Civil Design Guide

for Public Street Improvements

CITY OF PORTLAND, OREGON

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PBOT

PORTLAND BUREAU OF TRANSPORTATION

Editor: John Wilson, PE

Thank you to our technical leads: Jennie Tower and Jamie Jeffrey, Traffic Design; Jason Grassman and Eva Huntsinger, ADA Standards; Charles Radosta, Signals and Street Lighting; Scott Bryan, Pavement Design; Cameron Glasgow, Structures and Retaining Walls; Ryan Mace, Utilities; Paul Rudwick, Stormwater; Luke Leifeld, Rail. A special thanks to the many other reviewers and contributors.

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1 INTRODUCTION

1.1 PURPOSE

The Portland Bureau of Transportation (PBOT) has developed this Civil Design Guide to assist when preparing construction drawings for street improvements in the City of Portland.

1.2 APPLICABLE STANDARDS AND INTENT

This document is intended to provide guidance for the design of new construction and reconstruction of public streets within the City of Portland. This guide is not comprehensive, but instead supplements local, state, and national standards applicable to public street improvements. The guide is in general agreement with the American Association of State Highway and Transportation Officials (AASHTO) document “A Policy on Geometric Design of Highways and Streets.” In addition, sound engineering judgment must continue to be a vital part in the process of applying the design criteria and guidance to individual projects.

The City of Portland considers it important to follow the design criteria and guidance in this manual to ensure that the public streets will serve their intended purpose and achieve the City's transportation goals of safety, mobility, and asset management. The criteria and guidance reflect current practice, identify essential technical details, and promote consistency. However, they are not intended to restrict the engineer's creativity or replace sound engineering judgment.

The engineer may produce plans that address unique circumstances or design solutions, provided the engineered products reflect safe design elements and satisfy the standards of the City. Furthermore, the criteria and guidance provided in this document are intended for use when designing new construction projects at new locations or reconstruction projects at an existing location. Resurfacing, Restoration, or Rehabilitation (3R) projects may have a significantly limited scope such that many of the criteria in this guide may not be achievable within the scope of the project. 3R projects generally follow NCHRP Report 876 design guidelines.

Understanding and applying equity in projects and design creates fairness within the distribution of resources. Although transportation planning focuses greatly on integrating equity in the transportation system and services, many aspects are equally applicable to civil design. Lack of modal equity creates risks, particularly for older adults, people of color, and people walking in low-income communities, as they are disproportionately represented in fatal crashes involving people walking. Review PBOT's Equity Initiatives webpage for additional resources and examples of equity in practice.

The following documents include standards, guides, and best practices required for street design. The list represents common documents applicable at this time and is not intended to be inclusive of all standards. As standards and criteria are updated and change, the engineer is expected to correctly apply and incorporate those new requirements.

US Department of Transportation ADA Standards, spec. 2010 ADA Standards as promulgated by the Federal Highway Administration
A Policy on Geometric Design of Highways and Streets, AASHTO
AASHTO Roadside Design Guide
ODOT Highway Design Manual
ODOT Pavement Design Guide
City of Portland Municipal Code and Policy Document
PBOT Traffic Design Manual Volume 1: Permanent Traffic Control and Design
PBOT Traffic Design Manual Volume 2: Temporary Traffic Control
PBOT Traffic Signal Design Guide
PBOT Development Review Manual
PBOT Survey Standard Deliverables
Portland Plans Preparation Guide
Portland Street Lighting Design Guide
Portland Street Tree Planting Standards
Designing for Truck Movements and Other Large Vehicles
Portland Pedestrian Design Guide
Portland Protected Bicycle Lane Planning and Design Guide
Portland Streetcar Design Development Standards
Portland Trail Design Guidelines
Stormwater Management Manual
TriMet Bus Stop Guidelines
NACTO Urban Street Design Guide
NACTO Urban Bikeway Design Guide

1.3 STANDARD DETAILS, DRAWINGS AND REPORTS

PBOT provides approved standard drawings, details, and reports on the PBOT Engineering webpage located at www.portland.gov/transportation/engineering.

Standard details are used to quickly add detail to a specific project and are not backed by engineering analysis or a report. Generally, these are either (a) a template that needs project-specific data, (b) a new design style that is being tried or (c) a rarely used item that may require regular updates. Standard details may require modifications by the project engineer. Only when the project engineer of record evaluates a standard detail and finds it applicable to the project plans, then the project engineer of record shall stamp the standard detail and incorporate the details into the project plans.

Standard drawings are approved by the applicable Portland Bureau (PWB, BES, PBOT) Chief Engineer and are backed by an engineering analysis, calculations, and/or justification to support the work. It is the responsibility of the project professional of record that standard drawings are used as originally intended. Standard drawings are compliant with the City's Standard Specifications. Standard drawing reports are stamped by a Bureau Engineer and contain additional data for use by the designer and engineer of record. The reports include background information and assumptions used in the development of the standard drawing.

The Oregon Department of Transportation (ODOT) standard drawings and details may be used on a project with approval. Several ODOT standard drawings have been preapproved for use. Contact the City design lead for a list of preapproved ODOT standard drawings. Common ODOT standard drawings used include drawings related to mailboxes, inlets, guardrail, barrier, fence, and Erosion Control. For City work on state highways some ODOT ramp standard drawings may be required to avoid design exceptions in ODOT review. Contact a PBOT ADA Technical Advisor for ADA design assistance. Note, there may be some ODOT standard drawings that do not comply with PBOT criteria, such as "Manhole" drawings.

1.4 DESIGN CRITERIA AND EXCEPTIONS

The design criteria specified in this guide represent local jurisdictional standards currently in use by PBOT. Other standards apply to roadway design, including the standards described in the ODOT Highway Design Manual and those set by AASHTO, NACTO, and the FHWA. Deviations from these standards may require an approved design exception.

It is the engineer's responsibility to design using best practices, incorporating design elements that address policies of the City, and optimize the operation and safety of the system. In the context of the project, if the proposed impacts from the design are deemed too great then, with proper justification, a design exception or alternative review may be evaluated.

The intent of design exceptions is to determine and justify that good engineering decisions are made involving design standards in constrained areas. Design exceptions in high density urban areas can be more common due to the constraints in an urban setting, such as right-of-way impacts and construction costs.

Apply for and complete design exceptions as early as possible. Design exceptions obtained during the planning or survey phases do not need to be requested again unless significant changes have been made to the design. Contact Permit Engineering or Civil Engineering and Drafting Division of PBOT for information regarding the current design exception process and forms.

Projects on State Highways or the National Highway System (NHS) on federally funded projects require that design exceptions be approved by ODOT. Design exceptions for Design Loading Structural Capacity and Design Speed on NHS roads may require FHWA approval. See Chapter 14 of the ODOT Highway Design Manual for more information.

1.5 STANDARD MATERIALS AND PRODUCTS

Use of standard materials and products contributes to providing a transportation system that is efficient to maintain and reduces perpetual maintenance costs. Select materials with consideration for these costs and long-term appearance. Tinted concretes or stamped asphalt pavements that require repair will be restored with standard materials unless a maintenance agreement or other permit is approved.

The Construction Products List (CPL) contains a comprehensive listing of finished products found to be acceptable by PBOT for use with specific categories in roadway construction. The current list and form for requesting a product review can be found on the PBOT Engineering webpage.

The Qualified Products List (QPL) is a list of products evaluated by ODOT. The QPL and CPL are not identical but contain many of the same items. Use of an item exclusively listed in the QPL requires advance approval from PBOT.

Approved aggregates, asphalt mix designs, and concrete are maintained by PBOT, and can be found on the PBOT Engineering webpage.

Electrical equipment and material, including signal controllers, applicable to signals and street lighting infrastructure can be found on the PBOT Engineering webpage.

1.6 REVISIONS TO THE DESIGN GUIDE

PBOT Engineering Services will periodically update the Design Guide to reflect any changes in standards and best practices. PBOT encourages users of the Design Guide to suggest needed corrections or improvements via the form on the PBOT Engineering webpage.

2 HORIZONTAL ALIGNMENT: PLAN VIEW

2.1 PURPOSE

The horizontal alignment is a critical component to achieving the City's Vision Zero commitment which seeks to eliminate preventable traffic deaths and injuries. The horizontal design should provide space to accommodate all road users, design vehicles, and design speeds. The traffic engineer typically determines the alignment of curbs in collaboration with other specialties. Ensure that enough horizontal design information is provided to the contractor, surveyor, and inspector for construction of the project.

2.2 DESIGN CRITERIA

- Sawcut Lines - Specify sawcut lines outside of bike lanes.
- Horizontal Transitions - For horizontal transitions of the curb adjacent to shoulders or parking lanes, use a 6:1 taper, or a combination of reverse curves with radii equal to or larger than 10 feet.

2.3 DESIGN CONSIDERATIONS

A licensed Oregon surveyor establishes a control network for the project. Establish horizontal control based in the Oregon Coordinate Reference System (OCRS) Portland Zone using the Global Navigation Satellite System (GNSS). A surveyor must reconcile a new control whenever independent projects are combined. A statement on the plans is required indicating the datum that was used.

Station alignments from west to east, and south to north. The centerline of the proposed street improvements is usually the centerline of the right-of-way. The improvements may be shifted right or left of the right-of-way centerline based on topographic or encroachment conditions. When laying out proposed street improvements, whole number or half number widths for travel lanes, parking, frontage zone, bike/pedestrian widths show design intent. Construction plans have a separate section for horizontal alignment and right of way. These lines are labeled: Control lines are annotated with POB coordinates, Bearing, distance curve data, and having a separate 3d alignment file with independent stationing as applicable. Show enough horizontal alignment information in the plans that the surveyor can create the alignment using software of their choice. Use matchlines to show continuation of the plan view on a succeeding sheet. Identify the matchline by station (for example, label as: 5+34.02 Matchline, See Sheet 3). Design information beyond the matchline must be shown on the next sheet. Extend the horizontal alignment design of streets that will be built in the future and show at least 100 feet of design information past the project limits.

Show all existing and proposed facilities, including vegetation, buried and above-ground utilities, and constructed features.

Use standard construction notes listed on the PBOT Engineering Services webpage for consistency with standard construction specifications and pay items. Carefully consider the impacts of street construction on installed landscape improvements in the public right of way and be sensitive to property owners' concerns when determining the disposition of the improvements. Indicate "protect" or "remove" for all landscaping installed by property owners within the project construction area.

Specify the length of transitions between typical sections and into existing infrastructure.

Along non-tangent segments of curb, the sawcut lines may be mitered as shown in Figure 1.

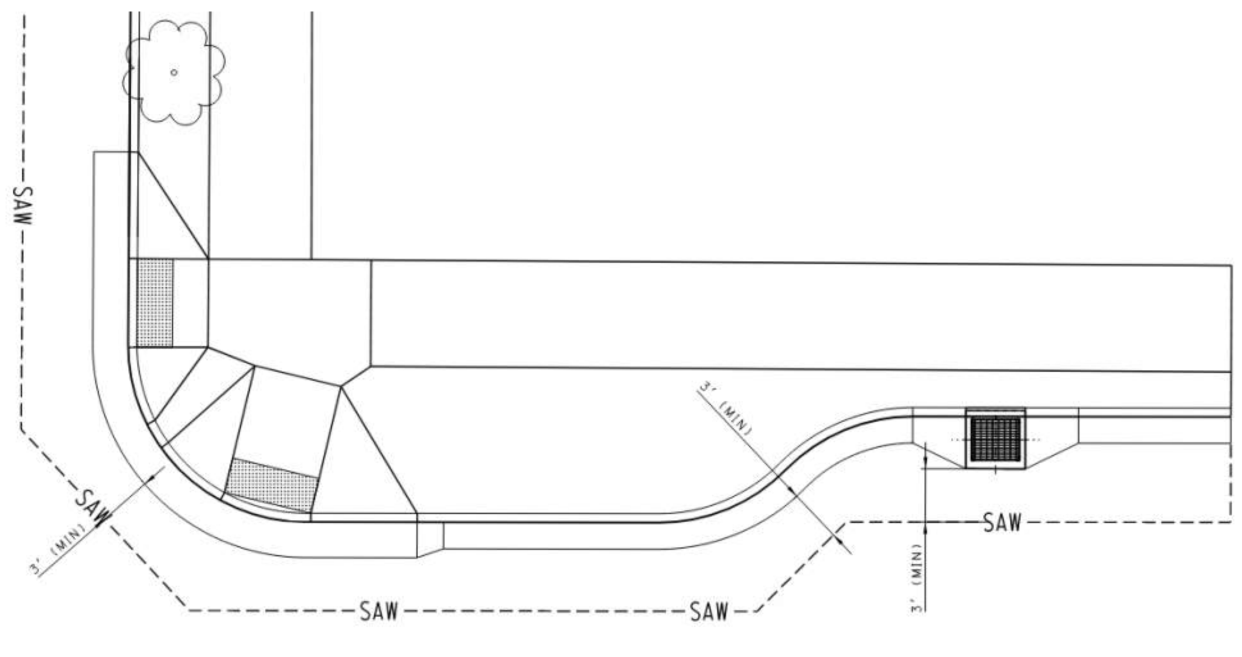

Figure 1 - Sawcut at Curb Extension

3 VERTICAL ALIGNMENT: PROFILE VIEW

3.1 PURPOSE

To ensure that enough vertical design information is provided to the contractor, surveyor, and inspector for construction of the project. Specify a vertical alignment that provides adequate sight distance for stopping, and adequate gutter slope for drainage.

3.2 DESIGN CRITERIA

- City Datum - Tie vertical control to nearest existing City-established and maintained benchmark. The use of other vertical datums or non-City benchmarks is not allowed.
- Maximum Pavement Slope - The maximum design street grade is 12% on busy streets, and 15% on local streets. The continuous maximum grade shall not exceed 500 lineal feet.
- Minimum Pavement Slope - Minimum longitudinal gutter grade is 0.5%.

3.3 DESIGN CONSIDERATIONS

A Licensed Surveyor in Oregon establishes a control network for the project. Elevations should be in City datum based on the City Benchmarks. A statement should be provided on the plans indicating the datum and specific benchmark that was used.

Design a vertical curve for street centerline longitudinal grade changes greater than 2.5% algebraic difference. Vertical curves should meet AASHTO standards. Show proposed and existing surfaces on all profiles. Extend centerline profiles at least 100ft past improvements. Extend gutter profiles at least 10 feet past improvements.

Specify portland cement concrete for grades exceeding 18%, with an approved design exception. Design all street grades, intersections, and super-elevation transitions to minimize the concentrated flow of stormwater over the pavement.

For streets with gutter grades less than 1%, specify combination concrete curb and gutter. If the existing street includes curb without gutter, specify standard curb for continuity with adjacent infrastructure.

4 STREET SECTIONS

4.1 PURPOSE

Ensure that enough information is shown on the typical sections to clarify the construction details.

4.2 DESIGN CRITERIA

- Bench Behind Sidewalk - Include a bench behind sidewalks with sideslopes 3H:1V or steeper.
- Sideslopes - Specify foreslopes and backslopes 2H:1V or flatter unless supported by a geotechnical report prepared by an engineer.
- Curb Exposure - 3" minimum, 7" maximum

4.3 DESIGN CONSIDERATIONS

Specify curb exposure of six inches on PBOT streets, and seven inches on ODOT streets. In retrofit situations, the curb exposure may range from four to six inches. Flush curb may be specified on Alternative Residential Streets to stabilize the edge of asphalt.

Required widths for local streets are prescribed in the "Creating Public Streets with Pedestrian Connections through the Land Use and Building Permit Process" guide. Streets with higher classification require traffic engineer analysis.

Review the Transportation System Plan to determine if the project is within an adopted street plan area. For these projects, review subcategory 1 of the PBOT administrative rules for additional requirements.

Historically, the standard gutter width has been 18 inches. Specify 12-inch-wide gutters adjacent to bike lanes. Specify 24-inch-wide gutters at the bottom of retrofit curb ramps when the difference in grades between the curb ramp and cross-slope of the street (counter slope) would otherwise be greater than 11%. It is common that engineers specify 24” gutters, when gutters are required, to simplify design and construction adjacent to ADA ramps.

The crown of the road should generally follow the centerline alignment. Offset crowns may be allowed at the quarter point of the roadway or a completed superelevated section (also known as a shed) may be allowed due to topography. When designing an offset crown, consider construction requirements for pavement and traffic control as typical paving machines cannot span transverse grade breaks.

Inverted crown (valley gutter) streets may be specified on narrow rights-of ways, such as alleys and Alternative Residential Streets, as they provide a method of stormwater conveyance without curbs. As the spread of stormwater will often encroach into the wheel path, they are not recommended unless vehicle speeds are low. PCC is the preferred material, as asphalt joints are more prone to early failure in these circumstances.

A bench behind the sidewalk is required for sideslopes of 3H:1V or steeper to prevent soil from sloughing into or undermining the sidewalk. The bench is typically 1 foot wide, with a 2% slope toward the gutter. Typically, a maximum 3H:1V sideslope is used in residential areas as it's the steepest slope that can be easily mowed. Foreslopes beyond back of sidewalk steeper than 2H:1V, or a vertical drop of 30 inches or more, typically require a pedestrian guardrail unless the bench behind the sidewalk is at least 2 feet wide.

A bench behind curb in street sections without sidewalk is required to prevent vegetation from blocking sight distance and to provide a minimal clear zone and maintenance path. The bench is typically 3 feet wide with a 2% slope toward the gutter.

Provide at least 6 inches of separation from work limits to private property or obtain appropriate temporary construction easements. Where the cut or the fill section extends from the roadway onto private property, a slope modification temporary easement is required.

5 PAVEMENT DESIGN

5.1 PURPOSE

Incorporate structural sections to ensure that the street pavement is correctly designed for economical construction and low-cost maintenance for the entire pavement design life.

5.2 DESIGN CRITERIA

- Design Standard and Methodology
- ODOT Pavement Design Guide
- MEPDG / AASHTOWare Pavement ME
- AASHTO Guide for Design of Pavement Structures, 1993/1998 (www.paveexpressdesign.com, www.pavementdesigner.org)
- DowelCAD 2.0 (https://www.acpa.org/dowelcad/)

Table 1 - PCC Design Criteria

Design Life (new concrete)	50 years
Minimum Thickness	6 inches
Reliability Level (R)	90
Combined Standard Error (S_0)	0.39
Initial Serviceability Index (p_o)	4.5
Terminal Serviceability Index (p_t)	2.5
% of Slabs Cracked at End of Design Life	50%
3rd point loading 28-day flex. strength (S_c)	690psi
PCC Modulus of Elasticity (E_C)	4,400,000
Agg. Base Resilient Modulus (M_R)	20,000psi
Subgrade Resilient Modulus (M_R)	4,500psi (presumptive)

Table 2 - ACP Design Criteria

Design Life (new asphalt)	30 years, 50 years (Pavement ME)
Design Life (preserving asphalt)	15 years
Minimum Thickness	3 inches

Reliability Level (R)	90
Combined Standard Error (S_0)	0.49
Initial Serviceability Index (p_o)	4.2
Terminal Serviceability Index (p_t)	2.5
Asphalt Layer Coefficient (a)	0.42
Drainage Coefficient (m)	1
Agg. Base Layer Coefficient (a_i)	0.1
Agg. Subbase Layer Coefficient (a_i)	0.08
Agg. Base Resilient Modulus (M_R)	20,000psi
Subgrade Resilient Modulus (M_R)	4,500psi (presumptive)

5.3 DESIGN CONSIDERATIONS

A pavement design should be completed on new streets, when rehabilitating existing streets, when widening, or when projects impact a substantial portion of the roadway. Round up all level thicknesses to the nearest inch. Typically, standard drawings may be used in lieu of a pavement design for utility and retrofit projects where the existing asphalt structure is intact and adequate for traffic loads. Contact the PBOT Pavement Manager to confirm a pavement design is not required, or to confirm assumptions about the adequacy of the existing pavement structure.

Where a fluctuating water table may rise to within 3 feet of the surface, consider using subsurface drainage systems or a permeable base rock to keep water out of the pavement structure.

Perform laboratory testing to determine the Resilient Modulus (M_R) of the subgrade; do not correlate between CBR or R-value tests and M_R. Subgrade M_R may be back-calculated from Falling Weight Deflectometer testing and knowledge of the existing pavement structure.

Consult the traffic engineer for AADT in each of the 13 federally designated vehicle classes. Subtract TriMet busses from category 4, and add them to their own category, with a rate of 934 ESALs (Equivalent Single-Axle Loads) per bus per year. Articulating buses, such as the Nova Bus LFS Arctic 60, should use a rate of 1761 ESALs. Assume a 1% traffic growth rate per year unless otherwise indicated by the traffic engineer.

Plain concrete pavements should be jointed. Dowel bars are required over the wheel paths.

Work on streets that have been paved within 5 years require additional pavement reconstruction known as "Pavement Moratorium" requirements. PBOT Utility Permits and PBOT Maintenance Operations maintain the pavement moratorium database.

Base aggregate may be 1-1/2" minus or 2" minus as available. Do not specify the use of one-inch-minus. Specify 2" of 3/4" minus on top of base courses for a paving surface.

Specify the use of geotextile on collector and arterial streets. Specify geogrid on arterial streets. Treated subgrade is allowed but is not often practical with the required staging and traffic control.

On asphalt streets, specify portland cement concrete bus pads at high frequency bus stops.

6 INTERSECTIONS

6.1 PURPOSE

To ensure that key construction information regarding intersection alignment, offset, traffic signal and street lighting poles, curb radii, sidewalk curb ramps, and curb returns is provided on the plans.

6.2 DESIGN CRITERIA

- Maximum Grade - For all travel lanes within an intersection, specify longitudinal grades of not more than 6%.

6.3 DESIGN CONSIDERATIONS

The traffic engineer will specify street alignment, curb alignment and intersection offset. Typically, streets should be designed as near to right angles as practical. When forming a T intersection, it should be at least 100 feet from the nearest intersection (as referenced by street centerlines). See PCC 17.82.020 for street and alley alignments for new development. See PCC 17.88.040 for through street spacing standards for new development.

Curb extensions may be provided at intersection corners. General guidance on curb extension design is available in the TDM Vol.1. Dimensions for curb extensions and intersection corner radii will be specified by the traffic engineer. The traffic engineer will specify the smallest corner radius that accommodates the appropriate design vehicle.

Carry the grade line of the "major" street through the intersection. Warp the grade of the "minor" to fit, as shown in Figure 2. Use grade line combinations for smooth vehicle movements.

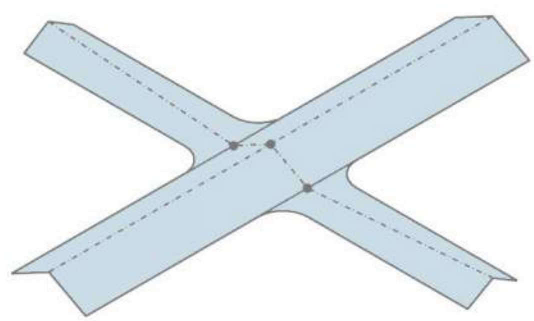

Figure 2 - Warping Side Streets

The gradients of intersecting roads should be as flat as practical to minimize stopping distance and startup delay, as shown in Figure 3. Avoid grades more than 3% on intersecting roads within the functional area of intersections. Where conditions make such designs too expensive, grades should not exceed 6%.

Crosswalks should typically not exceed 2% cross slope. Crosswalks on approaches that are not stop or yield controlled may have a cross slope up to 5%. Crosswalks at midblock crossings may match the running grade of the street. In cases where the crosswalk cross slope is greater than 2%, make the transition from the landing to the crosswalk within the shoulder if possible. The rate of cross-slope transition should not exceed 1% per foot. The low point, inlet location, should be at least 3 feet outside the ramp throat to prevent uneven grades and limit gutter spread within the crossing.

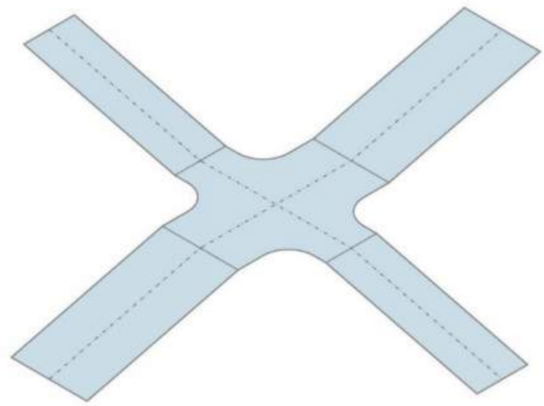

Figure 3 - Intersection of Steep Streets

Concrete crosswalks on asphalt streets are not acceptable unless the portland cement concrete is specified for the entire intersection, including approaches and impact panels.

7 TRAFFIC ISLANDS, SEPARATORS AND RAISED MEDIANS

7.1 PURPOSE

To ensure that enough design information is provided to construct improvements that include islands or medians.

7.2 DESIGN CRITERIA

- Accessible Routes - Specify a route at least 4 feet wide.
- Median Width - Specify raised medians at least 2 feet wide.
- Transit Islands - Specify ramps and accessible routes from sidewalks to transit loading zones.

7.3 DESIGN CONSIDERATIONS

Traffic islands, traffic separators and raised medians are features used to channelize traffic, implement access management and/or provide pedestrian refuges. Islands and raised medians may be marked with tubular markers or pavement markers. Their location and alignment must be approved by the traffic engineer.

Use raised islands, traffic separators, or medians to provide refuge for pedestrians or prohibit traffic movements. Where curbed medians will serve as pedestrian refuges, they should be at least 6 feet wide. Match the pass-through width to the crosswalk.

Offset islands, separators, and raised medians from the edge of lanes as specified by the traffic engineer and per the Traffic Design Manual.

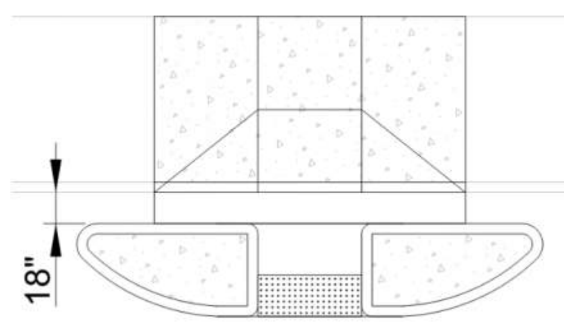

Figure 4 - Floating Curb Extension

Floating curb extensions may be used when construction of a standard curb extension will cause ponding of stormwater that cannot be solved by construction of inlets and standard leads due to lack of existing stormwater infrastructure. Standard curb extensions are the preferred alternative because they facilitate better drainage control and street sweeping. Design floating curb extensions using a horizontal alignment that mimics a standard curb extension (see Traffic Design Manual). The standard width between street curb and floating curb extension is 18 inches to facilitate manual cleaning with a broom or a shovel; the minimum width is 12 inches. Specify truncated domes on the pavement next to the adjacent travel lane, rather than on the ramp, to signal to the pedestrian when they will enter traffic.

8 CUL-DE-SACS

8.1 PURPOSE

To ensure that key cul-de-sac construction information concerning radii, profiles, high point designation, and cross-slopes is included in the project design.

8.2 DESIGN CRITERIA

- Radius - Cul-de-sac radii for local streets are prescribed in the Creating Public Streets and Pedestrian Connections through the Land Use and Building Permit Process guide or otherwise established by the traffic engineer.
- Crown - The connection from the typical street section crown shall continue to the radius point of the cul-de-sac.
- Cross-Slope - The cross-slope of the cul-de-sac (from the radius point to the gutter) shall not exceed 6 percent.
- Curbs – Specify mountable curbs when cul-de-sacs are less than 60ft in diameter. Specify curb-tight sidewalks when cul-de-sacs are less than 40 feet in diameter. For mountable curb, street furnishings, trees, sign supports, and above grade utilities must be placed in the frontage zone.

8.3 DESIGN CONSIDERATIONS

Curb-tight sidewalk within a cul-de-sac may be 6 feet wide, provided there is at least 5 feet of additional right-of-way behind the sidewalk for trash cans and street furniture. Provide a gutter profile from the tangent of the left gutter to the tangent of the right gutter.

9 SIDEWALKS

9.1 PURPOSE

To ensure that enough design information is provided to help the contractor construct the improvements that will safely serve pedestrian traffic.

9.2 DESIGN CRITERIA

- Sidewalk Width - 5 feet min.
- Accessible Routes - Specify a route at least 4 feet wide along sidewalks and minimum 3 feet wide to doorways.

9.3 DESIGN CONSIDERATIONS

Sidewalk widths are exclusive of curbs. Sidewalk width requirements are dependent on the Transportation System Plan Street Design Classification. Where a future sidewalk will be constructed adjacent to new street curb, specify a keyed curb. Reference the Pedestrian Design Guide for additional information regarding sidewalk design, zone designation, and best practices.

Curbside sidewalk on bridges, and where sidewalk is separated from traffic with a barrier at the curb line, should be at least 7 feet wide. The sidewalks should be separated from the roadway with a furnishing zone when possible. Provide adequate space within curb-tight sidewalks to accommodate typical roadside elements while maintaining an accessible route. Table 3 lists the typical widths required for common elements in the furnishing zone, considering minimum setback from the face of curb and the element dimensions.

Table 3 - Furnishing Zone Width Requirements

Feature	Width Required
Signal/Utility Pole	2.5-3ft
Hydrant	3.5ft
Mailbox	1.3-3ft
Sign	2-3ft
Signal Cabinet	3.5ft
Tree	3ft

Cross slopes should slope toward the road to prevent stormwater from leaving the right-of-way. Cross slopes may slope away from the curb where additional design features or considerations will ensure that stormwater will not enter private property.

Do not specify truncated domes at bus stops except where Federal Transit Authority standards dictate their use (light rail transit stops).

10 CURB RAMPS

10.1 PURPOSE

To ensure that sidewalks and crosswalks are accessible to all.

10.2 DESIGN CRITERIA

- Returned Curbs – Return must be perpendicular to tangent segment of curb, adjacent to a non-walkable surface (landscaping), and entirely within the furnishing zone.
- Curb Exposure – Between two perpendicular or combination curb ramps, specify a minimum curb exposure of 3 inches for a length of 1 foot between the adjacent flares.
- Grade Breaks – Specify grade breaks at the top and bottom of ramp runs to be perpendicular to the direction of the ramp run.
- See the ADA Curb Ramp Design Report for additional criteria.

10.3 DESIGN CONSIDERATIONS

Specify curb ramps in accordance with criteria listed in the ADA Curb Ramp Design Report found on the PBOT Engineering Services webpage. The criteria are based on US DOT/FHWA requirements and PBOT standards and complies with ADA Standards. The ramp running grade and cross slope criteria account for working tolerances in the Standard Construction Specifications. Exceptions to curb ramp criteria require documentation on the Curb Ramp Design Report.

Design curb ramps per the Chapter 7 of FHWA's Part II Best Practices Design Guide for Designing Sidewalks and Trails for Access. Use of the FHWA guide should determine the appropriate curb ramp type, location, and specifications. The following information supplements the FHWA guide.

Design to accommodate staking tolerances. Traffic signal pole horizontal tolerance is ±0.2 foot. Retaining wall horizontal tolerance is ±0.1 foot. A robust design will account for tolerances and differing site conditions. Avoid specifying minimum horizontal dimensions. Specify ramps 5 feet wide, or 8 feet wide for multi-use paths. Specify landings to match pedestrian through zone whenever practical. Show all features and obstructions to scale on elevation detail plans to confirm an accessible route is provided.

When designing curb ramps that connect to existing curbs with exposure less than 6 inches, develop a full 6 inches of curb exposure at the end of the ramp flare and specify transitions outside of the flare.

Diagonal curb ramps require a landing/turning space at the bottom of the ramp. The landing must be located entirely outside of the travel lanes, including bike lanes, on either street.

Where the elevation of the landing at the back of the sidewalk is less than 3 inches above the gutter line, include provisions to prevent street stormwater runoff from discharging onto private property; most designs require a curb at the back of the landing or inlets flanking the curb ramp. If a curb is provided at the back of the landing, provide an additional foot of clearance from the wall within the landing. Thus, the minimum sidewalk corridor to construct combination curb ramps for a 6-inch curb height is 8 feet (0.5-foot curb, 2-foot ramp, 5-foot landing, 0.5-foot curb behind landing).

CURB RAMP STYLE, LOCATION AND ORIENTATION

Construct ramps so that they align with the receiving ramp across the street as much as possible while maintaining the centerline of the ramp being perpendicular to the longitudinal street grade (gutter grade) to provide a steadier movement of the wheelchair when moving from the ramp to the street (or vice versa). An optimal design typically results in placing the curb ramp within the tangent portion of the curb, as shown in Figure 5. If this places the throat of a perpendicular ramp wholly or partially outside of the legal crosswalk, include supporting documentation from the traffic engineer in the ramp report. Documentation may be an email, and should indicate that the traffic engineer has reviewed the crosswalk location and finds the design acceptable. It's generally acceptable for the ramp throat to be up to 20 feet from nearest curb line on the adjacent street, if supported by the traffic engineer. If the traffic engineer is not supportive of a variance, work with the ADA Technical Advisor for other ramp configuration alternatives.

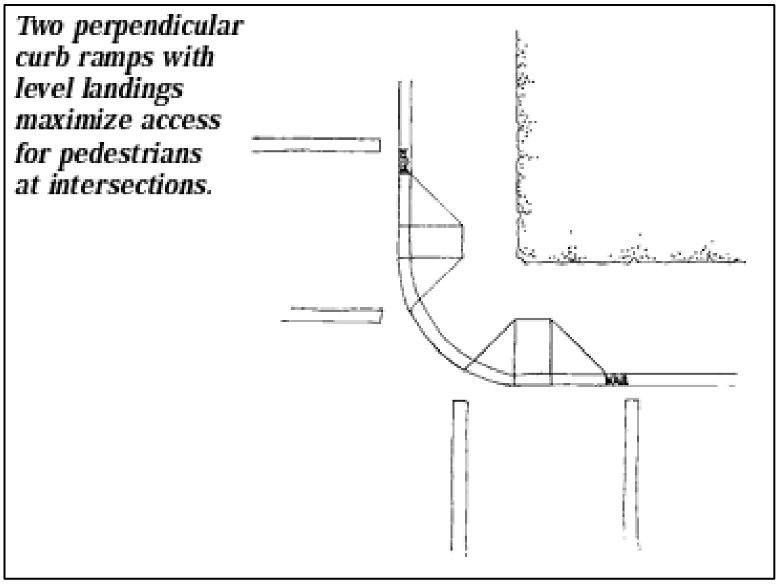

Figure 5 - Preferable Design with Two Perpendicular Ramps at Each Corner and Within Legal Crosswalk.

In situations where there is not enough space for two accessible perpendicular ramps at the corner, consider using a diagonal ramp with a level space (2% or less) outside the traveled way at the bottom of the ramp for wheelchair users to adjust their direction before crossing the street. Specify that the centerline of the curb ramp be perpendicular to the normal gutter flow line so that the grade break is perpendicular to the ramp run. Specify the level space at the bottom of the ramp project at least 4 feet into the roadway and as wide as the ramp. See Figure 6.

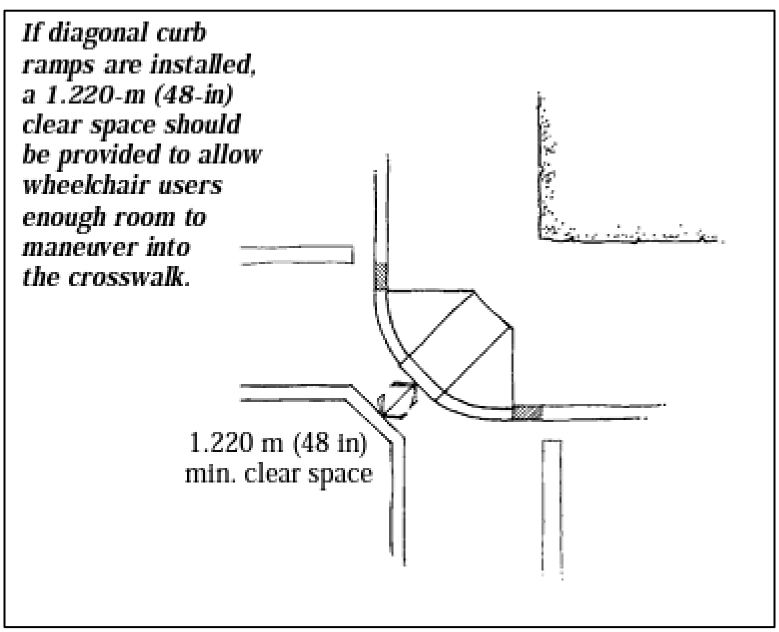

Figure 6 - Acceptable Design with ADA Technical Advisor Approval

Skewed intersections present a unique challenge because the designer must balance the ramp alignment and shorter crossing distance against out-of-direction travel. For example, at a skewed intersection, aligning a ramp with a companion ramp will require the user navigate a circuitous route, but provide a shorter length of exposure to traffic while crossing the street. Factors such as road use, visibility, and demand factor into this decision, so work with the traffic engineer and ADA coordinator to provide a recommendation to the ADA Technical Advisor.

Review City Engineer Directive ST 003 for additional information regarding ramp placement. If the traffic engineer determines that a crosswalk should be closed, a Crosswalk Closure will need to be approved by the City Traffic Engineer (submitted by the traffic engineer).

PUSHBUTTON POLE PLACEMENT

The designer should work with the Traffic Design Section and Signals, Street Light, and ITS Section concerning placement of signal poles. Generally, specify pushbuttons as shown in Figure 7. Option 1 and 4 are preferred. Option 2 and 3 are acceptable if options 1 and 4 are infeasible.

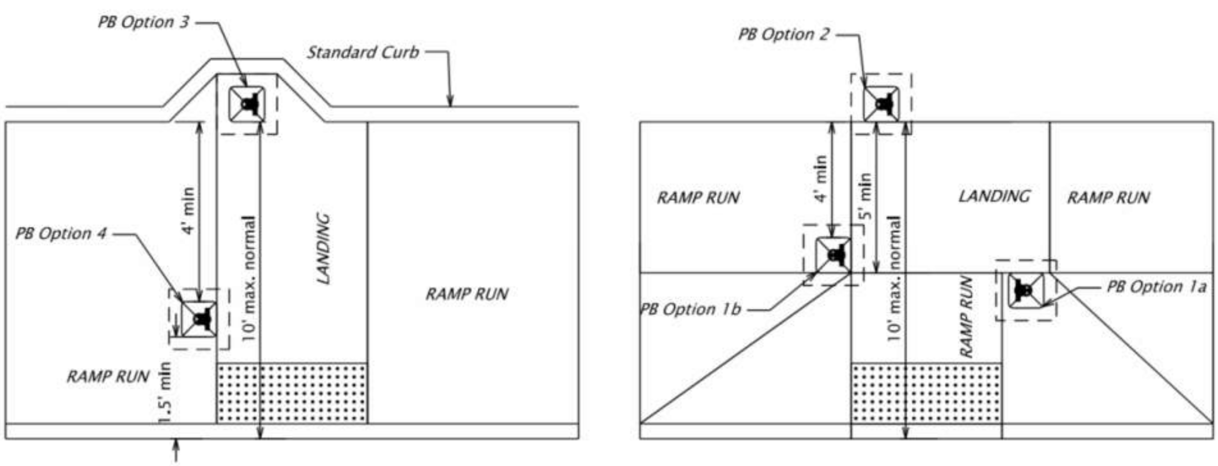

Figure 7 - Pushbutton Locations

CURB RAMP RETROFIT

When an accessible ramp cannot be constructed within the existing right-of-way, the ramp should meet ADA Standards to the maximum extent feasible within the scope of the project. Any ramps that are not fully compliant require documentation per the ramp report.

The addition of gutters at curb ramps has the potential to create steep grades beyond the gutter within the crosswalk. Reconstructed and patched asphalt concrete pavement cannot reduce accessibility and surface slopes shall be equal to or better than the existing conditions. The limit for asphalt concrete pavement reconstruction is to the edge of the adjacent travel lane.

It is often more cost effective to fix existing accessible features as part of curb ramp retrofit projects. For example, if curb ramps are being installed at a signalized intersection as part of a roadway resurfacing project, there is no requirement to expand the project scope to include adding or relocating pushbuttons or pedestrian signals unless those features are being replaced as part of the project. However, future replacement of those features will be more costly. Consult with the district signal engineer to coordinate with the accessible pushbutton transition plan.

Parallel ramp runs that connect to existing sidewalks with a cross slope greater than 2% may be warped continuously provided that the rate of change of the cross slope is at most 1% per foot (0.5% per foot is preferred). The cross slope within the ramp run should be compliant adjacent to flares, so that the property owner is not required to reconstruct the City-maintained ADA ramp when they replace their noncompliant sidewalk.

See the PROWAAC Special Report for Design for Alterations (2007) for more information and best practices related to retrofit projects.

ADA requires that pedestrian walkways prevent accumulation of water and be free of debris. Addressing existing drainage and ponding within the footprint of improvements is also an ADA requirement. When new curb ramps are placed in a location with drainage issues, those issues must be resolved or documented with an approved variance.

11 DRIVEWAYS

11.1 PURPOSE

To ensure that important construction information relating to the location and design of driveways is included in the construction plans.

11.2 DESIGN CRITERIA

- Width - See PBOT Admin Rule TRN-10.40.
- Location - See PBOT Admin Rule TRN-10.40.
- Drainage - Design all driveways with positive drainage to the street and at least 3 inches of freeboard.

11.3 DESIGN CONSIDERATIONS

Refer to PBOT Admin Rule TRN-10.40 for additional considerations regarding driveway design. Exceptions to this admin rule require approval from the traffic engineer. Capital projects do not process driveway design exceptions, but instead gain approval of exceptions to the administrative rule through the plan approval process. Additional driveways (non-pre-existing) require a permit from BDS. Existing driveways that do not access legal on-site vehicle areas may not be reconstructed with CIP projects unless the owner can provide documentation from BDS of an approved on-site vehicle area. Existing driveways that access approved vehicle areas are replaced with projects matching the existing widths, unless otherwise required by a development review. If no on-site vehicle area exists or if there is a question of whether it's a legal space, a determination will need to be made whether a driveway approach can be constructed.

Keep the driveway apron and wings free of obstructions, including streetlights, street trees, utility poles, utility pole guy wires, mailboxes, SSL sidewalk boxes, and signage. Maintain 5-feet horizontal clearance from the driveway (including flared aprons) to any vertical obstructions.

Exercise care in the vertical design of driveways and driveway aprons. Severe grade breaks will limit the use of the driveway by many types of vehicles. Provide separate plan and profiles for driveways when vertical curves are required, or to verify concept of design vehicle clearance for grades that exceed allowances on the Standard Drawings.

If non-standard driveways are needed to accommodate existing horizontal or vertical constrictions, show these unique driveways with separate design details, profile, or both.

NCHRP Report 659 provides additional guidance on location, placement, and grades for driveways. The maximum recommended grade break is 10% for a crest, and 9% for a sag; however, other common applications may require different grades based on the appropriate design vehicles.

The 1-inch lip provided at driveways is intended to allow the future placement of a pavement overlay without requiring pavement removal, and to confine very low stormwater flows to the street. Because overlay pavement maintenance without cold plane pavement removal can only be performed along a segment that is absent of curb ramps, the lip may be omitted on urban corridors with sidewalks. Do not specify a lip along streets with marked bicycle lanes when it may introduce an additional vertical element that could cause a bicycle crash.

Provide a 4-foot-wide accessible route at all driveways that cross sidewalks. For curb-tight fully lowered driveways with a wing running slope greater than 8.33%, the wing length must be increased up to a maximum of 15 feet to reduce the running slope as close to 8.33% as possible.

On retrofit projects where new sidewalk is being built along an existing road that contains driveways with cross slope exceeding 2%, the driveways must be reconstructed to meet ADA Standards to the maximum extent feasible within the scope of the project See the PROWAAC Special Report for Design for Alterations for more information and best practices.

When a driveway is located within a crosswalk, do not specify a curb ramp within the throat of the driveway. Review City Engineer Directive ST 003-01 and work with the traffic engineer to determine whether to relocate the ramp outside the legal crosswalk, close the driveway, close the crosswalk, or not construct a curb ramp.

Do not specify truncated domes where sidewalks cross alley driveways or other driveways unless they are designed as an intersection (e.g., shopping center driveways, signalized driveways).

12 STRUCTURES AND RETAINING WALLS

12.1 PURPOSE

To ensure that the construction plans include key construction information that will provide for the design of structures and minimize the impacts of cut and fill activities. Coordinate closely with structural design on wall layout, alignment, and elevations.

12.2 DESIGN CRITERIA

- Materials - Do not specify timber retaining structures. Reference PBOT Retaining Wall Guidance for additional information.
- Fill Slopes - Show the toe of fill on the plan view. Design fill slopes at 2H:1V or flatter. Under certain conditions, and when supported by a soils report, compacted fills may be steeper.
- Cut Slopes - Show the top of cut on the plan view. Design cut slopes at 2H:1V or flatter. Under certain conditions, and when supported by a soils report, clayey soils may be cut temporarily to a maximum of 1H:1V.
- Fall Protection - Provide fall protection (such as pedestrian guardrail) when there is a vertical drop greater than 30 inches or when fill slopes steeper than 2H:1V are within 2ft of a sidewalk.

12.3 DESIGN CONSIDERATIONS

Retaining walls are expensive to design, construct and maintain. Consider grading out slopes whenever possible to avoid the short- and long-term costs of retaining walls. If retaining walls are required, they shall be located on private property to the extent feasible and not considered a City asset. If a wall is to be a City asset, this must be explicitly called out by the engineer on the approved plans. Generally, if the wall will be retaining the street, it is a City asset and should be placed within the right-of-way; if it is retaining private property, it is a private asset and should be placed within private property. One nuance to this is that if the wall is retaining the sidewalk and being built for the benefit of keeping the adjacent property flat it should be placed within private property. Reference PBOT Bridges and Structures Division Standards for additional requirements, design criteria, and guidance.

Cuts and fills that extend onto private property (especially developed property) are a sensitive issue. Provide cross-sections that clearly show how the cut or fill affects existing structures, fences, landscaping, drainage patterns, driveways, and other improvements. Consider design alternatives to mitigate the impacts on adjacent properties. Provide a plan and elevation view of the wall at the wall control line. The wall control line is typically the base of the front face of the wall stem (front face being the side away from the retained earth). Provide sectional views with wall details and relationship to adjacent roadway and sidewalk.

The top elevation of wall should be designed to project a minimum of 6 inches above adjacent finished grade to allow for future sloughing of backfill and to allow for varying sidewalk grades. Provide elevations for top and bottom of wall. Provide a minimum 2-foot-wide level walkway and maintenance easement behind fill walls and in front of cut walls. Reference PBOT Retaining Wall Guidance and PBOT Bridges and Structures Division Standards for additional information on preferred maintenance and inspection easements.

Wall termini details require special attention and consideration. Generally, it is considered best practice to slope wall ends down at approximately 45 degrees, if possible and grades allow. Also, the horizontal alignment of the sloped wall end should angle toward the bottom of the slope for a smooth transition. This detail can be difficult to achieve in a constrained urban environment. Pay particular attention to the interaction of the new wall and any existing walls. Avoid positive connections between City-owned and private walls. Use a bond breaker between walls in those instances, if feasible.

13 BARRIER DEVICES AND ROADSIDE SAFETY

13.1 PURPOSE

To ensure the plans address roadside safety improvements.

13.2 DESIGN CRITERIA

- Follow the AASHTO Roadside Design Guide and ODOT Highway Design Manual for barrier and crash cushion placement.

13.3 DESIGN CONSIDERATIONS

The AASHTO Roadside Design Guide provides guidance regarding roadside clearances and should be used to evaluate roadside hazards. Chapter 10 of the Roadside Design Guide provides additional guidance with clear zone in an urban context. Refer to Chapter 12 of the Roadside Design Guide for additional considerations for low-volume roadways. If approved, use the FHWA Barrier Guide for Low Volume and Low Speed Roads.

See the ODOT Highway Design Manual for guidance on completing a roadside inventory, safety mitigation measures, and criteria for replacing existing deficient barriers. Emphasis should be placed on completing a roadside inventory and evaluating roadside hazards on City streets in a rural context. Guardrail protecting fixed objects needs approximately 6 feet from face of rail to object to provide space for adequate deflection.

Typically, a traffic engineer will work with the civil engineer to complete a clear-zone analysis and determine the length, location, and alignment of any roadside barriers needed to protect against roadside hazards. A civil engineer will complete the guardrail/barrier design. Work with a structural engineer when barrier is connected to a structure.

When considering the installation of a barrier device, specify at least two feet of shy distance from the device. Follow the ODOT Highway Design Manual and reference ODOT Standard Drawings when specifying guardrail or concrete barrier.

14 STREET TREES

14.1 PURPOSE

To ensure that the plans provide for the protection of existing trees, removal of trees that are incompatible with planned improvements, and planting of new trees that are in harmony with other trees and improvements in the right-of-way.

14.2 DESIGN CRITERIA

- Tree Protection, Removal, and Installation - See Title 11 of Portland City Code.
- Tree Location and Spacing - See City of Portland PP&R Urban Forestry Street Tree Planting Standards.

14.3 DESIGN CONSIDERATIONS

All trees in the public right-of-way are valuable assets to Portlanders and are an important part of the City's green infrastructure. Design street improvements so the contractor, exercising reasonable care, can construct the project without damaging trees that are designated to be protected. See the Pedestrian Design Guide for additional guidance related to tree plantings within the pedestrian corridor.

Roadway alignment, fill slopes, excavations, soil compaction from construction equipment, building construction, and utility trenching may adversely impact existing trees. Evaluate the impacts on each existing tree and make an initial proposal on the condition of each tree in the project construction impact zone. The City Forester will make a final determination of the impact zone.

During the plan review phase of the project, the City Forester will review the project for compliance with street tree preservation, protection, and planting requirements. If directed by the City Forester, conduct exploratory root excavations to determine the extent of impact a tree may be subjected to during construction. Select trees from the approved street tree planting list. Tree planting lists are categorized by the width of the available planting spaces.

Specify street trees and tree wells outside of the pedestrian through zone. Dimension tree wells to align with sidewalk scoring, typically 4ftx9ft. Review the Pedestrian Design Guide for furnishing zone width as related to trees. Avoid using tree grates, but ensure they meet ADA Standards if used. Do not specify electrical outlets or other utilities within tree wells unless approved by Urban Forestry and with an encroachment permit. When specifying tree species, grates, and locations, consider that the adjacent property owner is responsible for related maintenance.

Tree grates are not required, even in areas with existing tree grates. For projects along frontages with existing tree grates, grates in good condition can remain. Damaged grates must be removed and do not require replacement, although they may be replaced. Any sections of tree grate already embedded in tree should be cut off and not attempted to be dislodged from tree. Mulch or compost should be used to bring the tree well flush with adjacent surface.

Street trees should be placed at least 25 feet from intersections, as measured from the intersection street curb line and exclusive of curb extensions. This setback is intended to provide approaching vehicles adequate sight distance of crossing vehicles, pedestrians, and other road users. A larger setback may be for visibility needs as determined by the traffic engineer.

Normally trees should be placed at least 25 feet from street lights, but may be as close to 15 feet from a street light with a narrow-growing tree species and if approved by the street lighting engineer.

TREE REMOVAL

Removal of existing trees requires approval from Urban Forestry. There are two separate forms depending on the reason for tree removal: trees removed due to conflicts or for non-safety reasons; trees removed for safety reasons.

If trees need to be removed for conflicts or non-safety reasons (e.g. conflict with a new ADA ramp, driveways, bus loading areas, etc.) City staff will review the request as part of the public works permit review process or through the preliminary project design form on City projects.

Under Title 11, the City Traffic Engineer has the authority to remove trees they deem as dangerous. The City Traffic Engineer (or their representative) can notify Urban Forestry that they have deemed a tree (or trees) a safety concern that require removal. They do this by completing a PBOT Safety Hazard Tree Removal Application, found on the Urban Forestry / Tree Permits webpage.

15 EROSION CONTROL

15.1 PURPOSE

To ensure that the construction plans include measures to prevent disturbed soil from leaving the construction site where the eroded materials could clog streets, storm drains, culverts, and stream channels; cause private property damage; or become a source of water pollution.

15.2 DESIGN CRITERIA

- Erosion Control Plan - Show erosion controls as an integral part of the construction plans.

15.3 DESIGN CONSIDERATIONS

An Erosion, Sediment, and Pollution Control Plan (ESPCP) is a detailed description of where and how activities will be implemented to control erosion, sediment, and pollutants on a project. The ESPCP is a central, specific component to the overall site development management plan. The goal of erosion prevention is to limit the time and area of ground disturbance, keep pollutants separate from stormwater runoff, and establish permanent ground cover as quickly and thoroughly as possible.

For even a simple project, such as a frontage improvement on an existing paved street, erosion control will require the contractor to protect the nearest downstream inlet or catch basin.

PBOT Capital Projects are covered under an NPDES 1200CA General Permit for clearing, grading, excavation, and stockpiling activities. Review the permit as well as any appropriate provisions in the construction documents to ensure compliance. Specify appropriate controls and best practices, inlet protections and sediment barrier, to prevent soils from leaving the site without proper disposal.

Consider the temporary pedestrian accessible routes when designing the erosion control plan and provide enough flexibility to allow an accessible route free of erosion control devices.

See the City of Portland Erosion Control Manual for more information.

16 UTILITIES

16.1 PURPOSE

To ensure that the engineer coordinates the design of the street improvements with other users of the public right-of-way; to ensure enough design information is provided on the plans so the street improvements can be efficiently constructed.

16.2 DESIGN CRITERIA

- Maintain at least 36 inches of cover over all utilities.
- Maintain at least 18 inches of continuous cover over existing cast-iron water mains during construction.

16.3 DESIGN CONSIDERATIONS

NOTIFICATION AND COORDINATION

During the design survey for the project, request an underground utility locate from the Utility Notification Center, and record the marked locations, and document the locations of all marked utilities on the base map of the construction plans. For projects that include signals, beacons, or poles, survey any aerial utilities that might conflict with equipment.

If requested, the PBOT Utility section will send notification to all utilities at 30%, 60%, 100%, and Notice to Proceed. Utilities will respond to these notices with information regarding conflicts and ownership.

During the 60% design phase, meet with each utility company that has existing or proposed plant and facilities in the right-of-way that will be impacted by the project. Show the proposed final location of all utilities on the plans. Pothole all utilities at new inlet lead crossings and show them in any inlet lead profiles if applicable. Valve measurement information can be gathered from PWB but is not as exact as a pothole.

Construction of public street improvements directly impacts all utilities that use the public right-of-way. After new pavement is placed in the street, PBOT will not allow cutting of this new pavement for at least 5 years without additional resurfacing requirements per PCC 17.24.100. Ensure pavement moratorium notification form is filled out during design and completion of construction.

PBOT Utility Permits approves utility locations within the right-of-way. Although individual utilities may have a preferred location, it is subject to review by the Utility Permit group, in accordance with TRN-10.19. Standard detail P-504 provides acceptable alignments for most rights-of-way and aligns with the BES Sewer and Drainage Facility Design Manual and Portland Water Bureau best practices.

UTILITY RELOCATIONS

Follow the utility relocation process specified in TRN-10.45. Relocation requests must come through City staff or permit application from the affected utility. City staff must send relocation requests to the PBOT Utility Permit group for relocation letters. Provide construction staking for proposed utility locations to ensure they align with improvements. Utility companies will follow TRN-10.19 when requesting a permit to relocate their facilities. Familiarity with these two administrative rules will reduce project delays.

When power poles are relocated and existing wires are transferred to new poles, the utilities relocate from the top of the pole down to the lowest utility on the pole. Each utility may cut the old pole off just above the next lower utility to allow them to lift the wires over the pole to attach to the new pole. The pole owner is responsible to ensure that the pole transfer is completed per TRN-10.45.

When overhead utilities, such as communication lines, conflict with proposed facilities like signals and street lights, develop an exhibit showing the conflict with the proposed infrastructure (signal) and confirm the specific utility owner in conflict and the clearance requirement per NESC Rule 234B. Utilities that are leased to be on electrical utility poles will check the clearances on the poles and initiate a ticket in the National Joint Utilities Notification System (NJUNS) to have the connections moved or request a taller pole. Send a relocation demand letter to the pole owner, copying the lessee, along with an exhibit showing the conflicting infrastructure and required clearances so the conflicting utility can begin the relocation process. Communication utilities' service vehicles are often limited to servicing facilities at heights no greater than 25 feet, which can impact whether it's feasible to simply raise the utilities on the pole or if the facilities must be relocated (e.g. underground).

WATER MAINS

Oregon administrative rule 00333.061.0050(8)(f) requires at least 30 inches of cover over distribution system piping. In cases where a main is approved with less than 36 inches of cover with a PBOT design exception, approval for an exception to the OAR will be required as well unless 30 inches of cover is provided. Work with the Portland Water Bureau for processing the design exceptions.

UTILITY LAYOUT

The efficient layout of utilities along a frontage can help preserve existing trees or planting sites for new trees planting sites, as well as space for stormwater management which depends on gravity to channel runoff to facilities typically located at corners. To help ensure efficient use of the public right-of-way, PBOT Public Works may look to see if an applicant has done the following:

1. Take advantage of the 25’ from a corner where trees cannot be planted as a prime area for hydrants, utility poles, signs, utility connections, utility vaults, and stormwater facilities

2. Minimize the spacing between utility connections while meeting utility codes (e.g., spacing requirements for water, sanitary, etc.)

3. Locate utility connections (including water meters) as close to or within driveways as possible, either through the throat, within the wing area, or in the furnishing zone next adjacent to the driveway, dependent on utility requirements

17 STORMWATER DRAINAGE

17.1 PURPOSE

This section provides design parameters and supporting references for the design of surface storm drainage systems associated with transportation facilities including gutters, inlets, and inlet leads.

17.2 DESIGN CRITERIA

Much of the design criteria and considerations in this section comes directly or in part from the latest ODOT Hydraulic Design Manual (HDM) or BES Sewer and Drainage Facilities Design Manual (SDFDM).

HYDROLOGY

The rational method will be used for determining peak runoff flow rates for inlets, gutter spread design, and inlet lead pipe design. The drainage area includes all stormwater runoff draining to the point of interest, including runoff from private properties and roof downspouts. Table 4 below shows rainfall intensities for a five-minute time of concentration (t_c). Refer to the SDFDM for the runoff coefficient (C) and additional information.

Equation 1: Rational Method

$$Q = CIA$$

Q = Peak runoff flow rate, cubic feet per second

C = Runoff coefficient representing a ratio of runoff to rainfall, dimensionless

I = Average rainfall intensity, inches per hour

A = Drainage area contributing to the point of interest, acres

	Rainfall Intensity, inches per hour Return Period, years					
Time, minutes	2	5	10	25	50	100
5	1.92	2.47	2.86	3.32	3.75	4.14

Table 4 - Rainfall Intensities for Various Return Periods, 5-minute t_c

ALLOWABLE SPREAD

The design flowrate is the bypass flow from any upstream inlets plus the runoff from any additional areas draining to the inlet. The bypass flow for inlets on grade will be no larger than 30%. Minimize gutter spread according to Table 5.

Road Classification and Inlet Location		Design Storm	Allowable Spread	Clogging
Local Streets	On grade	10-year	1/2 Driving Lane	n/a
	Local sag point	25-year	1/2 Driving Lane	50%
	Major/Main line sag point	50-year	1/2 Driving Lane	50%
Arterials and Collectors	On grade	10-year	2 feet into Driving Lane	n/a
	Local sag point	25-year	2 feet into Driving Lane	50%
	Major/Main line sag point	50-year	2 feet into Driving Lane	50%

Table 5 – Allowable Inlet Spread

Inlet spread calculations must be based on Hydraulic Engineering Center No. 22 (HEC 22). The HEC 22 methodology is available in several computer programs, including the FHWA Hydraulic Toolbox which is available for free. Nomographs, hand calculations, and spreadsheets which utilize HEC 22 are also acceptable methods.

ON GRADE INLETS

Space on grade inlets 200 to 400 feet apart on continuous grades, and at intersection corners ahead of curb ramps to reduce ponding. On grade inlet spacing of less than 200 feet may be required adjacent to sags, in areas with either cross slopes or longitudinal slopes less than 1%, or in areas with limited pavement outside the travel lane.

SAG AND FLANKING INLETS

Specify one inlet at the lowest point in the sag and at least one flanking inlet adjacent to the sag inlet. Specify an additional flanking inlet (for a total of two flanking inlets, one on each side) adjacent to the sag inlet for major and main lag sag points. See sag definitions in glossary and HDM for additional information.

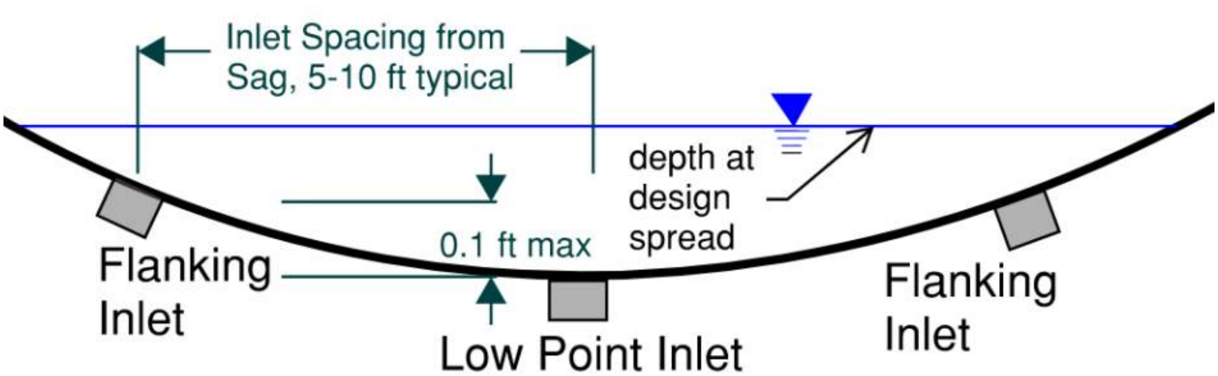

Figure 8 - Flanking Inlets

DEPRESSIONS

Curb inlets (CG-3) typically have a two-inch depression, tapered over three feet, while combination (CG-1, CG-2) and grate inlets (G-1, G-2) have a 1.5-inch depression, tapered over 1.5 feet.

	CG-1	CG-2	CG-3
Depth (in)	1.5	1.5	2
Taper (ft)	1.5	1.5	3
Slope (V:H)	1:12	1:12	1:18

Table 6 – Typical Inlet Depression

When inlets are placed adjacent to a curb ramp or within the flare, do not construct the typical depression, indicated on the standard drawing. Depress to the extent possible without interfering with the ramp design criteria. Curb inlets require a minimum one-inch depression to function properly. Grate inlets can function with limited to no depression if needed.

<u>Within the designated striped bike lanes:</u>

- Larger combination and grate inlets (CG-2, G-2) are a hazard for bicyclists and are not to be placed in a bicycle lane.
- On grade combination (CG-1) and grate inlets (G-1, end-to-end) are to be placed with a reduced depression, one inch or less.
- Sag combination (CG-1) and grate inlets (G-1, end-to-end) are to have a one-inch depression when built in a designated striped bike lane.
- Curb inlets (CG-3) are to have a one-inch depression when in a bicycle lane.
- Adjust all existing grate inlets within the scope of a project to remove abrupt edges when located in a designated striped bike lane.

INLET LEADS

Inlet lead pipes (laterals) connect inlets in series or directly to a sewer main. The minimum inlet lead inside diameter (ID) shall be 12 inches. No more than two inlets can be connected in series, i.e., “daisy-chained”. New inlet lead connections will connect to the nearest maintenance hole. When an existing maintenance hole is not available, a new maintenance hole will be installed. Specify inlet leads slope at least 2%.

The pipe material depends upon the depth of cover:

- If cover is three feet or greater, PVC D3034 SDR35 is recommended for typical pipe applications.
- If less cover is available, DIP is preferred, although C900 is allowed with a design exception and supporting load calculation.

See the SDFDM for additional information.

17.3 DESIGN CONSIDERATIONS

INLETS

See below for design conditions that should be considered when evaluating inlet spacing length for on grade inlets.

Shorter Inlet Spacing (roughly 200 feet) typical on the following:

- Higher speed roads and/or arterials.
- Roads with limited to no pavement outside the travel lane (shoulder, on-street parking, or a bicycle lane).
- Roads with less than 1% cross slope and/or longitudinal slope.
- Superelevated roadways.

Longer Inlet Spacing (roughly 400 feet) typical on following:

- Lower speed and/or local streets.
- Streets with pavement outside the travel lane (shoulder, on-street parking and/or a bicycle lane).
- Streets with greater than 4% cross slope and longitudinal slope.

When the roadway transitions from a centerline crown to a shed section, extra care should be made to capture as much run-off ahead of the transition and to limit the amount of surface water shedding across or into the new section. This may require additional inlets above what is typical.

The purpose of flanking inlets is to act in relief of the inlet at the low point if it should become clogged or if the design spread is exceeded. Flanking inlets should be located so they will function before water spread exceeds the allowable spread at the sag location. Flanking inlets should be located so that they will receive all the flow when the primary inlet at the bottom of the sag is clogged. Flanking inlets should be placed a maximum of 0.1 foot higher than the sag inlet.

INLET TYPES

The preferred inlet type for road drainage are combination inlets (CG-1, CG-2). Grate inlets (G-1, G-2, end-to-end) and curb opening inlets (CG-3) are acceptable if design constraints do not allow for combination inlets.

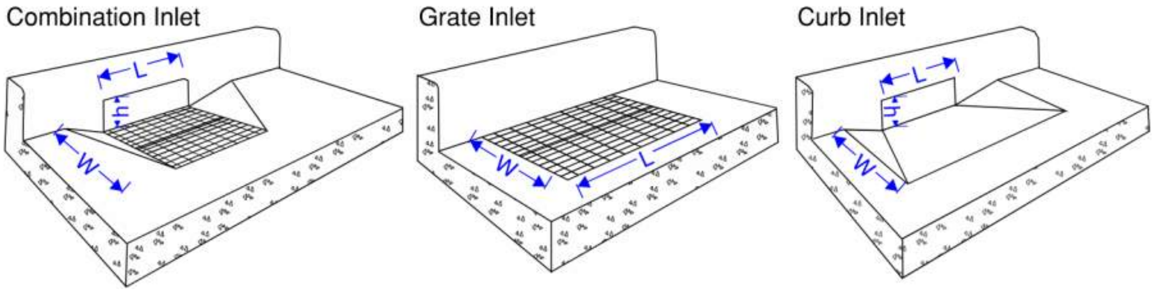

Figure 9 - Inlet Types and Critical Dimensions

COMBINATION INLETS

Combination inlets provide both a grate and a curb opening and are the preferred inlet type for road drainage. This allows for excellent spread reduction without the higher risk of clogging of grate-only inlets. Larger combination inlets (CG-2) conflict with bicyclists and are not to be used in bicycle lanes.

Figure 10 - Combination Inlet

GRATE INLETS

Grate inlets consist of an opening in the gutter covered by one or more grates. They are best suited for use on continuous grades or in areas with limited or low curb exposure. Standard grate inlets should not be used at sag points due to clogging risk. Larger grate-only inlets (G-2) conflict with bicyclists and are not to be used in bicycle lanes. Concrete double inlet (end-to-end) as shown Standard Drawing P-203, may be used on streets with slopes greater than 4%, or when the inlet is adjacent to a travel lane or bicycle lane.

Figure 11 - Grate Inlet

Figure 12 - Curb Inlet

CURB INLETS

Curb inlets are vertical openings in the curb covered by a top slab. They are best suited for use at sag points since they can convey large quantities of debris. They are a viable alternative to grates in many locations where grates would be hazardous for pedestrians or bicyclists. They are not recommended for use on steep continuous grades. Curb inlets require a minimum one-inch depression to function properly.

INLET DESIGN FOR BICYCLISTS

Well-designed gutters and inlets limit the hydraulic spread within the bicycle lane, not just in the automobile travel lane. Limit spread in bicycle lanes to the maximum extent possible, especially for smaller storm events (0.5 in/hr – 1 in/hr).

Figure 13 - End-to-End Inlet

Combination and grate inlets as well as wide gutter pans can reduce the spread of runoff, but often create a poor travel way for cyclists. Select an inlet that manages the gutter spread and maximizes the usable width of the bicycle lane.

RETROFIT PROJECTS

For projects retrofitting existing streets (e.g., ADA ramps, sidewalks, maintenance, paving), designers must meet the design criteria to the maximum extent feasible within the scope of the project. Historical urban flooding and drainage issues must be examined, and the designer should walk the project site during a significant rain event to observe drainage deficiencies. Critical drainage locations, including sag points, poor site distance, and anticipated higher inlet spread locations must be evaluated (flatter slopes, longer inlet spacing, limited space outside the driving lane, etc.) to ensure existing conditions are functioning properly.

18 RAIL

18.1 PURPOSE

To ensure that plans conform to ODOT's Railroad-Highway Grade Crossing Safety Program.

18.2 DESIGN CRITERIA

- Contract plans conform with approved Rail Crossing Orders.

18.3 DESIGN CONSIDERATIONS

ODOT, through the Rail and Public Transit Division’s Crossing Safety Unit is the regulatory agency responsible for rail crossings in Oregon. Per ORS 824.202, the Crossing Safety Unit has authority over all rail crossings to include but not limited to safety, placement of warning devices, geometry of the road approaches and any other appurtenances to a crossing. 23 CFR 646 governs the development of highway projects involving railroads, including the requirements of an agreement.

ODOT’s Highway Division, employs a Rail Coordinator that acts as a single point of contact with the Railroads. This person is responsible for acquiring permanent easements and other property rights from the Railroads and is a good source of information when coordinating with the railroads and road authorities in Oregon. PBOT employs a Rail Coordinator that reviews all proposed rail crossing orders within the City of Portland.

Anyone desiring an alteration, closure or to add a crossing, must contact the Crossing Safety Unit prior to any work. The Rail Crossing Unit’s jurisdiction extends a distance equal to the safe stopping distance, for the posted or statutory speed, measured back from the location of the stop clearance lines. Any project within the safe stopping distance of a railroad should contact the office and include the City's Rail Coordinator during the preliminary design phase of the project to determine requirements. Note Rail Crossing Safety Unit’s jurisdiction for grade-separated crossings will be at the crossing only.

Coordination during project development with ODOT and each affected railroad is required. Any agreement required by the affected railroad is necessary to set forth the essential terms and conditions to be adhered to in the modification or relocation of railroad facilities and encroachments into railroad right of way. Negotiations with railroads can be lengthy and intricate so it is important to begin discussions with railroads at an early stage of project development. Information on rail crossings, ODOT contacts, crossing applications and law can be found at ODOT’s Rail and Public Transit website.

ODOT’s relocation procedures, state law, and federal regulations can be found on the ODOT Railroad Relocation Program webpage. Examples of railroad agreements and boilerplate contract specifications are available under Part 00000-Documents and Forms on the ODOT Boilerplate Special Provisions webpage.

19 GLOSSARY

For definitions not listed, reference the Standard Construction Specifications.

AASHTO: American Association of State Highway and Transportation Officials.

BUSY STREET: A street with lane markings or a transit bus route.

CITY DATUM: The vertical control system used by the City of Portland, established from mean sea level at Astoria in 1896 (Ordinance No. 9667). This datum is exactly 1.375 feet above the datum used by the U.S. Geological Survey (USGS), Multnomah County, and ODOT. City Hall elevation is 78.835 feet above mean sea level.

CITY ENGINEER: The duly appointed City Engineer, or appropriate designees.

CITY FORESTER: The manager of Urban Forestry, or appropriate designees.

CONTRACTOR: The person or organization responsible for performing the construction work.

DEVELOPER: Any person who is proposing to develop property in the City of Portland. The developer participates in the City of Portland’s development review process and may be required to make public improvements (streets, sanitary sewers, storm drainage facilities, or water mains) as a condition of development approval.

DRIVING LANE: The travel lane for motorized vehicles (the bicycle lane is not a driving lane)

FHWA: Federal Highway Administration

NACTO: National Association of City Transportation Officials.

SAG POINT, LOCAL: A localized low point in a warped shoulder or road profile of limited length. Ponding water has an opportunity to reach other downstream inlets if inlets are clogged.

SAG POINT, MAIN LINE: A low point in the roadway centerline vertical curve. Ponding water has no other outlet than from inlets in this location.

SAG POINT, MAJOR: A major sag point refers to a low point that can overflow only if water can pond to a depth of 1.5 feet or more.

ALTERNATIVE RESIDENTIAL STREETS: Approved by Ordinance 185759, typically 16-20ft paved width, and may include gravel shoulder or sidewalk on one side. See Traffic Design Guide for additional details and design criteria.

STANDARD CONSTRUCTION SPECIFICATIONS: A document containing the City of Portland's standard specifications for construction within the City of Portland.

TRAFFIC ENGINEER: The duly appointed City Traffic Engineer, or appropriate designees.