



ELEVATED TRANSIT

DESIGN GUIDE



Metro[®]

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ELEVATED TRANSIT

DESIGN GUIDE



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INTRODUCTION & BACKGROUND

The Elevated Transit Design Guide is a discussion tool to inform planning analysis and design studies for elevated (aerial) rail and bus rapid transit (BRT) stations and transit infrastructure. The Guide aims to help transit professionals and community stakeholders evaluate how elevated transit infrastructure will fit within existing streets and neighborhoods and identify design strategies to deliver transit stations and structures that are well integrated into communities. The Guide builds upon Metro's Systemwide Station Design Standards to maintain a consistent, state-of-the-art visual identity for the Agency.

Elevator



To Parking



To Buses

Elevator



To Parking/Restrooms

Metro Red Line





MEASURE M CONTEXT

Over the next 40 years, Metro will nearly double the size of the rail and BRT network by extending existing lines and building new ones. Transit lines will run through neighborhoods in a variety of configurations: in underground tunnels, off street in dedicated transit right-of-way (ROW), and in the center of city streets. Measure M projects will expand mobility and transportation choices for the region and will alter the physical, economic, and social landscape of Los Angeles County.

From early planning stages through construction, the transit corridor delivery process takes many years, if not decades to complete. Community outreach is critical throughout the process to engage a wide spectrum of stakeholder groups - from technical experts to local residents and businesses who will experience change in their neighborhoods.



For more information, go to metro.net/theplan.

Rail Station

Transfer Station

Busway Station

Service Street

UNDER CONSTRUCTION

PLANNED SEGMENT

Metro Rail

- Red Line** ● North Hollywood to Union Station
- Purple Line** ● Wishai/Western to Union Station
- Blue Line** ● Downtown LA to Long Beach
- Expo Line** ● Downtown LA to Santa Monica
- Green Line** ● Redondo Beach to Norwalk
- Gold Line** ● East Los Angeles to Azusa

Metro Busway

- Orange Line** ■ Chatsworth to North Hollywood
- Silver Line** ■ San Pedro to El Monte
- Street Service in Downtown LA and San Pedro

Regional Rail

- Amtrak**
amtrak.com
- Metrolink**
metrolinkrivers.com

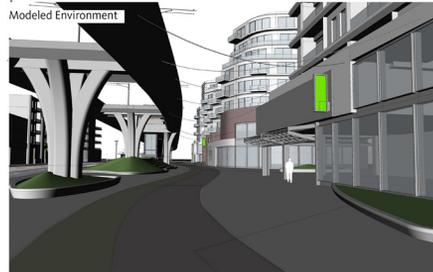
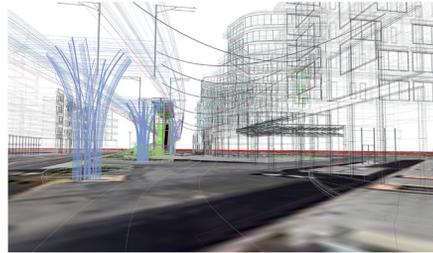
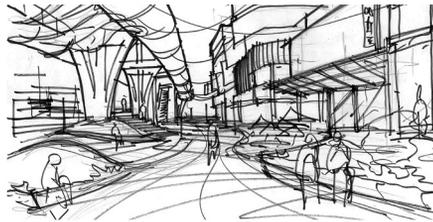
Airport Shuttle

- LAX FlyAway**
laxa.org/flyaway
- LAX Shuttle (free)**
laxa.org

MAY 2017 Subject to Change



ELEVATED STATIONS PROVIDE AN OPPORTUNITY FOR RIDERS TO SEE THE CITY FROM ABOVE



VISUALIZATIONS AS A PLANNING TOOL

The design of the transit system and how it relates to the built environment is a key concern for communities engaged in the planning of new transit lines. Visualizations can improve technical discussions between team members, as well as help facilitate productive conversations with communities on the lasting impacts of transit infrastructure in neighborhoods to guide decision-making.

The visuals in the Guide include precedent photographs, illustrative diagrams, street sections, and conceptual renderings to inform discussions and generate ideas on design solutions to respond to diverse and evolving communities in Los Angeles County.



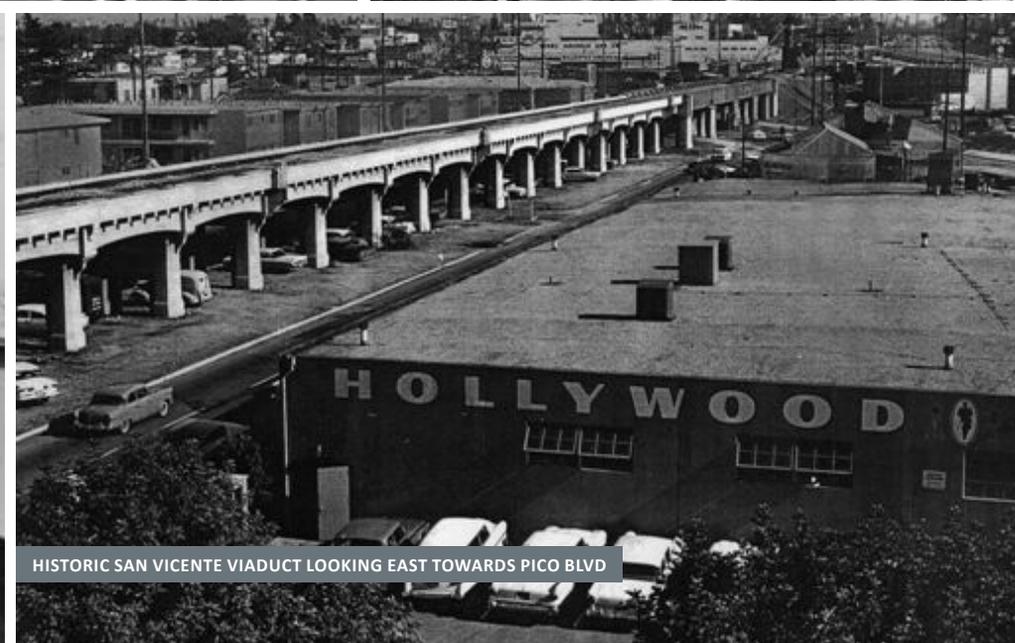
AERIAL VIEW OF SAN VICENTE VIADUCT OVER LA BREA AVENUE



FAIRFAX, OLYMPIC, SAN VICENTE INTERSECTION. CA 1936



HISTORIC SAN VICENTE VIADUCT AT PICO BLVD LOOKING WEST



HISTORIC SAN VICENTE VIADUCT LOOKING EAST TOWARDS PICO BLVD



PASSENGERS BOARDING STREETCAR AT WEST BLVD BRIDGE

EARLY RAIL IN LA

Los Angeles County's history with rail began long before Metro, first with the transcontinental railroad in the late 1880s, followed by a dense inter-city electric streetcar system, which reached its peak in the 1940s. The Pacific Electric "Red-car" system ran along the roadway in lanes shared with cars, as well as over bridges and in viaducts in many parts of Los Angeles.

As Metro works on a major expansion of the transit network, it is helpful to look to the past for precedents on how transit architecture was integrated into the built environment. The massing, scale, siting, and artwork of transit bridges, trenches, tracks (guideways), and other large support structures must be considered in the planning of new transit lines.



HIGHLAND BLVD LOOKING NORTH. CA 1939



UNDERGROUND RAIL



STREET LEVEL (AT-GRADE) RAIL





ELEVATED (AERIAL) RAIL

RAIL CORRIDORS AND THE URBAN EXPERIENCE

Urban rail returned to Los Angeles in the 1990s with the construction and opening of the Metro Blue Line in 1995, connecting Downtown Long Beach to Downtown Los Angeles. The Metro system currently has six rail lines and two BRT lines in operation in a variety of station and track configurations, including:

- Underground (subway) tunnels and stations along the Red, Purple, Gold and Blue Lines;
- Street level (at-grade) tracks and stations along the Exposition (Expo), Blue, Orange, Silver, and Gold Lines; and
- Elevated (aerial) tracks and stations along the Green, Expo, Silver and Gold Lines.

As the Metro system expands, there will be significant trade-off conversations on the elevation or “vertical profile” of future transit lines. Highly congested roadways make it difficult to operate desirable and reliable train speeds at the street level. Underground transit is the most expensive alternative and has the most lengthy construction period. Elevated transit has raised concerns for some community members due to the highly visible infrastructure (e.g. columns, straddle bents), which can be perceived as looming over neighborhoods. However, as a high speed transit option that is less costly than underground tunnels, it merits discussion.

The following pages summarize trade-offs between the different vertical profile options and the importance of planning for visual mitigation through art and architectural elements to create lasting large-scale landmarks.



BELOW GRADE \$1 BILLION / MILE

BENEFITS

- High travel speeds
- High passenger capacity
- No conflict points between trains and pedestrians, cyclists, vehicles
- Weather protected power source (third rail)
- Limited visual impacts
- Limited noise impacts
- Opportunity to expand station access over time with additional station entrances
- Opportunity to integrate station with development above

CHALLENGES

- Complex engineering and construction process
- High cost of construction with significant impacts to businesses and public streets
- Utility relocation
- Property acquisitions, construction staging, and permanent structures
- Vibration
- Vertical circulation required for riders to reach underground trains
- Operational equipment impacts at surface (vents, power generator, etc)



AT-GRADE \$150 MILLION / MILE

BENEFITS

- Highly visibility to riders and potential riders
- Accessible from street level (limited vertical circulation)
- Small footprint of station and limited impacts to adjacent properties
- Lowest cost alternative

CHALLENGES

- Low travel speeds, particularly when operating in street with vehicular traffic
- Inherent conflict points between trains and pedestrians, cyclists, vehicles in street
- Noise/vibration (often mitigated by sound walls)
- Exposed power source (OCS), which can be damaged by weather (heat, wind, etc.)



UNDERGROUND



AT-GRADE (STREET-LEVEL)



BENEFITS

- High travel speeds
- High visibility to riders and potential riders
- No conflicts between trains and pedestrians, cyclists, vehicles
- Skyline views for riders
- Potential to integrate station entrance into adjacent development
- Opportunity to enhance newly created and high visible infrastructure through art and architecture
- Lower cost than subway



ABOVE-GRADE
\$300 MILLION / MILE

CHALLENGES

- Visual, sun/shadow impacts
- Surface impacts to streets and adjacent properties for structural supports (columns)
- Exposed power source (OCS), which can be damaged by weather (heat, wind, etc.)
- Noise/vibration (often mitigated by sound walls)
- Vertical circulation required for riders to access train

VERTICAL PROFILES

The diagram (left) outlines key differences between the vertical profile of transit infrastructure. These topics should be addressed early in the planning and design process as they impact the project's cost, constructibility, and relationship to the built environment.



ABOVE-GRADE (ELEVATED)



GOLD LINE, FOOTHILL EXTENSION BRIDGE 2012 | ANDREW LEICESTER



EXPO LINE, TRANSITION WALLS AND ADJACENT BIKE PATH



CHINATOWN STATION/DEVELOPMENT INTERFACE



EXPO LINE, ELEVATED STATION

ELEVATED RAIL IN LA

There are a few examples of elevated rail in the existing Metro network. The photos (left) illustrate how structural elements are integrated into the community including:

- Enhanced concrete columns and carriageway form-work can radically change a basic bridge into an enduring landmark and gateway;
- Mechanically stabilized earth (MSE) wall supporting the trackway as it transitions from street level to elevated rail adjacent to a dedicated bike path, and
- Station mezzanine that connects the station to a raised courtyard of an adjacent development (Chinatown Station).



ELEVATED RAIL STATION INTEGRATED WITH HIGH DENSITY DEVELOPMENT (VANCOUVER, CANADA)



SCULPTURAL FORMS REDUCE VISUAL MASS AND BULK OF ELEVATED RAIL STRUCTURE (HAGUE, NETHERLANDS)



CABLES ALLOW BRIDGE TO SPAN LONG AREA WHILE SERVING AS ICONIC GATEWAY FEATURE (JERUSALEM, ISRAEL)

ELEVATED RAIL ABROAD

Concrete has been the material of choice for Metro transit infrastructure due to its durability, cost, and structural integrity. However, other parts of the world have explored using alternatives to concrete, such as steel framing and cable-stay structures.

The choice of material impacts the cost, constructibility, ease of maintenance, responsiveness to earthquakes and other structural challenges.

Materiality also impacts the visual bulk of the infrastructure, how heavy or light the massing appears, shade and shadow on adjacent streets, and a sense of beauty.

Where feasible, Metro may consider using the shape, form, and design details of elevated transit corridors for aesthetic purposes, as well as utility.



HISTORIC COLORADO STREET BRIDGE, 1912



6TH STREET VIADUCT BRIDGE AND LEONARD HILL ARTS PLAZA, 2020

ICONIC INFRASTRUCTURE

While the majority of community stakeholder discussions regarding transit design are focused on station architecture, there are many structural elements that are part of the transit system, which have lasting visual impacts and present an opportunity for design thinking.

Large scale infrastructure investments that embrace artist and architect collaboration can result in celebrated sculptural forms that become iconic gateways to the communities that they serve.

Including architectural considerations as part of the structural system for elevated transit systems will help arrive at better design concepts and details that may be supported by community stakeholders.





ELEVATED STATIONS SCALE & TYPOLOGIES

This section addresses the scale and configuration of elevated stations and how they respond to the existing and future built environment around them. Elevated stations must be site responsive and scaled accordingly to create well-integrated, memorable architecture.

A LOW-RISE



B MID-RISE





C HIGH-RISE

SCALE OF DEVELOPMENT

A LOW-RISE NEIGHBORHOOD

- Special attention to be paid to the height of the guideway while protecting views of businesses.
- Study size and shape of the support columns to reduce appearance of bulk.

B MID-RISE NEIGHBORHOOD

- Opportunity for direct connection to adjacent development.
- Privacy and noise considerations between train platform and adjacent building windows / outdoor spaces.

C HIGH RISE NEIGHBORHOOD

- Greater flexibility on the height of the guideway and mezzanine.
- Special attention required for vertical circulation to ensure easy navigation and flow for riders.
- Opportunity for direct connection to adjacent developments.
- Privacy and noise considerations between train platform and adjacent building windows / outdoor spaces.



Platform

1

INFORMATION SIGNAGE

INFORMATION SIGNAGE

Platform

2

Exit INFORMATION SIGNAGE

Exit INFORMATION SIGNAGE

Platform

2



1 SIDE PLATFORM

Best suited for locations where there is limited space in street for support structures and station entrances can be located off street.



2 CENTER PLATFORM

Best suited for off-street locations where station plaza is separated from vehicular traffic.



3 MEZZANINE

Best suited for locations where height of guideway is of similar scale to surrounding development.



4 TRANSFER

Station serving two or more lines.



5 TERMINUS

End of the line station, which typically accommodates additional track for vehicle storage, track switching and servicing.

STATION TYPOLOGIES

The following pages discuss five elevated station typologies and key considerations to maximize safety, access, and rider convenience and to reduce potential negative impacts to surrounding properties.

Each station type has its own set of opportunities and challenges to meet customer needs (e.g. access, navigation), as well as operations, maintenance, constructibility, etc.

Conceptual renderings and illustrative sections help identify how station components interface with the adjacent properties, sidewalks, and streets. The diagrams build upon Metro's Systemwide Station Design Standards to provide a station environment that is easy to navigate for riders and uses materials that are durable.

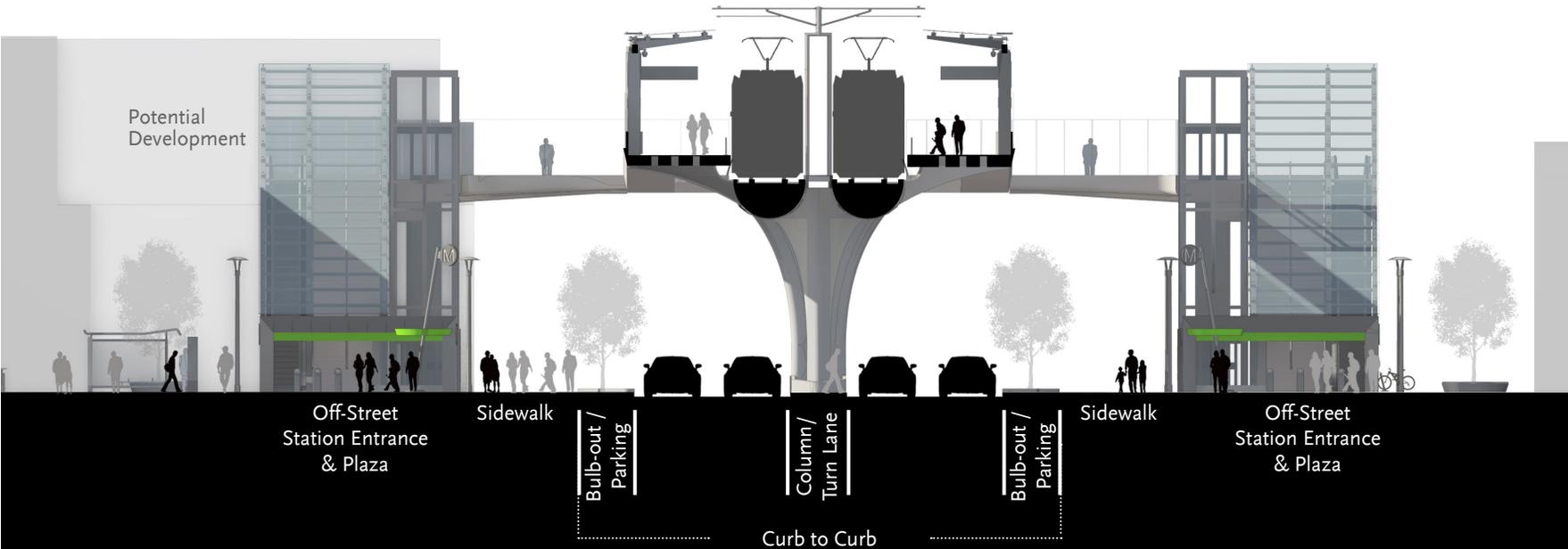


HUB



1 SIDE PLATFORM KEY CONSIDERATIONS

- Best suited for on-street sites where there is limited space in street for station entries.
- Requires property acquisition on each side of the street for station entrances.
- Pedestrian bridge from platform presents opportunity to directly connect to adjacent development.
- Two entrances require two sets of vertical circulation (stairs, escalators, elevators), customer amenities (e.g. seating, signage, canopies), which can increase overall station costs.
- To change direction of travel, riders must exit station, cross street and re-enter station.
- Side platform configuration does not allow for easy transfers to a connecting transit line.

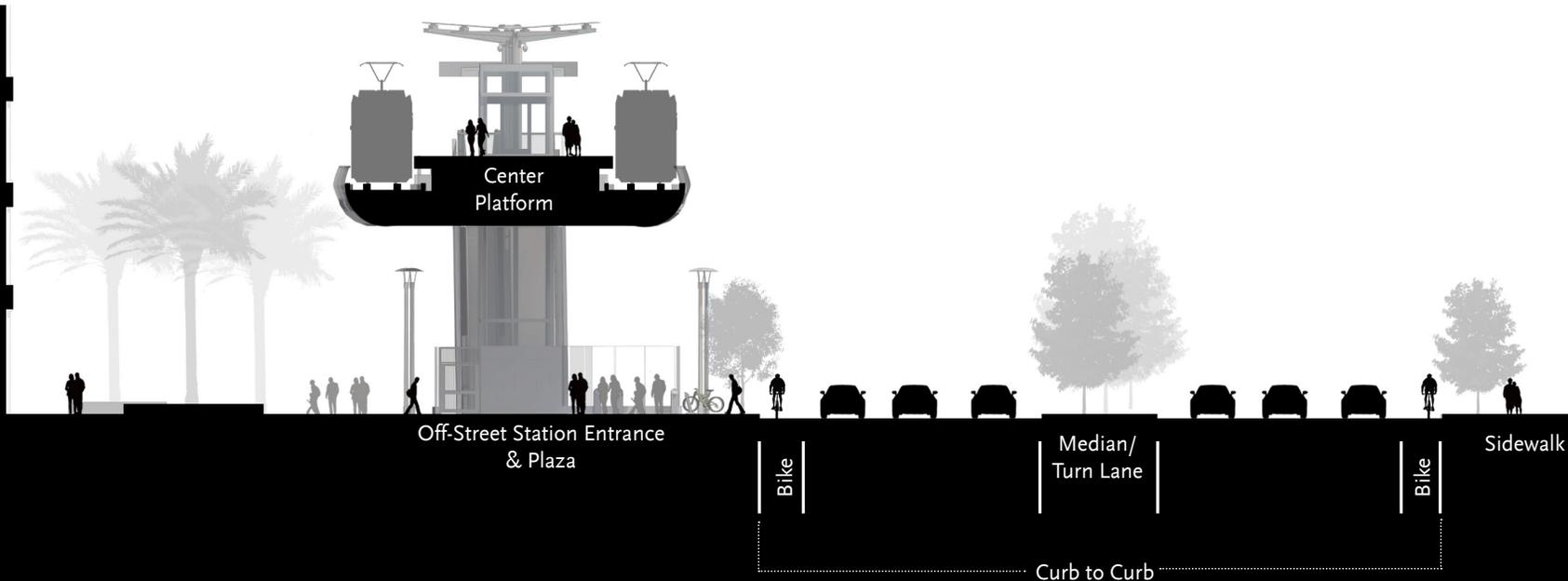






2 CENTER PLATFORM KEY CONSIDERATIONS

- Best suited for off-street sites where riders can enter the station through a plaza that is separated from vehicular traffic for safety.
- Requires large footprint at street level to accommodate entrance with ticketing, fare gates, and vertical circulation elements to reach the platform.
- Customer amenities (e.g. seating, signage) and architectural elements (e.g. lighting, canopy) are consolidated on single platform, which can reduce overall station costs.
- Single platform serves both directions of travel, providing flexibility to riders who can access either direction of travel from same platform.
- Platform size (length and width) must accommodate space for passengers arriving from both directions of travel at the same time.
- On-street station locations will require special safety and access treatments to address pedestrians in close proximity to vehicles when entering and exiting station.





Platform

Mezzanine

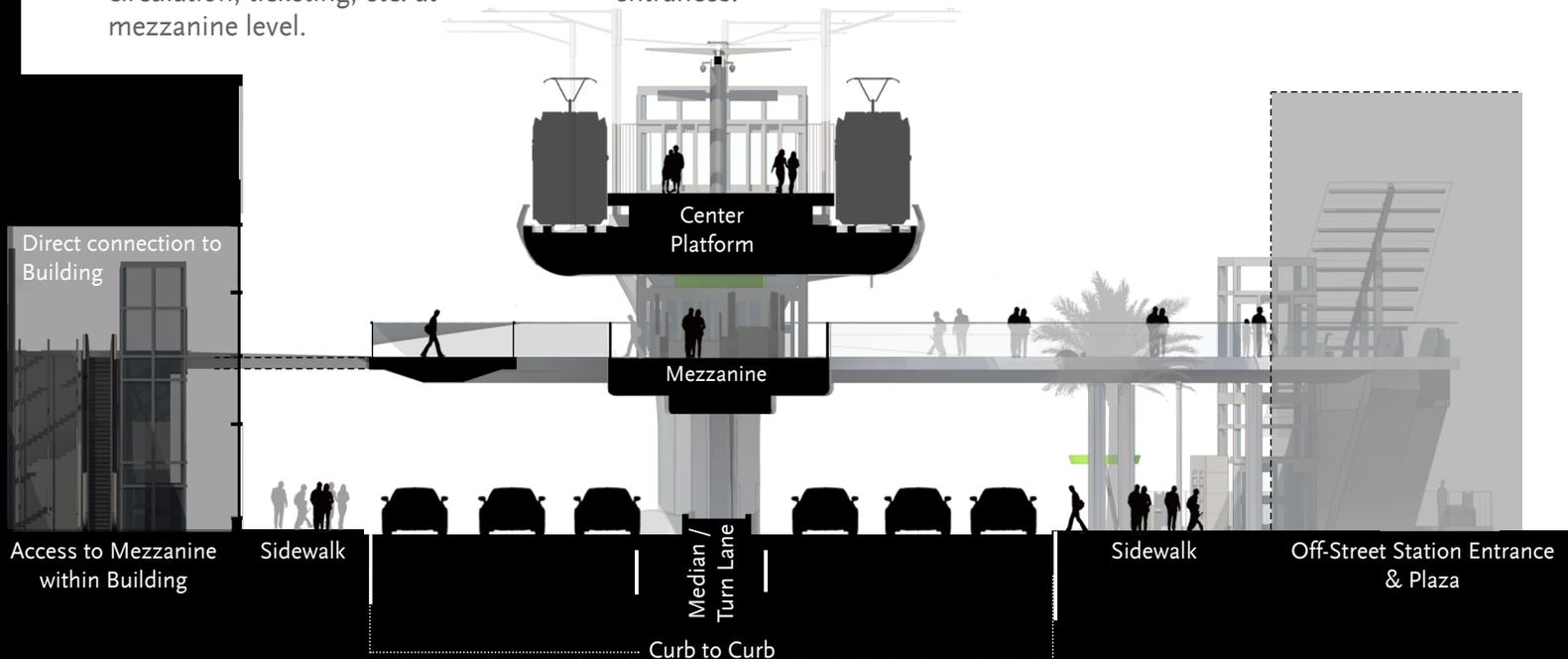
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4



3 MEZZANINE KEY CONSIDERATIONS

- Best suited for sites where scale and height of adjacent development is of similar height to platform in order to reduce the visual impact of structures.
- Accommodates two connecting lines where passengers change lines at mezzanine level.
- Allows for smaller footprint at street level by placing vertical circulation, ticketing, etc. at mezzanine level.
- Allows riders flexibility to change travel direction without leaving station.
- Riders can access the platform from a pedestrian bridge that connects to street level, and can directly connect to adjacent development.
- Requires property acquisition on each side of the street for station entrances.
- Creates opportunity to directly connect to adjacent development from mezzanine.
- Design of columns and support structures can help improve compatibility with built environment. See Chapter 3 on best practices.



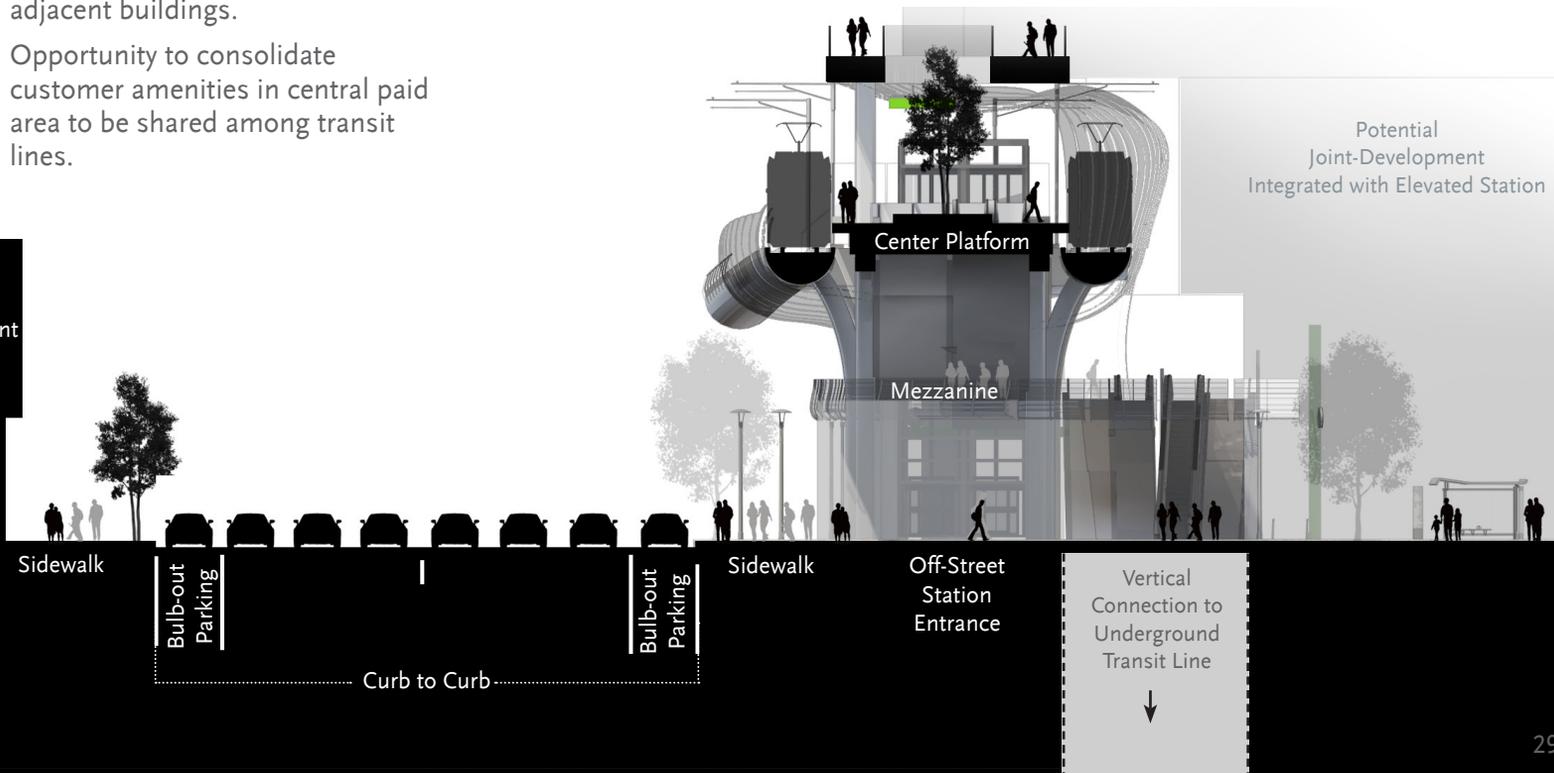




4 TRANSFER STATION KEY CONSIDERATIONS

- Station connects two or more lines. May require mezzanine to accommodate connections.
- Transfer station between two elevated lines will increase height and mass of station. Consider scale of surrounding development and opportunities to integrate pedestrian bridges directly into adjacent buildings.
- Opportunity to consolidate customer amenities in central paid area to be shared among transit lines.
- Passenger flow and circulation modeling is critical during planning and design phases to reduce pinch points and crowding.
- May require significant vertical circulation planning studies to connect passengers between different platform levels.
- May require retrofits to adjust platform size and circulation space when transit lines connect that differ in capacity (e.g. high capacity heavy rail trains connecting with lower capacity light rail trains).
- Allocate space for other connecting modes (e.g. bikes, scooter, bus) that would connect to station.

Adjacent
Development





DO NOT BLOCK INTERSECTION

43

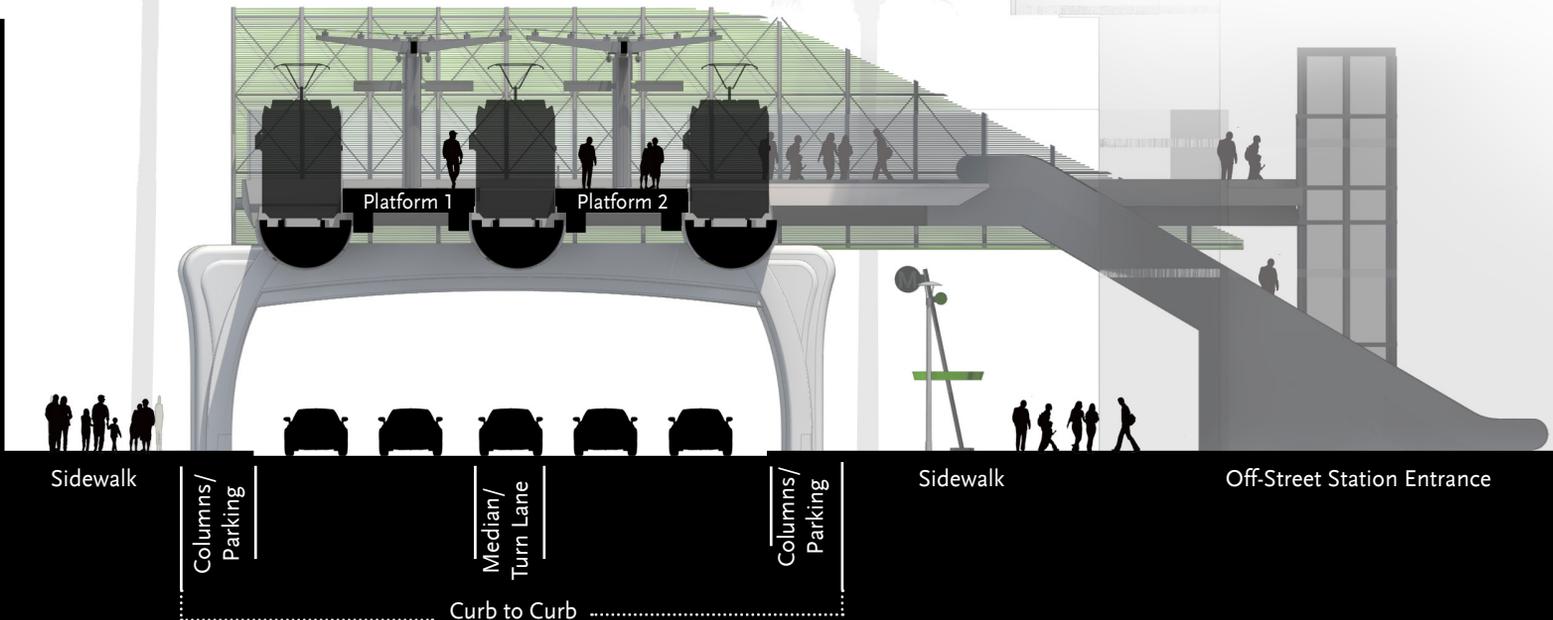
237 MUSEUM

002



5 TERMINUS STATION KEY CONSIDERATIONS

- End of the line station, typically requires large footprint to accommodate two platforms and three tracks to move trains in/out of service.
- Off-street entrance needed to accommodate customer information, ticketing, vertical circulation, etc.
- Requires attention to a manage passenger flow and ensure easy navigation between platforms and street level.
- Major structural supports (e.g. straddle bents) needed to support three elevated tracks.
- Requires room within street right-of-way or adjacent property to accommodate touchdown points of support structures.
- Attention is needed to allocate space for connecting modes to support multi-modal connections that feed station (e.g. bus, bike, scooters) and manage curb space.







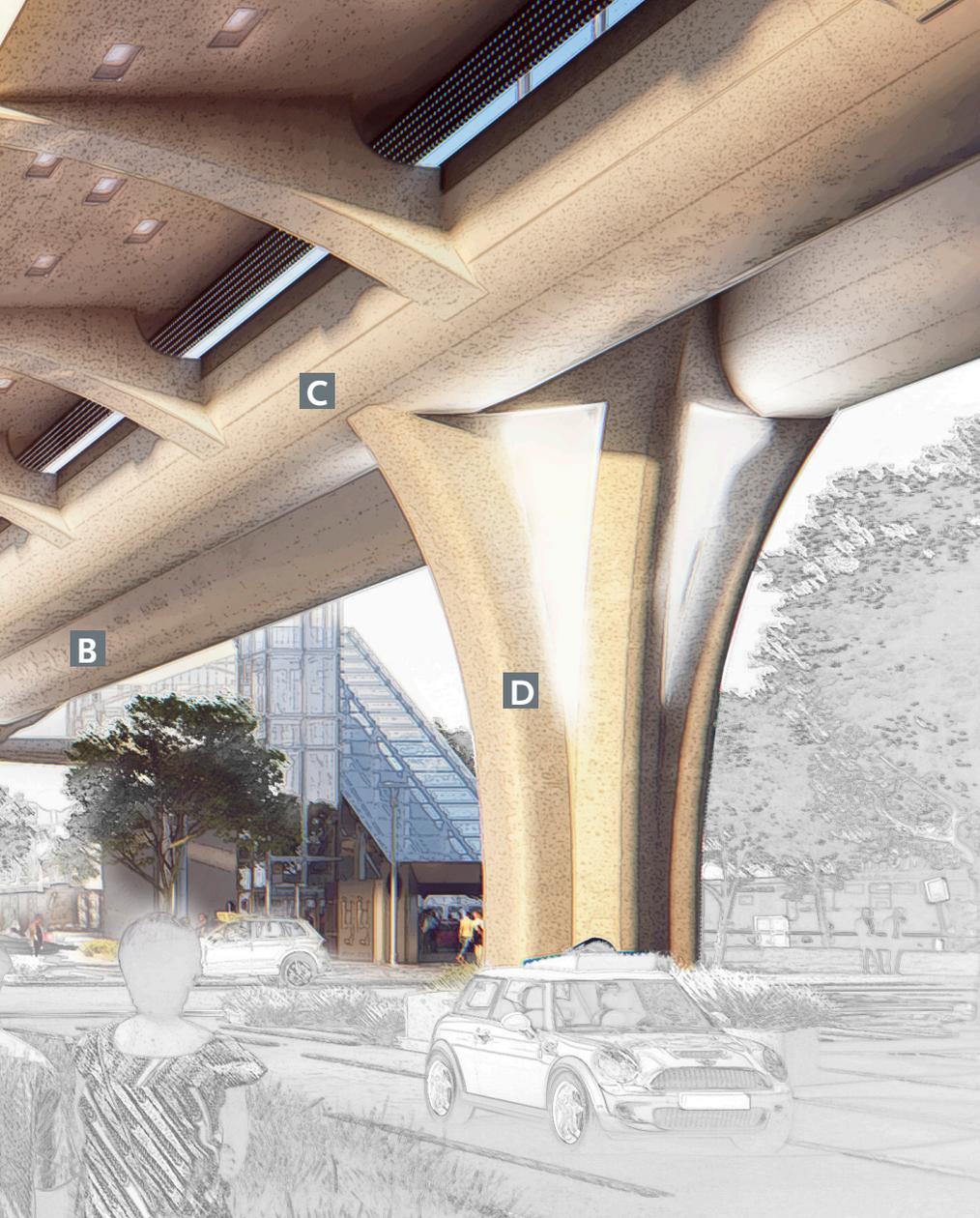
BEST PRACTICES

FOR ELEVATED TRANSIT

This section presents best practices in elevated transit architecture and infrastructure, offering strategies to seamlessly integrate transit into the built environment. The following topics are explored:

- Massing
- Materiality
- Support Structures
- Straddle Bents
- Long Spans
- Elevation Transitions
- Below Elevated Structures
- Architectural Lighting
- Integrated Artwork

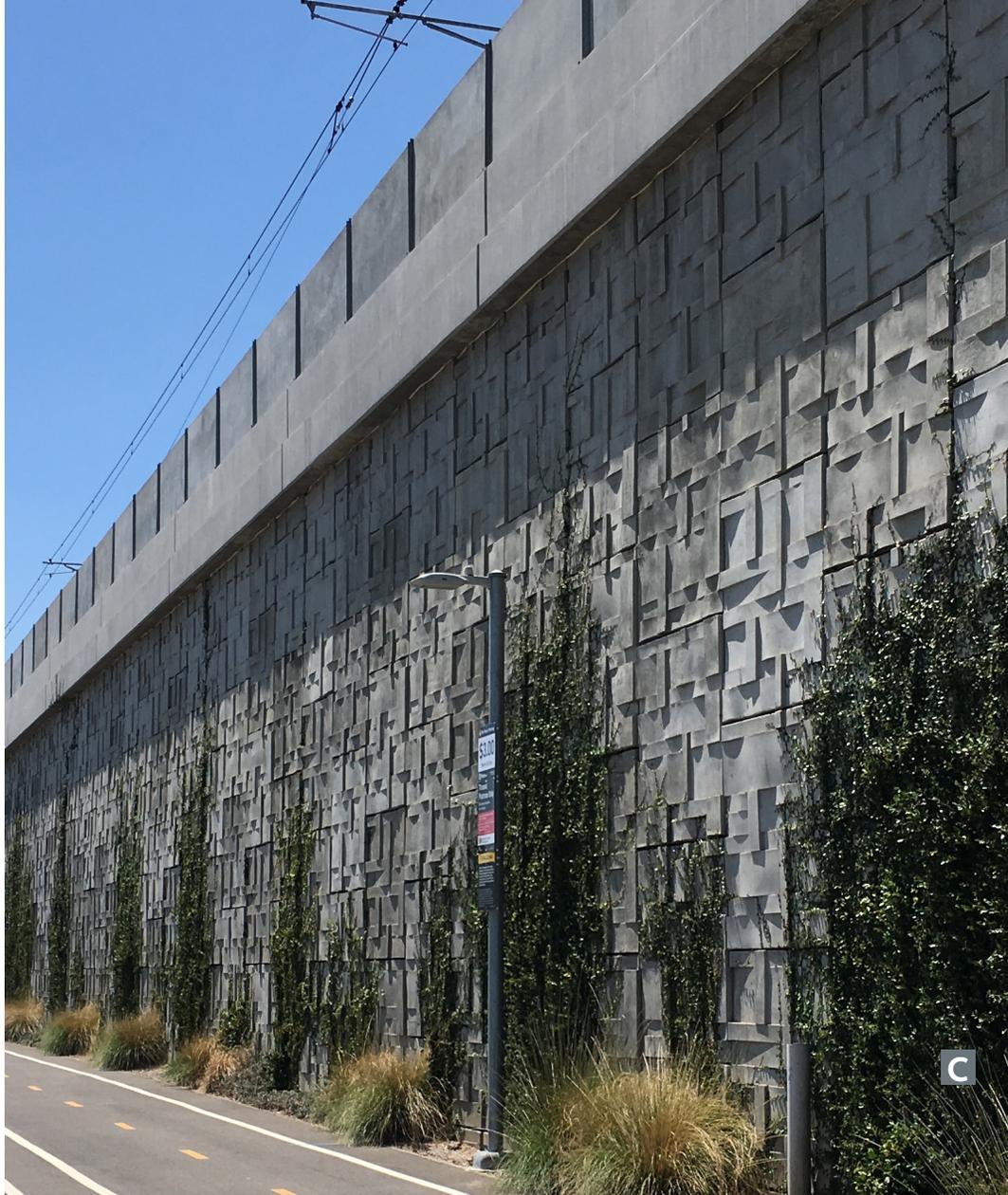




BEST PRACTICES MASSING

- A** Explore ways to connect stations into existing or new buildings with elevated pedestrian pathways.
- B** Consider minimum and maximum height of guideway and relationship to adjacent buildings to protect views of storefronts, if possible, and to reduce the perceived bulk and mass of aerial structures.
- C** Consider ways to reduce shadow impacts from structures, such as using curvilinear architectural elements and rounded forms.
- D** Use light colors for columns and guideway structures to reduce the visual impact and create a perception of lightness.





BEST PRACTICES MATERIALITY

A MAINTENANCE

Use durable materials such as glass, stainless steel and architectural grade finished concrete included in Metro's Systemwide Station Design Standards. Several new technologies are coming into play that allow surfaces to be self-cleaning and graffiti resistant. Consider these as options to reduce the burden of wear and tear on the longevity of the chosen materials.

B VISUAL IMPACT

Color, texture, and the treatment or finish of common materials like concrete affect the visual impact of infrastructure, creating shadows and reflectivity effects.

C SUSTAINABILITY

Large structures can be designed as more than passive monoliths. Consider opportunities for landscaping, solar cladding, carbon sequestration and other materials to add an active layer to the infrastructure.





BEST PRACTICES SUPPORT STRUCTURES

A PATTERN

Patterns can be molded into concrete columns to enhance the aesthetic of the infrastructure.

B LANDSCAPE

Vines that climb columns and other support structures can soften the visual impact of the infrastructure and green the urban environment. Plant types and growth patterns need to be vetted by Operations & Maintenance staff to ensure they do not compromise the durability of structures and safety of operations.

C SCULPTURE & FORM

Consider how to treat the form of support columns as sculptural elements to reduce the appearance of bulk and mass.



A



CARRE

EAT



BEST PRACTICES LONG SPANS

A Cables, often used for bridges that cross water, also can be used as structural supports for transit lines that span long intersections where there is no space for support columns in the street right-of-way. The cable system should be designed as a piece of architecture that can serve as a gateway to neighborhoods.

B Textures applied to the concrete forms can transform mundane structures into iconic architecture.

C The height of the guideway impacts how big and bulky the support columns appear at street level. A higher guideway tends to make the support columns appear smaller. However, a higher guideway may require additional structural support.





BEST PRACTICES ELEVATION TRANSITIONS

- A** Grade crossings or transitions in the height of the guideway from elevated to at-grade tracks or underground tunnels can span multiple blocks and thus require special design treatment to avoid creating a barrier for the neighborhood that can impede circulation and block views.
- B** Consider using changes in topography (natural hills/slopes) as opportunities to reduce the length of the transition structures.
- C** Identify pedestrian access points to support walkability in neighborhoods.
- D** Consider how architectural lighting and other sculptural elements can be used to reduce the visual impact of structure.





A

M

C

B

BEST PRACTICES BELOW THE STRUCTURE

- A** Consider splitting the guideway to allow for sunlight to reach public spaces below.
- B** Activate building frontages that front transit areas with transparent windows and storefronts to promote visibility and safety.
- C** Incorporate outdoor dining, seating and other gathering places where feasible.
- D** Create opportunities for welcoming landscaping as part of the plaza design.





ILLUMINATED UNDERPASS, SHANGHAI

BEST PRACTICES

ARCHITECTURAL LIGHTING



A SAFETY & SECURITY

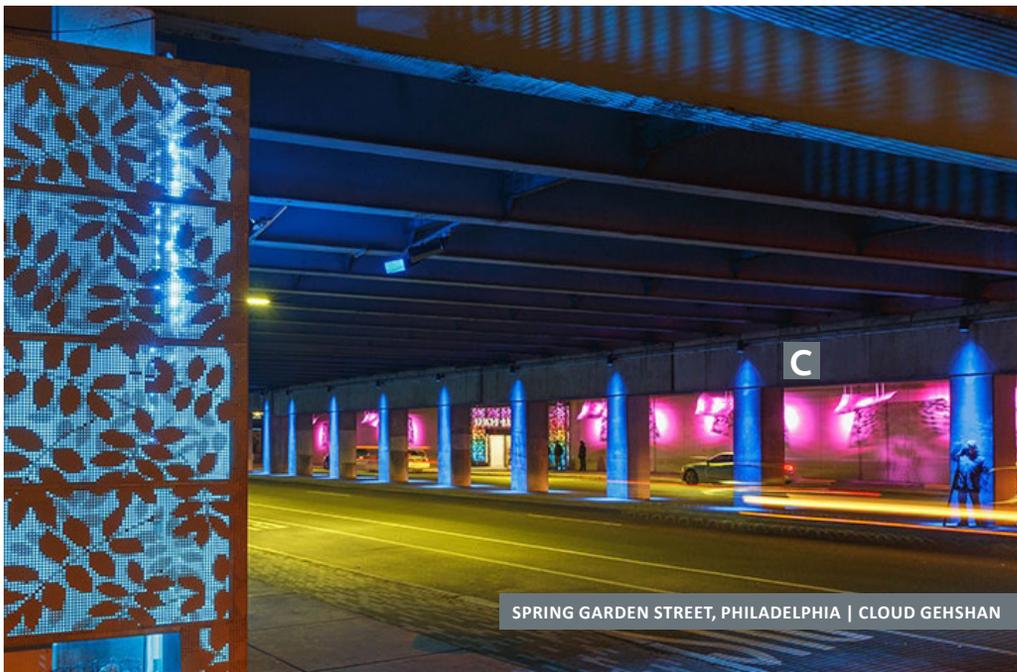
A comprehensive lighting strategy is crucial in creating a safe environment at night. Consider opportunities to not only light efficiently, but also creatively.

B INTEGRATED LIGHTING

Consider ways to integrate lighting into the station architecture to reduce clutter. Lighting can enhance and emphasize key elements of the architectural design, as well as strengthen the station's identity.

C PROJECTIONS

Consider opportunities to use exterior surfaces as a canvas for artwork projections, that can also improve safety and security at night. Artwork should be coordinated early in the design process with Metro Art & Design to be thoughtfully integrated into the overall design and architecture.

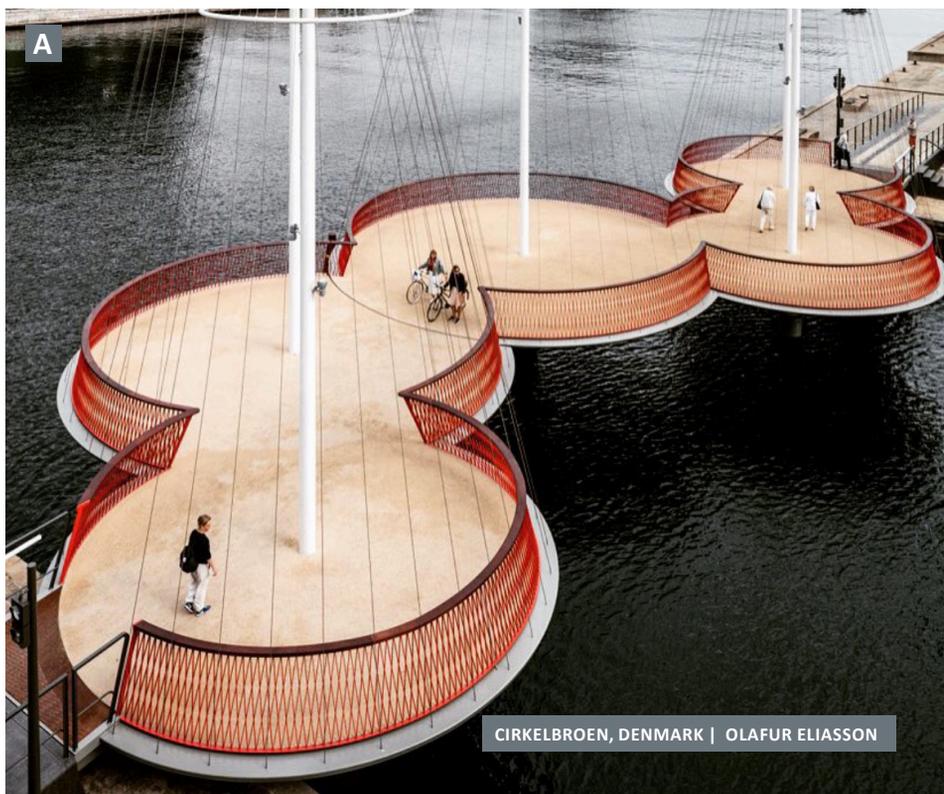




ÄLVSBERG BRIDGE, SWEDEN | CHRISTO GUELOV "LET'S COLOR GOTHENBURG"



GOLDEN BRIDGE, VIETNAM | TA LANDSCAPE ARCHITECTURE ELIASSON



CIRKELBROEN, DENMARK | OLAFUR ELIASSON

BEST PRACTICES INTEGRATED ARTWORK

A ART AS INFRASTRUCTURE

Bridges, columns, tunnels, and other transit support structures provide ideal locations for iconic and playful artworks, providing an exceptional rider experience for Metro's expanding transit system.

B EARLY COORDINATION

Working with an artist during early planning and preliminary engineering phases solidifies the artist's role in the design, and the project team's ability to maximize this investment. Project plazas, bridges, canopies, and other high optic places where people will gather or gaze provide excellent opportunities for artwork integration.

"We recognize that the inclusion of art in the design of public spaces creates a more inviting environment" - Metro Board, 1989





DISCUSSION GUIDE FOR TRANSIT PROJECTS

The list below presents a set of questions to discuss among inter-disciplinary teams early in the transit corridor planning process to maximize positive outcomes for communities.

INFRASTRUCTURE & SITE REQUIREMENTS

- How much space is available in the street right-of-way to accommodate transit structures?
- How does the station location impact rider access?
- How will riders reach the station platform (side platform, center platform, mezzanine)?
- Will the transit line be required to span large intersections, which will need specialized supports (e.g. straddle bents? bridges?)
- Where will structural supports be located (on-street or off-street)? What type of property acquisitions are needed?
- Will support structures impact pedestrian, bike, or vehicular access in the area?
- What type of street reconfiguration may be required to fit the transit infrastructure and enhance walkability?
- Is there an opportunity to add traffic calming or active transportation improvements when redesigning the street?
- Are major utility lines (power lines, storm drains) located near the transit guideway, which will require relocation?

DESIGN & CUSTOMER EXPERIENCE

- What is the scale and height of surrounding development? How does it relate to the height of the proposed guideway? What design strategies can be used to make the infrastructure more compatible with surrounding development?
- Is it possible to directly connect station entrances and access points to adjacent properties? Or future development?
- What type of uses will occur below the elevated guideway and stations? Is there an opportunity to activate this space with landscaping or placemaking amenities?
- Are there privacy considerations to address for adjacent properties (e.g. residential units, historic buildings)?
- How will the design meet Metro's Systemwide Station Design Standards? Are there components that are not addressed by Metro's design criteria and need to be developed?
- What types of materials, finishes, or other design techniques may be used to soften or lighten the appearance of the structures?
- Are there opportunities to integrate creative lighting, signage, or artwork into the structures to improve aesthetics?



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