncoming vehicles (see Standard Detail 01510-09A).
    f. Consider a traffic signal or hybrid pedestrian beacon if the appropriate warrants in the TMUTCD are satisfied. Requires approval of City Traffic Engineer.
    g. Enhancements are strongly encouraged where appropriate, including:
        i. Raised crossing
        ii. Curb extension
        iii. Median refuge island

8. Driveways:

    a. Driveways shall be designed to safely accommodate bicyclists, pedestrians and motorized vehicle users. Where a driveway crosses a dedicated on-street or off-street bikeway, the driveway should be designed to enhance the visibility of the bikeway user.

    b. Signage:
        i. Stops signs (R1-1) should be placed on primary commercial driveways to indicate a full stop by motor vehicles before entering and crossing a bicycle facility. Where the bicycle facility is in or immediately adjacent to the roadway, the stop sign should be placed before the bicycle facility.
        ii. Where a stop sign is not provided on the driveway approach, Bicycle Crossing Warning Sign (W11-1) or dual Combination Bike and Ped Crossing Warning Sign (W11-15) should be considered.

c. Pavement Markings: Where bicycle facilities cross driveways, the design should clearly communicate that bicyclists have the right-of-way by defining the bicycle facility width and associated placement across the driveway. Green bicycle pavement markings should be used across primary commercial driveways.

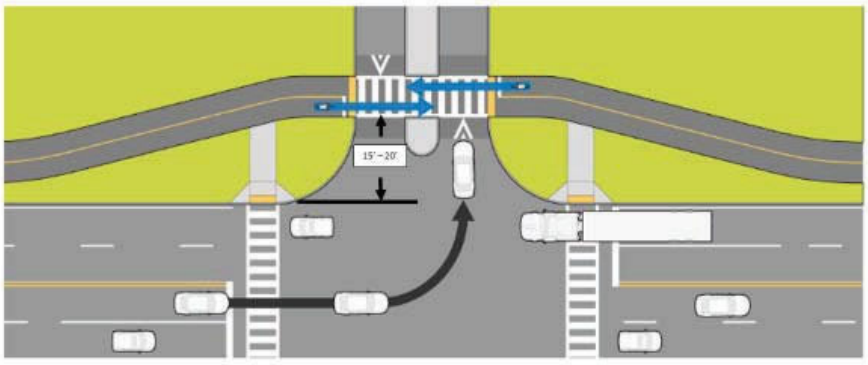
d. Curb Radius: Driveway curb radius should be selected to encourage slower vehicular movements across the bicycle facility. Based on engineering judgment, the smallest feasible curb radius should be selected based on AASHTO design vehicles. Additional curb radius design considerations are discussed in Chapter 15.08.

e. Driveway Spacing: Driveway consolidation should be considered where bike facilities are present. Each driveway presents an additional vehicle-bicycle conflict point. Refer to Chapter 15.08 for driveway spacing standards.

f. Vehicle Parking should be prohibited at least 20-ft from the edge of a driveway along the roadway.

g. Landscaping and other street-side elements shall not reduce sight distance across the bicycle facility below AASHTO minimums.

h. Optional Treatments: Bicycle safety enhancements such as raised crossings and recessed driveway crossings can be considered based on engineering judgment and shall require Houston Public Works approval prior to implementation. Recessed driveway crossings should be between 15-ft to 20-ft from the edge of the roadway pavement to enable one vehicle to queue between the roadway and the bicycle facility. See figure below:



F. INTERSECTION TREATMENTS

1. Overview: Intersections present significant challenges to bicyclists, and specific accommodations should be provided to ensure bicyclist safety and comfort. These accommodations may include additional signing and striping, signal modifications, and deliberate transitions from one type of bicycle facility to another.

2. Standard Intersection Treatments for Bicycles Facilities

   a. General:
      i. Bicyclists are required by law to obey traffic control devices at intersections; therefore, traffic control devices shall be designed to account for identified bicycle needs.
      ii. Intersections shall be designed to logically position bicyclists through an intersection from an approaching bicycle facility to the receiving bicycle facility.
      iii. Wayfinding signage should be included wherever two designated bicycle facilities intersect or where a bicycle facility changes direction.
      iv. Green bicycle pavement markings may be used to increase bicycle facility visibility and identify potential conflict areas and increased cyclist/vehicular awareness. Green bicycle pavement markings should not be used in lieu of but in addition to white pavement markings.

   b. Traffic signal considerations:
      General standards for signalized intersections are defined in Chapter 15 and include bicycle accommodations. Bicycle-related signal options are summarized below.
      i. Signal timing and actuation shall consider the needs of bicyclists.
      ii. Bicycle signal heads may be installed at signalized intersections to provide guidance for bicyclists at intersections where movements may not be apparent or where bicycle-specific signal strategies (e.g. bicycle-only phases) are employed.
      iii. Bicycle detection should be used along high-comfort bicycle facilities at actuated traffic signals to alert the signal controller of bicyclist demand.
      iv. When bicycle detection is used, a Bicycle Signal Actuation Sign (R10-22) should be used, and a Bicycle Detection Marking (Standard Detail 01510-09A) shall be placed on the pavement indicating the optimal position for a bicyclist to actuate the signal.
      v. Visibility-limited signal faces shall be adjusted to ensure bicyclists can see the signal indications. If the visibility-limited signal faces cannot be aimed to serve the bicyclist, then separate signal faces shall be provided for bicyclists.

c. On-street bicycle facilities:
   i. On-street bicycle facilities generally do not include crossing markings through intersections. However, crossing markings should be considered when additional guidance is needed to direct bicyclists through the intersection or when increased awareness of bicyclists activity is desired.
   ii. Intersection crossing markings are shown on Standard Detail 01510-09A and may consist of:
      1. Dashed white pavement markings aligned with the lateral extensions of the approach bicycle facility.
      2. A combination of dashed white pavement markings and green bicycle pavement markings may be considered when additional guidance is needed to direct bicyclists through the intersection or when increased visibility is desired.
   iii. If used, intersection crossing markings shall define a space through the intersection with a width that is the greater of 1) the width of the approaching bicycle facility or 2) the standard width for a corresponding high-comfort bicycle facility.
   iv. On approaches to intersections without dedicated right-turn lanes, on-street bicycle facilities should be extended to the STOP bar with the typical characteristics of the facility.
   v. On approaches to major intersections without dedicated right-turn lanes and with high right-turn volumes or with a transit stop, on-street bicycle facilities should be extended to the STOP bar. Any buffer should be dropped approximately 50-200-ft from the STOP bar, and from that point the bicycle facility should be defined by dot striping to emphasize the movements of right-turn vehicles across the bicycle facility.
   vi. Bicycle facilities should not generally terminate at intersections. Where on-street bicycle facilities end at an intersection, signage should be sufficient to provide bicyclists an opportunity to safely make necessary accommodations. At a minimum, "Bike Lane Ends" signage (R3-17, R3-17b) signage shall be used.
   vii. At intersections where on-street, high-comfort bicycle facilities cannot be extended to the intersection because of geometric or ROW constraints, off-street bicycle facility transitions should be explored.
   viii. When transitioning between off-street bicycle facilities and on-street bicycle facilities, the grade should be smooth and comfortable, without significant longitudinal pavement joints or sharp changes in direction. Maximum slope should be 1:7.

d. Separated on-street bicycle facilities:
   i. For two-way separated on-street bicycle facilities (i.e., cycle tracks), bidirectional bicycle traffic shall be designated through the intersection with a center yellow dash and corresponding white dash on the vehicle side lateral extension of the bicycle facility.
   ii. Bicycle-green pavement markings may be considered when additional guidance is needed to direct bicyclists through the intersection or when increased visibility is desired.

e. Off-street bicycle facilities:
   i. People riding bicycles on off-street facilities may not utilize standard pedestrian crosswalks, whether the crosswalks are marked or unmarked. Bicycle crossings must provide bicycle-specific crossing markings.
   ii. Where off-street bicycle-only facilities cross a road, bicycle-green continental pavement markings should designate the bicycle crossing area. These markings should be placed adjacent to the white pedestrian continental pavement markings if present. These roadway crossings may be midblock, at unsignalized intersections, or at signalized intersections.
   iii. Where off-street shared bicycle/pedestrian facilities cross a road, Dual Use Markings shall be used. These roadway crossings may be midblock, at unsignalized intersections, or at signalized intersections.
   iv. Dual Use Markings shall consist of white 24-inch continental pavement markings flanked by 24-inch by 24-inch square green bicycle pavement markings. The width of the white markings shall be greater of 8-ft or the width of the approach facility. See Standard Detail 01510-09A.

3. Special Case Intersection Accommodations for Bicycle Facilities

a. Dedicated Right-Turn Lanes

   i. General:
      1. Dedicated right-turn lanes present crossing challenges for bicycle facilities and should be designed to highlight the crossing maneuver and prioritize bicyclists.
      2. The need for dedicated vehicular turn lanes at intersections should be based on vehicular capacity requirements. Where capacity requirements are satisfied by multiple lane assignment combinations, a dedicated right-turn lane should be considered when bicycle/right-turn conflicts are projected to be high (more than approximately 5 bike/turning-vehicle conflicts/peak hour).

   ii. Design:
      1. See Standard Detail 01510-09A for design details.
      2. Where a dedicated right-turn lane is used, an adjacent on-street bike lane should continue through to the intersection on the left side of the right-turn lane.

3. An on-street bike lane shall not be located on the right side of a dedicated right-turn lane.
4. Where a dedicated right-turn lane crosses a bike lane, the bike lane shall not be required to shift more than 3-ft. This is intended to clarify the requirement for vehicles crossing into the dedicated right-turn lane to yield to bicyclists in the bicycle lane.

iii. Markings:

1. The width of an on-street bike lane adjacent to the left side of a dedicated right-turn lane shall be a minimum of 5-ft (desirable 6-ft).
2. The bike lane through the bike/right-turn conflict zone shall be delineated with combination white/bicycle-green dashed pavement markings.
3. The defined conflict zone should end a minimum of 20-ft from the intersection. Within the section of the bike lane past the conflict zone, the lane shall be fully demarcated with green bicycle pavement markings between two 6-in solid white lines and shall include bike lane symbol and arrow pavement markings.

iv. Signage:

1. A "Right Lane Must Turn Right" sign shall be used at the intersection, and a "Begin Right Turn Lane / Yield to Bikes" sign shall be used at the beginning of the bike lane/right-turn conflict zone.

b. Two-Stage Turn Queue Boxes

i. General:

1. Two-Stage Turn Queue Boxes are an intersection improvement consisting of pavement markings and signage that simplify turn movements for bicyclists across adjacent lanes of traffic or to accommodate two stage crossings. They are most frequently used to facilitate left-turn movements for bicyclists in a bike lane without requiring bicyclists to first merge with adjacent traffic into the appropriate turn lane. Instead, bicyclists make the turn in two movements: first, proceeding through the intersection in the bike lane, then turning ninety degrees within the Queue Box to face in the desired direction in front of motorists on the cross street. Two-Stage Turn Queue Boxes should be considered at intersections for roadways with heavy traffic volumes and when designated on-street bicycle facilities are provided on both intersecting streets.
2. Shall require approval by Houston Public Works.
3. Should only be installed along roadways with designated on-street bicycle facilities.

ii. Design
1. Shall be green bicycle pavement markings with an approved material that provides adequate surface traction.
2. Shall include a bicycle symbol and turn arrow pavement markings to designate the space for turning bicycle use only.
3. Shall be placed in a protected zone that will not be encroached upon by vehicles along the origin street. Depending on the intersection geometry, this zone can be located between the lateral extension of the bicycle facility and the adjacent travel lane on the origin street when a buffer exists or between the pedestrian crosswalk and the bicycle lane.
4. Shall include a "No Turn on Red" sign mounted on the signal assembly directed towards the vehicles on the cross street that would stop behind the turn box.
5. Should be positioned to orient the bicyclist towards the receiving bicycle facility on the cross street.
6. May utilize Intersection Crossing Markings to indicate desired path of bicyclists across the intersection in relation to the Two-Stage Turn Queue Box.

c. Bicycle Box:

i. Purpose: Bike boxes are an intersection design component consisting of pavement markings and signage that enables bicyclists to queue at a red light in front of stopped vehicles in adjacent lanes. Bike boxes promote bicyclist safety by positioning bike riders in front of vehicular traffic improving bicyclist visibility and reducing potential conflicts between bicyclists and turning vehicles. They should be considered at locations where the volume of turning traffic in conflict with an adjacent bicycle facility is high.

ii. Suitability and approvals
1. Shall require approval by the City Traffic Engineer.
2. Shall be allowed only at signalized intersections.
3. Shall only be used in conjunction with on-street bicycle facilities, including standard bike lanes, buffered bike lanes, and separated bicycle lanes.
4. Shall only be approved across a single direction of general purpose lanes. A single bike box will not be approved across bidirectional travel lanes.
5. A bike box may extend across multiple adjacent lanes to accommodate bicycle left-turn movements.

iii. Design
1. See Standard Detail 01510-09A for design details.
2. Shall be filled with bicycle-green pavement markings that provides adequate surface traction.
3. Shall be located between the pedestrian crosswalk and the vehicular STOP bar.
4. Shall include a bicycle symbol pavement marker to designate the space for bicycle use only.
5. Shall include a R10-11A "No Turn on Red" sign mounted on the signal assembly when those movements would be otherwise allowed across the bike box.

d. Roundabouts

i. Purpose: See Chapter 15 regarding general Roundabout Considerations for all roadway users. Bicycle considerations are discussed here.
ii. Bicycle lanes shall not be provided within the circulatory roadway.
iii. Where bicycle lanes or shoulders are used on approach roadways, they should be terminated at least 100-ft from the edge of the circulatory roadway.
iv. Bicyclists may choose to merge with traffic and travel like other vehicles, or a ramp may be provided to allow them to exit the roadway onto the sidewalk (or shared use path) and travel as pedestrians.
v. If a ramp is provided for bicyclists to access the sidewalk, the slope shall not exceed 7:1. Lighting should be considered for increased facility safety at transition point.

4. Side-of-street Transitions

a. General: Side-of-street transitions provide options for transitioning a bicycle facility from one side of the street to the other. For example, a bidirectional cycle track that transitions to a pair of standard one-way bicycle lanes at a traffic signal.

b. Two Stage Crossings

i. General
1. Accommodate bicyclist transitions from one side of the roadway to the other at a signalized intersection by requiring bicyclists to cross each road on a separate signal phase.
2. Shall require approval by Houston Public Works.
3. Shall require bicycle-specific signals and/or signal timing consideration for each stage of the crossing.

4. A designated staging zone shall be provided in which bicyclists can safely wait for the second crossing phase. Staging locations may be located on or off-street based roadway geometrics, available pavement width, presence of on-street parking, lane assignments, and turning movements.
5. This staging zone shall not place the bicyclist in conflict with vehicular traffic.
6. Appropriate pavement markings should be provided to define each crossing.

ii. Design
1. Shall use bicycle-green pavement markings with an approved material that provides adequate surface traction.
2. Shall include a bicycle symbol and turn arrow pavement markings to designate the space for turning bicycle use only.
3. Shall be placed in a protected zone that will not be encroached upon by vehicles along the origin or cross street.
4. May utilize Intersection Crossing Markings to indicate desired path of bicyclists across the intersection.

c. Diagonal Crossing Phase

i. General: Bicyclists transition from one side of the road to the other in a single, independent signal phase at a signalized intersection.
ii. Shall require approval by Houston Public Works.
iii. Is, when feasible, the preferred method of transitioning bicycle travel from one side of the roadway to the opposite side.
iv. Shall require a traffic study to determine feasibility of a diagonal crossing phase. The study shall utilize existing traffic counts and bicycle counts or, if bicycle counts are unavailable, a projection of bicycle usage to determine existing and projected intersection level-of-service (LOS) under NO-BUILD and BUILD scenarios. The LOS shall be computed using Highway Capacity Manual methodology, as detailed in Chapter 15: Traffic Studies.
v. Shall utilize a bicycle-specific signal head, pointing diagonally across the intersection from the receiving bicycle facility towards the originating bicycle facility.
vi. Shall utilize a specific bicycle crossing signal phase that allows bicycles to travel diagonally across the intersection without vehicular conflicts.
vii. Shall require bicycle detection of a type approved by Houston Public Works to call the diagonal signal phase. The diagonal signal phase shall not be called without a detected bicyclist.
viii. May utilize individual signal phases for the different directions of bicycle travel (when applicable) so that the diagonal signal phase is only called when a bicycle is traveling in that direction.

ix. Shall utilize Intersection Crossing Markings to delineate diagonal path of travel across intersection.
x. Should utilize a Bicycle Pavement Marking Symbol and an Arrow Pavement Marker to indicate the diagonal direction of bicycle travel.
xi. Shall utilize signage to indicate the diagonal crossing for the bicycle approach.

G. BIKEWAY AMENITIES

1. Bike Parking: Bicycle parking and associated bicycle racks placed within the public right of way should not impede the flow of traffic (vehicular, pedestrian, or other) or cause any unnecessary obstruction within the right of way. Bike rack spacing and placement shall be approved by Houston Public Works staff. General Spacing standards include:

Table 17.1 – Spacing Standards

~~Spacing Standards:~~			
Location	Orientation	Minimum (in)	Standard (in)
Between Racks	Side-by-Side	36"	48"
	End-to-end	72"	96"
From Curb	Perpendicular	36"	-
	Parallel	24"	-
From Wall	Perpendicular	48"	-
	Parallel	36"	-
From Tree	Parallel	36"	48"

2. Wayfinding: Wayfinding provide direction, destination, and distance information as needed for bicycle travel. If several destinations are to be shown at a single location, they may be placed on a single sign with an arrow (and the distance, if desired) for each name. If more than one destination lies in the same direction, a single arrow may be used for the destinations.

a. A Bike Route sign (D11-1) may be used along any type of bicycle facility as a wayfinding sign.

b. The D1 series of wayfinding signage may be used in conjunction with a Bike Route sign (D11-1).

c. Wayfinding signage, if used, should be placed at logical intervals, especially prior to and at bicycle network decision points.

d. Alternative wayfinding signage design may be provided on off-street trails.

e. Listed Destinations: Requires coordination with and approval by Houston Public Works. Wayfinding should indicate directions to neighborhood amenities and destinations. Wayfinding within the public right-of-way shall not promote the use of any one private or for-profit business (except for grocery stores). Examples of acceptable destinations include:

i. Management District (i.e. Downtown, Montrose, EaDO, etc.),
ii. Transit station (i.e. Park-n-Ride, light rail platform)
iii. Government service centers
iv. Trail access points
v. School/University
vi. Library,
vii. Grocery Store
viii. Bikeway amenities (bike parking, bike shop, bike service center.
ix. Bicycle Parking Area - D4-3

H. BIKE DETOURS

1. Bicycle detours shall be provided wherever a bicycle facility is obstructed.

2. Bicycle detours shall provide a level of user comfort that is equivalent to or superior to that of the obstructed facility.

3. Bicycle detours shall be provided for trail obstructions that reroute trail users to a public street.

17.05 RESERVED FOR TRANSIT DESIGN REQUIREMENTS

A TRANSIT OVERVIEW: TRANSIT OVERVIEW: Reserved

B. TRANSIT SECTION INTRODUCTION: Reserved

C. TRANSIT STOP TYPOLOGIES, STANDARD DIMENSIONS: Reserved

D. TRANSIT STOP PLACEMENT: Reserved

E. TRANSIT STOP CONFIGURATIONS: Reserved

F. TRANSITWAYS: Reserved

G. PAVEMENT MARKINGS/SIGNAGE: Reserved

17.06 PEDESTRIAN DESIGN REQUIREMENTS

A. ~~Design Guidance~~Pedestrian Realm Concept

The Pedestrian Realm includes all elements in the public right of way between the face of curb and the ROW line. This critical element of the public ROW improves safety for all roadway users. It provides dedicated space for people to walk, bike, and wait for transit. It also provides space to ensure adequate sight lines for vehicular drivers and other roadway users. Finally, it also provides accommodations for signage, utilities, street trees, benches, and other necessary or desirable roadway features.

Figure 17.4 shows the components of the Pedestrian Realm, which include:

- Sidewalk – Paved surface for walking and other acceptable public uses.
- Safety Buffer – A paved or unpaved surface between the sidewalk and the back of curb that is intended for utility poles, signage, street trees, benches, METRO transit stops, bike racks, and other approved public uses. If the buffer is paved, then the combined sidewalk and frontage buffer area shall be a minimum of 10 ft.
- Frontage Buffer – A paved or unpaved buffer between the sidewalk and the private ROW line. The safety buffer ensures that the sidewalk is not constructed immediately adjacent to a sight-restricted driveway, building entrance, or other conflict zones.

Figure 17.4 – Pedestrian Realm Components

B. Design Standards

1. City of Houston standards for the design of the Pedestrian Realm and components are shown in Table 17.2

Table 17.2 - Minimum Sidewalk Widths

	Desirable Minimum (ft)	Absolute Minimum (ft)
Pedestrian Realm Width	15	10
Sidewalk Width (Major Thoroughfare, Collector, Transit Street, Type A Street)	6-10+	6
Sidewalk Width (Local)	5+	5
Frontage Buffer	3	0
Safety Buffer	4	2

2. Wherever the minimum elements of the Pedestrian Realm are not met within the public ROW, a sidewalk easement shall be considered before a variance will be approved.

3. The desirable minimum values are preferred to provide a safer, more comfortable experience for people walking.

4. If a sidewalk is used by bicyclists and pedestrians, it should be designed as an off-street bicycle facility or trail as defined in 17.04 Bicycle Geometric Design Requirements.

5. Sidewalks at intersections should be free of obstructions and surface encroachments such as signposts, power poles and down guy wires.

6. Where use of standard sidewalk/ramp details is not possible due to field conditions, engineer shall submit proposed design drawings to City Engineer for approval. Design drawings shall include site field survey conditions.

7. Sidewalks traversing rail lines shall be at 0% slope for a distance of 5 feet from the Center Line of the track.

8. Alternative methods of sidewalk construction may be used in places where tree preservation is of concern. Alternative materials may be but are not limited to decomposed granite and checkered plate.

~~1.~~9. Sidewalk design shall be coordinated with bus stop locations and METRO. See 17.05 Transit Design Requirements.

10. Midblock crosswalks

i. Requires prior approval by HPW.

ii. May be appropriate based on area context including trail intersections and at major trip generators.

iii. All mid-block crosswalks shall be ADA compliant.

iv. For further design considerations, see paragraph 17.04.E.7 – Midblock Crossings.

C. Curb Ramps

1. Curb ramps shall be constructed at all intersection corners for any approach that includes a defined sidewalk.

2. Curb ramps shall cross the street as close as possible to 90 degrees to the centerline of street.

3. Curb ramps shall not point into the center of the intersection.

4. Curb ramps constructed on an intersection corner should be interconnected to create a walking route around the corner.

5. The design of curb ramps shall consider ramp direction, driveway crossings, crosswalk locations and the location of the sidewalk with respect to the curb. Standard curb ramp details are shown in the City's Standard Details.

6. Where use of standard curb ramp details is not possible due to field conditions, engineer shall submit proposed design drawings to City Engineer for approval. Design drawings shall include site field survey conditions.

7. All ramps and sidewalks/walkways shall be constructed in accordance with Agency standard details, Texas Accessibility Standards (TAS), and Americans with Disabilities Act (ADA) Requirements. If there is a conflict in the requirements, the strictest requirements shall govern.

8. Curb ramps that are steeper than a 1:15 max slope will not be accepted by the City of Houston.

~~2. Minimum Sidewalk Width – six (6) ft or more shall be installed along major thoroughfares and five (5) ft or more shall be installed along all other streets. Where appropriate sidewalks may be split or reduced in width at pinch points to preserve mature street trees, and should remain ADA compliant. For Transit Streets see section 10.6.I.3.~~

~~3. The pedestrian realm shall be a minimum of 10 (ten) ft which includes the sidewalk~~

and associated pedestrian amenities such as a pedestrian buffer, tree plantings, or furniture zone. Pedestrian zones should be greater than ten (10) ft where appropriate and may include additional amenities such as a METRO bus shelter and/or bike parking.

4. Sidewalk width should exceed the minimum when ROW is available.

5. A buffer between the sidewalk and roadway is desirable for sidewalks less than ten (10) ft in width. The desirable minimum width is four (4) ft, with an absolute minimum width of two (2) ft.

6. If a sidewalk is used by bicyclists and pedestrians, it should be designed as an off-street bicycle facility or trail as defined in 17.04 BICYCLE GEOMETRIC DESIGN REQUIREMENTS.

7. All curb ramps shall comply with ADA and Texas Accessibility Standards (TAS) requirements.

8. Curb ramps shall be constructed at all signalized intersections and at any legal crossing points for existing or planned sidewalks.

9. Sidewalks constructed along Type A Streets – for Transit Corridor Streets shall have a minimum width of six (6) ft. Ramps, approaches and sidewalks shall comply with ADA and Texas Accessibility Standards (TAS) requirements. Sidewalks for Transit Corridor Street and Type A Streets:

   a. Chapter 42, Article IV – Transit Corridor Development, of the Code of Ordinances regulates improvements constructed in the public right of way within 1,320 ft of each transit station (Ch. 42, Sec 401-406).

   b. Mandatory requirements are summarized below and shown in Standard Detail 02775-08. These requirements are required under IBC, Section 3110). (1) Minimum Sidewalk Width – six (6) ft (must be located within the public right of way or sidewalk easement). (2) Minimum Vertical Clear Zone, a continuous obstacle free path, for a minimum width of six (6) ft and a minimum height of seven and one-half (7 ½) ft.

   c. Performance Standards – Refer to Chapter 42 Sections 401-406:

      i. Minimum Pedestrian Realm – Fifteen (15) ft distance from back of curb to a building's facade or other improvements (can be entirely within public right of way or a combination of public right of way and public access easement).

      ii. Maximum softscape area in the pedestrian realm is 20% of the surface area of the pedestrian realm excluding any driveways and shall be located at least two (2) ft from the back-of-curb of any street area used for parking.

10. Sidewalks at intersections should be free of obstructions and surface encroachments such as sign posts, power poles and down guy wires.

11. Where use of standard sidewalk/ramp details is not possible due to field conditions, engineer shall submit proposed design drawings to City Engineer for approval. Design drawings shall include site field survey conditions.

12. Curb ramps should cross street at 90 degrees to centerline of street. At skewed intersections, curb should be adjusted to allow for high visibility crossing. Stop bars and signage may be used to further alert motor vehicles of crossing.

13. All ramps constructed on an intersection corner should be designed such that a person walking can turn the corner without entering the street.

14. Midblock crossings shall be considered on a case-by-case basis and in coordination with Houston Public Works based on engineering judgment. The design of pedestrian midblock crossings shall follow the requirements in the Midblock Crossing discussion in Section 17.04.

15. Sidewalks traversing rail lines shall be at 0% slope for a distance of five (5) ft from the Center Line of the track.

16. Alternative methods of sidewalk construction may be used in places where tree preservation is of concern. Alternative materials may be but are not limited to decomposed granite and checkered plate.

END OF CHAPTER

b. Transit Corridor Streets - Chapter 42 of the City of Houston Code of Ordinances (Subdivisions, Developments and Platting) and this Infrastructure Design Manual provide planning rules and design standards to achieve multi-modal transportation corridors along designated Transit Streets.

Where a TIA for proposed development along a Transit Corridor Street is required by this chapter, it shall include trip generation estimates in accordance with guidelines presented in Figure 15.04.02. The TIA shall include a summary of estimated trips by applicable transportation categories. Transportation categories may include automobile, truck, transit, bicycle and pedestrian. Trip allocations shall be supported by documentation including data from local planning agencies, records of actual ridership from local transit agencies, statistical data from similar projects in other locations, standards from professional organizations, and other applicable resources. Where the existing, background or projected conditions are LOS E or F and existing physical conditions limit available mitigation measures, the Analysis Engineer shall meet with the City Engineer to review probable community impacts and possible mitigation measures, if any. Approval of TIA's along Transit Corridor Streets may not be withheld where all reasonable and feasible access management and offsite mitigation measures in the public street right of way have been exhausted. Access management and offsite mitigation measures may include the addition of pedestrian/bicycle facilities transit amenities, the installation of turn lanes and/or additional lanes of traffic such as deceleration lanes, the installation of traffic signals, the construction of traffic control features or medians, and/or limitations on the number of driveways.

c. Major Thoroughfares - Chapter 42 of the City of Houston Code of Ordinances establish roadways to be classified as Major Thoroughfares by inclusion on the Major Thoroughfare and Freeway Plan (MTFP). Major Thoroughfares are roadways designed to allow for access from large traffic trip generators and move traffic between adjacent activity centers. Projects in Traffic Impact Categories II, III and IV (see Table 15.04.01) along Major Thoroughfares are expected and fostered because of the traffic carrying capacity. Similar to a Transit Corridor Street, where the existing, background or projected conditions are LOS E or F and existing physical conditions limit available mitigation measures, the Analysis Engineer shall meet with the City Engineer to review probable community impacts and possible mitigation measures if any. Approval of TIA's along Major Thoroughfares may not be withheld where all reasonable and feasible access management and offsite mitigation measures in the public street right of way have been exhausted. Access management and offsite mitigation measures may include the addition of pedestrian/bicycle facilities, the installation of turn lanes and/or additional lanes of traffic such as deceleration lanes, the installation of traffic signals, the construction of traffic control features or medians, and/or limitations on the

number of driveways.

d. Central Business District - Boundaries of the Central Business District (CBD) are defined in Section 15.03. Development and redevelopment of the CBD are anticipated to involve high rise, large traffic generating facilities. Similar to a Transit Corridor Street, where the existing, background or projected conditions are LOS E or F and existing physical conditions limit available mitigation measures, the Analysis Engineer shall meet with the City Engineer to review probable community impacts and possible mitigation measures if any. Approval of TIA's in the CBD may not be withheld where all reasonable and feasible access management and offsite mitigation measures in the public street right of way have been exhausted. Access management and offsite mitigation measures may include the addition of pedestrian/bicycle facilities, the installation of turn lanes and/or additional lanes of traffic such as deceleration lanes, the installation of traffic signals, the construction of traffic control features or medians, and/or limitations on the number of driveways.

e. Major Activity Centers are defined in Section 15.03. Development and redevelopment in Major Activity Centers is anticipated to involve high rise, large traffic generating facilities. Similar to a Transit Corridor Street or Major Thoroughfare, where the existing background or projected conditions are LOS E or F and existing physical conditions limit available mitigation measures, the Analysis Engineer shall meet with the City Engineer to review probable community impacts and mitigation measures, if any. Approval of TIAs within a Major Activity Center may not be withheld when all reasonable and feasible access management and offsite mitigation measures in the public street right of way have been exhausted. Access management and offsite mitigation measures may include the addition of pedestrian/bicycle facilities transit amenities, the installation of turn lanes and/or additional lanes of traffic such as deceleration lanes, the installation of traffic signals, the construction of traffic control features or medians, and/or limitations on the number of driveways.

f. The Mitigation Decision Tree for local roadways and collector streets is shown in Figure 15.04.04 below. The chart is color coded. Purple indicates acceptable levels of service A-D; yellow indicates marginal level of service E; and red indicates unacceptable level of service F. The Tree components are defined as follows:

(1) Existing - represents the performance of the existing street network

(2) Background - represents the performance of the street network for a future year, "no build" scenario. Includes future volumes without the proposed development; accounts for traffic from projects under construction but not yet in operation; and includes any future improvements to the street network that are already programmed, regardless of whether the proposed development is built.

(3) Projected - represents the performance of the street network for a future year, "build scenario", which represents the future street volumes with the proposed development in place. Other than changes in traffic volumes, the "Projected" scenario includes the same street network conditions as the "Background" scenario.

(4) Mitigation - represents the performance of the future street network with the proposed development and with proposed mitigations resulting from the proposed development. Mitigation action is required for all conditions indicated in this row of the Decision Tree.

(5) LOS E and LOS F

(a) Prior to final approval/disapproval involving LOS E and LOS F, the Applicant will meet with City Engineer to review all aspects of proposed development and adjacent roadway conditions including intersection delays.

(b) For areas in the street system where the current LOS is E, the existing LOS must be maintained or improved after development. For example, if the LOS prior to the proposed development is E, then once the development is in place, the projected LOS must be at least E.

(c) For areas in the street system where the current LOS is F, the traffic impacts of the development on the streets and intersection within the analysis area shall be mitigated such that the delay and queuing do not deteriorate beyond Background Conditions.

g. Methodology for computing eachtype of MOE and determining corresponding LOS can be found in the Highway Capacity Manual (HCM).

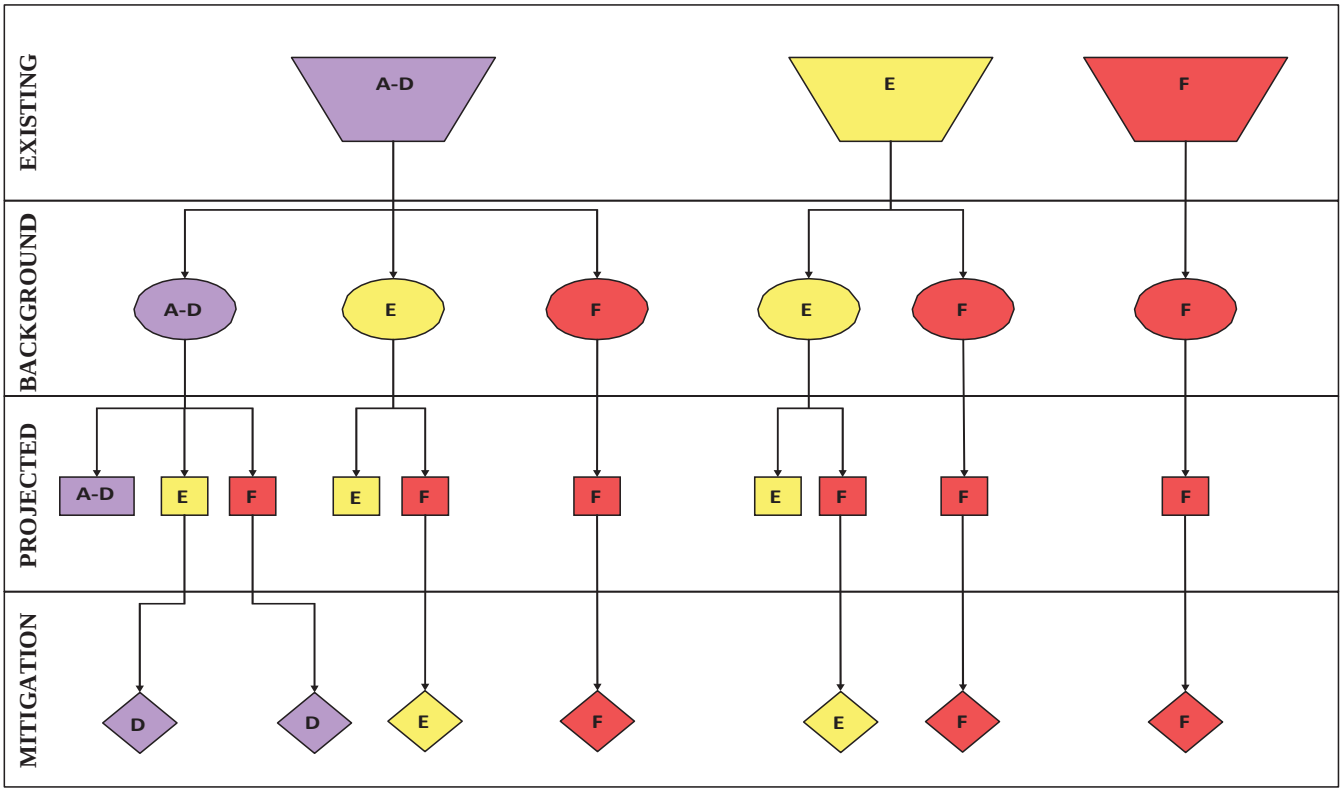


Figure 15.04.04 Mitigation Decision Tree (Collector and Local Roadways)

h. Traffic signal retiming is not considered an acceptable mitigation measure unless it is first approved by the City of Houston Traffic Signal Operations. Typically, an individual intersection cannot be re-optimized in the future if it is a part of coordinated street network. This may only be possible if the entire street network is re-timed to allow for system wide signal progression. If signal retiming is approved by the City as a mitigation measure, it should be included in the "Mitigation" scenario.

7. Traffic Impact Analysis Submission Requirements

a. The Analysis Engineer must identify all of the required data and information in the appropriate sections of the report.

b. Text contained in the document shall be comprehensive and complete.

c. The report shall have an electronic copy of final submittals along with the bound copy.

d. The report shall contain a table of contents, lists of figures and list of tables. A typical TIA report outline is shown in the following sections.

I. Executive Summary

(a) Site Location & Analysis Area
(b) Development Description
(c) Conclusions
(d) Recommendations

II. Introduction

(a) A statement about the purpose and objectives of the analysis.
(b) A description of the existing and expected land use and intensity.
(1) If residential, number and type of dwelling units.
(2) If commercial or industrial, square footage and type.
(3) If redevelopment, what is the expected trip generation differential.
(c) A vicinity map identifying major industrial and site access intersections and other approved projects near the development.
(d) A site plan for the development.
(e) A description of development phasing and estimate year each phase will begin and end.

III. Area Conditions

(a) A description of the analysis area.
(b) A description of existing and future land uses within the analysis area. The description should include current land use, densities and occupancy, anticipated development, undeveloped properties, and current master plans.
(1) If residential, number and type of dwelling units.
(2) If commercial or industrial, square footage and type.
(c) A combination of narratives, tables and figures detailing area street system characteristics within the analysis area including:
(1) Programmed street improvements in the area (City of Houston 5 year Capital Improvement Plan)
(2) Additional streets that may be impacted
(3) Functional Street Classifications (based upon Major Thoroughfare and Freeway Plan)
(4) Posted Speed Limits
(5) Distance, and alignments from existing streets, driveways, and/or median openings to development access (need to assess Access Management Standards)
(6) Traffic control devices (traffic signals and Stop signs)
(7) Signal locations and timings (offsets need to be shown if in coordination)
(8) Intersection layout, lane usage, and street configuration
(9) Street right-of-way widths
(10) Lane widths
(11) Current traffic volumes within the past 1 year to have been captured on a typical Tuesday, Wednesday, or Thursday for all streets in the analysis. Any traffic volumes older than 1 year may not be

acceptable and will need to be justified. The Analysis Engineer should also make every reasonable effort to count traffic that accurately reflects a true "peak period' for the area, which includes any potential seasonal variations (i.e. schools, churches, etc.). Depending on the type of development, it may also be necessary to capture volumes on a typical weekend.

i. 24-hour counts at major intersection and site access intersections

ii. Turning movement counts (Peak Hours)

(12) Pedestrians and Bikes (If Applicable)

i. Facilities

ii. Volumes

(13) Transit Service (If Applicable)

i. All bus stops, bus pads, bus shelters

ii. Ridership (where applicable/when available)

iii. Routes and Service Intervals

(14) Crash Analysis (if Applicable) over the past 3 years, including number and types of crashes as well as severity of injuries.

(15) Existing sight distances – Intersection and stopping sight distances, vertical and horizontal clearances. Refer to Chapter 10, Section 10.06.B.3. Intersection Sight Distance.

IV. Required Table(s)

(a) Twenty-four hour approach volumes at major and site access intersections.

(b) Peak Hour approach volumes at major and site access intersections.

V. Required Figure(s)

(a) Major and site access intersection lane configuration diagrams with existing Twenty-four hour approach volumes. Preferably overlaid onto aerial photography.

(b) Major and site access intersection lane configuration diagrams with existing AM and PM peak hour turning movement volumes. Preferably overlaid onto aerial photography.

(c) The Analysis Engineer may also use photographs (identifying location from where it was taken as well as the date and time stamp) to document existing conditions.

VI. Projected Traffic

(a) Sufficient details of calculations so that all calculations can be verified.

(b) Site generated traffic volumes (24-hour and peak periods) by corresponding development phase or year.

(c) Trip Generation - List of trip generation rates and/or sources of rates used for the study.

(d) Trip Distribution and Assignment - The gravity model or other acceptable trip distribution model used to estimate trip distribution. The Analysis Engineer can complete this task either manually or with applicable

computer models.

(1) Background traffic volumes (24-hour and peak periods) by corresponding development phase or year.

(e) Traffic Volumes should account for all approved developments in the analysis area as well as area growth beyond the analysis area. Contact the City for information about surrounding developments.

(1) Pass-by and diverted traffic volume reduction rates, if applicable.

(2) Pedestrian, bicycle and transit reduction rates, and supporting evidence, if applicable.

(3) Internal capture reduction rates, if applicable.

(4) Total project traffic volumes (24-hour and peak periods) by corresponding development phase or year. Future traffic as may be required for a development with multiple phases should also be included.

(f) Required Table(s)

(1) Pass-by trip, internal capture, pedestrian, bicycles, and transit reduction rates used, if applicable.

(2) Twenty-Four hour approach volumes for background, pass-by, site generated, and total project traffic conditions at major and site access intersections and any additional transportation facilities specified by the City.

(3) Peak Hour approach volumes for background, pass-by, site generated, and total project traffic conditions at major and site access intersections and any additional transportation facilities specified by the City.

(g) Required Figure(s)

(1) Twenty-Four hour, and peak hour approach volumes for background, pass-by, site generated, and total project traffic conditions overlaid onto major and site access intersections lane configuration diagrams. Preferably overlaid onto aerial photography.

(2) Peak hour turning movement volumes for background, pass-by, site generated, and total project traffic conditions overlaid onto major and site access intersections lane configuration diagrams. Preferably overlaid onto aerial photography.

(3) Distribution and assignment rates for pass-by and site generated traffic volumes overlaid onto major and site access intersections lane configuration diagrams. Preferably overlaid onto aerial photography.

VII. Traffic Analysis

Analyze existing, background and project Traffic Conditions LOS and Delay at all major and site access intersections and determine MOEs of any additional transportation facilities within the analysis area as necessary or as specified by the City.

(a) Analysis must utilize existing traffic volumes.

(b) Analysis must utilize total projected traffic volumes which include site

generated traffic and the background traffic to complete analyses for the required study limits and horizons as they correspond to the predetermined TIA category.

(c) Analysis may be prepared manually or by using various software programs such as Highway Capacity Software, Synchro or as approved by the City.

(d) Analysis must utilize the capacity analysis methodology found in the current edition of the Highway Capacity Manual, or control delay calculations from Synchro or other software as approved by the City, and/or delay calculations from micro-simulation of the complete street network (no individual intersections) to determine LOS.

(e) Determination of necessary or specified MOEs should be completed using state- of-the-practice engineering methods.

(f) In addition to LOS and delay, the Analysis Engineer should identify critical movements regarding capacity and potential locations of queue spillback.

(g) The Analysis Engineer should perform a signal warrant analysis for unsignalized intersections (engineering judgment) using the signal warrant guidelines. Additionally, as part of the improvements analysis the Analysis Engineer should analyze any unsignalized intersections warranting a signal as a signalized intersection and discuss within the TIA report.

(h) Tables of existing, background and project traffic conditions LOS and delay for each major and site access intersection and MOEs for any additional transportation facilities specified by the City, include critical movements and queue spillbacks.

VIII. Additional Information (If Applicable)

(a) Site circulation and off-site parking requirements.

(b) Potential parking impact to adjacent neighborhoods and neighborhood parking

(c) Evaluation of potential need for traffic calming including bulb out, chicanes, roundabouts, or those elements found in Section 15.19 of this chapter.

(d) Others (If Applicable)

(1) Crash Analysis
(2) Traffic control needs
(3) Transit (bus and rail)
(4) Pedestrian and bicycle access
(5) Delivery and service vehicles
(6) Transportation demand management.

IX. Transportation Improvements Analysis (Mitigation Measures)

(a) A description and justification of needed transportation improvements to accommodate project traffic conditions

(b) LOS and Delay evaluation and comparison including review of critical

movements and queue spillbacks

(c) MOE comparison for any additional transportation facilities specified by the City

(d) Table(s)

(1) LOS and Delay comparisons for improvements including critical movements and queue spillback

(2) MOE comparisons for any additional transportation facilities improvements

(e) Figure(s)

(1) Concept schematics of improvements including corresponding LOS and Delay values.

X. Site Improvement Analysis

(a) A description of site circulation and recommendations for improvement.

(b) A description of on-site parking and recommendations for improvement including shared parking, if applicable

(c) A description of expected delivery and service vehicle operation and facility use and recommendations for improvement.

(d) A description of expected site passenger loading characteristics related to bus stop/transit and recommendations for improvement.

(e) A description of adherence to related access management concepts as can be found in the City's set of Access Management Standards including driveway design, access spacing, and turning movement treatments.

XI. Conclusions and Recommendations

(a) Traffic Impacts

(b) Adjacent transportation improvements for each horizon year addressing, at a minimum, the following:

(1) Traffic control device(s) (modification or installation)

(2) Additional capacity (left, right, or through lanes)

(3) Need for acceleration or deceleration lanes

(4) Critical movements

(5) Length of storage bays

(6) Implementation schedule

(c) Off site transportation improvements

(1) Modification to existing traffic control device(s)

(2) Additional traffic control device(s)

(3) Additional capacity at major intersections

(4) Additional street capacity

(5) Other

(d) Site transportation improvements

(1) Access Management

(2) Site circulation and parking

(e) Mitigation Measures

(1) The TIA report shall identify the mitigation measures needed as a result of any traffic impacts of the proposed development or redevelopment. The TIA report should also identify who or what

exactly caused the need for each mitigation measure. This information will be used when the Applicant meets with the City Engineer about the implementation and cost appropriations for mitigations measures.

XII. Appendices

Appendices may be included as an attached CD having individual electronic file folders for each appendix and appropriately titled Adobe PDF files.

(a) Basic Trip Generation Worksheet
(b) Capacity Analysis Worksheets or Modeling Software Output
(c) Traffic Volumes (24-hour and peak hour turning movement counts)
(d) Selected Photographs

C. TECHNICAL NOTES

1. Background Trip Determination

Background or non-site traffic forecasts are necessary to determine the impact of the development in horizon years such as the projected year of opening, year of full build-out and five years after full build-out. Background traffic consists of all trips that do not begin or end in the analysis area and all attraction and production trips from existing development within the analysis area. Trips generated from existing development within the analysis area are important as the proposed development may influence existing traffic patterns and potentially generate new trips for existing developments. Background traffic volumes should also include trips generated from other proposed developments within the analysis area. The Analysis Engineer should check with the City to ensure that all approved developments have been included in background traffic determination.

2. Methodologies for Background Traffic Determination

a. There are three basic methodologies used to determine background traffic volumes: build-out, area transportation planning, and trending. Each of these methodologies has strengths and weaknesses. Some methods may be more appropriate depending on the category of the Development. The Analysis Engineer may use any of the three aforementioned methods to determine background traffic volumes. The City anticipates that the majority of background traffic calculations will be completed using trending methods. For this reason, the City provides the following information on trending.

b. Trending or the use of growth rates is a common method used to generate background traffic. This method is particularly useful for smaller developments and studies having shorter horizon periods (5 to 10 years). City of Houston traffic volumes have typically grown between one and two percent per year. Although these growth rates are typical for the whole of the City,

there are some areas that may have higher and lower rates of growth. The Analysis Engineer may find higher growth rates in outlying areas of the City having lower development density, and lower growth rates in older more mature areas of the City that have little or no year-to-year changes in traffic. In general, the City of Houston experiences a growth rate of one percent for all trending analyses. It is a requirement and the responsibility of the Analysis Engineer to apply appropriate growth rates as they correspond to different areas of the city. The Analysis Engineer should provide and justify an expected area growth rate in the proposal of scope for approval by the City. Where feasible, growth rates should be calculated from historical counts.

3. Site Trip Generation

The City requires that the Analysis Engineer generate site traffic using the methodologies found in the current edition of the ITE publication, Trip Generation Handbook. This includes following the "Recommended Procedure for Estimating Trip Generation", as shown in Figure 15.04.02. General Trip Generation Rates shall be obtained from the Trip Generation Handbook, current edition.

The ITE publication suggests using rates from local studies as a preferred method for generating site traffic. If the Analysis Engineer utilizes local studies to determine appropriate rates, it is a requirement and the responsibility of the Analysis Engineer to reference these studies in the TIA report. In addition, the Analysis Engineer must make available copies of the referenced studies if requested by the City. If local rates are not available, the Analysis Engineer shall use equations and rates from the current edition of the ITE Trip Generation report as long as it follows the ITE Recommended Procedure, as shown in Figure 15.04.02. Otherwise, Analysis Engineer should consult with the City and local data may need to be collected

4. Pass-by Trips / Internal Capture

a. The City Traffic Engineer shall approve all pass-by and internal capture reduction for use in the TIA.

b. The added pass-by trip will have little impact on through movement traffic operations or be part of a potential change in travel demand requiring adjacent transportation infrastructure improvements. However, the City recognizes that pass-by trips can affect left- and right- turning movement frequency and may require installation of turn lanes or other forms of mitigation (i.e., exclusive phasing, timing optimization, capacity increase). The Analysis Engineer should redistribute pass-by trips from the through movement to the appropriate left- or right- turning movement for analysis purposes. The Analysis Engineer should provide and justify an expected reduction rate for pass-by trips in the proposal of scope for approval by the City.

c. Development access connections should still carry pass-by trips and the Analysis Engineer should consider those trips in calculating the total number

of trips generated by the proposed development and for necessary adjacent street improvements due to these trips. The City also recommends that the Analysis Engineer account for pass-by trips in the trip assignment step to ensure appropriate left and right turning movement volumes as these added turning vehicles may require the need for the installation of new or additional storage at existing left- and right-turn lanes.

d. Internal capture is the application of a percent reduction in generated trips (driveway trips) and is typically applicable to projects such as shopping centers with out-lots.

5. Generating Trips for Redevelopment

a. For proposed redevelopment, the City allows the Analysis Engineer to subtract trips generated by the existing development from those the new development will generate. Existing trips are preferably derived from traffic counts.

b. If an Applicant proposes changes to only a portion of an existing development, the City allows the Analysis Engineer to subtract any trips associated with that portion of the existing development from the trip that the proposed redevelopment will generate.

6. Site Trip Distribution and Assignment

a. Site traffic distribution and assignment are very subjective tasks and requires the Analysis Engineer to exercise engineering judgment and to call on past experiences in transportation planning.

b. Trip Distribution

(1) Trip distribution efforts, in general, take into consideration the Development as a whole. Determining how generated traffic will access the proposed development can vary greatly and depends on several factors:

(a) Type of development
(b) Size of the development
(c) Where the development will draw or attract traffic from
(d) Competing developments in the area
(e) Surrounding land uses
(f) Condition and capacity of the surrounding street system

(2) The City recommends the Analysis Engineer refer to, or utilize previously determined trip distribution models, planning software, or other recognized and substantiated methods to distribute traffic.

(3) It is a requirement and the responsibility of the Analysis Engineer to document the methodologies or references utilized in completing the task of trip distribution in the TIA report. The Analysis Engineer will also be responsible to provide copies of referenced studies or models if

requested by the City.

7. Trip Assignment

Assigning trips determines the amount of traffic on routes within the street network and analysis area. The Analysis Engineer should assign trips after considering several area and street network characteristics such as logical routings, left-turn movements at unsignalized intersections and access connections, available capacity and existing travel times. The Analysis Engineer should consider traffic conditions for each horizon year and adjust trip assignments accordingly. The Analysis Engineer may also find it necessary to prepare different sets of trip assignments for site generated trips. This may especially be useful if there are a significant number of pass-by trips. It is a requirement and the responsibility of the Analysis Engineer to detail and explain assumptions in the narrative portion of the TIA report.

8. Traffic Analysis

a. Capacity analyses shall be performed on the transportation facilities within the determined analysis area. The Analysis Engineer shall use the methodology of the HCM to complete any capacity analysis. The analyses may be prepared manually or by using various available software programs such as HCS, Synchro, or as approved by the City. In addition to capacity analyses, the Analysis Engineer should consider other factors including safety, circulation, traffic control needs, transit, neighborhood traffic impacts, pedestrian and bicycle access, delivery and service vehicles and transportation demand management.

b. For each analysis horizon, the Analysis Engineer shall utilize the total project traffic volume which includes site generated traffic and the background traffic. Background traffic shall include traffic from other proposed developments within the analysis area and horizon. The Analysis Engineer shall also complete capacity analyses for existing and background conditions in order to provide LOS comparisons.

c. The analysis and site plan of the Development are an iterative process required for each horizon year. The purpose is to show the relationship between the site, its circulation, and plan along with the existing area street system. Accomplishing this allows the Analysis Engineer to better determine deficiencies and develop alternatives for consideration. The Analysis Engineer should define and identify impacts, deficiencies, and need for improvement. The analysis of existing conditions is essential in order to determine pre-development deficiencies and need for improvements.

d. The Analysis Engineer shall tabulate and report LOS and Delay for the transportation facilities within the determined analysis area. The Analysis Engineer should tabulate overall intersection LOS and delay for each

approach and individual movements. The City recognizes that left turning movements and in many cases, the approach LOS may be less than desirable at stop-controlled facilities. Intersection capacity analysis shall include analysis of queue spillbacks and capacity of left and right turn lanes. The LOS for turning movements at all access connections (driveways and turning lanes) at the project site shall also be analyzed.

e. If the Applicant is proposing a traffic signal at an intersection or access connections, the Analysis Engineer shall use the warranting process prescribed by the City's Signal Engineering Section Design Guidelines.

f. All capacity analysis worksheets and modeling software outputs for the existing conditions and horizon years shall be included in the TIA report as an appendix. The City may also require the actual model to be submitted in electronic form.

9. Site Access and Off-Site Improvements

a. The Analysis Engineer should identify needs and deficiencies using the previously prepared analyses. In addition, the Analysis Engineer should develop alternatives to address these needs and should address both on- and off-site improvements, if applicable.

b. Mitigation measures can include, but are not limited to, median openings, turn lanes, bicycle/pedestrian/transit amenities, traffic calming and traffic signals. The Analysis Engineer shall analyze proposed mitigation measures for capacity and other factors. The Analysis Engineer shall base capacity improvements on the LOS.

10. Previously Proposed Transportation Improvements

The Analysis Engineer can factor proposed network improvements into the analysis and can use them as mitigation measures. For example, if the Applicant schedules a Development to open in three years, and the City has a capital project that will widen the street before that time, the Analysis Engineer can consider the proposed capital improvement in the analysis.

11. Phased Developments

a. Phased Developments often present a challenge for the Applicant. In many cases, Phase I of the development is well defined while additional phases are vague and may change with market conditions.

b. It is acceptable to the City for an Applicant to submit a TIA for all phases of the Development including proposed improvements at the start of a project. However, if future phases of the Development change, generating more traffic

than what the Applicant had previously submitted to the City, it will be necessary for an Analysis Engineer to update the existing TIA or prepare a new one. If the Applicant only submits to the City the first phase of the Development, the Applicant should be aware that conditions may change potentially requiring additional on- and off-site improvements. If a Development is to be completed in phases, the TIA can also propose phasing of mitigation. However, the Analysis Engineer must analyze any mitigation measures proposed for the appropriate horizon year.

12. On-Site Planning

a. An integral component of any TIA should include basic site planning. This includes the identification of access connections (e.g., transit connections to existing bicycle and pedestrian facilities), internal circulation, service and delivery access connections and service bays including the use of turning templates as appropriate, and the identification of optimal building locations.

b. Access connections operate as intersections and the City treats them as such. They should have an appropriate number of lanes, adequate storage "ready access to existing transit facilities," pedestrian facilities and appropriate signing and pavement markings. Adequate storage for a larger Development's access connections is often a concern, and if not designed properly, will operate inefficiently creating the potential for traffic to back up onto the street system. Joint access between adjoining properties is desirable; particularly where street frontages are short or internal volumes will be low. Driveways should be located near the property line if possible or the Applicant should make cross access agreements with adjoining property owners.

c. On-site circulation and street design should be consistent with off-site streets. The area street system has shaped driver behavior and expectations; violating these expectations provides potential for safety problems.

d. Consistency between off-site and on-site signage and pavement markings is desirable for managing drivers' expectations. To the extent practical, use of Texas Manual on Uniform Traffic Control Devices (TxMUTCD) approved signs and pavement markings is recommended. Site access connections shall conform to City of Houston Access Management Standards and the Applicant and the Analysis Engineer should consider the following principles:
   (1) Locating proposed traffic signals to provide for progression along the intersecting street.
   (2) Providing the minimum number of access connections that can adequately serve all anticipated traffic traveling to the site.
   (3) Providing adequate capacity/storage at access connections to ensure that traffic accessing the site does not spill back onto adjacent streets.
   (4) Intersecting two-way driveways with streets as close to perpendicular as possible.

(5) Providing adequate capacity/storage at internal intersections, especially those adjacent to public street access connections, to ensure that traffic within the site does not spill back onto adjacent streets.

(6) Providing adequate sight distance and appropriate safety measures at all access connections and internal intersections.

(7) Locate site driveways across from existing public streets, driveways or existing median break locations, i.e., avoid offset driveways or access connections.

e. The Analysis Engineer should base storage lengths at access connections on the City of Houston Design Manual and Access Management Standards. For smaller developments, the Analysis Engineer should design parking and access connections to allow vehicles to align themselves perpendicularly to the adjacent street system. For larger developments, the Analysis Engineer should provide adequate storage to ensure that exiting traffic does not hinder internal circulation. The Analysis Engineer should estimate potential on-site queuing and provide adequate stacking spaces to prevent impacts on adjacent streets as well as bicycle/pedestrian facilities.

D. Traffic Analysis in Major Activity Centers

The City Engineer, together with the Planning and Development Department, may cooperate with management districts, development authorities or other public or private organizations to prepare a transportation plan within a Major Activity Center. While the City may provide oversight, the preparation of the plan is not the responsibility of the City.

1. Transportation Plan and Traffic Analysis

a. The horizon year projections can be used to generate trips for the Major Activity Center study area. A Traffic Impact Analysis can be prepared using this transportation plan identifying impacts and mitigation measures. A plan can be included for how mitigation measures are implemented and these can be incorporated into transportation plans and capital improvement programs within a Major Activity Center.

b. It may be necessary for the Transportation Plan and Traffic Analysis to be updated once every three years.

c. Any proposed development within the Transportation Plan and Traffic Analysis Study Area that will produce the same or less PHT than a use described in the Transportation Plan shall be exempt from preparing a TIA.

d. Any proposed development within the Transportation Plan and Traffic Analysis Study Area that will produce more PHT that described in the Transportation Plan shall be required to amend the Plan or submit a separate stand alone TIA.

2. Developments within a Major Activity Center without a Transportation Plan and associated Traffic Analysis will follow the traffic study requirements in this chapter.

3. Developments within a Major Activity Center will always have the option of preparing a separate TIA specifically for their development.

15.05 TRAFFIC ENGINEERING STUDY FOR DESIGN

15.05.01 GENERAL

Whenever a new roadway is constructed, or when changes are proposed to the cross section of an existing roadway, a Traffic Engineering Study should be performed to determine critical design criteria for the project. Example of projects that may modify the cross section of an existing roadway include the dedication of one or multiple lanes to transit vehicles or pavement marking modifications for implementation of bicycle facilities.

General considerations for a Traffic Engineering Study:

A. The scope of a proposed Traffic Engineering Study shall be coordinated with Transportation and Drainage Operations.

B. A Traffic Engineering Study should emphasize roadway safety for all modes of transportation. Access management strategies should be considered for their potential safety benefits. These strategies can include location of driveways; locations of median openings; and turn restrictions.

C. A traffic engineering study shall be prepared for:
   a. New roadway construction
   b. Roadway reconstruction
   c. Existing roadway cross section modification (e.g. for inclusion of transit, bicycle, or pedestrian infrastructure)

D. The recommendations of the Traffic Engineering Study for design will address such issues including but not limited to:
   a. Number of lanes
   b. Lane assignments
   c. Traffic control including roundabouts and traffic signals
   d. Access management (including driveway locations, median openings, and turn restrictions), and
   e. Accommodations for bicyclists, pedestrians, and transit services

E. The Traffic Engineering Study will comply with requirements of the most recent versions of the Texas Manual on Uniform Traffic Control Devices (TMUTCD), Transportation Research Board Highway Capacity Manual (HCM), AASHTO A Policy on Geometric Design of Highways and Streets ("Green Book"), and other standards of traffic engineering practice, as appropriate.

F. Computer simulation modeling software used in the development of the Traffic Engineering Study must be approved by the City Traffic Engineer for use.

G. When prepared for City of Houston Capital Projects, study findings will be summarized and documented in the Traffic Engineering Report (TER) for design.

15.05.02 COMPONENTS OF TRAFFIC ENGINEERING STUDY

The following sections summarize general components of a Traffic Engineering Study. Specific scope and level of detail should be coordinated with the City Traffic Engineer to tailor the study to the specific design project.

A. Executive Summary — A one- to two-page summary of key features of the report with an emphasis on recommendations. It should be suitable for distribution as an informational handout on the project at public open houses or meetings with citizens.

B. Introduction - a general project description with location map and a discussion of significant landmarks and destinations in the vicinity.

C. Existing Conditions

1. Roadway - Inventory of existing conditions for all roadways, intersecting roadways, and intersections to be improved. The inventory shall include but is not limited to:

a. Roadway geometry and typical roadway cross sections including median treatments and channelization

b. Major traffic-control devices (roundabouts, signals, school zones, stop signs)

c. Auxiliary lanes (left- and right-turn lanes)

d. Sidewalks and designated pedestrian/bicyclist crossing locations

e. Type and frequency of transit as well as any transit stops or stations

f. Bicycle recommendations from the Houston Bike Plan for the corridor and intersecting roadways/trails

g. Availability and location of on-street parking

h. Posted speed limits

i. Ongoing and planned roadway construction projects along or across the project corridor that could impact traffic operations

j. Planned major development in the vicinity of the project

k. Locations of schools and other major traffic generators, including those in development

l. Description of intersection, roadway, and pedestrian lighting

m. Description of existing Intelligent Transportation Systems (ITS) based on Transportation and Drainage Operations data

n. Traffic signs and pavement markings, when requested

2. Traffic data — Traffic data collected for the traffic study shall comply with Section 15.06: Traffic Volumes. The traffic data collection schedule shall be coordinated and approved by the City Traffic Engineer. Data collected should include:

a. Turning movement traffic counts for critical intersections (a.m. and p.m. peak hours). Critical intersections will be determined during the project scoping process. If major off-peak activity is identified (including the weekends), traffic counts for additional hours may be required.

b. Hourly approach traffic volume counts for one full 24-hour period at critical intersections may be needed to determine feasibility of various traffic control options, or if additional peak hours are identified.

c. Average Daily Traffic (ADT) with directional information, hourly volumes, and vehicle speed and classification along the project corridor between existing signalized intersections and other intersecting major streets and critical side streets.

d. Optional: At least one year of crash data from the Houston Police Department for the roadway and at critical intersections collision data (city data). Crash data is required for safety mitigation projects. Crashes should be categorized by "signal-correctable" or "not-signal-correctable." Signal-correctable crashes include right-angle crashes and crashes involving bicyclists and/or pedestrians. They do not include crashes involving left-turn "failure to yield" crashes from the major street or crashes involving right-turning traffic.

e. Capacity and level-of-service analyses for existing conditions along the segments and at critical intersections (a.m. and p.m. peak-hour periods).

f. K (proportion of the ADT occurring in the peak hour) and D (proportion of the peak-hour traffic in the peak direction) factors.

g. Peak-hour factor by approach and by movement at critical intersections as determined by the project manager in coordination with the traffic engineer.

h. Heavy vehicle (truck and bus) percentage during the peak a.m. and p.m. peak periods.

D. Future Projected Design Conditions

Future conditions shall be analyzed for opening day with existing geometry and opening day with proposed alternatives. Additionally, analyses may be requested for a future design year (typically 20 years in the future). The future analyses shall include:

1. Peak hour volume projections for all roadways, intersecting roadways, intersections, and major driveways within the limits of the project or as determined by the Project Manager in coordination with the City Traffic Engineer. The volumes should be based on existing traffic volumes and on traffic projections prepared by the City of Houston or by the Houston-Galveston Area Council regional transportation demand model.

2. Capacity analyses shall be performed at critical intersections impacted by the project for all peak hours. For corridor projects that do not impact critical intersections, Generalized Daily Service Volumes as defined by the HCM may be used to estimate corridor LOS.

3. Discussion of potential traffic impacts on adjacent neighborhoods (both during and after construction), including traffic calming and access management issues, as well as potential mitigation strategies.

4. Preparation of traffic signal warrant analyses for the project opening year at critical intersections as determined by the Project Manager in coordination with the City Traffic Engineer and identified in the project scoping process. Traffic signal warrant analyses will be conducted in accordance with Section 15.11.

5. Preparation of hybrid pedestrian beacon (HAWK) warrants at major midblock crossing locations (e.g. main entrances of schools, trail crossings).

E. Conclusions and Recommendations

1. Summary of improvements necessary to achieve safety, multimodal, and LOS goals as determined by Project Manager in coordination with the City Traffic Engineer.

2. Conceptual improvement diagram illustrating recommended improvements.

3. Recommendations for traffic control including roundabouts, traffic signals, and STOP signs.

4. Proposed roadway typical cross sections, including general purpose lanes, bike lanes, parking lanes, medians, pedestrian realm, and sidewalk.

5. Proposed lane assignments at critical intersections to achieve safety, multimodal, and LOS goals.

6. Auxiliary lanes (left- and right-turn lanes, acceleration and deceleration lanes) including recommended lengths per City approved methodology.

7. Recommendations for transit, pedestrian, and bicyclist facilities, including:

   i. Bike facility type
   ii. Transit facility stop/station locations and special accommodations
   iii. Sidewalks and curb ramps
   iv. Pedestrian/bicyclist crossing locations, including midblock crosswalks and median openings
   v. Pedestrian amenities, including street trees

8. For proposed roundabouts: provide a high-level discussion of proposed lane assignments and expected ROW impacts

9. When the Traffic Engineering Study is prepared to support a City of Houston Capital Project, provide design parameters to be used during final project design including:

   i. Design speeds
   ii. Design vehicle(s)
   iii. Sight distances
   iv. Shoulders
   v. Access control
   vi. Clear zones

10. Access management features, including:

    i. Proposed driveway locations
    ii. Proposed median opening locations
    iii. Access/turn restrictions

11. Proposed strategies for mitigating traffic impact to adjacent neighborhoods.

12. Speed zones if any are proposed that vary from state-defined prima facie speeds, including school speed zones.

13. Recommended locations for school zone flashing beacons.

14. ITS recommendations based on Transportation and Drainage Operations program requirements.

15.06 TRAFFIC VOLUMES

A. The City of Houston, HPW collects and stores a broad range of traffic data to assist design engineers in maintaining and designing safe, and cost effective facilities. The traffic data collection efforts include traffic volume and vehicle classification and speed data surveys, utilizing road tubes, permanent loop sensors, or other devices.

B. The City of Houston uploads and stores historical traffic counts on the City GIMS portal: http://www.gims.houstontx.gov/portalWS/MainPortal.aspx

15.06.01 TRAFFIC STUDIES

A. New traffic volumes must be collected for all traffic studies if existing counts are more than 1 year old if located in an area experiencing high growth or more than 2 years old in all other areas.

B. Counts must be conducted between Tuesday and Thursday when school is in session. They must not be collected on holidays or the day before or after a holiday or when special events may disrupt typical traffic flows.

C. Summer counts may not be used unless authorized by the City Traffic Engineer.

D. General peak hour counts should be conducted between 7-9 am and 4-6 pm. If there is a peak hour generator (such as a bus stop or school) that may affect the designated peak times, this must be identified and approved by the City Traffic Engineer prior to use.

E. ADT and approach counts should include vehicle speeds and a calculated 85th-percentile speed as well as vehicle classifications broken into at least three categories based on size or number of axles.

15.06.02 ADJUSTMENT FACTORS

1. Seasonal Factors. If requested, traffic volumes should be adjusted to reflect the seasonal changes in traffic volumes. The monthly seasonal factor for a particular month is computed by dividing the average annual daily traffic (AADT) by the particular month average daily traffic (ADT):

$$SF = \frac{AADT}{MonthlyADT}$$

2. Peak Hour Factor (PHF). The hourly volume during the analysis hour divided by the peak 15-minute flow rate within the analysis hour. Hourly counts used in traffic analyses must use a PHF adjustment, which is computed by dividing the measured hourly volume by the PHF. Intersection PHF will be applied to all turning movement volumes unless otherwise directed by the City Traffic Engineer.

$$PHF = \frac{HourlyVolume}{4V_{15}}$$

3. K Factors (design hour factor)

   a. The proportion of the AADT occurring in a peak hour. The K- factor is utilized in traffic forecasts to estimate a future peak hour volume to determine roadway capacity needs. The K-factor is used to determine the Design Hour Volume (DHV).

   b. Traffic projections are expressed as AADT and DHV. AADT and DHV are related to each other by use of the K-factor:

$$DHV = AADT \times K$$

4. D-Factor (Directional Distribution)

   a. The percentage of the total, two-way design hour traffic traveling in the peak direction.

   b. The directional distribution is an essential traffic parameter used to determine the Directional Design Hour Volume (DDHV) for the design year. The DDHV is the product obtained by multiplying the DHV and the D-Factor.

$$DDHV = DHV \times D$$

15.07 SCHOOL ZONE POLICIES

15.07.01 GENERAL

A. The City of Houston, HPW, Transportation and Drainage Operations, Schools Coordination Program works with school principals or their designated representatives to develop a plan for creating safe and efficient school zones which balance pedestrian safety, bicycle safety, and roadway mobility needs.

B. School speed zones are installed where students cross or are likely to cross roadways by themselves but may not have a level of mental cognizance to do so safely. The school must be clearly defined as an elementary or middle/junior high school.

C. As the school's principal is in overall responsible charge for all activities associated with a school, the City does not respond specifically to requests from the community at large but do

present any suggestions received to the principal for consideration.

D. All proposed changes or new school zone requests shall be referred to the School Coordinator, at 832-395-3000. In addition, detailed School Zone Policy can be obtained at https://www.publicworks.houstontx.gov/sites/default/files/assets/004-schoolzone_policy_2019.pdf~~https://edocs.publicworks.houstontx.gov/division-files/traffic-operations-division/school-coordination-program/80-school-zone-installation.html~~.

15.07.02 DESIGN REQUIREMENTS ON ROADWAYS WITH EXISTING SCHOOL ZONE

A. Description of Design/Review Process

1. Project Initiation

a. The Consultant shall meet with the City of Houston to discuss the project in detail prior to beginning the school zone redesign/replacement. At this meeting, typical and any specialty school zone issues within the project limits will be discussed. The meeting regarding school zone will generally occur as part of other project initiation meetings and will not require a separate meeting.

2. Collect School Zone Data and Design

a. Collect all data required to develop existing school zone items including but not limited to school zone beacons, designated school crossings, designated or proposed bikeways and school start time and dismissal time. Typically, school zone information will be included as part of the general existing condition data collection effort as defined by the Policy and Procedures for School Zone Installation and Removal.

b. The Consultant shall prepare a plan to maintain existing school zones in safe operational manner if school is in session during construction and replace existing school zones as implemented previously before start of construction. Complete replacement or modification may be required by City of Houston to meet the current standards.

15.07.03 EXISTING SCHOOL ZONES DURING CONSTRUCTION

A. It is the responsibility of the Contractor performing the work to accommodate safe movement of school related activities during the entire duration of the construction period.

B. The Contractor may need to relocate school beacons, school zone signs temporarily during construction before implementation of school zone equipment per design plans at the Contractor's expense. Coordinate relocation of flashing beacons and signage with City staff and school principal.

15.08 ACCESS MANAGEMENT STANDARDS

A. APPLICABILITY

1. The Access Management Standards contained in this section are applicable to each development, all or a portion, which is located within the defined corporate city limits of the City of Houston, Texas.

2. The requirements contained within this section are design standards and will serve as a basis for development plat approvals and building permits. These standards should be used in conjunction with the Houston City Code of Ordinances and other requirements set forth in the Infrastructure Design Manual.

3. Requirements for Access Management Design Techniques - Additional references/ resources are available in Chapter 40 – Streets and Sidewalks of the City of Houston Municipal Code of Ordinances and the Houston Amendments to the 2003 International Building Code; http://www.municode.com/resources/gateway.asp?pid=10123&sid=43.

B. GENERAL

The overall purpose of implementing the City of Houston Access Management Standards is to enhance the functionality of City streets. This enhancement will be accomplished through preservation and improvement of operational efficiency and safety. "Access Management" is the systematic control of the location, spacing, design, and operation of driveways, medians, auxiliary lanes, and intersections in order to improve the balance between access and mobility while preserving street efficiency and safety.

C. ACCESS MANAGEMENT DESIGN

1. Driveways

   a. Driveways and their associated openings should be located and designed to provide reasonable access between private property and the street right of way. The driveway should not create an unmanaged traffic hazard for drivers entering the street or for drivers on the through street, nor negatively impact normal use of street right of way.

   b. The proper location and design of a driveway should be consistent with the safety and convenience of the public and must take into account nature and volume of traffic on abutting streets, dimensions and construction of abutting streets, use of developed property, dimensions of the developed property, and type and locations of improvements to the developed property.

   c. Driveway design considers the effect of vehicles to/from developed property on the movement of traffic and the safety of traveling public on abutting

streets.

d. Driveways are based on two property classifications: single family residential and all others.

e. Driveways to/from a property should include no more than the minimum number to provide reasonable access between the property and abutting street.

f. Driveway width is measured at the beginning of the driveway radii tangents within the driveway (see Figure 15.08.01). Driveway Radius is the rounded edge of a driveway that permits easier entry and exit by turning vehicles. Design standards for minimum driveway width and radius can be found in Table 15.08.01.

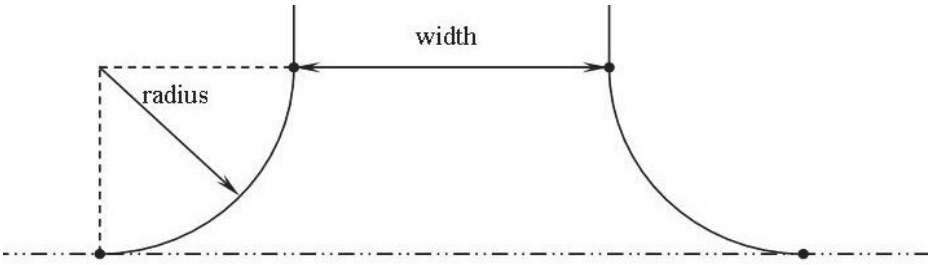


Figure 15.08.01 Driveway Radius and Width

Table 15.08.01 Driveway Design Criteria

	Single Family Residential				Townhomes / Condos**				Commercial*			
	Radius (ft)		Width (ft)		Radius (ft)		Width (ft)		Radius (ft)		Width (ft)	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
~~Shared Access~~Two-way or Shared Access	10	4	24	12	10	4	24	18	20	10	35	24
One-Way	10	4	20	12	10	4	24	15	20	10	20	15

~~* Verify radius and width using turning templates for trucks.~~

~~** If the number of townhomes/condos exceeds twelve (12) units, the development will be considered a 'commercial' development.~~

g. General Driveway Design Criteria

(1) A driveway shall not connect to a sub-standard street. This will not apply to removal and replacement of single-family residential driveways.

(2) A shared driveway cannot connect to a street with a width of less than 18-feet

~~(1)~~(3) One-way driveways must intersect city streets between 45 and 90 degrees.

~~(2)~~(4) Skewed, one-way drives are permitted only on one-way streets and divided streets with no median opening.

~~(3)~~(5) Two-way driveways must intersect city streets at approximately 90

degrees.

~~(4)~~(6) Where situations permit, AASHTO design vehicles may be used to justify driveway radii.

~~(5)~~(7) No driveway radius shall encroach on abutting property or corner radius.

~~(6)~~(8) Driveways shall not be permitted within limits of any intersection. (Design exception shall be required for major thoroughfare locations with existing esplanades and streets used for residential access.)

~~(7)~~(9) For one-way driveways, the entry driveway shall precede exit driveways (in direction of adjacent travel lane).

~~(8)~~(10) Driveway must remain tangential for a minimum of 20 feet past the property line.

~~(9)~~(11) Where present or projected traffic operations indicate needs for alternative driveway geometrics, additional consideration may be given.

2. Driveways and Loading Docks/Wells/Berths

a. Loading docks/wells/berths are not permitted for back-in loading from an adjacent Major Thoroughfare.

b. Loading docks/wells/berths must be located on site to provide for approach and maneuvering on-site with appropriate space to accommodate dimensions of vehicles accessing site.

c. Loading docks/wells/berths must be located on site such that sufficient area is available to store commercial motor vehicle, truck-tractor, trailer, or semi-trailer or combination of such vehicles within the developed property and no part of vehicle shall protrude over the property line or obstruct any public street or sidewalk in whole or in part.

3. Driveway and Corner Clearance Spacing

a. General Driveway Spacing Criteria

(1) The distance between connections (driveway-driveway and driveway-street) is measured along the edge of traveled way from the closest edge of pavement of the first connection to the closest edge of pavement of the second connection

(2) A pair of one-way driveways (entry and exit) should be considered as a two-way driveway for driveway spacing purposes.

(3) Spacing between one-way driveways requires the entry precedes the exit in the direction off the adjacent travel lane and the one-way pair meets spacing requirements from adjacent driveways or streets.

(4) For the special situation of multiple entry driveways placed on one-way street and exit driveways placed on a different street, two same

street driveways should be considered as a one-way pair.

(5) Driveways on a street without a median should align with driveways on the opposite side of the street.

(6) Driveways shall not be placed in the intersection limits (see 15.03.I for definition of intersection limits).

(7) Driveway should be placed of a minimum offset distance of 75 ft from the median nose.

b. Residential Driveway Spacing - see Figure 15.08.02 for residential driveway spacing definitions and Table 15.08.02 for residential driveway spacing criteria.

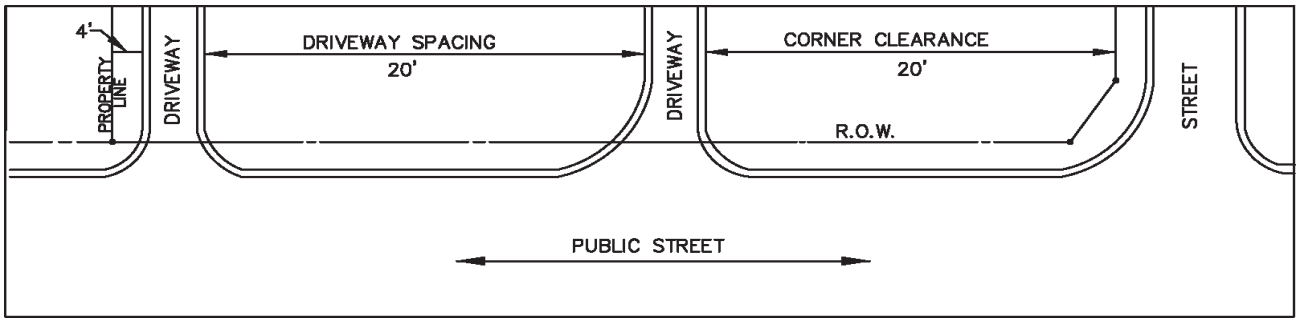


Figure 15.08.02 Residential Driveway Spacing

Table 15.08.02 Residential Driveway Spacing Criteria

	Between Adjacent Driveways	Between Adjacent Street ROW	Between Side Property Line	Maximum Number of Driveways
	Spacing (Minimum dimension in ft)			
Single Family Residential	20(1)	20	4(5)	2

(1) 10 foot minimum between pair of one-way driveways
(2) All proposed access connections must be placed to achieve adequate intersection sight distance for safe and efficient departure from the proposed location (comply with AASHTO standard).
(3) Driveway radius cannot extend beyond property line.
(4) Driveway radius cannot extend into public street or other driveway curb radius.
(5) When spacing of driveways results in a roadside ditch that is less than 8' long (e.g., less than 8' between culverts), options shall be considered to address maintenance challenges and may include replacement of the short roadside ditch with a long run culvert.

c. Non-Residential Driveway Spacing - see Figure 15.08.03 for non-residential driveway spacing definitions and Table 15.08.03 for non-residential driveway placement criteria.

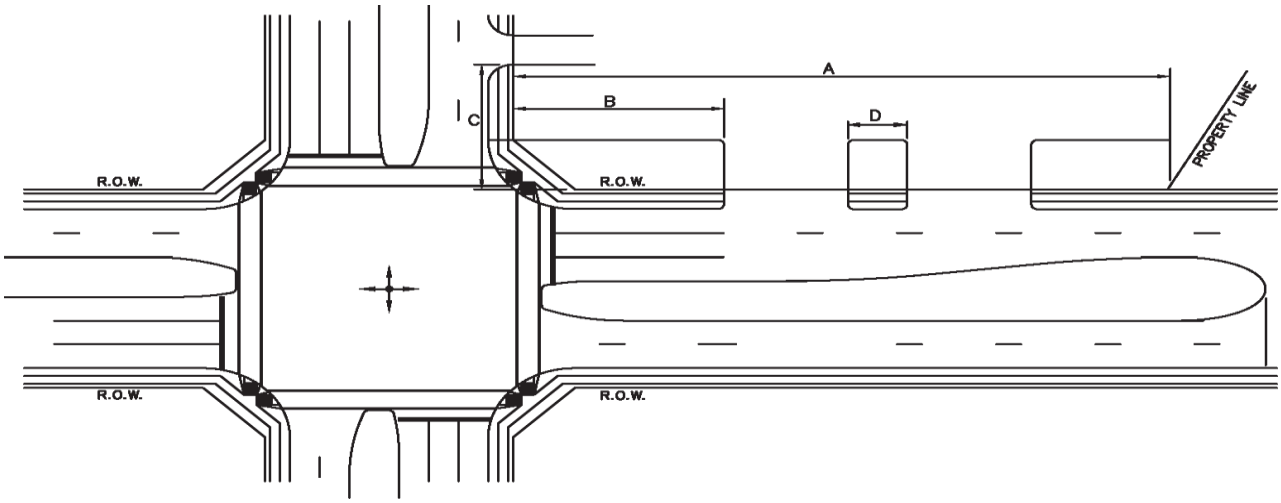


Figure 15.08.03 Driveway Placement

Table 15.08.03 Non-Residential Driveway Placement Criteria (1)

A	Number of Driveways	B	C	D
Frontage (2)		**Minimum Driveway Offset (Primary Street)**	**Minimum Driveway Offset (8) (Intersecting Street)**	**Minimum Driveway Spacing**
Up to 170 feet	1	100 feet	60 feet	20 feet
170 to 250 feet	2	100 feet	60 feet	40 feet
250 to 450 feet	3	100 feet	60 feet	40 feet
> 450 feet	1 additional / 250' frontage	100 feet	60 feet	40 feet

(1) Applicable to driveways designed for commercial traffic (auto, truck, and bus access).
(2) Where the development frontage is equal to or greater than the distance to first median opening, at least one driveway will be aligned with the existing and/or future location of the median opening.
(3) For CBD or Locations unable to comply, approval of the City Engineer required.
(4) All proposed access connections must be placed to achieve adequate intersection sight distance for safe and efficient departure from the proposed access connection (comply with AASHTO standard).
(5) The minimum driveway offset for all major thoroughfare shall be 100 feet.
(6) Driveway radius cannot extend beyond property line.
(7) Driveway radius cannot extend into public street or other driveway curb radius.
(8) Minimum offset will be 100' along bus routes.

4. Medians

a. Median design involves mainly median type, opening, and length. Installing medians provides the potential for safer street operation, increased capacity, and improved aesthetics.

b. Median Openings
Median openings allow vehicles to cross opposing traffic lanes at designated locations. Requirements for median openings can be found in Chapter 10.08 of this manual.

c. Minimum Median Lengths
The minimum lengths of medians between openings are determined by the functional classification of the street and the type of interruption (thoroughfare, collector, local street, private driveway, etc.) of the adjacent openings. Requirements can be found in Chapter 10.08 of this Manual.

5. Treatments for Turning Movements

a. Turn lanes provide a refuge area for left and right turning vehicles. Turn lanes may be placed at intersection approaches, driveway approaches, and median openings to remove turning vehicles from the through lanes, thus reducing congestion and improving traffic operations, capacity, and safety.

b. Dedicated Left-Turn Lanes
(1) Left-turn lanes shall be considered in the following situations:
(a) All signalized intersection approaches along planned or existing streets having a classification of collector or higher;
(b) All unsignalized intersections and driveways along divided streets having a classification of collector or higher;
(c) All unsignalized intersections and driveways along undivided streets having a classification of thoroughfare or higher;
(d) All developments in excess of five acres located within 500 feet of the intersection of two or more thoroughfare facilities;
(e) New public or private school construction;
(f) Shopping centers and other traffic generators with a lease space in excess of one hundred thousand square feet;
(g) Places of worship.
(2) Request not to install dedicated left-turn lanes shall be guided by a traffic study and requires approval from the City Engineer.

c. Dedicated Right-Turn Lanes
The use of dedicated right-turn lanes should always be guided by a traffic study.

6. Minimum Turning Treatment Storage Length

a. Storage length, as shown in Figure 15.08.04, is an important design element that ensures the provision of sufficient turn lane storage capacity to reduce instances of spillback. Left- and right-turn lane storage lengths must not be less than the minimum requirements outlined in Chapter 10.06 of this Manual.

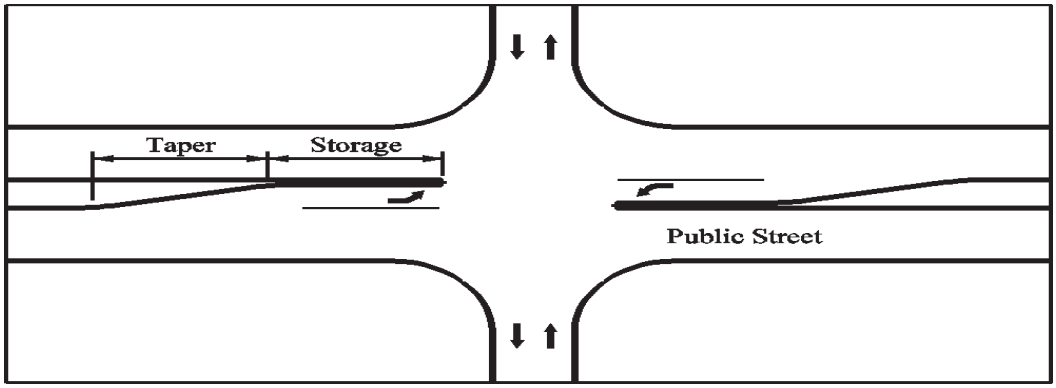


Figure 15.08.04 Turn Lane Details

b. Calculating Required Storage Length (Single Lane)
The required storage length for both left- and right-turn lanes can be obtained using traffic modeling software such as the latest version of the HCM Software (HCS) or Synchro/SimTraffic. The 95th percentile queue length is a widely accepted value for storage length. The following methods may be used to determine storage length.

Signalized Storage Length
For signalized intersections, the storage length should be determined based on results from computer analysis software.

Unsignalized Storage Length
Equation 1 is used to calculate unsignalized storage length.

$$L=(V/30)(2)(S) \qquad \text{(Equation 1)}$$

Where:
L = storage length in feet
V/30 = turning volume in a two-minute interval
2 = a factor that provides for storage of all left-turning vehicles on most cycles
S = queue storage length, in feet per vehicle

15.09 TRAFFIC SIGNS

15.09.01 GENERAL

A. This section of the Design Manual contains the criteria and formats to be used in designing and preparing plans for the installation and refurbishing of traffic signs in the City of Houston. The intent is to establish standard procedures and requirements that will be used by engineering designers and consultants when designing signing for City of Houston projects. All design shall also be in accordance with the Standard Highway Sign Designs (SHSD) for Texas and with the Texas Manual of Uniform Traffic Control Devices (TMUTCD).

B. This document provides Designers and Consultants with:

1. the design requirements and guidelines for ensuring uniformity in sign types, mounting, size, and placement; and

2. the required format of plan sheets to allow ease of review, minimization of construction errors, and facilitation of maintenance.

15.09.02 DESIGN REQUIREMENTS

A. Description of Design/Review Process

1. Project Initiation

a. Determine Requirements of Other Agencies.
If the project falls under TxDOT's jurisdiction, verify TxDOT's signing requirements and if discrepancies exist between the City's requirements and TxDOT's, the Consultant shall meet with the City Traffic Engineer to reconcile any differences.

b. The Consultant shall meet with the City of Houston prior to beginning the signing design to discuss the project in detail. At this meeting, typical and any specialty signing within the project limits will be discussed. The meeting regarding traffic signing will generally occur as part of other project initiation meetings and will not require a separate meeting.

2. Collect Engineering Data

a. Collect all data required to develop a base map of existing conditions which can be used for the design process. Typically, traffic signing design will be included as part of a roadway, intersection, or traffic signal design project, and base maps for traffic signing design can be generated from the topographic survey and/or other design sheets.

b. The Consultant shall visit the project site to inventory and identify physical features that may impact traffic signing designs.

c. The Consultant shall perform an inventory of existing signing. The inventory shall include but is not limited to the following:
   (1) Sign size, sign material, and general condition of the sign
   (2) Sign type and legend
   (3) Posted speed limit(s)
   (4) Any specialty signs
   (5) Sign post and foundation type
   (6) Identify signs that will need to be relocated or replaced.
   (7) Any obstructions or geometric features that may interfere with the installation or visibility of signs.

3. Develop Base Map of Existing Conditions

   a. The Consultant shall develop a base map showing all the applicable data collected. The base map or drawing will be used to show the traffic signing design.

   b. The base map shall include but is not limited to the following information:
      (1) All roadway curb and gutter or edges of pavement
      (2) Roadway stations and centerline
      (3) Right-of-way, easements and street names
      (4) Driveways and intersections
      (5) Sidewalks, bus stops, pads, and shelters
      (6) Other features deemed pertinent

4. Plans and Drawings

   a. General
      (1) All traffic signing design shall be prepared on design sheet size required by the Project Manager, using the Standard City of Houston, Houston Public Works Title Block. On the Traffic signing plans; proposed pavement markings shall be shown as a background information without callouts. Refer to Section 15.10, Pavement Markings, for details regarding the design of pavement markings.
      (2) All full size designs shall be prepared at a scale of 1 inch equals 40 feet. If other design scales are needed, approval from the City Project Manager is needed before beginning design.
      (3) All construction drawings shall be prepared in accordance with Chapter 3, Graphic Requirements.
      (4) On projects where the Consultant finds it necessary to deviate from the standard format presented herein, due to project scope or design requirements, the City's Project Manager should be consulted to determine an acceptable alternate format. Any changes to the format are at the discretion of the City's project manager.

b. General Notes

General Notes shown on City of Houston Standard Detail 01509-01 should appear on all traffic sign design sheets. Additional notes may be added by the Consultant as may be necessary to properly clarify the intent of the design. The general notes in short include but not limited to the following items.

(1) Prior to start of construction, all existing signs within the area of construction shall be inventoried and documented jointly by the City Inspector and the Contractor. This document will be jointly signed by both parties reflecting the sign type, sign size, sign condition, sign location, reflectivity adequacy, etc. The Contractor is held accountable for these signs throughout the Project and at the Project's completion.

(2) The Contractor will be responsible for safeguarding existing signs so that they either continue to remain visible and upright in the field or they are collected and stored in a secure area when temporary signs are used in lieu of the existing signs.

(3) The Contractor will be responsible for re-installing existing signs that have been removed and stored by the Contractor if required per construction plans. The Contractor will provide and install signs that were documented missing prior to the start of work.

(4) The Contractor shall replace any signs that are lost or damaged during construction. All signs shall meet City standards.

(5) The Contractor shall install all permanent signs, posts and hardware as shown on the plans.

c. Ground Mounted Signs

(1) All ground mounted signs, unless noted otherwise, shall be mounted at a height of 7 feet measured from the bottom of the sign to the top of curb or top of roadway at edge of pavement and shall be a minimum of 24 inches from the edge of pavement or curb.

(2) All ground mounted signs shall use perforated square metal tubing 1-3/4" by 1-3/4". Special permission from the City Traffic Engineer will be required to use any other metal sign post.

(3) Refer to City of Houston Standard Details 01509-01 and 01509-01A for additional design requirements.

d. Street Name Signs

(1) Street name signs shall include block numbers per the Standard Details.

(2) Ground-mounted street name signs shall have a height of 9 inches. The length shall be 30 inches minimum and 48 inches maximum (in 1- inch increments). Sign plates longer than 48 inches must be approved by the City Traffic Engineer.

(3) Refer to City of Houston Standard Detail 01509-02 (Street Name Sign and Sign Mounting) for additional requirements related to ground mounted street name signs. Refer to Chapter 15, Section 15.11 (Traffic

Signals) of this Manual for overhead mounted street name signs.

(4) Customized street name signs require separate approval from the City Traffic Engineer. This includes ground mounted signs, overhead street name signs, and sign toppers. Interested parties should contact the Traffic Hotline at 832-395-3000 to apply.

(5) All new signs shall have the City bar code stickers.

e. Ground Mounted Sign Sizes

(1) All "STOP" and "YIELD" signs installed in the City of Houston shall be a minimum of 36 inches for vehicular traffic and 18 inches for non-motorized traffic.

(2) Refer to City of Houston Standard Detail 01509-03 (Ground Mounted Sign Sizes) for dimensions of typically used sign plates and dimension of attachment holes.

f. Sign Placement

(1) The placement of all signs shall be in conformance with the latest edition of the Texas Manual of Uniform Traffic Control Devices (TMUTCD).

(2) Refer to City of Houston Standard Detail 01509-04 (Sign Placement) for typical sign placement details and street name signs at typical intersections.

(3) Refer to Traffic Signal Details for additional information regarding typical placement and location for signs mounted on mast arms.

g. City of Houston Approved Signs

(1) City of Houston Standard Detail 01509-05 and 01509-06 provide lists of Regulatory, Warning, Construction Work, Bicycle, and School signs with corresponding sign nomenclature, and dimension.

(2) The designer shall use the signs listed on City of Houston Standard Detail 01509-05 and 01509-06. Special permission from the City Traffic Engineer will be required to adjust the sign dimensions and/or use additional signs approved by TMUTCD. Note that this does not apply to special signs and guide signs specifically tailored for a specific location.

(3) Guide signs for the following entities may be permitted within the City right-of-way. These entities may be required to install and maintain their own signs:

- Public airports with a minimum of 15 regularly scheduled flights daily.
- College and university campuses with a minimum of 500 off-street parking spaces.
- Recreation and cultural interest facilities with minimum annual attendance of 100,000 visitors.
- Hospitals with designated trauma facilities.

Contact TDO for submittal and approval requirements.

h. Sign Summary Sheet

The Consultant shall include a sign summary sheet as part of the signing design. The format of the Sign Summary Sheet is shown by City of Houston Standard Detail 01509-07 (Summary of Signs). The sign summary table shall include the following information: plan sheet number, sign number, sign nomenclature, sign text, dimensions, post type, number of posts, sign area (square footage only for special signs), and sign post size.

15.10 TRAFFIC PAVEMENT MARKINGS

15.10.01 GENERAL

A. This section of the Design Manual contains the criteria and formats to be used in designing and preparing plans for the installation of pavement markings in the City of Houston. The intent is to establish standard procedures and requirements that will be used by engineering designers and consultants when designing pavement markings for City of Houston projects. All design shall also be in accordance with the Texas Manual of Uniform Traffic Control Devices (TMUTCD).

B. This document provides Designers and Consultants with:

1. The design requirements and guidelines for ensuring uniformity in pavement marking materials, arrangement, and details; and

2. The required format of plan sheets to allow ease of review, minimization of construction errors, and facilitation of maintenance.

15.10.02 DESIGN REQUIREMENTS

A. Description of Design/Review Process

1. Project Initiation

a. Determine Requirements of Other Agencies. If the project falls under TxDOT's jurisdiction, verify TxDOT's pavement marking requirements and if discrepancies exist between the City's requirements and TxDOT's, the Consultant shall meet with the City Traffic Engineer to reconcile any differences.

b. The Consultant shall meet with the City of Houston prior to beginning the pavement marking design to discuss the project in detail. At this meeting, typical and any specialty pavement markings within the project limits will be discussed. The meeting regarding pavement marking generally occurs as part of other project initiation meetings and will not require a separate meeting.

2. Collect Engineering Data

a. Collect all data required to develop a base map of existing conditions which can be used for the design process. Typically, pavement marking design will be included as part of a roadway, intersection, or traffic signal design project and base maps for traffic pavement marking design can be generated from the topographic survey and/or other design sheets.

b. The Consultant shall visit the project site to inventory and identify physical features that may impact pavement marking design.

c. The Consultant shall perform an inventory of existing pavement markings. The inventory shall include but is not limited to the following:
   (1) Lane width, pavement marking material, and general condition of the markings
   (2) Posted speed limit(s)
   (3) Any special pavement markings such as rail crossings, school zone, bicycle facilities, etc., and
   (4) Existing lane configurations and lane assignments.

3. Develop Base Map of Existing Conditions

a. The Consultant shall develop a base map showing all the applicable data collected. The base map or drawing will be used to show the pavement marking design.

b. The base map shall include but is not limited to the following information:
   (1) All roadway curb and gutter or edges of pavement
   (2) Roadway stations and centerline
   (3) Right-of-way
   (4) Driveways and intersections
   (5) Sidewalks, bus stops, pads, and shelters
   (6) Other features deemed pertinent

4. Plans and Drawings

a. General
   (1) All pavement markings design shall be prepared on design sheet size required by the Project Manager, using the Standard City of Houston, Houston Public Works Title Block. Traffic signing and pavement markings shall be shown on different plan sheets. Refer to Section 15.09, Traffic Signs, for details regarding the design of traffic signs.
   (2) All full size designs shall be prepared at a scale of 1 inch equals 40 feet excluding notes and detail sheets. If other design scales are needed, approval from the City Project Manager is needed before beginning design.
   (3) All construction drawings shall be prepared in accordance with Chapter 3, Graphic Requirements.
   (4) On projects where the Consultant finds it necessary to deviate from the standard format presented herein, due to project scope or design requirements, the City's Project Manager should be consulted to determine an acceptable alternate format. Any changes to the format are at the discretion of the City's project manager.
   (5) Limits of the project (beginning and ending stations) are to be provided including centerlines and stationing at 100-foot intervals.
   (6) All changes to pavement marking lines and symbols shall be labeled by station call-outs to the nearest whole number (##+##).
   (7) Existing pavement markings to remain and proposed items such as ROW lines, edge of pavement, and curbs shall be delineated at lighter weight/shade than proposed pavement markings on pavement marking design sheets.
   (8) At a minimum, lane widths between lane markings and face of curb/edge of pavements shall be provided every 500 feet using the center of the pavement markings as a reference point.
   (9) General notes and quantities of pavement markings and sheet shall be prepared for every design project. In addition, line style designation methodology shown on City of Houston Standard Detail 01510-01 shall be used to call out pavement marking line types on all design sheets.

b. General Notes

General Notes shown in City of Houston Standard Detail 01510-01 should appear on all pavement marking design sheets. Additional notes may be added by the Designer as may be necessary to properly clarify the intent of the design.

(1) With the general notes a table showing bid items and quantities shall be provided.

(2) Every type of pavement marking line width, pattern, and width combination shall be assigned specific bid item with quantity in linear feet (LF). For example, lane lines (WB4) will have total LF quantity and unique bid item number.

(3) Every symbol and text type shall be assigned a bid item with quantity as Each (EA). For example, white single arrow will have total count quantity and unique bid item number.

(4) Every type of Raised Pavement Marker (RPM) shall be assigned a bid item with quantity as Each (EA). For example, Type I-C "C" RRPM will have total count quantity and unique bid item number.

c. Left/Right-Turn "Only" and Arrow Spacing (Refer to City of Houston Standard Detail 01510-02)

d. Pavement Marking Words (Refer to City of Houston Standard Detail 01510-03)

e. Pavement Marking Symbols and Arrows (Refer to City of Houston Standard Detail 01510-04)

f. Standard Pavement Markings with Reflective Raised Pavement Markers for Position Guidance (Refer to City of Houston Standard Detail 01510-05)

g. Use of Reflective Chip Seal Marker for Temporary Markings (Refer to City of Houston Standard Detail 01510-06)

(1) On some long term temporary pavement markings plan, the designer may select use of raised pavement marker buttons instead of chip seal marker. In such cases the designer has to provide special temporary pavement marking RPM button arrangements for each line type and use of reflective raised pavement markers.

h. Pavement Marking for Accessible Parking (Refer to City of Houston Standard Detail 01510-07)

(1) Please note that angled parking on public streets requires City Council approval before implementation per City of Houston Code of Ordinances.

i. Railroad Crossing Pavement Markings (Refer to City of Houston Standard Detail 01510-08)

j. Bicycle Facilities Pavement Markings (Refer to City of Houston Standard Detail 01510-09)

k. Crosswalks Pavement Markings (Refer to City of Houston Standard Detail 01510-10)

(1) High visibility crosswalks should only be used where documented need is identified such as designated school crossings.

l. Right- and Left-Turn Lanes (Refer to City of Houston Standard Details 01510-11 and 01510-12)

m. Two-Way Left-Turn Lanes (Refer to City of Houston Standard Details 01510-13 and 01510-14)

15.11 TRAFFIC SIGNALS

Requirements for reviewed and approved plans not constructed within a 2-year period.

15.11.01 GENERAL

A. This document presents the criteria and formats to be used in designing improvements and preparing plans for traffic signal work in the City of Houston. It will also outline general requirements and guidelines to be followed by the designers of traffic signals for the City of Houston. This section is not intended to replace sound engineering judgment or the standards of engineering practice. The designer shall also follow the guidelines published in the Texas Manual on Uniform Traffic Control Devices and in documents from the Institute of Transportation Engineers.

B. These design guidelines are applicable to both new traffic signal construction and to the modification of existing traffic signals. If any portion of a traffic signal installation is being modified, the City requires the entire signal be upgraded to current standards. Permission to deviate from these standards must be received prior to submission on construction drawings for review and approval.

C. The document provides consultants with:

1. The analysis requirements for determining what improvements should be recommended,

2. The design requirements and guidelines for ensuring uniformity in type and location of equipment, operational features, and intersection layout; and

3. The required format of plans and contract documents to allow ease of review, minimization of construction errors, and facilitation of maintenance.

15.11.02 DESIGN REQUIREMENTS

A. Description of Design/ Review Process

1. Solicit Information From Other Agencies

   a. Determine Requirements of Other Agencies & Property Owners.
   Verify with TxDOT their requirements if the intersection or street approaches fall under their jurisdiction. If discrepancies exist between the City's requirements and TxDOT's, the Consultant shall meet with the City Traffic Engineer to reconcile any differences. If access to private property (residential, industrial, or commercial, etc.) is involved, the Consultant shall contact the property owner involved, determine how the access will be affected, and coordinate with the City any differences which may exist.

   b. Contact Appropriate Electrical Utility for Power Hook-up and Illumination Requirements. The Consultant shall verify with the electric utility involved in the project the power hook-up requirements. The Consultant shall work with the Utility to determine the service location during design and this location shall be indicated on the plans. The Consultant shall note who is responsible for each component of a service hook-up, including the conduit and cable run from the load center to the power source, the conduit riser on the power pole and the actual splice into the power system. The responsibilities shall be clearly stated in the project plans.

   c. Contact the Railroads and Verify Their Requirements Regarding Traffic Signal Pre-emption or Crossing of Tracks with Conduit Runs.
   If railroad pre-emption is required in compliance with MUTCD guidelines, contact should be made with the railroad's manager of telecommunications and signals, and the City of Houston's signal operations representative early in the design process to determine their needs or requirements. If railroad right-of-way must be crossed with conduit runs, the Consultant shall determine the railroad's requirements for conduit type, size, depth, construction methods and restrictions.

2. Collect Engineering Data.

   a. Collect all data required to develop a base map of existing conditions which can be used for the design process and operational evaluation.

   b. Topographic Features
   On each approach where advance detection or street improvements are anticipated, detailed information on topographic features should be collected for the area within 500 feet of the intersection. Otherwise, the topographic information is only required for the distance anticipated for the detection zone setbacks and for poles, traffic signal controllers, and related underground conduits.
      (1) Widths and alignments of streets, lanes, and shoulders
      (2) Median widths and lengths
      (3) Curve radii
      (4) Tapers
      (5) Turn lanes

(6) Driveways & sidewalks
(7) Pavement type
(8) Existing pavement markings and raised channelization
(9) Grades
(10) Sight distance obstructions
(11) Parking conditions
(12) Right-of-way lines and easements
(13) Building lines
(14) Angle of intersecting streets
(15) Trees and shrubs
(16) Railings and barriers
(17) ADA accessible curb ramps
(18) Street furniture
(19) Drainage features
(20) Traffic signal equipment:
  (a) Pole locations
  (b) Signal head locations and types
  (c) Controller cabinet location
  (d) Pull boxes (location and size), and conduits
  (e) Detector locations
  (f) Service location (existing and potential)
  (g) Existing signal communications system and associated infrastructure
  (h) Emergency and/or railroad preemption systems
(21) Existing illumination (location and type)
(22) Existing signs
(23) Existing pavement markings
(24) Overhead utilities (horizontal and vertical clearances)
(25) Underground utilities

Special attention should be given to obtaining a precise location of utilities. The designer shall request utility information from all utilities within the survey area. Field location should be requested for all utilities including traffic signal cables, conduits and detectors. Accurate horizontal and vertical clearance information shall be obtained for overhead utility lines including the sag of the cables between supports.

c. Operational Data (If the Location has an Existing Traffic Signal):
(1) Phasing and timings
(2) Signal displays
(3) Type of controller and cabinet
(4) Detection methodology
(5) Traffic Signal Communications System Features

d. Traffic Data (If Required by the City):
(1) Counts and projected volumes (24-hour approach and turning

movements in am, pm, and noon peaks)
(2) Speed limit and speed study
(3) Accident history and diagrams (if available)
(4) Pedestrian volume and patterns

e. Miscellaneous Data:
(1) Bus stops and routes
(2) Adjacent land uses
(3) Proximity of railroad crossings
(4) Proximity of emergency vehicle sources
(5) Other construction in progress in the area
(6) Adjacent street and drainage structures

It may be possible to obtain information on existing topographic features from existing plans or maps. This data may be used for reference, but all plan preparation shall be based on field survey unless pre-approved by the City. Operational data and traffic data may be available from the City but may need to be supplemented by studies conducted by the Consultant.

3. Develop Base Map of Existing Conditions.

a. The Consultant shall develop a base map showing all the applicable data collected. This map will be used as a base for showing all phases of the traffic signal design work and all geometric design work.

b. Directional Orientation

All plan sheets shall have the intersection oriented with North to the top of the sheet or to the right of the sheet (if required to provide significantly better utilization of space).

c. Scale

Traffic signal plans should be drawn a 1" = 20' scale at full size. Break lines may be used to show advanced detection of other features away for the intersection. Blown up details at a larger scale shall be used to illustrate areas with numerous conflicts or many items to be shown in a compact area such as intersection corners.

d. Existing Conditions

The traffic signal base maps shall be printed using CSI Standards resulting in a lighter tone for existing conditions. The plan shall include, but not be limited to, the following information:
(1) Right-of-way, easements and street names
(2) Curbs and medians
(3) Lane lines and channelization
(4) Sidewalks

(5) Utilities (underground and overhead):
  (a) Electric
  (b) Gas
  (c) Telephone
  (d) Communications & Cable TV
  (e) Traffic and Illumination
  (f) Sanitary Sewer
  (g) Storm Sewer
  (h) Water
  (i) Utility manholes, vaults and valves
(6) Monuments and benchmarks
(7) Driveways
(8) Signs and poles
(9) Angle of intersecting streets
(10) Building lines
(11) Other pertinent features (e.g., trees, shrubs, street furniture, bus stops, etc.)

4. Plans and Drawings

a. General.
  (1) All plans and drawings should be prepared with black ink on Consultant furnished 22-inch x 34-inch Mylar reproducible sheets, using the Standard City of Houston, Transportation and Drainage Operations Title Block on all traffic sheets.
  (2) Standard Title Sheet, General Notes and Responsibilities Sheet, Traffic Signal Plan Sheet(s), Pole Schedule and Cable Schematic Sheet, and Detail Sheets, should be used for all traffic signal projects. An electronic Title Sheet, General Notes and Responsibilities Sheet and blank Pole Schedule are available from the City for use on traffic signal projects. Plan sets should not include copies of the City's standard traffic signal details.
  (3) If necessary, additional sheets for plans and profiles, pavement markings or signing shall be provided as needed or as directed.
  (4) A legend will be provided showing any non-standard symbols.
  (5) On projects where the Consultant finds it necessary to deviate from the standard format presented herein, due to project scope or design requirements, the City's Project Manager should be consulted to determine an acceptable alternate format. Any changes to the format are at the discretion of the City's project manager.
  (6) Graphic requirements for engineering drawings shall comply with Chapter 3, Graphic Requirements. New lane striping shall be shown using CSI/NCS pen format.

b. Plan sets should consist of the elements listed below:
  (1) Title Sheet (City Standard)
  (2) General Notes and Responsibilities Sheet
  (3) Traffic Signal Plan Sheet(s)

(4) Pole Schedule and Cable Schematic Sheet(s)
(5) Special (or nonstandard) Detail Sheet(s) (as required)
(6) Plan and Profile Sheets (as required)
(7) Pavement Marking Sheet(s) (as required)
(8) Signing Plan Sheet(s) (as required)
(9) 11-inch by 17-inch plan sheet showing locations of curb lines, sidewalks/ramps, signals and signal cabinets with WB-50 turn movements superimposed over the intersection. This sheet is to be submitted with plan sets for review but is not required as mylar sheet in final plan set.

City of Houston Standard Traffic Drawings shall **NOT** be included as a part of the plan set.

c. Provide a table showing stations and offsets for vehicle detection systems and stop lines on the plan sheet. A sample table is shown below.

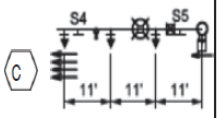
ITEM BY DIRECTION	STREET 1 STATION OF APPROACH EDGE	OFFSET FROM CONST. CL TO CL OF DETECTOR	ITEM BY DIRECTION	STREET 2 STATION OF APPROACH EDGE	OFFSET FROM CONST. CL TO CL OF DETECTOR
EASTBOUND: STOP LINE:	STA. XX+XX STA.		SOUTHBOU: STOP LINE:	STA. XX+XX	
PHASE 2 PULSE LOOP	XX+XX STA	CENTERED IN LANE	PHASE 4 PULSE LOOP	STA. XX+XX	CENTERED IN LANE
PHASE 5 PRESENCE LOOP	XX+XX	CENTERED IN LANE			
WESTBOUND: STOP LINE: PHASE 6 PULSE LOOP	STA. XX+XX STA. XX+XX	CENTERED IN LANE	NORTHBOUND: STOP LINE: PHASE 8 PULSE LOOP	STA. XX+XX STA. XX+XX	CENTERED IN LANE

Example Stop Line and Detector Locations Schedule

d. Pole Schedule, Traffic Signal Controller, and Cable Schematic Sheets.

(1) Pole Schedule

A pole schedule shall be provided showing the pole and its identifier, the pole type, information on the mast arm(s), signal heads, luminaire, pedestrian pushbuttons and signs, pole location, communications system, and relative City standards. Each pole will have its own row within the schedule. The pole schedule shall be a table formatted as shown below.

POLE NUMBER	POLE TYPE	MAST ARM		SIGNALS		LUMINAIRE TYPE	PED PB TYPE/SIGN	REMARKS	LOCATION	STANDARDS
		SIGNAL	LUMINAIRE	MOUNTING	FACE					
	TYPE 1	35'	15'	3 - ASTROBRAC 1 - SIDE OF POLE	1 - H4LF 2 - H3 1 - CDP	106 WATT SYSTEM MAX. LED COBRA HEAD LUMINAIRE	POLARA NAVIGATOR R10-3E {L}	PREEMPT SENSOR {DUALTURRETS} SPP RADIO SIGNS: S4 - R10-17T {36"x42"} S5 - STREET NAME	POLE C; STA 4+08, 56'LT xxxx ROAD. CONSTR. CENTERLINE	02893-02 02893-03 02893-04A 02893-04B 02893-05 02893-09 02893-12

Example Traffic Signal Pole Schedule

(2) Traffic Signal Controller

Meter service and signal controller cabinet assemblies shall be displayed in the Traffic Signal Controller table.

CABINET	TYPE	CONTROLLER	AUX CONTROL	REMARKS	LOCATION	STANDARDS
A	METERED PEDESTAL SERVICE UL TYPE 3R	METERED SERVICE PEDESTAL WITH 30 AMP & 60 AMP SINGLE POLE CIRCUIT BREAKERS	-	PROVIDE METER SOCKET WINDOW 4"H X 6"W	STA. 5+53.18, 53.36' RT {TO CENTER OF CABINET) xxx RD CENTERLINE	02893-14
B	TYPE 340 ITS	2070LX W/1C CPU MODULE W/GPS SERIAL COMMUNICATIONS MODULE	-	STD SPEC 16730 & 16731 UNINTERRUPTIBLE POWER SUPPLY, STD SPEC 16732 FIELD HARDENED ETHERNET SWITCH {MIN. TWO FIBER PORTS AND SIX COPPER PORTS), STD SPEC 16733 WIMAX, STD SPEC 16734 GPS SERIAL COMMUNICATIONS MODULE, STD SPEC 16785	STA. 5+71.84, 52.55' RT {TO CENTER OF CABINET) xxx ROAD CENTERLINE	02893-10C

Example Traffic Signal Controller Schedule

(3) Cable Schematic

Low and high-voltage cable schematics shall be displayed on the pole schedule and cable schematic sheet. The cable schematic shall include:

(a) Conduit Run Identifiers
(b) Conduit Size
(c) Type of Conductors in each run
(d) Legend
(e) Consultant shall conduct interim review of project status and technical issues with city at appropriate project milestones agreed upon by City and consultant.

5. Field Books

a. Typically, field books will be prepared by the City upon receipt of signed and sealed plans in PDF format and original CAD files. A designer should not submit a field book unless specifically requested by the City.

b. If requested, field books should contain the following:

(1) 2070 Programming/Timing Sheets
(2) CMU Programming Sheets
(3) ITS Cabinet Drawings
(4) Input Panel Sheets
(5) Output Panel Sheets
(6) Intersection Signal Layout
(7) Field Terminal Wiring
(8) Accessible Pedestrian Signal Sheets
(9) Output Assembly/Controller Interface
(10) Complete Assembly

If any timing data is requested by the City, it shall be submitted electronically in a format specified by the City.

B. Intersection Design Study

The purpose of this operational analysis is to document the information, assumptions, and procedures used to develop the preliminary design and to affirm that the design level of service will be provided through the design year.

1. Conditions to be analyzed

The Intersection Design Study shall present an analysis of the intersection traffic operation and level of service for the AM and PM peak hours for each of the following conditions:

a. Existing traffic and geometric conditions.

b. Projected traffic and proposed geometric conditions in the design year with the traffic signal(s) in operations.

c. Projected traffic and proposed geometric conditions at project completion, including projections of any new traffic due to trip diversions and/or known new trip generation with traffic signals in operation.

d. Projected traffic and proposed geometric conditions in the intermediate year with traffic signals in operation.

2. Method of Analysis

The level of service for the signalized conditions shall be determined in accordance with the procedures defined in the current edition of the Highway Capacity Manual (HCM). An approved software (Highway Capacity Software (HCS), Synchro or VisSim) will be used, and the printouts from that software will be part of the study. Other software packages may be acceptable, but their use will require prior approval by the City. When the Consultant proposes a less conservative design than determined by HCM method, Consultant will be required to provide supporting evidence to the satisfaction of the City. If the City requests additional analysis to evaluate new/alternative technology and such work causes additional work, Consultant shall obtain written authorization from the City prior to initiating work.

3. Required Level of Service:

The level of service to be provided in the design year shall be level of service D or better (i.e., LOS A, B, or C).

4. Application Method

The Operational method shall be used for all analysis.

5. Procedure

The Consultant shall determine the geometrics required to provide the design level of service in the design year. After determining the required geometrics, the Consultant shall analyze the intersection for the proposed geometrics and projected traffic upon project completion using the methodology for unsignalized intersections. If these conditions result in a level of service "B" or better for all movements, additional analysis may be required, but will be considered extra work.

6. Traffic Signal Warrant Analysis

a. The engineer shall obtain a previously completed traffic signal warrant analysis or perform a new traffic signal warrant analysis for the intersection.

b. Signal warrant analyses shall employ the traffic signal warrants contained in the Texas Manual in Uniform Traffic Control Devices. New analyses should focus on the "strong" warrants, which the City defines as Warrants 1 - Eight-Hour Vehicular Volume and Warrant 7 - Crash Experience. The other warrants may be considered in special circumstances and with approval by the City Traffic Engineer. Satisfaction of one or more signal warrants does not guarantee approval of a traffic signal. All new traffic signals must be approved by the City Traffic Engineer prior to construction. In the case of satisfaction of Warrant 7 - Crash Experience, all other feasible options for mitigation of the crash problem must be exhausted before a signal is approved.

c. The engineer should note that not all warrants are applicable to all intersections.

d. The engineer shall also avoid mid-block locations for new signals. New signals should be spaced at least ¼ mile away from existing or planned signals.

e. The City requires that a minimum of eight (8) hours (includes am and pm peak hours) of turning movement counts be collected for a traffic signal warrant analysis. If a right turn lane is available or is recommended, all right turning traffic shall be deducted from the hourly approach volumes. If a shared through/right turn lane exists, one half of all right turning traffic on the approach shall be deducted. This is based on the presumption that right turning vehicles typically do not require a traffic signal in order to safely enter another street. In the case of a de-facto right-turn lane, such as when right-turning traffic greatly exceeds through traffic in the rightmost lane, engineering judgment should be used to determine the appropriate reduction of right-turn volumes.

f. When conducting a traffic signal warrant analysis, engineering judgment is required to determine whether the left turn lane is counted as an additional lane. As a rule of thumb, the engineer should consider the ratio of left turning traffic to the other traffic. If the left turning volume exceeds twenty (20) percent of the total traffic, the left turn lane should be counted as an additional lane. Exclusive right turn lanes are not to be counted as an additional lane since their volumes are be deducted from the totals.

g. Crash analysis: One year of crash data shall be used for assessing Warrant 7 - Crash History. Crash records can be obtained through the TxDOT Crash Record Information System (C.R.I.S.) online database or from Houston Police Department. Crashes should be categorized as "signal-correctable" or "not-signal-correctable." Signal-correctable crashes include right-angle crashes and crashes involving bicyclists and/or pedestrians. They do not include crashes involving left-turn "failure to yield" crashes from the major street or crashes involving right-turning traffic. Only "signal-correctable" crashes are to be used in the warrant analysis.

7. Hybrid Pedestrian Signals

   a. Hybrid Pedestrian Signals or High Intensity Activated Crosswalks (HAWK) studies shall follow the same basic procedures as those for a standard traffic signal warrant analysis except they shall use the warranting conditions set forth in Section 4F.01 Application of Pedestrian Hybrid Beacons of the Texas Manual on Uniform Traffic Control Devices.

   b. HAWK signals are intended for use at mid-block crossings and should not be proposed in conflict with guidelines provided by the Texas Manual on Uniform Traffic Control Devices without discussing with the City Traffic Engineer.

8. Bicycle Signals

   An engineering analysis of operational and geometric conditions shall be performed to determine the need and recommendation for bicycle signals. Considerations for application of bicycle signals include but are not limited to the following:

   a. Where a stand-alone bike path or multi-use path crosses a street, especially where the needed bicycle clearance time differs substantially from the needed pedestrian clearance time.

   b. To split signal phases at intersections where a predominant bicycle movement conflicts with a main motor vehicle movement during the same green phase.

   c. At intersections where a bicycle facility transitions from a cycle track to a bicycle lane, if turning movements are significant.

   d. At intersections with contra-flow bicycle movements that otherwise would have no signal indication and where a normal traffic signal head may encourage wrong-way driving by motorists.

   e. To give bicyclists an advanced green (leading pedestrian interval), or to indicate an "all-bike" phase where bicyclist turning movements are high.

   f. To make it legal for bicyclists to enter an intersection during an all-pedestrian phase.

   g. At complex intersections that may otherwise be difficult for bicyclists to navigate.

   h. At intersections with high numbers of bicycle and motor vehicle crashes.

   i. At intersections near schools (primary, secondary, and university).

   j. At intersections near rail stations, transit centers, and where two or more bus routes intersect.

9. Left Turn Phasing Analysis

a. Purpose. These guidelines provide a method to uniformly evaluate and install appropriate left turn phasing at traffic signals within the City of Houston. These guidelines attempt to minimize the restrictions placed on motorists' ability to turn safely through gaps in opposing traffic when such turns can be performed safely.

b. Procedure. Information should be obtained by means of engineering studies and compared with these guidelines. Rigid adherence to these guidelines is not a replacement for good engineering judgment.

c. General Guidelines and Considerations.
   (1) Traffic engineering judgment must be used to determine left turn phasing recommendations. Final engineering recommendations, based on engineering judgment may supersede any or all guidelines.
   (2) The least restrictive form of left turn phasing, that can operate safely, should be considered for implementation. More restrictive control can be made as traffic conditions change.
   (3) Proper "yellow trap" protection phasing is required when protected-permitted phasing is used in a lead-lag configuration.
   (4) Permitted left turn phasing is primarily suited for intersections where opposing and left turn volumes are low and left turns are able to turn through gaps in traffic without great difficulty or excessive delay.
   (5) Protected-permitted phasing is appropriate when the left turn need is based predominately on volume and delay and the signal is at a moderately traveled intersection where frequent gaps for left turns occur.
   (6) Protected-only left turn phasing should be used when left turn phasing is required primarily for safety reasons based on left turn crash experience or site conditions, or when the opposing number of lanes is three or more.

d. Permitted Left Turn Phasing. Permitted left turn phasing may be installed based on the following guidelines:

   (1) Traffic Volumes. This guideline is based on minimum peak hour left turn volume and the product of the peak hour left turn and opposing volumes (LT x OV) and the number of opposing lanes (NL). Permitted phasing may be appropriate if:
      (a) Peak hour left turn volume is less than 2 vehicles per cycle.
      (b) Peak hour (LT x OV)/NL is below 50,000.
   (2) Site Conditions. This guideline is based on several existing conditions at the intersection location. Permitted phasing may be appropriate if:
      (a) Available sight distance is greater than 350 feet when the opposing traffic is traveling at 35 mph or less, or greater than 400 feet when the opposing traffic is traveling at 40 mph.
      (b) Opposing speed is less than 45 mph.

(c) Multiple left turns are not in operation.
(d) Median width and the number of opposing lanes do not preclude safe permitted turn operations.

(3) Vehicle Delay. This guideline is based on peak hour left turn delay. Permitted phasing may be appropriate if:
(a) The mean peak hour delay per left turning vehicle is less than 50 seconds.
(b) The total peak hour left turn delay is less than 3.0 vehicle hours.

(4) Crash Experience. The installation of a more restrictive form of left turn control may be required if six (6) or more left turn crashes occurred in the past twelve (12) months.

e. Protected - Permitted Left Turn Phasing. Protected-permitted left turn phasing provides the benefits of permitted left turn phasing while adding left turn capacity and can reduce delay to motorists. Protected-permitted phasing may be appropriate for the following conditions:
(1) Traffic Volume. Protected-permitted phasing may be appropriate if:
(a) Peak hour left turn volume is greater than 2 vehicles per cycle.
(b) Product of the peak hour (LT x OV) is less than 400,000.
(c) Peak hour (LT x OV)/NL is between 50,000 and 200,000.
(2) Site Conditions. See guideline for permitted left turn signal phasing.
(3) Vehicle Delay. Protected-permitted phasing may be appropriate if:
(a) The mean peak hour delay per left turning vehicle exceeds 50 seconds.
(b) The total peak hour left turn delay exceeds 3.0 vehicle hours (per leg).
(4) Crash Experience. See guideline for permitted left turn phasing.

f. Protected-Only Left Turn Phasing. Protected-only left turn phasing is the most restrictive form of left turn control. Protected-only left turn phasing may be appropriate under the following conditions.
(1) Traffic Volume. Protected- only phasing may be appropriate if:
(a) Peak hour left turn volume is greater than 2 vehicles per cycle.
(b) Product of peak hour (LT x OV) is greater than 400,000.
(c) Peak hour (LT x OV)\NL is greater than 200,000.
(2) Site Conditions. Protected-only phasing may be appropriate if:
(a) Available sight distance is less than 350 feet when the opposing traffic is traveling at 35 mph or less, or less than 400 feet when the opposing traffic is traveling at 40 mph or more.
(b) Opposing speed is greater than, or equal to 45 mph.
(c) Multiple left turns are in operation.
(d) Median width and number of opposing lanes preclude safe permitted turn operations.
(3) Vehicle Delay. See guideline for protected-permitted left turn signal phasing.
(4) Crash Experience.
(a) Six (6) or more left turn crashes occurred in the most recent

twelve (12) month period.

(5) Policy Compliance. All new left turn phasing installed within the City of Houston will be evaluated and installed using these guidelines and engineering judgment.

(6) Policy Exception. Exceptions shall be allowed, as deemed appropriate, by the Assistant Director managing the Traffic Operations Branch.

10. Alternative Lane Configurations

a. The level of service analysis shall be used to determine the required number of through lanes and auxiliary lanes (left and/or right turn lanes) needed to most economically provide the necessary level of service.

b. Left turn lanes greatly benefit the operation of an intersection which has enough traffic to require signals. As a result, all new traffic signal designs shall require the inclusion of a left turn lane unless otherwise specified by the City. In areas such as the Central Business District, where speeds are low and right-of-way is not available or is very expensive, the benefits of left turn lanes may be outweighed by the cost.

c. Right turn lanes and double left turn lanes should be considered as a means of achieving the desired level of service where the specific turning volumes are very high.

11. Alternative Phasing

a. Permitted Left Turns. Permitted only left turns (no separate signal phase displayed) shall be used unless more restrictive left turn phasing is required as described below.

b. Protected/Permitted Left Turn Phasing. Protected/permitted left turn phases are required when any one of the following criteria is met:

(1) They are needed to achieve the required level of service.

(2) The left-turn demand meets the guidelines stated in the current "Left Turn Phasing Analysis" section of this document.

c. Protected Left Turn Phases. Protected only left turn phases are required when the following criterion is met:
The left-turn demand meets the guidelines stated in the current "Left Turn Phasing Guidelines" section of this document.

d. Split Phasing. Split phasing shall be defined as separating two opposing directions of traffic such that the compatible through and protected left turn movement receives the right-of-way simultaneously. Split phasing shall require the approval of the City prior to submitting the preliminary design plans. This phasing should only be used if one of the following conditions exists:

(1) The opposing approaches are offset to the extent that simultaneous left turns in opposing directions would cause a high number of conflicts, resulting in a high collision potential, and the left turn demand is sufficiently high to require as much green time as the adjacent through movement. When left turn volumes are lighter, and physical conflict exists, lead-lag operation should be used.

(2) Double left turn lanes are used in one or both directions and the turning radii are not sufficient to allow simultaneous left turns without conflicts between opposing left turn traffic, and subject to the same volume requirements in item (a) above.

(3) The left turn volume is extremely heavy on an approach that does not allow the construction of a separate left turn lane.

(4) Left turn volumes are extremely heavy on opposing approaches and both are nearly equal to the adjacent through movement critical lane volume (A check should be made to determine that the design hour level of service will be significantly improved and that there will not be substantial decreases in level of service during other hours of the day).

(5) The critical lane volumes are lowest when drivers are permitted to turn left from more than one lane, and are also permitted to use the right-most left turn lane as a through lane.

(6) If the intersection is in an interconnected system and the coordination plan would be improved by splitting the phases.

e. Right Turn Overlaps. Overlaps are encouraged where needed. Right-turn overlaps should be used only if there is a dedicated right turn lane on the approach and pedestrians are prohibited from crossing parallel and to the right of the concurrent through movement from the same approach. If right turn overlaps are provided, it will be necessary to prohibit u-turns for the opposing left turn approach. Appropriate signing should be detailed in the plans. An example of this operation would be when the left turn arrows on the main street approach are displayed simultaneously with a right turn arrow on one or both side street approaches. This type of operation should only be used where:

(1) there are 250 or more right turns during a peak hour and;

(2) there are 200 or more corresponding left turns during the same hour and;

(3) the per lane through volume for the same approach is approximately equal to, or less than, the right turn volume.

C. Geometric Design Elements

If the construction of geometric changes in the street is required, the work shall be done in accordance with the City of Houston's Uniform Development Code, Chapter 10 of the Infrastructure Design Manual, and in accordance with the following criteria:

1. Design Speed

   The design speed for a street shall be based on the 85th percentile speed, or as directed.

2. Design Vehicle

   The design vehicle shall be a WB-50 (AASHTO Green Book) or as directed.

3. Auxiliary Lane Design

   a. Opposing left turn lanes shall be designed for protected/permitted left turn signalization unless protected only left turn phasing is required by Section 15.11.02.B.7. Sight distance for drivers of left turning vehicles to see beyond opposing left turning vehicles shall be calculated in accordance with Case III A - Crossing Maneuver (AASHTO Green Book).

   b. The storage length of the left or right turn lanes shall be determined based on the expected queue length as defined in Section 15.08 C.6. of the Infrastructure Design Manual. The minimum left turn lane storage length shall be 100 feet unless restricted by other factors. The maximum left-turn lane length should be 400 feet. If the expected queue storage length exceeds 400 feet or the left turning volume during the peak hour exceeds 200 vehicles, dual left turn lanes should be considered.

4. Tapers

   a. A taper, in this context, refers to the transition in pavement width between the centerline and the edge of pavement, e.g., the lateral transition of a median to accommodate a left turn bay. Wherever possible, the transition taper shall be a symmetrical reverse curve. This taper length shall not be subtracted from the total required storage length (Total Turn Lane Length = Storage Length + Transition Taper length).

   b. All approach taper ratios for collectors and thoroughfares shall be based on the posted speed limit plus 5 mph or 85th percentile speed (whichever is greater) and shall be calculated using the formulas described in the Texas Manual on Uniform Traffic Control Devices.

5. Islands

   Generally, raised (curbed) islands for the use of channelizing traffic, as in the case of a right turn lane, shall not be used. When islands are needed, sizes and dimensions should meet the recommended AASHTO requirements. Mountable curb and gutter shall be used on all islands.

6. Medians

a. The minimum width of a raised median shall be four feet from face of curb to face of curb. A six-foot width shall be considered where a left turn lane is opposed by three or more right and through lanes to provide greater pedestrian storage and to reduce pedestrian clearance timings.

b. Both vehicle and pedestrian characteristics should be considered for design of the location of the median nose.

c. Bullet nose medians shall be required adjacent to a left turn bay at an intersection with a street other than a primary arterial. This 3-centered curve shall have radii of 50', 3', and 50'.

d. The median opening must be wide enough to provide for adequate turning movements by left turning vehicles. In no case shall the median opening be narrower than 40 ft.

e. In the development of a left or right turn lane; the pavement shall be widened via a symmetrical reverse curve as described in the Infrastructure Design Manual, Figure 10.06-07.

7. Pedestrian Access Ramps

At intersection corners without sidewalks, where traffic signal poles are to be installed, a pedestrian landing shall be constructed according to the City of Houston Specifications and Standard Drawings. The ramp design should be directional and in most cases, two directional ramps per corner shall be required. Approval of the ramp design as part of intersection layout should not be construed as approval of the ramp designs for traffic signal designs.

8. Curb Return Radius

Where two streets intersect, certain radii are required for the curbs per the Infrastructure Design Manual.

D. Pavement Markings

Before traffic signals are located on the base map, the pavement markings (existing or proposed) should be located to act as a guide in the location of signal heads and detector loops. Pavement markings shall conform to the Standard Specifications and Detail Sheets as well as meet the following guidelines:

1. Pavement Marking Materials

a. Preformed plastic pavement markings, as specified in the Standard Specifications, shall be used for all lane lines, island markings, cross hatching, arrows and legends.

b. Preformed plastic pavement markings, as specified in the Standard Specifications, shall be used for all pedestrian crosswalks and stop bars.

2. Lane Lines

a. Lane lines shall be aligned with corresponding lane lines on the opposite side of the intersection.

b. Lane lines shall terminate at the stop or at the curb return (on uncontrolled approaches).

3. Crosswalks

a. Crosswalks shall be installed across all approaches except where pedestrians are prohibited from crossing. They shall provide access to all corners of an intersection.

b. Crosswalks shall be ten feet wide. See the City of Houston Standard Detail for crosswalk configuration.

c. Crosswalks should match up with ADA accessible ramps where possible.

d. No transverse marking shall be placed within 18" of the curb or raised median.

e. High visibility crosswalks shall be used only in exceptional scenarios at signalized and non-signalized crossings on collector and thoroughfare roadways requiring extra emphasis such as immediately adjacent school facilities, rail stations, transit centers, and/or any other consideration evaluated and approved by the City.

4. Stop Lines

a. Stop lines shall be placed at all signalized locations.

b. The stop lines shall be 24" wide and extend from a point 18" from the curb to the solid double yellow line (or a point 18" from the raised median). It shall be in accordance with City Standards.

5. Turn Arrows and Legends

City of Houston only uses Arrows or Only's in exclusive turn lanes.

E. Traffic Signal Hardware Design

The traffic signal hardware shall be designed in accordance with the following criteria:

1. Traffic Signal Heads and Lane Use Control Signs

a. Number and Location of Heads:
   (1) The minimum number of traffic signal heads for all approaches shall be in conformance with the current edition of the TMUTCD.
   (2) Generally, one traffic signal head will be provided for each through lane.
   (3) Generally, the traffic signal heads shall be located directly above the center of the travel lane.
   (4) Typically, a minimum of two left turn traffic signal heads shall be provided. One left turn traffic signal head will be located centered over the left turn lane. A second left turn head shall be provided on the far-left corner of the intersection adequately aligned with the left turning path. Additional left turn traffic signal heads are required for multiple left turn lanes.
   (5) Where there is only one approach lane, two signal heads shall be located at least 8 feet apart between edge of backplates, with the center of the separation between the heads located over the center of the lane.
   (6) Bicycle signal heads shall be placed in a location clearly visible to oncoming bicycles. Typically, a single signal head is sufficient; however, consideration of near-sided bicycle signals may be given for improved visibility.

b. Size and Configuration:
   (1) Generally, all traffic signal heads shall be oriented in a horizontal alignment.
   (2) All pole mounted traffic signal heads shall be mounted vertically in line with the pole shaft.
   (3) All sections of vehicular traffic signal heads shall have 12" LED indications.
   (4) For permissive only mode left turns, steady 3-section RYG shall be used (H3 horizontal, V3 vertical). R10-12 "LEFT TURN YIELD ON GREEN BALL" sign shall be installed immediately adjacent to the traffic signal head.
   (5) For protected/permissive mode left turns with an exclusive left turn lane, 4-section RYYG flashing yellow arrow signal shall be used (H4LF horizontal, V4LF vertical). R10-17T "LEFT TURN YIELD ON FLASHING YELLOW ARROW" sign shall be installed immediately adjacent to the left turn signal head, and below the second left turn head placed on the far-left corner.
   (6) For protected/permissive mode left turns with a left/through share lane, steady 5-section RYYGG signal shall be used (H5L horizontal, V5L vertical). R10-12 "LEFT TURN YIELD ON GREEN BALL" sign shall be installed immediately adjacent to the traffic signal head if horizontal, and below the left turn head if vertical. No supplemental signal head in the far-left corner is required for this case.
   (7) For protected only mode left turns, steady 3-section RYG all arrows shall be used (H3L horizontal, V3L vertical). R10-5 "LEFT TURN ON GREEN ARROW ONLY" sign shall be installed immediately adjacent to the left turn signal head, and below the second left turn

head placed on the far-left corner.

(8) At split-phase approaches, the left-most head shall be a 4-section RYGG head with a left arrow section (H4TL horizontal, V4TL vertical). No sign is required to accompany this signal head. No supplemental signal head in the far-left corner is required for this case.

(9) Signal heads located in the Downtown and Uptown District shall be black in color. All other traffic signal heads in the City shall be yellow unless otherwise specified by the City.

(10) Bicycle signal heads shall be mounted vertically.

(11) All sections of bicycle signal heads shall have 12" LED bicycle indications. Steady vertical 3-section RYG bicycle shall be used (B3). "*bicycle symbol* SIGNAL" sign plaque (R10-10B) shall be added below the bicycle signal head.

c. Type of Signal Head:

(1) All signal head housings shall be constructed of polycarbonate in accordance with the Standard Specifications.

(2) Optically programmed signal heads shall be used whenever the indications can be viewed by two or more conflicting movements of traffic at skewed intersections, or where two sets of indications for the same direction are not to be viewed simultaneously, such as the second set of indications on the cross street at an offset intersection.

(3) Bi-modal indication signal sections shall not be used.

d. Type of Mounting:

(1) All mast arm-mounted traffic signal heads will be mounted on a tenon using a fully adjustable "Astro-Brac Atlas Large Capacity" mount assembly, or an approved equal. In exceptional circumstances when a tenon is not available on the mast arm and after obtaining authorization from the City of Houston, a hole should be drilled and a tenon clamp kit used.

(2) Side-mount signal heads shall be mounted using standard mountings and shown on the plans as being on a side of the pole away from vehicular traffic.

e. Backplates:

(1) All vehicular traffic signal heads on steel poles shall be equipped with black louvered backplates conforming to Standard Specifications.

(2) All bicycle signal heads (B3) shall be equipped with yellow louvered backplates conforming to Standard Specifications.

f. Installation Procedures:

Mast arms shall be drilled for wire accesses after installation on the pole base to provide concealed wiring and proper signal head location. All signal head installations shall comply with mounting requirements per Standard Specification 16715 Vehicle Signal Heads.

2. Pedestrian Traffic Signal Heads

a. Type and Number:
(1) Pedestrian traffic signal heads shall be installed wherever crosswalks are provided, except crossing free right turn lanes.
(2) Two pedestrian traffic signal heads shall be installed, one at each end of the crosswalk being controlled. Pedestrian signals may be placed on median islands if the signal heads are not visible for the entire length of the crossing and/or operational considerations indicate benefit of two-stage crossings along with adequate pedestrian refuge area available on the median. In such case, additional pedestrian signal heads shall be placed in the median facing each direction.

b. Legend:
Generally, all pedestrian signal heads shall have international symbol messages consisting of a Portland orange upraised hand (symbolizing DON'T WALK) and a lunar white walking man (symbolizing WALK).

c. Size and Configuration:
(1) All pedestrian traffic signal heads shall have 16" LED Countdown indications.
(2) Pedestrian traffic signal heads located in the Downtown and Uptown District shall be black in color. All other pedestrian traffic signal heads in the City shall be yellow unless otherwise specified by the City.

d. Location:
Pedestrian traffic signal heads shall be located as nearly in line with the crosswalk as possible. If the mast arm pole is located such that the pedestrian signal will be blocked by stopped vehicles or if it is more than 20 feet outside of the crosswalk lines extended, then an alternative means of mounting shall be designed. Pedestrian traffic signal heads shall be mounted 8 feet (to the bottom of the head) above the walking surface on the side of pole away from vehicular traffic. Pedestrian traffic signals shall be shown on the plans as being mounted on the side of the pole away from vehicular traffic by use of the respective symbol.

3. Relocating Traffic Signal Heads

Signal heads shall be relocated only when they are in good condition, are in conformance with this section, and no modifications are necessary. The relocation of any traffic signal heads shall require the prior approval of the City.

4. Mast Arm Assemblies and Poles

Typically, the City requires that mast arm poles be used for all new traffic signal installations. In special cases, the City may allow strain pole installations based on a written recommendation by the engineer explaining the need for a span wire design. Traffic signal heads mounted vertically on a pole shaft shall be allowed as supplemental signal indications, but shall not be used as the exclusive method of mounting traffic signals for any approach without prior approval from the City.

a. Location (Including Setback):
   (1) On streets with curbing, poles shall be located such the center of the pole is a minimum of five (5) feet from the face of curb. On streets without curbing, or with speeds greater than 35 MPH, poles shall be located a minimum of 10 feet behind the edge of pavement or 3 feet behind the edge of the paved shoulder, whichever is greater, and should be located 15 feet from a line extended from the edge of the through traffic lanes.
   (2) Mast arm traffic signal poles should not be located in the median unless no other option exists. Any mast arm poles located in the median shall require approval by the City prior to the preliminary plan submittal.
   (3) Poles should be located in line with the opposing directions stop line (approximately four feet behind the crosswalk line).
   (4) Poles should be located as close to the sidewalk or pedestrian landing as possible for pedestrian pushbutton access, yet still be within the guidelines for distance from the curb or traveled way.
   (5) No poles shall be located in wheelchair ramps or such that they are an obstruction to pedestrians or wheelchairs.
   (6) On the plans, the Consultant shall tie down the location of all poles referenced to the street centerline by station to the nearest foot and offset to the nearest half foot.

b. Mast Arm Lengths:
   (1) Minimum mast arm length that shall be used is 25 feet.
   (2) Mast arms longer than 55 feet in length may require an evaluation of the pole and foundation to be used as determined by the City.
   (3) Mast arm lengths should allow for probable future modifications to the signal. If a left turn lane exists, the arm should extend to the center of the left turn lane.

c. Clearances from Utilities:

   Poles shall be located such that all portions of the poles and attached equipment have clearances from overhead utilities in accordance with the requirements of the local utility and the National Electrical Safety Code (NESC).

d. Material and Style:
   (1) All poles shall conform to the Standard Specifications and Details. Special poles and features shall be coordinated and approved by the City.
   (2) The centerline of the mast arm shall be at 90 degrees to the centerline of the approach it is serving unless otherwise required.

e. Delivery Time:

Typical delivery time for mast arm poles is 8 - 12 weeks from the approval of submittals. The number of days specified in the contract should account for the long delivery time.

f. Luminaires and Luminaire Mast Arms:

Luminaires shall be included in all intersection designs unless otherwise indicated by the City, and shall meet the following requirements:
   (1) One luminaire shall be utilized for each leg of the intersection.
   (2) Luminaires to be positioned to illuminate crosswalks.
   (3) All installations shall meet the current National Electrical Code requirements.
   (4) The street lighting photo cell shall be mounted in the traffic signal service panel unless otherwise designated by the City of Houston.
   (5) Power for the street lighting should come from the traffic signal service panel.
   (6) Fixture attributes shall adhere to the latest City specifications for intersection lighting.

g. Device Mounting:

No non-traffic related devices may be mounted on the mast arm. Non-traffic related devices may be mounted on the pole shaft with approval. All devices to be installed on the signal pole and mast arm assembly shall be in accordance with the maximum loading information provided by the manufacturer. Reference to City of Houston Standard Detail for Traffic Signal Structures 02893-04B. The installation of any device in deviation of the traffic signal items defined on Standard Detail 02893-04B shall be submitted for review to the City with the respective supporting structural analysis.

5. Pedestrian Pushbuttons

Pedestrian pushbuttons shall be required at all new or modified traffic signal locations within the City of Houston. The omission of pedestrian pushbuttons at any location shall require the approval of the City.

a. All pedestrian pushbuttons shall be Polara Navigator or approved equal Accessible Pedestrian Systems (APS).

b. No more than one pedestrian pushbutton shall be located on a single traffic signal pole.

c. Pedestrian pushbuttons should be located no more than ten (10) feet from the face of curb or more than five (5) feet from the crosswalk extension.

d. Pedestrian pushbuttons shall be separated by a minimum distance of ten (10) feet.

e. All pedestrian pushbutton stations shall be accompanied by a pedestrian pushbutton sign (R10-3e) with instructions.

F. Controller and Cabinet Design

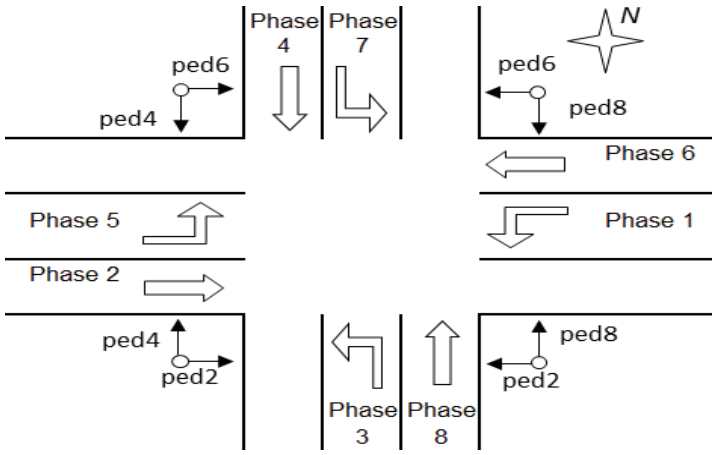
1. Controllers

All new controllers shall be the Type 2070 Advanced Traffic Controllers (ATC) in compliance with the latest Model 2070 Controller Unit Specification unless otherwise directed by the City.

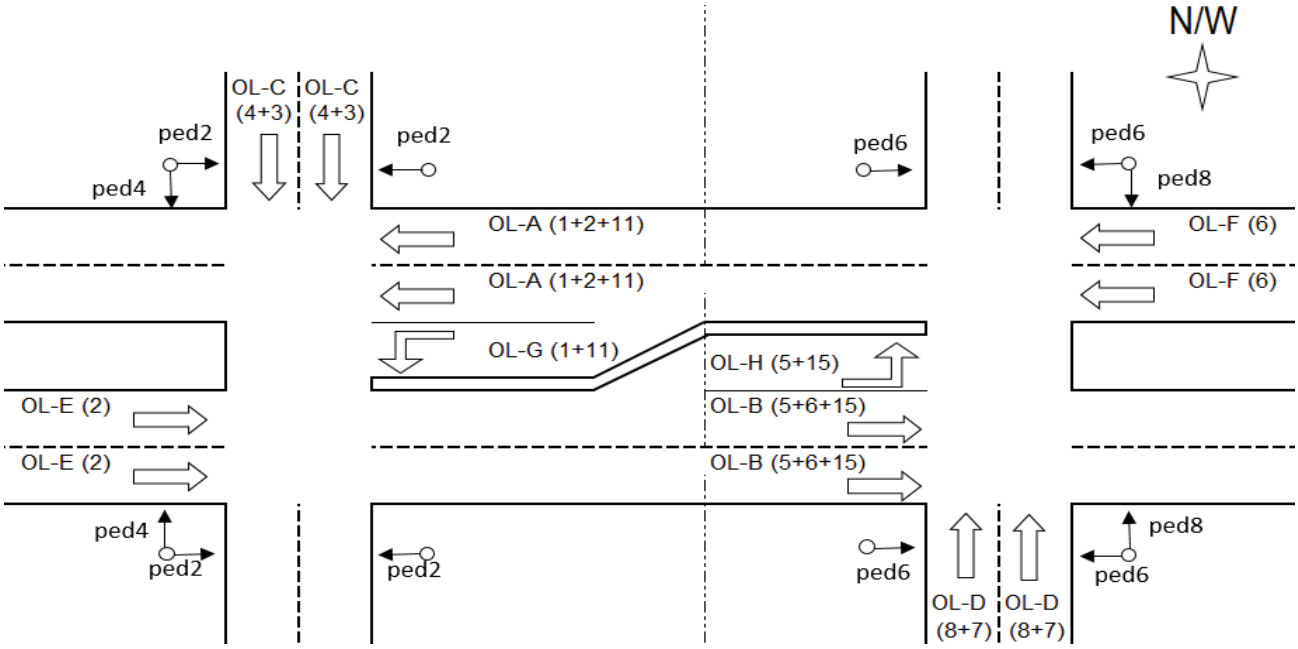
2. Phasing

a. The sequence of operations shall be shown by the phasing sequence diagram for each intersection on the plan sheet. Permitted movements shall not be indicated unless part of a protected/permitted sequence. All pedestrian movements shall be shown.

b. Phases shall be designated on the traffic signal plan sheet in accordance with the standard NEMA phase designations. In addition, the phases shall be assigned as follows (unless limited by the controller cabinet). As shown, phases 3 and 8 are to be oriented north on standard 8-phase intersections, and phase 8 is to be assigned to the feeder road approach oriented north or west as shown.



Standard 8-phase Intersection



Standard Diamond Interchange Intersection (4-Phase Operation)

3. Controller Cabinet Type

   a. New Type 2070 ATC controllers shall be housed in one of a selection of four cabinets from the Standard Specifications:

      (1) Type 340 ITS Cabinet (Housing Package Type 3) - This is the standard cabinet for installation at City of Houston Intersections. This cabinet shall be used at locations where 8 or more phase operation would be employed in the new or future system. This cabinet will fit on a standard NEMA "P" cabinet foundation. Type 342 ITS Cabinet (Housing Package Type 1) - The Type 342 ITS cabinet is a smaller cabinet that uses the Type 332 cabinet profile and will fit a Type 332 cabinet foundation. This cabinet should only be used on intersection retrofit projects where the existing foundations and conduit system are to remain. It should not be specified without prior approval by the City. Type 346 ITS Cabinet (Housing Package Type 2) - The Type 346 ITS cabinet generally has the same capabilities as the Type 342 cabinet in a smaller unit. These cabinets are to be used in the Downtown area, pedestrian hybrid beacon locations, and fire stations. stations.

   b. Selection of which cabinet to use shall be based on the cabinet use descriptions above, and approved by the City.

4. Controller Cabinet Location

a. The controller cabinet should be located to minimize the probability of being hit by a vehicle. Locations particularly susceptible to accident damage are:
(1) The far corner (apex) for a dual left turn or right turn movement where the crossing street doesn't have a raised median.
(2) The far corner (apex) for a heavy left turn movement.
(3) The far right corner of a high-speed approach where a right angle collision can knock a car into the controller.
(4) Generally, the controller should be located upstream on the heaviest approach and/or back from the corner on the minor approach if there is a significant difference in approach volumes or speeds. Consideration should be given to locating the controller where it is protected by an existing non-breakaway pole or a mast arm pole.

b. Where possible, the controller should be located on the same corner as the power supply. Special care should be taken that the load center is not separated from the controller by a wide, high speed or high volume street.

c. Areas subject to flooding shall be avoided. Where not possible, the foundation should be raised 2' above the 100-year flood plain.

d. Cabinet placement should not obstruct the minimum sight distance of any approach of the intersection. The cabinet should not obstruct the sidewalk or

e. the ramp, even when the doors are open. Care shall be taken such that the cabinet doors do not open off the right-of-way.

f. Cabinets shall be positioned such that when the door opens, the maintenance personnel will have a clear view of the intersection and the inside of the cabinet. If the cabinet is too high to see over, the cabinet shall be positioned and oriented so that the technician has a clear view of the intersection without looking around the open door.

g. No device serving purposes different that traffic signal operations shall be placed on top or attached in any way to the traffic signal cabinet without the prior review and approval of the City. No device compromising the physical integrity of the signal cabinet will be authorized.

G. Detector Design

1. General

The City's practice is to install inductive loop detectors as primary detection method at all new traffic signal installations. The use of wireless magnetometers as an alternative detection method shall be considered if the installation of inductive loops is unfeasible (e.g. bridge deck, paver surface) or impractical (e.g. poor pavement conditions). Video detection should not be proposed as a permanent system as it will

only be considered during temporary construction. Any other detection technologies shall require prior approval of the City.

2. Emergency Vehicle Pre-Emption Equipment
All new City traffic signal installations shall require the installation of GTT Opticom emergency pre-emption equipment. Sensors shall be installed for all intersection approaches. The City of Houston uses a coded system which requires proprietary software. For this reason, only GTT (Global Technologies, LLC) Opticom equipment can be used for City installations.

3. Inductive Loop Detectors

Inductive loop detectors are the standard means of vehicle detection to be used in the City of Houston.

a. Types of loop installations shall be broken into two categories depending on the proposed pavement work:
   (1) Pre-formed Loops - Use pre-formed loops any place where the entire loop falls in an area of new, overlaid, milled and replaced, or seal-coated pavement. The excavation and patching required are easily covered up by the pavement work, and the pre-formed loops can last virtually forever, if properly installed.

   (2) Saw cut Loops - Use saw cut loops if the loop or any part of the loop would end up in an existing pavement that will not be modified by any of the methods noted above. This is a less desirable method of loop installation, but can give acceptable loop life if properly installed.

b. The detector lead-in cable is a shielded twisted pair cable extending from the loop pull box to the controller cabinet. The detector lead-in cable shall be a continuous run without splices.

c. Except where noted otherwise, dimensions for detector loop setbacks shall be referenced from stop line. The detector reference line should be curved if needed to follow the alignment of the street.

d. Each loop shall be connected to its own detector lead-in cable. Multiple detector lead-in cables may run in the same conduit.

4. Wireless Magnetometers

Wireless magnetometers vehicle detection systems (WMVDS) are accepted as a secondary method to provide actuation at an intersection. WMVDS may be proposed only when unfeasible and/or impractical circumstances prevent from installing inductance loops.

a. Magnetometers are small sensors embedded in holes drilled in the road surface. The installation for this method of detection consists of multiple

components including but not limited to access points, contact closure cards, radios, and repeaters. Care shall be taken to assure proper location and placement of each to achieve the envisioned performance.

b. A single magnetometer sensor provides a 6-foot by 6-foot detection zone. Multiple wireless magnetometer sensors shall be used to provide the equivalent detection zones defined for high and low-speed approaches.

c. All wireless magnetometers shall be called out on the signal plan sheet with specific labels, stations and offsets for accurate placement.

5. Identification Scheme

Detectors shall be identified on the plan sheets by their phase, lane and purpose. Each lane will be numbered from left to right starting with the lane closest to the centerline. Advance detection loops shall be identified as pulse loops. Detectors in through lanes at the stop line will be designated as call detectors. Finally, detectors in the turn lanes or on low speed minor approaches shall be presence detectors. For example, when speaking about the advance loop for eastbound in the lane closest to the median would be referred to as the Phase 2 pulse loop 1.

6. Advance Detectors on Higher Speed Approaches (Posted Speed > 30 MPH)

a. Location

(1) For higher speed approaches, advance inductance loop detectors for the through lanes of traffic are required and shall be located five (5) seconds from the stop line using the following table:

Advance Detector Location Table

Posted Speed/ Design Speed (mph)	Advance Detector Distance (ft.)*
30	220
35	260
40	300
45	330
50	370
55	410
*As measured from the leading detector edge to the stop line.	

(2) In addition to the advance detectors, call detectors in each lane shall be placed near the crosswalk. The front edge of a 6' x 6' detection zone (either pre-formed or saw cut loops, or magnetometers) shall be located four (4) feet back from the stop line. At locations involving skewed intersections, or other extenuating circumstances, the detector positions and sizes may need to be adjusted to account for vehicles stopping in front of or in the crosswalk. In all cases, detection must be provided 10 feet upstream from the back of the crosswalk. The intent

of the detectors placement is to prevent the smallest passenger cars, motorcycles and bicycles from being caught in an undetected area. If adjusted, the size and spacing of the detectors shall remain constant.

b. Detector Lead-in Cable

(1) The upstream pulse loops for the dilemma zone protection shall be on separate detector amplifier channels.

(2) If there is more than one through lane, adjacent upstream loops shall be placed on separate channels without connection to any other loop.

(3) The two stop line loops shall be spliced in series at the cabinet and connected to the same detector amplifier. This amplifier shall be the "call" input amplifier, with the loops of each lane split between the two channels.

(4) The upstream loop detector lead-in cables shall be routed to the nearest junction box along a patch perpendicular to the direction of travel. Homeruns for adjacent loops, less than 16 feet apart, should be routed to the nearest junction box in the same cut to the extent possible to minimize excavation of the pavement. When loops are adjacent to medians, the homerun can be routed directly to the median and then to the nearest junction box.

(5) The stop line loop lead-in cable will generally be routed to the same junction box. All the detector lead-in cables for conduit-encased loops should be routed parallel and adjacent to each other along a path perpendicular to the direction of travel. A path parallel to the direction of travel may be needed from the individual loop to the common perpendicular routing.

7. Detectors on Low Speed Approaches

a. Location

(1) Large area presence detection shall be used on approaches with less than 35 MPH posted or anticipated 85th percentile speed. It shall also be used on side street approaches, with a posted or anticipated 85th percentile speed of 35 MPH, if the higher through phase critical lane volume is less than one-half the critical lane volume of the highest volume main street through phase.

(a) Pre-formed Loops. A 6' x 21' presence detection zone shall consist of one (1) 6' x 6' detector loop placed in each lane beginning at the stop line, and a second 6' x 6' detector loop placed an additional 9 feet upstream of the trailing edge of the first detector. An additional 6'x6' detector loop shall be placed in front of the stop line if the curb return allows for a full vehicle length to the stop line.

(b) Saw cut Loops. A 6' x 20' presence detection zone shall consist of one (1) 6' x 6' detector loop placed in each lane beginning at the stop line, and one (1) 6' x 10' detector loop placed 4 feet upstream of the trailing edge of the first detector. An additional

6'x6' detector loop shall be placed in front of the stop line if the extension of the curb line allows for a full vehicle length to the stop line.

(c) If using magnetometer vehicle detectors, an equivalent detection zone shall be provided considering a single sensor offers a 6-foot by 6-foot coverage. An additional sensor shall be placed in front of the stop line if the curb return allows for a full vehicle length to the stop line.

(2) At locations involving skewed intersections, or other extenuating circumstances, the detector positions, number or sizes may need to be adjusted to account for vehicles stopping in front of or in the crosswalk. Care should be taken to not leave too much undetected space immediately upstream of the crosswalk. The intent of the detector placement is to prevent the smallest passenger cars, motorcycles and bicycles from being caught in an undetected area. If adjusted, the distances between the detectors shall remain constant.

b. Detector Lead-in Cable

(1) In the case of the pre-formed detector loops, the loops in a lane may be combined on one channel. In all cases, each loop shall be spliced to its own detector lead-in cable running back to the cabinet.

(2) Detector lead-in cables for the loops closest to the intersection should be routed to the same junction box. Detector lead-in cables for adjacent loops should be routed to the nearest junction box in the same cut to the extent possible to minimize excavation of the pavement. A path parallel to the direction of travel may be needed from the individual loop to the common perpendicular routing.

8. Downstream Detection

Downstream detector loops shall be placed on the receiving lanes of all through approaches, low and high speed, one hundred (100) feet measured from the crosswalk line furthest from the intersection. In case of no crosswalk line present or not clearly marked, downstream detector loops to be placed one hundred (100) feet measured from the curb return furthest from the intersection.

9. Left Turn Lane Detection

a. Location

(1) Large area presence detection shall be used for left turn lane detections.

(a) Pre-formed Loops. A 6'x 51' presence detection zone shall consist of one (1) 6'x 6' detector loop with trailing edge four (4) feet in front of the stop line extending into the crosswalk, and additional three (3) 6'x 6' detector loops placed at nine (9) feet intervals upstream starting at the trailing edge of each loop.

(b) Saw cut Loops. A 6'x 50' presence detection zone shall generally consist of one (1) 6'x 6' detector loop with trailing

edge four (4) feet in front of the stop line extending into the crosswalk, one (1) 6'x 6' detector loop placed with leading edge at the stop line, and one (1) 6'x 30' detector loop placed four (4) feet behind the trailing edge of the stop line detector loop.

(c) If using magnetometer vehicle detectors, an equivalent detection zone shall be provided considering a single sensor offers a 6-foot by 6-foot coverage.

(2) At locations involving skewed intersections, or other extenuating circumstances, the detector positions, number or sizes may need to be adjusted to account for vehicles stopping in front of or in the crosswalk. Care should be taken to not leave too much undetected space immediately upstream of the crosswalk. The intent of the detector placement is to prevent the smallest passenger cars, motorcycles and bicycles from being caught in an undetected area. If adjusted, the distances between the detectors shall remain constant.

b. Detector Lead-in Cable

(1) Where medians are constructed adjacent to left turn lanes, the detector lead-in cable(s) should be routed to a junction box in the median.

(2) In the case of the pre-formed loops, the upstream loop shall be connected to its own channel on an amplifier. The other loops may be combined on one channel. For multiple saw cut loops, the rear loop and front loops shall be on separate channels. In all cases, each loop shall be spliced to its own lead-in cable running back to the cabinet.

(3) If there are two or more left turn lanes, all the loops in one lane shall be connected in a like manner as described in paragraph b. above.

10. Right Turn Lane Detection

a. Location

Detection for a right turn lane shall be installed in the same manner as a presence detection zone for a through lane on a low speed approach.

b. Detector Lead-in Cable

The right turn presence detection loop shall be connected into its own detector lead-in cable, and separate channel on an extension amplifier for the through phase.

11. Installation of Vehicle Detection Systems

See the Standard Specifications and Details for construction requirements for primary (inductance loops) and secondary (wireless magnetometers) vehicle detection methods.

12. Video Imaging Vehicle Detection Systems (VIVDS)

The City's practice is to install inductive loop detectors as a standard means of detection. Wireless magnetometers are considered acceptable when installation of loops is unfeasible and/or impractical. Video detection is only to be used to provide vehicle detection on a temporary basis (e.g. construction) and in special cases where the City has approved its use prior to the preparation of final plans.

When using video detection systems, at least one camera shall be installed for each intersection approach.

13. Bicycle Detection

(a) Bicycle detection systems shall be consistent with the method used for vehicle detection at the intersection.
(b) Bicycle detection shall be considered at new and modified signalized intersections when the existing or proposed bicycle lane meets any of the conditions to warrant a bicycle signal.
(c) Bicycle detection shall be installed at new and modified signalized intersections when the existing or proposed bicycle lane is on an approach typically operated in actuated mode, and that therefore, requires a method to recognize the presence of a bicycle to receive a green indication and proceed parallel to the adjacent vehicular movement.
(d) Bicycle detection shall not be installed at signalized intersections when none of the applications to warrant bicycle signals are met, or the bicycle lane is located on a major approach typically operated in fixed-time mode, and that therefore, does not requires a method to recognize the presence of a bicycle to receive a green indication and proceed parallel to the adjacent vehicular movement served every signal cycle.
(e) If loop detectors are used, diagonal slashed and quadrupole loop detectors are recommended for bicycle lanes. Refer to Loop Detector Standard Details.
(f) If wireless sensors are used, the system selected shall supplement and be compatible with the existing or selected wireless vehicle detection system used at the intersection.

When bicycle detection is used, a Bicycle Signal Actuation sign (R10-22) shall be used, and a symbol shall be placed on the pavement indicating the optimal position for a bicyclist to actuate the signal. Refer to Standard Signs and Pavement Markings Drawings.

14. Other Detection Devices

The engineer may recommend other detection technologies and submit a written recommendation outlining the benefits of the technology. However, the City reserves the final authority to approve or disapprove the use of these technologies.

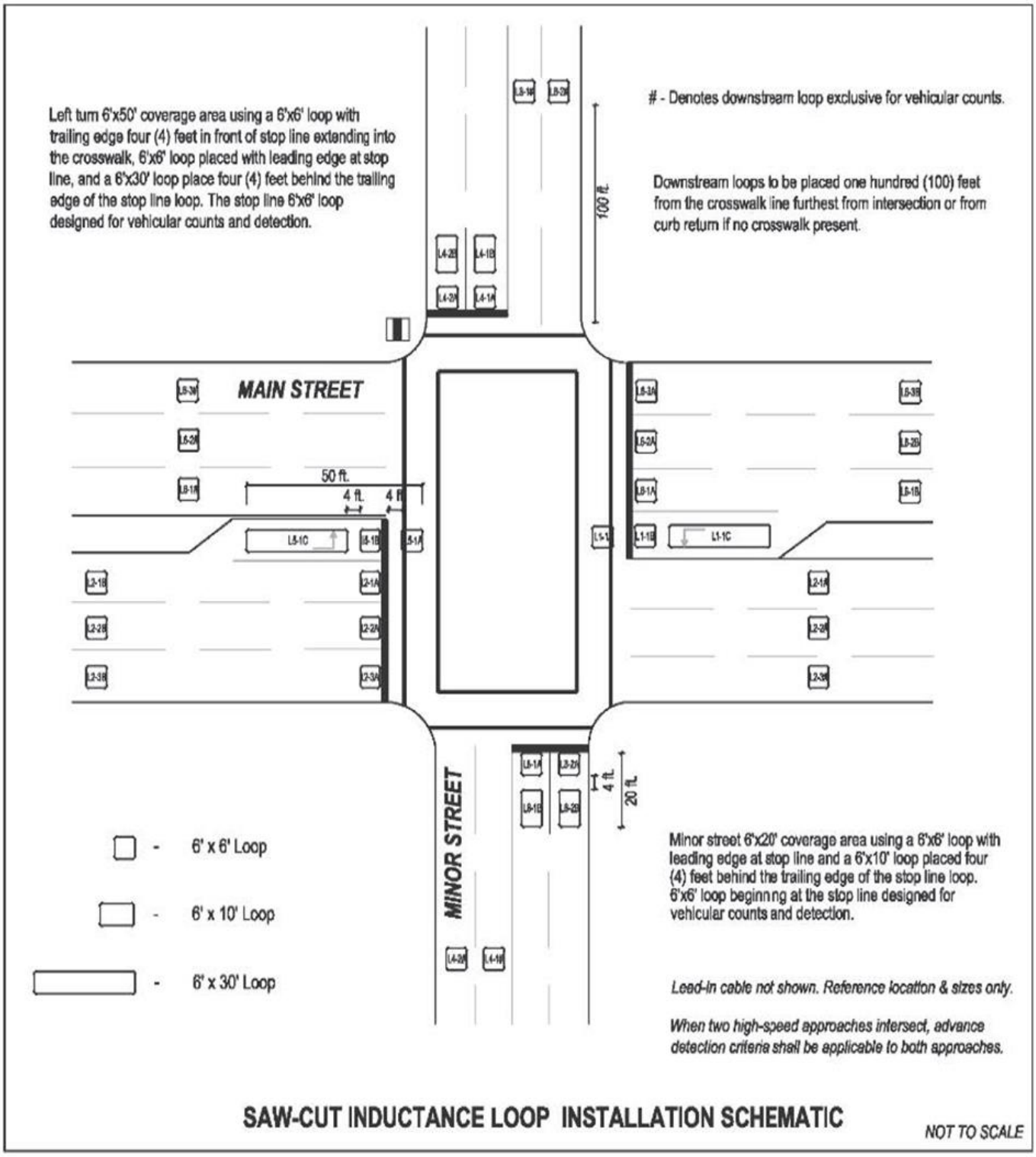


Figure 15.11.01a Saw-Cut Inductance Loop Installation Schematic

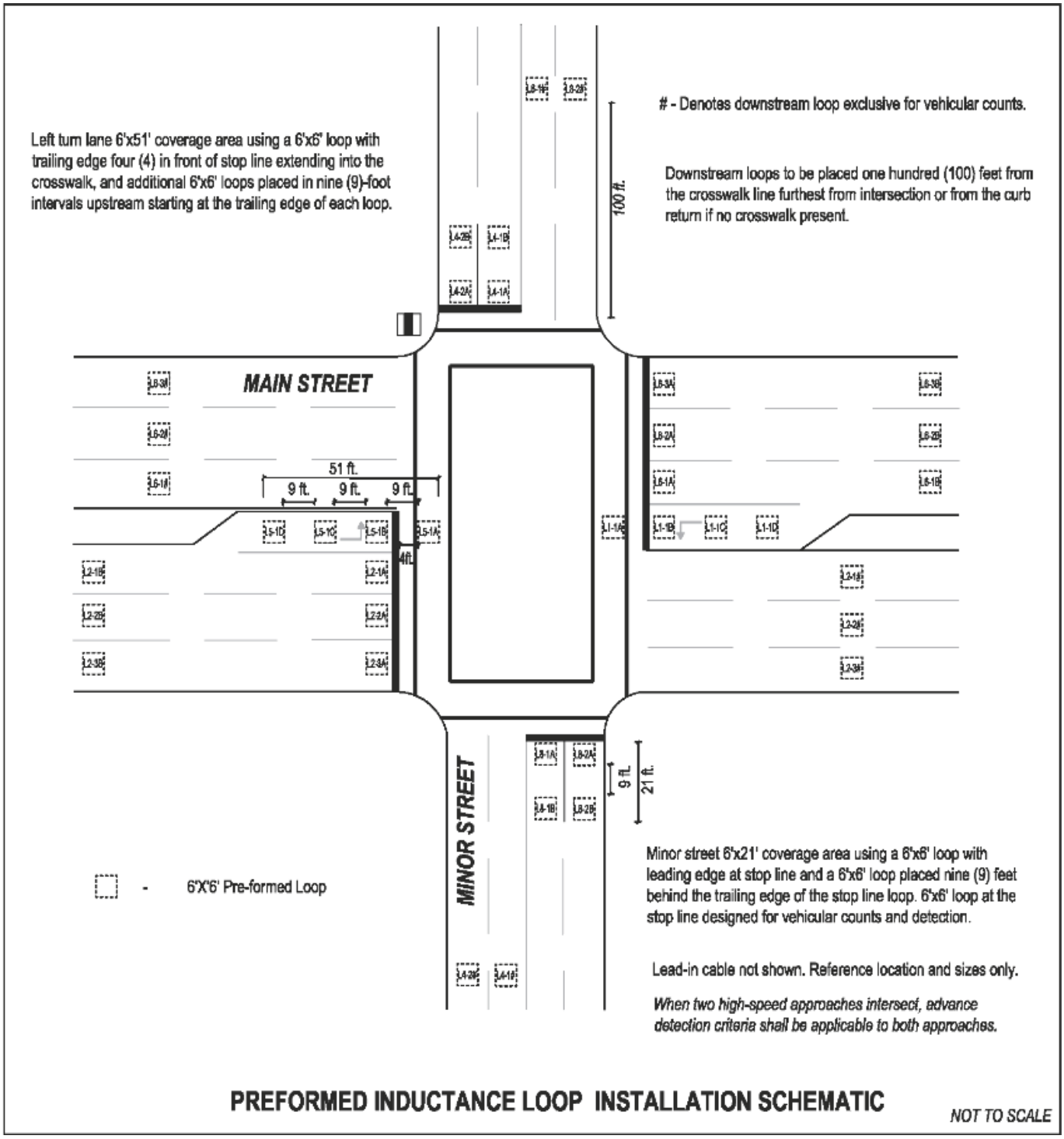


Figure 15.11.01b Pre-Formed Inductance Loop Installation Schematic

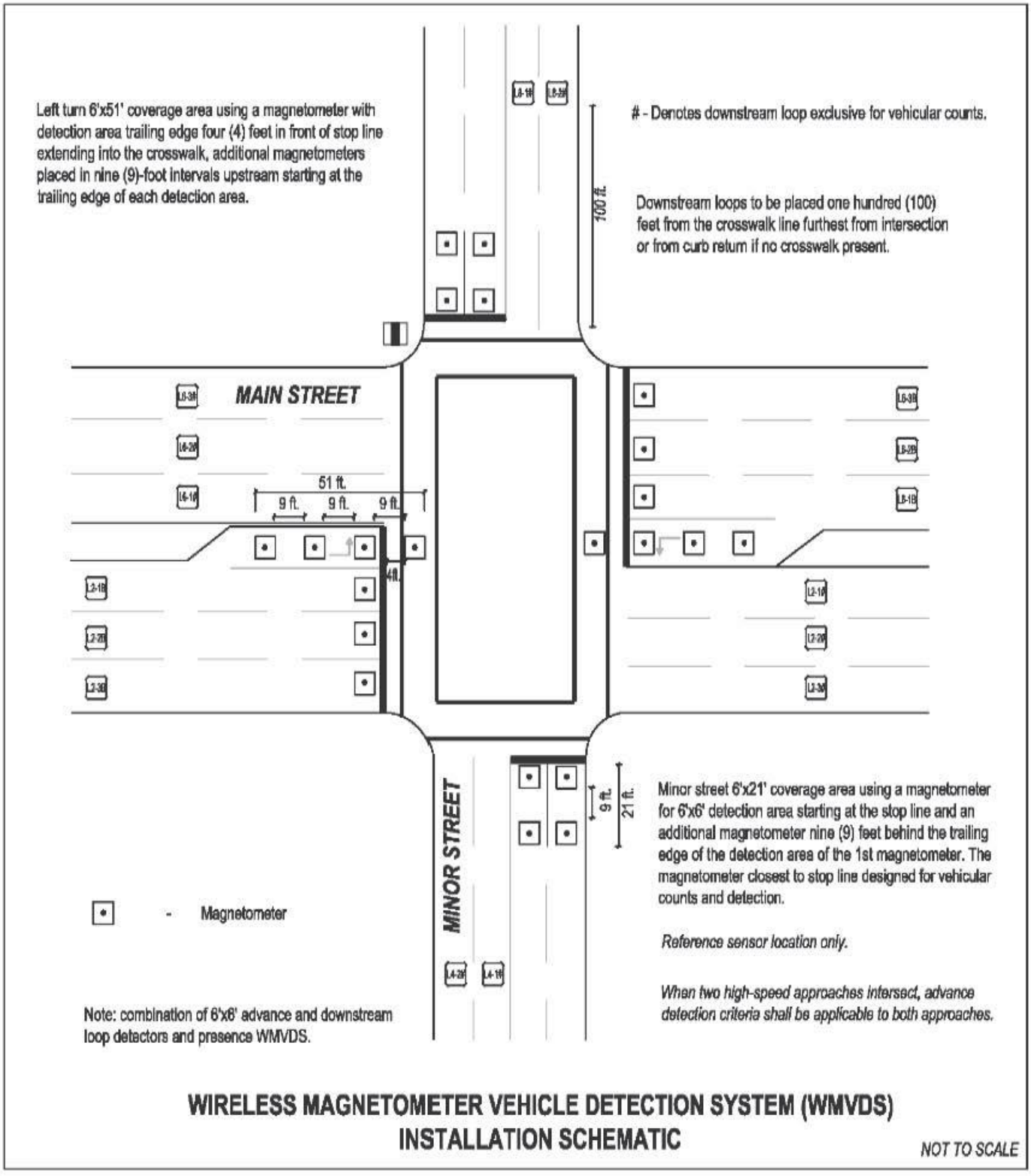


Figure 15.11.01c Wireless Magnetometer Vehicle Detection System (WMVDS) Installation Schematic

H. Underground Systems

1. Conduit

a. Type of Conduit

All conduits shall be as specified in the Standard Specifications. The designer must pay careful attention to where the Standard Specifications call for certain types of conduits for certain uses as well as when boring and encasing is to be used so the estimates can accurately reflect the field quantities.

b. Installation

(1) Conduit shall be installed according to the Standard Specifications. Requirements for depth below finish grade shall be strictly adhered to.
(2) The Consultant, in conjunction with the City, shall determine if conduit crossing certain paved streets should be shown as open cut or bored due to extensive utility problems. The specifications should require an alternate bid option of both methods to allow for unforeseen factors.
(3) In general, conduit runs crossing paved alleys, drives, and streets shall be bored.

c. Conduit Sizing

(1) Conduits shall be sized according to minimum allowed sizes and allowed conduit fill.
(2) Conduit placed under roadway shall not be less than 3-inch in diameter.
(3) Conduit shall be in ½" incremental sizes, with the exception of the rigid galvanized conduits on span-wire installations as shown in the Standard Details.
(4) Conduit fill shall not exceed 40% on any one conduit or 26% average for all conduits on any one run.
(5) When crossing the street with interconnects cable, the spare conduit required for a street crossing may be used if adequate capacity is available.
(6) One (1) inch conduit shall only be used to protect the Street Loop Wire from the loop to the adjacent pull box.

Table 15.11.01
Dimensions and Maximum Percentage of Filled Area of Conduit

Trade Size	Internal Diameter (In)	Cross Sectional Area (Sq In)	26% Fill (Sq In)	40% Fill (Sq In)
1"	1.029	0.83	0.22	0.33
2"	2.047	3.29	0.86	1.32
2-1/2"	2.445	4.70	1.22	1.88
3"	3.042	7.27	1.89	2.91
4"	3.998	12.55	3.26	5.02

Source: National Electrical Code; Chapter 9, Table 4.

d. Length of Conduit Run

Conduit runs should be limited to 190 feet between pull boxes or structures where the cable is reasonably accessible for pulling. If the conduit run is very straight, with no more than 180 degrees of bend, and contains only a single cable, the run may be extended to about 350 feet.

e. Spare Conduits

Spare conduits shall be installed as shown in the Standard Details.

f. Location of Conduit Runs

(1) If new sidewalk is part of the construction, conduit runs may be located under the new sidewalk with the junction boxes being constructed flush with the sidewalk.
(2) If the sidewalk is existing, and a planting strip exists between the curb and the sidewalk, the conduit and junction boxes should be located either in the planting strip or on the other side of the sidewalk (right-of-way permitting), whichever has fewer utility conflicts.
(3) If there is no curb and gutter, the conduit and junction boxes should be located as far as possible back near the right-of-way, but not in drainage areas.
(4) Conduit runs shall be located away from drainage collection points whenever possible.

2. Pull Boxes

a. Size

Three sizes are available for use from the Standard Specifications and Details. The designer shall select the applicable box based on number and size of conduits to be contained in the box. If the designer is concerned that the standard pull box will be too small, they should select the next larger size pull box. The three sizes of standard pull boxes used by the City and their applications are:

Type A - To be used for detector loop pull boxes and hardwire interconnect boxes.

Type B - This is the standard traffic signal pull box, but may also be used as a detector loop pull box where multiple loops enter a single pull box.

Type C - This is the standard pull box to be used for most communications applications. It can also be used for traffic signals where a large pull box is required due to multiple large conduits entering the pull box. The most frequent use of this pull box in traffic signal construction is for the pull box adjacent to the controller cabinet.

b. Location

(1) A pull box is generally required adjacent to each loop, set behind the curb or located on the shoulder to minimize being run over by vehicles.

(2) For low speed approach and turn lane detectors, a junction box should be located to minimize the length of the detector lead-in cable.

(3) Each quadrant of the intersection shall have a pull box that is within 30 feet of the traffic signal pole. This pull box should service the traffic signal pole, detector lead-in conduit, and the conduit crossing the street. If the intersection is actuated, this pull box can usually be the same box servicing the detectors at the crosswalk, and possibly the left turn detectors if no median island exists. It should be located to allow the most direct path for the detector lead-in cables as well as the conduit crossing the street.

(4) Pull boxes located on corners should be positioned so that turning vehicles do not track across the pull box.

(5) At span-wire signal installations, item c. holds true for the pull box location with the exception that you do not have a street-crossing conduit running to this pull box in most cases.

(6) On the quadrant where the controller cabinet is located, there should generally be only the one pull box which services the conduit crossing the street, some detector loops, traffic signal pole, and the controller cabinet. An additional pull box is required in the Type 332 foundation, per the Standard Detail, and is also required in many cases where the controller cabinet is post-mounted.

(7) For interconnect runs between intersections, pull boxes shall be provided at appropriate intervals.

3. Traffic Signal Communications

See requirements in Section 15.19.

I. Electrical Cable

1. Detector Lead-In Cable

a. Detector lead-in cable shall be 14 AWG IMSA 50-2-1984 shielded cable meeting the requirements of the Standard Specifications.

b. All detector lead-ins cables shall be continuous runs from the splice with the loop to the controller cabinet terminal strip.

c. Each loop shall be individually brought back to the cabinet on a separate shielded cable.

2. Street Loop Wire

Street Loop Wire shall be 14 AWG IMSA 51-5-1985 cable.

3. Power Cable

a. Power shall be 120 volt, single-cycle, 60 Hz AC.

b. All services shall comply with Electric Company requirements and consist of six (6) #4 AWG XHHW stranded wires and an 8 AWG Solid Bare Ground. The six #4 AWG XHHW wires shall consist of two (2) white, one (1) black, one (1) red and two (2) green wires. A black #4 AWG XHHW stranded wire will be used for the "hot" signal leg and a white #4 AWG XHHW stranded wire will be used for the "common" signal leg. The two green, one red and one spare white #4 AWG XHHW stranded wires shall be reserved as spares or for future luminaire usage.

4. Signal Cable

a. Traffic Signal Heads

(1) All traffic signal heads shall be serviced with a 7 conductor, 14 AWG IMSA 19-1-1984 cable meeting the requirements of the Standard Specifications.

(2) IMSA cables are to run un-spliced from the controller cabinet to the terminal strip in the pole or to the signal heads where termination in the pole is unavailable.

(3) Each approach will require that at least two heads be on separate IMSA cables. For additional heads, cables may be run from the first through head with a second cable from the first head to the additional heads.

(4) Each protected/permissive and protected only left turn signal heads

shall be serviced by its own cable with no splices to other heads.

b. Pedestrian Signal Heads and Pushbuttons

(1) Each pedestrian signal head shall be serviced by its own five (5) conductors, 14 AWG IMSA 19-1-1984 cables with no splices to other heads.

(2) Each pedestrian pushbutton shall be serviced by a three (3) conductor, 14 AWG IMSA 19-1-1984 cables.

c. Installation, Continuity of Cables, and Splices

All cable shall meet the requirements of the Standard Specifications for installation, continuity, and splices.

No conduit or isolated cable for purposes different than traffic signal service should be attached or placed inside any signal pole.

5. Spare Cables

Where future pedestrian movements or left turn signal heads are anticipated, spare electric cables shall be routed from the controller cabinet to the pole on which they would be installed. In all cases, sufficient spare cable should be provided to connect to the future location of the equipment.

6. Voltage Drop Calculations

The designer shall take into account voltage drop calculations where applicable due to loss over long distances and consider special exceptions to the wire sizes normally used to accommodate losses.

J. Electrical Services

1. Type

The City's standard installation for electrical service will be a service pedestal. All service pedestals and poles shall be as shown in the Standard Specifications and Details and in compliance with the electric company standards.

2. Procedures for Hook-Up to Utility Company

a. The utility company shall be contacted for the location of the power source and to verify their procedures for hook-up of power during the design process.

b. Appropriate notes shall be placed on the plan sheet detailing the Contractor's responsibilities for hook-up, including sufficient advance notice to allow hook-up when the signal system is ready for testing.

c. The service center shall be a ground-mounted service pedestal when there is to be a steel pole installation. On wood pole span-wire type installations, a wood pole-mounted service assembly is appropriate. Under no circumstances will the electric company or the City allow a meter assembly to be attached to an electric company pole. The assembly has to be located either on a corner signal support pole or a separately installed service pole, put in by the contractor.

K. Signs

1. General

All traffic sign codes in this section are from the current editions of the Standard Highway Sign Designs for Texas and the TMUTCD.

2. Overhead Mounted Street Name Signs

a. A street name sign (D3, Texas Manual on Uniform Traffic Control Devices) for each approach shall be installed on the mast arm between the pole and the first signal head as shown on the Standard Detail.

b. If the two legs of the cross street have different names, two signs with arrows shall be installed in lieu of a single street name sign. The sign on the left shall have an arrow pointing left followed by the street name. To the right of this sign is a sign with the name of the street to the right followed by an arrow pointing right.

c. Street name signs shall include block numbers per the Standard Details.

d. Customized street name signs require separate approval from the City Traffic Engineer. Interested parties should contact the Traffic Hotline at 832-395-3000 to apply.

3. Overhead Lane Use Control Signs

Refer to Traffic Signal Heads and Lane Use Control Signs in Section E.

4. Median and Island Approaches

a. Median approaches should have an R4-7 Keep Right sign (symbol only) mounted at the nose of the median.

b. Island approaches, with same directional traffic on both sides shall have a W12-1 Double Arrow sign mounted at the nose of the island.

5. Pedestrian Pushbutton Signs

Pedestrian Pushbutton signs shall be as shown in the Standard Details.

a. An R10-3e shall be used at most locations.

b. An R10-3b may be used at installations where standard pedestrian indications without the countdown feature are used.

6. No Pedestrian Crossing Signs

An R9-3A sign with plaque shall be installed on the mast arm pole at each side of an approach where no pedestrian signals or crosswalks are used.

7. Sheeting on Intersection Control Signs

All traffic control signs that are mounted overhead shall have diamond grade reflective sheeting. This applies to street name signs, one-way signs, turn restriction signs, etc. Any other supplemental intersection control signs that are ground mounted shall use at a minimum high intensity prismatic reflective sheeting.

8. Other Traffic Signs

Other traffic control signs, e.g., one-way, left lane must turn left, no right turn on red, no parking, etc., shall be installed as needed. These signs shall meet the requirements of the TMUTCD.

L. Battery Backup/ Uninterrupted Power Supply (UPS) Systems

1. General

The City of Houston shall require the installation of Battery Back Up/Uninterrupted Power Supply (UPS) systems on all new or reconstructed traffic signals. The Battery Backup/UPS System will meet the requirements of the Standard Specifications.

15.12 TRAFFIC CONTROL PLAN

15.12.01 GENERAL

A. This section of the Design Manual contains general guidelines and instructions to be used in determining appropriate construction sequencing and preparation of traffic control plans. The intent is to establish standard procedures and requirements that will be used by engineering designers and consultants when preparing traffic control plans for City of Houston projects. In turn consistent application of lane closures and minimal inconvenience to the traveling public will reduce frustration due to negative impacts of construction activities and improve safety because of uniformity of lane/sidewalk closure techniques. All design shall also be in accordance with the latest version of the Texas Manual on Uniform Traffic Control Devices (TMUTCD).

B. This document provides Designers and Consultants with:

1. requirements and guidelines for ensuring uniformity in lane/sidewalk closure techniques; and

2. the required format of plan sheets to allow ease of review, minimization of construction errors, and facilitation of maintenance of traffic control setup by the Contractor.

15.12.02 DESIGN REQUIREMENTS

A. Description of Design/Review Process

1. Project Initiation

a. Determine Requirements of Other Agencies. If the project falls under TxDOT's jurisdiction, verify TxDOT's traffic control requirements and approval process is needed. The Consultant shall meet with appropriate TxDOT personnel to determine how to prepare the traffic control setup. After the meeting the Consultant shall meet with City of Houston Project Manager/City Traffic Engineer to discuss traffic control plans per TxDOT requirements and come up with an action plan to prepare construction sequencing and traffic control plans. This task could be handled via phone/e-mail correspondence.

b. The Consultant shall meet with the City of Houston prior to beginning the construction sequencing and traffic control plans to discuss the project in detail. At this meeting, typical and any conditions that need to be considered in preparation of construction sequencing and traffic control plans will be discussed. The meeting regarding traffic control plans will generally occur as part of other project initiation meetings and design review meetings. Based on the discretion of the City Traffic Engineer and/or City of Houston Project Manager a special meeting may be organized to discuss specifics of the

project in regards to construction sequencing and traffic control setup.

B. Data Collection

a. Collect all data required to produce construction sequencing plans and traffic control plans. Typically, at this stage of the design process proposed improvements and goals of the project have been developed. Therefore, existing topographic survey and/or improvement design sheets will be used as the base file to produce construction sequencing plans.

b. The Consultant shall visit the project site to inventory and identify physical features that may impact construction sequencing and traffic control plans such as access driveways to special adjacent properties that may require special considerations in preparing traffic control plans such as schools, police stations, fire stations, churches, properties with only one access point, and relatively high demand commercial developments.

C. Plans and Drawings

a. General

(1) All construction sequencing and traffic control design plans shall be prepared on 22" x 34" Mylar reproducible sheets, using the Standard City of Houston, Houston Public Works Title Block. Construction sequencing and traffic control plans shall be shown on different plan sheets.

(2) All full size designs for construction sequencing and traffic control plans shall be prepared at any scale as long as the notes and callouts are readable.

(3) All construction drawings shall be prepared in accordance with Chapter 3, Graphic Requirements.

(4) On projects where the Consultant finds it necessary to deviate from the standard format presented herein, due to project scope or design requirements, the City's Project Manager should be consulted to determine an acceptable alternate format. Any changes to the format are at the discretion of the City's project manager.

(5) Construction sequencing plan should include all aspects of the improvement project such as removal of existing features such as curb, pavement, signs, implementation of temporary pavement to facilitate traffic, implementation of temporary signal locations, and installation of all proposed elements of the project.

(6) Each phase of construction sequencing plan shall have separate traffic

control plan including associated detour routes and signal modification plans as necessary. The Consultant should look into using standard lane closures to reduce the number of plan sheets from phase to phase. In addition, if simple signal head adjustments are need for signal modification of different phases, the Consultant is encouraged to only use one signal modification plan for different phases.

(7) Each phase of construction sequencing plan shall make every effort to leave existing sidewalk accessible to pedestrians while project related improvement activities commence forward. Complete sidewalk closure must be minimized as much as possible.

(8) The contractor shall provide 11 foot travel lanes on traffic control plans outside the Central Business District (CBD), and a minimum 10 foot wide travel lanes within the CBD. Any deviation will have to be approved by the City Traffic Engineer.

(9) The Contractor shall provide at a minimum two traversable lanes within the CBD. Any deviation will have to be approved by the City Traffic Engineer.

(10) Where a bicycle facility is present, the Contractor shall provide as high comfort bicycle detour as possible. See Chapter 17 for the design of high comfort bicycle facilities. If the bus stop is present, the contractor shall provide an accessible comfortable pedestrian route to access the bus stop.

(11) Lane closures on Major Thoroughfares according to the latest classifications by the Planning and Development Department; existing directional vehicular movements shall be maintained throughout the duration of the construction project. There may be special construction activities that may require limitations of movements on major thoroughfares. These situations must be approved by the City Traffic Engineer. Typically, such approvals are associated with peak period restrictions and/or special traffic control plan and requirement of extensive advertisement to the traveling public especially to stake holders substantially impacted in the vicinity.

(12) Trench walls should not be three feet from the edge of the traveled way at any stage of the construction.

(13) Traffic control devices shall be in place before starting any excavation.

(14) For vertical drop-off greater than one foot along roadway, low profile concrete barriers with appropriate end protections must be installed.

b. General Notes.

The following General Notes should be included on the traffic control plan. Additional notes may be added by the Consultant as may be necessary to properly clarify the intent of the design.

(1) The Contractor shall provide and install traffic control devices in conformance with Part VI of Texas Manual on Uniform Traffic Control Devices (TMUTCD) latest edition with revisions during the entire construction period.

(2) All signs and traffic control devices shall conform to the latest version of the TMUTCD.

(3) No lanes shall be closed during the hours of 7:00 AM to 9:00 AM and 4:00 PM to 6:00 PM Monday thru Friday without approval of the City Traffic Engineer.

(4) No work shall be performed in residential areas from 7:00 PM to 7:00 AM.

(5) Contractor shall maintain approved number of through lanes of traffic in each direction during construction working hours. Traffic control plans shall include one-way and/or detour plans. Contractor shall maintain ADA compliant pedestrian access to bus stops and adequate bus access to the bus stops.

(6) Contractor shall maintain traffic lanes and detours according to traffic control plans during working hours.

(7) Contractor shall cover open pavement excavations for minor utility work with anchored steel plates during non-working hours, and open lanes for normal traffic flow when feasible.

(8) If the Contractor chooses to use a different method of "Traffic Control Plans" during the construction than what is outlined in the contract drawings, the Contractor shall be responsible to prepare and submit an alternate set of traffic control plans to the City of Houston Project Manager for approval ten working days prior to implementation. These plans shall be drawn to scale on reproducible mylars and shall be sealed by a Licensed Engineer in the State of Texas. Transportation & Drainage Operations representative approval is required to accept the proposed changes.

(9) Contractor shall secure lane/sidewalk/bicycle facility closure permits from Transportation & Drainage Operations (Mobility Permit Section at http://www.gims.houstontx.gov/portalWS/MainPortal.aspx) before

implementing the traffic control plan. The application must be submitted at least ten business days prior to the implementation of the traffic control plan and/or beginning construction work. The Contractor shall provide traffic control plans, construction sequencing, and construction schedule with the application.

(10) Contractor shall have approved traffic control plan and permit at the job site for inspection at all times.

(11) During pavement surface restoration projects; the Contractor shall not open closed lanes until the pavement surface has cured enough to allow vehicular traffic according to City of Houston Standard Specifications.

(12) The Contractor is responsible for scheduling and coordinating all construction activities with stake holders in the vicinity including emergency response agencies such as Houston Police Department, Houston Fire Department, and Metropolitan Transit Authority.

(13) Contractor shall be responsible for issuing all work directives to all sub-contractors, utility companies, and all other entities performing construction work associated with the project.

(14) Nothing in these notes or plans shall relieve the Contractor of the responsibility for job site conditions during the course of construction of the project; including safety of all modes of transportation, persons, and property, and that this requirement shall apply continuously and not be limited to working hours.

(15) The Transportation & Drainage Operations (Mobility Permits Group) per the direction of the City Traffic Engineer have the right to demand the installation of additional traffic control devices or modifications to these plans and notes, as deemed necessary to promote the safe and orderly flow of traffic, including pedestrians and bicycles, through the construction work zone. The Contractor shall comply with these additional requests or modifications with due diligence.

(16) All existing traffic control signs and pavement markings shall be maintained in visible locations during construction unless prior written approval is obtained from City of Houston Project Manager. The Contractor shall restore or replace (at the discretion of the City Traffic Engineer) any pavement marking or signing damaged during construction operations, including Raised Pavement Markers (RPMs).

(17) When entering or leaving roadways carrying public traffic, the

Contractors equipment, whether empty or loaded shall in all cases yield to public traffic with the assistance of Contractor provided certified flagger/peace officer.

(18) Access to driveways adjacent to the construction work zone shall be maintained at all times as much as possible. Additional cones and/or delineators may be required to delineate the driveway access route through the construction work zone. A minimum of one travel lane shall be maintained across the driveways, unless prior written approval is obtained from City of Houston Project Manager.

(19) Spillage resulting from hauling operations along or across any public traveled way shall be removed immediately by the Contractor.

(20) The Contractor shall submit an application for temporary parking restrictions if there are parking meters located at the proposed lane closures from Parking Management Division (832-393-8690) at least ten business days before implementation of lane closures. In addition, temporary no parking signs shall be posted 24 hours prior to commencement of work.

(21) Additional off duty police officers/flaggers may be requested to direct traffic when lanes are blocked at the discretion of the City Project Manager even if they are not specifically identified on the project plans.

(22) The Contractor shall replace within 72 hours, all traffic signal loop detectors damaged during construction.

(23) In general, a solar powered flashing arrow board shall be required on all major thoroughfare lane closures. Exceptions to flashing arrow boards and/or implementation on residential lane closures shall be approved by the City Traffic Engineer.

(24) Approved traffic control plan shall be in place before starting any excavation.

c. General Notes and Channelization Spacing (Refer to City of Houston Standard Detail 01512- 01)

d. General Lane Closure Guidance (Refer to City of Houston Standard Detail 01512-02)

e. General Detour Guidance (Refer to City of Houston Standard Detail 01512-03)

f. Long Term Major Street Lane Closure (Refer to City of Houston Standard

Detail 01512-04)

g. Long Term Minor Street Lane Closure (Refer to City of Houston Standard Detail 01512-05)

h. Short term Minor Street Intersection Lane Closures (Refer to City of Houston Standard Details 01512-06 through 01512-12)

15.13 MINIMUM VERTICAL CLEARANCE

15.13.01 GENERAL

This section of the design manual contains the requirements for minimum vertical clearances for structures, utilities and traffic control devices.

15.13.02 MINIMUM VERTICAL CLEARANCE GUIDANCE

A. Pedestrian Sky Bridges
Refer Chapter 16, Miscellaneous, for sky bridge clearance requirements.

B. Overhead Traffic Signal Devices
Refer Chapter 15, Section 11 of this manual and Standard Detail # 02893 for minimum clearance requirements for overhead traffic signal devices.

C. Traffic Signs
Refer to Chapter 15, Section 11 traffic signal section of this manual, and TMUTCD for overhead sign installation requirements.

D. Vehicular Bridge
The bottom of the lowest point of the structure in the public right of way should be a minimum of 14.5 feet over the entire roadway width. If a clearance is less than 17.5 ft, it must contain appropriate signs, and it requires approval of the City Engineer and the City Traffic Engineer.

E. Building Structures Over Public Right of Way
The bottom of the lowest point of the structure in public right of way should be a minimum of 18.5 feet over the entire roadway width.

F. Railroad Overpass Clearances
Highway structures over railroads are referred to as railroad overpasses. Vertical clearance for new structures over railroad tracks must be 23'-6" feet minimum measured from the top of rail to the lowest obstruction under the highway structure. In cases where electric powered trains are involved, additional vertical clearance may be required.

G. Railroad Underpass
Prior to resurfacing under railroads, approval must be obtained from the railroad company.

H. Obtain approval from Office of City Engineer for exception or deviations from these

requirements.

15.14 STREET EXTENSIONS

A. For streets that will be extended, the traffic study will recommend appropriate posted speed limit and parking restrictions that are consistent with the existing street segments at both ends.

B. For street extensions that occur in phases, the design will include installations of appropriate pavement markings and warning signs (e.g., speed reduction signs, no outlet.) to ensure safe traffic operations and street transition until the full extensions are completed.

15.15 NEIGHBORHOOD TRAFFIC MANAGEMENT PROGRAM

15.15.01 GENERAL

A. The City of Houston, HPW, Transportation & Drainage Operations administers the Neighborhood Traffic Management Program (NTMP) per the requirements of City of Houston Code of Ordinances Chapter 45, Article XV.

B. Due to House Bill 3082, the City of Houston is obligated to go through the NTMP process as prescribed by City of Houston Code of Ordinances Chapter 45, Article XV in order to implement traffic calming devices within City of Houston jurisdiction.

C. Traffic calming device is any type of device consisting of the physical structure or other improvement constructed, placed, whether on a temporary or a permanent basis, to mitigate speeding or cut-through traffic on local streets such as but not limited to speed cushions, median islands, traffic circles, chicanes, chokers, and raised pedestrian crossing islands.

D. The NTMP comprises of the Speed Control Program and Volume Control Program. For neighborhoods that are interested in only speed cushions, the Speed Control Program offers a shorter process with no traffic study and public meeting requirements.

E. All proposed traffic calming measures shall have to go through the NTMP process before implementation. Detailed information on the process, brochure, and application form can be obtained at https://www.publicworks.houstontx.gov/tdo-documents~~http://www.publicworks.houstontx.gov/tod/programs.html~~. The requestor can also contact the NTMP group at NTMP@Houstontx.gov or 832-395-3000 for additional assistance.

F. If a project receives public requests for traffic calming devices, the design team shall strive to accommodate the requests within the project limits. The NTMP staff can guide the team through the process to obtain the appropriate approvals. Installation cost of the approved devices will be incidental to the project.

15.15.02 DESIGN REQUIREMENTS ON ROADWAYS WITH ALREADY APPROVED TRAFFIC CALMING DEVICES

A. Description of Design/Review Process

1. Project Initiation

a. The Consultant shall meet with the City of Houston prior to beginning the redesign/replacement of traffic calming devices to discuss the project in detail. At this meeting, typical and any specialty items in regard to the traffic calming measures will be discussed. The meeting regarding traffic calming measures will generally occur as part of other project initiation meetings and will not require a separate meeting.

2. Collect Traffic Calming Measures Data and Design

a. Collect all data required including but not limited locations of existing speed humps, speed cushions, and any other traffic calming devices.

3. The City of Houston does not use speed humps anymore. Therefore, all existing speed humps within the affected construction limit of a given project shall be replaced with speed cushions per the requirements of City of Houston Standard Detail 13501-01 as part of the improvement project and using the project funds.

4. Typically, all existing traffic calming devices shall be returned in place at the same location unless directed by the City Project Manager/City Traffic Engineer to adjust.

15.15.03 NTMP PROCESS

A. The NTMP process is detailed in the City of Houston Code of Ordinances Chapter 45, Article XV. In summary, Figures 15.15.01 and 15.15.02 outline the process including the requirements of City Council approval for the Speed Control and Volume Control Programs.

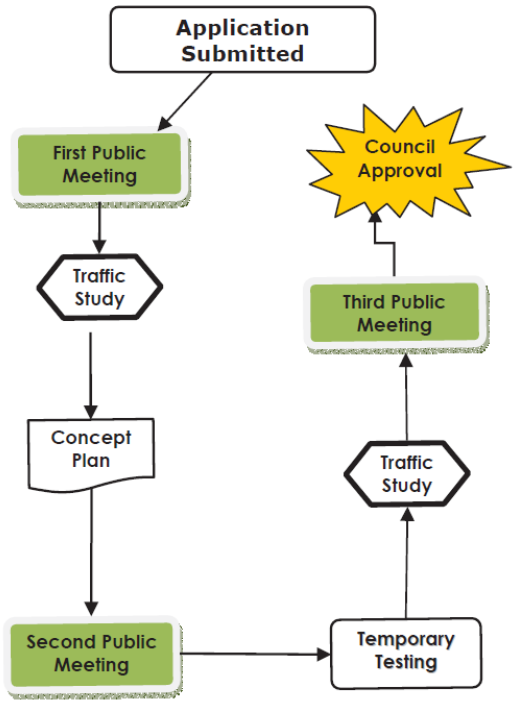


Figure 15.15.01 - Summarized NTMP Process - Volume Control Program

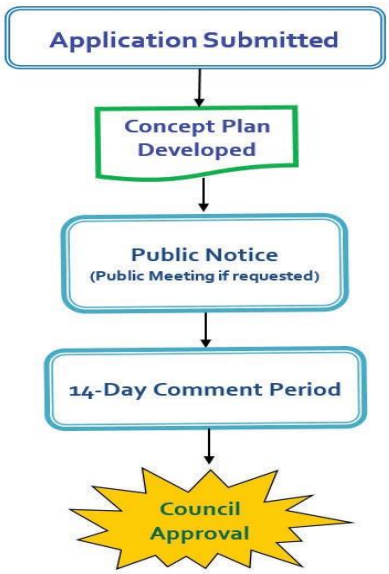


Figure 15.15.02 - Summarized NTMP Process - Speed Control Program

B. Typically, the NTMP group directs an applicant through the process. In some cases, a neighborhood group or organization may choose to use a Consultant to go through the process, and construct the traffic calming devices using private funds.

1. The Consultant tasked by the group shall meet with the City of Houston Transportation & Drainage Operations staff responsible for the NTMP prior to starting the design. At this meeting, there will be discussion of the level of involvement by the Consultant to go through the process.

2. If the Consultant requests City of Houston resources to assist with some of the tasks, there may be a waiting period to start the process.

15.16 STREETLIGHT DESIGN REQUIREMENTS

15.16.01 DESIGN REQUIREMENTS - CAPITAL IMPROVEMENT PROJECTS

The following design requirements are applicable within the City street rights-of-way and are intended for lights owned and installed by CenterPoint Energy. The Consultant is to contact the City's prior to implementing the below criteria to determine ownership and design methodology. This recommended practice is applicable to all capital improvement projects, including but not limited to street, bridge, water, wastewater, and storm sewer projects. The consultant will be responsible for designing the street lighting layout associated with each project by following the guidelines listed below. Note that the below criteria are solely for the use of the standard Cobra style light fixtures on cobra poles. Areas requiring or requesting decorative type lighting will need direction from the City's Streetlight Section on developing a streetlight design and cost.

1. It is the City's practice to upgrade the street lighting along all roadways to current recommended levels as part of capital improvement projects.

2. Areas without wood power poles are considered candidates for metal pole streetlights. The design consultant will prepare the lighting layout, spacing the streetlights at a distance of approximately 200' +/- 20' for driveway/utility conflicts. Typically, a streetlight placed 3-4 ft. behind back of curb will illuminate two lanes. Roadway sections that are four or more lanes should be illuminated from both sides. For sections less than four lanes, stagger the streetlights along both sides of the roadway, maintaining the 200' +/- 20' spacing. The design should also include any existing street lighting. Proposed and existing street lights should be called out by station numbers. Generally, begin layouts at intersections and work away.

3. The design must identify which of the existing streetlights will require relocating or temporary removal during the construction phase. Plans shall be submitted to the Transportation & Drainage Operations for review/approval. Upon our approval, the City will submit the approved layout to CenterPoint Energy for a conduit/pullbox layout and cost estimate for the temporary removal/re-installation of the existing streetlights. These costs will then be forwarded to the Project Manager and included as a line item in the bidding documents for cash allowance to pay CenterPoint. Note that CenterPoint will require payment prior to providing service.

4. When overhead power and wood pole street lighting exist in an area, the design should utilize existing wooden utility poles for any additional streetlights while maintaining a 175' +/- 15' spacing. Mixing of wood and metal pole streetlights along local streets in neighborhoods is generally not allowed and shall require prior approval from the City.

5. Along thoroughfares and collectors with four or more lanes, wood poles may exist along only one side of the roadway. In these instances, it is acceptable to have wood pole streetlights along one side while having metal pole streetlights along the other.

6. Upon completion of the project it is the contractor's responsibility to notify the Streetlight Section in writing that the conduit has been installed & inspected and meets CenterPoint's specifications before the authorization for new/re-installed metal pole streetlights can proceed.

7. Locations of existing and proposed street lights (station numbers) need to be shown. Do not show lighting outside of the public roadway right-of-way.

8. Pole number for existing street lights must be shown. This is a 6-digit number that is stenciled approximately 6' above grade on the street side of the light.

9. Depict type of existing and proposed street lights (metal pole or wood pole) - note: wood poles are never installed for the sole purpose of street lighting).

10. All metal pole street lights that could potentially be impacted by construction activities shall be removed and reinstalled. The removal and reinstallation will be completed by CenterPoint. The cost for this service will be included in the project as cash allowance to pay CenterPoint.

11. The proposed locations of new street lights should not necessarily be based on the existing light locations. The layout should be created from scratch, following the spacing criteria described above.

12. When removing/replacing lights in residential areas, it is generally preferable to replace lights in the same location, unless relocation is necessary to meet the lighting and spacing criteria.

13. In residential area, show parcel boundaries (property lines)

14. In residential areas, place lights on property lines and at property corners 2' off the radius of the curve (refer to the CenterPoint Energy streetlight staking detail).

15. No lights should be placed at a 45 degree angle at the intersections

16. Do not place proposed lights under heavy tree canopy (typical mounting height of a streetlight pole is 26'). Field verify to ensure appropriate clearance. Where tree canopy is unavoidable, plans must specify that tree canopy will need to be trimmed a minimum 5' radius around the projected streetlight pole mounting height (all trimming to be part of project cost, CNP will not trim trees nor install lights in heavy

tree canopy).

17. Do not place proposed lights in any wheelchair ramps or sidewalks.

18. If decorative lighting is requested by the neighborhood, the Consultant will submit the standard layout to the City. CenterPoint will prepare a separate decorative lighting layout. The City will review both layouts and determine which layout will be implemented.

19. Based on the City approved layout, CenterPoint will prepare a conduit layout, which the Consultant will incorporate into the design. The Contractor is responsible for the conduit installation. CenterPoint will be responsible for installing and energizing the streetlights. Payment to CenterPoint will be included in the project as a cash allowance item.

20. If temporary lighting is required, design and installation will be completed by CNP. Cost for this service will be included in the project as cash allowance from the contractor to CNP.

15.16.02 DESIGN REQUIREMENTS - CITIZEN REQUEST

1. The primary purpose of street lighting is to illuminate the roadway. Street lights are not intended for providing security lighting, pedestrian lighting, parking lots lighting or any other private property lighting. A street segment must be within the City limits in order to be eligible for street lights. All street lights are installed, owned and maintained by Center Point Energy. However, the City must approve for any street light installation that is within the City right-of-way. Once it is installed, the City pays for the operating and maintenance cost of the street light.

2. Street light types - The City of Houston standard street light type includes Light Emitting Diode (LED) in a cobra style light fixture mounted on wooden pole or metal pole.

   a. Wood Pole Lights: The City will authorize for street light installation on wooden utility poles wherever possible.

   b. Metal Pole Lights: If an area does not have existing wooden pole with overhead power lines, then a metal pole streetlight powered by underground lines will be installed. There may be a cost associated with this type of installation.

   c. Wattage: Various wattages will be installed depending on the road to be illuminated. 45 watt LED fixtures will be installed on local roadways and 95 watt LED fixtures on collector type roadways. 115 watt LED fixtures are typically installed along major thoroughfares. LED street lights technology continues to advance. Increased efficiencies will change the applicable wattages and the designer should refer to the latest City specification for roadway lighting.

3. Street light spacing requirements. Metal pole street lights are typically installed approximately 200 feet apart (+/- 20') with 10 feet for property line adjustment. Street lights are typically installed on public right-of-way avoiding obstructions such as trees, manhole, and inlets. Spacing for street lights on wooden utility poles may vary depending on the existing location of the wood poles. However, spacing will normally be 150 to 200 feet apart for adequate roadway illumination.

4. Street light(s) can be requested by application. A Street Light Survey Request Form is available through the City of Houston website (https://www.publicworks.houstontx.gov/tdo-documents~~https://edocs.publicworks.houstontx.gov/division-files/traffic-operations-division/programs.html~~) or by calling (832) 395-3000. This application must be completely filled out and submitted to the City by mail or by fax. Upon receipt of the application, the City will conduct a street light survey and provide a written response in approximately 6 - 8 weeks thereafter. If the City determines that street light is feasible as a result of the survey, the City will authorize Center Point Energy for street light installation. Streetlights deemed necessary along Major Thoroughfares will incur an installation cost by CenterPoint Energy. Funding for the installation cost will be processed and paid by the City. CenterPoint Energy will schedule the installation once it receives payment. Timelines for the installation will vary depending on the City's ability to fund the request.

5. Cost for street lights. Typically, there is no charge to the applicant for any street light that can be installed on an existing wooden pole, or any street light (wooden or metal) that is installed on a roadway that is classified as a major thoroughfare per the City of Houston. However, there is a charge for the installation of a new street light on a metal pole on city local roads. There may be an additional charge by CNP for local roads that require a high level of illumination. Per Section 40-3 of the City Code of Ordinances, the applicant is required to pay for the first year's operating cost prior to authorizing the installation of the street light. This is a one-time charge to the applicant. The cost may vary but average around $200.00 per street light.

6. Enhanced street light. The street light program also offers enhanced street lights upon request. Locations and types of enhanced street lights must meet the following requirements:

   a. Locations of enhanced street lights must be within a current Management District, Tax Increment Reinvestment Zone (TIRZ), recognized by City of Houston.

   b. Enhanced street light must be approved by the Street Light Program coordinator coordinated with City's other Capital Improvement Project.

15.17 COMPLETE STREET CLOSURE

A. A street can permanently be closed by a private entity after the City relinquishes the street right-of-way and access easement. The City Joint Referral Committee (JRC) reviews and approves all abandonment and sale of street, alley, or easement. Information about the JRC

can be found here:
https://www.publicworks.houstontx.gov/joint-referral-committeehttps://www.publicworks.houstontx.gov/notices/joint-referral-committee.html.

B. A local, residential street can be closed for traffic calming purposes. Requests for such closure are administered by the Neighborhood Traffic Calming Program (NTMP).

C. Temporary complete street closure is strongly discouraged. If such closures are required and demonstrated to minimize construction impacts and improve public safety, closure permit can be obtained from the Mobility Permit Section. Temporary closure to serve a special event will require a permit from the Mayor's Office. Below are general requirements for temporary, construction-related street closures.

- Planned full street closures require a mobility permit from the Traffic Management Branch.
- Purpose and anticipated duration of the proposed full street closure must accompany the mobility permit application.
- Traffic Control and Detour Plan must be sealed by a Texas licensed Professional Engineer.
- Public notification. Change message signs (CMS) must be displayed a minimum of 7 days in advance of the proposed full street closure.

15.18 INTERSECTION TURNING TEMPLATES / DESIGN VEHICLES

- Pedestrian and bicycle connections should be maintained whenever possible; otherwise, most direct detours should be provided.
- Criteria for selecting design vehicles are provided in Chapter 10
- Dimensions and turning templates of design vehicles may be found in the AASHTO Green Book
- Dual left-turn and dual right-turn lanes should be designed for the SU-30 in the inside lane and the standard design vehicle in the outside lane
- Turning template diagrams will be submitted to the City upon request

15.19 INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

15.19.01 ITS Devices

All existing ITS infrastructure must be shown on design plans and kept operational during construction. All new and redesigned traffic signals shall have new ITS infrastructure included in the design. All ITS devices shall be designed with the following criteria:

- Ethernet Switch - A new Field Hardened Managed Ethernet Switches shall be installed at all traffic signals. If fiber cable is the communication method then the switch shall have City of Houston standard fiber cable ports.
- Bluetooth - A new Bluetooth card and antenna shall be installed at all traffic signals with existing Bluetooth infrastructure. All new Bluetooth equipment shall be compatible with existing Bluetooth travel time monitoring system.

- Gateway – A new Gateway shall be installed at all traffic signals. The Gateway shall be Meraki Z1 Teleworker or an approved equal and shall include a 5 year enterprise license.
- Dynamic Message Sign (DMS) – A new DMS shall be installed on all projects that require the removal or relocation of existing DMS.
- Closed Circuit TV (CCTV) - A new CCTV camera shall be installed at all traffic signals with existing cameras.
- Midblock Count Station - A new midblock count station shall be installed on all projects that require the removal or relocation of existing midblock count stations.

15.19.02 General Requirements

It is the responsibility of the design engineer to field verify all ITS devices and communications infrastructure within the project limits. Also, it is the responsibility of the design engineer to perform all necessary research, coordination and analysis for ITS device and communications deployment.

All ITS devices and communications infrastructure shall be:

- Compatible with existing infrastructure;
- Securely installed and mounted on din rail / shelf if applicable;
- Integrated into the relevant central system for control and monitoring;
- Kept operational during construction;
- Properly configured to current City of Houston Specifications and Standards.

Refer to the City of Houston's website for ITS device specifications and standard drawings. Contact Transportation & Drainage Operations / ITS section for compatibility questions with City of Houston ITS and/or communications infrastructure. Contact the Transportation & Drainage Operations / ITS section for questions and/or request at 713.881.3172.

15.19.03 Traffic Signal Communications

Fiber Optic Cable (FOC) shall be the standard form of traffic signal communications. All City of Houston projects shall include provisions for new FOC. Also, provisions for tying the new FOC into Houston TranStar via existing FOC (or Wireless Broadband (WB) if no FOC path exists to Houston TranStar) shall be included.

- Fiber Optic Cable (FOC)
  - All drop cable shall be terminated in an SFDU;
  - Pre-connectorized pigtails shall be used - all cables to be spliced;
  - For traffic signals being reconstructed:
    - Ensure new conduit is deployed between traffic signal cabinet and splice enclosure;
    - Deploy new drop cable at all locations;
    - Deploy new communications service box next to cabinet;

- Deploy new splice enclosure at all locations.
  - All FOC deployed shall be tied into existing FOC for backhaul to Houston TranStar (if the existing FOC is within close proximity**);
  - All design plans need to have splice details.
- WB Subscribers - In special cases where there is no FOC backhaul to Houston TranStar, within close proximity**, WB subscribers shall be deployed as the communications backhaul method. The subscriber shall be installed on a 10 foot extension pole mounted on top of traffic signal pole.
- Cellular - USB air cards are in use at many traffic signals. These shall be maintained during construction. Also, the air card shall be reinstalled with newly deployed ITS infrastructure.

**Close proximity is considered less than ½ mile. If existing FOC is further, contact the Transportation & Drainage Operations / ITS section for guidance and clarification at 713.881.3172. A FOC master plan is maintained by the ITS section. This will be referenced to determine if FOC shall be routed to the existing FOC even if further than ½ mile.

15.19.04 ITS Notes to be added to all plans:

A. Any interruption of ITS operations requires City of Houston Transportation & Drainage Operations / ITS section approval at a minimum of one (1) week in advance at 713.881.3172 or 713-881-3000 (Houston TranStar).

B. All existing ITS infrastructure and traffic signal communications shall be kept operational during construction.

C. Any questions or concerns related to deployment of any ITS device call City of Houston Transportation & Drainage Operations / ITS section at 713.881.3172 or 713-881-3000 (Houston TranStar).

D. All ITS devices removed shall be given to Transportation & Drainage Operations / ITS section staff immediately upon removal.

END OF ~~SECTION~~CHAPTER

APPENDIX 1

CHAPTER 15

Appendix 1 presents a typical City of Houston signalized intersection design illustrating the requirements for proposed new traffic signal installation or reconstruction of existing ones. Existing field conditions vary from one location to another; therefore, the design engineer with consultation with the City of Houston's project manager shall determine the appropriate type, size, and location of any applicable traffic component.

Typical positions and arrangements of traffic signal heads and signs related to various configurations are also shown in Appendix 1.

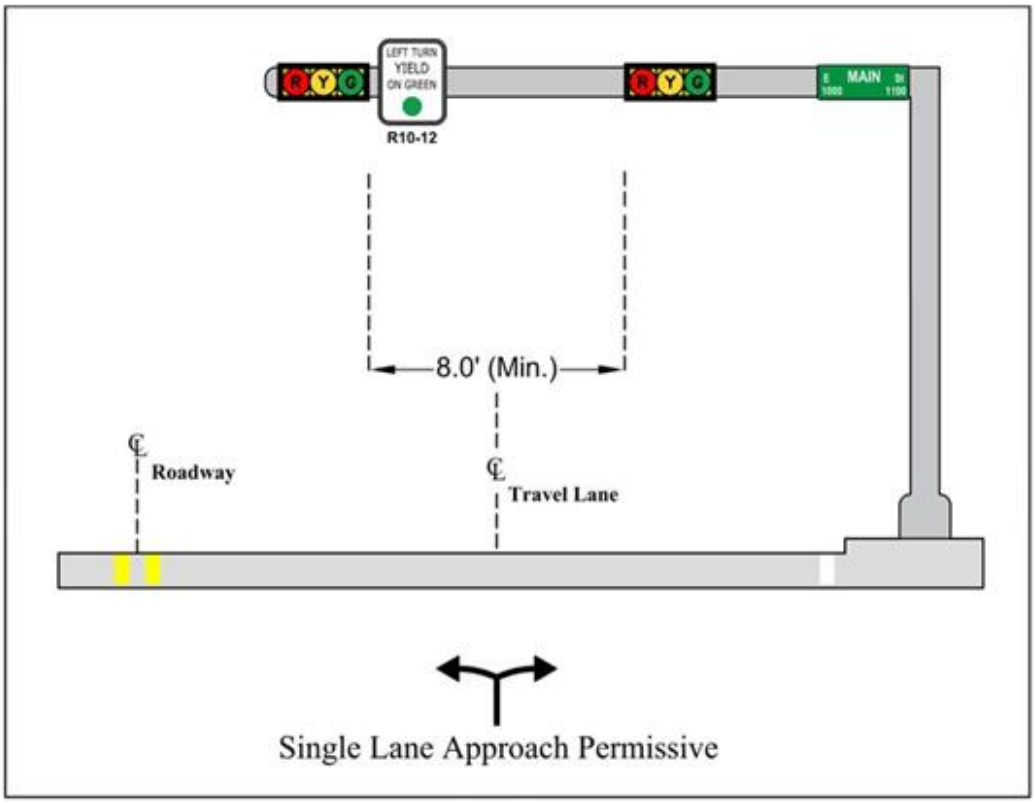
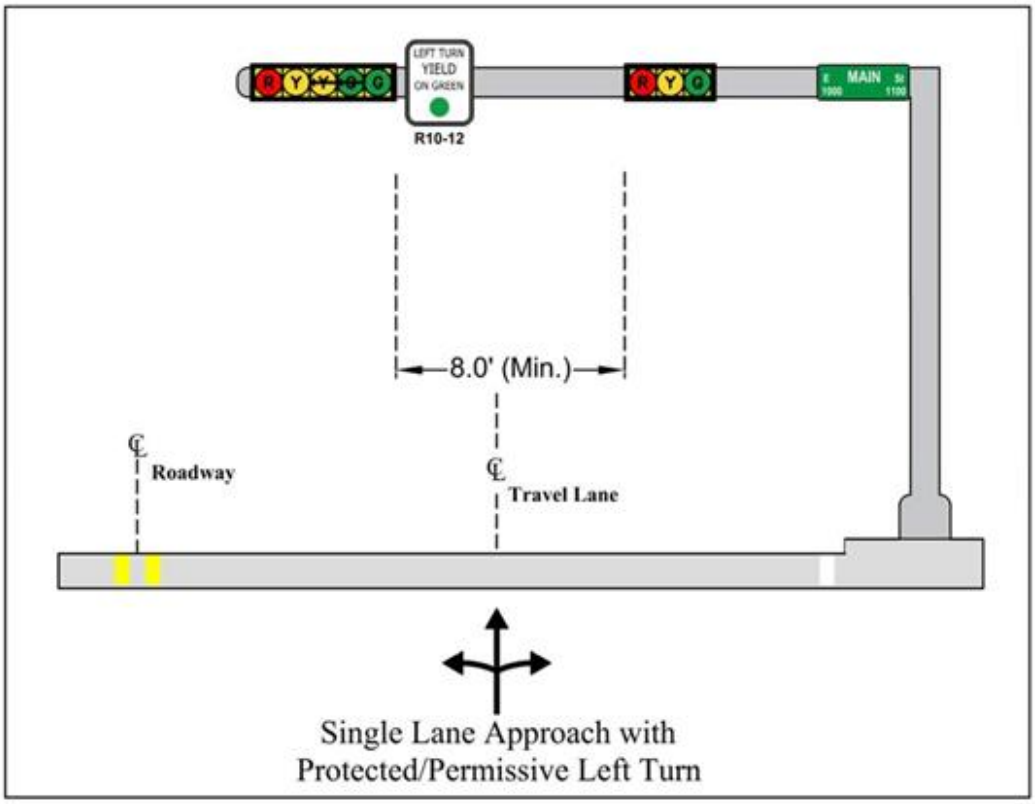


Figure 1



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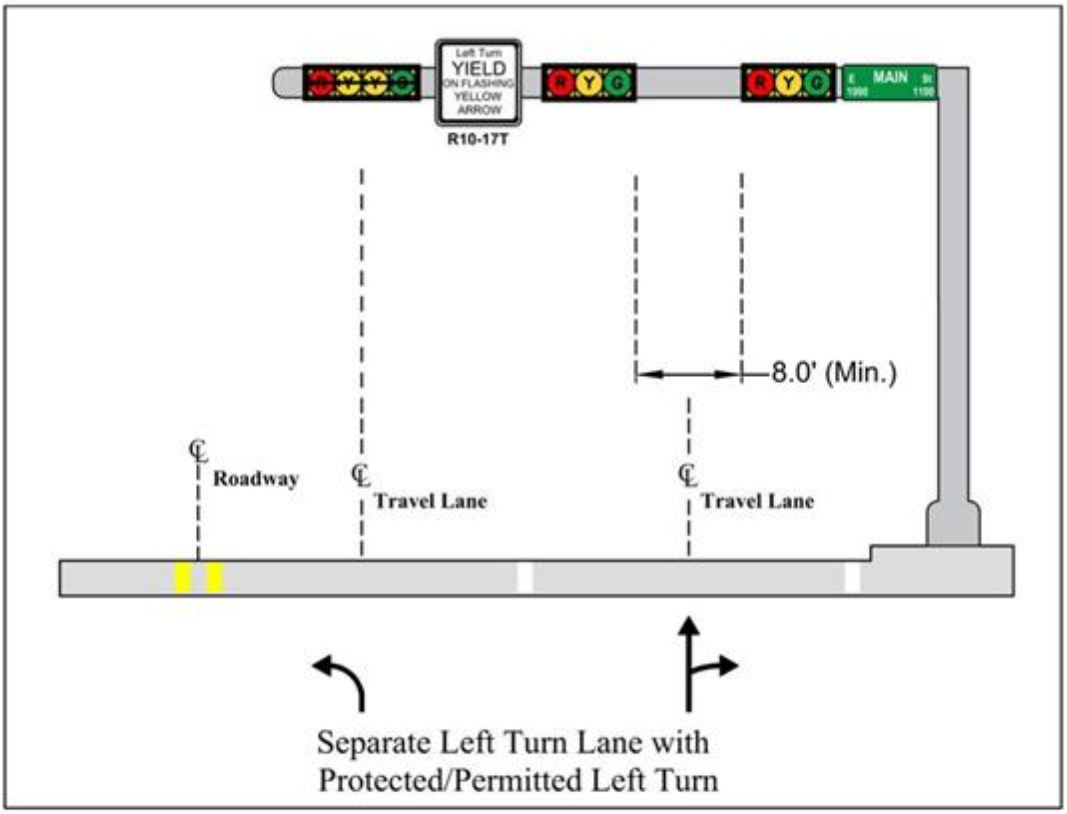

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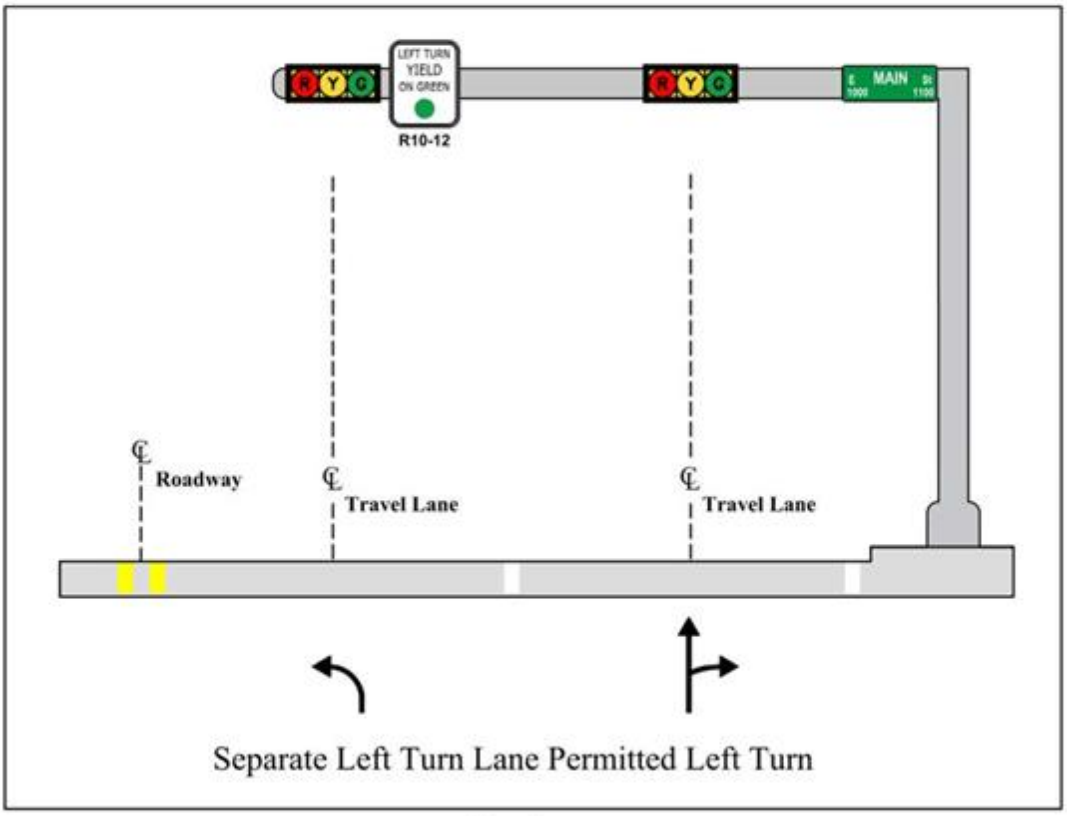

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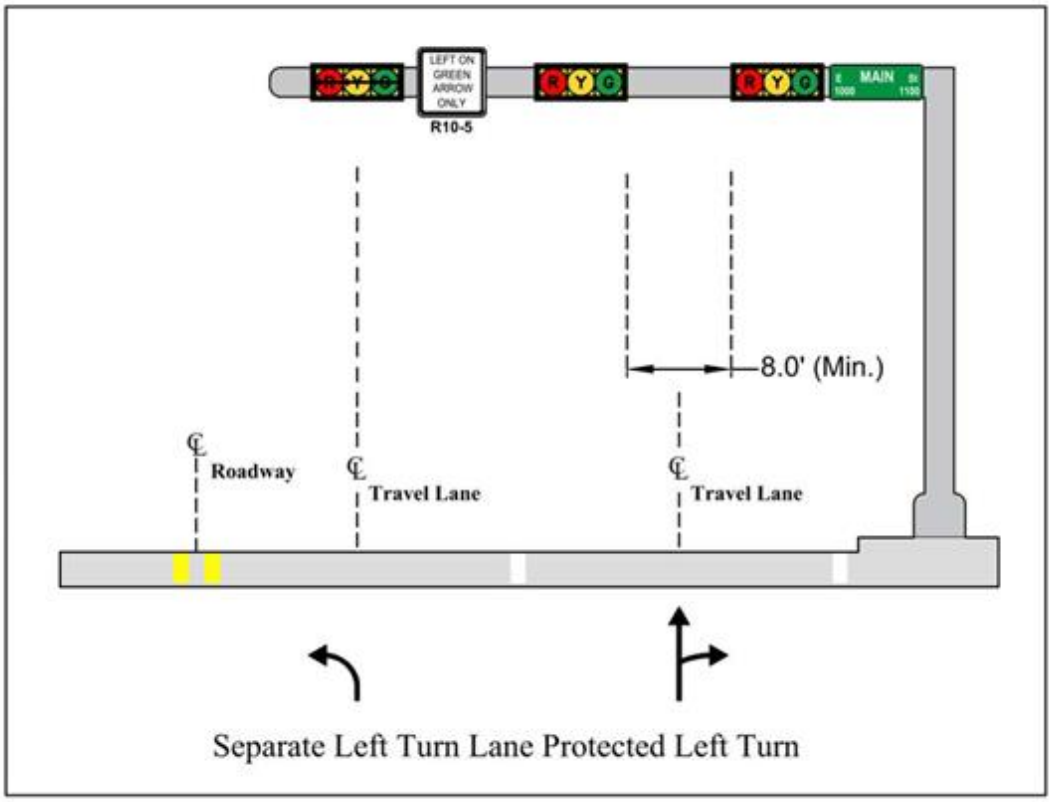

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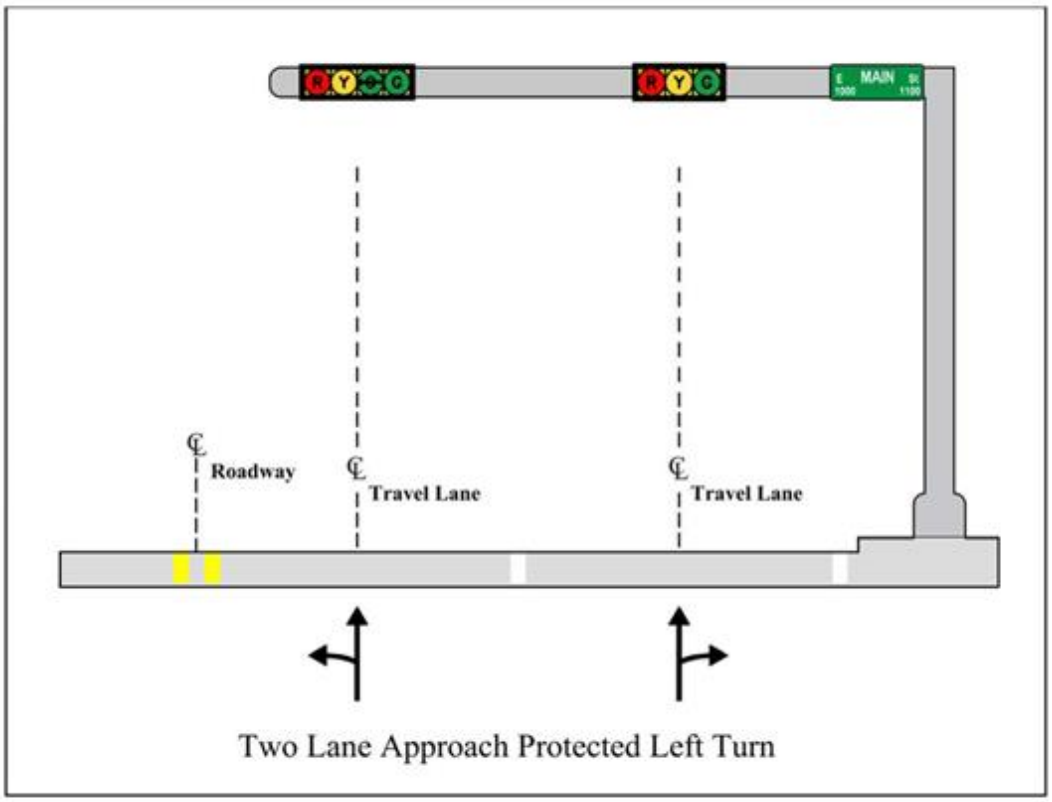

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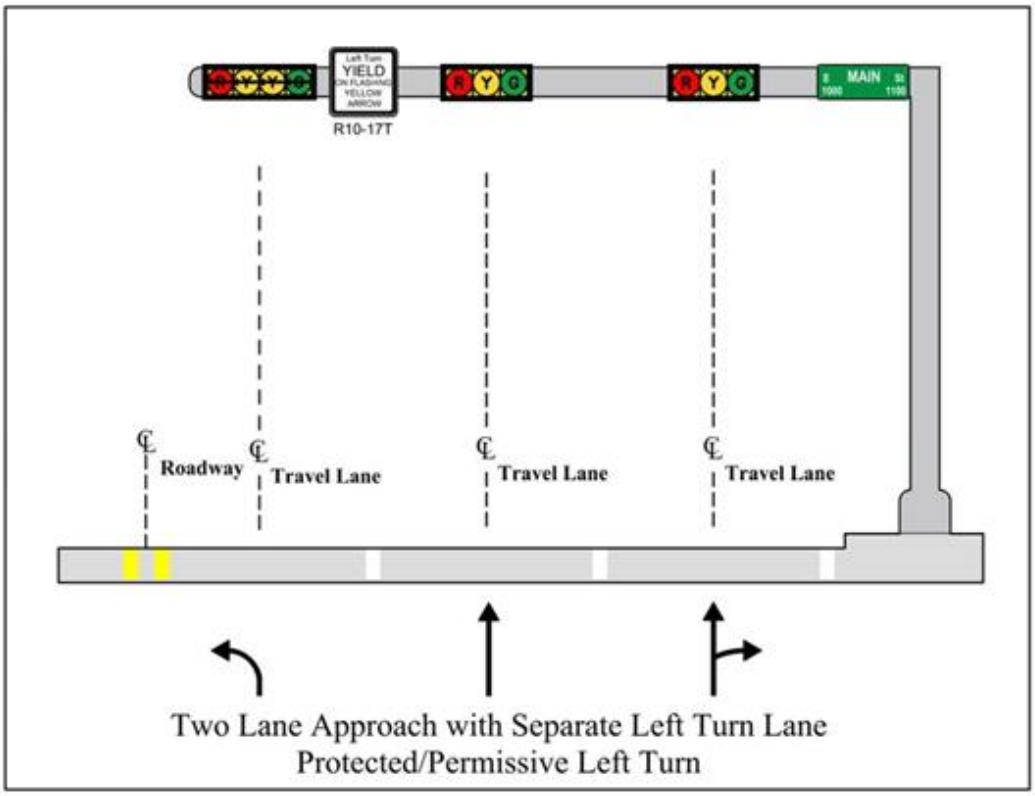

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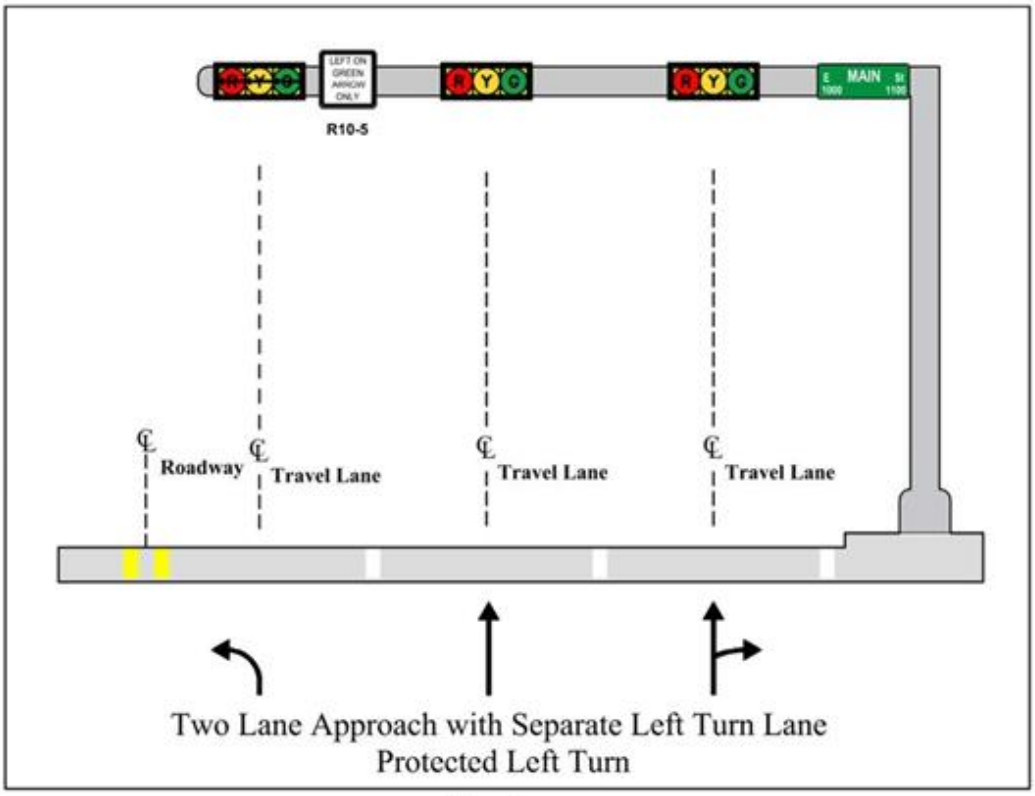

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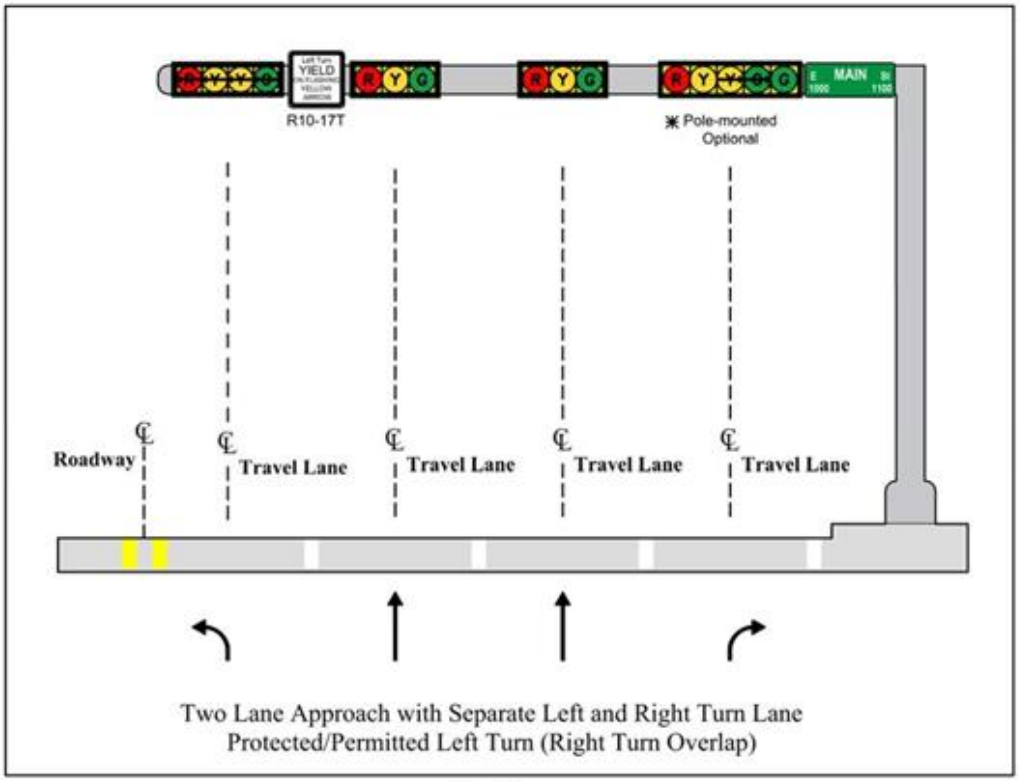
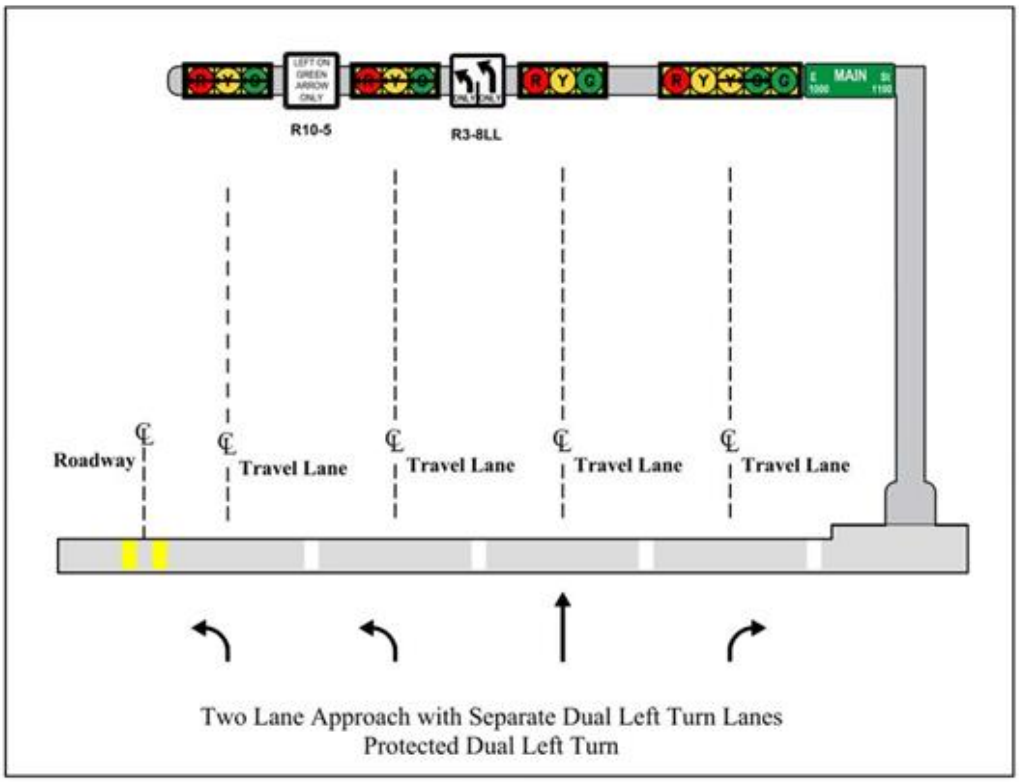


Two Lane Approach with Separate Left and Right Turn Lane
Protected/Permitted Left Turn (Right Turn Overlap)

Figure 9



Two Lane Approach with Separate Dual Left Turn Lanes
Protected Dual Left Turn

Figure 10

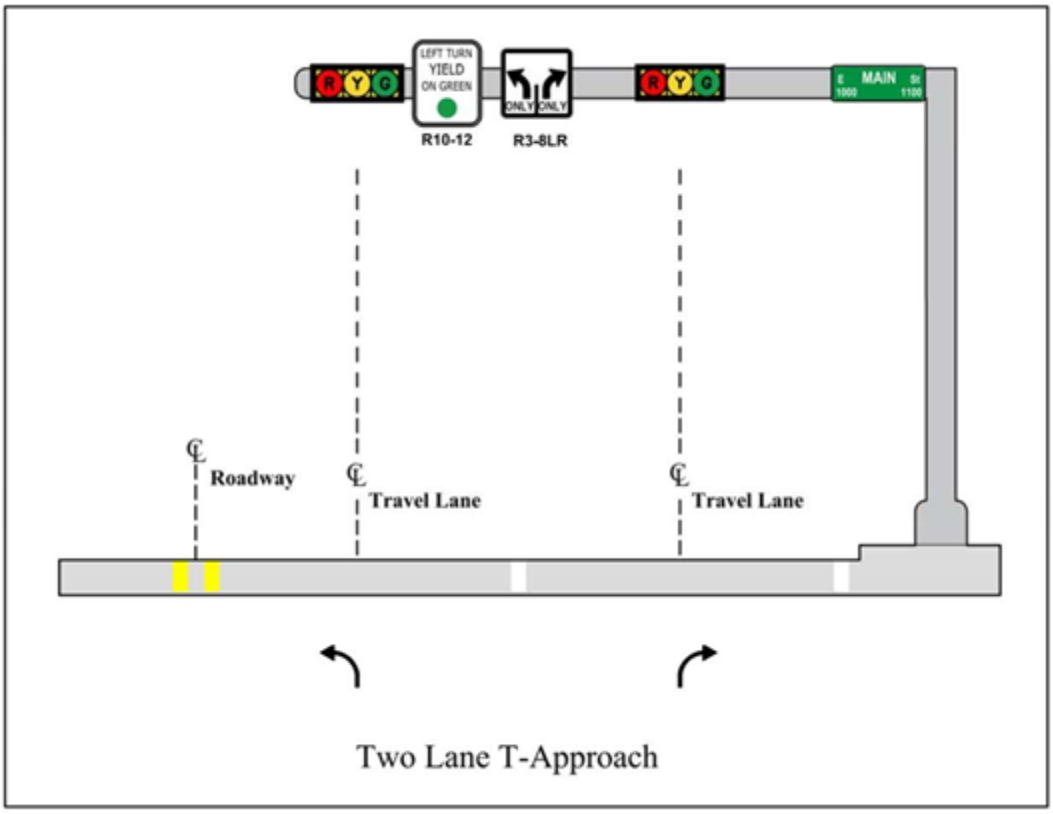
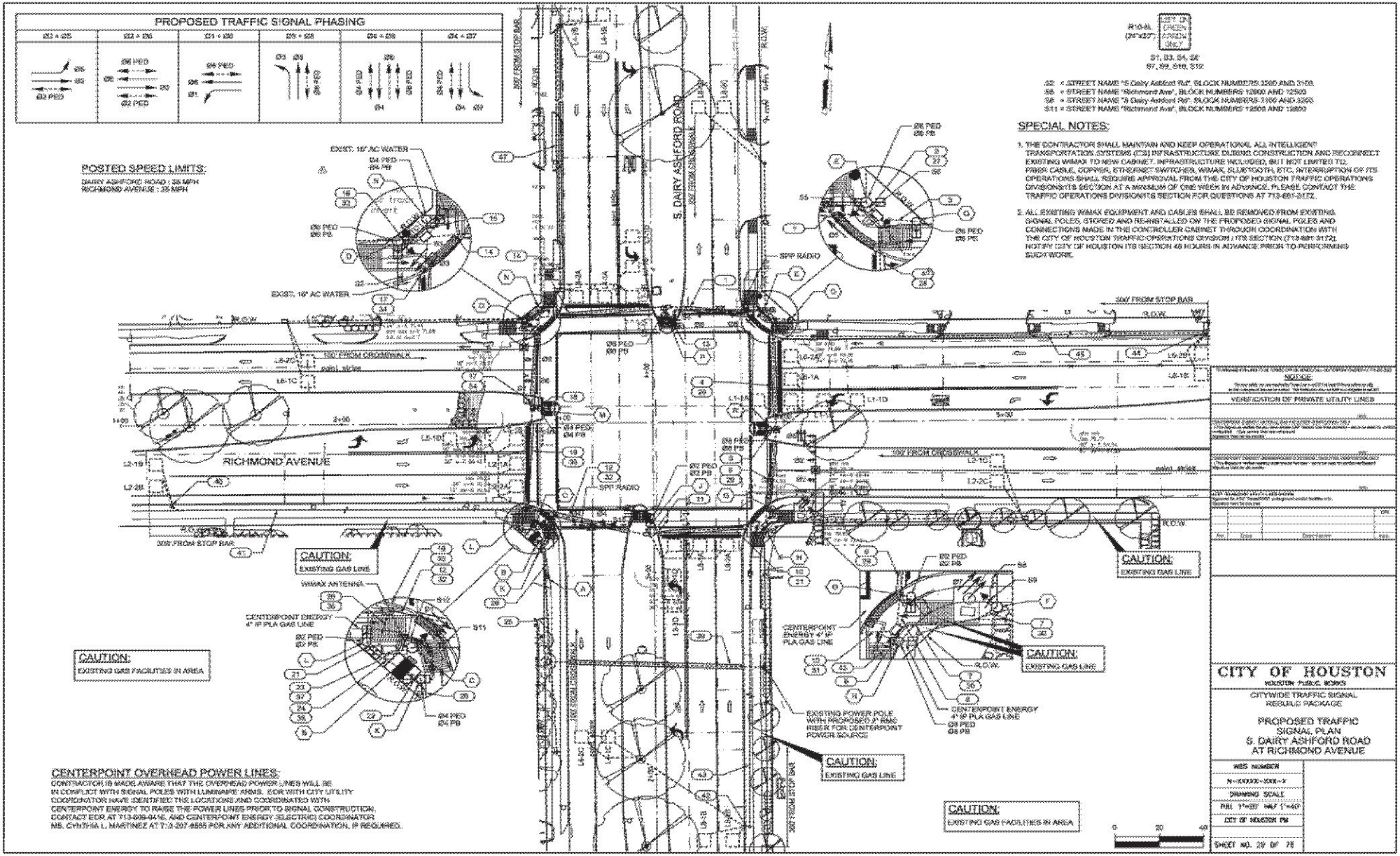
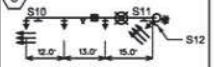
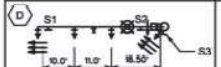
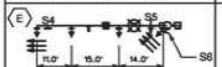
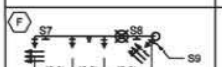

LEFT TURN
YIELD
ON GREEN
R10-12
ONLY
ONLY
R3-8LR
MAIN
Roadway
Travel Lane
Travel Lane
Two Lane T-Approach

Figure 11

Traffic Signal Design Exhibits



PROPOSED TRAFFIC SIGNAL POLE SCHEDULE

POLE NUMBER	POLE TYPE	MAST ARM		SIGNALS		LUMINAIRE TYPE	PED PB TYPE/SIGN	REMARKS	LOCATION	STANDARDS
		SIGNAL	LUMINAIRE	MOUNTING	FACE					
C 	TYPE 2	40'	15'	3 - ASTROBRAC 1 - SIDE OF POLE	1 - H3L 2 - H3 1 - V3L	106-WATT SYSTEM MAX LED COBRA HEAD LUMINAIRE	-	PRE-EMPT SENSOR (DUAL TURRETS) WIMAX ANTENNA SPP RADIO SIGNS: S10 = R10-5L (30"x36") S11 = STREET NAME S12 = R10-5L (30"x36")	AT APPROX: POLE C: STA. 2+89, 51' RT RICHMOND AVE. CONST ℄	02893-02 02893-12 02893-03 02893-04A 02893-04B 02893-05 02893-09
D 	TYPE 2	40'	15'	3 - ASTROBRAC 2 - SIDE OF POLE	1 - H3L 2 - H3 1 - V3L 1 GDP	106-WATT SYSTEM MAX LED COBRA HEAD LUMINAIRE	POLARA NAVIGATOR R10-3E (R)	PRE-EMPT SENSOR (DUAL TURRETS) SIGNS: S1 = R10-5L (30"x36") S2 = STREET NAME S3 = R10-5L (30"x36")	AT APPROX: POLE D: STA. 2+83, 52' LT RICHMOND AVE. CONST ℄	02893-02 02893-12 02893-03 02893-04A 02893-04B 02893 05 02893-09
E 	TYPE 2	40'	15'	3 - ASTROBRAC 2 - SIDE OF POLE	1 - H3L 2 - H3 1 - V3L 1 - CDP	106-WATT SYSTEM MAX LED COBRA HEAD LUMINAIRE	POLARA NAVIGATOR R10-3E (R)	PRE-EMPT SENSOR SPP RADIO (DUAL TURRETS) SIGNS: S4 = R10-5L (30"x36") S5 = STREET NAME S6 = R10-5L (30"x36")	AT APPROX: POLE E: STA. 3+92, 56' LT RICHMOND AVE. CONST ℄	02893-02 02893-12 02893-03 02893-04A 02893-04B 02893-05 02893-09
F 	TYPE 1	35'	15'	3 - ASTROBRAC 1 - SIDE OF POLE	1 - H3L 2 - H3 1 - V3L	106-WATT SYSTEM MAX LED COBRA HEAD LUMINAIRE	-	PRE-EMPT SENSOR (DUAL TURRETS) SPP RADIO SIGNS: S7 = R10 6L (30"x36") S8 = STREET NAME S9 = R10-5L (30"x36")	AT APPROX: POLE F: STA. 4+14, 46' RT RICHMOND AVE. CONST ℄	02893-02 02893-12 02893-03 02893-04A 02893 04B 02893-05 02893-09
H 	PED POLE 16'	-	-	1 SIDE OF POLE	1 GDP	-	POLARA NAVIGATOR R10-3E (L)	-	AT APPROX: POLE H: STA. 3+92, 54' RT RICHMOND AVE. CONST ℄	02893-02 02893-03 02893-06 02893-07
G L N Q 	PED POLE 15'	-	-	1 - SIDE OF POLE	1 - CDP	-	POLARA NAVIGATOR R10-3E (L)	-	AT APPROX: POLE G: STA. 3+95, 43' RT POLE L: STA. 2+78, 49' RT POLE N: STA. 2+89, 57' LT POLE Q: STA. 4+03, 51' LT RICHMOND AVE. CONST ℄	02893-02 02893-03 02893-06 02893-07
J M P R 	PED POLE 15'	-	-	2 - SIDE OF POLE	2 - CDP	-	POLARA NAVIGATOR R10-3E L (R)	-	AT APPROX: POLE J: STA. 3+38, 50' RT POLE M: STA. 2+89, 07' LT POLE P: STA. 3+46, 54' LT POLE R: STA. 4+94, 03' RT RICHMOND AVE. CONST ℄	02893-02 02893-03 02893-06 02893-07
K 	PED POLE 15'	-	-	1 - SIDE OF POLE	1 - CDP	-	POLARA NAVIGATOR R10-3E (R)	-	AT APPROX: POLE K: STA. 2+90, 59' RT RICHMOND AVE. CONST ℄	02893-02 02893-03 02893-06 02893-07

TRAFFIC SIGNAL CONTROLLER

CABINET	TYPE	CONTROLLER	AUX. CONTROL	REMARKS	LOCATION	STANDARDS
A	METERED PEDESTAL SERVICE UL TYPE 3R	METERED PEDESTAL SERVICE WITH ONE 30 AMP AND ONE 60 AMP BREAKER AND PHOTOCELL	-	PROVIDE METER SOCKET WINDOW 4" H X 6" W	AT APPROX: STA. 2+92, 75' LT (CENTER OF CABINET) RICHMOND AVE. CONST ℄	02893-14
B 	TYPE 340 ITS	2070LX CONTROLLER UINIT W/ 2070-1C CPU MODULE WITH GPS SERIAL COMMUNICATIONS MODULE & UPS BATTARY BACK-UP SYSTEM	-	STANDARD SPECIFICATION 16730 & 16731 UNINTERRUPTIBLE POWER SUPPLY - STANDARD SPECIFICATION 16732 FIELD HARDENED ETHERNET SWITCH (SIX COPPER PORTS ONLY) - STANDARD SPECIFICATION 16733 WIMAX - STANDARD SPECIFICATION 16734 GPS SERIAL COMMUNICATIONS MODULE- STANDARD SPECIFICATION 16785	AT APPROX: STA. 2+86, 57' RT (CENTER OF CABINET) RICHMOND AVE. CONST ℄	02893-10C

NOTES:
1. ALL SIGNAL HEADS WILL BE 12" WITH LOUVERED BLACK BACK PLATES AND YELLOW HOUSING
2. POLES G, K, L, M AND Q WILL HAVE CONCRETE FOUNDATION
3. POLES H, J, N, P AND R WILL HAVE SCREW-IN ANCHOR FOUNDATION

STOP LINE AND PREFORMED LOOPS LOCATIONS

ITEM BY DIRECTION	STATION S. DAIRY ASHFORD RD.	OFFSET
SOUTHBOUND		
STOP LINE @ GUTTER	4+32	39' LT
STOP LINE @ CENTERLINE	4+32	01' LT
SOUTHBOUND (THRU LANES)		
PHASE 4 CALL (6'X6') LOOP		
L4-1A, L4-2A	4+33	
PHASE 4 PULSE LOOPS		CENTERED IN LANE
L4-1B LEADING EDGE (6'X6')	300' FROM STOP BAR	
L4-2B LEADING EDGE (6'X6')	300' FROM STOP BAR	
PHASE 2 DOWNSTREAM LOOPS		
L4-1C, L4-2C (6'X6')	2+15.62	
SOUTHBOUND (LEFT TURN LANE)		
PHASE 7 PRESENCE LOOPS		
L7-1A (6'X6') LOOP	4+18	CENTERED IN LANE
L7-1B (6'X6') LOOP	4+33	
L7-1C (6'X6') LOOP	4+48	
L7-1D (6'X6') LOOP	4+63	
NORTHBOUND		
STOP LINE @ GUTTER	3+18	39' RT
STOP LINE @ CENTERLINE	3+18	03' RT
NORTHBOUND (THRU LANES)		
PHASE 8 CALL (6'X6') LOOPS		
L8-1A, L8-2A	3+14	
PHASE 8 PULSE LOOPS		CENTERED IN LANE
L8-1B LEADING EDGE (6'X6')	300' FROM STOP BAR	
L8-2B LEADING EDGE (6'X6')	300' FROM STOP BAR	
PHASE 2 DOWNSTREAM LOOPS		
L8-1C, L8-2C (6'X6')	5+27	
NORTHBOUND (LEFT TURN LANE)		
PHASE 3 PRESENCE LOOPS		
L3-1A (6'X6') LOOP	3+26	
L3-1B (6'X6') LOOP	3+11	CENTERED IN LANE
L3-1C (6'X6') LOOP	2+96	
L3-1D (6'X6') LOOP	2+81	

ITEM BY DIRECTION	STATION RICHMOND AVE.	OFFSET
EASTBOUND		
STOP LINE @ GUTTER	2+84	39' RT
STOP LINE @ CENTERLINE	2+84	01' RT
EASTBOUND (THRU LANES)		
PHASE 2 CALL (6'X6') LOOPS		
L2-1A, L2-2A	2+76	
PHASE 2 PULSE LOOPS		CENTERED IN LANE
L2-1B LEADING EDGE (6'X6')	300' FROM STOP BAR	
L2-2B LEADING EDGE (6'X6')	300' FROM STOP BAR	
PHASE 2 DOWNSTREAM LOOPS		
L2-1C, L2-2C	5+28	
EASTBOUND (LEFT TURN LANE)		
PHASE 5 PRESENCE LOOPS		
L5-1A (6'X6') LOOP	2+91	CENTERED IN LANE
L5-1B (6'X6') LOOP	2+76	
L5-1C (6'X6') LOOP	2+61	
L5-1D (6'X6') LOOP	2+46	
WESTBOUND		
STOP LINE @ GUTTER	3+98	40' LT
STOP LINE @ CENTERLINE	3+98	05' LT
WESTBOUND (THRU LANES)		
PHASE 6 CALL (6'X6') LOOPS		
L6-1A, L6-2A	4+00	
PHASE 6 PULSE LOOPS		CENTERED IN LANE
L6-1B LEADING EDGE (6'X6')	300' FROM STOP BAR	
L6-2B LEADING EDGE (6'X6')	300' FROM STOP BAR	
PHASE 6 DOWNSTREAM LOOPS		
L6-1C, L6-2C	1+82	
WESTBOUND (LEFT TURN LANE)		
PHASE 1 PRESENCE LOOPS		
L1-1A (6'X6') LOOP	3+85	CENTERED IN LANE
L1-1B (6'X6') LOOP	4+00	
L1-1C (6'X6') LOOP	4+15	
L1-1D (6'X6') LOOP	4+30	

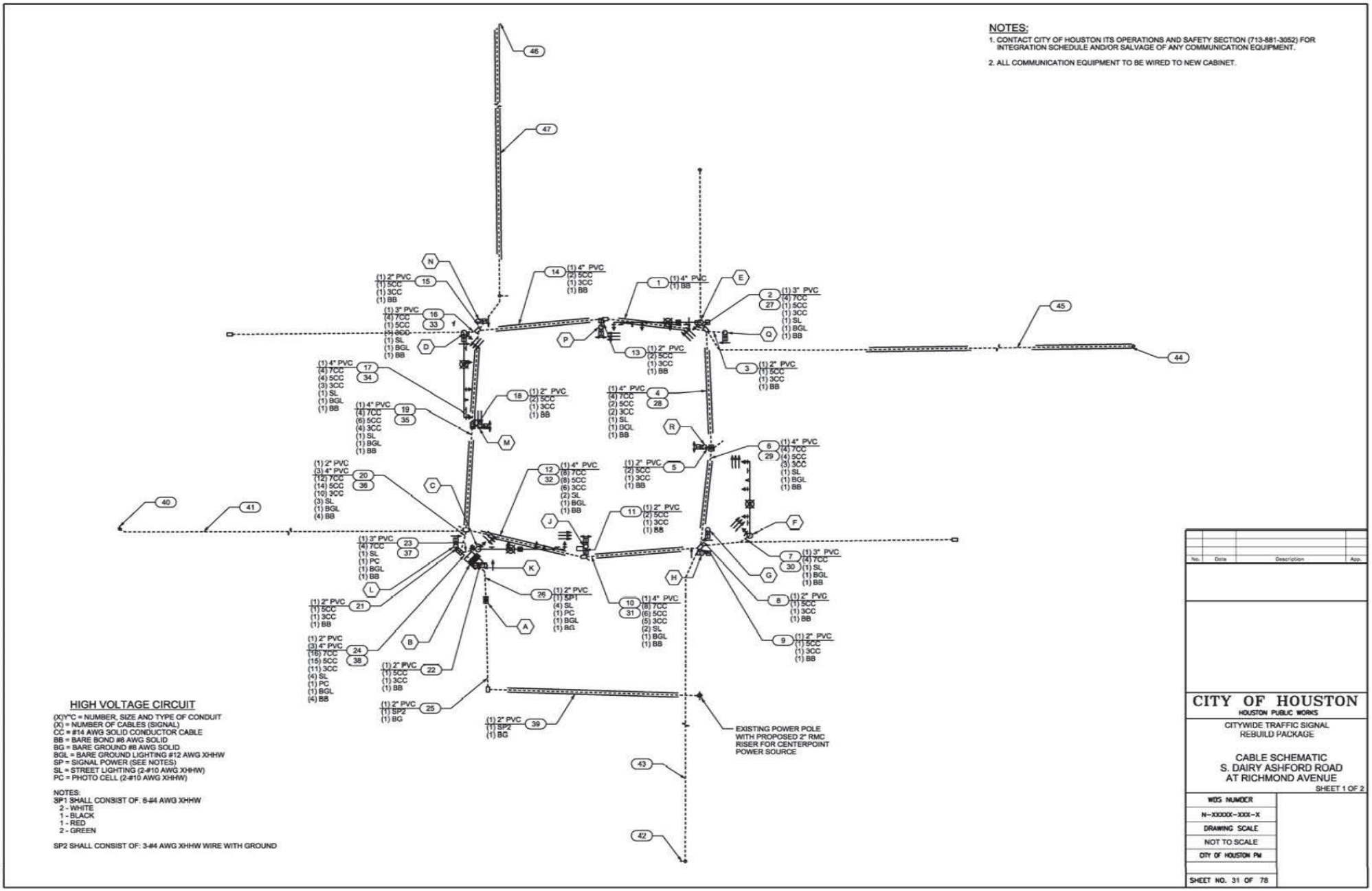
No.	Date	Description	App.

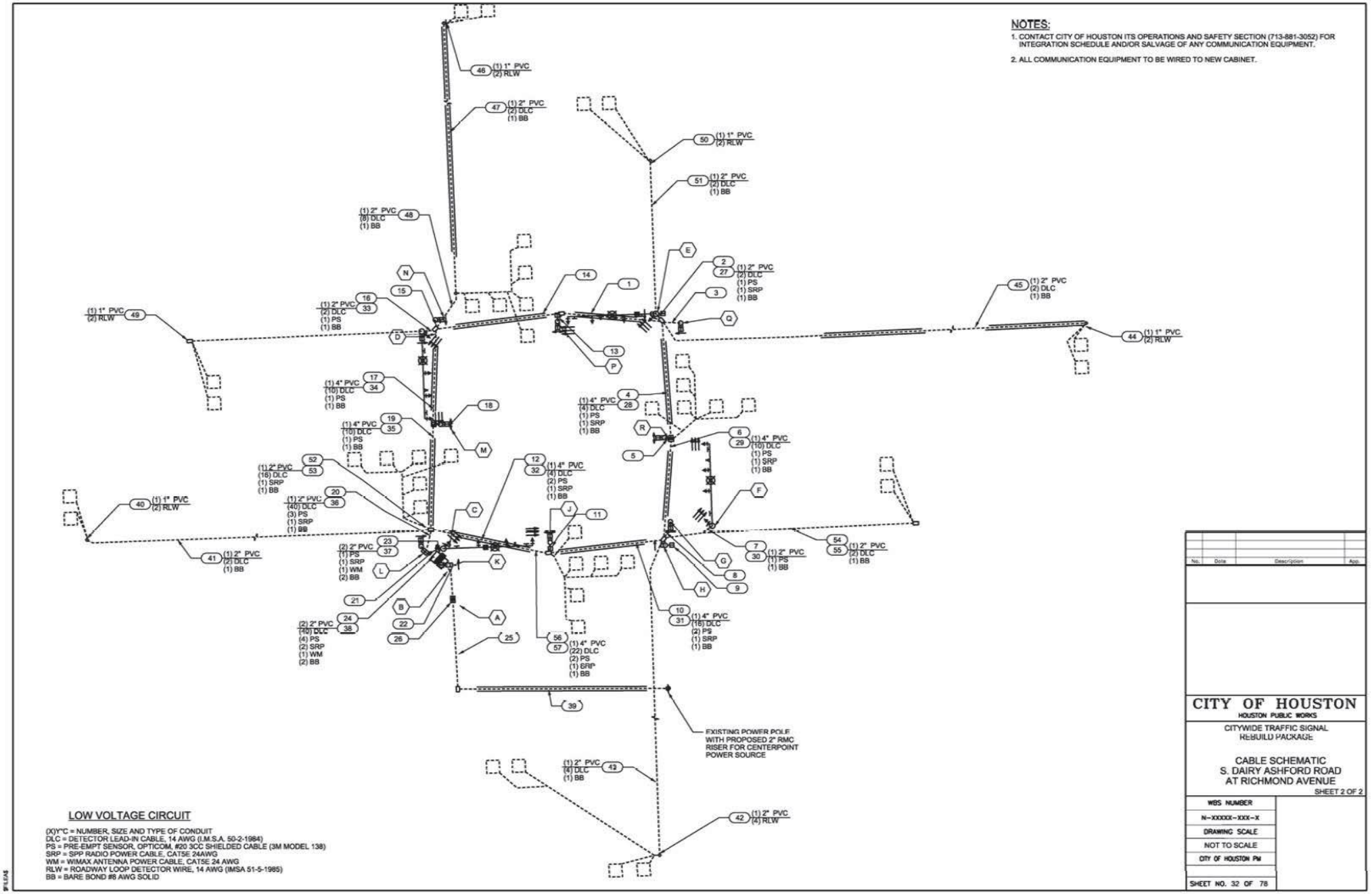
CITY OF HOUSTON
HOUSTON PUBLIC WORKS

CITYWIDE TRAFFIC SIGNAL REBUILD PACKAGE

TRAFFIC SIGNAL POLE SCHEDULE
S. DAIRY ASHFORD ROAD AT RICHMOND AVENUE

WOS NUMBER	
N-XXXXX-XXX-X	
DRAWING SCALE	
NOT TO SCALE	
CITY OF HOUSTON PM	
SHEET NO. 30 OF 78	


NOTES:
1. CONTACT CITY OF HOUSTON ITS OPERATIONS AND SAFETY SECTION (713-881-3052) FOR INTEGRATION SCHEDULE AND/OR SALVAGE OF ANY COMMUNICATION EQUIPMENT.
2. ALL COMMUNICATION EQUIPMENT TO BE WIRED TO NEW CABINET.
HIGH VOLTAGE CIRCUIT
(X)Y*C = NUMBER, SIZE AND TYPE OF CONDUIT
(X) = NUMBER OF CABLES (SIGNAL)
CC = #14 AWG SOLID CONDUCTOR CABLE
BB = BARE BOND #8 AWG SOLID
BG = BARE GROUND #8 AWG SOLID
BGL = BARE GROUND LIGHTING #12 AWG XHHW
SP = SIGNAL POWER (SEE NOTES)
SL = STREET LIGHTING (2-#10 AWG XHHW)
PC = PHOTO CELL (2-#10 AWG XHHW)
NOTES:
SP1 SHALL CONSIST OF: 6-#4 AWG XHHW
2 - WHITE
1 - BLACK
1 - RED
2 - GREEN
SP2 SHALL CONSIST OF: 3-#4 AWG XHHW WIRE WITH GROUND
EXISTING POWER POLE WITH PROPOSED 2" RMC RISER FOR CENTERPOINT POWER SOURCE
CITY OF HOUSTON
HOUSTON PUBLIC WORKS
CITYWIDE TRAFFIC SIGNAL REBUILD PACKAGE
CABLE SCHEMATIC
S. DAIRY ASHFORD ROAD AT RICHMOND AVENUE
SHEET 1 OF 2
WBS NUMBER
N-XXXXX-XXX-X
DRAWING SCALE
NOT TO SCALE
CITY OF HOUSTON PM
SHEET NO. 31 OF 78


NOTES:
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2. ALL COMMUNICATION EQUIPMENT TO BE WIRED TO NEW CABINET.
LOW VOLTAGE CIRCUIT
(X)"C = NUMBER, SIZE AND TYPE OF CONDUIT
DLC = DETECTOR LEAD-IN CABLE, 14 AWG (I.M.S.A. 50-2-1984)
PS = PRE-EMPT SENSOR, OPTICOM, #20 3CC SHIELDED CABLE (3M MODEL 138)
SRP = SPP RADIO POWER CABLE, CAT5E 24AWG
WM = WIMAX ANTENNA POWER CABLE, CAT5E 24 AWG
RLW = ROADWAY LOOP DETECTOR WIRE, 14 AWG (IMSA 51-5-1985)
BB = BARE BOND #8 AWG SOLID
EXISTING POWER POLE WITH PROPOSED 2" RMC RISER FOR CENTERPOINT POWER SOURCE
CITY OF HOUSTON
HOUSTON PUBLIC WORKS
CITYWIDE TRAFFIC SIGNAL REBUILD PACKAGE
CABLE SCHEMATIC
S. DAIRY ASHFORD ROAD AT RICHMOND AVENUE
SHEET 2 OF 2
WBS NUMBER
N-XXXXX-XXX-X
DRAWING SCALE
NOT TO SCALE
CITY OF HOUSTON PW
SHEET NO. 32 OF 78