SANDAG

General Design Criteria

San Diego Trolley

MTS

September 2014

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Design Criteria Manual
Draft Rev 0 September 2014

Prepared by:
The San Diego Association of Governments (SANDAG)

This Manual is published as a set of general guidelines for the planning and design of bus and light rail transit extensions and improvements. While this Manual is comprehensive, it is not meant to replace the standard design process. Project design is still the responsibility of the designer.

The intent of the Manual is to establish general criteria for project design. However, deviations are anticipated from time to time. The Director of Rail must approve any such changes or deviations.

John Haggerty
Director of Rail

9/5/2014
Date

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REVISION RECORD
GENERAL DESIGN CRITERIA MANUAL

REV. NO	REV. DATE	SECTION (S) AFFECTED	COMMENTS
0	09/2014	All	Initial Issue

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Table of Contents

List of Appendices

List of Tables

Terms and Abbreviations

The following acronyms, initialisms, and short forms are used in this report.

Acronyms	List of Terms
AASHTO	American Association of State Highway and Transportation Officials
AC	Asphaltic Concrete
ACE	Advanced Conceptual Engineering
ADA	Americans with Disabilities Act
AREMA	American Railway Engineering and Maintenance-of-Way Association
BDS	Bridge Design Specifications (Caltrans)
BMP	Best Management Practices
CAB	Crushed Aggregate Base
Caltrans	State of California Department of Transportation
CBC	California Building Code
CCTV	Closed Circuit Television
CEQA	California Environmental Quality Act
CEQA	California Environmental Quality Act
CFC	California Fire Code
CFR	Code of Federal Regulations
CPTED	Crime Prevention Through Environmental Design
CPUC	California Public Utilities Commission
CWR	Continuous Welded Rail
EA	Environmental Assessment
EC	Erosion Control
EN	European Standards
F	Fahrenheit
FEMA	Federal Emergency Management Agency
FRA	Federal Railroad Administration
ft/s	Feet per Second
FTA	Federal Transit Administration
IDS	Intrusion Detection System
LAN	Local Area Network
LRFD	Load and Resistance Factor

Acronyms	List of Terms
LRT	Light Rail Transit
LRV	Light Rail Vehicle
MM&PI	SANDAG Director of Mobility Management and Project Implementation
mph	Miles per Hour
MTS	San Diego Metropolitan Transit System
NACE	National Association of Corrosion Engineers
NCTD	Metro Link – North County Transit District
NEPA	National Environmental Policy Act
NF	Nosing Forces
NFPA	National Fire Protection Association
NPDES	National Pollutant Discharge Elimination System
OCS	Overhead Contact System
PE	Professional Engineer
ppm	Person per Minute
PRC	Public Resources Code
R	Radius
R	Resistance Value for Soil
ROW	Right-of-Way
RWQCB	Regional Water Quality Control Board
SANDAG	San Diego Association of Governments
SWPPP	Storm Water Pollution Prevention Plan
USC	United States Code
VSS	Video Surveillance System
WPC	Water Pollution Control

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1.0 INTRODUCTION

These criteria establish requirements for the design of both bus and rail facilities for the San Diego Metropolitan Transit System (MTS). Design shall be consistent with applicable regulations and laws, and the San Diego Association of Governments (SANDAG) policies and procurement requirements.

In general, the criteria herein are the standards to be used in all designs. Deviations and additional criteria for a specific project will only be considered based upon a written request with a description of the deviation or addition, explanation of benefits and costs (see Request to Deviate from Baseline Design Criteria or Standard, Appendix A). Request for deviations shall be reviewed by the affected service operators and other agencies as deemed appropriate by the SANDAG project manager (Project Manager). To be approved as project criteria, all deviation must be approved by the SANDAG Director of Mobility Management and Project Implementation. At the direction of the Director, significant changes or deviations will require the approval of the SANDAG Executive Director and MTS.

All references made to other agency regulations, guidelines, manuals, or criteria, as supplemental to the criteria herein, were current and accurate at the time of publication for this document. Users of this Design Criteria shall confirm accuracy of references as agencies, titles, or sections may have changed over time.

1.1 Transit System Overview

MTS and the North County Transit District operate light rail and commuter rail over infrastructure owned and maintained by each agency; operate local, express, and commuter bus service on public streets and highways, and own and operate maintenance and support facilities. SANDAG has the legal responsibility to design and construct capital infrastructure improvements for the operating agencies, maintain as-built records, and manage the configuration of safety critical elements.

1.2 Stakeholders

SANDAG is the lead agency for implementing transit and rail improvement projects in the region for its transit operating partners. Other rail entities also operate in the region for which SANDAG is not responsible, such as Amtrak and the Burlington Northern Santa Fe Railway. The following list identifies the transit operating partners and other rail entities:

- MTS
- San Diego and Arizona Eastern Railroad
- North County Transit District
- Los Angeles–San Diego–San Luis Obispo Rail Corridor Agency
- Metrolink
- Amtrak
- Burlington Northern Santa Fe Railway

1.3 Purpose and Scope

These criteria establish requirements for design of bus transit and electrified light rail transit systems.

1.4 Governing Regulations and Laws

SANDAG projects shall be designed in conformance with the requirements of funding agencies; federal, state, and local regulatory agencies; and applicable standards and codes, except where exceeded by requirements in these criteria.

Funding and regulatory agencies include, but are not limited to, the following:

- Federal Transit Administration
- Federal Highway Administration
- Federal Rail Administration
- National Highway Traffic Safety Administration
- Occupational Safety and Health Administration
- U.S. Department of Transportation
- California Department of Transportation
- California Public Utilities Commission (CPUC)
- Environmental Protection Agency

1.4.1 Bus Standards and Codes

- Federal Motor Carrier Safety Regulations
- Federal Mass Vehicle Safety Standards
- Americans with Disabilities Act (ADA)
- State regulations (e.g., California Highway Patrol and California Air Resources Board)
- Compressed Natural Gas Regulations by U.S. Department of Transportation and American National Standards Institute and Natural Gas Vehicles Requirements
- American Society of Heating, Refrigeration, and Air Conditioning Engineers
- Environmental Protection Agency
- Society of American Engineers

1.4.2 Electrified Light Rail Transit

- American Railway Engineering and Maintenance-of-Way Association

  Trackwork and signaling design shall follow the requirements of the American Railway Engineering and Maintenance-of-Way Association design manuals, standard plans, and design guidance.

- Federal

  The Code of Federal Regulations, Title 49, "Transportation," shall apply to design of light rail trolley operations as follows:

  - Part 37 – Transportation services for individuals with disabilities (ADA)
  - Part 38 – (ADA) accessibilities specifications for transportation vehicles
  - Part 213 – Track safety standards
  - Part 236 – Rules, standards, and instructions, governing the installation, inspection, maintenance, and repair of signal and train control

  Where light rail projects are designed on tracks shared with freight rail or commuter rail operations and the jurisdiction of the Federal Railway Administration applies, railroad design shall comply with Federal Railway Administration standards and requirements.

- State of California
  - CPUC: The General Orders of the CPUC shall apply as follows:
    a) General Order No. 26-D - Clearances on Railroads and Street Railroads as to Side and Overhead Structures, Parallel Tracks, and Crossings
    b) General Order No. 33-B - Construction, Reconstruction, Maintenance, and Operation of Interlocking Plants of Railroads
    c) General Order No. 52 - Construction and Operation of Power and Communication Lines for the Prevention or Mitigation of Inductive Interference
    d) General Order No. 72-B - Standard Types of Pavement Construction at Railroad Grade Crossings
    e) General Order No. 75-D - Regulations Governing Standards for Warning Devices for At-Grade Highway-Rail Crossing
    f) General Order No. 88-B - Rules for Altering Public Highway-Rail Crossings
    g) General Order No. 95 - Overhead Electric Line Construction
    h) General Order No. 108 - Filing of Railroad Operating Department Rules
    i) General Order No. 110 - Radio Communications in Railroad Operations
    j) General Order No. 118 - Construction, Reconstruction, and Maintenance of Walkways and Control of Vegetation Adjacent to Railroad Tracks
    k) General Order No. 128 - Construction of Underground Electric Supply and Communication Systems
    l) General Order No. 131-D - Planning and Construction of Facilities for the Generation of Electricity and Certain Electric Transmission Facilities
    m) General Order No. 135 - The Occupancy of Public Grade Crossings by Railroads

n) General Order No. 143-B - Design, Construction, and Operation of Light Rail Transit Systems

o) General Order No. 164-D - Rules and Regulations Governing State Safety Oversight of Rail Fixed Guideway Systems

- Division of Industrial Safety

  The electrical orders in Title 8 of the Division of Industrial Safety, as applicable to Trolley facilities (Chapter 4, Subchapter 5), shall be implemented.

- California Department of Transportation

  a) Standard Specifications (latest edition)

  b) Standard Plans (latest edition)

  c) Bridge Planning and Design Manual (latest updates)

- State of California, Energy Commission, Title 24, Part 6
- California Building Code, Title 24, Part 2

1.5 Acronyms and Abbreviations

See "Table and Abbreviations" table at the beginning of this document.

1.6 Energy Resource and Management

1.6.1 Green Transportation Concepts

Designers shall evaluate "green" construction materials and technologies that limit greenhouse gas emissions, utilize recycled and/or environmentally friendly materials, conserve energy, conserve water, and allow storm water to penetrate into soils or pass through biological filters before entering drains or watercourses. Evaluation shall consider effectiveness of a material or technology with respect to cost, availability, maintainability, and constructability. Designs including green materials and technology shall be approved by the SANDAG project manager except where required by law or applicable regulation.

2.0 Compliance with Environmental Laws

2.1 California Environmental Quality Act (CEQA)

The designer shall consult with the San Diego Association of Governments (SANDAG) Environmental Manager to verify the applicable environmental requirements for the project under CEQA (California Public Resources Code [PRC] §21000 et seq. and the State CEQA Guidelines [14 California Code of Regulations §15000 et seq.]) and determine whether those requirements have been completed. The SANDAG Principal Planner of the Environmental/ Public Facilities Section of the Land Use and Transportation Planning Department is responsible for determining whether the project requires any additional CEQA documentation and, if so, the appropriate type of CEQA document that may be required. If required, CEQA documentation may be prepared by SANDAG or tasked to a consultant and would consist of one of the following: Notice of Exemption; Negative Declaration; Mitigated Negative Declaration; Environmental Impact Report; or a supplement or addendum to a previously approved CEQA document. CEQA documentation shall be supported by technical studies, as appropriate.

The SANDAG Environmental Manager shall provide the completed and approved CEQA document to the designer to integrate the environmental requirements into the project design. Ongoing coordination between the designer, the SANDAG Project Manager (Project Manager), and the SANDAG Environmental Manager will be required to ensure the project maintains consistency with the approved environmental document. The designer shall notify the Project Manager and SANDAG Environmental Manager of any project condition that may create unanticipated or unmitigated environmental impacts requiring additional environmental review or that may preclude the implementation of identified environmental requirements.

2.2 National Environmental Policy Act (NEPA)

The designer shall consult with the Project Manager and the SANDAG Environmental Manager to evaluate applicability of NEPA (42 United States Code [USC] §4321 et seq.) to the project. The SANDAG Principal Planner of the Environmental/ Public Facilities Section of the Land Use and Transportation Planning Department is responsible for determining whether the project requires any additional NEPA documentation and, if so, the appropriate type of document that may be required in compliance with NEPA. SANDAG projects that involve a federal agency, either through direct participation funding or authorization of a discretionary permit (such as a Clean Water Act §404 permit), may be subject to a NEPA evaluation. SANDAG shall determine and notify the designer if a project is exempt from NEPA. If required, NEPA documentation may be prepared by SANDAG or tasked to a consultant.

The SANDAG Environmental Manager shall provide the completed and approved NEPA document to the designer to integrate the environmental requirements into the project design. Ongoing coordination between the designer, the Project Manager, and the SANDAG Environmental Manager will be required to ensure the project maintains consistency with the approved environmental document. The designer shall notify the Project Manager and SANDAG Environmental Manager of any project condition that may create unanticipated or unmitigated environmental impacts requiring additional

environmental review or that may preclude the implementation of identified environmental requirements.

The environmental documentation process for both Federal Transit Administration (FTA) funded projects and Federal Railroad Administration (FRA) funded projects is outlined below, as these are the primary federal funding agencies for SANDAG projects. For projects that require NEPA documentation as a result of other federal agency participation (e.g., U.S. Army Corps of Engineers due to issuance of a Clean Water Act §404 permit), the SANDAG Environmental Manager will identify the applicable NEPA implementing regulations for the agency/agencies involved to guide preparation of the NEPA documents.

For FTA funded projects, the designer shall refer to FTA guidelines titled "Environmental Impact and Related Procedures" to verify if the project may qualify as a Categorical Exclusion (CE). As directed by the Project Manager in consultation with the SANDAG Environmental Manager, documentation will be prepared that explains why the proposed project meets the criteria for a CE recommendation that the SANDAG Environmental/Public Facilities Section will provide to the federal lead agency. The documented CE recommendation shall be submitted to the SANDAG Project Manager and the Environmental Project Manager. In cases were an Environmental Assessment (EA) or an Environmental Impact Statement (EIS) may be required, at the direction of the Principal Planner of the SANDAG Environmental/Public Facilities Section, the designer or another consultant may be directed to provide support for the preparation of these documents.

For FRA projects, as directed by the Environmental Project Manager, the designer shall complete the FRA Categorical Exclusion Worksheet and SANDAG will submit the document to the FRA. Should the FRA determine that a CE is not appropriate, an EA or EIS may be required in accordance with the FRA guidelines titled "Procedures for Considering Environmental Impacts." In cases were an EA or an EIS may be required, at the direction of the Principal Planner of the SANDAG Environmental/Public Facilities Section, the designer or another consultant may be directed to provide support for the preparation of these documents.

2.3 Other Environmental Laws

The designer, with assistance from the SANDAG Environmental Manager, shall determine if there is a reasonable possibility that the project or element of the project is subject to any of the following environmental laws:

- 15 USC 2601-2671: Toxic Substances Control Act
- 16 USC 1451–1464: Coastal Zone Management Act
- 16 USC 1531 et seq.: Endangered Species Act
- 16 USC 431-433: American Antiquities Act
- 16 USC 461-467: National Natural Landmarks Program
- 16 USC 470f: National Historic Preservation Act, Section 106

- 16 USC 6301: Paleontological Resources Preservation Act
- 16 USC 661–666: Fish and Wildlife Coordination Act
- 16 USC 703–712: Migratory Bird Treaty Act
- 23 Code of Federal Regulations (CFR) Part 774: U.S. Department of Transportation Act of 1966, Section 4(f)
- 33 USC 1251 et seq.: Clean Water Act
- 33 USC 4401 et seq.: Rivers and Harbors Act, Sections 9 and 10
- 33 USC 525 et seq.: General Bridge Act of 1946
- 40 CFR 131.12: Federal Antidegradation Policy
- 40 CFR 131.28: National Toxics Rule
- 40 CFR Part 131: Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California (California Toxics Rule)
- 42 USC 2000d et seq.: Civil Rights Act of 1964, Title VI
- 42 USC 300f et seq.: Safe Drinking Water Act of 1974
- 42 USC 6901 et seq. (1976): Resource Conservation and Recovery Act
- 42 USC 7401 et seq.: Clean Air Act
- 42 USC 9601 et seq. (1980): Comprehensive Environmental Response, Compensation, and Liability Act
- 49 USC 5301(e), 5323(b), and 5324(b): Federal Transit Law
- 49 USC Chapter 53: Public Transportation
- Executive Order 11988: Floodplain Management
- Executive Order 11990: Protection of Wetlands
- Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
- Executive Order 13045: Protection of Children from Environmental Health Risks and Safety Risks
- Executive Order 13112: Invasive Species
- Executive Order 13514: Federal Leadership in Environmental, Energy, and Economic Performance
- Public Law 111-011, Title VI Subtitle D: Omnibus Public Land Management Act of 2009
- Public Law 92-574: Noise Control Act of 1972
- Public Law 94-265 (as amended): Magnuson-Stevens Fishery Conservation and Management Act

- California Assembly Bill 32: Global Warming Solutions Act of 2006
- California Fish and Game Code, Section 1600 et seq.: Fish and Wildlife Protection and Conservation
- California Fish and Game Code, Section 2050 et seq.: California Endangered Species Act
- California Fish and Game Code, Section 3503 regarding protection of birds' nests
- California Fish and Game Code, Sections 1900–1913: Native Plant Protection Act
- California PRC Section 30000 et seq.: California Coastal Act of 1976
- California PRC Section 5097.5 regarding historic, prehistoric, archaeological, and paleontological resources on public lands
- California Water Code, Section 13000–16104: Porter-Cologne Water Quality Control Act
- Office of the Governor Executive Order S-3-05 establishing greenhouse gas reduction targets
- Office of the Governor Executive Order S-13-08: Sea Level Rise
- Office of the Governor Executive Order W-59-93: Wetland – No Net Loss Policy
- State Water Resources Control Board Resolution No. 68-16: State Antidegradation Policy

If the project may be subject to one or more of these regulations, the designer shall notify the Project Manager and SANDAG Environmental Manager, who will then consult the Principal Planner of the SANDAG Environmental/Public Facilities to ensure compliance with all applicable regulatory requirements.

3.0 DESIGN GOALS

The design goal for all projects implemented under these criteria is development of construction-ready documents that meet the project's functional and aesthetic requirements while minimizing the initial capital cost. Functional and aesthetic goals of the project shall meet the safety, transit operation, maintainability, accessibility, and urban and art design requirements included in the project description and the approved environmental and preliminary engineering documents. Design shall primarily use service-proven techniques and off-the-shelf equipment and materials. Compatibility with existing facilities shall be a primary consideration in the selection of material and equipment. By state law, the San Diego Association of Governments (SANDAG) must provide for competitive bidding to the maximum extent possible; therefore, proprietary materials, systems, or equipment may not be specified without the approval of the project manager and a sole-source justification.

3.1 Proven Hardware

The design of projects shall incorporate proven subsystems, hardware, and design concepts. All of the major subsystems shall be specified from established manufacturers, have a documented operating history of previous and current usage, and be available off the shelf, to the greatest extent possible. The same requirements shall apply to spare parts. Waiver of these requirements will be considered only where the alternative material offers substantial technical and cost advantages, is in an advanced state of development, and has accumulated substantial test data under near-revenue conditions and as approved by SANDAG.

3.2 Design Life

The transit system's fixed facilities shall be designed for continued operation over a minimum period of 50 years before complete refurbishment and renovations are necessary due to wear and tear and obsolescence. The 50-year service life shall be used unless stated otherwise for particular pieces of equipment or systems in other sections. Major system equipment shall be designed for continued operation over a minimum period of 30 years before complete replacement becomes necessary.

3.3 Service Integration

All aspects of design must be considered when evaluating service integration and shall be reviewed and analyzed during preliminary engineering efforts. Where service integration is in conflict with existing systems, the designer shall inform SANDAG and assist in determining a resolution.

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4.0 DESIGN AND CONSTRUCTION STANDARDS

4.1 Drafting/Plan Criteria

All contract drawings shall be prepared using the supported version of AutoCAD or MicroStation in accordance with best engineering practices and the following project requirements:

a) San Diego Association of Governments (SANDAG) contract plans shall be printable to 22 inches by 34 inches, with an outside border dimension of 21 inches by 32.75 inches to allow for half-size reduction onto 11 inches by 17 inches sheets. Plan sheets shall utilize standard SANDAG title blocks.

b) In general, the typical scale for all plan and profile drawings will be 1 inch = 40 feet for horizontal measurements. The vertical scale shall typically be five (5) times that of the horizontal scale; however, variances are allowed based on project-specific topographic relief. Additional variances for scale are allowed to maintain legibility of details and lettering when half-sized reductions of the sheets are produced.

c) Typically, text height for general notes and plan sheet annotations shall be 0.14 inch.

d) Projects shall be designed in U.S. Customary Units.

e) Project plans shall be prepared in electronic format. Final plans shall be submitted on full-sized printed bond paper and in CAD and PDF format on a portable external storage media. CADD standards followed shall be those of the California Department of Transportation (Caltrans) as much as possible. Any CADD standard differences from Caltrans shall be submitted by the designer in a project-specific CADD manual at the beginning of the project.

f) Where applicable, details shall be prepared in accordance with or by reference made to the most current versions of Standard Plans from Caltrans and the San Diego Regional Standard Drawings and Standard Plans for Public Works Construction (Greenbook).

g) A typical project plan set shall generally include the following plans:

- Cover sheet (per SANDAG standards)
- Project location/drawings index/abbreviations sheet
- General notes/legend sheet
- Key map and survey controls
- Horizontal control/alignment
- Typical sections
- Demolition
- Plan and profile
- Signing and striping
- Traffic handling

- Construction details
- Construction staging
- Drainage and grading
- Utility relocation
- Temporary Water Pollution Control/Erosion Control Plans
- Architectural drawings
- Electrical and mechanical
- Landscape
- Structural
- Trackwork
- Systems
- Right-of-way
- Standard plans

h) All standard elements for drawings, such as borders, cover sheet layout, general notes, etc., shall be obtained from SANDAG.

4.2 Specifications

a) The project-specific design Specifications shall be Contract Special Provisions numbered Sections 10 and beyond. The Special Provisions shall be prepared by the designer based on project-specific requirements, and these sections shall correlate with SANDAG's Special Provisions, Sections 1 through 9. The designer shall ensure that Sections 10 and beyond do not conflict with Sections 1 through 9.

b) The SANDAG Project Manager and the designer will be required to fill out a SANDAG-provided form (Electronic Info [EI] Form) that tells the SANDAG Contracts Analyst project details so Sections 1 through 9 can be individualized for the project. Details to be provided will include scope, number of working days, liquidated damages, cost estimate, etc.

c) Where applicable, specifications shall be in accordance with or reference made to other agency standard specifications, including but not limited to, the most current versions of Caltrans Standard Specifications or Standard Specifications for Public Works Construction. The designer shall utilize local supplements to standard specifications, as appropriate. Note that if another agency's standard specifications have received a recent update, those updates may not have yet been reviewed and accepted by SANDAG. The designer shall verify with the SANDAG Project Manager the local supplements to use for the project.

d) Format for specifications shall follow Caltrans outlining configuration and be prepared using a supported version of Microsoft Word. Additional formatting requirements shall be as follows:

Font type:	Arial
Font size:	11 point
Top margin:	1 inch
Bottom margin:	1 inch
Side margins:	0.75 inch
Headers and footers:	0.5 inch

4.3 Submittals

a) General

Unless otherwise indicated in this design criterion, all aspects of design submittals shall follow the schedule as defined below. Submittal packages shall be complete with drawings and specifications. Cost estimates shall be included in the submittal package starting at the 35% submittal schedule.

Each submittal package shall be accompanied with a transmittal letter and progress status report. Each subsequent submittal following the 35% submittal shall also include an updated design schedule and comment review log.

The schedule of submittals shall be as listed below, except where an alternate schedule of submittals has been approved by SANDAG and the designer on a project-specific basis and defined in the scope of work for the design contract, task order, or amendment.

- Draft: 35%, 65%,100%
- Final

b) Submittal Format

- Submittal packages shall be in both hardcopy and electronic format in the sizes and quantities as required by the contract or task order for each drawing submittal level.
- Drawings
  - 35% drawings shall include: cover sheet; vicinity maps; drawing index listing all sheets proposed at the 100% submittal with the sheets included in the 35% submittal in bold type; and section, plan, and detail sheets sufficient to confirm the overall project design configuration and elements. The 35% shall include plans for all the project design disciplines.
  - 65% drawings shall include: cover sheet; vicinity maps; drawing index listing all sheets proposed at the 100% submittal with the sheets included in the 65% submittal in bold type; and section, plan, and detail sheets sufficient to review the project design in detail. The 65% plans shall include detail-level plans for all the project design disciplines and include, as needed, construction phasing, traffic control, construction storm-water control, utility service and relocation plans, and shall show right-of-way lines.

- 100% drawings shall include: cover sheet; vicinity maps; drawing index listing all sheets; and section, plan, and detail sheets of the complete project design. The 100% plans shall include complete detailed plans for all the project design disciplines and include, as needed, complete construction phasing, traffic control, construction storm-water control, utility service and relocation designs, and shall show accurate right-of-way line lines.
- Final shall include one full-sized plan set with wet signature on each drawing. Final plans shall be the 100% submittal with changes incorporated from the 100% submittal review comments. Where 100% review comments are not included, an explanations shall be included in the final comment and review documents and brought to the Project Manager's attention.

- Specifications

  Hard and electronic copies of the technical special provisions "Specifications" shall be submitted with the submittals as indicated below in the form, format, and quantity required by the Project Manager.

  - 65% – Specifications shall include language providing qualitative and quantitative information on materials, products, and processes to be provided by the construction contractor for at least all the work shown in the 65% drawings. Specification language shall include a description of the measurement and payment for the bid item work included in the 65% drawings.
  - 100% – Specifications shall include language providing qualitative and quantitative information on materials, products, and processes to be provided by the construction contractor for all the work shown in the 100% drawings. Specification language shall include a description of the measurement and payment for each bid item of work included in the 100% drawings. In addition, the 100% Specifications submittal shall include proposed language for contract boilerplate Sections 5, 6, and 8 describing the Contractor's working limitations and contract working days.
  - Final – Specifications shall include one wet signature page for the responsible engineer for each discipline included in the project specifications. Final Specifications shall be the 100% submittal with changes incorporated from the 100% submittal review comments. Where 100% review comments are not included, an explanations shall be included in the final comment and review documents and brought to the Project Manager's attention.

c) Estimates

- 35% – At the discretion and direction of the Project Manager, a project construction estimate shall be submitted with the 35% submittal. The estimate shall, to the extent possible, use quantities developed in design extended by unit costs. The estimate may use rough estimates of quantity and unit cost or be based on projects of similar work and scale. The estimate shall be logically developed on a spreadsheet with an item description, quantity, and unit cost. Other factors, such as contingencies, third-party costs, vehicles, or other items, will be included at the direction of the Project Manager.

- 65% – A detailed project construction estimate shall be submitted with the 65% submittal. The estimate shall use quantities developed in the 65% design extended by unit costs. The estimate shall be logically developed on a spreadsheet with an item description, quantity, and unit cost. Quantity take-off data used to develop the estimate shall be included with the 65% estimate submittal. Other factors, such as contingencies, third-party costs, vehicles, or other items, will be included at the direction of the Project Manager
- 100% – A complete project construction estimate shall be submitted with the 100% submittal. The estimate shall use quantities developed in the 100% design extended by unit costs. The estimate shall be on a spreadsheet with the complete item descriptions, quantities, and unit costs. Quantity take-off data used to develop the estimate shall be included with the 100% estimate submittal. Other factors, such as contingencies, third-party costs, vehicles, or other items, will be included at the direction of the Project Manager.
- Final – The final estimate shall be the 100% submittal with changes incorporated from the 100% submittal review comments. Where 100% review comments are not addressed in the estimate, an explanation shall be included in the final comment and review documents and brought to the Project Manager's attention.

d) Comment and Review Documentation

The designer shall maintain a comment and review tracking log or other comment tracking system throughout the design submittal process. Comment tracking documentation shall number comments in a logical manner, include descriptions of the comment, identify the commenter, and describe the comment disposition.

- 35% – Initiate comment-tracking documentation.
- 65% – Provide updated comment tracking documentation with current comment disposition.
- 100% – Provide complete updated comment tracking documentation with the proposed final comment disposition.
- Final – Provide complete updated comment tracking documentation with the final comment disposition. Final review comments in which changes differed significantly from the commenter's intention shall be brought to the Project Manager's attention.

e) Design Calculations, Reports, and Tests

The designer shall submit hardcopy and electronic documents for other items pertinent to the project in the form, format, and in the quantity directed by the Project Manager. Soils and geotechnical reports, structural calculations, and hazardous materials analysis shall be submitted in draft at the 65% submittal and signed and complete with the Final submittal. Other reports, tests, and design documentation shall be submitted as required by this criterion, contract, or the Project Manager.

4.4 As-Builts/Record Drawings

Where a design modifies or expands an existing facility, the designer shall obtain relevant as-built documentation of the existing facility for review prior to start of design. If a previously constructed project was a SANDAG project, as-builts may be obtained through SANDAG. The designer shall develop as-built drawings after the completion of the project. The designer is responsible to verify the actual as-built conditions of a facility, system, or control function during design and, as needed, perform field measurements, tests, or operating functions to validate its design.

4.5 Stamps and Signatures

All drawings and specifications shall contain a stamp of an authorizing Professional Engineer (PE) currently registered in the State of California showing the name, registration number, and registration expiration date of the authorizing PE. An authorizing PE shall be specifically qualified for the engineering discipline related to a particular drawing or subset of drawings the PE is signing for. The stamp and the PE qualification shall be in accordance with the California Department of Consumer Affairs. All drawings submitted as Final shall contain the signature of the appropriate authorizing PE. SANDAG requires a half-sized and full-sized PDF set. If required by the SANDAG project manager, a full-sized set of reproducible drawings shall also be submitted with a wet signature on each drawing.

5.0 CIVIL WORK

This chapter provides general design guidelines for multiple disciplines specific to civil works and shall be applied to all San Diego Association of Governments (SANDAG) projects. The designer shall note that some additional civil works design criteria related specifically to light rail transit (LRT) facilities or bus transit facilities may apply and therefore should reference the appropriate sections within Volumes 2 and 3 of this manual.

5.1 Survey Control

5.1.1 Project Alignment

Project alignment control shall be established on the California State Plane Coordinate system, NAD 83, Zone 6, by ties to monuments with values published by the U.S. Geological Survey, San Diego County, or the California Department of Transportation (Caltrans) – second order – second class minimum order of accuracy.

Coordinates shown on maps, plans, and other related documents shall be CCS83 coordinates. The reference network for CCS83 coordinates shall be the CA-HPGN.

Project alignment control shall be established to a minimum accuracy of 1:20,000 (Caltrans modified second order – second class).

The monuments set for project alignment control shall be of a permanent nature in accordance with the San Diego Regional Standards and as approved by the SANDAG project manager.

Record of survey for project monuments shall be provided as directed by the SANDAG project manager. A systematic numbering system shall be established and approved by the SANDAG project manager for all alignment control monuments.

Where the project mapping ties to existing SANDAG monuments or controlled mapping, any corrections or adjustment to existing monuments or plans to conform to NAD 83 shall be made by the designer and identified in the survey notes and on the plans.

Copies of all field notes and calculations shall be supplied to the SANDAG project manager with the 100 percent design submittal.

5.1.2 Vertical Alignment Control

Vertical control shall be based on the North American Vertical Datum of 1988, second order accuracy or higher. Where design involves previous work that used the National Geodetic Vertical Datum of 1929, all data shall be checked and converted as necessary to North American Vertical Datum of 1988.

Project alignment control surveys greater than 1 mile in length shall be tied to a minimum of two benchmarks unless a second benchmark has not been established within 3,000 feet of the alignment. Additional benchmarks shall be tied at a maximum

interval of 5 miles along the alignment unless no benchmark has been established within 1 mile of the alignment.

5.1.3 Survey Procedures

Field survey procedures shall be per the most current Caltrans Survey Manual.

5.1.4 Aerial Photography

Aerial photography shall be provided as needed to complete an engineering project or as required by the scope of work. The designer shall supply aerial photography and photogrammetric products in accordance with the best practice and standards.

Contact prints on resin-coated paper shall be furnished to SANDAG in the number required by the contract or the project manager. Digitized photo-files of photographs compatible with and viewable through AutoCAD and Micro Station shall be furnished as required on electronic media specified by the Project Manager.

5.1.5 Map Compilation

In accordance with the design scope of work, the designer shall develop or accept, verify, and, if needed, adjust existing base mapping for a project. Base mapping shall be defined as scaled mapping showing the physical features and elevations of the project site at the start of design. The mapping limits shall adequately cover the project, as required, to complete the project study or design. The mapping limits, stereo model layout and coverage, and photo control layout shall be submitted to the SANDAG Project Manager for approval prior to the beginning of field work or aerial photography.

Contour intervals appropriate to the project design requirements shall be selected by the designer and approved by the Project Manager prior to compilation of mapping.

Map contents, symbols, grid system, and editing style shall conform to the standards adopted by Caltrans.

5.1.6 Map Accuracy

The designer shall be responsible for verifying the accuracy of all mapping provided or developed for a project.

The position of all grid ticks and all monuments shall not vary more than 0.01 inch from their coordinate position.

At least 90 percent of all well-defined planimetric features shall be within 0.025 inch of their true position.

All contours shall be within one-half contour interval of true elevation.

Contours shall reflect the crown or cross slope of all paved areas, including paved ditches.

In areas not obscured by grass, weeds, or brush, all spot elevations shall be within one-fourth contour interval of true elevation.

5.1.7 Field Survey Checks of Mapping

Field surveys shall be conducted to confirm mapping accuracy.

5.1.8 References

- *Caltrans CADD Users Manual*
- *Caltrans Plans Preparation Manual*

5.1.9 Format

Base mapping for projects shall be provided on A3-size Mylar sheets and electronic format or as specified by the contract or project manager. Digitized data files shall be ASCII files written either in the Drawing Interchange File format readable into a drawing file format by Autodesk's "AutoCAD" program or in a format that can be imported into Bentley MicroStation InRoads in the version currently in use by SANDAG.

5.1.10 Coordinate Grids

Mapping shall include coordinate grid markings and grid ticks. The size of the grid tick symbol shall be 0.6 inch by 0.6 inch at final plotted scale. Grid ticks shall be rotated orthogonal with the project coordinate system and shall be spaced as follows:

Imperial	Grid Spacing (Drawing Units)
1 inch = 10 feet	75 feet
1 inch = 20 feet	150 feet
1 inch = 50 feet	325 feet
1 inch = 100 feet	650 feet
1 inch = 200 feet	1650 feet
1 inch = 400 feet	3275 feet

5.1.11 Symbols

The symbols shall be generally from the library developed for the Caltrans Divisions of Design CADD system as shown in the *Caltrans CADD Users Manual*, Appendix A1.

5.2 Permits, Reviews, and Approvals

Designer shall determine applicable permit requirements and prepare submittal packages for permit applications. Permit packages shall be submitted to appropriate agencies for review. Designer shall attend review meetings and incorporate comments into the package as necessary.

5.2.1 Environmental Regulatory Agencies

- United States Army Corps of Engineers
- United States Coast Guard
- United States Fish and Wildlife Service
- California Department of Fish and Wildlife (formerly Fish and Game)
- California Environmental Protection Agency
- San Diego County Department of Environmental Health
- San Diego Regional Water Quality Control Board
- State Water Resource Control Board
- California Coastal Commission
- San Diego Air Pollution Control District

5.2.2 Traffic Regulatory Agencies

- Caltrans
- City having jurisdiction in which project encroaches

5.2.3 Utilities and Other Agencies

Other agencies shall be consulted as needed during the design process for potential review and permit requirements, include, but are not limited to, the following:

a) Utilities
   - San Diego Gas & Electric
   - Local and regional water supply districts
   - Cox and Time Warner Cable
   - AT&T, Sprint, Verizon, and T-Mobile communications

b) San Diego Historical Society

c) San Diego Port Authority

d) California Public Utilities Commission (CPUC)

e) Metropolitan Transit System (MTS)/North County Transit District (NCTD)

5.3 Street Designs

5.3.1 General

Unless otherwise specified, all road and street design shall be in accordance with the current standard plans, specifications, and design guidelines of the local jurisdictions. For those cases where the local jurisdictions have no design guidelines, the Caltrans Design Standards shall be used.

Street and road design within the jurisdiction of a local agency shall have a title block for that agency, be designed to the agency's standards, and approved/signed by the agency.

5.3.2 Paving

a) Codes and Standards

All pavements in public streets shall be in conformance with the current specifications and practices of the local jurisdictions or Caltrans standards for state highways and right-of-ways. In a case where the local jurisdictions have no codes or standards, the Caltrans standards shall be followed.

b) Restored Pavement

Restored pavement shall conform to widths prevailing prior to transit construction. No street, sidewalk, or alley widening shall be included unless required in the project description or environmental document. Pavement shall be restored with similar materials existing prior to the transit project to current local agency or Caltrans specifications and standards.

c) New Pavement

New pavements shall be of materials conforming to the latest standards of the agency having jurisdiction and maintenance responsibility. See also Section 5.8 "Structures," for requirements concerning pavement recommendations.

5.3.2.1 Traffic Signals

a) Codes and Standards

All relocations, temporary or permanent, and restoration of traffic signal facilities shall be in accordance with the practices of the local jurisdictions. In the case where the local jurisdictions have no standards, the *California Manual of Uniform Traffic Control Devices*, and Caltrans standard plans and specifications shall be followed.

Traffic signal plans need to include a title block and approval signature by the agency in charge of operating and maintaining the signal.

b) New and Existing Signal Installations

New traffic signal installations shall provide for all required auto, bicycle, and pedestrian movements in addition to signal priority or pre-emption that may be required for rail or bus movements. All existing signals shall be modified to accommodate any revisions to auto, bicycle, and pedestrian movements and signal priority or pre-emption for railway vehicles or buses where required. All traffic signal installations and modifications shall be compatible with the local jurisdiction's traffic signal control program and standards or Caltrans traffic signal program and standards for State Highways or Right-of-Way.

5.4 Hydrology/Hydraulics

5.4.1 General

Project features such as track, transit stations, bridges, depressed section structures, street improvements, and support facilities (e.g., substations and transit station parking)

shall be designed to minimize and avoid potential water resources impacts (direct and indirect; short-term and long-term) as a result of a project.

Unless otherwise specified, all water resources design shall be in accordance with the current standard plans, specifications, and design guidelines of the local jurisdictions. This includes relocation or modification of existing drainage facilities and systems. For work within MTS and/or NCTD right-of-way, or where a jurisdiction has not established a code or standard, the most current version of the county/city guidelines shall be used, unless where otherwise noted below.

5.4.2 Drainage (On-Site and Off-Site)

Existing drainage systems shall be identified. Existing drainage facilities that conflict with the proposed alignment infrastructure should be evaluated for relocation and/or removal. In general, SANDAG will be responsible for mitigating impacts directly caused by its projects and will not improve or replace existing inadequate drainage systems not affected by the project.

To the extent practical, services to adjoining properties shall be maintained by "protecting-in-place"; where not achievable, the designer shall evaluate alternative facilities or diverting to other points. Replacement and new drainage structures shall be reinforced concrete. Corrugated metal pipe is not permitted for new construction. Use of polyvinyl chloride and/or high-density polyethylene is not allowed under track segments. Culverts and storm drains passing beneath track segments or maintenance roadways shall be reinforced concrete pipe rated at 4000D for the entire length of the buried pipe. All materials must satisfy the durability design life of the project. Reinforced concrete pipes shall be of at least 18 inches in diameter, unless otherwise approved by SANDAG.

Any potential for drainage run-on shall be intercepted and prevented from entering the right-of-way. The designer shall determine the best means of interception in accordance with local jurisdictional guidelines. Interception of run-on shall in no way cause flooding, erosion, or interruption of necessary drainage functions to adjacent properties or up/downstream facilities.

Where an on-site drainage facility is designed to handle both off-site and on-site flows, such as concrete-lined ditches, the design will be coordinated with the jurisdiction involved. Effort should be made to maintain current flow paths and drainage patterns for surface runoff and other drainage to the maximum extent possible.

5.4.2.1 Design Storm Frequency

In general, projects shall be designed to convey the following design storm frequencies:

- Track section drainage: Track drainage facilities (e.g., swales, storm drains/culverts) adjacent to or crossing the track shall be designed for the 100-year design storm flow.
- Storm drains/culverts: Storm drains and culverts shall be designed to convey the 100-year design storm flow.

- Floodplains: Floodplains shall be designed to efficiently convey 100-year design storm flood elevation as determined by the more restrictive of the following: Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps, local agency floodplain/floodway maps, the results of hydraulic studies prepared for SANDAG, or other studies accepted by SANDAG.
- Stations, parking lots, and access roads: Surface drainage facilities (e.g., storm drainage inlets, underground storm drain systems) located within stations, streets, and parking lots shall be designed to convey the 50-year design storm flow or the local jurisdiction's criteria, whichever is more conservative.

The above design storm frequencies may be modified if the local jurisdictional agency has a more conservative standard, pending SANDAG approval.

5.4.2.2 Ballasted Track

All design parameters shall comply with Volume 2—LRT Design Criteria, Section 1.1.2.1.

5.4.2.3 Grade Crossings

All design parameters shall comply with Volume 2—LRT Design Criteria, Section 1.1.2.2.

5.4.2.4 Underdrains

Underdrains, unless otherwise approved, shall not be used to collect surface drainage. Underdrains used to drain runoff from trackbed areas shall consist of perforated pipe as follows:

- Underdrains less than 500 feet shall be at least 6 inches in diameter.
- Underdrains greater than or equal to 500 feet shall be at least 8 inches in diameter.
- At least 6 inches of a gravel layer wrapped with filter fabric (minimum weight 4 ounces/square yard) shall be placed between the gravel and the surrounding soil.
- Underdrains shall connect to a drainage system or daylight to areas that will not be adversely affected by the anticipated drainage.
- Clean-outs shall be included on all underdrains at intervals and locations that allow for adequate maintenance.
- Underdrain outlets on retaining walls are not permitted where water would be allowed to drain across paved public areas or into a transit way.

5.4.3 Water Quality and Hydromodification

Each project would be required to comply with the most current version of the *State Water Resources Control Board National Pollutant Discharge Elimination System (NPDES) Permit and Waste Discharge Requirements for Discharges from the Municipal Separate Storm Sewer Systems Draining the Watersheds within the San Diego Region*. Where applicable, the project shall be supplemented with the applicable NPDES requirements of the local jurisdiction.

The project will be required to evaluate impacts to all waters. The project shall implement through contract specifications, source and treatment-control measures contained in local-related guidance documents (e.g., Caltrans, City of San Diego) to alleviate short- and long-term impacts to water quality.

Project design considerations should include, but not be limited to, local agency requirements and concerns; climate; land use; soil classification; geology; topography; sediment and receiving water risk levels; study area hydrologic units, areas, and sub-areas; study area watershed management areas; beneficial uses and water quality objectives of affected water bodies; Clean Water Act Section 303(d) impaired water bodies within the study area and associated water quality objectives and total maximum daily loads; water quality degradation from urban runoff caused by an increase in impervious surfaces.

Low impact development and hydromodification approaches should be incorporated into site design and storm-water management to maintain the site's predevelopment runoff rates and volumes as required by the local jurisdictions. SANDAG would select and implement specific low-impact development measures and techniques depending on site location/size and storm-water treatment needs.

5.4.4 Floodplains/Floodways

The project will be required to evaluate avoidance of impacts associated with the modification of floodplains. Additionally, direct or indirect support of floodplain development where there is a practicable alternative shall be avoided. Further, the project will restore and preserve the natural and beneficial values served by floodplains impacted by the project. Project design considerations should include, but not be limited to, flooding potential from increased runoff/impervious surfaces; and changes to floodplains/floodways from bridge crossings, channel modifications, and longitudinal encroachments.

Freeboard requirements shall be evaluated against all applicable agency regulations (e.g., city, Caltrans, American Railway Engineering and Maintenance-of-Way Association (AREMA)). Where applicable, a minimum of 1 foot of freeboard shall be provided to any adjacent properties. Both SANDAG and local regulatory flood passage criteria shall be evaluated, and the more conservative criteria shall be adopted. Any deviations will require a design exception.

To the maximum extent practicable, the design shall minimize:

- Increases to the floodplain or inundation hazard to adjacent properties. The designed storm-water control and conveyance system shall not impact adjacent properties upstream or downstream of MTS and/or SANDAG facilities beyond historic and legal allowances without consent and documented approval from adjacent property owners and governing jurisdictions, including the San Diego Regional Water Quality Control Board (RWQCB), FEMA, and the jurisdictional Floodplain Manager.
- An increase to the flood level of a regulatory floodway. (Regulatory Floodway: the channel of a river or other water course and the adjacent land areas that shall be

reserved in order to discharge the FEMA-designated base flood without cumulatively increasing the water surface elevation more than a designated height).

- Reduction of the flood storage capacity or impedance of the movement of floodwater within a regulatory floodway.

5.4.5 Project Requirements

The packages described below shall be submitted to appropriate agencies (e.g., RWQCB, city, Caltrans) for review. Designer shall attend review meetings and incorporate comments into the package as necessary.

5.4.5.1 Hydrology/Hydraulics

Final design shall include plans and specifications for all structural, earthwork, civil, and landscape features necessary to provide hydrology/hydraulics for the project. The designer shall verify that the hydrology/hydraulics features are not in conflict with other project features.

In accordance with the design scope of work, the designer shall develop Drainage Plans for all areas disturbed by construction. At a minimum, the plans shall include layouts, profiles, cross sections, and details.

The hydrology/hydraulics design shall be incorporated into design documents (e.g., Drainage Report) as required by the local jurisdiction, as well as project specifications as part of the project bidding documentation.

At a minimum, the design documents should include the following:

- Topographic sheets (at an appropriate scale) with drainage areas outlined; existing and proposed facilities identified, including storm drains, culverts, inlets/outlets, and channels; and labeling of areas/subareas with acreage, flow arrows, and travel lengths.
- Soils classification and land use mapping.
- Hydrology calculations using the method identified by the local jurisdiction (e.g., Rational Method, National Resources Conservation Service) using industry-accepted software (e.g., HEC-HMS, AES, Civil Design). If a method is not specified, the Rational Method shall be used for drainage areas up to approximately 1 square mile in size and the National Resources Conservation Service hydrologic method shall be used for drainage areas exceeding approximately 1 square mile in size.
- Flow rates and velocities in channels, pipes, and structures (shall be shown in either figure or table format).

5.4.5.2 Water Quality and Hydromodification

In accordance with local jurisdictional guidelines, the designer shall incorporate water quality and hydromodification measures into the Drainage and Grading Plans for all areas disturbed by the project. At a minimum, the plans shall include type, location, and installation. Final design shall include plans and specifications for all best management practices (BMPs). Additionally, the design must consider integration into the permanent

landscape of the project since these BMPs are to remain in place and operational. BMPs must be designed to maintain storm-water quality control after project completion. Construction BMPs shall be designed in accordance with Section 5.4.

The water quality and hydromodification design shall be incorporated into design documents (e.g., Storm Water Data Report, Water Quality Technical Report) as required by the local jurisdiction and project specifications as part of the project bidding documentation. For those cases where local jurisdictions have no design document requirements, a Storm Water Data Report shall be developed in accordance with the *Caltrans Storm Water Quality Handbooks* to document all storm-water quality design. Hydromodification design would be incorporated into the Drainage Report (see section 5.4.5.1).

5.4.5.3 Floodplains/Floodways

In accordance with the design scope of work, the designer shall develop modeling for all water bodies disturbed by construction using industry-accepted software (e.g., HEC-RAS, SWIMM).

The floodplain/floodway design shall be incorporated into design documents (e.g., Location Hydraulic Studies, Floodplain Analysis Report) as required by the local jurisdiction. Additionally, the designer shall prepare all documentation, applications, and plans required for approval of any Flood Insurance Rate Maps revision in accordance with the FEMA regulations. Such applications include a Conditional Letter of Map Revision and/or a Letter of Map Revision, if required.

5.4.6 References

- *Hydrology Manual*—County of San Diego
- *Drainage Design Manual*—City of San Diego
- *Storm Water Standards*—City of San Diego
- *Low Impact Development Handbook, Stormwater Management Strategies*—County of San Diego
- *Storm Water Quality Handbooks, Project Planning and Design Guide*—Caltrans

5.5 Erosion and Sediment Controls

5.5.1 General

Unless otherwise specified, all water pollution control (WPC) (temporary construction site BMPs) and erosion control (EC) (post-construction site BMPs) design shall be in accordance with the current standard plans, specifications, and design guidelines of the local jurisdictions in whose right-of-way the project would be constructed. For those cases where the local jurisdictions have no design guidelines, the *Caltrans Storm Water Quality Handbooks*, referenced in Section 5.5.4, shall be used.

The project would be required to comply with the most current version of the State Water Resources Control Board NPDES *General Permit for Discharges of Storm Water Associated with Construction Activity* (also commonly referred to as the Construction

General Permit) or the *NPDES Statewide Storm Water Permit and Waste Discharge Requirements (WDRs) for the State of California, Department of Transportation (Caltrans)* or any reissuance thereafter. Where applicable, the project shall be supplemented with applicable NPDES requirements of the local jurisdiction.

5.5.2 Best Management Practices

Each project would be required to mitigate for the short-term impacts to water quality during construction by use of construction site BMPs. BMPs that have been approved by the local jurisdiction are preferred, but alternative BMPs shall be allowed with SANDAG Project Manager approval. Where project conditions prohibit the use of approved BMPs, the designer shall consult the SANDAG Project Manager/department of the local jurisdiction.

5.5.3 Project Requirements

In accordance with the design scope of work, the designer shall develop WPC Plans and EC Plans for all areas disturbed by construction. At a minimum, the plans shall include type, location, installation, and maintenance details. Additionally, the EC (post-construction) design must consider integration into the permanent landscape of the project. Post-construction site BMPs are to remain-in-place and operational after project completion and shall be designed to maintain storm-water quality control for a minimum of one rainy season after project completion.

The WPC and EC design shall be incorporated into design documents (e.g., Storm Water Data Report, Water Quality Technical Report, Storm Water Pollution Prevention Plan (SWPPP) or Water Pollution Control Plan) as required by the local jurisdiction, as well as project specifications as part of the project bidding documentation. The WPC, EC, and SWPPP packages shall be submitted to appropriate local jurisdictional agencies (e.g., RWQCB, city, Caltrans) for review. The designer shall attend review meetings and incorporate comments into the package as necessary.

At a minimum, the design documents should include the following:

- Overview of the BMP selection and design process, regulations and permits, design compliance reporting, and annual reporting requirements
- Background information and guidance necessary for the appropriate selection of BMPs
- Identification of specific staff responsibilities (e.g., Qualified SWPPP Developer, Qualified SWPPP Practitioner, Designated Inspector(s))
- Determination of the feasibility of implementing construction and post-construction site BMPs and identification of project exemption criteria

5.5.4 References

- *Storm Water Quality Handbooks, Project Planning and Design Guide*—Caltrans
- *Storm Water Quality Handbooks, Construction Site Best Management Practices*—Caltrans
- *Storm Water Standards*—City of San Diego

- *Construction General Permit*—State Water Resources Control Board
- *Statewide Storm Water Permit and Waste Discharge Requirements (WDRs) for the State of California, Department of Transportation*—State Water Resources Control Board

5.6 Utilities

5.6.1 General

These criteria shall govern the maintenance, support, restoration, relocation, and construction of new and/or existing utilities and services encountered or affected by construction of a transit system project. In the design, due consideration shall be given to the needs of the transit system, the requirements and obligations of the utility organizations, traffic impacts during construction and maintenance, and any existing agreements between the utility owner and SANDAG.

5.6.2 Existing Utilities

All designs involving maintenance, support, relocation, or other utility work shall conform to the applicable specification, criteria, and standard drawings of the concerned utility owner and/or the CPUC. After review by SANDAG, the consultant shall submit utility designs to each affected utility owner or agency for review and approval.

All utilities that are in conflict or affected by a transit project shall be categorized as follows, unless otherwise directed by the engineer:

- Category 1:

  Utilities that will be relocated or modified by the utility owner. The following types of privately owned utilities typically fall in this category: telephone, cable television, fiber optics, gas, petroleum, and power.

- Category 2:

  Utilities that will be relocated or modified by SANDAG. The following types of publicly owned utilities typically fall in this category: water and sewer.

The designer shall obtain record information, develop a utility plan, evaluate potential conflicts, pothole utilities, and determine which utilities will require relocation as described in this section.

a) Obtaining Record Information

   Within two weeks following authorization to start design, the designer shall submit a request for Category 1 utility information and a project site plan to the SANDAG Utility Coordinator, unless the SANDAG Utility Coordinator delegates the responsibility to others. The Utility Coordinator will contact the utility companies and obtain facility information from the various Category 1 utility companies.

   Within four weeks following authorization to start design, the designer shall obtain as-built information for all Category 2 utilities from the various agencies with Category 2 utilities located within the project limits.

b) Utility Plans

The designer shall take the record information and develop a utility base plan that shows the location of the existing utilities based on the historical information obtained. The utility base plan shall be included in the project's 35% submittal.

c) Evaluate Potential Conflicts

1) Following the 35% submittal, the designer shall identify and create a list of potential utility conflicts. The list shall include the following:

- Name of utility provider
- Approximate location by station number and offset
- Approximate elevation as applicable
- Size of existing utility
- Description of conflict

2) After completion of the above list the designer shall arrange a utility evaluation meeting with the utility coordinator and review each of the potential conflict locations. Each location of potential conflict shall be evaluated to determine if construction of the proposed improvement will likely impact the utility and then determine which locations could be avoided by making design changes, which locations are potentially unavoidable, and which locations should potentially be pot holed or located by other means to further assess the potential conflict. Wherever feasible, the designer shall avoid utility conflicts. Following the conclusion of the evaluation meeting, the designer shall:

- Locate in the field all utilities with potential conflicts and obtain additional field observed information.
- Once the information has been obtained after locating the utilities, it shall be used to further assess the potential conflicts and a list of confirmed conflicts shall be created. Each of the confirmed conflicts shall be evaluated by the designer to determine if design changes can be made to avoid the existing utility and permit it to be protected in place.

3) Prior to the 65% design submittal, the designer shall meet with the SANDAG utility coordinator and review each of the confirmed conflicts providing details on why the conflict is unavoidable. The designer shall provide the Utility Coordinator with a conflict list and plans that identify the utility conflicts.

d) Relocation Design and Coordination

The SANDAG Utility Coordinator will make arrangements with the utility companies to relocate Category 1 utilities. Relocation of utilities will occur either before or during construction. If the relocation work takes place concurrently with construction, then the designer shall include utility coordination language in the contract documents.

Where relocation of Category 2 utilities is needed, the design shall provide service equal to that offered by the existing installations, unless otherwise specified by the SANDAG

Director of Mobility Management and Project Implementation (MM&PI). Category 2 utilities shall be designed by the designer, and utility relocation plans shall be submitted to the utility owner for review and approval.

The designer shall identify all known utilities on the contract documents as "Existing Utility," "Abandoned Utility," "Protect in Place," or "Existing Utility to be Relocated by Others," including the name of the utility owner, size, and pothole data summary table. The designer shall show the proposed new locations of the relocated utilities in the contract documents. Drawings shall be submitted for approval to the SANDAG Utility Coordinator and Project Manager.

The design shall minimize interruption of existing utility service. Where temporary relocation is needed to perform work, the designer shall specify in the contract documents that the utilities shall be restored upon completion of work. Replacements for existing utilities shall be designed to provide service essentially equal to that offered by the existing installations. Designers must bring any proposal for betterment to the attention of SANDAG at an early stage of the design. No betterments shall be included unless specifically approved by the utility owner or public agency, and SANDAG prior to final design.

5.6.3 New Services

a) Design Requirements for New Utility Services and Equipment

Connection points for new utility services to existing utilities shall be shown on the contract documents, including, but not limited to, water, telephone, power, and sewer.

b) New Category 1 Services

The designer shall be responsible for coordinating with the SANDAG Utility Coordinator and the utility company on all new Category 1 utility services. The designer shall include in the contract documents the following requirements for new Category 1 utility services:

1) The designer shall include design and specifications for cabling raceways, access pads, clearances, and equipment pads as required to be in place by the utility prior to new service installation.
2) The designer shall specify that work inspection and acceptance by the utility company's inspector shall be coordinated by the contractor.
3) The contractor shall coordinate with the utility company to access the work site to pull in cables, set all necessary equipment, terminate all cables required to establish service, install metering equipment, and initiate the services upon completion of infrastructure installation.

Where directed in the contract or by the Project Manager, the designer shall provide a complete design of the Category 1 utility service and submit to utility company for review and approval.

For projects that require the utility distribution system to be extended (to the point of connection to the meter of the project), the designer shall notify the SANDAG utility

coordinator. The designer shall, at SANDAG's direction, design any needed Category 1 utility system extension.

Prior to beginning design of an extension, the designer shall request a meeting with the SANDAG Utility Coordinator and the utility company to identify existing utility facilities that can be used for the proposed service.

c) New Category 2 Services

The designer shall be responsible for designing all new Category 2 services and coordinating the location of service connections to existing utility facilities needed for the project.

5.6.4 Design Requirements for Underground Utilities

All designs involving maintenance, support, relocation, or other utility work shall conform to the applicable specifications, criteria, and standard drawings of the utility owner and/or the CPUC. Pipes shall be located, where practical, to cross beneath the transit way at approximately 90 degrees but not less than 45 degrees.

Where a steel casing is used for utilities under a railroad or rail transit way, the depth of cover criteria should follow AREMA for all casing pipe, except that for casing pipe under LRT-only tracks the cover may be reduced to 4.5 feet with the written approval of the Project Manager.

Where casing pipe is installed without a protective coating or is not cathodically protected, the wall thickness shall be increased to the nearest standard size or a minimum of 0.063 inch greater than the thickness required, except for diameters less than 12 inches.

Casing pipe and joints shall be of steel and of leak-proof construction. The inside diameter of the casing pipe shall be at least 2 inches greater than the largest outside diameter of the carrier pipe, joints, or couplings and at least 4 inches greater for carrier pipe 6 inches and over in diameter. Casing pipe shall be sized to allow the carrier pipe to be removed without disturbing the casing pipe.

All non-metallic buried utilities shall have detection aids or tone wires within SANDAG right-of-way for field locating buried pipes. Pipes abandoned in place beneath a transit way shall be plugged and filled with suitable material approved by SANDAG.

Manholes, valves, vaults, and other utility-related appurtenances needing periodic access, maintenance, or operation should not be placed within the transit right-of-way (refer also to Section 5.6.8).

Where new utilities, not associated with a SANDAG project, are proposed to cross under a transit right-of-way, the designer shall be required to incorporate the most current utility design requirements into contract documents.

5.6.5 Pressurized Pipelines and Pipelines Conveying Flammable Substances

a) Carrier Pipe

Pressurized pipelines and pipelines carrying oil, liquefied petroleum gas, and other flammable liquid products shall be fabricated of steel pipe material and conform to the requirements of the current American National Standards Institute (ANSI) B 31.4, ANSl B 31.8, and other applicable ANSl codes. Carrier pipe must be coated and cathodically protected to industry standards (European Standards (EN) 12068:1999, EN 50162:2004, BS 7361-1:1991, National Association of Corrosion Engineers (NACE) SP0169:2007). Test sites (NACE TM 0497) for monitoring the pipeline shall be provided within 50 feet of the transit way crossing.

b) Casing Pipe

All pressurized pipelines and pipelines carrying flammable substances shall be encased except on pipelines where the stress in the pipe from internal pressure and external loads does not exceed 40 percent of the specified minimum yield strength of the steel pipe material, and as approved by the Project Manager. The length of the casing pipe shall extend across the width of the right-of-way. Casing pipes shall be designed to withstand freight railroad or transit loadings, whichever is greater, and shall be coated with a suitable material to provide cathodic protection (EN 12068:1999) in accordance with industry standards (refer to Section 5.8.4 (g), for load requirements).

5.6.6 Pipelines Conveying Nonflammable Substances

This section covers the minimum requirements for pipelines installed on or adjacent to transit right-of-way to carry steam, water, or any nonflammable substance not covered in Section 5.6.5.

a) Carrier Pipe

Pipelines carrying steam, water, or any nonflammable substance shall be of acceptable material and construction in conformance to the owner's requirements and as approved by the SANDAG Utility Coordinator or Project Manager.

b) Casing Pipe

All pressurized pipelines and pipelines carrying pressurized nonflammable substances shall be encased except on pipelines where the stress in the pipe from internal pressure and external loads does not exceed 40 percent of the specified minimum yield strength of the steel pipe material and as approved by the Project Manager. The length of the casing pipe shall extend across the width of the right-of-way. Casing pipes shall be designed to withstand freight railroad or transit loadings, whichever is greater, and shall be coated with a suitable material to provide cathodic protection (EN 12068:1999) in accordance with industry standards (refer to Section 5.8.4 (g), for load requirements).

c) Storm Drains and Sanitary Sewers

Storm drains and sewer crossings whose carrier pipes do not have sufficient strength to support transit loads are to be protected with a steel or concrete casing pipe or with

concrete encasements. Encasements and casing pipes shall be in accordance with Section 5.6.4.

Minimum pipe sizes for sanitary sewers shall be 6 inches in diameter. Sanitary sewers shall be designed to give velocities of not less than 2 feet per second when flowing full, based on the following formula:

$$V = \frac{1.486 R^{2/3} S^{1/2}}{n}$$

Where:

V = Velocity of flow (feet per second)
R = Hydraulic radius (feet)
S = Slope of total head line (feet/feet)
n = Manning roughness coefficient

5.6.7 Fire Protection Facilities

Maintenance, relocation, and support of existing fire protection facilities within SANDAG right-of-way shall be in strict conformance with the current standards of the agency having jurisdiction and shall be approved by SANDAG and the appropriate fire protection agency.

Design shall indicate which facilities are to be maintained complete in place, which are to be removed, which are to be maintained and supported, and which are to be temporarily relocated and replaced after SANDAG's work is completed. Lines to be abandoned in place, or lines that are already abandoned, shall also be indicated.

Design for new fire protection facilities shall be performed by the designer in compliance with current National Fire Protection Association and local building codes. See the LRT Design Criteria for design specifics applicable to the project.

5.6.8 Easements and Encroachment Permits

The placement of any utility within SANDAG or transit-agency-owned right-of-way requires an entitlement agreement (easement or license) and right-of-entry permit for construction. These agreements are issued by the owner of the right-of-way. The designer shall assist the utility agency in preparation of entitlement agreements or and right-of-entry permit documentation. All required entitlement agreements shall be shown on the design plans (refer to Section 5.7).

The replacement or modification of an existing utility shall conform to the standards and criteria for new utilities as presented in these Design Criteria. If Category 1 utility companies submit a right-of-way description to SANDAG for the necessary right-of-way for a new or replacement location, the designer, upon request of the SANDAG Utility Coordinator, shall review the document and confirm the accuracy of the information submitted.

5.7 Right-of-Way

Right-of-way (ROW) is the composite total requirement of all interests and uses of real property needed to construct, maintain, protect, and operate the transit system. Some ROW

requirements are temporary and reversionary in nature, while other requirements are permanent as dictated by operating needs. The intent is to acquire and maintain the minimum ROW required consistent with the requirements of the system and good ROW practices. Because ROW plans approved by SANDAG are used as a basis for acquisition of property, all interest and uses required shall be shown on the ROW plans together with the detailed property dispositions.

5.7.1 General

SANDAG is responsible for the actual descriptions of the property to be acquired for any transit project. The taking envelope is influenced by the topography, drainage, retaining walls, service roads, utilities, and the nature of the structures and side slopes selected. Therefore it is the responsibility of the designer to establish the right-of-way limits based upon the project design and the size and term for any temporary construction easements.

The designer shall develop a set of ROW plans showing limits of the permanent and temporary ROW. ROW shall be shown using simple curves and tangents. Spiral curves will not be used in ROW descriptions. Chords may be used instead of curves under special conditions approved by SANDAG.

5.7.2 Types of Right-of-Way

The designer shall consider the following types of ROW when determining the envelope of design influence:

a) Fee Simple

Fee simple indicates full ownership of the property. Fee simple should always be the first type of ROW to be considered for any permanent surface or aerial construction. If this is not practical, then another type of ROW may be used.

b) Easement

A non-possessing interest held by one party in land of another whereby the first party is accorded partial use of such land for a specific purpose, such as surface, aerial, and underground uses. An easement can provide space for transit structures and for future maintenance of structures that support facilities located on private property. Limits of spatial use may be applied both laterally and vertically. When determining easement limits, the designer shall consider basic width, drainage, supporting slopes and structures, utilities, setbacks, and the overall effect on the property involved. The designer shall consider the following types of easements:

1) Permanent Surface Easement

An easement that provides space for the transit facility when it is not practical or advisable to acquire a fee interest. This easement shall have the same parameters as fee ownership. Upper limits shall be described only where passing under an existing structure or aerial easement.

2) Permanent Underground Easement

An easement that encompasses the total transit facility located beneath the surface of the ground. This easement shall have definite upper and lateral limits to be shown on the drawings. Lower limits shall be described only where special limiting features exist.

3) Permanent Aerial Easement

A permanent aerial easement completely envelopes the aerial portion of the transit facility. This easement shall have definite lower and side limits and be shown on the drawings. Where required, the upper limits shall be described. Supporting elements must be considered and may require special treatment.

4) Construction Easement

A construction easement is temporary in nature with a defined duration, and shall provide sufficient space to allow for the use of property by a contractor for construction.

5) Utility Easement

Utility easements required to serve the transit system shall be treated as ROW. Bearings and distances along the sides shall be shown, as well as the length and widths of the easements and ties to the limits of the ROW. Utility easements shall be described by the designer unless the subject utility determines its own easement.

5.7.3 Right-of-Way Limits

The following criteria are provided as guidelines for establishing the limits of the ROW. The dimensions are given for minimum conditions and must be modified where engineering or real estate requirements dictate additional needs. All ROW limits shall be vertical or horizontal planes and includes either fee simple or easement interests.

a) At-Grade Construction

1) Height Limit

Normally, a height limit is not required. When an upper limit is required, the limit shall be described by the elevations of horizontal planes, stepped as required and co-locating the steps with existing property lines or prominent suitable topographical features.

2) Lateral Limit

The right-of-way needed will depend upon the nature of the facility, clearances, and whether slope banks and retaining walls or other structures are required. When considering a tie-back system, all tie-backs shall fall within the obtained right-of-way. For general applications, the designer shall refer to the standard minimum ROW limits of the agency within whose jurisdiction that portion of the project falls.

Additional ROW may be required beyond the minimum limits for the entire transit way, including associated slope banks and structures depending upon the

ownership and maintenance responsibilities of those facilities. Additional rights-of-way may be required for access roads, drainage facilities, maintenance access, construction areas, substations and other operational systems, public and private utilities-tree trimming, sight lines/distances, and construction staging. For example, additional ROW may be required where the proposed acquisition will leave the property owner with an uneconomic remnant. Any additional ROW required that necessitates deviation from the minimum limits set above shall require approval by SANDAG and/or the governing agency.

3) Depth Limit

The depth limit when required shall be defined in a manner similar to that for the height limit, using a minimum vertical distance below top of finish grade, except in retained fill sections. In retained fill sections, the depth limit shall include the structural support system required for fill sections.

b) Aerial Construction

1) Height Limit

When an upper limit is required, the limit shall be described by the elevations of horizontal planes, stepped as required and co-locating the steps with existing property lines or prominent suitable topographical features.

2) Lateral Limit

Lateral limit shall be a minimum of 2 feet beyond the limit of structures. Where transit way or station platforms are elevated, the lateral limit shall be the structure's drip-line. Improvements over private property and non-transportation ROW, the lateral limits must be established in coordination with the operating entity. Additional easements shall be described by the designer and acquired by SANDAG for maintenance of and repairs to structures.

3) Lower Limit

Where required by local conditions and/or specifically directed by SANDAG, the lower limit shall be ground level with specified use restrictions, except where crossing other ROW. For aerial support structures, the lower limit shall include support foundation and foundation for any anchoring mechanism.

c) Drainage and Utility Easements

ROW for public and private utility easements shall be sufficient to accommodate future maintenance and replacement.

1) Open Drainage Ditches

The minimum total width for surface drainage easements shall be governed by local agency requirements. Two feet of width from the outside edges of the ditch shall be provided, at a minimum. Where parallel access is not available, an additional width of 12 feet, on one side, would be required to accommodate maintenance. Transit wayside equipment shall not be placed within drainage ditch right-of-way.

2) Underground Drainage Utilities

The easement widths for underground drainage systems and utilities shall be approved by the local agency involved. As a guideline, the minimum easement width is 10 feet with 2 feet minimum clearance from the outside edge of the structure to the easement line or projected 1:1 slope starting from the outside edge of structure. Where 1:1 projection interferes with other structures, 2 feet minimum clearance shall apply.

d) Stations

ROW required for stations shall include space needed for platforms, pedestrian and vehicular circulation, bus service operations, emergency and maintenance vehicle access, parking, bicycle lockers, utility services, operational systems, and ancillary facilities for stations.

ROW for station parking and access shall be based on patronage forecasts, bus service, and parking demand.

e) ROW Fencing

Fencing may be required in certain areas to provide security and/or ensure safety. Fencing shall be parallel to the guideway, forming an open-ended envelope and allowing unrestricted transit movement. Fencing shall generally be provided along areas of exclusive transit ROW and operation. Fencing shall be installed at the ROW line as determined in Section 5.7.3 (a).

Fencing is not generally required in public ROW where SANDAG operations occur within the street; exceptions are where pedestrian movements across the SANDAG guideway are restricted to certain areas for safety reasons.

5.8 Structures

This section provides the criteria and guidelines for structures. Because the general criteria for structures is applicable to both highway and rail structures, both types of projects are presented together in this section and no separate criteria are provided in LRT Design Criteria and Bus Transit Design Criteria. However, the designer shall note that in Section 5.8.4, “Bridges,” there are significant additional design criteria required for rail structures; therefore, separate paragraphs have been provided for highway and rail structures to distinguish between the two.

5.8.1 General

SANDAG's transit system includes structures for highways, light rail vehicles (LRVs), commuter trains, and shared transit/freight tracks. The type of structure will depend upon the characteristics of the particular site, what transit type the structure will be used for, and what type of transit function it will have.

5.8.2 Design Codes, Manuals, and Specifications

Unless otherwise specified herein, design requirements for bridges, tunnels, catenary anchorage, culverts, and retaining walls shall be as specified in the latest Edition of the

American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor (LRFD) Bridge Design Specifications (BDS) with Caltrans Amendments, and the following provisions for rail transit facilities:

a) For structures carrying commuter rail and freight trains, or structures that carry other traffic over tracks used by freight trains, the provisions of the AREMA Manual shall be satisfied. Where provisions of AREMA differ from similar provisions in AASHTO, the resulting design must accommodate the most restrictive provisions.

b) Buildings, including stations, station shelters, and maintenance buildings, shall be designed in accordance with the current edition of the California Building Code, with the prescribed wind and seismic forces per American Society of Civil Engineers 7-10. Seismic design provision shall be for Seismic Zone Four (D).

c) Overhead Contact System (OCS) structures shall comply with the requirements of the CPUC General Orders including, but not limited to, General Order 95C.

5.8.3 Geotechnical

Prior to design of any structure, the designer shall evaluate and recommend the requirements for geotechnical investigation. The requirements for geotechnical investigations shall be outlined in the Basis of Design Report for the project, when applicable. Otherwise the geotechnical investigation shall be included in the design proposal. An investigation shall determine the nature of the foundation material and other pertinent subsurface characteristics required to support the design of the project. Geotechnical reports shall be prepared under the supervision of, and signed and stamped by, a geotechnical engineer or engineering geologist registered in the state of California.

a) Geotechnical Report

Geotechnical reports shall include an executive summary, soil boring logs, testing methods, and recommendations with alternatives. Logs for all exploration work shall include type of soil (based on the Uniform Soil Classification System), field density, groundwater level at each boring, and moisture content. Where required, geotechnical reports shall identify refusal depths and rock profiles. The report at a minimum shall include the following:

1) Embankments, including as needed analysis and recommendations for:

- Slope stability of cuts and fills
- Erosion control
- Material, placing and compaction
- Fill settlements, including settlement versus time
- Expansion potential
- Foundation soil preparation, including removal of unsuitable materials
- Groundwater and subdrainage control
- Retaining structures design parameters

2) Pavement Recommendations, including:

- Recommended structural pavement sections
- Identification and remediation alternatives for any expansive and settlement sensitive soils
- Pavement thickness, course classification and reinforcement
- Drainage requirements
- Overexcavation, backfill replacement, and subgrade treatment
- Subgrade reinforcement/geotextiles or chemical subgrade treatments, including rate of application and mixing requirements

3) Retaining Walls

In general, retaining walls are defined in Section 5.8.5 of these design criteria. In the case of alternative wall systems as defined in Section 5.8.5 (A) of these criteria, the geotechnical data and investigation criteria will be determined on a case-by-case basis and may include the requirements below as well as additional investigations and testing. The geotechnical reports for "Retaining Structures" shall include the following:

- Active fluid pressure on cantilever walls and at-rest earth pressures on top-restrained walls for level and sloping backfill (drained and undrained) and surcharge loads from adjacent structures, equipments, vehicles, and trains. Specify whether wall friction was considered.
- Active soil pressure on braced/rigid walls for level and sloping backfill (drained and undrained) and surcharge loads from adjacent structures, equipment, vehicles, and trains. Specify whether wall friction was considered. (Depending upon soil type and bracing, equivalent fluid pressure may not be appropriate. Ref. Naval Facilities Engineering Command Design Manual 7.2).
- Structural backfill specifications and compaction using excavated or imported material.
- Permeable materials specification for backfill behind retaining walls.
- Passive pressure, base friction factor, and combinations, including the amount of movement necessary to achieve passive pressure. Provide reduced passive pressure value for limited wall movement and/or sloping finished grade in front of the wall.
- Structure settlements, total and differential, including settlement versus time.
- Seismically induced settlements, including liquefaction settlements.
- Corrective measures for expansive soils.
- Corrosion problems due to soluble salts in the soil and recommendation for type of cement to be used.

- Drainage recommendations, including backfill type, subdrains, weep-holes, and brow ditches.
- Recommendations to establish overall stability of the retaining wall and adjoining improvements.

4) Bridges

The soils reports for bridges shall include information as defined in the latest versions of *Caltrans Guidelines for Structures Foundation Reports* and *Foundation Report Preparation for Bridges*, including the following:

- A minimum of one exploratory boring shall be performed at each bridge abutment and at each column support, where practical.
- Exploratory borings shall extend below the proposed bottom of footings for spread footings and below the tip elevation of piles for pile foundations.

5) Pipes

Soils reports for pipe trenches shall be evaluated in accordance with Section 5.8.3 for each individual storm drain, sewer, water, and other underground structures. In general, reports are required for pipe trenches where the pipe is 4 feet in diameter or greater and the cover over the pipe is 6 feet or greater. The report shall include the following:

- Recommended stable construction slope for pipe trench excavation with side slopes
- Lateral earth pressure for sheeting and shoring design for trenches and jacking pits using braced or cantilevered sheeting and shoring construction with level or sloping backfill
- Allowable bearing pressure and lateral earth pressures for permanent structures
- Buoyant weight of soil that may be used to resist uplift on structures and pipelines for high groundwater conditions
- Predicted scour depth for the river and stream crossings as provided in the project hydraulic report
- Groundwater and dewatering
- Settlement of pipe during and after construction
- Seismic considerations for pipe, including special construction recommendations
- Corrosion considerations, including problems due to soil type(s) and soluble salts in the soil
- Specifications for pipe bedding, initial backfill, placing and compacting requirements, including estimates for settlement of backfill
- Consideration and recommendation for control of water seeping through pipe bedding and backfill

6) Tunnels

As part of the design effort, specific criteria shall be developed by the designer, and submitted to SANDAG for approval, specifying the extent of the geotechnical investigations, testing requirements, and types of reports to be used to develop design of major underground structures. These criteria will be required as part of the consultant's Basis of Design Report. Additional discussion for the tunnels is provided in Section 5.8.6.

7) Trackwork

Soils report for trackwork shall provide analysis and recommendations as listed in 1) Embankments, and shall include evaluation of soil and water characteristics, as defined in LRT Design Criteria Section 3.2.5 for determination of the potential for corrosion and stray current effects.

5.8.4 Bridges

a) Type Selection Report

Prior to beginning final design, it shall be the responsibility of the designer to prepare and submit a Bridge Type Selection Report to the SANDAG Director of MM&PI for approval. The designer shall consider the applicable SANDAG Design Criteria, recommendation of Caltrans Memo to Designers Section 1-29 Attachment 4, Bridge Design Aids Manual, site constraints, geotechnical information, costs, etc., and include a recommendation for the preferred bridge type(s) to be considered. A meeting may be required to discuss the recommendations made in this report. Final design should not proceed until the Bridge Type Selection Report is approved by the SANDAG Director of MM&PI.

b) Clearances

Vertical and horizontal clearances for roadways and other facilities passing under bridges shall be provided in accordance with applicable federal, state, or local agency codes. Vertical and horizontal clearances for bridges passing over tracks carrying LRV/commuter rail/freight rail traffic, including provision for overhead contract wire systems, shall comply with applicable CPUC general orders. In addition, the designer shall consider clearances required for track maintenance and other special equipment. Bridges over or under the San Diego Northern Railway (formerly the Atchison, Topeka & Santa Fe Railway) will be subject to additional conditions specified by the North San Diego County Transit Development Board. Bridge vertical clearances over waterways will be governed by the standards of the regulatory body, with consideration of adequate freeboard for the passage of surface debris.

c) Fencing

Fencing shall be installed on new (or existing) bridges that pass over a transit guideway and are used by pedestrians. Fencing shall be designed to discourage dropping or throwing objects onto the ROW. Fencing shall have a curved top toward the inside of the bridge. The fence type typically used in this application is a 10-foot-high chain-link fence with a 1-inch mesh. However, architectural styles and material type may be considered in some areas for aesthetic reasons in coordination with

SANDAG and the local agency having jurisdiction. Fencing installation shall be discussed with the agency having jurisdiction over the bridge.

d) Stray Current Corrosion Protection

Bridges shall be designed with stray current protection measures and test stations. The designer shall prepare project-specific stray current protection details based on the recommendations of a corrosion specialist, for approval by SANDAG.

e) Railings and Barriers

All bridges shall be provided with hand railings. All pedestrian bridges and bridges with sidewalks shall have hand railings or fencing. Hand railings shall be galvanized or anodized and be provided on both sides of the structure; the railings shall be at 42 inches minimum height above the surface of the walkway and have a diameter of 1.5 inches. Fencing, when required, shall have a curved top toward the inside of the bridge, as described in (c) Fencing.

All fence and railing for bridges designed for electrified light rail shall be grounded

f) Dead Loads

Dead loads consist of the weight of the entire structure, including permanently installed trackwork, pavement, walls, partitions, overhead catenary poles and signaling systems, as well as supporting foundation/pedestal, safety walkways, parapet walls, pipes, conduits, and cables. Component dead load shall consist of the weights of all components and nonstructural attachments of the structure, including plinths and rails. Superimposed dead load shall include the weights of ballast, track ties, and all utilities attached to the structure, including OCS poles and catenary wires.

g) Live Loads

Design live loads shall be determined by the most conservative of service, maintenance, and construction loads on the bridge.

- Highway Live Loads

  Highway design live loads shall be as specified in the latest version of AASHTO LRFD BDS with Caltrans Amendments.

- LRV Live Loads

  LRV live loads (vehicle and loaded weights) shall be as specified in LRT Design Criteria Section 7.6.

- Commuter and Freight Live Loads

  Freight trains operate on certain portions of the LRT system. Freight trains shall operate at 40 miles per hour (mph) maximum from Broadway south to the train yard, and LRVs will operate at 55 mph maximum. The design of structures carrying freight shall be based on freight loads of Cooper E-80 loading in accordance with the AREMA requirements.

The design of structures carrying freight north of Broadway shall be in accordance with NCTD requirements.

h) Live Load Dynamic Load Allowance

- Highway Loads:

  Design of live loading of structures supporting highways shall be increased by the percentage specified in AASHTO LRFD BDS Section 3.6.2 and as shown in Table 3.6.2.1-1 for Dynamic Load Allowance, IM with Caltrans Amendment.

- Freight Trains and LRV Loads:

  Design live loading of structures supporting freight shall be increased for vertical dynamic load allowance effect as specified in AREMA, with consideration for the type of structure being designed. Live loading of structures supporting LRT shall be increased by the percentage specified in AASHTO LRFD BDS Section 3.6.2 for Dynamic Load Allowance IM, and as shown in Table 3.6.2.1-1 with Caltrans Amendment.

  In addition to the vertical dynamic load allowance, a horizontal dynamic load allowance or nosing force equal to 10 percent of rail transit design LRV load shall be applied to design live loading of structures supporting light rail. This force shall be equally distributed to the individual axles of the vehicle and shall be applied horizontally in the vertical plane containing each axle. The force shall be assumed to act in either direction transverse to the track through a point 4 feet above the top of low rail.

i) Derailment Loads

- Vertical Derailment Load

  Vertical derailment load shall be that produced by two to four vehicles placed with their longitudinal axes parallel to the track.

  Lateral vehicle excursion shall vary from 4 inches minimum to 3 feet maximum for tangent track and curved track with a radius greater than 5,000 feet. For track with smaller radii, the maximum excursion shall be adjusted so that the derailed wheel flange is located 8 inches from the rail traffic face of the nearest barrier, if any, or the edge of deck. In any case, for tracks protected by guardrails, the maximum excursion shall be limited to that allowed by the placement of the guardrails.

  A dynamic load allowance of 100 percent of a single vehicle weight shall be applied in computing the equivalent static derailment load. This shall be in lieu of the impact provided in AASHTO LRFD BDS Article 3.6.2.

  When checking any component of superstructure or substructure that supports two or more tracks, only one train on one track shall be considered to have derailed, with the other track(s) remaining operational.

  All elements of the structure shall be checked assuming simultaneous application of all derailed wheel loads. However, the reduction of positive moment in

continuous slabs due to derailed wheel loads in adjacent spans shall not be allowed.

- Horizontal Derailment Load

  For cross sections having clearance between vehicle and barrier wall of 6 inches to 3 feet, with maximum vehicle speeds of 55 mph, the force on the barrier/curb due to horizontal derailment loads shall be taken as 40 percent of a single vehicle weight acting 2 feet above top of rail or at top of curb and normal to the barrier wall for a distance of 10 feet along the wall. Barriers farther than 3 feet from vehicles need not be considered. For tracks protected by guardrails, this force shall be considered to be resisted by the guardrails. For train speeds greater than 55 mph, horizontal derailment load shall be as specified in AREMA.

- Loading Combinations

  Incorporate rail transit loads into the loading combination provisions of AASHTO LRFD BDS Section 3.3.2 by means of the following modifications and as shown on Table 5-1:

  Add to the list of terms:

  - LL_{LRV} = Light Rail Live load
  - NF = Nosing Force
  - DR = Derailment Load

Table 5-1. Load Combinations and Load Factors

Load Combination Limit State	DC DD DW EH EV ES EL PS CR SH	LL_{HL-93} LL_{LRV} IM CE NF BR PL LS	LL_{Permit} IM CE	WA	WS	WL	FR	TU CR SH TTR TLR	TG	SE	EQ	BL	IC	CT	CV	DR
Strength – I	γ_P	1.75	-	1.00	-	-	1.00	0.5/ 1.20	γ_{TG}	γ_{SE}	-	-	-	-	-	-
Strength – II	γ_P	-	1.35	1.00	-	-	1.00	0.5/ 1.20	γ_{TG}	γ_{SE}	-	-	-	-	-	-
Strength – III	γ_P	-	-	1.00	1.40	-	1.00	0.5/ 1.20	γ_{TG}	γ_{SE}	-	-	-	-	-	-
Strength – IV	γ_P	-	-	1.00	-	-	1.00	0.5/ 1.20	-	-	-	-	-	-	-	-
Strength – V	γ_P	1.35	-	1.00	0.40	1.00	1.00	0.5/ 1.20	γ_{TG}	γ_{SE}	-	-	-	-	-	-
Extreme Event – I	1.00	γ_{EQ}	-	1.00	-	-	1.00	-	-	-	1.00	-	-	-	-	-
Extreme Event – II	1.00	0.5	-	1.00	-	-	1.00	-	-	-	-	1.00	1.00	1.00	1.00	-
Extreme Event – III	1.00	1.35	-	1.00	-	-	1.00	-	-	-	-	-	-	-	--	1.00
Service – I	1.00	1.00	-	1.00	0.30	1.00	1.00	1.00/ 1.20	γ_{TG}	γ_{SE}	-	-	-	-	-	-
Service – II	1.00	1.30	-	1.00	-	-	1.00	1.00/ 1.20	-	-	-	-	-	-	-	-
Service – III	1.00	0.8	-	1.00	-	-	1.00	1.00/ 1.20	γ_{TG}	γ_{SE}	-	-	-	-	-	-
Service – IV	1.00	-	-	1.00	0.70	-	1.00	1.00/ 1.20	-	1.00	-	-	-	-	-	-

Table 5-1. Load Combinations and Load Factors (Continued)

Load Combination Limit State	DC DD DW EH EV ES EL PS CR SH	LL_{HL-93} LL_{LRV} IM CE NF BR PL LS	LL_{P-15} IM CE	WA	WS	WL	FR	TU CR SH TTR TLR	TG	SE	EQ	BL	IC	CT	CV	DR
Fatigue – I LL_{HL-93}, LL_{LRV}, IM, CE Only	-	1.75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fatigue – II LL_{PERMIT}, IM, CE Only	-	-	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-

* See AASHTO LRFD BDS Table 3.4.1-2 for load factors not shown.

j) Longitudinal Forces

Longitudinal force due to train acceleration and deceleration shall be provided as follows:

Longitudinal Force = 25 percent of the LRT train loading for decelerating and accelerating trains.

This force shall be applied to the rails and supporting structure as a uniformly distributed load over the length of the train in a horizontal plane at the top of the low rail. Consideration shall be given to combinations of acceleration and deceleration forces where more than one track occurs. In ballasted tracks with continuously welded or bolted rails spanning the entire structure, up to 50 percent of this force may be assumed to be transferred outside the structure.

Longitudinal force for freight loadings shall be as specified in AREMA.

k) Centrifugal Force

Determination of centrifugal force due to rail vehicles on curved tracks shall be as provided in AASHTO LRFD BDS Section 3.6.3 and the resulting force shall be applied 4 feet above the top of low rail.

The effects of horizontal impact/nosing force on curved tracks need not be combined with centrifugal force and only the larger of the two forces shall be considered.

Centrifugal force due to freight and commuter trains shall be as specified in AREMA.

l) Wind Loads

Wind loads on structures carrying LRT shall be as specified in AASHTO LRFD BDS Section 3.8.

Wind loads on structures carrying freight and commuter trains shall be as specified in AREMA.

m) Wind on Live Load

For highway or exclusive light rail structures wind on live load shall be as specified in AASHTO LRFD BDS Section 3.8. Longitudinal and transverse loads shall be applied simultaneously. The transverse force shall be applied to the rails and superstructure as loads concentrated at the axle locations and in a plane 6 feet above the top of low rail. The longitudinal force shall be applied to the rails and superstructure as a load uniformly distributed over the length of the train in a horizontal plane 6 feet above the top of low rail.

For the design of substructure elements supporting two tracks, loads shall be increased by 30 percent when both tracks are loaded; this factor accounts fully for the shielding effect of vehicle on vehicle as the two trains run alongside each other.

For structures carrying freight loading, the wind on live load shall be as specified in AREMA. Wind loading on catenary shall be considered in the design of both

superstructure and substructure elements. Loads (magnitude and location) shall be determined per manufacturer specifications.

n) Sidewalk, Platforms, and Walkway Loadings

Maintenance and emergency walkways and their immediate supports shall be designed for a live load of 90 pounds per square foot of walkway area. Safety railings shall be provided and shall be designed in accordance with AASHTO LRFD BDS Sections 13.8.1 and 13.8.2.

Live loads for the design of pedestrian bridges shall be in accordance with AASHTO LRFD BDS Section 3.6.1.6.

o) Thermal Forces

Force effects due to uniform temperature changes, temperature gradients, shrinkage, and creep shall be considered in the design of structures in accordance with AASHTO LRFD BDS Section 3.12. The design shall consider the following values of temperature rise and fall and the coefficient of thermal expansion:

Concrete:

Coastal and central areas: Temperature rise and fall of ± 35 degrees Fahrenheit (F)

Inland and desert areas: Temperature rise and fall of ± 40 degrees F

Coefficient of expansion: 0.0000060/degree F

Structural steel:

Rise and fall of ± 50 degrees F

Coefficient of Expansion: 0.0000065/degree F

p) Water Loads

The effect of flowing water on piers shall be calculated as specified in AASHTO LRFD BDS Section 3.7 Water Loads.

- Force of Drift

  Effects of drift shall be considered. Sufficient freeboard should be provided over waterways in accordance with the requirements of the agency having jurisdiction over the waterway.

- Buoyancy

  Buoyancy shall be considered where it affects the design. The structure shall be designed to resist the stresses due to buoyancy in accordance with AASHTO LRFD BDS Section 3.7.2.

q) Earth Pressure

Earth pressures shall be calculated as stated in AASHTO 3.11.5 Earth Pressure and as provided by the project Geotechnical Engineer. For freight loadings transmitted through earth, provisions of AREMA shall be satisfied.

r) Seismic Forces

Seismic design shall be performed in accordance with the latest version of the Caltrans Seismic Design Criteria.

For structures carrying freight loads, the ground motion levels of AREMA Chapter 9 shall be considered in addition to those specified above.

s) Reduction in Load Intensity

For structures carrying LRV loads, a track shall be treated as a traffic lane. Only for structures carrying more than two tracks, provisions of AASHTO LRFD BDS Section 3.6.1.1.2 for multiple presence factors will be applicable.

t) Force due to Rail Restraint

For structures carrying direct fixation track work, the thermal rail-structure interaction shall be investigated for the entire structure including at least 200 feet of at grade track beyond each abutment. A project-specific Rail-Structure Interaction Report shall be prepared for SANDAG review and approval. This report shall address the maximum rail stresses and approach for inclusion of resultant forces, considered as temperature forces with the associated load factors, in the design of superstructure and substructure components of the aerial structure.

Two analyses shall be performed: One, with all rails continuous over the structure and beyond. The other, with one of the rails assumed broken at a point of maximum rail stress according to the first analysis. A temperature range of 68 degrees F +70 degrees F / -50 degrees F in the rail shall be used for the analyses. The broken rail gap shall be calculated on the basis of static equilibrium, and the magnitude of gap shall be limited based on the wheel diameter.

u) Loading Combinations

The design of reinforced concrete structures shall be by LRFD and in accordance with AASHTO LRFD BDS for the load cases specified in Table 5-1.

For structures that carry freight, the load factor groups of AREMA must be considered, in addition to those specified above.

Design of structural steel and timber members for the load cases specified in Table 5-1 shall be in accordance with AASHTO LRFD BDS Sections 6 and 8, respectively.

v) Distribution of Wheel Loads to Stringers, Longitudinal Beams, and Floor Beams

Rail transit loads shall be distributed per AASHTO LRFD BDS Section 4.6.2.1.5 provisions with the following exceptions:

1) Follow the appropriate provisions for all stringer and beam systems except concrete box girders and multi-beam precast concrete sections. When necessary to accommodate mixed train and truck traffic, divide the roadway into longitudinal strips, separate track space from truck lanes, and apply appropriate loads to the respective strips.
2) Follow the appropriate provisions for multi-beam precast concrete sections.
3) For concrete box girders, use the load distribution influence lines from the computer-aided concrete box girder distribution procedure developed by the Caltrans Office of Structures Design or other acceptable method.

w) Distribution of Loads and Design of Concrete Slabs

Rail transit loads shall be distributed per AASHTO LRFD BDS Section 4.6.2.1.5 provisions with the following exceptions:

1) Ballasted Track

Axle loads may be assumed as uniformly distributed longitudinally over a length of 3 feet, plus the depth of ballast under the tie, plus twice the effective depth of slab, except as limited by axle spacing.

Wheel loads may be assumed to have uniform lateral distribution over a width equal to the length of the tie plus the depth of ballast under the tie, except as limited by the proximity of adjacent tracks or the extent of the structure.

2) Direct Fixation Track

Where wheel loads are transmitted to the deck slab through rail mountings placed directly on the slab, the wheel load shall be assumed as uniformly distributed over a length of 3 feet along the rail. This load may be distributed transversely (normal to the rail and centered on the rail) by the width of the rail fastener pad plus twice the depth of the deck and track concrete.

For derailment loads where the LRV wheels bear directly on the slab, the wheel loads shall be assumed to be distributed over 3 feet of the slab in a direction perpendicular to the main reinforcement.

x) Distribution of Commuter Freight Loads

Commuter and freight loads shall be distributed to elements as specified in AREMA.

y) Ballasted Track on Bridges

New structures under approximately 100 feet in length shall have ballasted trackways unless it is not practical for structural or maintenance reasons (e.g., weight of ballast, clearance, or profile restrictions) or aesthetic and visual impact reasons. A minimum of 9 inches of ballast shall be placed under the ties. Ballasted structures shall be designed to drain completely to keep the ballast as dry as possible, and a waterproofing membrane shall be installed on the bridge decks and up the sides to a

point level with the top of the rail. The edge of ballast must be retained by a curb or equivalent structure.

z) Direct Fixation

Direct fixation should be used on long structures in excess of approximately 300 feet in length and on shorter structures where clearance, structure depth, maintenance, and aesthetics are a concern.

aa) Cost Analysis: Direct Fixation vs. Ballasted Track on Bridges

A cost analysis should be performed on proposed bridges between 100 and 300 feet in length to determine the most cost-effective method of track construction. The proposed method of construction shall be included in the type selection report.

bb) Track Approaches to Structures

Track approaches to bridge abutments having a skew of 10 degrees or more from normal to the track shall be designed to ensure that the tracks enter normal to the structure by normalizing the bridge abutment to the tracks or adding a normalizing approach slab.

Approach slabs to control settlement shall be approved by the SANDAG Director of MM&PI before proceeding with the design.

cc) Guardrail

The use of guardrail is not required on light-rail-only structures and shall not be included without the approval of the SANDAG Director of MM&PI.

dd) Spans

The span configuration shall consider adjacent facilities (roadway, railway, and waterway), structure types, feasibility of falsework, time of construction, passage of flood debris, site seismicity, and costs.

ee) Material

Concrete is preferred for maintenance, cost, and appearance, but alternatives in steel may be considered if they can be shown to be superior and cost-effective on a life-cycle cost basis, including the costs of maintenance. Timber may be used only when upgrading, repairing, or matching an existing timber structure.

ff) Foundation Investigations

All substructure designs shall be based upon a geotechnical investigation and interpretation by a California-licensed engineering geologist or geotechnical engineer who specializes in foundations, including deep foundations for large bridge structures. Investigations must conform to provisions specified in AASHTO LRFD BDS and AREMA, as appropriate, and Section 5.8.3 “Geotechnical Investigations,” of these design criteria.

gg) Foundation Type

Foundation type requirements shall be assessed by designers based on the review of existing soils and geotechnical information. The foundation type shall be agreed upon by the Structural Engineer and Geotechnical Engineer and shall be designed to the codes and standards of AASHTO LRFD BDS and AREMA, as appropriate.

hh) Abutments

Abutments shall be designed to the requirements of AASHTO LRFD BDS Section 11 and AREMA as appropriate. In addition, consideration shall be given to abutment stability during construction before inclusion of additional dead loads.

To provide a smooth transition from the ballasted at-grade section to the aerial structure, an approach slab shall be provided at all abutments. The approach slab shall have a length of not less than 20 feet.

ii) Embankments

Embankments shall be designed to the standards of Caltrans Standard Specifications, Section 19-6 and as specified in Section 5.8.3.

jj) Overhead Contact System Poles

In some cases, the length and profile of a structure may require the use of OCS poles within the structure. The required pole locations, pole loads, and pole base bolt patterns require the approval of SANDAG. Catenary poles on structures should be supported on a foundation/pedestal constructed inside the bridge structure below the pole. When OCS poles are included, CPUC specifies loading and requires clearances be provided for maintenance walkways, which shall also be incorporated into the length and profile of the design structure (refer to Part 3, Section 3.3.1 “Alignment and Clearance,” for clearances).

kk) Provisions for Systems Equipment

The designer shall include provisions for all systems and station equipment required in Section 6.0 and Part 3, Section 3.2; this includes but is not limited to, the following:

1) Conduits for signal and traction power feeders, loops, lighting, outlets, video surveillance system, ticket vending machines, and destination signs
2) Additional platform area with anchor bolts for signal enclosures and signals
3) Raceways under station platforms

The designer shall consider when sizing the bridge members that some of the raceways will need to be installed in columns, under station platforms, and into the bases of feeder poles.

5.8.5 Retaining Walls

Retaining walls shall be designed in accordance with AASHTO LRFD BDS Section 11. Retaining walls specified shall be limited to those included in the Caltrans Standard Plans or proprietary wall system contained in the approved list by Caltrans for "Earth Retaining Systems." Other wall systems, or retaining walls with loading or height exceeding the Caltrans Standard Plans, will require a type selection study that must be approved by the SANDAG Director of MM&PI before final design can proceed.

A live load surcharge shall be applied where vehicle load is expected to act on the surface of the backwall within a distance equal to one-half the wall height behind the back face of the wall. If the surcharge is for a highway, the intensity of the load shall be in accordance with AASHTO LRFD BDS Section 3.11.6.4. Live load surcharge for different LRV loading, as shown in LRT Design Criteria Section 7.6, shall be calculated based on the project-specific parameters and included in the project's Basis of Design report.

a) Alternative Wall Systems

Alternative wall systems in general are acceptable in the following conditions:

1) Mechanically stabilized walls listed in Caltrans-approved "earth retaining systems" that do not exceed 15 feet design height.
2) Gravity walls that do not exceed 6 feet in height.
3) Alternate wall systems that exceed these requirements will be considered in a type selection study similar to Section 5.8.4 of these design criteria. All proprietary wall systems listed by Caltrans in its "earth retaining systems" and other proprietary system are acceptable for use but will still be subject to a complete structural analysis and will require an independent check by a registered California civil or structural engineer. Proprietary walls systems not listed in the Caltrans "earth retaining systems" can be used with approval of the SANDAG Director of MM&PI. In order for structural analysis and approval of an alternative wall system listed in the "earth retaining systems" or a proprietary system, the designer shall submit a complete set of design drawings and site-specific calculations signed by the EOR and independently checked by a registered Civil Engineer in the State of California.

b) The overall stability of retaining walls shall be evaluated based on the provisions of AASHTO LRFD BDS Sections 11.6.2 and 11.6.3.

c) Clearances

For standard gravity type walls, lateral limits for walls shall be 2 feet outside edge of footing. Additional walls may include mechanically stabilized earth retaining structures, ground anchor walls, and soil nail walls. Lateral limits for these walls shall be the same as for gravity walls; however, ROW shall also consider the reach of the wall's anchoring mechanism. Where a wall's anchoring mechanism's reach is beyond that of the wall's footing, the 2-feet extension shall apply to the anchoring mechanism.

Height limits above a wall's required function shall be in accordance with the local agency or as directed by SANDAG.

d) Safety Railings

Safety railings shall be installed on retaining structures in accordance with the *Caltrans Highway Design Manual.*

e) Landscaping

Where practical, landscaping should be incorporated into retaining structures where the structures are visible to passengers or the public.

f) Freeboard

Conventional retaining and crib walls shall be designed using Caltrans standards wherever possible. A minimum freeboard of 12 inches shall be used on retaining walls.

g) Graffiti Control

Reinforced concrete retaining walls shall be coated with an approved graffiti protection coating to 10 feet above grade, a landscape covering, or alternative surface treatment as approved by the SANDAG Director of MM&PI.

h) Provisions for Systems Equipment

The designer shall include provisions for all systems and station equipment required in retaining walls and foundations, including but not limited to, the following:

1) Conduits for signal and traction power feeders, loops, lighting, outlets, video surveillance, ticket vending machines, and destination signs

2) Additional platform area with anchor bolts for signal enclosures and signals

i) Architectural Treatments

Reinforced concrete retaining walls may include a surface texture treatment for aesthetic purposes, as approved by the Project Manager.

5.8.6 Tunnels and Underground Stations and Underground Structures

Specific design criteria for these specialized facilities shall be developed by the designer and submitted as a separate design report. This design report must be approved by the SANDAG Director of MM&PI prior to proceeding with final design.

Tunnel structures required for LRT, buses, highway access under LRT track, and pedestrian access shall be considered buried structures or culverts, and shall be designed in accordance with AASHTO. All buried structures longer than 400 feet and designed to carry LRV shall have direct fixation track. Grade separation shall have a drainage system designed to prevent any freestanding water on the structure bottom slab and also prevent any ground-water infiltration under and into the structure.

a) Portals and U-Sections

1) Tunnels and box section entrance portals shall be designed in a manner to minimize the rate-of-change of pressure on a train or bus passing through the portal.

2) The pressure rise is a function of the cross-sectional area of the portal entrance, length of tunnel, vehicle nose configuration, and the entrance speed of the train or

bus. These factors shall be considered in the design in order to minimize pressure rise.

5.8.7 Barriers

Guardrail system and concrete barriers shall comply with Caltrans Standard Specifications (Section 83) and Standard Drawings. Modifications to the standards may be necessary on a project-specific basis depending on application. All modifications to Standards shall require approval by both the SANDAG Director of MM&PI and Caltrans.

5.9 Construction Phasing

5.9.1 Traffic Maintenance

a) Design consideration for control and maintenance of traffic shall be in compliance with Caltrans Standard Specifications Sections, 7-1.03, "Public Convenience," 7-1.04, "Public Safety," and 12, "Temporary Traffic Control."

b) Lane closure requirements shall be coordinated with the agency of jurisdiction in which the lane closure falls. Lane closure charts issued by the respective local agencies for local roadway closures or Caltrans for closures on state facilities shall be included with the design. Where detours are required for lane or roadway closures, the design shall include a list of appropriate personnel requiring notification prior to implementation of a detour. The following closure requirements and conditions shall be considered in design:

- Closure schedule
- Reopening of closures
- Construction Zone Enhanced Enforcement Program
- Traffic control systems

5.9.2 Construction Phasing Plans

Where the design scope of work requires construction staging or phasing plans, the consultant shall develop drawings and specifications to be included in the design documents that indicate a proposed sequencing of construction activities. Construction staging or phasing plans shall be developed in coordination with the local agencies and transit operator(s), as required, to show a logical reasonable sequence for construction activities. Construction staging or phasing plans shall show the proposed sequence of construction based on time and work limits by phase. Construction staging or phasing plans shall include consideration of known or expected limitations to work site access for traffic, rail operations, environmental restrictions or other limitations, limits to work hours for existing operations, noise or other factors, and delivery of critical long lead time material or equipment.

Construction cost estimates shall consider phasing in development of unit prices.

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6.0 TRANSIT CENTERS

The following design criteria shall be applicable to transit centers bus transit, electrified light rail transit (LRT). The general concepts can also be used for both bus and LRT-exclusive stations; however, for specific criteria relating to exclusively LRT and bus transit stations, the designer shall also refer to the Station sections in the San Diego Association of Government's (SANDAG's) LRT Design Criteria and Bus Transit Design Criteria.

General concepts for design criteria should include the following:

a) The overall station design must seek to maximize passenger safety and convenience, maximize neighborhood value, and minimize design and construction costs and maintenance requirements. Long-term maintenance costs must also be weighed against short-term capital costs.

b) The station, as an integral part of the transit system, must facilitate the movement of passengers to and from the transit vehicles and into and out of the immediate station or transfer area in a safe, convenient, and cost-effective manner.

c) Adjacent movements and land use patterns shall be incorporated into the station design. Where adjacent areas are subject to redevelopment, station design should include potential integration of that development. Stations may be incorporated into large commercial and/or residential developments through a joint-development project.

d) The station layout should direct passengers past fare equipment including ticket vending machines and personal card interface devices where applicable.

6.1 Codes and Standards

Stations shall be designed in accordance with the most current edition of the following:

a) International Code Council, International Building Code

b) California Building Code (CBC) (current version)

c) National Fire Protection Association 130, Standard for Fixed Guideway Transit and Passenger Rail Systems

d) National Electric Code

e) Americans with Disabilities Act Accessibility Guidelines

f) California Accessibility Reference Manual

g) California State Department of Transportation (Caltrans) Standards

h) City Standards (governing jurisdiction);

i) County of San Diego Standards

j) Occupational Safety and Health Standards 29 Federal Register Part 1910

k) California Public Utilities Commission

l) Metropolitan Transit System San Diego Trolley Station Sign Program: Design Guidelines Manual, latest edition

Where no provisions are made in the codes for particular features of the design because transportation and/or transit facilities are not covered or the provisions made are found infeasible, the best professional practice shall be followed with the approval of the SANDAG Director of Mobility Management and Project Implementation (MM&PI).

6.1.1 Accessibility

Transit center accessibility shall be provided by following the requirements of the 2010 Americans with Disabilities Act (ADA) Standards for Accessible Design and the CBC. Where the federal ADA standards differ from the state CBC, the designer shall follow the most stringent requirements, as determined by SANDAG. Station designs will also be reviewed by the Social Services Transportation Advisory Council in regard to accessibility compliance.

Accessibility elements requiring consideration in design include, but are not limited to, the following:

a) Accessible routes
b) Parking
c) Ramps
d) Handrails
e) Landings
f) Cross slopes
g) Flangeways
h) Station amenities: phones and ticket vending machines
i) Signage
j) Safety
k) Grate covers

6.2 Site Layout

6.2.1 General Circulation and Access

a) Access Control

Access control shall be provided through the incorporation of clearly defined ingress and egress areas by use of sidewalks, ramps, walls, railing, fencing, planters, and lighting, supplemented with signage. Access control shall be conducive to transit patrons and definitive such as to deter loitering by clear and obvious designation of Fare Paid Zones.

b) Pedestrian Assembly Areas

Pedestrian assembly areas, including platforms and mezzanines, shall be sized to accommodate the expected maximum demand, using 6 square feet of space per person

but not less than the minimum station design standards for light rail transit (LRT) and commuter rail platforms.

c) Pedestrian Circulation

Design for all pedestrian circulation shall be continuously connected by accessible routes in compliance with current CBC and ADA Guidelines Standards and provide safe and efficient movement of passengers in all areas of the station to which they routinely have access. Consider the following points for applicability in achieving good pedestrian orientation and circulation:

- Where applicable, provide access to the pedestrian network in the surrounding community.
- Locate passageways, stairways, elevators, and shelters to encourage balanced loading and unloading.
- Make passage from kiss-and-ride and park-and-ride areas and between transfer areas clear and simple with sufficient lighting.
- Provide a minimum of 8 feet clear space from the loading edge of curb. Ensure adequate room for mainstream pedestrian flow to maneuver around slower or hesitant pedestrians. Examples of obstructions and/or obstacles may include the following:
  - Ticket vending machines
  - Ticket/card validators
  - Pay phones
  - Stairs
  - Railings
  - Columns
  - Bicycle racks/lockers
  - Benches
  - Trash receptacles
  - Posts
  - Poles
  - Information sign frames
  - Monument signs
  - Planters
  - Shelters
  - Catenary poles
  - Light poles

Obstructions/obstacles such as these shall be kept outside of the main pedestrian through zone. In addition, the smaller items such as trash receptacles and benches shall be secured to the platform to prevent movement into pedestrian flow, interference with train operations, or vandalism.

- Avoid cross-circulation at fare vending locations and decision points (e.g., route maps and informational displays). All potential obstructions shall be plotted on the station plans for reference to ensure clear accessible routes and unobstructed pedestrian pathways.
- Provide landings at curb ramps and blended transitions with clear length of 48 inches and clear width at least as wide as the curb ramp, excluding flares. Provide clear boarding area of 96 inches measured perpendicular to the curb or vehicle roadway edge by clear width of 60 inches measured parallel to vehicle roadway. A clear path shall be provided between directional bar mats and tactile signs.
- Protruding objects between 27 inches and 80 inches above the finished floor shall protrude no more than 4 inches into walkways in accordance with CBC and 2010 ADA Standards.
- Provide ramps and other components as required for a complete and continuous accessible route in accordance with CBC/ADA requirements. Grades at stations shall be minimized through design and shall conform to slope criteria for accessibility, or stair and ramp criteria as noted in Section 6.2.1 (d).
- Cross flows, dead ends, and turns greater than 90 degrees are undesirable for both patron security and circulation.
- Shelter elements shall have sufficient transparency to provide adequate visual surveillance of the station area to discourage vandalism and enhance patron safety.
- Provide adequate sight distance and visibility along pedestrian routes at stations. Should visual impediments be deemed unavoidable, fast-moving pedestrians, such as skate boarders and bicyclists, should be considered, and other solutions to improve the line of site, such as mirrors, should be proposed by the designer.
- Provide a minimum of two points of access/egress from station loading areas that meet the requirements of National Fire Protection Association 130.
- Avoid potential crush points between a fixed object and the moving transit vehicles.

d) Vertical Circulation

(Note: Local or more recent code criteria may supersede the below listed criteria. The designer shall verify current criteria.)

Design criteria for vertical circulation will vary depending on the type and layout of a station.

The following are minimum design considerations:

1) For vertical changes less than 8 feet, use ramps and, in addition, if applicable, stairs.
2) For vertical changes 8 feet to 16.5 feet, use stairs and ramps. An elevator may also be incorporated where passenger demand or space limitation restrict the installation of accessible ramps and stairways. Installation of an elevator may be deferred as directed by SANDAG.
3) For vertical changes greater than 16.5 feet, stairs and two elevators per station are required.
4) Stairs

   Stair configuration, including geometrics, treads, risers, railing, identification, and striping for the visually impaired shall comply with the CBC and the following additional requirements:

   - Risers shall not be open.
   - Maximum height between landings should be 12 feet. Minimum landing depth shall be at least equal to effective stair width.
   - Minimum headroom measured perpendicular to tread at noising is 7.5 feet. Continuous soffits without obstructions should be held at 10 feet
   - Stairwells shall be illuminated.
   - Treads shall be finished with non-slip surface material.
   - The striping on stairs shall be yellow in conformance with federal color No. 33538.
   - Exterior stair treads shall be designed so that water will not accumulate on the walking surface.
   - Designer shall consider maximum flow through capacity when determining geometric layout of stairs.
   - Where stairs are adjacent to an escalator, they shall be parallel to the angle of inclination of the escalator (30 degrees).
5) Ramps

   Ramps should be as flat as possible. Ramp slopes shall be 1:15 maximum, where practical. A maximum ramp slope of 1:12 may be used with the approval of the Project Manager. Changes in level up to 0.25 inch may be vertical. It is desired that there be no vertical change within a ramp; however, where it cannot be avoided changes in level between 0.25 inch and 0.5 inch shall be beveled with a slope no greater than 1:2. Changes in vertical level greater than 0.5 inch shall be incorporated into the ramp.

   Any pedestrian path of travel, except street sidewalks, with a slope greater than1:20 shall be considered a ramp and shall be designed in accordance with CBC and ADA

requirements. Handrails, meeting the requirements of Article 9 below, are required for all ramps.

Designer shall consider maximum flow through capacity when determining geometric layout of ramps.

6) Curb Ramps

Curb ramps shall be installed where a pedestrian way crosses a curb. Pedestrian curb ramps, including detectable warning surfaces and grooved borders, shall be placed in accordance with City of San Diego Standards. Curb ramps within Caltrans right-of-way shall be in accordance with Caltrans standards.

7) Escalators

The use of escalators is discouraged due to maintenance concerns. Any proposed escalator will require approval of the SANDAG Director of MM&PI. If escalators are approved, design shall comply with the American Society of Mechanical Engineers A17.1, Title 8 (California Division of Occupational Safety and Health), and ADA. Escalators shall be protected from direct exposure to weather. Any proposed escalators shall be detailed in the Basis of Design Report with respect to justification, locations, cost, size, length, width, power consumption, and maintenance costs.

Where there is an indoor station with sufficient space and stairways at multiple levels or height of level changes are excessive, the station shall be designed for possible future installation of escalators.

Where escalators are necessitated and approved by the SANDAG Director of MM&PI, the following design criteria shall be followed:

- Escalators shall be dual speed, 1.5 feet per second (ft/s) and 2 ft/s in “up” and “down” directions. For purposes of design, capacities in person per minute (ppm) shall be assumed to be as follows:

48 inches nominal width	2 ft/s – 100 ppm
36 inches nominal width	1.5 ft/s – 75 ppm

- Desired width for escalator shall be 48 inches.
- Secured stop/start controls shall be provided on site.
- Escalators shall be full reversible and controlled by key-operated switches to stop or reverse direction. The top and bottom of the escalator shall be equipped with an “Emergency Stop” switch with covered alarm. Alarm shall be wired to central control and/or on site security station if applicable.
- Measures shall be taken to protect escalator machine room from flooding.
- Escalators shall be certifiable under State of California inspection.

8) Elevators

Elevator design shall comply with CBC and ADA requirements.

- Considerations—Elevators shall be considered whenever vertical differences exceed 16.5 feet. Any elevator will require approval of the SANDAG Director of MM&PI. Where an elevator is provided, the elevator cab equipment and operational controls shall be suitably designed for use by persons with disabilities. Elevators shall include accommodations for telephones and closed-circuit television within the cab, including conduit and cabling. Elevator machine rooms shall be located as near as practical to hoistways but clear of public platform areas. Where elevators provide a primary means of vertical circulation, a minimum of two elevators is required. A backup power system shall be provided where elevators are installed and there is no other ADA-accessible path. Construction contract special provisions shall clearly require elevator components rated for exterior applications subject to direct sunlight and rain.
- Cab Dimensions—Elevators shall be sized according to CBC and ADA requirements and to accommodate expected crowds, wheelchairs, stretchers, platform-mounted equipment, and station maintenance equipment.
- Cab and Hoistway Finishes—To enhance security, both the elevator cab and the elevator hoistway shall be designed to allow for observation into the cab from the exterior to the maximum extent possible. Hoistways shall be designed to prevent intrusion in conformance with Title 8. All metal cladding, doors, walls, railings, and trim shall be brushed stainless steel. All controls and appurtenances shall be vandal resistant.

9) Handrails and Wheel Guide Rails

Handrails required for stairs and ramps shall be between 34 inches and 38 inches high, in accordance with CBC and ADA requirements for ramps and stairs. The handgrip portion of the handrails shall not be less than 1.25 inches or more than 1.5 inches outside diameter, or the shape shall provide an equivalent gripping surface. Handrails shall be metal, non-painted, with a corrosion-resistant finish. Round handrail shapes are preferred. No curb is required when a guide rail is provided, centered 3 inches plus or minus 1 inch above the surface of the walk or ramp. Wheel guide rails shall be installed in accordance with CBC and ADA requirements. Elevated station platforms shall be enclosed with a metal safety railing 66 inches high. Drop-offs exceeding 4 inches in vertical height, such as at planters, require either a guide rail or a 6-inch curb in accordance with CBC requirements. Stations within street right-of-way shall consider vehicular site distance.

6.2.2 Modal Interchange

a) General

Station facilities shall be designed to promote convenient, efficient, and safe transfer of patrons between the various transportation modes, including rail transit, bus, bike, walk, and automobile. Other considerations for design in relation to modal interchange include parking, kiss-and-ride, taxi stands, and trip generators within a 0.5-mile radius of the

station. Station design shall include field inspections to review areas outside of the station limits for improvements to walkway, lighting, or traffic signals that would improve the station's functions. Any improvements to these facilities outside the station boundaries will be recommended to the Project Manager and approved by SANDAG prior to inclusion in the design.

b) Buses

The station shall be designed to include the number of bus bays proposed in preliminary engineering. In routing buses through the station, it is desirable to route buses to the station platform with a minimal increase in operating time and minimal conflict with other vehicles and station operations. Additional considerations are as follows:

- Where applicable, buses should load and unload adjacent to the rail platforms.
- Ingress and egress points should be free of delays from on-street vehicular movement.
- Wherever feasible, buses should have exclusive bus lanes that should be well designated to prevent automobile access.

Designer shall also incorporate provisions for para-transit operations. Drop-off locations for para-transit shall be as close as possible to transfer loading zones or accessibility points to the loading zones.

For more criteria related to bus-exclusive station requirements, the designer shall reference the Bus Transit Design Criteria.

c) Kiss-and-Ride/Taxi Access

Passenger drop-off and loading zones should comply with CBC and ADA requirements. Special drop-off and waiting areas for kiss-and-ride passengers and transition to taxi operations shall be located as close to the platform as possible. Provision shall be made for a drop-off area at the nearest curbside to the station entrance. Short-term parking may be provided near the platform for patron pick up as requested by the operating entity and approved by the Project Manager. The drop-off area should not conflict with pedestrian movement or other modal operations.

d) Bicycles

Bicycle storage areas shall be outside the loading zones. Provisions shall be made for bicycle racks and lockers such that they will be located out of walkways and pedestrian paths of travel and positioned so that bicycles in racks will be parallel to the adjacent path of travel. To promote security, bicycle storage areas should be visible from the street or station entrance.

e) Pedestrian Access Paths

Pedestrians transitioning between transportation modes should be directed to cross bus or vehicular lanes at curb ramps. The crossing area shall be clearly delineated and comply with the crosswalk marking requirements of the U.S. Department of

Transportation Federal Highway Administration's *Manual on Uniform Traffic Control Devices for Streets and Highways*.

In general, pedestrian access paths shall be located at the following locations when applicable:

- Between bus bays where curbing is parallel at bus ingress and egress points
- Between platform and station parking or shared-use parking where an active vehicle lane intersects pedestrian access
- Between adjacent sidewalks and station access points

All paths shall be adequately lit, in accordance with Title 24, for safety during evening operation, and comply with state and local requirements.

f) Coordination with Other Modes of Transportation

Where other modes of transportation utilize a station, design efforts shall be coordinated with other agencies involved in those various modes of transportation.

6.2.3 Clearances

All areas within the station providing access for both pedestrians and vehicles shall meet all clearance requirements for pedestrian and vehicular movement. Consideration shall be given to the following:

a) Type of vehicles using the station facility or needing to gain access, including buses, maintenance vehicles, and emergency response vehicles

b) Vertical clearances for overhead objects such as signs, lighting, shelters, stairwells, landscaping, and other structures within accessible areas

c) Lateral clearances: ensure pedestrian-accessible areas meet accessibility (CBC/ADA) requirements for lateral clear space. Ensure driveways, parking lot aisles and stalls, and turning radius meet vehicular requirements.

6.2.4 Station Emergency Access

Station design shall allow for ingress and egress of emergency vehicles and personnel into station and onto platform area or at a minimum adjacent to the platform area. Consideration shall be given to clearances for emergency vehicles, personnel, and their equipment, such as gurneys or stretchers.

6.3 Parking (Park-and-Ride)

6.3.1 General

The design for parking lots shall be in conformance with the requirements of the agency in whose jurisdiction the project falls and the criteria herein. The design for parking lots shall, at a minimum, consider the following:

a) Minimize the distances between the parking area and the bus and LRT platforms

b) Lighting, circulation, and landscaping in conjunction with the safety and operations of the station

c) Coordination with SANDAG regarding capacity

d) Compliance with accessibility codes and standards (CBC/ADA)

6.3.2 Layout and Circulation

a) General

External circulation plans, including location of entrances and exits, traffic signals, and bus stop facilities, will be coordinated with local agencies during the planning stages.

Internal layout will be based on property shape and will be coordinated with local agencies during the planning and preliminary engineering stages.

Parking lot construction documents will include a signing and striping plan.

b) Entrance and Exit

Entrances and exits should be designed with the following considerations:

- Minimize automobile/bus conflicts.
- Provide adequate sight distances.
- Where more than one major roadway bounds the parking lot, provide an entrance and exit at each roadway. However, the following should be considered in finalizing the number of entrances and exits:
  1) Number of vehicles expected to use the facility
  2) Local traffic conditions
  3) Site configuration
- Entrances and exits shall not be located close to roadway intersections, but shall be located so as to facilitate inbound traffic.
- Dimensions shall be adequate to accommodate expected traffic flows, and configuration shall be in accordance with the local governing agency (lines up with an existing intersection or is at least 300 feet from an existing intersection).
- Where buses will be using an entrance/exit, the design shall provide for the additional traffic loads.
- Grade changes at entrance ways shall be designed to accommodate bus over-hang and wheel base length with sufficient clearance to avoid contact with the pavement.

c) Parking

Quantity, aisles, and spacing for parking should be laid out to provide the most efficient use of land and conform to the following:

1) Parking spaces should equate to approximately 100 stalls per acre.
2) Where possible, parking lot layout shall be oriented with aisles parallel to pedestrian flows along the shortest routes to station platforms to encourage pedestrians to walk down aisles where they can easily be seen by drivers.
3) When parallel aisles are not practical, perpendicular aisles shall be provided along with separate pedestrian sidewalks and crosswalks.
4) Parking spaces shall be standard stall dimension when possible. Where additional spaces are needed to accommodate higher usage, compact spaces shall be utilized.
5) When space allows, circulation within parking lots shall be internal having no need for public street access for additional access.

6.3.3 Accessible Requirements for Parking Lots

Accessible reserved parking spaces for persons with disabilities shall be provided at all LRT parking lots. These spaces shall be located nearest to the station platforms. The number of accessible spaces for each LRT lot shall be as shown below, in accordance with CBC and ADA requirements.

Total Spaces in Parking Lot	Minimum Accessible Reserved Spaces
1 to 25	1
26 to 50	2
51 to 75	3
76 to 100	4
101 to 150	5
151 to 200	6
201 to 300	7
301 to 400	8
401 to 500	9
501 to 1,000	2 percent of total
1,001 and over	20 + 1 (for each 100 over 1,000)

Additional criteria:

a) Standard accessible spaces for persons with disabilities shall be 14 feet wide; 9 feet for the vehicle and 5 feet for the access aisle, and 18 feet minimum in length.
b) One in every eight accessible spaces, but not less than one, shall be van accessible, in accordance with CBC and ADA.

c) A van-accessible space(s) shall be 17 feet wide; 9 feet for the vehicle and 8 feet for the access aisle, in accordance with Title 24.

d) Accessible parking spaces shall be 18 feet long and located so that users are not required to travel behind parked cars other than their own.

e) Accessible parking space access aisles shall connect directly to an accessible route and can be shared by two accessible parking spaces.

f) For van-accessible space, the access aisle shall be to the right when pulling in forward.

g) Accessible parking spaces shall be striped in accordance with CBC requirements.

6.3.4 Grading and Drainage

Slope of access drives shall not be less than 0.5 percent or more than 10 percent. A separate pedestrian ramp shall be provided where the slope of an access drive exceeds 5 percent. Drainage shall be directed away from areas where pedestrians will walk. No parking stall shall have a slope from head end to back end of greater than 4 percent, or side slope of greater than 4 percent. Slopes in accessible parking stalls shall not exceed 2 percent in any direction in accordance with CBC and ADA requirements.

6.3.5 Paving

Paving design shall conform to applicable Caltrans standards. Where buses utilize station bus pads or bus drop-off areas, bus pads will be 12 feet wide minimum and constructed of a minimum 9-inch-thick concrete over a 12-inch base (include minimum reinforcing or WWF). Additional concrete may be required in driveways and other areas depending on frequency and type of buses.

For circulation roads subject to bus loadings, use a minimum of 6 inches of asphaltic concrete (AC) over a minimum of 8 inches of crushed aggregate base (CAB). Where the soil R-value is less than 50 and greater than 10, add a minimum of 6 inches of granular subbase; if the R-value is less than 10, use a minimum of 12 inches of subbase. For areas of the parking lot not subject to bus traffic, use a minimum of 3 inches of AC for R-values greater than 40, and a minimum of 4 inches of AC for R-values less than 40, over a 6-inch CAB base.

Where paving may occur within the City of San Diego Right-of-Way, cement treated base shall be used in place of CAB.

6.3.6 Wheel Stops

Wheel stops shall be used adjacent to any walkways, barriers, or landscaped areas. Wheel stops shall be 6 feet in length.

6.3.7 Signs

See CBC, ADA and local requirements for sign lettering specifications, mounting requirements, and height.

A warning sign regarding unauthorized use of disabled parking spaces shall be posted at each parking lot entrance or adjacent to the accessible spaces in accordance with CBC requirements. Each parking space reserved for persons with disabilities shall be identified by a sign permanently posted immediately adjacent to and visible to each stall or space, and van-accessible spaces shall have an additional sign stating "VAN ACCESSIBLE" in accordance with CBC requirements.

Fencing plans shall be prepared for all projects requiring fencing as prescribed in these guidelines. Fencing plans shall identify fence type and location as well as gate locations. Fencing layout may be shown on appropriate plans of other disciplines with reference to detail sheets or standards.

6.3.8 Fencing Objectives

The fundamental objective of fencing within the station area is to control access in the following manner:

a) Separate platform/paid zones from through pedestrian traffic

b) Direct patron flow

c) Designate station perimeter

d) Safety

6.3.9 Fence Types

In general, the fencing types listed below shall follow Caltrans Standard Specifications and Standard Plans. The following descriptions are standard fencing types used by SANDAG. Exceptions can be made on an individual basis but only with the approval of the SANDAG Director of MM&PI.

a) Type 1: Standard 6-foot Chain-Link Fence

The fabric shall consist of 6-foot-wide, galvanized, No. 9 gauge chain link with 2-inch mesh. The framework shall consist of posts, top rails, and bottom rails, where required, made from 2.5-inch-diameter galvanized pipe. All posts shall be placed a maximum of 10 feet on center in 9-inches diameter, 2-foot-deep concrete foundations. Terminal posts, braces, and gate frames shall be constructed of 3-inch-diameter galvanized pipe. Gates may be slide or swing-type, but swing-type gates shall not be allowed to swing closer than 9 feet to the centerline of any track. No. 7 gauge galvanized tension wires with barbed selvages shall be used at the top and bottom of the chain-link fabric.

In some cases, black vinyl coated chain-link fabric may be used. The fabric shall be 11-gauge chain link with permafused black vinyl coating.

Standard 1-inch chain-link mesh shall be specified in areas known to have, or anticipated to have, high levels of trespassing across the right-of-way.

b) Type 2: Standard 4-foot Chain-Link Fence

This fence shall be constructed the same as Type 1 chain-link fence at a height of 4 feet.

c) Type 3: Standard 6-foot Steel-Picket Fence

This fence shall be constructed of prefabricated panels and posts made of welded or bolted heavy-gauge tubular steel members. Type 3 fencing shall be factory galvanized and primed. Fence color shall be as directed by the Project Manager and factory painted where applicable. The fence panels shall be welded or bolted to the posts, and all field-welded surfaces of the fence shall be painted with zinc rich primer and painted to match the fence, if applicable. Fence panels shall consist of pickets with a minimum 0.625-inch^2 cross-sectional area spaced 4.5 inches on center.

d) Type 4: Standard 4-foot Steel-Picket Fence

This fence shall be constructed the same as Type 3 steel-picket fence at a height of 4 feet. If a fence is adjacent to a pedestrian walkway with an abrupt change in level of 4 inches or more, then the fence shall have a guide rail provided, centered 3 inches plus or minus 1 inch above the surface of the walk in accordance with Title 24, Part 2.

For Type 3 and 4 fencing, final architectural appearance and configuration shall be as approved by the SANDAG Project Manager.

6.3.10 Fencing Applications

The fencing applications described below are typical; however, they may change or be modified or combined at the direction of the Project Manager.

a) Type 1 Fence

- Along both sides of the right-of-way unless a substantial barrier exists in conformance with California Public Utilities Commission General Order No. 143-B, Title 9.
- Along one side of right-of-way in areas where LRT tracks run parallel to drainage ditches, slopes, or existing walls or barriers. Determination of one side application shall be at the direction of the Project Manager.
- Perimeter of station where access is to be prohibited (typically along edge of parking lot farthest from LRT platform).
- Between tracks where ballasted track is within station platform area.
- Black vinyl shall be used at the direction of the Project Manager.
- Black vinyl along transition lines between station and urban centers (in locations farthest from the station).

b) Type 2 Fence

- Landscaped areas along right-of-way, where permissible (black vinyl shall be used in all landscaped areas).
- Black vinyl along transition lines between station and urban centers (in locations closest to the station).

c) Type 3 Fence

- Not used within station areas unless directed by Project Manager.
- For perimeter of a substation if the substation is within the limits of a LRT station (see LRT Design Criteria).

d) Type 4 Fence

- Landscaped areas where applicable
- Separation line between the LRT platform paid zone and adjacent pedestrian through traffic.

e) Gates

Fencing shall generally have lockable gates at suitable locations for easy access for maintenance vehicles and personnel. Gates shall be every 1,500 feet if no other access to the right-of-way is available. Gates shall be as close to a signal case as practical.

6.4 Station Amenities

6.4.1 Shelters

a) General

Stations shall have at least two or more shelters on each bus and LRT platform to provide shading and protection from inclement weather. Shelter types and styles shall be as approved by SANDAG Director of MM&PI.

b) Joint Use

Where a station is in conjunction with a joint-use development, shelter design, if necessitated, may require additional approvals by local agencies and/or private developers. Integration of shelters into the joint-use development shall be considered in the design.

c) Materials

- Shelter shall be designed with readily and locally available material
- Material shall be durable and able to withstand corrosive effects of the environment, withstand vandalism, and be economical to repair or replace.

d) Design Considerations

- Shelters must be designed to allow easy surveillance for patron security and to discourage vandalism.
- The extent of coverage must be evaluated on a station-by-station basis and maximum cover provided as appropriate and as the budget allows.
- Minimum size criteria for each shelter group are described below.

The types and placement of shelters shall be included in the 35 percent design submittal.

- Passenger Shelters

The minimum size of a shelter shall be 4 feet by 17 feet having a solid covered roof no less than 4 feet in width and no less than 7.5 feet in height. Height restrictions may apply in accordance with station operations or safety concerns. Shelters shall comply with ADA requirements.

- Operator Shelters

  A 10-foot-square concrete pad shall be designed at an LRT terminus and other high volume stations as directed by the Project Manager to support a prefabricated operator's shelter. Power and phone conduits shall be stubbed-out in the slab at grade.

6.4.2 Public Information Communications

Refer to the LRT Design Criteria in regard to public information communications.

6.4.3 Passenger Seating

Benches shall be provided on rail platforms and bus transfer waiting areas. Platform benches shall also be included within the shelters and coordinated with the station finish materials. Benches shall not be placed so as to restrict circulation patterns or queuing areas. Benches in the bus transfer waiting areas shall be coordinated with appropriate bus operators. Locate at least one bench near the disabled boarding areas. Bench seats shall be 18 inches above the finished floor following adjacent grades. If the condition of a sloping platform or station occurs, the top of the bench seat surface shall be 17 inches minimum and 19 inches maximum above ground. Design drawings shall account for and reflect final platform/station grading and drainage design. Benches shall be located to provide space for wheelchair seating 30 inches wide by 48 inches long directly adjacent to the bench. Benches shall include dividers to designate seats and discourage lying down. Specified benches shall be highly vandal resistant. The quantity of benches shall be determined based on estimated ridership for the station.

a) Standard Benches

- Commercially available benches shall be used unless special station furnishings have been identified in planning or preliminary engineering.
- Benches shall be fabricated from minimum 10-gauge steel and have dividers to designate seats and discourage lying down.
- Benches shall be anchored to the platform.

b) Special Design

SANDAG, a local agency, and/or private developer may elect to use a special design. Special designed benches must include the following:

- Architectural, structural, plans and specifications
- Coordination of material with special design shelters
- Designed to discourage lying down
- CBC/ADA compliant

6.4.4 Public Telephone

(Note: Applicable to transit centers and LRT stations only)

A minimum of one coin-operated telephone shall be provided at each station unless otherwise directed by the SANDAG Director of MM&PI and at least one location in the associated waiting areas shall be stubbed for a phone. At least one phone shall be equipped with a volume control and provide corresponding signage. All telephones shall comply with the requirements of ADA. Public phones shall be located near the waiting areas for use by patrons entering the system. A clear and level area 30 inches by 48 inches shall be provided at each pay phone for forward or side approach by a wheelchair. The designer shall specify half of the phones mounted with the highest operable part 48 inches above the floor (forward approach) and half of the phones mounted with the highest operable part 54 inches above the floor (side approach).

If an interior public phone is provided in a transit facility, or if four or more are provided at a station entrance and one is interior, one public text telephone must be provided according to ADA requirements. SANDAG and the system operator will request that the phone company provide a text telephone at stations forecast to have high ridership.

6.4.5 Maintenance Features

(Note: Applicable to transit centers and LRT stations only)

The following maintenance features shall be provided at each station platform:

a) Water

Hose bibs with quick couplers in flush-mounted concrete hand holes shall be provided on each platform every 50 feet along platforms, plazas, and ramps. The plans shall include the water meter and back-flow preventer plotted to scale. Plans shall show existing or new water lines from the meter to the point of connection to the water main.

b) Power

A minimum of three waterproof, 120-volt, 20-amp, grounded duplex electrical convenience receptacles shall be provided on each platform and shall, typically, be mounted on light poles encased in a security J-box.

c) Service Panel

A central pedestal for an electric service panel, telephone, public address, train-to-wayside communications, and telemetry hardware with lockable door shall be located, where possible, near the end of a platform. The location shall not impede any pedestrian flow nor provide a hiding place.

d) Servicing

Space shall be provided adjacent to the platform for the parking of service vehicles (e.g., revenue, maintenance, and line supervisor trucks) and shall be so marked. This space shall be as close to the fare machines as possible and, at a minimum, shall accommodate one standard-sized truck or van. The parking space shall have a lighting

fixture placed within 10 feet of the space and positioned to illuminate this space and the surrounding area.

When space limitations preclude the provision of parking space adjacent to the platform, the platform itself will be used for the temporary parking of maintenance and other service vehicles. In this case, at least one platform at each station shall allow vehicle access without the need to mount a curb. The entrance to this platform shall be free of all obstructions, shall be long enough to park a full-sized van or pickup truck, and shall be wide enough that pedestrians will not be forced onto the track area when a maintenance vehicle is on the platform.

At stations designed in this manner, the ticket vending equipment shall be located within reasonable proximity to the on-platform vehicle parking area and not at the opposite end of the station. Any special design elements (such as architectural pavers) shall be located outside the vehicle parking area of the platform or shall be constructed so as to withstand vehicle traffic/parking.

6.4.6 Restrooms

Restrooms for transit operators shall be considered at terminus stations and transfer stations. Restrooms for transit patrons shall be considered at rail terminus stations and transfer points, but only in conjunction with an agreement by a private or public entity to operate and maintain the restroom. Restrooms shall be designed only upon the approval of the SANDAG Director of MM&PI. At stations where public restrooms are specified to be provided, a separate water meter shall be shown so that sewer fees are not calculated based on irrigation flows. Restrooms shall be designed to meet the requirements of ADA and Title 24.

6.4.7 Special Events

At terminus and transfer stations, an area shall be provided for placement of a Trolley ticket sales trailer during special events. The area shall be designed, sized, and located to meet the station requirements of the LRT Design Criteria.

6.4.8 Clearances

See Section 6.2.3 for clearance requirements related to station amenities.

6.5 Fare Collection

See LRT Design Criteria Chapter 6.10.

6.6 Station System

See LRT Design Criteria Chapter 6.

6.7 Materials

The quality and character of station materials utilizing simple and durable materials have a direct effect on maintenance requirements and the image of each facility. This section specifies the basic requirements and criteria that have been established for such materials to

be used in public areas of the stations so that the quality level and maintenance requirements of these materials will be consistent throughout the system.

In specifying manufactured items or materials, preference shall be given to standard off-the-shelf items available from more than one supplier over custom-made or single-source items. This will help expedite maintenance procedures both in procurement and installation. This also shall apply to finish, size, color, pattern, or composition. Slight variations in appearance should be allowed so potentially less costly products or materials of equal quality can be used.

Designer may propose alternate materials that may be better suited to the environment and design of individual stations, provided that the materials meet the performance standards specified and have a proven track record for similar applications. Any proposed alternative will require approval by the SANDAG Project Manager.

6.7.1 Performance Standards

a) Durability

Durable and cost-effective materials shall be used that have consistent wear, strength, and weathering qualities. Materials shall maintain their appearance throughout their useful life.

b) Low Maintenance

Life-cycle maintenance costs shall be considered in the evaluation of all materials and finishes.

c) Availability

Materials shall be readily available with minimal lead time for procurement and obtainable through multiple sources regionally or nationally.

d) Cleaning

Materials exposed to contact by the general public shall be selected that are easily cleaned through the use of common equipment and cleaning agents. Minor soiling should not be apparent.

e) Quality of Appearance

Materials shall be appealing in appearance and texture, and provide continuity throughout the station.

f) Repair or Replacement

In addition to the general statement above, in order to reduce inventory and maintenance costs, materials shall be standardized as much as possible for easy repair or replacement without undue cost or disruption of LRT operation.

g) Non-slip

All surface areas for pedestrian traffic, such as stairways, platforms, ramps, landings, architectural enhancements, and hand grip surfaces, such as railing along ramps and stairs, shall be non-slip. Floor finishes shall be non-slip even when wet.

h) Compatibility

Selected materials shall be compatible with the San Diego area climate. In addition, with the high variability of material types used in conjunction with each other, including incorporation of existing elements, material compatibility shall be analyzed as well. Materials selected shall also be compatible with chemical compounds found in common cleaning agents and their equipment as described in (d) above.

i) Corrosion Resistance

Because of moisture and the electrical currents involved in transit operation, special consideration must be given to prevention of atmospheric corrosion control for the reduction of maintenance costs and preservation of appearance. Designer shall minimize atmospheric corrosion effects through the use of protective coatings, protective barriers, and selection of corrosive-resistant materials. The design shall avoid configurations that will entrap moisture. The design shall permit drainage and allow washing of pollutant particles. The use of dissimilar metal combinations, or use dielectric devices between dissimilar metal combinations, shall be avoided; when this is not possible, coatings or sealants shall be used. Non-corrosive metals shall be used when possible or required.

j) Water Resistance

All finish materials in underground spaces shall be selected and detailed with proper attention to waterproofing, cavity walls, drainage, and venting. All drainage cavities shall have provisions for cleanouts.

k) Fire Resistance

"Flame spread" ratings shall conform to the applicable building code definition for the material being used.

l) Finish Materials

Dense, hard, nonporous materials shall be used in all applications. Finish materials shall be corrosion, acid, and alkali resistant and shall be compatible with chemical compounds required for maintenance.

m) Detailing

Detailing of finishes shall avoid unnecessary surfaces that may collect dirt and complicate cleaning. Wall surfaces shall be vertical and flush. All edge and finish materials shall be detailed through incorporation of joints and textures that minimize requirements for true, visually perfect installation over long distances.

n) Texture

Materials within reach of passengers shall be easily cleaned, with a finish to prevent or conceal scratching, soiling, and to maintain desired illumination levels. Materials with homogeneous colors shall be selected. The use of paint, stains, and coatings shall be minimized.

Graffiti-resistant products shall be used to protect surfaces susceptible to graffiti. Graffiti-resistant products shall allow for removal of graffiti without damage to the surface.

o) Color

Materials shall be selected with consideration to symmetry and balance within a station and throughout the system. Materials with homogenous colors shall be selected over those with surface finishes or veneers. Colors shall be selected and/or approved by the SANDAG Director of MM&PI.

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7.0 ARCHITECTURAL TREATMENTS

7.1 Platforms

Platforms shall have non-skid durable surfaces designed to be easily maintained and, to the extent possible, hide dirt and stains. Platforms may be concrete, colored concrete, pavers, or other surfaces approved by the Project Manager. Trackway paving shall be concrete. Trackway paving is typically non-colored or dark grey-colored concrete. Platform architectural treatments may include the following:

a) Textural treatments

b) Color variations and stains

c) Formed patterns

d) Pavers

Detectable warning pavers shall comply with requirements of the California Building Code (CBC) and Americans with Disabilities Act (ADA), except detectable warning pavers for the Trolley system, which shall comply with the Federal Transit Administration approved equivalent facilitation for detectable pavers that provide a level landing area for the on-board access ramp:

a) 4 inches thick by 24 inches wide pre-cast concrete paver

b) Slip resistant

c) Integrally tinted with yellow conforming to Federal Color No. 33538

A detectable warning paver strip shall be placed at the platform edge for the full length of the platform, except at ramps. The detectable warning shall be placed 6 inches behind the face of curb.

The detectable warning shall contrast with adjacent walking surfaces in conformance with the reflective formula stated in CBC Sections and ADA Standards for Accessible Design.

A 6-inch-wide strip cast in dark grey concrete or laid with dark grey or black pavers, along the platform side of the detectable warning the full length of the platform. Every 25 feet along the strip, the statement "STAND BEHIND LINE" shall be etched into the strip and painted in white, 4-inch letters.

7.2 Directional Bar Mat

A detectable directional texture mat shall be placed behind the detectable warning at the approximate positioning of the second door of the first light rail vehicle car for a three-car train on the boarding platforms, as shown in the Standard Plans, and comply with the dimensional requirements of the CBC. The texture mat shall be oriented such that the directional texture is perpendicular to the tracks. The detectable directional texture mat shall be urethane, slip resistant, and yellow, conforming to Federal Color No. 33538 in accordance with CBC requirements.

A tactile information sign shall be positioned directly behind the directional bar mat at the back of platform. If the tactile information sign cannot be located in this position due to other platform equipment or causes obstruction to pedestrian flow, the bar mat location shall be adjusted a maximum of 2 feet in either direction along the platform to accommodate the placement of the tactile information sign, which provides the station name and destination in Braille and in raised letters.

7.3 International Symbol of Accessibility

The international symbol of accessibility shall be painted behind the detectable warning on the platform at the first door of the first car to line up with the wheelchair lift location, as shown in the Standard Plans, in accordance with ADA Standards for Accessible Design. The international symbol of accessibility shall be located on the plans so that the area is kept clear for wheelchair maneuverability.

7.4 Lighting

a) General

The lighting criteria contained herein are intended to provide functional and aesthetic guidelines necessary to design lighting for stations, parking lots, bus transfer areas, and any special structures of the transit system and to ensure a safe and comfortable environment. Conformance with these criteria is required to ensure consistency for system facilities and to provide intended maintenance quality, convenience, safety, and efficiency of the transit facility.

General objectives for lighting are as follows:

- Promote safety by identifying and properly illuminating areas and elements of potential hazard
- Enhance the system's visual and functional clarity by differentiating between site circulation networks, station entrances, and platforms
- Reinforce the presentation of graphic messages
- Minimize impact on surrounding properties

b) Codes and Standards

Lighting and emergency systems shall be in accordance with applicable codes and standards as listed below:

- American National Standards Institute C2 National Electrical Safety Code
- National Fire Protection Association (NFPA) 70 National Electrical Code
- NFPA 101 Life Safety Code
- NFPA 110 Standard for Emergency and Standby Power Systems
- NFPA 130 Standard for Fixed Guideway Transit System
- CBC

- Illumination Engineering Society Lighting Handbook
- Underwriters' Laboratories
- San Diego Gas & Electric Service Standards and Guide Manual
- Americans with Disabilities Act Accessibility Guidelines, Section 10.3.1(11)

c) Standard Elements

1) Where possible, luminaries and lamp types shall be standardized system wide to provide design and perceptual unity and simplify maintenance requirements. If system-wide standardization cannot be obtained, at a minimum, standardization within each station shall be provided and material and model types shall be standard "off-the-shelf" items for ease of replacement and maintenance. Light poles are often used to mount appurtenances such as public address speakers, signs, and video cameras. Designers shall account for these loads when sizing the poles.

2) Light fixtures and standards shall be incorporated into the structural and architectural elements of the stations as follows:

- Signage
- Platform
- Shelters
- Seating areas
- Fare vending and validator equipment
- Ramps, stairs, walls, and rails
- Bus loading areas
- Pedestrian walkways and crossings
- All parking areas

3) All lighting provided for stations and parking lots shall be full color spectrum. All light controls will work with a photo cell and time clock. Lighting circuits shall be designed so that reduced lighting levels could be provided after Trolley service ends by allowing alternate lights to be turned off.

4) Station platform lights shall be mounted at a minimum of 15 feet high, spaced to meet the minimum illumination criteria but spaced at not more than every 60 feet apart. All station shelters shall have vandal-resistant lighting under the covered area. Parking lot lights shall be installed 30 feet above the ground. Fixtures shall be resistant to vandalism. Lights shall continue to operate when adjacent lights of a circuit fail.

d) Illumination Levels

Illumination levels shall define and differentiate between station areas, decision and transition points, and areas of potential hazard. In addition to quantity of light, illumination levels shall be uniform and minimize glare. Luminaries shall be so selected, located, and/or aimed that while accomplishing their primary purpose they will produce a minimum

of objectionable glare or interference with vehicular traffic, neighboring areas, and Trolley operations. Illumination levels for specified locations shall be as follows:

Location	Footcandles	
At-grade and aerial station platforms	5	
Fare collection, fare vending, and concession areas	15	
Stairs, escalators, and passageways	15	
Elevators	15	
	Minimum	
	Normal	
Vehicular access roadways	2	
Bus loading/unloading	5	
Kiss-and-ride	5	
Open parking	2	
	Average	
	Normal	
Underguideway parking	2	
Covered parking structures:		
Entrances	2	50*
Traffic lanes	2	10*
Storage	1	5*
Pedestrian ways:		
Walkways, ramps, and bridges	5	
Tunnels and passages	5	
At-grade crossings	5	
Yards and maintenance areas	5	
Traction power substations	50	Inside
Traction power substations	2	Outside
Emergency egress routes	1	

*Sum of electric and daylight

e) Illumination Plan

An illumination plan shall be submitted prior to the start of final design showing source locations and probable illumination levels in the field of areas to be lighted. This plan shall be the basis for completing the lighting design plans. Lighting design plans shall be

overlaid with civil, architectural, structural, signage, electrical, and utility plans and all conflicts shall be resolved.

f) Emergency Lighting

Emergency lighting shall be provided for aerial and subterranean stations. Illumination level shall be as indicated in (d) above.

Exit lights, lights for essential signs, and emergency lights shall be included in the emergency lighting circuit. They shall be provided with a separate neutral and shall be separately wired from emergency distribution panels.

g) Emergency Backup Power System

The design of emergency backup power systems for emergency lighting and communication systems shall comply with all applicable federal, state, and local rules and regulations for the facility, in particular the NFPA. Upon loss of normal power, emergency circuits shall be in operation for 90 minutes, drawing power from the uninterruptible power system or other emergency lighting systems. A manual change-over switch and a receptacle shall be provided to accept a portable standby generator for the emergency lighting only. Additional loads for the backup power system shall be included at the direction of the Project Manager. Upon approval from SANDAG, a battery and charger system may be used in place of an uninterruptible power system design.

7.5 Trash Receptacles

Trash receptacles shall be provided on all station platforms and shall be coordinated with seating units. Trash receptacles shall be coordinated with the station finish materials and allow for easy service access and maintenance. Trash can enclosures shall be lockable and sized to accommodate a 300gallon trash can. Enclosures shall be secured to the surface to prevent removal by patrons but allow removal for maintenance. The number of trash can receptacles shall be determined based on estimated ridership for the station.

When finish is a painting or coating system, specifications should reflect custom color-matching with other elements of the station, platform, or canopy.

At key transit stations designated by the Metropolitan Transit System, explosion-resistant trash receptacles shall be provided, conforming to current Transit Security Administration requirements.

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8.0 LANDSCAPING AND IRRIGATION

8.1 Introduction

This section provides objectives, general criteria, and design parameters for the landscaping of San Diego Association of Governments (SANDAG) facilities. These include the following areas:

a) Stations, including park-and-ride lots and kiss-and-ride areas

b) Traction power substations

c) Communications/signal facilities

d) Yards and shops

e) Right-of-way line sections

Given the varying size and complexity of projects, it is important that the design consider commonality with the projects' diverse settings. Therefore the designer is encouraged to provide recommendations or discuss deviations from the General Criteria where this might improve design. All designs shall be reviewed by SANDAG, San Diego Trolley, Inc., and San Diego Transit Corporation. Deviations to the guidelines provided in these documents, however, must be approved in writing by the SANDAG Director of Mobility Management and Project Implementation.

8.2 Objectives

a) To provide a drought-resistant and low-maintenance landscape responsive to and compatible with intended transit operations, station architecture, graphics, and lighting design

b) To provide an attractive environment at stations

c) To assist in controlling the access to the system by reinforcing designated pedestrian and vehicular circulation system movement, and creating barriers elsewhere along the right-of-way as required

d) To establish visual identity along the alignment through consistent use of a few basic paving, walls, and plant materials while maintaining visual interest and compatibility with adjacent areas through the use of other materials that vary from site to site

e) To establish visual screening where necessary to soften the impact of unattractive adjacent land uses and provide privacy to adjacent residential property

f) To coordinate grading required for landscape design with overall site grading improvements

g) To discourage graffiti

8.3 Design Guidelines

8.3.1 Compatibility with the System Design

Based on the above objectives and in consideration of unique environmental conditions, the following landscape design criteria have been developed to ensure consistency throughout transit facilities:

a) Where trees are proposed, trees shall be selected and placed to maintain a minimum clear distance of 20 feet from the nearest rail, except when trees are planted within a station where the minimum clear distance from rail shall be 14 feet.

b) Shrubs and ground covers shall be located at a minimum of 10 feet from the nearest rail to minimize the deposit of plant litter in the ballast and ballast drainage system, and to avoid damage to plants from herbicide used within the ballast area. Plant litter shall include both deposit of foliage and rooting systems.

c) Planting, where adjacent to or in combination with signaling cabinets, wayside communication, lighting, and signage, shall not interfere with access to any facilities for maintenance. Plant selection and location shall be coordinated with light rail transit (LRT) operational elements to avoid obstruction or interference. At a minimum, maintain 2 feet clear space for all non-access sides and 4 feet minimum clear distance in front of access areas.

d) Where planting is applicable along bus routes and at transit centers in the bus area, plant selection and placement shall be such that line of sight or directional signs are not obstructed.

8.3.2 Operations, Safety, and Security

a) Plant materials shall be selected and located to prevent the following:

- Obstruction of transit operator's view of approaches to stations, curves, intersections with on-coming traffic, directional signs, special trackwork or grade crossings, signals, or vision through curves
- Obstruction of auto/truck driver or pedestrian visibility of approaching transit vehicles at crossings
- Restriction of access to or use of hydrants and safety walkway areas
- Avoidance of conflicts with all existing utilities, including overhead utility lines, underground utilities, and underground vaults
- Hindrance of surveillance by patrolling police, transit security, or surveillance cameras

b) Waiting areas at bus stops and kiss-and-ride areas shall be pleasant and comfortable for short-term use but be visually accessible for security reasons.

c) Plant material that has thorns or is poisonous shall not be located in areas accessible by patrons.

8.3.3 Access

Patrons shall have relatively unobstructed access to transit stations at designated entries. Plant materials may be used in combination with walls, fences, and walkways to control patron movement to these entries and discourage access at other locations. Barrier-type plantings shall be considered for locations where public streets parallel transit facilities. In addition to the required width of walkways and sidewalks, a natural design element that provides distinction from the walk surface shall be provided on the side away from bus stops and parking/passenger off-loading areas. This guide path may be a combination of design elements, but must be straight and uncomplicated in line.

8.3.4 Site Preparation

a) Finish grading shall be sloped for adequate drainage. Wherever possible, slopes shall not exceed 4:1. For slopes steeper than 4:1, special planting and irrigation shall be required to minimize erosion.

b) All slopes shall be stabilized to prevent physical failure, erosion, and maintenance problems. This may include non-plant material during the plant establishment stage.

c) Soil amendments shall be specified based on tests made during design or specified in construction. The designer shall specify type, rate of application, and application method for soil amendments.

8.4 Selection of Plant Materials

a) Cost, Availability, and Growth Rates

Shrub and plant materials shall not be selected that are unusually expensive, locally unavailable, or so exceptionally slow growing as to unduly delay the achievement of mature plantings. Shrub and plant materials shall be selected to produce minimum pollen in station areas. Shade trees shall be selected that produce a relatively mature canopy within 10 years of installation. Ground covers shall be selected that provide complete coverage within two years of installation. Plants shall not be aggressive such that they overtake other plants or require excessive maintenance in order to contain them within their designated planting areas.

b) Environmental Adaptability

Plant materials shall generally be perennials having low water requirements and shall be tolerant of Southern California climatic conditions, including atmospheric pollutants. They should be resistant to disease, suitable for high traffic areas, long-lived, and not require frequent replacement.

c) Maintenance

Landscape designs shall minimize maintenance requirements. Landscape designs shall not use lawn or any other plant materials requiring intensive care, such as clipped formal hedges, espaliers, pleached materials, plants unusually attractive to rodents or insects, plants that secrete or otherwise stain pavement, or plants that produce large amounts of litter. Plant selection shall consider plant size at maturity in spacing of materials in order to minimize pruning requirements. Planting designs shall consider ease of access by

maintenance crews to plant materials during transit operating hours. Areas that require erosion protection shall be landscaped with low-maintenance ground covers.

d) Station/Park-and-Ride Lots

Sidewalk stations shall incorporate a street tree pattern and shall match existing patterns or establish one where none exists. Where street trees exist near a site, similar species shall be used in new planting around the station where such planting conforms to these criteria. The use of tree grates is discouraged except where required to meet Americans with Disabilities Act clearance. Grid openings in gratings shall be limited to 0.5 inch in the direction of traffic flow in accordance with Americans with Disabilities Act requirements. Maximum slopes for planting shall be two horizontal to one vertical with a minimum 3-foot flat area at the top and bottom of the slope. Existing plant material shall be preserved wherever possible when the material is judged appropriate. If a sidewalk-station is within a city's right-of-way, plant selection and planting guidelines shall conform to that city's guidelines.

Transit park-and-ride areas should be screened from adjacent buildings by planting strips or changes in grade. Along the street perimeter, a low evergreen shrub mass, generally less than 3 feet in height, shall partially screen cars yet allow street surveillance into the lot. Taller accent plants may be used at various intervals where this does not limit surveillance.

At stations with park-and-ride or major bus transfer facilities, trees shall be located (where practical) around the perimeter and along the major pedestrian walks leading to the station to achieve the initial large scale subdivision of the site and to emphasize the major pedestrian routes to the station.

Small- and medium-sized tree plantings may be located so as to achieve secondary subdivision of the site and to provide an intermediate scale between the structure, the large tree pattern, and the smallest elements. Small trees shall be located to emphasize the direction of important internal traffic.

Ground cover and small shrubs shall be provided within the curbed areas between parking isles, at the ends of parking isles, and in borders and above and inside cribwalls or other retaining wall system accepting of planting.

e) Tree Protection and Support

Existing trees that are healthy and attractive shall be preserved wherever possible. Appropriate protection during construction shall be specified for those trees that are to remain.

All trees in pedestrian areas shall be staked. For non-pedestrian areas, trees under 24-inch box size shall be staked. Trees 24-inch box size or greater shall be guyed.

f) Miscellaneous

Landscaping outside of stations, except as indicated in this section, shall not be provided unless directed by the Project Manager.

Landscaping may be used outside of stations at substations, bridge approaches, retaining walls, erosion control locations, and as indicated in the mitigation requirements of the project environmental documents.

Landscaped areas should allow for periodic weed spraying as well as the cutting, pulling, and removal of weeds along the right-of-way.

8.5 Fertilizations/Herbicides

a) Plant material shall be fertilized at the time of installation, and a fertilization schedule shall be established in the maintenance schedule.

b) Herbicides considered for use shall be organic, when available, or a product that is proven to be non-persistent and non-damaging to the environment.

8.6 Irrigation

a) Standards

Design of irrigation systems shall produce plans and specifications that provide a system in conformance to the requirements of Caltrans Standard Specifications, Section 20 – Erosion Control and Highway Planting. Plans, specifications, and estimates shall be based on unit costs for grading, soil improvements, planting, irrigation, and plant establishment maintenance. The SANDAG project manager may approve lump-sum contract provisions.

b) Water Supply

All landscape provided on SANDAG projects, other than non-irrigated hydroseed slope protection, shall be irrigated. Irrigation shall be by a dedicated meter, using recycled water, if available, or assigned a separate irrigation billing rate, if available from the water provider. The plans shall indicate the main line water source, any laterals from the main to the meter required, and the party responsible for developing the laterals. The designer shall prepare the meter request and provide all application forms (filled out), calculations, meter cost and capacity cost estimates, and plans required by the water provider. SANDAG's Utility Coordinator shall process water meter applications and arrange for payment of meter and capacity fees.

Backflow preventers shall be designed and included on the plans in accordance with the requirements of the water provider. Backflow preventers shall be placed in a vandal-resistant locked steel enclosure on a concrete slab as shown in the regional standards.

c) Automatic Control and Valves

All irrigation shall be automatically controlled using electrically powered irrigation controllers and valves provided with a metered power supply. Solar-powered controllers and valves may only be used with approval of the Project Manager. The plans shall show the meter locations and power sources, and indicate the party responsible for establishing the power meter connection.

Specifications for irrigation controllers and valve equipment shall indicate only the highest quality products. Where SANDAG has standardized a specific piece of equipment, sole

source may be used, as approved by the SANDAG Project Manager. All irrigation controllers shall be enclosed in vandal-resistant steel enclosures placed on a concrete foundation.

The plans and specifications shall indicate requirements for all strainers, pressure reducers, and other equipment required to meet state and local requirements and for a long-lasting and functioning irrigation system.

d) Distribution and Heads

Piping for the irrigation system shall conform to the Standard Specifications and these General Criteria.

Irrigation pipes crossing LRT or railroad tracks shall be placed in a sleeve. Sleeves that are 6 inches or smaller shall be schedule 80 polyvinyl chloride. Sleeves larger than 6 inches shall be steel per American Railway Engineering and Maintenance-of-Way Association Volume 1, Chapter 1, Part 5. The top of the sleeve shall be 5.5 feet below the top of tie and extend 25 feet beyond the centerline of the track or terminate 2 feet inside the LRT right-of-way line, where right-of-way is restricted.

Irrigation piping in station planter areas shall be a minimum of 2 feet below grade. Irrigation piping in station parking areas or parallel to rail tracks and within the SANDAG right-of-way shall be a minimum of 3 feet below grade. Piping in street right-of-way shall conform to the requirements of the controlling local agency.

To the greatest extent possible, all irrigation heads shall be designed to function below the surface grade. Where irrigation heads are required to be above surface grade, pop-up heads shall be evaluated before exposed heads on risers are considered. Irrigation heads have proven to be highly susceptible to vandalism; therefore, heads shall be specified that are economical to replace and of high quality. Generally irrigation heads shall be plastic with a minimum number of parts per head. Where SANDAG has standardized a specific piece of equipment, sole source may be used, as approved by the SANDAG Project Manager.

To assist in water conservation, drip or other alternative systems of irrigation may be designed, where applicable, as long as they meet the standard requirements herein and must obtain approval from the Project Engineer.

9.0 SAFETY AND SECURITY

9.1 Introduction

The purpose of this chapter is to establish safety and security standards for the design of elements of a bus rapid transit and/or a light rail transit (LRT) system. To ensure the safety and security of the system and to resolve hazards and mitigate vulnerabilities, the designer and contractors shall comply with the minimum requirements in this section and, where applicable, the latest version of the project's Safety and Security Management Plan and the Safety and Security Certification Plan, as well as with the State Safety Oversight Agency (in California, the Public Utility Commission's), approved System Safety Program Plan and System Security Plan.

9.2 General Safety and Security Design Requirements

General system safety and security design requirements are as follows:

a) Identified hazards and vulnerabilities shall be eliminated or associated risk shall be reduced through design, including material selection or substitution. When potentially hazardous materials must be used, such materials selected shall pose the least risk throughout the life cycle of the system.

b) Hazardous substances, components, and operations shall be isolated from other activities, areas, personnel, and incompatible materials.

c) Equipment shall be located so that access during operations, servicing, maintenance, repair, or adjustment minimizes personnel exposure to hazards (e.g., hazardous chemicals, high voltage, electromagnetic radiation, cutting edges, or sharp points) and threats.

d) Risk resulting from excessive environmental conditions (e.g. temperature, pressure, noise, toxicity, acceleration, and vibration) shall be minimized.

e) Risk resulting from human error in system operation and support shall be minimized as part of the design effort.

f) Risk resulting from excessive vulnerability to threats (e.g., theft, vandalism, sabotage, assault) shall be minimized as part of the deign effort.

g) In the case of risk from hazards and vulnerabilities that cannot be eliminated, alternatives that will minimize such risk shall be considered.

h) The designer shall ensure power sources, controls, and critical components of redundant subsystems shall be protected by physical separation or shielding, or by other mutually acceptable methods.

i) When alternate design approaches cannot eliminate a hazard, warning devices and cautionary notes shall be provided in assembly, operations, maintenance, and repair instructions, and distinctive markings shall be provided on hazardous components, equipment, and facilities to provide clear and sufficient warning of a hazard. These shall be standardized in accordance with commonly accepted commercial practice. Where no such common practice exists, the design shall propose the method or

methods to be used for review and approval. The design shall provide all warnings, cautions, and distinctive markings proposed for review and comment.

As directed by the Project Manager, a qualitative and quantitative analyses shall be prepared, documented, and furnished as part of the design process. At a minimum, on Federal Transit Administration (FTA) funded New Starts projects, a Preliminary Hazard Analysis and a Threat and Vulnerability Analysis shall be conducted for the project. Additional hazard analyses and threat and vulnerability analyses may be conducted to determine design requirements to mitigate a hazard or threat. If a recommended hazard resolution or vulnerability mitigation conflicts with the approved Design Criteria, it will be evaluated through the same process as any other deviation from the approved Design Criteria.

As directed by the Project Manager, a Safety and Security Certifiable Items List shall be prepared as the basis to develop design modifications and operating and maintenance procedures to eliminate or mitigate hazards and vulnerabilities.

Safety and security information and procedures shall be developed and included in the project specifications. These shall include, but not be limited to, hazard notifications, testing plans and procedures, training, maintenance procedures, and operating procedures for both normal and emergency situations. In the case of an extension to an operating system, existing plans and procedures will be evaluated.

9.3 General Safety and Security Design Criteria

The project design shall address system elements according to the requirements of the applicable standards listed in the Design Criteria. Should any standard or requirement conflict, the most stringent standard shall apply. Standards, specifications, regulations, design handbooks, safety and security design checklists, and other sources of guidance shall be reviewed for pertinent safety or security design requirements applicable to the system. The design shall establish criteria derived from applicable information.

9.3.1 General Safety Criteria

General system safety criteria include the following:

1) Minimize exposure of personnel operating, maintaining, or repairing equipment to hazards such as entrapment, chemical burns, electrical shock, cutting edges, sharp points, electromagnetic radiation, or toxic atmospheres.
2) Emergency equipment/devices for public use shall be clearly identified and accessible.
3) Where failures could result in personal injury, major system damage, or inadvertent operation of safety critical equipment, redundancy or fail-safe principles shall be incorporated into the design.
4) Physical and functional interfaces between subsystems shall be analyzed. Those hazards associated with interfaces shall be specifically identified as system integration hazards and tracked for resolution.

5) There shall be no single-point failures in the system that can result in an unacceptable or undesirable hazard condition.

6) If an unacceptable or undesirable hazard condition can be caused by combining multiple incident failures, then the first failure shall be detected, and the system shall achieve a known safe state before subsequent failures occur.

7) All safety critical elements in a vital system shall be designed and implemented with fail-safe principles. Fail-safe principles shall be realized by designing the system to have intrinsically safe failure.

   - The following criteria shall be used, as a minimum, for implementing fail-safe functions and vital circuits:
     - Component failures or loss of input signals shall not cause unsafe consequences and shall not, when added to other failures, cause unsafe consequences.
     - Any number of simultaneous component failures attributable to the same cause or related causes shall not result in an unsafe condition.
   - The following criteria shall apply to electrical/electronic circuits:
     - Broken wires, damaged or dirty contacts, relays failing to respond when energized, or loss of power shall not result in an unsafe condition.
     - The relays used in vital circuits shall conform to all applicable parts of the American Railway Engineering and Maintenance-of-Way Association Communications and Signals Manual of Recommended Practice, Section 6, Relays.
     - Circuitry components fail in either the open or shorted condition. It shall be assumed that multi-terminal devices can fail with any combination of opens, shorts, or partial shorts between terminals.

8) Where redundancy is used in a safety critical area, there shall be no single point of failure that would result in the loss of safety protection. Redundant paths shall not contain a common failure mode.

9) Design shall include component interlocks wherever an out-of-sequence operation can cause a hazard.

10) Suitable warning and caution notes in operating, assembly, maintenance and repair instructions, and distinctive markings on hazardous components, equipment, or facilities for personal protection shall be provided.

11) Color-coding used for equipment and facilities shall be uniform.

12) The system safety analysis shall include review of fixed facilities and structures for employee access and maintenance safety.

13) Maintenance activities required to maintain safe operations shall be prescribed to the Operations Manager during the design phase. These maintenance activities shall be minimized in both frequency and complexity in design. The personnel qualifications required to adequately implement these activities shall also be identified.

14) Software faults shall not cause an unacceptable or undesirable hazard condition.

15) Unacceptable hazards shall be eliminated by design.

16) Hazardous substances, components, and operations shall be isolated from other activities, areas, personnel, and incompatible materials.

17) Risk resulting from excessive environmental conditions (e.g., temperature, pressure, noise, toxicity, acceleration, and vibration) shall be minimized.

9.3.2 General Security Criteria

System security shall be provided by a combination of procedures, subsystems, and devices to ensure the security of passengers, employees, equipment, and facilities.

The system security goal is to provide transit system facilities and operations that minimize threats to the employees, patrons, contractors, first responders, and the general public. Engineering designs must satisfy security design requirements applicable to the individual systems and elements, including the following:

- Designing security into the project by using such concepts as Crime Prevention through Environmental Design (CPTED).
- Incorporate security features into the designs to reduce threats and vulnerabilities, such as fencing, lighting, guard shacks, security office, gates, sensors or motion detectors, burglar/intrusion alarm systems, closed circuit television (CCTV), public address systems, emergency telephones, silent alarm, and card or controlled access.
- Implement, as appropriate, recommendations included in the FTA's Transit Security Design Considerations, FTA-TRI-MA-26-7085-05, November 2004.
- Comply with any U.S. Department of Homeland Security, Office for Domestic Preparedness directives.
- Use the Transportation Research Board report *Deterrence, Protection, and Preparation* as guidance throughout the design.

The security design shall evaluate the following strategies as a part of the design process of new facilities:

- Defensive Layering

  Defensive layering provides multiple levels of security in order to slow or prevent unauthorized access to a site.

- Crime Prevention through Environmental Design Principles

  CPTED focuses on design techniques and use of a particular space to deter crime with four basic elements: natural surveillance, natural access control, territorial reinforcement, and maintenance. CPTED strategies include maximizing visibility of people, patron flow areas, and building/structure areas; providing adequate lighting and minimizing shadows; installing graffiti guards and shatter protection for glass windows; using landscape plantings that maximize visibility; using gateway

treatments; controlling the perimeter; eliminating structural hiding places; and creating open lines of sight.

- Target Hardening

  Target hardening employs structural techniques to increase the ability of a building to withstand an explosion while minimizing the loss of life and property damage.

- Situational Crime Prevention Principles

  Situational Crime Prevention is closely related to CPTED. It is the design of the physical environment to produce desired behaviors in those who enter a facility by such factors as assuring cleanliness, the type and amount of staffing, and various operational and physical measures.

- Physical Security System Elements

  Physical security elements are intended to achieve the following:

  1) Delay an intruder to allow time to detect them
  2) Inform responders of a penetration of a facility or protected area

- Passenger Security

  A train-borne intercom shall be provided for passengers to notify the operator of any urgent incidents on board the vehicle.

- Public Security

  In addition to application of CPTED design principles, public street areas where the vehicles will pick up and discharge passengers should be designed to enable them to be maintained in a clean and secure manner. Stop areas shall be marked and illuminated for maximum assurance of safety and security, and shelters shall be designed to minimize vandalism and graffiti.

- Facility Security

  CCTV cameras shall be designed as directed by the Project Manager for Maintenance and Storage Facilities, and placed in storage areas with high value equipment and parts. Fire and intrusion alarm systems shall be provided to monitor critical facilities and equipment, such as traction power substations and communications equipment. Alarms and CCTV will be monitored at the Metropolitan Transit System Control Center.

- Information and Information System Security

  Sensitive data such as personal identification information, procurement documents, and security information shall be stored in systems that are fortified against unauthorized access. Contract specifications will require contractors to establish a formal information protection plan that at least meets the following Security Sensitive Information requirements.

- Compliance with the Code of Federal Regulations regarding the release of transit-related Homeland Security information.
- Protected security-related information may not be subject to subpoena or discovery and may not be subject to inspection by the general public. This shall include the following:
  - Assessments, plans, or records that reveal susceptibility to terrorism
  - Drawings, maps, or plans showing locations of vulnerabilities of infrastructure
  - Records or other information that detail specific emergency response plans
  - Written information detailing response agency plans to a terrorist attack
  - Identification of equipment used for covert, emergency, or tactical operations
  - Response agency radio frequencies, codes, passwords, or programs
- Personal, financial, and medical information shall be protected in accordance with federal regulations (e.g., Freedom of Information Act, Privacy Act, Health Insurance Portability and Accountability Act, and Health and Human Services Standards for Privacy of Individually Identifiable Health Information).

9.4 Site Considerations

Often site layouts can have a direct impact on the safety and security at the station or other facility. In order to improve safety and security, designers must understand and consider the following:

- Improving visibility (lines of sight, site illumination, and limiting physical impediments)
- Site control (camera placements, access points, subtle design features used to channel pedestrian flow, and security)
- Fare technology equipment and vending machine placement
- Conduit and cabling raceways
- Provisions for future technology deployments
- Various other site considerations

9.5 Technology

The purpose of this section is to provide the designer with information about existing safety and security systems technologies to help guide the design effort to ensure that quality designs are created by the designer that are compatible and consistent with existing design approaches and technology deployments.

9.5.1 Video Surveillance

The designer shall design or modify Video Surveillance Systems (VSS) at stations that are identified in the scope of work or as otherwise directed by the San Diego Association of Governments (SANDAG) Project Manager. VSS systems are covered in detail in the LRT Design Criteria, Chapter 6. The design of the VSS shall include, but not be limited to,

selection of camera types and locations, digital video recorders, poles and foundations, conduit and cabling, wide area network connections, and miscellaneous materials and equipment required for a complete installation. As directed by the Project Manager, security equipment shall be installed in its own enclosure or room. This enclosure or room shall be located near the utility service points or utility room. "Smart" cameras, also known as analytics, are desirable in stations.

VSSs shall be placed on the Wide Area Network. Microprocessor controllers and control system software shall be compatible with the existing system and shall support connections to a fiber-optic cable network without requiring replacement. All VSS cabling shall be outdoor-rated and properly sized for its intended use. The type of camera desired for the specific application shall dictate the type of communication method to be used between it and the network equipment (e.g., Ethernet, serial, or analog). All network cabling and interfaces shall conform to the requirements of LRT Design Criteria, Chapter 6 "Communications," "Local Area Network (LAN)."

If a station will be used by passengers going to or from a special event in the surrounding area on a regular basis, a Video Surveillance Monitoring Station shall be incorporated into existing monitoring stations in the Metropolitan Transit System Control Center unless otherwise directed by SANDAG.

9.5.2 Intrusion Detection/Access Control

Intrusion Detection and Access Control shall be incorporated into design as specified in the design scope of work and as indicated below (refer also to LRT Design Criteria, Chapter 6).

a) Access Control of Systems Facilities

Control and system facilities, such as communications enclosures, railway signal cabinets, utility service cabinets, access doors, and traction power substations, shall be locked with standard locks acceptable to the operator to restrict access in conformance with Code of Federal Regulations Title 49 Part 236.3. Enclosures and cabinets shall be designed to accept the operator's standard padlocks to prevent intrusion. Traction power substation, communications building, and room doors shall be keyed to accept the operator's standard keys. Intrusion detection of communications enclosures, railway signal cabinets, utility service cabinets, access doors, and traction power substations shall be evaluated on a project-specific basis and is not required unless otherwise directed by the Project Manager.

b) Access Control of Secured Facilities

Doors that are intended to restrict public access at points of entry into secure facilities shall include existing access control systems, except where achieving compatibility is not feasible, then the designer shall develop design alternatives as approved by SANDAG and the operator. Facilities that typically require access control readers include, but are not be limited to, underground station ancillary areas, fare handling areas, records and high value storage areas, control centers, and security control facilities.

Access to yards and storage facilities shall be controlled using security fences, locked gated access points, video surveillance systems, bollards, and automated spike systems (refer to Section 9.6).

9.6 Fire Protection

The designer shall prepare complete Plans, Special Provisions, and Engineer's Estimate for fire protection systems where specified or required that shall conform to all applicable federal, state, and local requirements for fire protection systems and fire-resistant materials and construction including, but not limited to, the requirements of the California Building Code (CBC) (refer to Section 9.9 for additional fire protection requirements.)

The designer shall submit complete plan sets to the applicable agency (state and/or city fire marshals) for review and approval. Any site walks or meetings required for agency review and approval shall be coordinated by the designer with the state and/or city fire marshals. Revisions shall be incorporated into the plan set as needed for approval. Resubmittals shall continue until approval is obtained.

9.7 Facilities

Non-public facilities, including maintenance, office and storage buildings, and yards, shall include security hardening systems. Security hardening systems may include the following elements as required to adequately secure the facility:

- Security fencing—Security fencing shall be made of chain link or tubular steel. Chain-link fencing shall be in accordance with California Department of Transportation Section 80-4 and, as required, be designed with a barbed wire/razor wire configuration (Barbed Tape Concertina or Barbed Tape Obstacle). Tubular steel fencing shall have a curved speared top guard and be designed to prevent climbing. Placement of fences shall comply with all right-of-way and clearance requirements as given in Section 5.7 and Part 3, Section 3.3.1.2.
- Security gates—The number of security gates shall be minimized. Security gates shall include both vehicle and man gates and shall be designed with the same material and style as the adjoining fence.
- Video Surveillance System—Types and placement of cameras shall be coordinated with the Project Manager. Once type and location of cameras have been determined, the designer shall include layout for conduit runs, power sources, and connection points (refer to Section 9.4).
- Card Access Control—Refer to Section 9.5.2 (b).
- Lighting—Illumination from lighting shall be sufficient to allow the VSS to operate properly. All lighting designs shall be coordinated with the camera types and locations.
- Additional elements, such as bollards and automated spike systems, may be incorporated as directed by the Project Manager.

9.8 Tunnels

9.8.1 Safety

a) Emergency Ventilation

Tunnel ventilation systems shall be designed in accordance with the following guides, codes, and standards:

- National Fire Protection Association Standard (NFPA) 130 Fixed Guideway Transit Systems (2010 edition)
- U.S. Department of Transportation Subway Environmental Design Handbook and Subway Environment Simulation Computer Program, together with its associated volumes and parts (1976)

Tunnel ventilation system must handle normal, congested, and fire emergency conditions. In normal operation, trains move through the system according to schedule. Trains operating in a tunnel will generate heat due to traction power, braking, and on board conditioning units/systems. The tunnel ventilation system shall be designed to remove heat generated by the trains and provide an outside air supply to the tunnel. A train stopped inside a tunnel due to congestion or any abnormal non-fire condition, will result in congested operation. The maximum allowable average tunnel air temperature at the congested train location shall not rise above the outdoor temperature by more than 5 degrees Celsius. A train on fire inside a tunnel or station will result in emergency operation. Under emergency operation, when a train fire occurs within the station trackway or inside the tunnel between stations, a tenable path for passenger evacuation and fire-fighting purposes must be created. This can be achieved through longitudinal ventilation or local smoke evacuation.

A comprehensive and systematic air quality analysis of any tunnel ventilation system shall be performed to ensure that the emissions from tunnel ventilation systems do not result in any exceedances of either the National Ambient Air Quality Standards or California Air Resources Board (California Code of Regulations Title 17) guidelines.

b) Lighting/Emergency Lighting and Emergency Backup Power System

General lighting shall be provided throughout the tunnel at a minimum maintained illumination level of 1.5 footcandles at the walking surface of walkways and all other components of emergency exits.

Threshold lighting shall be provided in the tunnel for a distance of 100 feet from each portal, at a minimum maintained illumination level of 10 footcandles at the walkway surface.

Emergency lighting shall be provided throughout the tunnel at a minimum maintained illumination level of 0.25 footcandles at the walking surface of walkways and all other components of emergency exits. The design of emergency backup power systems for emergency lighting and communication systems shall comply with all applicable federal, state, and local rules and regulations for the facility, in particular NFPA 130-2014, Section 6.4.7. The emergency backup power system shall provide a minimum of three hours continuous operation and shall have a maximum start-up time of three seconds.

Additional loads for the backup power system shall be included at the direction of the Project Manager.

c) Evacuation/Emergency Egress

Tunnels shall have raised walkways along the tunnel wall on both inbound and outbound sides of the track. Curb height for walkway shall not be greater than 8 inches and shall be designed to facilitate direct egress through the side doors of transit vehicles. The width shall be no less than 4 feet with minimum lateral clearance of 30 inches from the walkway surface to a height of 7 feet. Walkways shall extend the entire length of the tunnel structure and tie into the station platform area and/or the tunnel portal access area. Maximum cross slope of walkways, toward the trackway, shall not exceed 1 percent. A continuous handrail, meeting CBC requirements, shall be included in the design. Where double track is divided by a separation wall, access doors shall be located every 100 feet.

Signage shall be provided on the tunnel walls indicating location and direction to the nearest exit. Signage shall be painted on walls with minimum vertical size of 12 inches and shall be located the full length of the tunnel at 50-foot intervals. Signage shall be well illuminated and emergency lighting shall be provided.

Emergency telephones shall be located every 300 feet along the walkway and comply with NFPA 130 and the authority having jurisdiction.

d) Emergency Access

Access to the tunnel from either the portal or station side shall be such that emergency response personnel may gain access along with emergency equipment. At portals, where access is gained by stairs, sufficient clearances shall be provided to allow access of emergency personnel and their equipment. Any roadways to portals shall be designed to accommodate emergency vehicles. The designer shall coordinate with local emergency responders for emergency vehicle requirements.

9.8.2 Security

Portals, both external and interior, shall be equipped with an intrusion detection system (IDS) or "Hardened." The IDS shall have both audible and visual alarms that will provide notification to light rail vehicle operators in the vicinity and provide an alarm at a security control center. In addition, the IDS shall have digital recording capacity with time stamping capability. The designer shall incorporate proven and upgradable technology with an intuitive Graphic User Interface that is compatible with current SANDAG network systems. The designer shall coordinate with the operator's security and information technology managers for current system platforms. All system components shall be tamper proof, National Electrical Manufacturers Association rated, and conform to applicable Underwriters Laboratories standards. Conceptual design, layout, and equipment proposed shall be submitted during the 35 percent submittal process.

a) Access Control of Tunnel Entry Points

At a minimum, tunnel entry points, such as portals and connections to underground stations, shall have automatic motion detection systems and audio/visual warning devices to cover a defined security zone (refer also to Section 9.5.2).

1) Motion Detection

All non-public and emergency entrances and exits shall have a rule-based motion detection system that will be able to differentiate between authorized vehicles such as light rail vehicle cars or maintenance vehicles, and intruders, such as people on foot or foreign objects. When activated, the motion detection system shall automatically deploy audio/visual alarms locally (see below) and at a designated security control center.

2) Audio/Visual Warning

Local audio alarms shall include audio annunciations or sirens through amplified speakers, either automated or manually performed through the security control center, and visual warnings such as spinning red lights, strobes, or high-capacity flashers upon perimeter breach. Additional audio/visual warnings shall be provided at the designated security control center, such as a buzzing/beeping alarm and/or flashing bulb indicators.

9.9 Elevated Guideway

Elevated guideways shall comply with NFPA 130.

9.10 Fire/Life/Safety

a) General

System fire/life/safety design shall be in compliance with the California Public Utilities Commission, the Institute of Electrical and Electronics Engineers, the NFPA, the California Fire Code (CFC), the CBC, and Underwriters Laboratories standards and guidelines. The design shall include provisions to detect and notify patrons, operational personnel, and emergency response teams of hazardous conditions. These provisions shall allow for a safe and timely evacuation of patrons and operational personnel from the facility. The design shall also include safeguards to help minimize patrons, operational personnel, and emergency response forces' exposure to hazards. Systems to be considered in the design shall include, but not be limited to, the following:

Fire Protection—May include the following systems and/or components as needed or required by regulation or code:

1) Protective signaling systems, including fire and smoke detectors, audio/visual alarms, and warning devices.
2) Fire suppression system using either automatic/pre-action sprinkler protection or a clean agent, environmentally acceptable fire extinguishing system. Multipurpose portable fire extinguishers shall also be provided.
3) Water supply and fire hydrants sufficient for facility system.
4) Standpipes for at-grade, elevated, and subterranean facilities.
5) Emergency Management Panel shall be provided in any facility operating elevators, escalators, or emergency ventilation system. The Emergency Management Panel

shall be located in the immediate vicinity of the main or primary entrance to the facility.

Emergency Lighting and Signing—All required lights and signs for exits and places of safety shall be provided. Exit signs shall be illuminated internally. All emergency lighting shall be on the uninterruptible power supply. Signage for emergency contact information shall also be provided.

Communication—Refer to LRT Design Criteria, Chapter 6.

b) Power Supply

Uninterruptible power supply shall be provided for all critical fire/life/safety systems as directed by the SANDAG Director of Mobility Management and Project Implementation.

c) Fire Lanes

Fire lanes shall be designated around facilities in accordance with the CFC and as approved by the local and/or State Fire Marshall. Where facilities are elevated or subterranean, elevators and stairwells shall be designed in accordance to the CBC and CFC to accommodate passage of emergency response personnel and their equipment. Ancillary rooms shall allow for emergency access by keyed locks or electronic entry devices.

APPENDIX A REQUEST TO DEVIATE FROM BASELINE DESIGN CRITERIA OR STANDARD

Request to Deviate from Baseline Design Criteria or Standard

Date of Request: _____ Request No.: _____

ORIGINATOR	Requested By: _____ Consultant: _____ Project Name: _____ Project Number: _____
DEVIATION SOUGHT	Attach relevant standard/criteria/drawing/document showing "before" and "after" proposed deviation. Specify Baseline Documents including item number to be deviated from below:
REASON FOR REQUEST	Explain Reason For Request (Benefit or impact if not pursued):
JUSTIFICATION FOR DEVIATION	Explain Justification for Deviation: Cost Impact: $ Schedule Impact:
SANDAG APPROVALS	Project Manager Date Principal Engineer/Corridor Director Date SANDAG Director of Rail Date

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