



COLORADO
Department of Transportation

Colorado Tunnel Inventory & Inspection Manual

Draft: April 4, 2018



Colorado Tunnel Inventory
&
Inspection Manual

April 4, 2018

Reviewed By:

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Table of Contents

| | |
|--|-------|
| SECTION 1 INTRODUCTION | 1.1 |
| 1.1 Organization of the Specifications | 1.2 |
| 1.2 History of the Colorado Tunnel Inventory and Inspection Manual | 1.2 |
| 1.3 Purpose of the Specifications..... | 1.3 |
| 1.4 Units | 1.3 |
| SECTION 2 TUNNEL INVENTORY ITEMS | 2.1 |
| 2.1 Introduction | 2.4 |
| 2.2 Identification Items | 2.6 |
| 2.3 Age and Service Items..... | 2.23 |
| 2.4 Classification Items | 2.32 |
| 2.5 Geometric Data Items..... | 2.39 |
| 2.6 Inspection Items..... | 2.45 |
| 2.7 Load Rating and Posting Items..... | 2.52 |
| 2.8 Navigation Items | 2.59 |
| 2.9 Structure Type and Material Items | 2.62 |
| SECTION 3 ELEMENTS | 3.1 |
| 3.1 Introduction | 3.2 |
| 3.2 Structural Section..... | 3.6 |
| 3.3 Civil Section | 3.115 |
| 3.4 Mechanical Systems Section..... | 3.139 |
| 3.5 Electrical and Lighting Systems Section | 3.163 |
| 3.6 Fire/Life Safety/Security Systems Section | 3.183 |
| 3.7 Signs Section | 3.196 |
| 3.8 Protective Systems Section..... | 3.203 |
| SECTION 4 INSPECTION AND SAFETY STANDARDS | 4.1 |
| 4.1 Introduction – Inspection & Safety Standards..... | 4.3 |
| 4.2 CDOT Organization and Hierarchy | 4.3 |
| 4.3 Inspector Qualifications | 4.3 |
| 4.3.1 Consultant Program Manager..... | 4.4 |

Click to return to:



4.3.2 Team Leader..... 4.4

4.3.3 General Inspectors 4.5

4.3.4 Specialty Contractors or Discipline Specific Inspectors 4.5

4.4 Inspection Procedures, Techniques and Scheduling..... 4.6

4.4.1 Mobilization, Planning, Scheduling 4.6

4.4.2 Existing Tunnel Records 4.7

4.4.3 Traffic Control 4.7

4.4.4 Confined Space Entry 4.8

4.4.5 Lockout Tag-out 4.8

4.4.6 Night Inspection Work 4.8

4.4.7 Pre-Inspection Preparation of Tunnel..... 4.9

4.5 Inspection Types and Frequencies..... 4.9

4.5.1 Initial Inspection..... 4.10

4.5.2 Routine Inspection 4.10

4.5.3 Special Inspections 4.13

4.5.4 In-Depth Inspections 4.14

4.5.5 Damage Inspections..... 4.15

4.6 Health and Safety Procedures..... 4.15

4.6.1 Night Inspection Safety 4.17

4.6.2 Confined Space Safety..... 4.18

4.6.3 Hazardous Materials 4.19

4.6.4 Lockout/ Tag-Out 4.19

4.6.5 Traffic Control Safety 4.19

4.6.6 Overhead Power/Utility Lines 4.20

4.6.7 Electrical/Arc Flash..... 4.21

4.6.8 4.23

4.7 Inspection Techniques 4.24

SECTION 5 INSPECTION FINDINGS, DATA CAPTURE AND REPORT DELIVERABLES 5.1

5.1 Data Collecting and Deliverables 5.2

5.1.1 Recommended Complex Tunnel Report Content 5.2



5.1.2 Recommended Simple Tunnel Report Content 5.3

5.1.3 Cover Page 5.3

5.1.4 Tunnel Information 5.3

5.1.5 Introduction 5.3

5.1.6 Purpose and Scope..... 5.3

5.1.7 General System Descriptions 5.3

5.1.8 Inspection Procedures 5.4

5.1.9 Structure Inventory and Appraisal Report..... 5.4

5.1.10 Vertical Clearance Measurements..... 5.4

5.1.11 Inspection Findings 5.5

5.1.12 Inspection Results 5.5

5.1.13 Asset Recommendations 5.5

5.1.14 Appendices..... 5.6

5.1.15 Photographs..... 5.6

5.1.16 Sketches 5.6

5.1.17 Field Records..... 5.7

5.1.18 Auxiliary Report..... 5.7

5.2 Critical Inspection Finding / Essential Repair Findings..... 5.8

5.3 Condition State 4 Review Procedures..... 5.9

SECTION 6 ASSET RECOMMENDATIONS..... 6.1

6.1 Introduction 6.2

6.2 Functional Systems Test and Routine Maintenance..... 6.2

6.3 Asset Recommendations per the Inspection..... 6.3

6.3.1 Area of Repair 6.3

6.3.2 NTIS/CDOT Element 6.4

6.3.3 Action 6.4

6.3.4 Category..... 6.4

6.3.5 Priority..... 6.5

6.3.6 Timeline..... 6.7

6.3.7 Quantity and Type..... 6.7



6.3.8 Auxiliary Tasks 6.8

6.3.9 Estimated Cost 6.8

6.3.10 Status 6.8

6.3.11 Date Recommended 6.9

6.3.12 Commentary of Recommendation 6.9

6.4 Testing or Follow-Up Inspection Recommendations per the Inspection 6.9

SECTION 7 TUNNEL SPECIFIC INFORMATION 7.1

7.1 Introduction 7.2

7.2 Eisenhower and Johnson Memorial Tunnels 7.3

7.2.1 Tunnel Information 7.3

7.2.2 Unique Systems..... 7.3

7.2.3 Emergency Response and Plan of Action..... 7.6

7.2.4 Traffic Control Procedures 7.6

7.2.5 Inspection Personnel..... 7.6

7.3 Hanging Lake Tunnels 7.7

7.3.1 Tunnel Information 7.7

7.3.2 Unique Systems..... 7.7

7.3.3 Emergency Response and Plan of Action Provided by CDOT 7.8

7.3.4 Traffic Control Procedures 7.9

7.3.5 Inspection Personnel..... 7.9

7.4 Wolf Creek Tunnel 7.9

7.4.1 Tunnel Information 7.9

7.4.2 Unique Systems..... 7.9

7.4.3 Inspection Personnel..... 7.10

7.4.4 Traffic Control Procedures 7.10

7.5 Speer Blvd. Tunnel 7.11

7.5.1 Unique Systems..... 7.11

7.6 Simple Tunnels 7.11

7.6.1 Unlined Rock Tunnels..... 7.11

7.6.2 Off-System Tunnels..... 7.11



7.6.3 Traffic Control 7.11

Section 1 Introduction

| | |
|---|-----|
| 1.1 Organization of the Specifications..... | 1.2 |
| 1.2 History of the Colorado Tunnel Inventory and Inspection Manual..... | 1.2 |
| 1.3 Purpose of the Specifications | 1.3 |
| 1.4 Units..... | 1.3 |



1.1 Organization of the Specifications

- **Section 1 Introduction** is comprised of Organization of the Specifications, History of the Colorado Tunnel Inventory and Inspection Manual, Purpose of the Specifications, Units, and Acronyms.
- **Section 2 Tunnel Inventory Items** is comprised of eight characteristics representing each tunnel's: Identification Items, Age and Service, Classification, Geometric Data, Inspection, Load Rating and Posting, Navigation, and Structure Type & Material.
- **Section 3 Elements** is comprised of tunnel elements: Structural, Civil, Mechanical Systems, Electrical Systems, Lighting Systems, Fire/Life Safety/Security Systems, Signs, and Protective Systems. It is organized by general element type, material, and their physical location in the tunnel.
- **Section 4 Inspection and Safety Standards** is comprised of general tunnel safety guidelines and procedures for inspection as well as qualifications and recording requirements for tunnel inspections.
- **Section 5 Inspection Findings, Data Capture and Report Deliverables** is comprised of data collection, deliverables, and the procedure for reporting an Essential Repair Finding (ERF).
- **Section 6 Asset Recommendations** is comprised of definitions and guidance regarding criticality, timing and maintenance action code for asset recommendations made during the inspection.
- **Section 7 Tunnel Specific Information** is comprised of tunnel introductions and inspection procedures associated with Colorado's complex tunnels and region simple tunnels.

1.2 History of the Colorado Tunnel Inventory and Inspection Manual

The *National Tunnel Inspection Standards (NTIS)* were established following the ceiling collapse of the Interstate 90 tunnel in Boston, Massachusetts. The President signed the Moving Ahead for Progress in the 21st Century Act (MAP-21) which requires the Secretary to establish a national tunnel inventory and inspection standards. This led to the release of the *Tunnel Operations, Maintenance, Inspection, and Evaluation Manual (TOMIE)* and the *Specifications for the National Tunnel Inventory (SNTI)* on July 15, 2015.

Element based inspection practices have advanced the infrastructure inspection process. NTIS has applied this method to tunnels. It is intended that this inspection and reporting process will help create more efficient tunnel management systems, provide a process for overall condition assessment, and project a maintenance plan. Inspecting in-service tunnels is vital in protecting the traveling public, preserving the states tunnel investment, and ensuring goods are transported efficiently. The Colorado Tunnel Inventory and Inspection Manual (CTIIM) was adapted from the TOMIE and SNTI to provide additional state specific requirements. It is formatted with the intent that reports will have all the desired elements for both the National Tunnel Inventory (NTI) and the Colorado Department of Transportation (CDOT), and not require any modifications for submittal.

Prior to the NTIS release, Colorado inspected its tunnels under the National Bridge Inspection Standards using established unique structure keys or Tunnel Numbers. At the time of this publication, 20 state owned tunnels exist on the highway system, as well as 11 tunnels owned by local cities and counties.



The Colorado tunnel system is paramount to transportation along the east-west corridor of Interstate 70 as well as throughout the state.

CDOT MISSION STATEMENT

The mission of the Colorado Department of Transportation is to provide the best multi modal transportation system for Colorado that most effectively moves people, goods, and information.

CDOT VALUES

Safety – We work and live safely! We protect human life, preserve property, and put employee safety before production.

People – We value our employees! We acknowledge and recognize the skills and abilities of our coworkers, place a high priority on employee safety, and draw strength from our diversity and commitment to equal opportunity.

Integrity – We earn Colorado’s trust! We are honest and responsible in all that we do and hold ourselves to the highest moral and ethical standards.

Customer Service – We satisfy our customers! With a can-do attitude we work together and with others to respond effectively to our customer’s needs.

Excellence – We are committed to quality! We are leaders and problem solvers, continuously improving our products and services in support of our commitment to provide the best transportation systems for Colorado.

Respect – We respect each other! We are kind and civil with everyone, and we act with courage and humility.

1.3 Purpose of the Specifications

The Colorado Tunnel Inventory and Inspection Manual was prepared for the Colorado Department of Transportation to compliment tunnel inventory and inspections. The specifications and procedures in this manual will satisfy the requirements from the NTIS and MAP-21, as well as providing CDOT with state specific elements. It encompasses two federal documents as result of the NTIS, the SNTI, and TOMIE. The SNTI is fully incorporated into the CTIIM and any additions or modifications for CDOT purposes are incorporated into this manual. CDOT additions and modifications are identified in *italic* for NTI items. The TOMIE incorporation is the accepted manual to be followed and referenced by the inspection staff in partnership with this manual. The CTIIM will be used to inspect on and off system tunnels in the state of Colorado and provide consistent inspection requirements throughout the state.

1.4 Units

All units within this specification are United States customary units.

Section 2 Tunnel Inventory Items

| | |
|--|-------------------------------------|
| 2.1 Introduction..... | 2.4 |
| 2.2 Identification Items..... | 2.6 |
| Item I.1 - Tunnel Number | 2.7 |
| Item I.2 - Tunnel Name | 2.7 |
| Item I.3 - State Code | Error! Bookmark not defined. |
| Item I.4 - County Code..... | 2.9 |
| Item I.5 - Place Code..... | 2.10 |
| Item I.6 – Highway Agency District..... | 2.10 |
| Item I.6.1– Transportation Region..... | 2.12 |
| Item I.7 – Route Number | 2.13 |
| Item I.8 – Route Direction | 2.14 |
| Item I.9 – Route Type..... | 2.15 |
| Item I.10 – Facility Carried..... | 2.16 |
| Item I.11 –LRS Route ID | 2.16 |
| Item I.12 – LRS Mile Point..... | 2.17 |
| Item I.13 – Tunnel Portal’s Latitude | 2.18 |
| Item I.14 – Tunnel Portal’s Longitude..... | 2.18 |
| Item I.15 – Border Tunnel State or County Code | 2.19 |
| Item I.16 – Border Tunnel Financial Responsibility | 2.19 |
| Item I.17 – Border Tunnel Number..... | 2.20 |
| Item I.18 – Border Tunnel Inspection Responsibility..... | 2.21 |
| 2.3 Age and Service Items..... | 2.23 |
| Item A.1 – Year Built | 2.24 |
| Item A.2 – Year Rehabilitated..... | 2.24 |
| Item A.3 – Total Number of Lanes..... | 2.25 |
| Item A.4 – Annual Average Daily Traffic..... | 2.26 |
| Item A.4.1 – Peak Hourly Traffic Count | 2.26 |
| Item A.4.2 – Date of Peak Hourly Traffic Count..... | 2.27 |
| Item A.5 – Annual Average Daily Truck Traffic | 2.28 |

[Click to return to:](#)



Item A.5.1 – Percentage of Average Daily Truck Traffic 2.28

Item A.6 – Year of Annual Average Daily Traffic..... 2.29

Item A.7 – Detour Length 2.29

Item A.8 – Service in Tunnel 2.30

2.4 Classification Items 2.32

Item C.1 – Owner 2.33

Item C.2 – Operator 2.34

Item C.3 – Direction of Traffic..... 2.34

Item C.4 – Toll 2.35

Item C.5 – NHS Designation 2.35

Item C.6 – STRAHNET Designation 2.36

Item C.7 – Functional Classification 2.36

Item C.8 – Urban Code..... 2.37

2.5 Geometric Data Items..... 2.39

Item G.1 – Tunnel Length 2.40

Item G.2 – Minimum Vertical Clearance over Tunnel Roadway 2.41

Item G.3 – Roadway Width, Curb-to-Curb..... 2.41

Item G.4 – Left Sidewalk Width 2.42

Item G.5 - Right Sidewalk Width..... 2.43

2.6 Inspection Items 2.45

Item D.1 – Routine Inspection Target Date 2.46

Item D.2 – Actual Routine Inspection Date 2.46

Item D.3 – Routine Inspection Interval..... 2.47

Item D.4 – In-Depth Inspection 2.47

Item D.4.1 – In-Depth Inspection Date..... 2.48

Item D.4.2 – In-Depth Inspection Frequency..... 2.48

Item D.5 – Damage Inspection 2.49

Item D.5.1 - Damage Inspection Date..... 2.49

Item D.6.1 - Special Inspection Date..... 2.50

Item D.6.2 – Special Inspection Frequency 2.51



2.7 Load Rating and Posting Items 2.52

 Item L.1 – Load Rating Method 2.53

 Item L.2 – Inventory Load Rating Factor..... 2.54

 Item L.3 – Operating Load Rating Factor 2.54

 Item L.4 – Tunnel Load Posting Status..... 2.54

 Item L.5 – Posting Load - Gross 2.55

 Item L.6 – Posting Load – Axle 2.55

 Item L.7 – Posting Load –Type 3 2.56

 Item L.8 – Posting Load – Type 3S2 2.56

 Item L.9 – Posting Load – Type 3-2..... 2.57

 Item L.10 – Height Restriction 2.57

 Item L.11 – Hazardous Material Restriction 2.58

 Item L.12 – Other Restrictions..... 2.58

2.8 Navigation Items..... 2.59

 Item N.1 – Under Navigable Waterway..... 2.60

 Item N.2 – Navigable Waterway Clearance 2.60

 Item N.3 – Tunnel or Portal Island Protection from Navigation..... 2.61

2.9 Structure Type and Material Items..... 2.62

 Item S.1 – Number of Bores 2.63

 Item S.2 – Tunnel Shape 2.63

 Item S.3 – Portal Shape..... 2.64

 Item S.4 – Ground Conditions..... 2.65

 Item S.5 – Complex 2.65

 Item S.6 – Portal Material Type 2.66

 Item S.7 – Liner Material Type..... 2.66



2.1 Introduction

Section 2 presents tunnel inventory items arranged into the categories, described below, to facilitate ease of use and consistency by tunnel inspectors in the field. The inventory items for a tunnel describe the function and characteristics of the tunnel in a specific format. Items reported to the FHWA are defined by NTI in the SNTI. This manual contains both NTI and CDOT defined inventory items. They can be differentiated by the second column in the header of each inventory item.

The Item ID is a unique indicator assigned to each tunnel item, it is a letter followed by a number. Inventory items are identified by a letter based on the section and a number based on the order of appearance in that section. *Identification* items are identified with an “I” (Section 2.2), *Age and Service* items are identified with an “A” (Section 2.3), *Classification* items with a “C” (Section 2.4), *Geometric Data* items with a “G” (Section 2.5), *Inspection* items with a “D” (Section 2.6), *Load Rating and Posting* items with a “L” (Section 2.7), *Navigation* items with “N” (Section 2.8), and *Structure Type & Material* items with a “S” (Section 2.9).

For consistency amongst all CDOT asset inspection manuals, the terms Specification and Commentary referenced within the SNTI shall be replaced with Description and Procedure respectively. Additional Commentary shall be provided for state specific guidance.

The Description and Procedure portions provide the detailed description of each inventory item and some explanation or additional clarification to consider for coding each item. The Description is the required information to be recorded and shall be followed. The Procedure is intended to provide clarifying information and general guidance for recommended methods to meet the Description. Where there is ambiguity in the Description, state specific guidance has been provided in *italic*. State specific guidance shall not alter the data to be returned to the FHWA, but shall provide consistency amongst inspectors. If necessary, the FHWA Division office should be consulted for clarification and/or additional guidance.

The Coding Example portion provides examples of how to code the item.

Most inventory items for a specific tunnel will be recorded and submitted to CDOT for the initial inspection. The majority of these items will not change from inspection to inspection unless a rehabilitation or reconstruction has been performed. Review of the inventory items prior to the submittal of each inspection should be performed to ensure correctness of the information. If corrections may be necessary, they should be discussed with the appropriate program manager.

DESCRIPTION

Detailed description of requirements for each inventory item.

PROCEDURE

A series of explanations for each inventory item.

FORMAT

The *data entry* format of an item is broken into 6 parts: (1) Inventory Item Name, (2) Format, (3) Item ID, (4) Description, (5) Procedure and (6) Examples.



The Inventory Item Name is the name used to describe that particular item.

The Format details how the item should be coded by using one of following descriptions and lengths:

- AN# (Alpha Numeric where the # is the length of the field or unlimited if left blank)
 - AN3 is an example of an alpha numeric with a limit of 3 characters
- N# (Numeric where # is the length of the field)
- N(X,Y) indicates a decimal, where X is the length of the field and Y is the number places to the right of the decimal
 - Leading 0's are required for some numeric formats
- D (Date recorded as MMDDYYYY)
 - Leading 0's are required for date formats
- FP (X,Y) (Floating Point where X is the length of the number and Y is the number of decimals)



2.2 Identification Items

The items in this section uniquely identify and locate the tunnel.

ITEM I.1 - TUNNEL NUMBER 2.7

ITEM I.2 - TUNNEL NAME 2.7

ITEM I.3 - STATE CODE **ERROR! BOOKMARK NOT DEFINED.**

ITEM I.4 - COUNTY CODE 2.9

ITEM I.5 - PLACE CODE 2.10

ITEM I.6 – HIGHWAY AGENCY DISTRICT 2.10

ITEM I.6.1– TRANSPORTATION REGION 2.12

ITEM I.7 – ROUTE NUMBER 2.13

ITEM I.8 – ROUTE DIRECTION 2.14

ITEM I.9 – ROUTE TYPE 2.15

ITEM I.10 – FACILITY CARRIED 2.16

ITEM I.11 –LRS ROUTE ID 2.16

ITEM I.12 – LRS MILE POINT 2.17

ITEM I.13 – TUNNEL PORTAL’S LATITUDE..... 2.18

ITEM I.14 – TUNNEL PORTAL’S LONGITUDE 2.18

ITEM I.15 – BORDER TUNNEL STATE OR COUNTY CODE 2.19

ITEM I.16 – BORDER TUNNEL FINANCIAL RESPONSIBILITY 2.19

ITEM I.17 – BORDER TUNNEL NUMBER..... 2.20

ITEM I.18 – BORDER TUNNEL INSPECTION RESPONSIBILITY 2.21



| | | |
|--------------------------|-----|-----|
| Item I.1 - Tunnel Number | NTI | I.1 |
|--------------------------|-----|-----|

DESCRIPTION

Record the unique Tunnel Number assigned according to agency policy for each tunnel meeting the NTIS definition.

Do not change the Tunnel Number once it has been assigned and recorded.

PROCEDURE

There are no national policies established for assigning unique Tunnel Numbers. Therefore, each state transportation department, federal agency, or tribal government develops their own policy for assigning unique Tunnel Numbers.

It is preferable that one Tunnel Number be assigned to tunnels with multiple bores including ramps where they are connected, such as those sharing ventilation systems, etc.

When recording separate Tunnel Numbers for tunnels carrying multiple bores it is recommended to append the Tunnel Number with “L”, “C” or “R” looking stations ahead, where L=left, C=center, and R=right.

Consult the local FHWA Division office for questions concerning assigning Tunnel Numbers to unique or Complex tunnels.

COMMENTARY

See Appendix II: Existing Colorado Tunnels, for current Tunnel Numbers and maps.

FORMAT

AN15

CODING EXAMPLES

| <u>Description</u> | <u>NTI Code</u> |
|--------------------------|-----------------|
| Clear Creek Canyon No. 1 | F-15-AY |
| Johnson Tunnel | F-13-X |

| | | |
|------------------------|-----|-----|
| Item I.2 - Tunnel Name | NTI | I.2 |
|------------------------|-----|-----|

DESCRIPTION

Record the Tunnel Name assigned by the agency. If the tunnel is not named, leave this item blank.

PROCEDURE

There are no national policies established for assigning unique Tunnel Names. Therefore, each State Transportation Department or Federal agency develops their own policy for assigning unique Tunnel Names.

It is preferable that one Tunnel Name be assigned to tunnels with multiple bores.



COMMENTARY

Not all 100 format spaces must be filled.

FORMAT

AN100

CODING EXAMPLES

Description

NTI Code

Clear Creek Canyon No 1

Clear Creek No. 1

Johnson Tunnel (EJMT Eastbound)

Johnson Tunnel

| | | |
|-----------------------|-----|-----|
| Item I.3 - State Code | NTI | I.3 |
|-----------------------|-----|-----|

DESCRIPTION

Record the State Code where the tunnel is located using one of the codes in the table below.

PROCEDURE

State Codes are derived from the FIPS, Standard Codes for States (FIPS PUB 5-2).

COMMENTARY

In the case of a tunnel being shared between states, the State Code should reflect the state who is responsible for the maintenance of the tunnel. There are no tunnels currently in the Colorado system that are shared.

| State | FIPS Code |
|-------------------|-----------|
| Colorado | 08 |
| Nebraska | 31 |
| Arizona | 04 |
| New Mexico | 35 |
| Oklahoma | 40 |
| Kansas | 20 |
| Utah | 49 |
| Wyoming | 56 |

FORMAT

N (2,0)

CODING EXAMPLES

Click to return to:

Section 2



Description

NTI Code

Colorado

08

| | | |
|------------------------|-----|-----|
| Item I.4 - County Code | NTI | I.4 |
|------------------------|-----|-----|

DESCRIPTION

Record the FIPS code for the county, parish or borough in which the tunnel is located.

PROCEDURE

Use the FIPS codes in the current version of the Census of Population and Housing – Geographic Identification Code Scheme to determine the appropriate code.

County parish or borough codes can be found through a link at the following web site:

<http://www.census.gov/geo/reference/ansi.html>

COMMENTARY

Use the table below to identify the appropriate CDOT County Code where the tunnel is located. If a tunnel passes through multiple counties, use the county that predominately encompasses the tunnel.

| <u>County</u> | <u>FIPS</u> | <u>County</u> | <u>FIPS</u> | <u>County</u> | <u>FIPS</u> | <u>County</u> | <u>FIPS</u> |
|---------------|-------------|---------------|-------------|---------------|-------------|---------------|-------------|
| Adams | 001 | Dolores | 033 | Lake | 065 | Pitkin | 097 |
| Alamosa | 003 | Douglas | 035 | La Plata | 067 | Prowers | 099 |
| Arapahoe | 005 | Eagle | 037 | Larimer | 069 | Pueblo | 101 |
| Archuleta | 007 | Elbert | 039 | Las Animas | 071 | Rio Blanco | 103 |
| Baca | 009 | El Paso | 041 | Lincoln | 073 | Rio Grande | 105 |
| Bent | 011 | Fremont | 043 | Logan | 075 | Routt | 107 |
| Boulder | 013 | Garfield | 045 | Mesa | 077 | Saguache | 109 |
| Chaffee | 015 | Gilpin | 047 | Mineral | 079 | San Juan | 111 |
| Cheyenne | 017 | Grand | 049 | Moffat | 081 | San Miguel | 113 |
| Clear Creek | 019 | Gunnison | 051 | Montezuma | 083 | Sedgwick | 115 |
| Conejos | 021 | Hinsdale | 053 | Montrose | 085 | Summit | 117 |
| Costilla | 023 | Huerfano | 055 | Morgan | 087 | Teller | 119 |
| Crowley | 025 | Jackson | 057 | Otero | 089 | Washington | 121 |
| Custer | 027 | Jefferson | 059 | Ouray | 091 | Weld | 123 |
| Delta | 029 | Kiowa | 061 | Park | 093 | Yuma | 125 |
| Denver | 031 | Kit Carson | 063 | Phillips | 095 | | |

Click to return to:

Section 2



FORMAT

N (3,0)

CODING EXAMPLES

| <u>Description</u> | <u>NTI Code</u> |
|--------------------|-----------------|
| Clear Creek | 019 |
| Lincoln | 073 |

| | | |
|------------------------------|------------|------------|
| Item I.5 - Place Code | NTI | I.5 |
|------------------------------|------------|------------|

DESCRIPTION

Record the FIPS Place Code for the city, town, township, village, and other census-designated place where the tunnel is located.

Record 00000 if there is no FIPS Place Code for the tunnel’s location.

PROCEDURE

Use the FIPS codes in the current version of the Census of Population and Housing – Geographic Identification Code Scheme to determine the city, town, township, village, or other census-designated Place Code.

FIPS Place Codes can be found through a link at the following web site:
<http://www.census.gov/geo/reference/ansi.html>

COMMENTARY

Use the table in Appendix III: FIPS Place Codes to identify the Place Code, within Colorado, where the tunnel is located.

FORMAT

N (5,0)

CODING EXAMPLES

| <u>Description</u> | <u>NTI Code</u> |
|--------------------|-----------------|
| No Place Code | 00000 |
| Denver | 20000 |

| | | |
|---|------------|------------|
| Item I.6 – Highway Agency District | NTI | I.6 |
|---|------------|------------|

DESCRIPTION

Record the state transportation department district or region number/abbreviation where the tunnel is located. Federal agencies and tribal governments should record this item with their district system.



PROCEDURE

Where districts or regions are identified by number, use the existing number.

Where districts or regions are identified by name, use an abbreviated name.

COMMENTARY

This item is a two part code to identify the Engineering Region (1 digit) and Maintenance Section (1 digit) of the Colorado Department of Transportation District in which the tunnel is located. Maintenance Section Boundaries are generally within the Engineering Region Boundaries. There may be multiple Maintenance Sections within an Engineering Region.

In some cases, usually related to cost efficiency, structures may be assigned to Maintenance Sections outside the Engineering Region. The table below indicates the associated regions and sections. The Engineering Region numbers, Maintenance Section numbers within each Region, and main office locations are listed below. The Maintenance Sections that are marked with an asterisk () have their main offices located in a different Engineering Region but have some maintenance responsibility within the listed Engineering Region's boundary.*

Note: Former Engineering Region 6 and former Maintenance Section 8 no longer exist and have been absorbed by Engineering Region 1 and Maintenance Section 5, respectively.

Code the Engineering Region and Maintenance Section using the following tables below and maps published by the Division of Transportation Development located in Appendix IV: Colorado Region Map and Appendix V: CDOT Maintenance Regions Map.

| Region | Maint. Section | Location | Office Address | Office Phone # |
|--------|----------------|----------------------|--------------------------------|----------------|
| 1 | | REGION 1 OFFICE | 2000 So. Holly St., Denver | 303-757-6459 |
| | Sec 5 | Aurora Maintenance | 18500 E. Colfax | 303-365-7110 |
| | Sec 9 | Eisenhower Tunnel | P.O. Box 397, Idaho Spgs. | 303-512-5730 |
| 2 | | REGION 2 OFFICE | 905 Erie Avenue, Pueblo | 719-546-5452 |
| | Sec 4 | Pueblo Maintenance | 905 Erie Avenue | 719-546-5419 |
| 3 | | REGION 3 OFFICE | 222 So. 6TH St., Grand Jct. | 970-683-6202 |
| | Sec 2 | Grand Junction Maint | 606 So. Ninth St. | 970-683-6305 |
| | Sec 6 | Craig Maintenance | 260 Ranney St. | 970-826-5162 |
| | Sec 7* | Alamosa Maintenance | 1205 West Ave, Grand Jct. | 970-385-1651 |
| 4 | | REGION 4 OFFICE | 1420 2nd St., Greeley | 970-350-2103 |
| | Sec 1 | Greeley Maintenance | 1420 2nd St. | 970-350-2120 |



| | | | | |
|---|--------|-----------------------|--------------------------|--------------|
| | Sec 4* | Pueblo Maintenance | 905 Erie Avenue | 719-546-5419 |
| | Sec 5* | Aurora Maintenance | 18500 E. Colfax, Aurora | 303-365-7110 |
| 5 | | REGION 5 OFFICE | 3803 N. Main, Durango | 970-385-1402 |
| | Sec 2* | Grand Junction Maint. | 606 S. Ninth, Grand Jct. | 970-683-6305 |
| | Sec 3 | Durango Maintenance | 20581 Highway 60 W. | 970-385-1651 |
| | Sec 7 | Alamosa Maintenance | 1205 West Avenue | 970-385-1651 |

FORMAT

N (2,0)

CODING EXAMPLES

Description

NTI Code

Structure located in Engineering Region 1
(Denver, Metro Area), Maintenance Section 5 (Aurora)

15

Structure located in Engineering Region 5 (Durango),
however, is assigned to Maintenance Section 2 in Region 3 (Grand Junction) **52**

| | | |
|--|-------------|--------------|
| Item I.6.1– Transportation Region | CDOT | I.6.1 |
|--|-------------|--------------|

DESCRIPTION

Record the CDOT Transportation Planning Region (TPR) associated with the location of the tunnel.

PROCEDURE

A map showing TPR boundaries is located in Appendix VI.

From the TPR Map, determine the appropriate TPR and enter the code from the table below. The table includes the TPR name, TPR number, and associated counties.

| <u>Transportation Region</u> | <u>Location</u> |
|------------------------------|---|
| 01 | Pikes Peak Area Portions of El Paso County, including Colorado Springs, and portions of Teller County |
| 02 | Greater Denver Adams, Arapahoe, Boulder, Broomfield, Clear Creek, Denver, Douglas, Gilpin, and Jefferson Counties |
| 03 | North Front Range (Ft. Collins) Fort Collins Area, portions of Larimer and Weld Counties |
| 04 | Pueblo Area Pueblo County |

Click to return to:

Section 2



| | |
|-----------|---|
| 05 | Grand Valley Mesa County |
| 06 | Eastern Cheyenne, Elbert, Kit Carson, Lincoln, Logan, Phillips, Sedgwick, Washington, and Yuma Counties |
| 07 | Southeast Baca, Bent, Crowley, Kiowa, Otero, and Prowers Counties |
| 08 | San Luis Valley Alamosa, Chaffee, Conejos, Costilla, Mineral, Rio Grande, and Saguache Counties |
| 09 | Gunnison Valley Delta, Gunnison, Hinsdale, Montrose, Ouray, and San Miguel Counties |
| 10 | Southwest Archuleta, Dolores, La Plata, Montezuma, and San Juan Counties |
| 11 | Intermountain Eagle, Garfield, Lake, Pitkin, and Summit Counties |
| 12 | Northwest Grand, Jackson, Moffat, Rio Blanco, and Routt Counties |
| 13 | Upper Front Range Larimer, Morgan, and Weld Counties |
| 14 | Central Front Range Custer, Fremont, Park, and portions of El Paso and Teller Counties |
| 15 | South Central Huerfano and Las Animas Counties |

FORMAT

N (2,0)

CODING EXAMPLES

| <u>Route Number</u> | <u>Tunnel County</u> | <u>NTI Code</u> |
|---------------------|----------------------|-----------------|
| I70 | Clear Creek | 02 |
| US6 | Jefferson | 02 |
| I70 | Mesa | 05 |

| | | |
|--------------------------------|------------|------------|
| Item I.7 – Route Number | NTI | I.7 |
|--------------------------------|------------|------------|

DESCRIPTION

Click to return to:

Section 2



Record the Route Number that represents the route carried by the tunnel.

Include letters that are used as part of the Route Numbers.

Do not record the Route Direction for divided highways. Identify that information in Item I.8 – Route Direction item.

When multiple routes use the same lane or set of lanes, complete only one Route Number for the lanes using the highest class of route based on Item ID C.7 - Functional Classification.

Code 00000 for tunnels on roads without Route Numbers.

PROCEDURE

When concurrent routes are of the same hierarchy level, record the lowest numbered route.

FORMAT

AN5

CODING EXAMPLES

| <u>Route Number</u> | <u>NTI Code</u> |
|----------------------------|------------------------|
| I70 Westbound | 00070 |
| US 6 | 00006 |
| City Street | 00000 |

| | | |
|-----------------------------------|------------|------------|
| Item I.8 – Route Direction | NTI | I.8 |
|-----------------------------------|------------|------------|

DESCRIPTION

Record the Route Direction using one of the following codes for the route carried by the tunnel.

PROCEDURE

Use code 0 when the tunnel carries both directions of a divided highway.

Use code 0 when a roadway is undivided.

Route Direction is considered the designated direction of the route.

| <u>Description</u> | <u>Code</u> |
|------------------------|-------------|
| Divided Highway | 0 |
| North | 1 |
| East | 2 |
| South | 3 |
| West | 4 |



FORMAT

N (1,0)

CODING EXAMPLES

Route Direction

NTI Code

Clear Creek Canyon – US 6

0

Eisenhower Tunnel – Westbound I-70

4

| | | |
|------------------------------|------------|------------|
| Item I.9 – Route Type | NTI | I.9 |
|------------------------------|------------|------------|

DESCRIPTION

Record the Route Type using one of the following codes listed within the table below.

When two or more routes are concurrent, the highest class of route will be used (lowest applicable code). The hierarchy is in the order listed below.

PROCEDURE

When a roadway crosses through federal lands such as national parks, national forests or department of defense facilities and does not meet the description of codes 1 through 5 then use code 6.

When a public roadway crosses through state lands such as state parks or state forests and does not meet the description of codes 1 through 5 then use code 7.

Ramps should be coded based on the higher class of route it connects to.

| <u>Description</u> | <u>Code</u> |
|--|-------------|
| Interstate highway | 1 |
| U.S. numbered highway | 2 |
| State highway | 3 |
| County highway | 4 |
| City street | 5 |
| Federal lands road | 6 |
| State lands road | 7 |
| Other (includes Toll roads not otherwise indicated above) | 8 |

FORMAT

N (1,0)

CODING EXAMPLES

Click to return to:

Section 2



| <u>Route Type</u> | <u>NTI Code</u> |
|-------------------|-----------------|
| US 6 | 2 |
| Interstate 70 | 1 |

| | | |
|-------------------------------------|------------|-------------|
| Item I.10 – Facility Carried | NTI | I.10 |
|-------------------------------------|------------|-------------|

DESCRIPTION

Record the name of the facility that is carried through the tunnel.

PROCEDURE

The owner may include directional or other descriptive information in this field. Official names and local names may be included.

The name of the tunnel (i.e. Squirrel Hill Tunnel, Fort Pitt Tunnel, etc.) may be included in this item following the route name.

COMMENTARY

This field is not to exceed 50 characters.

FORMAT

AN100

CODING EXAMPLES

| <u>Tunnel Name</u> | <u>NTI Code</u> |
|--------------------|-------------------|
| Clear Creek No. 1 | US 6 |
| Beavertail (EB) | I-70E |
| Red Rocks | Red Rocks Park Rd |

| | | |
|--------------------------------|------------|-------------|
| Item I.11 –LRS Route ID | NTI | I.11 |
|--------------------------------|------------|-------------|

DESCRIPTION

Record the Linear Referencing System (LRS) Route ID that identifies the roadway on which the tunnel is located. Use the LRS Route ID which has been defined by the State for the Highway Performance Monitoring System (HPMS) for reporting purposes.

The LRS Route ID must match what is reported in HPMS. The LRS Route ID can be left blank if it is not available in HPMS.

PROCEDURE

The LRS Route ID is not necessarily the same as the Route Number posted along the roadway, but is a number used to uniquely identify a route within at least a county and perhaps throughout the State for Geographic Information System (GIS) analysis and mapping purposes.



Not all 60 format spaces must be filled.

FORMAT

AN60

CODING EXAMPLES

| <u>Tunnel Name</u> | <u>Route Carried</u> | <u>NTI Code</u> |
|--------------------|----------------------|-----------------|
| Eisenhower Tunnel | I 70 Westbound | 070A |
| Clear Creek No.3 | US 6 | 006G |

| | | |
|-----------------------------------|------------|-------------|
| Item I.12 – LRS Mile Point | NTI | I.12 |
|-----------------------------------|------------|-------------|

DESCRIPTION

Record the LRS Mile Point to the nearest thousandth. The mile point must be consistent with the LRS Inventory Route and mile point system for the HPMS.

For tunnels carrying an LRS inventory route, record the mile point at the tunnel portal for which the lowest LRS Mile Point occurs.

The LRS Mile Point can be left blank if it is not available in HPMS.

PROCEDURE

The LRS Mile Point is used to establish the location of the tunnel on the inventory route.

COMMENTARY

The Reference Point System has been established for state highways to identify the location of a structure on a route based on the measured distance from the beginning of the route. The beginning of a route is usually the western or southern state line, or it may be the junction with another highway. Reference points for odd numbered highways increase from South to North, reference points for even numbered highways increase from West to East. Exceptions are stub routes. They are measured from their terminus with other highways along their route regardless of direction. The designation should not change. Refer to CDOT’s “Field Log of Structures” for more details and to establish the direction of inventory for stub routes.

Note: Do not change this item without explicit approval of BMS Data Manager.

FORMAT

N (8,3)

CODING EXAMPLES

| <u>LRS Mile Point</u> | <u>NTI Code</u> |
|-----------------------|-----------------|
| 130.344 | 130.344 |
| 9.600 | 9.600 |

Click to return to:

Section 2



No mile point

(blank)

| | | |
|---|------------|-------------|
| Item I.13 – Tunnel Portal’s Latitude | NTI | I.13 |
|---|------------|-------------|

DESCRIPTION

Record the latitude of the tunnel portal in decimal degrees for all tunnels.

Record the latitude at the same location for the Item ID I.12 - LRS Mile Point. When Item ID I.12 - LRS Mile Point is blank, record the latitude at the tunnel portal on the edge of the right traveled way in the direction of the route at the lowest mile point.

PROCEDURE

Values recorded are assumed to be for the Northern Hemisphere and are to be consistent with LRS data that uses the North American Datum 1983.

COMMENTARY

The Latitude shall be taken at the junction of the tunnel portal with the lowest mile point and the right edge of pavement, or right rear. All values will be positive for the State of Colorado.

FORMAT

N (11,8)

CODING EXAMPLES

| <u>Tunnel Portal’s Latitude</u> | <u>NTI Code</u> |
|---------------------------------|-----------------|
| 25° 27’ 18.55” | 25.45515278 |
| 31° 5’ 50.65” | 31.09740278 |

| | | |
|--|------------|-------------|
| Item I.14 – Tunnel Portal’s Longitude | NTI | I.14 |
|--|------------|-------------|

DESCRIPTION

Record the longitude of the tunnel portal in decimal degrees for all tunnels.

Record the longitude at the same location for the Item ID I.12 - LRS Mile Point. When Item ID I.12 - LRS Mile Point is blank, record the longitude at the tunnel portal on the edge of the right traveled way in the direction of the route at the lowest mile point.

PROCEDURE

Values recorded are assumed to be for the Western Hemisphere and are to be consistent with LRS data that uses the North American Datum 1983.

COMMENTARY

Click to return to:

Section 2



The Longitude shall be taken at the junction of the tunnel portal with the lowest mile point and the right edge of pavement, or right rear. All values shall be recorded as positive to be consistent with data submittal to FHWA or as directed by CDOT Asset Management.

FORMAT

N (11,8)

CODING EXAMPLES

Tunnel Portal's Longitude

NTI Code

65° 27' 18.55"

65.45515278

75° 13' 26.69"

75.22408206

| | | |
|--|------------|-------------|
| Item I.15 – Border Tunnel State or Country Code | NTI | I.15 |
|--|------------|-------------|

DESCRIPTION

Record the neighboring state's code using the codes listed in the Item ID I.3 - State Code item.

Record this item for Border Tunnels when any owner within the state's geographical boundaries has some or all of the inspection, preservation, improvement or replacement responsibility.

Record the value CA for Canada or MX for Mexico when the tunnel crosses those borders.

Leave item blank when the tunnel does not cross a border with another state or country or when no owner within the state's geographical boundaries has any inspection, preservation, improvement, or replacement responsibility.

PROCEDURE

Use this item to indicate tunnels crossing borders of states or countries.

Consistency of submitted data by agencies with shared Border Tunnel inspection, preservation, improvement or replacement responsibility is essential.

COMMENTARY

Currently, there are no Border Tunnels in the State of Colorado; therefore, this code would be left blank. This also applies for Items I.16, I.17, and I.18.

FORMAT

AN2

CODING EXAMPLES

NTI Code

No State or Country Border

(blank)

| | | |
|---|------------|-------------|
| Item I.16 – Border Tunnel Financial Responsibility | NTI | I.16 |
|---|------------|-------------|



DESCRIPTION

Record the total percent financial responsibility, to the nearest percent, for all entities within the state’s geographical boundaries regardless of ownership.

Leave item blank when the tunnel does not cross a border with another state or country or when no owner within the state’s geographical boundaries has any inspection, preservation, improvement or replacement responsibility.

PROCEDURE

The intent of this item is to capture the financial responsibility for all entities within the State’s geographical boundaries, regardless of ownership of the tunnel (State, city, county, Toll authorities, etc.) and to compare financial responsibility with neighboring states or countries.

Financial responsibility includes current and future financial responsibilities for inspection, preservation, improvement or replacement whether by agency or contract forces. Agency financial responsibility may be documented in interagency agreements or memorandums of understanding and included as part of the tunnel file or record.

COMMENTARY

Currently, there are no Border Tunnels in the State of Colorado; therefore, this code would be left blank.

FORMAT

N (3,0)

CODING EXAMPLES

NTI

| | |
|----------------------------|---------|
| No State or Country Border | (blank) |
| 100% Responsibility | 100 |
| 25% Responsibility | 025 |

| | | |
|---|------------|-------------|
| Item I.17 – Border Tunnel Number | NTI | I.17 |
|---|------------|-------------|

DESCRIPTION

Record the neighboring state's exact Tunnel Number as used in the Item ID I.1 - Tunnel Number.

PROCEDURE

Record this item for Border Tunnels when any owner within the state’s geographical boundaries has shared responsibility for inspection, preservation, improvement or replacement.

Leave item blank when the tunnel does not cross a border with another state or country or when no owner within the state’s geographical boundaries has any inspection, preservation, improvement or replacement responsibility. Also leave blank when the bordering country does not have a Tunnel Number.

COMMENTARY

Click to return to:

Section 2



Currently, there are no Border Tunnels in the State of Colorado; therefore, this code would be left blank.

FORMAT

AN15

CODING EXAMPLES

NTI

No State or Country Border

(blank)

| | | |
|--|------------|-------------|
| Item I.18 – Border Tunnel Inspection Responsibility | NTI | I.18 |
|--|------------|-------------|

DESCRIPTION

Record the Border Tunnel Inspection Responsibility for any entity within the State’s geographical boundaries regardless of ownership using one of the following codes listed below.

Leave item blank when the tunnel does not cross a border with another State or Country or when no owner within the state’s geographical boundaries has any inspection, preservation, improvement or replacement responsibilities.

PROCEDURE

The intent of this item is to capture the Border Tunnel Inspection Responsibility for any entity within the State’s geographical boundaries, regardless of ownership of the tunnel (state, city, county, Toll authority etc.)

Agency inspection responsibility may be documented in interagency agreements or memorandums of understanding and included as part of the tunnel file or record.

COMMENTARY

Currently, there are no Border Tunnels in the State of Colorado; therefore, this code would be left blank.

| Description | Code |
|--|---------|
| No responsibility | (blank) |
| Shared responsibility with bordering State or country | 1 |
| Full responsibility | 2 |

FORMAT

N (1,0)



CODING EXAMPLES

NTI

No State or Country Border

(blank)



2.3 Age and Service Items

The items in this section define when the tunnel was constructed, when it was reconstructed, and the tunnel’s level of service.

ITEM A.1 – YEAR BUILT..... 2.24

ITEM A.2 – YEAR REHABILITATED..... 2.24

ITEM A.3 – TOTAL NUMBER OF LANES 2.25

ITEM A.4 – ANNUAL AVERAGE DAILY TRAFFIC 2.26

ITEM A.4.1 – PEAK HOURLY TRAFFIC COUNT..... 2.26

ITEM A.4.2 – DATE OF PEAK HOURLY TRAFFIC COUNT..... 2.27

ITEM A.5 – ANNUAL AVERAGE DAILY TRUCK TRAFFIC..... 2.28

ITEM A.5.1 – PERCENTAGE OF AVERAGE DAILY TRUCK TRAFFIC..... 2.28

ITEM A.6 – YEAR OF ANNUAL AVERAGE DAILY TRAFFIC..... 2.29

ITEM A.7 – DETOUR LENGTH 2.29

ITEM A.8 – SERVICE IN TUNNEL 2.30



| | | |
|------------------------------|------------|------------|
| Item A.1 – Year Built | NTI | A.1 |
|------------------------------|------------|------------|

DESCRIPTION

Record the year in which construction was completed and the tunnel was able to carry traffic.

For phased construction, record the year in which the first phase was completed and the tunnel was able to carry traffic.

PROCEDURE

Provide a best estimate when the Year Built is unknown; do not assign a default value. This date reflects the date when construction was completed, regardless of when the tunnel was open to traffic.

Rehabilitation of a structure does not change the Year Built. See Item ID A.2 - Year Rehabilitated.

FORMAT

N (4,0)

CODING EXAMPLES

| <u>Year Built</u> | <u>NTI Code</u> |
|--------------------------|------------------------|
| 1956 | 1956 |
| 2012 | 2012 |

| | | |
|--------------------------------------|------------|------------|
| Item A.2 – Year Rehabilitated | NTI | A.2 |
|--------------------------------------|------------|------------|

DESCRIPTION

Record the year of most recent rehabilitation of the structure. Code all 4 digits of the latest year in which rehabilitation of the structure was completed.

Record 0 if the tunnel has not been rehabilitated.

For a tunnel to be defined as rehabilitated, the type of work performed, whether or not it meets current minimum standards, must have been eligible for funding under any of the Federal-aid funding categories.

The eligibility criteria would apply to the work performed regardless of funding source.

PROCEDURE

Some types of work not to be considered as rehabilitation are:

- Safety feature replacement or upgrading (for example, tunnel rail, approach guardrail or impact attenuators)
- Painting of structural steel
- Overlay of tunnel roadway surface as part of a larger highway surfacing project (for example, overlay carried across tunnel invert for surface uniformity without additional tunnel work)



- Utility work
- Emergency repair to restore structural integrity to the previous condition following an accident
- Retrofitting to correct a deficiency which does not substantially alter physical geometry or increase the load carrying capacity
- Work performed to keep a tunnel operational while plans for complete rehabilitation are under preparation (for example, adding a temporary support)

COMMENTARY

According to the TOMIE, Section 3, rehabilitation implies that a large-scale repair program(s) has been developed with extended durations, substantial engineering input, and substantial cost. This includes projects like extensive structural repairs, overhauling the ventilation system, replacing the lighting system, or upgrading life/safety systems. This does not include retrofitting to correct a deficiency which does not substantially alter physical geometry or increase the load carrying capacity.

FORMAT

N (4,0)

CODING EXAMPLES

| <u>Year Rehabilitated</u> | <u>NTI Code</u> |
|---------------------------|-----------------|
| 1985 | 1985 |
| Never Rehabilitated | 0 |

| | | |
|---|------------|------------|
| Item A.3 – Total Number of Lanes | NTI | A.3 |
|---|------------|------------|

DESCRIPTION

Record the number of lanes being carried through the tunnel.

PROCEDURE

Include all lanes *carrying highway traffic (i.e., cars, trucks, buses)* which are striped or otherwise operated as a full width traffic lane for the entire length of the tunnel. This shall include any full width merge lanes, ramp lanes, turn lanes, and *Toll lanes, and shall be independent of directionality of usage.*

Do not include pedestrian sidewalks, bike paths, or rail lines.

FORMAT

N (2,0)

CODING EXAMPLES

| <u>Total Number of Lanes</u> | <u>NTI Code</u> |
|------------------------------|-----------------|
| Eisenhower Tunnel | 2 |
| Veterans Memorial EB | 3 |

Click to return to:

Section 2



| | | |
|--|------------|------------|
| Item A.4 – Annual Average Daily Traffic | NTI | A.4 |
|--|------------|------------|

DESCRIPTION

Record the Annual Average Daily Traffic (AADT) for the inventory route identified in Item ID I.7 - Route Number from the most recent count.

Record the design AADT for newly inventoried tunnels when actual AADT information is not yet available.

Maintain the last open AADT for tunnels that are temporarily closed until repair or replacement can be performed.

PROCEDURE

The AADT should be updated at intervals in accordance with the standards for the HPMS and standards/policies within the State.

For two-way facilities, provide the bidirectional AADT; for one-way facilities, provide the directional AADT.

All traffic, including trucks, is counted in AADT. The count of trucks should be used in Item ID A.5 – Average Daily Truck Traffic.

When HPMS or other planning data is not available, use a test estimate based on site familiarity with State standards and policies.

COMMENTARY

Use the Colorado Department of Transportation’s Online Traffic Information System (OTIS) in conjunction with CDOT Staff Traffic/Division of Transportation Development to update A.4 for On-System tunnels. Code a six digit number that identifies the AADT volume for the route being inventoried on the structure, including truck traffic from Item A5-Annual Average Daily Truck Traffic. The AADT count shall be the most current count available and the data must be compatible with other items coded for the structure.

For Off-System tunnels a counter shall be placed for a minimum of 48 hours and the data adjusted using seasonal adjustment rate tables annually provided by the Division of Transportation Development. The time placed shall include two weekdays.

FORMAT

N (6,0)

CODING EXAMPLES

| <u>Annual Average Daily Traffic</u> | <u>NTI Code</u> |
|--|------------------------|
| 15,600 | 015600 |
| 2,400 | 002400 |

| | | |
|---|-------------|--------------|
| Item A.4.1 – Peak Hourly Traffic Count | CDOT | A.4.1 |
|---|-------------|--------------|



DESCRIPTION

Record the highest Peak Hourly Traffic Count ever recorded for Item I.1 – Tunnel Number.

PROCEDURE

Use the Colorado Department of Transportation’s Online Traffic Information System in conjunction with CDOT Staff Traffic/Division of Transportation Development to update A.4.1 for On-System tunnels.

Included in this item are the trucks referred to in Item ID A.5 – Average Daily Truck Traffic.

COMMENTARY

This value is used in determining tunnel classification per NFPA 502 and requires peak through-put of the particular bore, irrespective of parallel structures carrying a singular route as identified in Item I.7 – Route Number.

Where this data is not relevant or applicable for the classification of tunnels per NFPA 502, this may be left blank for Off-System tunnels only.

FORMAT

N (6,0)

CODING EXAMPLES

| <u>Peak Hourly Traffic Count</u> | <u>NTI Code</u> |
|---|------------------------|
| 6,234 | 006234 |
| 1,236 | 001236 |
| Off-System tunnel | (blank) |

| | | |
|---|-------------|--------------|
| Item A.4.2 – Date of Peak Hourly Traffic Count | CDOT | A.4.2 |
|---|-------------|--------------|

DESCRIPTION

Record the date of the highest Peak Hourly Traffic Count ever recorded.

Procedure

For Off-System tunnels with Item A.4.1 left blank, this item may be left blank.

FORMAT

D, MMDDYYYY

CODING EXAMPLES

| <u>Year of Peak Average Daily Traffic</u> | <u>NTI Code</u> |
|--|------------------------|
| May 2, 1998 | 05021998 |
| Off-System tunnel | (blank) |



| | | |
|--|------------|------------|
| Item A.5 – Annual Average Daily Truck Traffic | NTI | A.5 |
|--|------------|------------|

DESCRIPTION

Record a 6-digit number that shows the most recent Annual Average Daily Truck Traffic (AADTT) count available for the inventory route identified in Item ID I.7 – Route Number. If the tunnel is closed, code the actual AADTT from before the closure occurred.

PROCEDURE

For two-way facilities, provide the bidirectional AADTT; for one-way facilities, provide the directional AADTT.

The AADTT should be updated at intervals in accordance with the standards for the HPMS and standards/policies within the state.

When HPMS or other planning data is not available, use the best estimate based on site familiarity or route Functional Classification in accordance with state standards and policies.

Do not include vans, pickup trucks and other light delivery trucks in AADTT. AADTT represents vehicle classes 4-13 as described in FHWA’s Traffic Monitoring Guide electronically available at: <http://www.fhwa.dot.gov/policyinformation/tmguide/>

COMMENTARY

Use the Colorado Department of Transportation’s Online Traffic Information System in conjunction with CDOT Staff Traffic/Division of Transportation Development to update A.5 for On-System tunnels.

When the HPMS is not available, consult the Regional Traffic Engineer to create a best estimate.

FORMAT

N (6,0)

CODING EXAMPLES

| <u>Average Daily Truck Traffic</u> | <u>NTI Code</u> |
|---|------------------------|
| 1,100 | 001100 |
| 253 | 000253 |

| | | |
|--|-------------|--------------|
| Item A.5.1 – Percentage of Annual Average Daily Truck Traffic | CDOT | A.5.1 |
|--|-------------|--------------|

DESCRIPTION

Record a 2-digit percentage that shows the percentage of Item A.4 – Annual Average Daily Traffic that is truck traffic. Do not include vans, pickup trucks and other light delivery trucks in this percentage.

PROCEDURE



Use the Colorado Department of Transportation’s Online Traffic Information System in conjunction with CDOT Staff Traffic/Division of Transportation Development to update Item A.4 for On-System tunnels.

COMMENTARY

Percentage of AADTT = (Item A.5 - Annual Average Daily Truck Traffic / Item A.4 - Annual Average Daily Traffic)*100

If this information is not available for Off-System tunnels, an estimate which represents the average percentage for the category of facility carried by the tunnel may be used.

For Off-System tunnels, this item is not required.

May be left blank if Item ID A.4 – Annual Average Daily Traffic is not greater than 100.

FORMAT

N (2,0)

CODING EXAMPLES

| <u>AADTT</u> | <u>AADT</u> | <u>NTI Code</u> |
|--------------|-------------|-----------------|
| 1,100 | 6,234 | 18 |

| | | |
|--|------------|------------|
| Item A.6 – Year of Annual Average Daily Traffic | NTI | A.6 |
|--|------------|------------|

DESCRIPTION

Record the year associated with the data recorded in the AADT in Item ID A.4 – Annual Average Daily Traffic.

PROCEDURE

This traffic data should be updated at intervals of approximately 5 years or in accordance with the standards for the HPMS and standards/policies within the State.

COMMENTARY

If the year of AADT is unknown, CDOT Asset Management staff shall direct the data entry.

FORMAT

N (4,0)

CODING EXAMPLES

| <u>Year of Annual Average Daily Traffic</u> | <u>NTI Code</u> |
|---|-----------------|
| AADT counted in 1999 | 1999 |

| | | |
|---------------------------------|------------|------------|
| Item A.7 – Detour Length | NTI | A.7 |
|---------------------------------|------------|------------|

DESCRIPTION



Record the Detour Length to the nearest mile. The Detour Length should represent the total additional travel for a vehicle which would result from closing of the tunnel.

Record 999 where a detour does not exist.

PROCEDURE

If multiple bores exist, and following an accident, one of the bores can be used to detour traffic code Detour Length as 1. If an accident would result in the closure of all bores for an extended period of time, then code the Detour Length for the additional travel length.

The factor to consider when determining if a bypass is available at the site is the potential for moving vehicles, including military vehicles, around the tunnel.

COMMENTARY

Colorado allows any paved roadway to be used as a detour route for state highway structures if the route is capable of carrying state legal loads. Any passable roadway can be used for Off-System structures. These detours may or may not allow overloads depending on the roadway condition.

Total distance shall be calculated from the point of detour to the point of re-entry onto the intended facility carried minus the original or intended length of travel.

FORMAT

N (3,0)

CODING EXAMPLES

| <u>Detour Length</u> | <u>NTI Code</u> |
|--|------------------------|
| 121 miles | 121 |
| Multiple bore tunnel where traffic can be diverted into the adjoining bore | 001 |
| No Detour exists | 999 |

| | | |
|-------------------------------------|------------|------------|
| Item A.8 – Service in Tunnel | NTI | A.8 |
|-------------------------------------|------------|------------|

DESCRIPTION

Record the type of Service in Tunnel using a 1-digit code.

The types of Service in Tunnel and shall be coded using one of the following codes:

PROCEDURE

Railroad types include freight, light rail, commuter rail, high-speed, electrified, and transit.

Use code 3 for bicycles and other non-highway modes of human transportation not covered in other codes (e.g., golf carts).



| <u>Description</u> | <u>Code</u> |
|----------------------------------|-------------|
| Highway | 1 |
| Highway and Railroad | 2 |
| Highway and Pedestrian | 3 |
| Highway, Railroad and Pedestrian | 4 |
| Other | 5 |

FORMAT

N (1,0)

CODING EXAMPLES

Service in Tunnel

NTI Code

Highway

1

Highway/railroad

2



2.4 Classification Items

The items in this section define the owner, operator and highway classification of the tunnel.

ITEM C.1 – OWNER 2.33

ITEM C.2 – OPERATOR 2.34

ITEM C.3 – DIRECTION OF TRAFFIC..... 2.34

ITEM C.4 – TOLL 2.35

ITEM C.5 – NHS DESIGNATION 2.35

ITEM C.6 – STRAHNET DESIGNATION 2.36

ITEM C.7 – FUNCTIONAL CLASSIFICATION..... 2.36

ITEM C.8 – URBAN CODE 2.37



| | | |
|------------------|-----|-----|
| Item C.1 – Owner | NTI | C.1 |
|------------------|-----|-----|

DESCRIPTION

Record agency that has ownership of the tunnel using one of the codes in the table below.

PROCEDURE

Use the hierarchy of State, Federal, county, city, railroad, and other private entity for multiple owners of a tunnel.

| <u>Description</u> | <u>Code</u> | <u>Description</u> | <u>Code</u> | <u>Description</u> | <u>Code</u> |
|---|-------------|---------------------------------------|-------------|--|-------------|
| State Highway Agency | 01 | General Services Administration (GSA) | 57 | U.S. Army Corps of Engineers | 70 |
| County Highway Agency | 02 | Smithsonian – National Zoo | 58 | Air Force | 72 |
| Town or Township Highway Agency | 03 | National Security Agency (NSA) | 59 | Navy/Marines | 73 |
| City or Municipal Highway Agency | 04 | Other Federal Agencies (not listed) | 60 | Army | 74 |
| State Park, Forest, or Reservation Agency | 11 | Indian Tribal Government | 61 | National Aeronautics and Space Administration (NASA) | 75 |
| Local Park, Forest, or Reservation Agency | 12 | Bureau of Indian Affairs (BIA) | 62 | Metropolitan Washington Airports Service | 76 |
| Other State Agencies | 21 | Bureau of Fish and Wildlife (FWS) | 63 | Pentagon | 77 |
| Other Local Agencies | 25 | U.S. Forest Service (USFS) | 64 | Agriculture Research Service (ARS) | 78 |
| Private (other than railroad) | 26 | National Park Service (NPS) | 66 | Department of Energy (DOE) | 79 |
| Railroad | 27 | Tennessee Valley Authority (TVA) | 67 | Unknown | 80 |
| State Toll Authority | 31 | Bureau of Land Management (BLM) | 68 | | |
| Local Toll Authority | 32 | Bureau of Reclamation (USBR) | 69 | | |

FORMAT

N (2,0)



CODING EXAMPLES

| <u>Owner</u> | <u>NTI Code</u> |
|---------------------------|-----------------|
| CDOT | 01 |
| City and County of Denver | 04 |

| | | |
|----------------------------|------------|------------|
| Item C.2 – Operator | NTI | C.2 |
|----------------------------|------------|------------|

DESCRIPTION

Record the agency that has maintenance responsibility for the tunnel using the codes from Item ID C.1- Owner to represent the type of agency that has primary responsibility for maintaining the structure.

PROCEDURE

Use the hierarchy of State, Federal, county, city, railroad, and other private entity for multiple Operators of a tunnel.

FORMAT

N (2,0)

| | | |
|--|------------|------------|
| Item C.3 – Direction of Traffic | NTI | C.3 |
|--|------------|------------|

DESCRIPTION

Record the Direction of Traffic of the inventory route identified in Item ID I.7 – Route Number that represents the traffic pattern using one of the following codes.

PROCEDURE

Code 3, variable traffic is intended to cover those tunnels in which the Direction of Traffic is *routinely* changed.

One lane 2-way traffic occurs when 2 lanes approach a narrow unstriped tunnel requiring vehicles to alternate turns through the tunnel.

When coding a tunnel with multiple bores, if traffic moves in both directions regardless of the individual traffic direction of a single bore, code as 2-way traffic.

| <u>Description</u> | <u>Code</u> |
|-----------------------------|-------------|
| Highway traffic not carried | 0 |
| 1-way traffic | 1 |
| 2-way traffic | 2 |
| Variable traffic | 3 |
| One lane 2-way traffic | 4 |



FORMAT

N (1,0)

| | | |
|------------------------|------------|------------|
| Item C.4 – Toll | NTI | C.4 |
|------------------------|------------|------------|

DESCRIPTION

Record the Toll status of the tunnel for the inventory route identified in Item ID I.7 – Route Number using one of the following codes:

PROCEDURE

Use code 0 when the tunnel is Toll-free and carries a Toll-free highway.

Use code 1 when Tolls are paid specifically to use the tunnel.

Use code 2 when Tolls are paid to use the facility including both the highway and tunnel.

COMMENTARY

Use code 0 when Toll or managed lanes exist however are not required to use the tunnel or the highway due to the presence of Toll-free lanes.

| <u>Description</u> | <u>Code</u> |
|-------------------------------|-------------|
| No Tolls. | 0 |
| Toll at tunnel. | 1 |
| Located on Toll route. | 2 |

FORMAT

N (1,0)

| | | |
|-----------------------------------|------------|------------|
| Item C.5 – NHS Designation | NTI | C.5 |
|-----------------------------------|------------|------------|

DESCRIPTION

Record whether the inventory route is on the National Highway System (NHS) or not on that system for the inventory route identified in Item ID I.7 – Route Number using one of the following codes:

PROCEDURE

The NHS includes the Interstate Highway System as well as other roads important to the nation’s economy, defense, and mobility. The NHS was developed by the Department of Transportation (DOT) in cooperation with states, local officials, and metropolitan planning organizations (MPOs).

NHS routes and connectors are identified in the HPMS.

State maps of the NHS can be found at:

https://www.fhwa.dot.gov/planning/national_highway_systems/nhs_maps/

Click to return to:

Section 2



COMMENTARY

A Colorado map of the NHS can be found at:

https://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/colorado/co_colorado.pdf

| Description | Code |
|------------------------------------|------|
| Inventory Route is not on the NHS. | 0 |
| Inventory Route is on the NHS. | 1 |

FORMAT

N (1,0)

| | | |
|--|------------|------------|
| Item C.6 – STRAHNET Designation | NTI | C.6 |
|--|------------|------------|

DESCRIPTION

Record the Strategic Highway Network (STRAHNET) designation for the inventory route identified in Item ID I.7 – Route Number using one of the following codes:

PROCEDURE

The STRAHNET is a system of Interstate and primary highways and connectors that provide access to major US military installations and strategic ports, and provides continuity and emergency capabilities for defence purposes. The STRAHNET is determined by the Surface Deployment and Distribution Command in coordination with the FHWA.

For the purposes of this item, the STRAHNET Connectors are considered included in the term STRAHNET.

STRAHNET routes can be found at:

https://www.fhwa.dot.gov/planning/national_highway_systems/nhs_maps/

A Colorado map of the STRAHNET system can be found at:

https://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/colorado/co_colorado.pdf

| Description | Code |
|--|------|
| Inventory Route is not a STRAHNET route. | 0 |
| Inventory Route is a STRAHNET route. | 1 |

FORMAT

N (1,0)

| | | |
|---|------------|------------|
| Item C.7 – Functional Classification | NTI | C.7 |
|---|------------|------------|



DESCRIPTION

Record the Functional Classification for the inventory route identified in Item ID I.7 – Inventory Route using the following table.

PROCEDURE

Functional Classifications result from the grouping of highways by the character of service they provide.

Ensure that the Functional Classification designated in this item is consistent with the HPMS.

FHWA Functional Classification Guidelines:

http://www.fhwa.dot.gov/planning/process/statewide/related/highway_functional_classifications/

COMMENTARY

Functional Classification is the process by which streets and highways are grouped into classes, or systems, according to the character of service they are intended to provide. The classifications are determined through a statewide planning process and approved by the Transportation Commission and provided to BMS by the Division of Transportation Development. Any changes to this classification must be addressed through the Division of Transportation Development (DTD) and approved by the Transportation Commission.

| <u>Description</u> | <u>Code</u> | <u>Description</u> | <u>Code</u> |
|--|-------------|--------------------|-------------|
| Interstate | 1 | Major Collector | 5 |
| Principal Arterial – Other Freeways or Expressways | 2 | Minor Collector | 6 |
| Principal Arterial – Other | 3 | Local | 7 |
| Minor Arterial | 4 | | |

FORMAT

N (1,0)

CODING EXAMPLES

Functional Classification

NTI Code

Interstate 1

Minor Collector 6

| | | |
|------------------------------|------------|------------|
| Item C.8 – Urban Code | NTI | C.8 |
|------------------------------|------------|------------|

DESCRIPTION

Record the urbanized area code for the tunnel, consistent with the State’s HPMS urban boundaries.

PROCEDURE

Click to return to:

Section 2



Urban Codes can be found on Appendix 1 of the 2010 HPMS Field Manual at:

<http://www.fhwa.dot.gov/policyinformation/hpms/fieldmanual/appendix.cfm>

For tunnels outside urbanized areas, Appendix 1 of the HPMS Field Manual indicates that code 99999 is used for rural areas with population less than 5,000 and code 99998 for small urban areas with population 5,000 – 49000.

State maps of the urban boundaries with roadways (map layers: labels, transportation and urban areas checked) can be found at: <http://tigerweb.geo.census.gov/TIGERweb2010/>

COMMENTARY

For Colorado Urban Codes see the table below.

| <u>Urban Area Name</u> | <u>Urban Code</u> |
|---------------------------|-------------------|
| Boulder | 09298 |
| Colorado Springs | 18856 |
| Denver-Aurora | 23527 |
| Fort Collins | 30628 |
| Grand Junction | 34273 |
| Greeley | 34786 |
| Lafayette-Louisville-Erie | 46126 |
| Longmont | 51175 |
| Pueblo | 72613 |

FORMAT

N (5,0)

CODING EXAMPLES

| <u>Urban Code</u> | <u>NTI Code</u> |
|-----------------------------------|-----------------|
| Denver | 23527 |
| Urban area less than 5,000 people | 99999 |



2.5 Geometric Data Items

The items in this section define the geometric data of the tunnel.

ITEM G.1 – TUNNEL LENGTH 2.40

ITEM G.2 – MINIMUM VERTICAL CLEARANCE OVER TUNNEL ROADWAY 2.41

ITEM G.3 – ROADWAY WIDTH, CURB-TO-CURB 2.41

ITEM G.4 – LEFT SIDEWALK WIDTH 2.42

ITEM G.5 - RIGHT SIDEWALK WIDTH 2.43

| | | |
|--------------------------|-----|-----|
| Item G.1 – Tunnel Length | NTI | G.1 |
|--------------------------|-----|-----|

DESCRIPTION

Record the length of the tunnel to the nearest foot.

The length shall be measured along the centerline of roadway.

A portal is defined as the entrance and exit of the tunnel exposed to the environment. They may include bare rock, constructed tunnel entrance structure, or buildings.

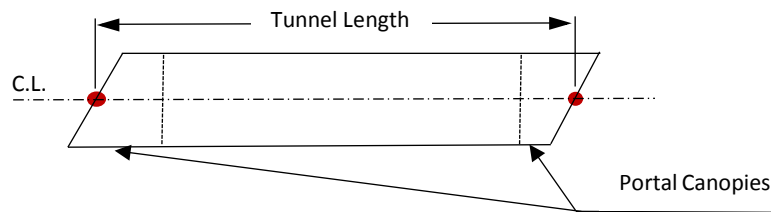
PROCEDURE

When a tunnel is divided into segments, record the length of the segment. For example: if a 1000-foot tunnel is divided into 4 – 250 foot segments, each segment will have a Tunnel Length of 250 feet.

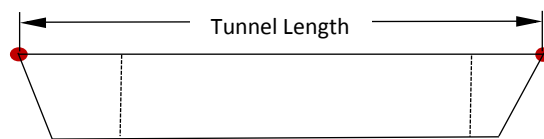
When multiple bores are reported as a single tunnel, record the length of the longest bore.

COMMENTARY

Tunnel length shall be recorded between the exterior faces of the portals at the roadway centerline. A portal is defined as the entrance and exit of the tunnel exposed to the environment. They may include bare rock, portal canopies, constructed tunnel entrance structure, or buildings.



Plan View



Elevation View

FORMAT

N (6,0)

CODING EXAMPLES

| <u>Tunnel Length</u> | <u>NTI Code</u> |
|----------------------|-----------------|
| 860.4 feet | 000860 |
| 2,400 feet | 002400 |

| | | |
|--|------------|------------|
| Item G.2 – Minimum Vertical Clearance over Tunnel Roadway | NTI | G.2 |
|--|------------|------------|

DESCRIPTION

Record the minimum vertical clearance between the mainline tunnel roadway surface and any overhead restriction, i.e. tunnel ceiling, overhead signs, lighting, etc.

PROCEDURE

The roadway surface includes any surface on which a vehicle can travel, including shoulders.

Ramps should be excluded when included as part of a tunnel system. The intent is to determine the restrictions of the primary route of the tunnel.

Figure G.2 below represents the Minimum Vertical Clearance over a tunnel roadway.

COMMENTARY

See Section 5.1.9 Vertical Clearance Measurements for more information.

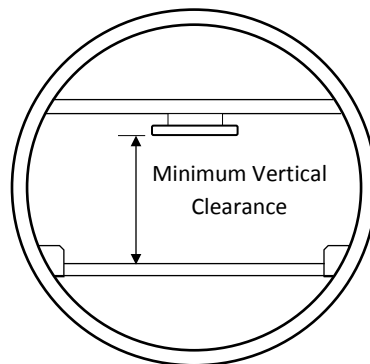


Figure G.2 - Drawing of Minimum Vertical Clearance

FORMAT

N (5,1)

CODING EXAMPLES

| <u>Minimum Vertical Clearance over Tunnel Roadway</u> | <u>NTI Code</u> |
|---|-----------------|
| 16.54 feet | 16.5 |
| 20.00 feet | 20.0 |

| | | |
|---|------------|------------|
| Item G.3 – Roadway Width, Curb-to-Curb | NTI | G.3 |
|---|------------|------------|

DESCRIPTION

Record the most restrictive minimum distance between curbs or rails on the mainline tunnel roadway.

PROCEDURE

Raised or non-mountable medians and barrier widths are to be excluded from the summation.

Ramps should be excluded when included as part of a tunnel system. The intent is to determine the restrictions of the primary route of the tunnel.

Figure G.3 below represents the Curb-to-Curb distance in a tunnel.

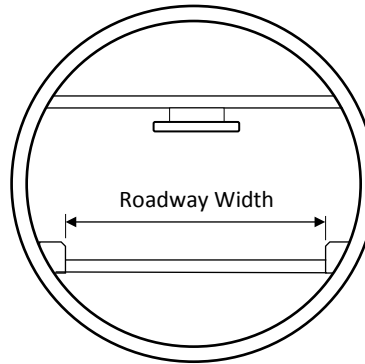


Figure G.3 – Curb-to-Curb width

FORMAT

N (4,1)

CODING EXAMPLES

| <u>Roadway Width, Curb-to-Curb</u> | <u>NTI Code</u> |
|------------------------------------|-----------------|
| 24.00 feet | 24.0 |
| 30.43 feet | 30.4 |

| | | |
|---------------------------------------|------------|------------|
| Item G.4 – Left Sidewalk Width | NTI | G.4 |
|---------------------------------------|------------|------------|

DESCRIPTION

Record the minimum width of the left sidewalk to the nearest tenth of a foot from the face of tunnel liner to the face of curb. Measure the width perpendicular to the centerline of the roadway.

Record 0 when the face of curb does not extend beyond the face of the tunnel liner.

PROCEDURE

Left sidewalk is determined based on the inventory direction, for example if the inventory route is south to north, the west sidewalk is the left. Figure G.4 below represents the Left Sidewalk Width in a tunnel.

COMMENTARY

The sidewalk shall only be measured and documented when intended to serve as a sidewalk. For example, the soil beyond roadway curbs in Clear Creek tunnels nor the barriers in Hanging Lake Tunnels qualify as a sidewalk.

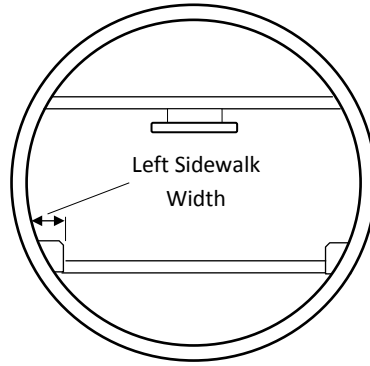


Figure G.4 - Sidewalk Width Looking in the Direction of Inventory

FORMAT

N (3,1)

CODING EXAMPLES

| <u>Left Sidewalk Width</u> | <u>NTI Code</u> |
|-----------------------------------|------------------------|
| No sidewalk | 0.0 |
| 3.63 feet | 3.6 |

| | | |
|--|------------|------------|
| Item G.5 - Right Sidewalk Width | NTI | G.5 |
|--|------------|------------|

DESCRIPTION

Record the minimum width of the right sidewalk to the nearest tenth of a foot from the face of tunnel liner to the face of curb. Measure the width perpendicular to the centerline of the roadway.

Record 0 when the face of curb does not extend beyond the face of the tunnel liner.

PROCEDURE

Right sidewalk is determined based on the inventory direction, for example if the inventory route is south to north, the east sidewalk is the right. Figure G.5 below represents the Right Sidewalk Width in a tunnel.

COMMENTARY

The sidewalk shall only be measured and documented when intended to serve as a sidewalk. For example, the soil beyond roadway curbs in Clear Creek tunnels nor the barriers in Hanging Lake Tunnels qualify as a sidewalk.

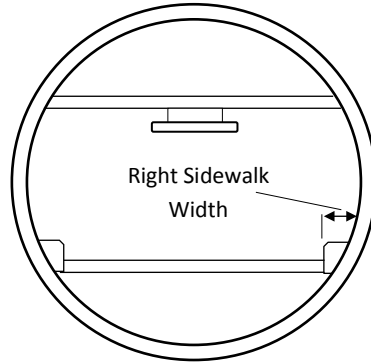


Figure G.5 - Sidewalk Width Looking in the Direction of Inventory

FORMAT

N (3,1)

CODING EXAMPLES

| <u>Right Sidewalk Width</u> | <u>NTI Code</u> |
|------------------------------------|------------------------|
| No sidewalk | 0.0 |
| 3.63 feet | 3.6 |
| 3 feet | 3.0 |



2.6 Inspection Items

The items in this section describe when inspections were performed and the type of inspections performed.

ITEM D.1 – ROUTINE INSPECTION TARGET DATE 2.46

ITEM D.2 – ACTUAL ROUTINE INSPECTION DATE 2.46

ITEM D.3 – ROUTINE INSPECTION INTERVAL 2.47

ITEM D.4 – IN-DEPTH INSPECTION 2.47

ITEM D.4.1 – IN-DEPTH INSPECTION DATE 2.48

ITEM D.4.2 – IN-DEPTH INSPECTION FREQUENCY 2.48

ITEM D.5 – DAMAGE INSPECTION 2.49

ITEM D.5.1 - DAMAGE INSPECTION DATE 2.49

ITEM D.6.1 - SPECIAL INSPECTION DATE 2.50

ITEM D.6.2 – SPECIAL INSPECTION FREQUENCY 2.51



| | | |
|--|------------|------------|
| Item D.1 – Routine Inspection Target Date | NTI | D.1 |
|--|------------|------------|

DESCRIPTION

Record the Routine Inspection Target Date as a month and year. Code an 8-digit number to represent the month, day, and year. The number of the month should be coded in the first two digits with a leading zero as required, the number of the day should be coded in the third and fourth digits with a leading zero as required, and the year to be coded as the fifth thru the eighth digits.

PROCEDURE

Initially, the target date is set by the program manager and should not be modified without prior notification to the FHWA Division Office.

The date is intended to provide the baseline for scheduling future routine inspections. The month associated with Item D.2-Actual Routine Inspection Date should be within 2 months (+/-) of this target month. The year represents the date in which the target date was set.

FORMAT

D, MMDDYYYY

CODING EXAMPLES

| <u>Routine Inspection Target Date</u> | <u>NTI Code</u> |
|--|------------------------|
| November 5, 1999 | 11051999 |
| August 21, 2012 | 08212012 |

| | | |
|--|------------|------------|
| Item D.2 – Actual Routine Inspection Date | NTI | D.2 |
|--|------------|------------|

DESCRIPTION

Record the month and year the actual routine inspection of the tunnel was performed. Code an 8-digit number to represent the month, day, and year. The number of the month should be coded in the first two digits with a leading zero as required, the number of the day should be coded in the third and fourth digits with a leading zero as required, and the year to be coded as the fifth thru the eighth digits.

PROCEDURE

This date should indicate when the routine inspection began.

COMMENTARY

Due to size and complexity of tunnels resulting in extended inspection duration, the inspection date shall be recorded as the date of completion. This ensures that an inspection is thorough and complete on time within the proper interval. This also mitigates loss of time for report preparation within the requirements set forth by the CDOT Program Manager.



FORMAT

D, MMDDYYYY

CODING EXAMPLES

| <u>Actual Routine Inspection Date</u> | <u>NTI Code</u> |
|---------------------------------------|-----------------|
| November 5, 1999 | 11051999 |
| August 21, 2012 | 08212012 |

| | | |
|---|------------|------------|
| Item D.3 – Routine Inspection Interval | NTI | D.3 |
|---|------------|------------|

DESCRIPTION

Record the number of months between designated routine inspections.

PROCEDURE

The designated inspection interval could vary from inspection to inspection depending on the condition of the tunnel at the time of inspection and the procedures established by the individual in-charge of the inspection program.

FORMAT

N (2,0)

CODING EXAMPLES

| <u>Routine Inspection Interval</u> | <u>NTI Code</u> |
|------------------------------------|-----------------|
| Every 6 months | 06 |
| Every 24 months | 24 |

| | | |
|---------------------------------------|------------|------------|
| Item D.4 – In-Depth Inspection | NTI | D.4 |
|---------------------------------------|------------|------------|

DESCRIPTION

Record this item for all records in the inventory. For the tunnel identified in Item ID I.1 – Tunnel Number, record whether the tunnel has an In-Depth Inspection scheduled.

PROCEDURE

A close-up inspection of one, several, or all tunnel structural elements or functional systems to identify any deficiencies not readily detectable using routine inspection procedures; hands-on inspection may be necessary at some locations. In-Depth Inspections may occur more or less frequently than routine inspections, as outlined in the tunnel-specific inspection procedures.

Use the table below to code if an In-Depth Inspection has or has not been scheduled.



| <u>Description</u> | <u>Code</u> |
|---|-------------|
| In-Depth Inspection has not been scheduled. | 0 |
| In-Depth Inspection has been scheduled. | 1 |

FORMAT

N (1,0)

| | | |
|--|-------------|--------------|
| Item D.4.1 – In-Depth Inspection Date | CDOT | D.4.1 |
|--|-------------|--------------|

DESCRIPTION

Record this item for the last In-Depth Inspection performed. The number of the month and day shall be coded with leading zeros as required and the year to be recorded as 4-digits.

PROCEDURE

If an In-Depth Inspection has never been performed and Item ID D.4 is coded 0, leave the entry blank.

FORMAT

D, MMDDYYYY

CODING EXAMPLES

| <u>In-Depth Inspection Date</u> | <u>NTI Code</u> |
|---------------------------------|-----------------|
| April 21,2013 | 04212013 |
| No In-Depth ever performed | (blank) |

| | | |
|---|-------------|--------------|
| Item D.4.2 – In-Depth Inspection Frequency | CDOT | D.4.2 |
|---|-------------|--------------|

DESCRIPTION

Record the number of months between designated In-Depth Inspections.

PROCEDURE

If an In-Depth Inspection is not required and Item ID D.4 is coded 0 or if the In-Depth Inspection is not to include a regular schedule, leave entry blank.

See Section 4.4.5 for more information on In-Depth Inspections of tunnels.

FORMAT

N (2,0)



CODING EXAMPLES

| <u>In-Depth Inspection Frequency</u> | <u>NTI Code</u> |
|--------------------------------------|-----------------|
| 48 months | 48 |
| No In-Depth Inspection required | (blank) |

| | | |
|-------------------------------------|------------|------------|
| Item D.5 – Damage Inspection | NTI | D.5 |
|-------------------------------------|------------|------------|

DESCRIPTION

Record this item for all records in the inventory. For the tunnel identified in Item ID I.1 – Tunnel Number, record whether the tunnel has a Damage Inspection performed. This should be coded as 1 if a Damage Inspection has been performed since the previous routine inspection (Item ID D.2 – Actual Routine Inspection Date).

PROCEDURE

This is an unscheduled inspection to assess structural damage resulting from environmental factors or human actions.

This item should be coded “1” if a Damage Inspection has occurred during the current Routine Inspection Interval. Assuming no further Damage Inspections have occurred, this item should return a “0” code in subsequent routine inspection cycles.

Use the table below to code if a Damage Inspection has or has not been performed.

| <u>Description</u> | <u>Code</u> |
|---|-------------|
| Damage Inspection has not been performed. | 0 |
| Damage Inspection has been performed. | 1 |

FORMAT

N (1,0)

| | | |
|--|-------------|--------------|
| Item D.5.1 - Damage Inspection Date | CDOT | D.5.1 |
|--|-------------|--------------|

DESCRIPTION

Record this item for the last Damage Inspection performed. The number of the month and day shall be coded with leading zeros as required and the year to be recorded as 4-digits.

PROCEDURE



If a Damage Inspection has never been performed leave the entry blank. Once a Damage Inspection has been performed, leave this entry coded as the last Damage Inspection Date unless a new Damage Inspection has been performed.

FORMAT

D, MMDDYYYY

CODING EXAMPLES

| | |
|--------------------------------------|------------------------|
| <u>Damage Inspection Date</u> | <u>NTI Code</u> |
| April 21,2013 | 04212013 |
| No Damage Inspection ever performed | (blank) |

| | | |
|--------------------------------------|------------|------------|
| Item D.6 – Special Inspection | NTI | D.6 |
|--------------------------------------|------------|------------|

DESCRIPTION

Record this item for all records in the inventory. For the tunnel identified in Item ID I.1 – Tunnel Number, record whether the tunnel has a Special Inspection scheduled.

PROCEDURE

An inspection, scheduled at the discretion of the tunnel owner, used to monitor a particular known or suspected deficiency.

Indicate in the commentary of the element report which element(s) are to be included in the Special Inspection procedures. Use the table below to code if a Special Inspection has or has not been scheduled.

| <u>Description</u> | <u>Code</u> |
|--|-------------|
| Special Inspection has not been scheduled. | 0 |
| Special Inspection has been scheduled. | 1 |

FORMAT

N (1,0)

| | | |
|---|-------------|--------------|
| Item D.6.1 - Special Inspection Date | CDOT | D.6.1 |
|---|-------------|--------------|

DESCRIPTION

Record this item for the last Special Inspection performed. The number of the month and day shall be coded with leading zeros as required and the year to be recorded as 4-digits.

PROCEDURE

If a Special Inspection has never been performed leave the entry blank.

FORMAT



D, MMDDYYYY

CODING EXAMPLES

| <u>Special Inspection Date</u> | <u>NTI Code</u> |
|---------------------------------------|------------------------|
| April 21,2013 | 04212013 |
| No Special Inspection ever performed | (blank) |

| | | |
|---|------|-------|
| Item D.6.2 – Special Inspection Frequency | CDOT | D.6.2 |
|---|------|-------|

DESCRIPTION

Record the number of months between designated Special Inspections.

PROCEDURE

If a Special Inspection is not required and Item ID D.6 is coded 0 or if the Special Inspection is not to include a regular schedule, leave entry blank.

FORMAT

N (2,0)

CODING EXAMPLES

| <u>Special Inspection Frequency</u> | <u>NTI Code</u> |
|--|------------------------|
| 48 months | 48 |
| No Special Inspection required | (blank) |



2.7 Load Rating and Posting Items

The items in this section are related to load rating and posting of the highway tunnel.

ITEM L.1 – LOAD RATING METHOD 2.53

ITEM L.2 – INVENTORY LOAD RATING FACTOR 2.54

ITEM L.3 – OPERATING LOAD RATING FACTOR 2.54

ITEM L.4 – TUNNEL LOAD POSTING STATUS 2.54

ITEM L.5 – POSTING LOAD - GROSS 2.55

ITEM L.6 – POSTING LOAD – AXLE 2.55

ITEM L.7 – POSTING LOAD –TYPE 3 2.56

ITEM L.8 – POSTING LOAD – TYPE 3S2 2.56

ITEM L.9 – POSTING LOAD – TYPE 3-2 2.57

ITEM L.10 – HEIGHT RESTRICTION 2.57

ITEM L.11 – HAZARDOUS MATERIAL RESTRICTION 2.58

ITEM L.12 – OTHER RESTRICTIONS 2.58



| | | |
|--------------------------------------|---------------------|------------|
| Item L.1 – Load Rating Method | NTI Modified | L.1 |
|--------------------------------------|---------------------|------------|

DESCRIPTION

Record the method used to determine the Load Rating of the tunnel using the table below.

PROCEDURE

Use code 0 when the load rating is determined by field evaluation and documented engineering judgement, typically done when plans are not available or in cases of severe deterioration.

Use code 5 when the tunnel has not been load rated or load rating documentation does not exist.

Use code N when the tunnel does not require a load rating. At-grade roadways in tunnels are exempt from load rating.

COMMENTARY

This is intended to capture the method used to determine the load capacity of structural slabs within tunnel bores or the tunnel structure carrying live loads. As of the issue date on this manual, only D-01-CC-185 requires a load rating.

| <u>Description</u> | <u>Code</u> | <u>Description</u> | <u>Code</u> |
|--|-------------|---|-------------|
| Field evaluation and documented engineering judgment | 0 | Load and Resistance Factor Rating (LRFR) rating reported by rating factor (RF) method using HL-93 loadings | 8 |
| Load Factor (LF) | 1 | Assigned rating based on Load Factor Design (LFD) | A |
| Allowable Stress (AS) | 2 | Assigned ratings based on Allowable Stress Design (ASD) | B |
| Load and Resistance Factor (LRFR) | 3 | Assigned ratings based on Load Factor Design (LFD) reported by rating factor (RF) using MS18 loading | C |
| Load Testing | 4 | Assigned rating based on Load Factor Design (LFD) reported by rating factor (RF) using MS18 loading | D |
| No rating analysis or evaluation performed | 5 | Assigned ratings based on Allowable Stress Design (ASD) reported by rating factor (RF) using MS18 loadings | E |
| Load Factor (LF) rating reported by rating factor (RF) method using MS18 loading | 6 | Assigned ratings based on Load and Resistance Factor Design (LRFD) reported by rating factor (RF) using HL93 loadings | F |



| | | | |
|---|---|-----------------------------|---|
| Allowable Stress (AS) rating reported by rating factor (RF) method using MS18 loading | 7 | Load rating is not required | N |
|---|---|-----------------------------|---|

FORMAT

AN1

| | | |
|--|------------|------------|
| Item L.2 – Inventory Load Rating Factor | NTI | L.2 |
|--|------------|------------|

DESCRIPTION

Record the Inventory Load Rating Factor, truncated to the hundredth, for the standard AASHTO HS-20 or HL-93 loadings.

PROCEDURE

Leave this item blank for tunnels not requiring a load rating (Item ID L.1 – Load Rating Method coded as N).

For LRFR, this is the rating factor for the design load rating at the inventory level of reliability using the HL-93 load considering all applicable strength and serviceability limit states.

Refer to the AASHTO Manual for Bridge Evaluation and the CDOT Load Rating Manual for details of HS-20 and HL-93 loadings and state specific practices and policies.

FORMAT

N (4,2)

| | | |
|--|------------|------------|
| Item L.3 – Operating Load Rating Factor | NTI | L.3 |
|--|------------|------------|

DESCRIPTION

Record the operating rating load rating factor, truncated to the nearest hundredth, for the standard AASHTO HS-20 or HL-93 loadings.

PROCEDURE

Leave this item blank for tunnels not requiring a load rating (Item ID L.1 – Load Rating Method coded as N).

For LRFR, this is the rating factor for the design load rating at the inventory level of reliability using the HL-93 load considering all applicable strength and serviceability limit states.

Refer to the AASHTO Manual for Bridge Evaluation and the CDOT Load Rating Manual for details of HS-20 and HL-93 loadings and state specific practices and policies.

FORMAT

N (4,2)

| | | |
|--|------------|------------|
| Item L.4 – Tunnel Load Posting Status | NTI | L.4 |
|--|------------|------------|

Click to return to:

Section 2



DESCRIPTION

Record the load posting status of the tunnel.

PROCEDURE

Use the table below to indicate the load posting status for the tunnel.

| <u>Description</u> | <u>Code</u> | <u>Description</u> | <u>Code</u> |
|---|-------------|--|-------------|
| No Restriction | A | New tunnel not opened to traffic | G |
| Posting or posting reduction recommended, but not implemented | B | Tunnel closed to all traffic | K |
| Would be posted or closed, but temporary shoring or similar allows for unrestricted traffic | D | Posted with weight limit sign(s) | P |
| Temporary structure in place to carry legal loads while tunnel is closed and awaiting replacement or rehabilitation | E | Posted with other load restriction sign(s) | R |

FORMAT

AN1

| | | |
|--|------------|------------|
| Item L.5 – Posting Load – Gross | NTI | L.5 |
|--|------------|------------|

DESCRIPTION

Record the gross weight limit shown in the load posting sign rounded down to the nearest U.S. ton.

PROCEDURE

Leave this item blank if a gross load posting sign is not used.

FORMAT

N (2,0)

| | | |
|---------------------------------------|------------|------------|
| Item L.6 – Posting Load – Axle | NTI | L.6 |
|---------------------------------------|------------|------------|

DESCRIPTION

Record the axle weight limit shown on the load posting sign rounded down to the nearest U.S. ton.

PROCEDURE

Leave this item blank if an axle load posting sign is not used.



This item can also be used for tandem axle load posting signs. The tandem axle weight can be recorded for this item when it is the lowest controlling axle weight limit.

FORMAT

N (2,0)

| | | |
|----------------------------------|-----|-----|
| Item L.7 – Posting Load – Type 3 | NTI | L.7 |
|----------------------------------|-----|-----|

DESCRIPTION

Record the weight limit value shown on the load posting sign for the AASHTO Type 3 vehicle or state equivalent rounded down to the nearest U.S. ton.

PROCEDURE

Leave this item blank if no posting sign is used for this vehicle type.

A state equivalent vehicle is considered to have the same number of axles and similar axle spacing as the AASHTO Type 3 vehicle.

Refer to the AASHTO Manual for Bridge Evaluations for legal load posting vehicle configurations.

COMMENTARY

Record the weight limit value shown on the load posting sign for the CDOT Type 3 vehicle rounded down to the nearest U.S. ton.

FORMAT

N (2,0)

| | | |
|------------------------------------|-----|-----|
| Item L.8 – Posting Load – Type 3S2 | NTI | L.8 |
|------------------------------------|-----|-----|

DESCRIPTION

Record the weight limit value shown on the load posting sign for the AASHTO Type 3S2 vehicle or state equivalent rounded down to the nearest U.S. ton.

PROCEDURE

Leave this item blank if no posting sign is used for this vehicle type.

A state equivalent vehicle is considered to have the same number of axles and similar axle spacing as the AASHTO Type 3S2 vehicle.

Refer to the AASHTO Manual for Bridge Evaluations for legal load posting vehicle configurations.

COMMENTARY

Record the weight limit value shown on the load posting sign for the CDOT Type 3S2 vehicle rounded down to the nearest U.S. ton.



FORMAT

N (2,0)

| | | |
|------------------------------------|-----|-----|
| Item L.9 – Posting Load – Type 3-3 | NTI | L.9 |
|------------------------------------|-----|-----|

DESCRIPTION

Record the weight limit value shown on the load posting sign for the AASHTO Type 3-3 vehicle or state equivalent rounded down to the nearest U.S. ton.

PROCEDURE

Leave this item blank if no posting sign is used for this vehicle type.

A state equivalent vehicle is considered to have the same number of axles and similar axle spacing as the AASHTO Type 3-3 vehicle.

Refer to the AASHTO Manual for Bridge Evaluations for legal load posting vehicle configurations.

COMMENTARY

Record the weight limit value shown on the load posting sign for the CDOT Type 3-2 vehicle rounded down to the nearest U.S. ton.

FORMAT

N (2,0)

| | | |
|--------------------------------|-----|------|
| Item L.10 – Height Restriction | NTI | L.10 |
|--------------------------------|-----|------|

DESCRIPTION

Record whether the tunnel has a Height Restriction.

PROCEDURE

Use the table below to code if the tunnel does or does not have a Height Restriction.

COMMENTARY

A tunnel is classified as being height restricted when the minimum vertical clearance is less than that defined in Section 5.1.10.

Minimum vertical clearance shall be defined as the most restrictive measurement over the usable travelway as defined in Section 5.1.10.

| <u>Description</u> | <u>Code</u> |
|--------------------|-------------|
| Yes | 1 |



| | |
|----|---|
| No | 0 |
|----|---|

FORMAT

N (1,0)

| | | |
|---|------------|-------------|
| Item L.11 – Hazardous Material Restriction | NTI | L.11 |
|---|------------|-------------|

DESCRIPTION

Record whether the tunnel has a hazardous material restriction.

PROCEDURE

Use the table below to code if the tunnel does or does not have a hazardous material restriction.

COMMENTARY

See Appendix VII: Rules Governing the Use of Tunnels on Colorado State Highways, 2 CCR 601-8 for more information.

| <u>Description</u> | <u>Code</u> |
|--------------------|-------------|
| Yes | 1 |
| No | 0 |

FORMAT

N (1,0)

| | | |
|---------------------------------------|------------|-------------|
| Item L.12 – Other Restrictions | NTI | L.12 |
|---------------------------------------|------------|-------------|

DESCRIPTION

Record whether the tunnel has a restriction other than load posting, height, or hazardous materials.

PROCEDURE

Other Restrictions could include width restrictions or requirements for police escorts for permit vehicles.

Use the table below to code if the tunnel does or does not have Other Restrictions.

| <u>Description</u> | <u>Code</u> |
|--------------------|-------------|
| Yes | 1 |
| No | 0 |

FORMAT

N (1,0)



2.8 Navigation Items

The items in this section are related to navigable waterways over the tunnel.

ITEM N.1 – UNDER NAVIGABLE WATERWAY..... 2.60

ITEM N.2 – NAVIGABLE WATERWAY CLEARANCE 2.60

ITEM N.3 – TUNNEL OR PORTAL ISLAND PROTECTION FROM NAVIGATION 2.61



| | | |
|--|------------|------------|
| Item N.1 – Under Navigable Waterway | NTI | N.1 |
|--|------------|------------|

DESCRIPTION

Record the one digit number to describe if the waterway above the tunnel is navigable. Some tunnels are located Under Navigable Waterways. If there is a navigable waterway above the tunnel, this item shall be coded 1. If there is not a navigable waterway above the tunnel, this item shall be coded 0.

PROCEDURE

Use the table below to code if a tunnel is under a navigable waterway.

COMMENTARY

Colorado does not currently have any tunnels Under Navigable Waterways.

| <u>Description</u> | <u>Code</u> |
|---|-------------|
| A navigable waterway is not above the tunnel. | 0 |
| A navigable waterway is above the tunnel. | 1 |

FORMAT

N (1,0)

| | | |
|--|------------|------------|
| Item N.2 – Navigable Waterway Clearance | NTI | N.2 |
|--|------------|------------|

DESCRIPTION

Record the minimum vertical clearance imposed at the site as measured above a datum that is specified on a navigation permit issued by a control agency (between top of tunnel or tunnel protection system and average water level). This measurement will show the clearance that is allowable for navigational purposes.

PROCEDURE

If the tunnel is not under a navigable waterway, code as 00.0.

COMMENTARY

Colorado does not currently have any tunnels Under Navigable Waterways.

FORMAT

N (3,1)

CODING EXAMPLES

Navigable Waterway Clearance

NTI Code

No waterway over tunnel

00.0



| | | |
|--|------------|------------|
| Item N.3 – Tunnel or Portal Island Protection from Navigation | NTI | N.3 |
|--|------------|------------|

DESCRIPTION

Record the codes below to indicate the presence and adequacy of top of tunnel protection and portal islands to protect against vessel collision.

PROCEDURE

If tunnel is not under a navigable waterway, code as 0.

COMMENTARY

Colorado does not currently have any tunnels Under Navigable Waterways.

| <u>Description</u> | <u>Code</u> |
|--|-------------|
| Navigation protection not required or not Under Navigable Waterway | 0 |
| In place and functioning | 1 |
| In place but in a deteriorated condition | 2 |
| In place but reevaluation of design suggested | 3 |
| None present but reevaluation suggested | 4 |

FORMAT

N (1,0)



2.9 Structure Type and Material Items

The items in this section are related to the tunnel shape and the adjacent materials surrounding the tunnel.

ITEM S.1 – NUMBER OF BORES 2.63

ITEM S.2 – TUNNEL SHAPE 2.63

ITEM S.3 – PORTAL SHAPE 2.64

ITEM S.4 – GROUND CONDITIONS..... 2.65

ITEM S.5 – COMPLEX 2.65

ITEM S.6 – PORTAL MATERIAL TYPE 2.66

ITEM S.7 – LINER MATERIAL TYPE 2.66



| | | |
|-----------------------------------|------------|------------|
| Item S.1 – Number of Bores | NTI | S.1 |
|-----------------------------------|------------|------------|

DESCRIPTION

Record the one digit number defining the Number of Bores in a tunnel. When recording and coding for this item, use the Number of Bores associated with Item ID I.1 – Tunnel Number.

PROCEDURE

Definition of a Tunnel Bore - an underground passageway for vehicles that pass under a mountain, waterway, or an urban area.

A ramp should not be counted as a bore unless it is being coded as a separate tunnel.

FORMAT

N (1,0)

| | | |
|--------------------------------|------------|------------|
| Item S.2 – Tunnel Shape | NTI | S.2 |
|--------------------------------|------------|------------|

DESCRIPTION

Record the type of Tunnel Shape.

PROCEDURE

Use the table and Figure S.2 below to code the Tunnel Shape.

| <u>Description</u> | <u>Code</u> |
|--------------------|-------------|
| Oval | 1 |
| Horseshoe | 2 |
| Box | 3 |
| Circular | 4 |

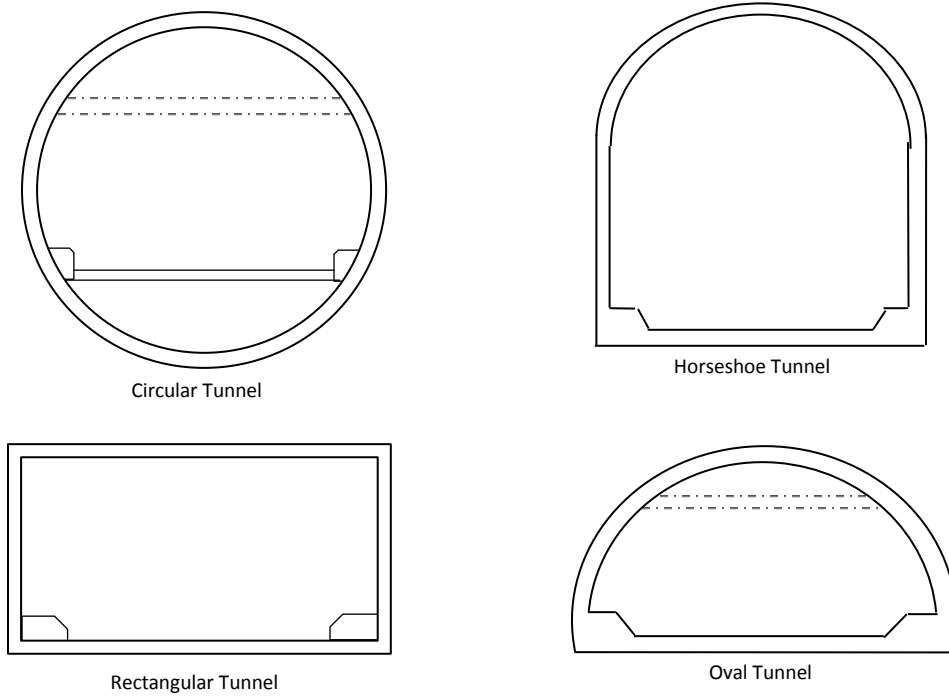


Figure S.2 - Tunnel Shapes

FORMAT

N (1,0)

| | | |
|-------------------------|-----|-----|
| Item S.3 – Portal Shape | NTI | S.3 |
|-------------------------|-----|-----|

DESCRIPTION

Record the type of Portal Shape. This may be different from item S.2.

PROCEDURE

See example shapes shown for Item ID S.2 - Tunnel Shape, Figure S.2.

Use the table below to code the tunnel Portal Shape.

| <u>Description</u> | <u>Code</u> |
|--------------------|-------------|
| Oval | 1 |
| Horseshoe | 2 |
| Box | 3 |
| Circular | 4 |



| | |
|-------|---|
| Other | 5 |
|-------|---|

FORMAT

N (1,0)

| | | |
|-------------------------------------|------------|------------|
| Item S.4 – Ground Conditions | NTI | S.4 |
|-------------------------------------|------------|------------|

DESCRIPTION

Record the primary type of Ground Conditions.

PROCEDURE

Use the table below and corresponding definitions to code the tunnel Ground Conditions.

| <u>Description</u> | <u>Code</u> |
|--------------------|-------------|
| Soil | 1 |
| Rock | 2 |
| Mixed Face | 3 |

Definitions:

Soil is used to define Ground Conditions consisting primarily of clay, silt, sand, gravel or a mixture.

Rock is used to define Ground Conditions consisting primarily of material that has rock structure in weathered to sound condition.

The term mixed face usually refers to a situation where the soil conditions vary along the length and/or height of the tunnel.

FORMAT

N (1,0)

| | | |
|---------------------------|------------|------------|
| Item S.5 – Complex | NTI | S.5 |
|---------------------------|------------|------------|

DESCRIPTION

Record whether a tunnel is Complex or not Complex using the following table.

PROCEDURE

A Complex tunnel is characterized by advanced or unique structural elements or functional systems.

Complex tunnels may include mechanical or fire suppression equipment to ventilate exhaust from the tunnel or provide protection against tunnel fires. A non-Complex tunnel, in contrast, is typically of a shorter length, not requiring any ventilation, and may or may not have lighting installed.



| <u>Description</u> | <u>Code</u> |
|---------------------------|-------------|
| The tunnel is not Complex | 0 |
| The tunnel is Complex | 1 |

FORMAT

N (1,0)

| | | |
|--|-------------|------------|
| Item S.6 – Portal Material Type | CDOT | S.6 |
|--|-------------|------------|

DESCRIPTION

Record the tunnel Portal Material Type

PROCEDURE

Use the table below to code a material type of the portal. For mixed material types code as 0.

| <u>Description</u> | <u>Code</u> |
|--------------------|-------------|
| Other | 0 |
| Concrete | 1 |
| Masonry | 2 |
| Unlined Rock | 3 |

FORMAT

N (1,0)

| | | |
|---------------------------------------|-------------|------------|
| Item S.7 – Liner Material Type | CDOT | S.7 |
|---------------------------------------|-------------|------------|

DESCRIPTION

Record the primary tunnel liner type.

PROCEDURE

Use table below to indicate what the primary material type of the tunnel liner is.

| <u>Description</u> | <u>Code</u> |
|------------------------|-------------|
| Other | 0 |
| Concrete Cast-in-Place | 1 |
| Concrete Precast | 2 |



| | |
|--------------|---|
| Shotcrete | 3 |
| Steel | 4 |
| Timber | 5 |
| Masonry | 6 |
| Unlined Rock | 7 |
| Mixed Types | 8 |

FORMAT

N (1,0)

Section 3 Elements

| | |
|---|-------|
| 3.1 Introduction | 3.2 |
| 3.2 Structural Section | 3.6 |
| 3.3 Civil Section..... | 3.115 |
| 3.4 Mechanical Systems Section..... | 3.139 |
| 3.5 Electrical and Lighting Systems Section..... | 3.163 |
| 3.6 Fire/Life Safety/Security Systems Section | 3.183 |
| 3.7 Signs Section | 3.196 |
| 3.8 Protective Systems Section..... | 3.203 |



3.1 Introduction

This section is comprised of tunnel elements arranged by general element type, material, and in order of their physical location in the tunnel to facilitate ease of use by tunnel inspectors in the field. An element is a defined part of a tunnel system or structure that is needed for the tunnel to function as intended.

| Element Number – Element Name | Agency Defined | Unit of Measure |
|-------------------------------|----------------|-----------------|
|-------------------------------|----------------|-----------------|

DESCRIPTION

Element description.

How to measure the quantity of this element.

PROCEDURE

Additional information about this element.

COMMENTARY

CDOT guidance specific to documentation practices or inventory.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------|--------------------------------------|--|---|---|
| General Condition | Good condition – no notable distress | Fair condition – isolated breakdowns or deterioration. | Poor condition – widespread deterioration or breakdowns without reducing load capacity. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel. |

The format of an element is described with a title, narrative, and condition table. The heading describes (1) Element Number and Description, (2) Agency Defined, and (3) Unit of Measure. Below the header is a Description of the element followed by the Condition State Definition Table.



The Element Number is the unique number assigned to represent that element. Element Numbers were derived based on their section, subsection, and element. For example, Elements 10000 to 10140 are part of the structural section, and are further grouped by subsection within this manual.

The Element Name is the name used to describe that particular element.

The Agency is denoted as either NTI or CDOT and identifies an element's origin as either the SNTI or an Agency Defined Element (ADE)

The Unit of Measure details the units to quantify that element. The Unit of Measure will be length, area, or each. Length should be reported in feet and area should be reported in square feet. The quantity 'each' should be recorded as the number of individual elements for the subsection. Each single unit quantity of an element is given a Condition State.

For consistency amongst all CDOT asset inspection manuals, the terms Specification and Commentary referenced within the SNTI shall be replaced with Description and Procedure respectively. Additional Commentary shall be provided for state specific guidance. Where necessary, state specific discussion has been italicized to denote variances between the SNTI and the CTIIM. Agency Defined Elements (ADEs) will not be italicized as they are entirely separate from the SNTI.

The Description and Procedure sections provide the detailed description of each element, how to calculate the quantity of the element and some explanation or additional clarification to consider for coding each element.

In addition to the elements defined by the SNTI, this manual identifies ADEs and additional defect criteria for sub-elements or components of larger systems. The intent of the additional guidance, shown in italics, is to aid in consistency of condition state assignment and distribution amongst inspectors. Additionally, the construct allows CDOT to expand their asset management program over time.

The Condition State Definition table lists defects and condition state language that is specific to that element. Only those defects which are appropriate for a specific element are listed. Each defect is then associated with four condition states and descriptive language based on the material type. This is done to recognize that the defect is dependent on the material and its severity.

- Condition State 1 is analogous to good condition;
- Condition State 2 is analogous to fair condition;
- Condition State 3 is analogous to poor condition;
- Condition State 4 is analogous to severe condition;

The limits of Condition States 1 through 3 are typically well defined for each defect. Condition State 4 is reserved for instances when the defect's conditions are beyond the limits of those defined in Condition States 1 through 3 and a structural review is recommended or has been performed and a reduced strength or serviceability condition exists following the review process.

Additional guidance for identifying a Condition State 4 is provided in the condition state table of many elements. This guidance may be overlooked if the condition merits a structural review or poses a direct safety concern. If a structural review has been performed and the strength or serviceability of the tunnel



is affected, the defect is to remain in Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is NOT affected, the condition state distribution for that defect is to be documented in Condition State 3. Detailed procedures for reporting a review and/or Condition State 4 are covered in Section 5.2.

An additional defect has been added for CDOT purposes regarding safety. If a defect poses an immediate safety concern for the travelway below, the area is to be recorded as a Condition State 4. This shall also be followed by issuance of a Critical Inspection Finding (CIF) or Essential Repair Finding (ERF) as described herein.

When multiple defects occupy the same location, assign the more severe condition state to the element. As of the issuance of this manual, defect condition state distributions are not required.

When inspecting and developing an element based report, a list of elements will be developed using the plans and on-site observation for the tunnel. Each element will be given a quantity as designated by the element table provided in this text. The element quantities will then be divided into condition states based on the defect descriptions, locations and extent of the defects present, and engineering judgment. Comments will be added under each element describing the defects and their locations. For more information on report requirements please see Section 5.

Many tunnels are constructed using two different tunnel liners, the initial support liner and the final support liner. Steel Tunnel Liners, Timber Tunnel Liners, Shotcrete Tunnel Liners, and rock bolts/dowels are often used as initial support during construction phase and are subsequently covered with the final liner. Most of the time, the initial tunnel liners structural supports are no longer needed after the final liner is in place. These elements are not required to hold a load and are considered out-of-service. These out-of-service elements should still be investigated if they have potential to cause deterioration to load bearing elements or pose a safety concern for the travelway below. If an element for the initial tunnel liner still carries a load needed for the structure, it is not out-of-service and should be included where condition assessment provides for appropriate documentation.

This element based documenting process ensures continuity between different inspection dates and inspectors. Assigning each element within a tunnel's inventory a universally defined condition state helps owners maintain their tunnels, allocate resources, provide reliable traffic rout for goods, and protect the traveling public. Over time and multiple inspections, the quality and deterioration of different systems can be accurately monitored and the need for repairs or Special Inspections programmed and recognized.

Example of recording Condition States:

A 4 ft long concrete girder would be divided into four 1-foot sections; each section would be assigned a condition state based on the defects present. If one 1-foot section had a 0.03 in. wide crack, that 1-foot section would be in Condition State 2. If the remaining three 1-foot sections had no deficiencies, they would be in Condition State 1. The result would be a total quantity of 4 ft, with 3 ft in Condition State 1 and 1 ft in Condition State 2.

If an element recorded as 'each' and is composed of multiple components and the components are in different condition states, record the highest numbered condition state for that defect. For example: A steel anchor assembly has two anchors. The hanger has begun the corrosion process; this places it in



Condition State 2. One anchor has cracking around the anchorage area and the concrete is not sound; this places it in Condition State 3. The other anchor also has cracking in the anchorage area, however the concrete is sound; this places it in Condition State 2. The entire assembly, recorded as one unit, would be in Condition State 3.



3.2 Structural Section

This section defines tunnel structural elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

| Element Number | Element Name | Unit of Measure |
|----------------------------|--|---------------------------|
| Liners | | |
| 10000 | Steel Tunnel Liner | AREA (Feet ²) |
| 10001 | Cast-in-Place Concrete Tunnel Liner | AREA (Feet ²) |
| 10002 | Precast Concrete Tunnel Liner | AREA (Feet ²) |
| 10003 | Shotcrete Tunnel Liner | AREA (Feet ²) |
| 10004 | Timber Tunnel Liner | AREA (Feet ²) |
| 10005 | Masonry Tunnel Liner | AREA (Feet ²) |
| 10006 | Unlined Rock Tunnel | AREA (Feet ²) |
| 10007 | Rock Bolt/Dowel | EACH |
| 10009 | Other Tunnel Liner | AREA (Feet ²) |
| Tunnel Roof Girders | | |
| 10010 | Steel Tunnel Roof Girders | LENGTH (Feet) |
| 10011 | Concrete Tunnel Roof Girders | LENGTH (Feet) |
| 10012 | Prestressed Concrete Tunnel Roof Girders | LENGTH (Feet) |
| 10019 | Other Tunnel Roof Girders | LENGTH (Feet) |
| Columns/Piles | | |
| 10020 | Steel Columns/Piles | EACH |
| 10021 | Concrete Columns/Piles | EACH |
| 10029 | Other Columns/Piles | EACH |
| Cross Passageway | | |
| 10030 | Steel Cross Passageway | LENGTH (Feet) |
| 10031 | Concrete Cross Passageway | LENGTH (Feet) |
| 10033 | Shotcrete Cross Passageway | LENGTH (Feet) |
| 10034 | Timber Cross Passageway | LENGTH (Feet) |

[Click to return to:](#)

Section 3



| | | |
|------------------------|-------------------------------------|---------------------------|
| 10035 | Masonry Cross Passageway | LENGTH (Feet) |
| 10036 | Unlined Rock Cross Passageway | LENGTH (Feet) |
| 10039 | Other Cross Passageway | LENGTH (Feet) |
| Interior Walls | | |
| 10041 | Concrete Interior Walls | AREA (Feet ²) |
| 10042 | Tile Lined Concrete Precast Panels | AREA (Feet ²) |
| 10049 | Other Interior Walls | AREA (Feet ²) |
| Portal | | |
| 10051 | Concrete Portal | AREA (Feet ²) |
| 10055 | Masonry Portal | AREA (Feet ²) |
| 10059 | Other Portal | AREA (Feet ²) |
| Ceiling Slab | | |
| 10061 | Concrete Ceiling Slab | AREA (Feet ²) |
| 10069 | Other Ceiling Slab | AREA (Feet ²) |
| Ceiling Girder | | |
| 10070 | Steel Ceiling Girder | LENGTH (Feet) |
| 10071 | Concrete Ceiling Girder | LENGTH (Feet) |
| 10072 | Prestressed Concrete Ceiling Girder | LENGTH (Feet) |
| 10079 | Other Ceiling Girder | LENGTH (Feet) |
| Hangers and Anchorages | | |
| 10080 | Steel Hangers and Anchorages | EACH |
| 10089 | Other Hangers and Anchorages | EACH |
| Ceiling Panels | | |
| 10090 | Steel Ceiling Panels | AREA (Feet ²) |
| 10091 | Concrete Ceiling Panels | AREA (Feet ²) |
| 10099 | Other Ceiling Panels | AREA (Feet ²) |
| Invert Slab | | |



| | | |
|---------------|------------------------------------|---------------------------|
| 10101 | Concrete Invert Slab | AREA (Feet ²) |
| 10109 | Other Invert Slab | AREA (Feet ²) |
| Slab-on-Grade | | |
| 10111 | Concrete Slab-on-Grade | AREA (Feet ²) |
| 10119 | Other Slab-on-Grade | AREA (Feet ²) |
| Invert Girder | | |
| 10120 | Steel Invert Girder | LENGTH (Feet) |
| 10121 | Concrete Invert Girder | LENGTH (Feet) |
| 10122 | Prestressed Concrete Invert Girder | LENGTH (Feet) |
| 10129 | Other Invert Girder | LENGTH (Feet) |
| Joints | | |
| 10130 | Strip Seal Expansion Joint | LENGTH (Feet) |
| 10131 | Pourable Joint Seal | LENGTH (Feet) |
| 10132 | Compression Joint Seal | LENGTH (Feet) |
| 10133 | Assembly Joint with Seal | LENGTH (Feet) |
| 10134 | Open Expansion Joint | LENGTH (Feet) |
| 10135 | Assembly Joint without Seal | LENGTH (Feet) |
| 10139 | Other Joint | LENGTH (Feet) |
| Gaskets | | |
| 10140 | Gaskets | LENGTH (Feet) |



| | | |
|-----------------------------------|------------|--|
| 10000 – Steel Tunnel Liner | NTI | Units: Square Feet (ft²) |
|-----------------------------------|------------|--|

DESCRIPTION

Record this element for all Steel Tunnel Liners. Steel Tunnel Liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Steel Tunnel Liners in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------|---|--|--|---|
| Corrosion | None | Freckled rust. Corrosion of the steel has initiated. | Section loss is evident or pack rust is present but does not warrant structural review. | <i>*Section loss is of the extent which impacts capacity, warrants structural review</i> |
| Cracking | None | Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar. | Identified crack exists that is not arrested but does not warrant structural review. | <i>* Severe unarrested cracking Crack is likely to or has propagated into critical stress area, warrants structural review</i> |
| Connections | Connection is in place and functioning as intended. | Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended. | Missing bolts, rivets, or fasteners; broken welds, pack rust with distortion but does not warrant a structural review. | <i>*Connection has failed (or failure of connector is imminent) which impacts connection capacity, warrants structural review</i> |
| Distortion | None | Distortion has received structural review and has been mitigated. | Distortion has received structural review and does not require mitigation. | <i>*Distortion is extensive and may impact capacity, warrants structural review</i> |



| | | | | |
|---------------|----------------------|--|---------------------------------------|---|
| Leakage | Dry surface | Saturated surface indicating seepage may be present or evidence of past seepage. | Fully saturated surface with seepage. | Seepage could range from dripping to flowing. <i>Ice Buildup</i> |
| <i>Safety</i> | <i>Not impacted.</i> | | | <i>Defect poses a safety concern for travelway below.</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

For the Leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.



| | | |
|--|------------|--|
| 10001 – Cast-in-Place Concrete Tunnel Liner | NTI | Units: Square Feet (ft²) |
|--|------------|--|

DESCRIPTION

Record this element for all Cast-in-Place Concrete Tunnel Liners. Cast-in-Place Concrete Tunnel Liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--|---|--|---|--|
| Delamination/ Spall/ Patched area/ <i>Scale</i> | None | Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | <i>*Spall affects capacity of the element, warrants a structural review.</i> |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | <i>*Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.</i> |
| Efflorescence/ Rust Staining ¹ | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaking, build-up, and/or rust present which is of concern to capacity, warrants a structural review.</i> |
| Cracking ² (Liners) | Width less than 0.012 in. or spacing greater than 5.0 ft. | Width 0.012 – 0.10 in.-below spring line or spacing of 1.0 – 5.0 ft. <i>Cracks exhibit structural sealant which is in good condition.</i> | Width greater than 0.10 in -below spring line or greater than 0.012 in above spring line or spacing less than 1 ft. <i>Cracks exhibit sealant used for</i> | <i>*Severe structural cracking which is of concern to capacity of structure, warrants a structural review.</i> |



| | | | | |
|----------------------|----------------------|---|--|---|
| | | | <i>water or leakage relocation or structural sealant is unsound.</i> | |
| Distortion | None | Distortion has received structural review and has been mitigated. <i>Distortion is construction related and does not affect capacity or serviceability of structure.</i> | Distortion has received structural review and does not require mitigation. | <i>*Distortion is extensive and is of concern to capacity of element, warrants structural review.</i> |
| Leakage ³ | Dry surface | Saturated surface indicating seepage may be present or evidence of past seepage. | Fully saturated surface with seepage. | Seepage could range from dripping to flowing. <i>Ice Buildup</i> |
| Safety (CDOT) | <i>Not impacted.</i> | | | <i>Defect poses a safety concern for travelway below.</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

¹ Heavy build-up of efflorescence and/or rust staining are both considered CS 3 for the tunnel liner. Careful evaluation should be used when determining whether rust staining or mineral deposits are present.

²When documenting cracking in the liner the type of cracking, orientation, and location should be considered in the analysis of the liner condition. Engineering judgement should be used when evaluating different types and severity of cracking. Typically, longitudinal cracking is more concerning than transverse cracking in the inverted portion(s) of circular, horseshoe, and oval liners. Longitudinal cracking should be thoroughly documented including any offset. Use TOMIE Section 4.9.1.1 for additional guidance.

³For the Leakage defect, add commentary in the documentation to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.

10001 – Cast-in-Place Concrete Tunnel Liner

Condition Rating Examples (Concrete Liner Element)



Condition State 2
Efflorescence at a construction joint in the liner



Condition State 3
Cracking in the tunnel liner above the springline



Condition State 3
Cracking with heavy efflorescence



Condition State 4
Active dripping leakage

Figure X: 10001 – Cast-in-Place Concrete Tunnel Liner Condition Rating Example Photos



| | | |
|---|------------|--|
| 10002 –Precast Concrete Tunnel Liner | NTI | Units: Square Feet (ft²) |
|---|------------|--|

DESCRIPTION

Record this element for all Precast Concrete Tunnel Liners. Precast Concrete Tunnel Liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Precast Concrete Tunnel Liners in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--|---|--|---|--|
| Delamination/ Spall/ Patched area/ <i>Scale</i> | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | <i>*Spall affects capacity of the element, warrants a structural review.</i> |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | <i>*Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.</i> |
| Efflorescence/ Rust Staining ¹ | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaking, build-up, and/or rust present which is of concern to capacity, warrants a structural review.</i> |
| Cracking ² (Liners) | Width less than 0.012 in. or spacing greater than 5.0 ft. | Width 0.012 – 0.10 in. below spring line or spacing of 1.0 – 5.0 ft. | Width greater than 0.10 in below spring line or greater than 0.012 in above | <i>*Severe structural cracking which is of concern to capacity of structure,</i> |



| | | | | |
|----------------------|----------------------|--|--|---|
| | | | spring line or spacing less than 1 ft. | warrants a structural review. |
| Distortion | None | Distortion has received structural review and has been mitigated. | Distortion has received structural review and does not require mitigation. | <i>*Distortion is extensive and is of concern to capacity of element, warrants structural review.</i> |
| Leakage ³ | Dry surface | Saturated surface indicating seepage may be present or evidence of past seepage. | Fully saturated surface with seepage. | Seepage could range from dripping to flowing. <i>Ice Buildup</i> |
| Safety (CDOT) | <i>Not impacted.</i> | | | <i>Defect poses a safety concern for travelway below.</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

¹ Heavy build-up of efflorescence and/or rust staining are both considered CS 3 for the tunnel liner. Careful evaluation should be used when determining whether rust staining or mineral deposits are present.

²When documenting cracking in the liner the type of cracking, orientation, and location should be considered in the analysis of the liner condition. Engineering judgement should be used when evaluating different types and severity of cracking. Typically, longitudinal cracking is more concerning than transverse cracking in the inverted portion(s) of circular, horseshoe, and oval liners. Longitudinal cracking should be thoroughly documented including any offset. Use TOMIE Section 4.9.1.1 for additional guidance.

³For the Leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.



| | | |
|---------------------------------------|------------|--|
| 10003 – Shotcrete Tunnel Liner | NTI | Units: Square Feet (ft²) |
|---------------------------------------|------------|--|

DESCRIPTION

Record this element for all Shotcrete Tunnel Liners. Shotcrete Tunnel Liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---|---|---|---|--|
| Delamination/ Spall/ Patched area/ <i>Scale</i> | None | Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | <i>*Spall affects capacity of the element, warrants a structural review.</i> |
| Exposed Rebar (<i>to include welded wire reinforcement, not exposed external reinforcement</i>) | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | <i>*Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.</i> |
| Efflorescence/ Rust Staining ¹ | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaking, build-up, and/or rust present which is of concern to capacity, warrants a structural review.</i> |
| Cracking (Liners) | Width less than 0.012 in. or spacing greater than 5.0 ft. | Width 0.012 – 0.10 in. below spring line or spacing of 1.0 – 5.0 ft. | With greater than 0.10 in below spring line or greater than 0.012 in above spring line or spacing less than 1 ft. | <i>*Severe structural cracking which is of concern to capacity of structure, warrants a structural review.</i> |



| | | | | |
|----------------------|----------------------|--|--|--|
| Distortion | None | Distortion has received structural review and has been mitigated. | Distortion has received structural review and does not require mitigation. | <i>*Distortion is extensive and is of concern to capacity of element, warrants structural review</i> |
| Leakage ² | Dry surface | Saturated surface indicating seepage may be present or evidence of past seepage. | Fully saturated surface with seepage. | Seepage could range from dripping to flowing. Ice Buildup |
| Safety (CDOT) | <i>Not impacted.</i> | | | <i>Defect poses a safety concern for travelway below.</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

¹ Heavy build-up of efflorescence and/or rust staining are both considered CS 3 for the tunnel liner. Careful evaluation should be used when determining whether rust staining or mineral deposits are present.

²For the leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.



| | | |
|------------------------------------|------------|--|
| 10004 – Timber Tunnel Liner | NTI | Units: Square Feet (ft²) |
|------------------------------------|------------|--|

DESCRIPTION

Record this element for all Timber Tunnel Liners. Timber Tunnel Liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

PROCEDURE

Timber Tunnel Liners consist of timber sets spaced along the length of the tunnel. Typically, the space between the sets is fitted with timber lagging. In the case where the area between the timber set is not timber lagging, also record a liner type, i.e. Unlined Rock, Shotcrete Liner, etc. to identify the area between the timber sets.

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Timber Tunnel Liners in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------|--------------------------|--|---|---|
| Decay or Rot | None | Decay has started in the timber sets or lagging. No fungus growth or discoloration is present. | Decay has resulted in loss of strength, deflection, or crushing of the element but not of a sufficient magnitude to affect the strength and serviceability of the tunnel. Fungus growth and discoloration is present. | <i>*More than 40% section loss, severe deflection or crushing, warrants structural review</i> |
| Voids | None | Small voids may exist in the annular space behind the lagging. | Large voids may exist in the annular space behind the lagging. | <i>*Voids exist that are greater than 40% section loss or extend more than 25% of the members length in the tension</i> |



| | | | | |
|-----------------------------|---|---|---|--|
| | | | | zone, warrants structural review. |
| Cracks/Splits/Checks | None | Cracks, splits or checks exist in the timber sets or lagging. | Cracks, splits or checks exist in the timber sets or lagging and has impacted strength and/or serviceability but does not warrant structural review. | <i>*Full member cracks, splits or checks; more than 25% of the members length in the tension zone, or to the extent which affects capacity, warrants structural review</i> |
| Timber Distortion | No off-set or misalignment between the timber members (good compression fit). | Off-set or misalignment between timber members may exist but is 0.125 in. or less. | Off-set or misalignment between timber members may exist and is between 0.125 in. and 0.25 in. | <i>*Severe distortion exists greater than 0.25 in, warrants structural review</i> |
| Insect Infestation | None | Infestation has started in the timber sets or lagging. | Infestation exists in the timber sets or lagging and has produced loss of strength or deflection of the element but not of a sufficient magnitude to affect the strength and/or serviceability of the tunnel. | <i>*Severe infestation exists in the timber sets or lagging and has produced loss of strength or deflection of the element of a sufficient magnitude to affect the strength and/or serviceability of the tunnel, warrants structural review.</i> |
| Loose or Missing Connectors | None | Loose bolts, or fasteners are present but the connection is in place and functioning as intended. | Missing bolts or fasteners but does not warrant a structural review. | <i>*Connection has failed (or failure of connector is imminent) which impacts connection capacity, warrants structural review.</i> |
| Leakage ¹ | Dry surface | Saturated surface indicating seepage may be present or | Fully saturated surface with seepage. | Seepage could range from dripping to flowing. <i>Ice Buildup</i> |



| | | | | |
|------------------|----------------------|---------------------------|--|---|
| | | evidence of past seepage. | | |
| Safety (CDOT) | <i>Not impacted.</i> | | | <i>Defect poses a safety concern for travelway below.</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

¹For the leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.



| | | |
|-------------------------------------|------------|--|
| 10005 – Masonry Tunnel Liner | NTI | Units: Square Feet (ft²) |
|-------------------------------------|------------|--|

DESCRIPTION

Record this element for all Masonry Tunnel Liners. Masonry Tunnel Liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Masonry Tunnel Liners in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--|--------------------------|---|---|--|
| Efflorescence/ Rust Staining ¹ | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaching, surrounding area unsound, warrants a structural review</i> |
| Mortar Breakdown | None | Cracking or voids in less than 10% of joints. | Cracking or voids in 10% or more of the joints. | <i>*Severe cracking, more than 25% of the joints, warrants structural review</i> |
| Split/Spall | None | Block or stone has split or spalled with no shifting. | Block or stone has split or spalled with shifting but does not warrant a structural review. | <i>*Split reduces stability of the structure, spalling with greater than 25% loss of block thickness, warrants structural review</i> |
| Patched Area | None | Sound patch. | Unsound patch. | <i>*Unsound patch which affects capacity of structure, warrants structural review.</i> |



| | | | | |
|----------------------|----------------------|--|---|---|
| Masonry Displacement | None | Block or stone has shifted slightly out of alignment. | Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review. | *Block or stone is severely misaligned, or detached from the structure, warrants structural review |
| Distortion | None | Distortion has received structural review and has been mitigated. | Distortion has received structural review and does not require mitigation. | *Distortion exceeds tolerable limits and reduces the stability of the element, warrants structural review |
| Leakage ² | Dry surface | Saturated surface indicating seepage may be present or evidence of past seepage. | Fully saturated surface with seepage. | Seepage could range from dripping to flowing. <i>Ice Buildup</i> |
| Safety (CDOT) | <i>Not impacted.</i> | | | <i>Defect poses a safety concern for travelway below.</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

¹ Heavy build-up of efflorescence and/or rust staining are both considered CS 3 for the tunnel liner. Careful evaluation should be used when determining whether rust staining or mineral deposits are present.

²For the Leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.



| | | |
|------------------------------------|------------|--|
| 10006 – Unlined Rock Tunnel | NTI | Units: Square Feet (ft²) |
|------------------------------------|------------|--|

DESCRIPTION

Record this element for all Unlined Rock Tunnels. Unlined Rock Tunnels function as the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of an Unlined Rock Tunnel is the product of the length of the tunnel (along the centerline) and the perimeter of the unlined rock.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

See Appendix VIII: GSI to Condition State Conversion Charts for additional CDOT guidance on coding condition states based on rock properties.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------|---|--|---|--|
| Rockfall | No drummy rock. No blocks or slabs apparent. No shear zones are in evidence. No displacements visible along joints, cracks. | Any blocks or slabs are tightly interlocked with the surrounding rock and are not in danger of separating from the parent rock mass. Any displacements along shear zones, joints or cracks appear to be old, i.e. to have come about prior to the existence of the tunnel. Drummy areas are less than or equal to 1.0 ft. in diameter. | Any blocks or slabs that are not tightly interlocked with the surrounding rock are small, i.e. less than 1 ft. in diameter. Displacements along shear zones, joints or cracks have occurred since was constructed. Drummy areas are greater than 1.0 ft. in diameter. | <i>*Any blocks or slabs that are not tightly interlocked with the surrounding rock and are large, i.e. greater than 1 ft. in diameter. Displacements along shear zones, joints or cracks have occurred and are in danger of further movement. Drummy areas are large and/or extensive. The condition warrants a structural review.</i> |
| Patched Areas | None | Sound patches. | Unsound patches. | <i>*Unsound patch which affects capacity of structure, warrants structural review.</i> |



| | | | | |
|----------------------|----------------------|--|---------------------------------------|---|
| Leakage ¹ | Dry surface | Saturated surface indicating seepage may be present or evidence of past seepage. | Fully saturated surface with seepage. | Seepage could range from dripping to flowing. <i>Ice Buildup</i> |
| <i>Safety (CDOT)</i> | <i>Not impacted.</i> | | | <i>Defect poses a safety concern for travelway below.</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

¹For the leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.



| | | |
|--------------------------------|------------|--------------------|
| 10007 – Rock Bolt/Dowel | NTI | Units: Each |
|--------------------------------|------------|--------------------|

DESCRIPTION

Record this element for all rock bolts or dowels.

The total number of Rock Bolt/Dowels is the sum of all the number of rock bolts and dowels.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

The element quantity shall consist of only those Rock Bolts/Dowels within the bore. This does not include those contained within the portal or approach cuts as they are managed by CDOT’s Geo-Hazards Group. Rock Bolts/Dowels outside of the bores shall be evaluated during inspections. Description, condition, and deficiency information shall be included within the appropriate Portal or Approach Embankment elements.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--|-------------------|---|---|---|
| Loose Bolt/Dowel Misalignment | None | Loose or missing nuts, but is in alignment and functioning as intended. | Loose or missing nuts; bolt/dowel out of alignment or loose. | *Bolt/dowel severely out of alignment loose, <i>failed</i> , or <i>failure is eminent</i> , warrants a structural review |
| Deformation or Cracking | None | Deformation or cracking of liner or supported rock. | Deformation or cracking and spalling of liner or supported rock. | *Severe deformation or cracking and spalling of liner or supported rock; <i>unsound area</i> , warrants a structural review |
| Corrosion (bolt assembly and bearing plate) | None | Freckled rust. Corrosion of the steel has initiated. | Section loss is evident or pack rust is present but does not warrant structural review. | *Section loss exceeds 15% of cross section, warrants a structural review |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.





| | | |
|-----------------------------------|------------|--|
| 10009 – Other Tunnel Liner | NTI | Units: Square Feet (ft²) |
|-----------------------------------|------------|--|

DESCRIPTION

Record this element for all tunnel liners composed of other materials not taken into account with other liner elements. Other Tunnel Liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.

The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Other Tunnel Liners in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|----------------------|--|--|--|--|
| Cracking | Cracks are present but have not allowed the rock to shift. | Cracks are present and rock has minor shifting. | Rocks are cracked with face deformation. Rocks are missing. | <i>*Extensive rock cracking with face deformation, or large areas missing, warrants structural review</i> |
| Distortion | None | Distortion has received structural review and has been mitigated. | Distortion has received structural review and does not require mitigation. | <i>*Distortion exceeds tolerable limits and reduces the stability of the element, warrants structural review</i> |
| Patched Areas | None | Sound patches. | Unsound patches. | <i>*Unsound patch which affects capacity of structure, warrants structural review.</i> |
| Leakage ¹ | Dry surface | Saturated surface indicating seepage may be present or evidence of past seepage. | Fully saturated surface with seepage. | Seepage could range from dripping to flowing. <i>Ice Buildup</i> |



| | | |
|--------------------------------|----------------------|---|
| <i>Safety</i> <i>(CDOT)</i> | <i>Not impacted.</i> | <i>Defect poses a safety concern for travelway below.</i> |
|--------------------------------|----------------------|---|

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

¹For the leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.



| | | |
|---|------------|-------------------------|
| 10010 – Steel Tunnel Roof Girder | NTI | Units: Feet (ft) |
|---|------------|-------------------------|

DESCRIPTION

Record this element for all Steel Tunnel Roof Girders. Tunnel roof girders support the tunnel roof liner or exposed rock which constitutes the tunnel roof.

The total length of tunnel roof girder is the sum of all the lengths of each tunnel roof girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Steel Tunnel Roof Girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------|---|--|---|--|
| Corrosion | None | Freckled rust. Corrosion of steel has initiated. | Section loss is evident or pack rust is present but does not warrant structural review. | <i>*Section loss is of the extent which impacts capacity, warrants structural review.</i> |
| Cracking | None | Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar. | Identified crack exists that is not arrested but does not warrant structural review. | <i>*Severe unarrested cracking Crack is likely to propagate into critical stress area, warrants structural review</i> |
| Connection | Connection is in place and functioning as intended. | Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended. | Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review. | <i>*Connection has failed or failure of connector is eminent, warrants structural review</i> |



| | | | | |
|------------|------|--|--|--|
| Distortion | None | Distortion not requiring mitigation or mitigated distortion. | Distortion that requires mitigation that has not been addressed, but does not warrant structural review. | <i>*Distortion exceeds tolerable limits and reduces the stability of the element, warrants structural review</i> |
|------------|------|--|--|--|

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



| | | |
|--|------------|-------------------------|
| 10011 – Concrete Tunnel Roof Girder | NTI | Units: Feet (ft) |
|--|------------|-------------------------|

DESCRIPTION

Record this element for all Concrete Tunnel Roof Girders. Tunnel roof girders support the tunnel roof liner or exposed rock which constitutes the tunnel roof.

The total length of tunnel roof girder is the sum of all the lengths of each tunnel roof girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Concrete Tunnel Roof Girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---|---|--|---|---|
| Delamination/ Spall/ Patched area/ Scale | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant a structural review. | <i>*Spall affects capacity of the element, warrants a structural review</i> |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | <i>*Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.</i> |
| Efflorescence/ Rust Staining | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaking, build-up, and/or rust present which is of concern to capacity, warrants a structural review</i> |
| Cracking | Width less than 0.012 in. or spacing greater than 3.0 ft. | Width 0.012 - 0.05 in. or spacing of 1 – 3.0 ft. | Width greater than 0.05 in. or spacing of less than 1 ft. | <i>*Severe structural cracking which is of concern to capacity of structure,</i> |



| | | | | |
|--|--|--|--|------------------------------|
| | | | | warrants a structural review |
|--|--|--|--|------------------------------|

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



| | | |
|--|------------|-------------------------|
| 10012 – Prestressed Concrete Tunnel Roof Girder | NTI | Units: Feet (ft) |
|--|------------|-------------------------|

DESCRIPTION

Record this element for all prestressed Concrete Tunnel Roof Girders. Tunnel roof girders support the tunnel roof liner or exposed rock which constitutes the tunnel roof.

The total length of tunnel roof girder is the sum of all the lengths of each tunnel roof girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--|---|--|---|---|
| Delamination/ Spall/ Patched area/ <i>Scale</i> | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | <i>*Spall affects capacity of the element, warrants a structural review</i> |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | <i>*Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.</i> |
| Exposed Prestressing | None | Present without section loss. | Present with section loss, but does not warrant structural review. | <i>*Prestressing tendon is severely corroded with measurable section loss or is severed, warrants structural review</i> |
| Cracking | Width less than 0.004 in. or spacing greater than 3 ft. | Width 0.004 - 0.009 in. or spacing of 1.0 - 3.0 ft. | Width greater than 0.009 in. or spacing less than 1 ft. | <i>*Severe structural cracking which is of concern to capacity of structure, warrants a structural review</i> |



| | | | | |
|---------------------------------|------|--|---------------------------------------|---|
| Efflorescence/ Rust Staining | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaking, build-up, and/or rust present which is of concern to capacity, warrants a structural review</i> |
|---------------------------------|------|--|---------------------------------------|---|

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



| | | |
|---|------------|-------------------------|
| 10019 – Other Tunnel Roof Girder | NTI | Units: Feet (ft) |
|---|------------|-------------------------|

DESCRIPTION

Record this element for all tunnel roof girders composed of other materials. Tunnel roof girders support the tunnel roof liner or exposed rock which constitutes the tunnel roof.

The total length of tunnel roof girder is the sum of all the lengths of each tunnel roof girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Other Tunnel Roof Girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------|--------------------------------------|--|---|---|
| General Condition | Good condition – no notable distress | Fair condition – isolated breakdowns or deterioration. | Poor condition – widespread deterioration or breakdowns without reducing load capacity. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel. |



| | | |
|----------------------------------|------------|--------------------|
| 10020 – Steel Column/Pile | NTI | Units: Each |
|----------------------------------|------------|--------------------|

DESCRIPTION

Record this element for all Steel Columns/Piles. Tunnel columns support the tunnel roof girders, tunnel ceiling girders tunnel Invert Girders. Tunnel piles provide support for the tunnel columns.

The total number of Columns/Piles is the sum of all the number of columns and piles.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

The majority of the Columns/Piles will be below grade and therefore not visible for inspection.

COMMENTARY

There are no Steel Column/Piles in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------|---|--|---|---|
| Corrosion | None | Freckled rust. Corrosion of steel has initiated. | Section loss is evident or pack rust is present but does not warrant structural review. | <i>*Section loss is of the extent which impacts capacity, warrants structural review.</i> |
| Cracking | None | Cracks that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar. | Identified crack exists that is not arrested but does not require structural review. | <i>*Severe unarrested cracking Crack is likely to propagate into critical stress area, warrants structural review</i> |
| Connection | Connection is in place and functioning as intended. | Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended. | Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant structural review. | <i>*Connection has failed (or failure of connector is imminent) which impacts connection capacity, warrants structural review</i> |
| Distortion | None | Distortion not requiring mitigation | Distortion that requires mitigation that has not been | <i>*Distortion is extensive, members are severely bent or</i> |



| | | | | |
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| | | or mitigated distortion. | addressed, but does not warrant structural review. | <i>bowed, warrants structural review</i> |
|--|--|--------------------------|--|--|

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



| | | |
|-------------------------------------|------------|--------------------|
| 10021 – Concrete Column/Pile | NTI | Units: Each |
|-------------------------------------|------------|--------------------|

DESCRIPTION

Record this element for all Concrete Columns/Piles. Tunnel columns support the tunnel roof girders, tunnel ceiling girders tunnel Invert Girders. Tunnel piles provide support for the tunnel columns.

The total number of Columns/Piles is the sum of all the number of columns and piles.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

The majority of the Columns/Piles will be below grade and therefore not visible for inspection.

COMMENTARY

There are no Concrete Column/Piles in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---|---|--|---|---|
| Delamination/ Spall/ Patched area | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | <i>*Spall affects capacity of the element, warrants a structural review</i> |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | <i>*Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.</i> |
| Efflorescence/ Rust Staining | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaking, build-up, and/or rust present which is of concern to capacity, warrants a structural review</i> |
| Cracking | Width less than 0.012 in. or spacing greater than 3.0 ft. | Width 0.012 - 0.05 in. or spacing of 1 – 3.0 ft. | Width greater than 0.05 in. or spacing of less than 1 ft. | <i>*Severe structural cracking which is of concern to capacity of structure,</i> |



| | | | | |
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| | <i>Cracks do not exhibit sealant.</i> | <i>Cracks exhibit sealant and sealant is in good condition.</i> | <i>Cracks exhibit sealant and sealant is showing signs of distress or failing.</i> | warrants a structural review |
|--|---------------------------------------|---|--|------------------------------|

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



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|----------------------------------|------------|--------------------|
| 10029 – Other Column/Pile | NTI | Units: Each |
|----------------------------------|------------|--------------------|

DESCRIPTION

Record this element for all Columns/Piles composed of other material. Tunnel columns support the tunnel roof girders, tunnel ceiling girders tunnel Invert Girders. Tunnel piles provide support for the tunnel columns.

The total number of Columns/Piles is the sum of all the number of columns and piles.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

The majority of the Columns/Piles will be below grade and therefore not visible for inspection.

COMMENTARY

There are no Other Column/Piles in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------|--------------------------------------|---|---|---|
| General Condition | Good condition – no notable distress | Fair condition- isolated breakdowns or deterioration. | Poor condition – widespread deterioration or breakdowns without reducing load capacity. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel. |



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| 10030 – Steel Cross Passageway | NTI | Units: Feet (ft) |
|---------------------------------------|------------|-------------------------|

DESCRIPTION

Record this element for all Steel Cross Passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.

The total length of cross passageways is the sum of all of the lengths of each cross passageway.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This element is to include Adits of similar material type.

For cross passageways separating two unique Tunnel Numbers, assign half of the cross passageway quantity per tunnel (CDOT).

Quantify and document all passageways in Square Feet for CDOT Asset Management in addition to linear feet for submittal to the FHWA.

There are no Steel Cross Passageways in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------|---|---|---|---|
| Corrosion | None | Freckled rust. Corrosion of the steel has initiated. | Section loss is evident or pack rust is present but does not warrant structural review. | <i>*Section loss is of the extent which impacts capacity, warrants structural review.</i> |
| Cracking | None | Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar. | Identified crack exists that is not arrested but does not require structural review. | <i>* Severe unarrested cracking Crack is likely to propagate into critical stress area, warrants structural review</i> |
| Connections | Connection is in place and functioning as intended. | Loose fasteners or pack rust without distortion is present but the connection is in place and | Missing bolts, rivets, broken welds, fasteners or pack rust with distortion | <i>*Connection has failed (or failure of connector is imminent) which impacts connection</i> |



| | | | | |
|----------------------|-------------|--|--|---|
| | | functioning as intended. | but does not warrant a structural review. | <i>capacity, warrants structural review</i> |
| Distortion | None | Distortion has received structural review and has been mitigated. | Distortion has received structural review and does not require mitigation. | <i>*Distortion is extensive and may impact capacity, warrants structural review</i> |
| Leakage ¹ | Dry surface | Saturated surface indicating seepage may be present or evidence of past seepage. | Fully saturated surface with seepage. | Seepage could range from dripping to flowing. <i>Ice Buildup</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

¹For the Leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.



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|--|------------|-------------------------|
| 10031 – Concrete Cross Passageway | NTI | Units: Feet (ft) |
|--|------------|-------------------------|

DESCRIPTION

Record this element for all Concrete Cross Passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.

The total length of cross passageways is the sum of all of the lengths of each cross passageway.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This element is to include Adits of similar material type.

For cross passageways separating two unique Tunnel Names, assign half of the cross passageway quantity per tunnel (CDOT).

Quantify and document all passageways in Square Feet for CDOT Asset Management in addition to linear feet for submittal to the FHWA.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--|-------------------|--|---|--|
| Delamination/ Spall/ Patched area | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | <i>*Spall affects capacity of the element, warrants a structural review.</i> |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | <i>*Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.</i> |
| Efflorescence/ Rust Staining ¹ | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaking, build-up, and/or rust present which is of concern to capacity,</i> |



| | | | | |
|----------------------|---|---|---|---|
| | | | | warrants a structural review |
| Cracking (Liners) | Width less than 0.012 in. or spacing greater than 5.0 ft. | Width 0.012 – 0.10 in. below spring line or spacing of 1.0 – 5.0 ft. <i>Cracks exhibit structural sealant which is in good condition.</i> | Width greater than 0.10 in. below spring line or greater than 0.012 in. above spring line or spacing of less than 1 ft. <i>Cracks exhibit sealant used for water or leakage relocation or structural sealant is unsound.</i> | <i>*Severe structural cracking which is of concern to capacity of structure, warrants a structural review</i> |
| Distortion | None | Distortion has received structural review and has been mitigated. <i>Distortion is construction related and does not affect capacity or serviceability of structure.</i> | Distortion has received structural review and does not require mitigation. | <i>*Distortion is extensive and is of concern to capacity of element, warrants structural review</i> |
| Leakage ² | Dry surface | Saturated surface indicating seepage may be present or evidence of past seepage. | Fully saturated surface with seepage. | Seepage could range from dripping to flowing. <i>Ice Buildup</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

¹ Heavy build-up of efflorescence and/or rust staining are both considered CS 3 for the cross passageways. Careful evaluation should be used when determining whether rust staining or mineral deposits are present.

²For the Leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.



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|---|------------|-------------------------|
| 10033 – Shotcrete Cross Passageway | NTI | Units: Feet (ft) |
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DESCRIPTION

Record this element for all Shotcrete Cross Passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.

The total length of cross passageways is the sum of all of the lengths of each cross passageway.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This element is to include Adits of similar material type.

For cross passageways separating two unique Tunnel Names, assign half of the cross passageway quantity per tunnel (CDOT).

Quantify and document all passageways in Square Feet for CDOT Asset Management in addition to linear feet for submittal to the FHWA.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--|-------------------|--|---|--|
| Delamination/ Spall/ Patched area/ <i>Scale</i> | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | <i>*Spall affects capacity of the element, warrants a structural review</i> |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | <i>*Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.</i> |
| Efflorescence/ Rust Staining ¹ | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaking, build-up, and/or rust present which is of concern to capacity,</i> |



| | | | | |
|----------------------|---|--|---|---|
| | | | | warrants a structural review |
| Cracking (Liners) | Width less than 0.012 in. or spacing greater than 5.0 ft. | Width 0.012 – 0.10 in. below spring line or spacing of 1.0 – 5.0 ft. | Width greater than 0.10 in below spring line or greater than 0.12 in above spring line or spacing less than 1 ft. | <i>*Severe structural cracking which is of concern to capacity of structure, warrants a structural review</i> |
| Distortion | None | Distortion has received structural review and has been mitigated. | Distortion has received structural review and does not require mitigation. | <i>*Distortion is extensive and is of concern to capacity of element, warrants structural review</i> |
| Leakage ² | Dry surface | Saturated surface indicating seepage may be present or evidence of past seepage. | Fully saturated surface with seepage. | Seepage could range from dripping to flowing. <i>Ice Buildup</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

¹ *Heavy build-up of efflorescence and/or rust staining are both considered CS 3 for the cross passageways. Careful evaluation should be used when determining whether rust staining or mineral deposits are present.*

² *For the Leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.*



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|--|------------|-------------------------|
| 10034 – Timber Cross Passageway | NTI | Units: Feet (ft) |
|--|------------|-------------------------|

DESCRIPTION

Record this element for all Shotcrete Cross Passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.

The total length of cross passageways is the sum of all of the lengths of each cross passageway.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This element is to include Adits of similar material type.

For cross passageways separating two unique Tunnel Names, assign half of the cross passageway quantity per tunnel (CDOT).

Quantify and document all passageways in Square Feet for CDOT Asset Management in addition to linear feet for submittal to the FHWA.

There are no Timber Cross Passageways in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--------------|-------------------|--|---|---|
| Decay or Rot | None | Decay has started in the timber sets or lagging. No fungus growth or discoloration is present. | Decay has resulted in loss of strength, deflection, or crushing of the element but not of a sufficient magnitude to affect the strength and serviceability of the tunnel. Fungus growth and discoloration is present. | <i>*More than 40% section loss, severe deflection or crushing, warrants structural review</i> |
| Voids | None | Small voids may exist in the annular space behind the lagging. | Large voids may exist in the annular space behind the lagging. | <i>*Voids exist that are greater than 40% section loss, warrants structural review</i> |



| | | | | |
|-----------------------------|---|---|---|---|
| Cracks/Splits/ Checks | None | Cracks, splits or checks exist in the timber sets or lagging. | Cracks, splits or checks exist in the timber sets or lagging and has impacted strength and/or serviceability but does not warrant structural review. | <i>*Full member cracks, splits or checks; more than 25% of the member in the tension zone, or to the extent which affects capacity, warrants structural review</i> |
| Timber Distortion | No off-set or misalignment between the timber members (good compression fit). | Off-set or misalignment between timber members may exist but is 0.125 in. or less. | Off-set or misalignment between timber members may exist and is between 0.125 in. and 0.25 in. | <i>*Severe distortion exists greater than 0.25 in, warrants structural review</i> |
| Insect Infestation | None | Infestation has started in the timber sets or lagging. | Infestation exists in the timber sets or lagging and has produced loss of strength or deflection of the element but not of a sufficient magnitude to affect the strength and/or serviceability of the tunnel. | <i>*Severe infestation exists in the timber sets or lagging and has produced loss of strength or deflection of the element of a sufficient magnitude to affect the strength and/or serviceability of the tunnel, warrants structural review</i> |
| Loose or Missing Connectors | None | Loose bolts, or fasteners are present but the connection is in place and functioning as intended. | Missing bolts or fasteners but does not warrant a structural review. | <i>*Connection has failed (or failure of connector is imminent) which impacts connection capacity, warrants structural review</i> |
| Leakage ¹ | Dry surface | Saturated surface indicating seepage may be present or evidence of past seepage. | Fully saturated surface with seepage. | Seepage could range from dripping to flowing. <i>Ice Buildup</i> |



*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

¹For the Leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.



| | | |
|---|------------|-------------------------|
| 10035 – Masonry Cross Passageway | NTI | Units: Feet (ft) |
|---|------------|-------------------------|

DESCRIPTION

Record this element for all Masonry Cross Passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.

The total length of cross passageways is the sum of all of the lengths of each cross passageway.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This element is to include Adits of similar material type.

For cross passageways separating two unique Tunnel Names, assign half of the cross passageway quantity per tunnel (CDOT).

Quantify and document all passageways in Square Feet for CDOT Asset Management in addition to linear feet for submittal to the FHWA.

There are no Masonry Cross Passageway in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------------------------|-------------------|---|---|--|
| Efflorescence/ Rust Staining | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaching, surrounding area unsound, warrants a structural review</i> |
| Mortar Breakdown | None | Cracking or voids in less than 10% of joints. | Cracking or voids in 10% or more of the joints. | <i>*Severe cracking, more than 25% of the joints, warrants structural review</i> |
| Split/Spall | None | Block or stone has split or spalled with no shifting. | Block or stone has split or spalled with shifting but does not warrant a structural review. | <i>*Split reduces stability of the structure, spalling with greater than 25% loss of block thickness, warrants structural review</i> |



| | | | | |
|----------------------|-------------|--|---|--|
| Patched Area | None | Sound patch. | Unsound patch. | <i>*Unsound patch which affects capacity of structure, warrants structural review.</i> |
| Masonry Displacement | None | Block or stone has shifted slightly out of alignment. | Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review. | <i>*Block or stone is severely misaligned, or detached from the structure, warrants structural review</i> |
| Distortion | None | Distortion has received structural review and has been mitigated. | Distortion has received structural review and does not require mitigation. | <i>*Distortion exceeds tolerable limits and reduces the stability of the element, warrants structural review</i> |
| Leakage ¹ | Dry Surface | Saturated surface indicating seepage may be present or evidence of past seepage. | Fully saturated surface with seepage. | Seepage could range from dripping to flowing. <i>Ice Buildup</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

¹For the Leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.



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|--|------------|-------------------------|
| 10036 – Unlined Rock Cross Passageway | NTI | Units: Feet (ft) |
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DESCRIPTION

Record this element for all Unlined Rock Cross Passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.

The total length of cross passageways is the sum of all of the lengths of each cross passageway.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This element is to include Adits of similar material type.

For cross passageways separating two unique Tunnel Names, assign half of the cross passageway quantity per tunnel (CDOT).

Quantify and document all passageways in Square Feet for CDOT Asset Management in addition to linear feet for submittal to the FHWA.

See Appendix VIII: GSI to Condition State Conversion Charts for additional CDOT guidance on coding condition states based on rock properties.

There are no Unlined Rock Cross Passageways in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|----------|---|---|---|--|
| Rockfall | No drummy rock. No blocks or slabs apparent. No shear zones are in evidence. No displacements visible along joints, cracks. | Any blocks or slabs are tightly interlocked with the surrounding rock and are not in danger of separating from the parent rock mass. Any displacements along shear zones, joints or cracks appear to be old, i.e. to have come about prior to the existence of the tunnel. Drummy areas are less than | Any blocks or slabs that are not tightly interlocked with the surrounding rock are small, i.e. less than 1 ft. in diameter. Displacements along shear zones, joints or cracks have occurred since was constructed. Drummy areas are greater than 1.0 ft. in diameter. | <i>*Area above the portal has blocks or slabs that are not tightly interlocked with the surrounding rock and are large, i.e. greater than 1 ft. in diameter. Displacements along shear zones, joints or cracks have occurred and are in danger of further movement. Drummy areas are large and/or extensive. The</i> |



| | | | | |
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| | | or equal to 1.0 ft. in diameter. | | <i>condition warrants a structural review.</i> |
| Patched Areas | None | Sound patches. | Unsound patches. | <i>*Unsound patch which affects capacity of structure, warrants structural review.</i> |
| Leakage ¹ | Dry Surface | Saturated surface indicating seepage may be present or evidence of past seepage. | Fully saturated surface with seepage. | Seepage could range from dripping to flowing. <i>Ice Buildup</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

¹For the Leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.



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|---------------------------------------|------------|-------------------------|
| 10039 – Other Cross Passageway | NTI | Units: Feet (ft) |
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DESCRIPTION

Record this element for all Other Cross Passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.

The total length of cross passageways is the sum of all of the lengths of each cross passageway.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This element is to include Adits of similar material type.

For cross passageways separating two unique Tunnel Names, assign half of the cross passageway quantity per tunnel.

Quantify and document all passageways in Square Feet for CDOT Asset Management in addition to linear feet for submittal to the FHWA.

There are no Other Cross Passageways in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------|--|---|--|--|
| Cracking | Cracks are present but have not allowed the rock to shift. | Cracks are present and rock has minor shifting. | Rocks are cracked with face deformation. Rocks are missing. | <i>*Extensive rock cracking with face deformation, or large areas missing, warrants structural review</i> |
| Distortion | None | Distortion has received structural review and has been mitigated. | Distortion has received structural review and does not require mitigation. | <i>*Distortion exceeds tolerable limits and reduces the stability of the element, warrants structural review</i> |
| Patched areas | None | Sound patches. | Unsound patches. | <i>*Unsound patch which affects capacity of structure, warrants structural review.</i> |



| | | | | |
|----------------------|-------------|--|---------------------------------------|---|
| Leakage ² | Dry Surface | Saturated surface indicating seepage may be present or evidence of past seepage. | Fully saturated surface with seepage. | Seepage could range from dripping to flowing. <i>Ice Buildup</i> |
|----------------------|-------------|--|---------------------------------------|---|

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

²For the Leakage defect add commentary in the description to address the time of year. Areas of leakage within the tunnel liner are subject to a CS 2 to CS 4 swing depending on the runoff conditions. In tunnels with severe water infiltration a Special Inspection may be needed during peak runoff season.



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| 10041 – Concrete Interior Walls | NTI | Units: Square Feet (ft²) |
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DESCRIPTION

Record this element for all Concrete Interior Walls. This element defines those internal walls in tunnels which are usually placed to separate traffic travelling in opposite directions. The internal wall also serves as a barrier between tunnel regions in an emergency to protect evacuees from smoke inhalation, fire or hazardous conditions.

The area of the interior wall is the product of the length (along the centerline) of the tunnel and the height.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

Concrete Interior Walls element shall be used to evaluate and document the Divider Wall within the plenums of Eisenhower and Johnson Tunnels. It is imperative to evaluate defects of the walls as potential indication of hanger condition.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--|-------------------|--|---|---|
| Delamination/ Spall/ Patched area/ <i>Scale</i> | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | <i>*Spall affects capacity of the element, warrants a structural review</i> |
| Exposed Rebar | None | Present without section loss. | Present with measurable section loss, but does not warrant structural review. | <i>*Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.</i> |
| Efflorescence/ Rust Staining | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaking, build-up, and/or rust present which is of concern to capacity, warrants a structural review</i> |



| | | | | |
|----------|--|---|---|---|
| Cracking | Width less than 0.012 in. or spacing greater than 5.0 ft. <i>Cracks do not exhibit sealant.</i> | Width 0.012 – 0.10 in. below spring line or spacing of 1.0 – 5.0 ft. <i>Cracks exhibit sealant and sealant is in good condition.</i> | Width greater than 0.10 in. below spring line or greater than 0.012 in. above spring line or spacing of less than 1 ft. <i>Cracks exhibit sealant and sealant is showing signs of distress or failing.</i> | <i>*Severe structural cracking which is of concern to capacity of structure, warrants a structural review</i> |
|----------|--|---|---|---|

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



| | | |
|---|-------------|--|
| 10042 – Tile Lined Concrete Precast Panels | CDOT | Units: Square Feet (ft²) |
|---|-------------|--|

DESCRIPTION

Record this element for Tile Lined Concrete Precast Panels. This element defines walls which are placed within the tunnel bore adjacent to traffic.

The area of the interior wall is the product of the length (along the centerline) of the tunnel and the height.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---|---|--|---|--|
| Delamination/ Spall/ Patched area/ Scale | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | *Spall affects capacity of the element, warrants a structural review |
| Exposed Rebar | None | Present without section loss. | Present with measurable section loss, but does not warrant structural review. | *Exposed rebar exhibits section loss and is in a critical area, warrants a structural review. |
| Efflorescence/ Rust Staining ¹ | None | Surface white without build-up or leaching without rust staining. | Heavy build-up and/or rust staining. | *Severe leaking, build-up, and/or rust present which is of concern to capacity, warrants a structural review |
| Cracking | Width less than 0.012 in. or spacing greater than 5.0 ft. Cracks do not exhibit sealant. | Width 0.012 – 0.05 in. or spacing of 1.0 – 5.0 ft. Cracks exhibit sealant and sealant is in good condition. | Width greater than 0.05 in. or spacing of less than 1 ft. Cracks exhibit sealant and sealant | *Severe structural cracking which is of concern to capacity of structure, warrants a structural review |



| | | | | |
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| | | | is showing signs of distress or failing. | |
| Anchorage | None | Minor displacement from anchorage location, freckled corrosion, connection is secure. | Moderate displacement from anchorage, pitted corrosion, connection is loose but does not require structural review. | *Severe displacement, connection is loose and failure is imminent, poses a concern for stability, warrants structural review. |
| Bearing area ² | None | Initial deterioration of the bearing area has begun. | Moderate deterioration of the bearing area exists and is affecting the bearing area, but does not require a structural review | * Significant loss in bearing, poses a concern for stability, warrants structural review. |
| Tile | Tiles adhered to this element shall be recorded in element 10953-Tunnel Tile and documented as a child-element. | | | |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

¹ Efflorescence buildup emanating from other elements is not to be included. Build-up of efflorescence on tile should be captured in the effectiveness defect for Element 10953 – Tunnel Tile.

² The bearing area of this element typically consists of shims or bearing beneath each anchorage, two per panel, with a mortar bed to capture lateral fixity effectiveness. Missing shim/bearings shall be CS4 until such time analysis is completed by CDOT Staff Bridge to determine shear capacity of anchorage assemblies (note: not all will be visible due to mortar).



| | | |
|-------------------------------------|------------|--|
| 10049 – Other Interior Walls | NTI | Units: Square Feet (ft²) |
|-------------------------------------|------------|--|

DESCRIPTION

Record this element for all interior walls composed of other materials. This element defines those internal walls in tunnels which are usually placed to separate traffic travelling in opposite directions. The internal wall also serves as a barrier between tunnel segments in an emergency to protect evacuees from smoke inhalation, fire or hazardous conditions.

The area of the interior wall is the product of the length (along the centerline) of the tunnel and the height.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Other Interior Walls in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

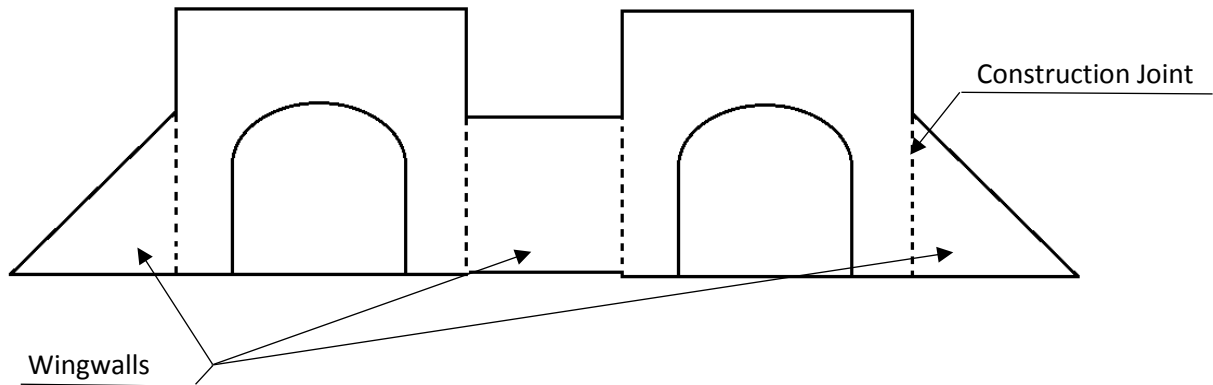
| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------|--------------------------------------|--|---|---|
| General Condition | Good condition – no notable distress | Fair condition – isolated breakdowns or deterioration. | Poor condition – widespread deterioration or breakdowns without reducing load capacity. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel. |

| | | |
|-------------------------|-----|---------------------------------------|
| 10051 – Concrete Portal | NTI | Units: Square Feet (ft ²) |
|-------------------------|-----|---------------------------------------|

DESCRIPTION

Record this element for all Concrete Portals. This element defines the portal façade, which comprise the architectural/structural elements that are above the roadway at the opening of the tunnel bore.

The area of the portal is the product of the width and height of the portal minus the area of the roadway opening. The area may include wingwalls which retain soil and rock near the portal but does not include walls leading up to the portal.



PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This element is to include portal canopies. Portal canopies should be classified as portal at the first construction joint between canopy and liner and delineate the Tunnel Liner length. This location should be clarified in each given report. This does not affect Tunnel Length which shall remain as the full length from edge of portal (or canopy) to edge of portal (or canopy).

Contiguous portal structures that extend laterally beyond the roadway extents shall be included. Any deviation in vector or full thickness construction joints shall delineate a wingwall and is not to be included. Retaining walls which are separate from the portal structure, or bores they are associated with, are to be inspected and quantified within CDOT's Wall Asset Management program. Any defects or condition commentary may be included for thoroughness.

**This may include portal canopies. Portal canopies should be classified as portal at the first construction joint between canopy and liner as delineation of Tunnel Length. This location should be clarified in each given report. This does not affect Tunnel Length which shall remain as the full length from edge of portal (or canopy) to edge of portal (or canopy).*



CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--|--|---|---|---|
| Delamination/ Spall/ Patched area/ <i>Scale</i> | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | <i>*Spall affects capacity of the element, warrants a structural review</i> |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | <i>*Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.</i> |
| Efflorescence/ Rust Staining | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaking, build-up, and/or rust present which is of concern to capacity, warrants a structural review</i> |
| Cracking (Liners) | Width less than 0.012 in. or spacing greater than 5.0 ft. <i>Cracks do not exhibit sealant.</i> | Width 0.012 – 0.10 in. below spring line or spacing of 1.0 – 5.0 ft. <i>Cracks exhibit sealant and sealant is in good condition.</i> | Width greater than 0.10 in. below spring line or greater than 0.012 in. above spring line or spacing of less than 1 ft. <i>Cracks exhibit sealant and sealant is showing signs of distress or failing.</i> | <i>*Severe structural cracking which is of concern to capacity of structure, warrants a structural review</i> |
| Settlement | None | Exists within tolerable limits or arrested with no observed structural distress. | Exceeds tolerable limits but does not warrant structural review. | <i>*Severe settlement leading to unstable conditions, warrants structural review</i> |



| | | |
|---------------------------------|--|---|
| <i>Safety (CDOT)</i> | <i>Not impacted.</i> | <i>Defect poses safety concern for travelway below, warrants structural review.</i> |
| <i>Impact Damage (CDOT)</i> | <i>Impact damage may be captured within cracking and spalling defects above. Safety concerns shall be incorporated as described in CS4</i> | <i>Impact has resulted in loss of structural capacity and/or poses a safety hazard, warrants structural review.</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



| | | |
|-------------------------------|------------|--|
| 10055 – Masonry Portal | NTI | Units: Square Feet (ft²) |
|-------------------------------|------------|--|

DESCRIPTION

Record this element for all Masonry Portals. This element defines the portal façade, which comprise the architectural/structural elements that are above the roadway at the opening of the tunnel bore.

The area of the portal is the product of the width and height of the portal minus the area of the roadway opening. The area may include wingwalls which retain soil and rock near the portal but does not include walls leading up to the portal.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

Contiguous portal structures that extend laterally beyond the roadway extents shall be included.

This may include portal canopies.

Rockfall having arrested atop or above is not to be considered a defect however ability to retain ground and mitigate rockfall from entering the roadway envelope shall be evaluated and documented.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------------------------|--------------------------|---|---|--|
| Efflorescence/ Rust Staining | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaching, surrounding area unsound, warrants a structural review</i> |
| Mortar Breakdown | None | Cracking or voids in less than 10% of joints. | Cracking or voids in 10% or more of the joints. | <i>*Severe cracking, more than 25% of the joints, warrants structural review</i> |
| Split/Spall | None | Block or stone has split or spalled with no shifting. | Block or stone has split or spalled with shifting but does not warrant a structural review. | <i>*Split reduces stability of the structure, spalling with greater than 25% loss of block thickness, warrants structural review</i> |
| Patched Area | None | Sound patch. | Unsound patch. | <i>*Unsound patch which affects capacity of structure,</i> |



| | | | | |
|----------------------|--|--|---|---|
| | | | | warrants structural review. |
| Masonry Displacement | None | Block or stone has shifted slightly out of alignment. | Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review. | <i>*Block or stone is severely misaligned, or detached from the structure, warrants structural review</i> |
| Settlement | None | Exists within tolerable limits or arrested with no observed structural distress. | Exceeds tolerable limits but does not warrant structural review. | <i>*Severe settlement leading to unstable conditions, warrants structural review</i> |
| Safety (CDOT) | <i>Not impacted.</i> | | | <i>Defect poses safety concern for travelway below.</i> |
| Impact Damage (CDOT) | <i>Impact damage has not resulted in loss of structural capacity and/or does not pose safety hazard. Rate impact damage to appropriate defect.</i> | | | <i>Impact has resulted in loss of structural capacity and/or poses a safety hazard, warrants structural review.</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

| | | |
|----------------------|-----|---------------------------------------|
| 10059 – Other Portal | NTI | Units: Square Feet (ft ²) |
|----------------------|-----|---------------------------------------|

DESCRIPTION

Record this element for all portals composed of other materials. This element defines the portal façade, which comprise the architectural/structural elements that are above the roadway at the opening of the tunnel bore.

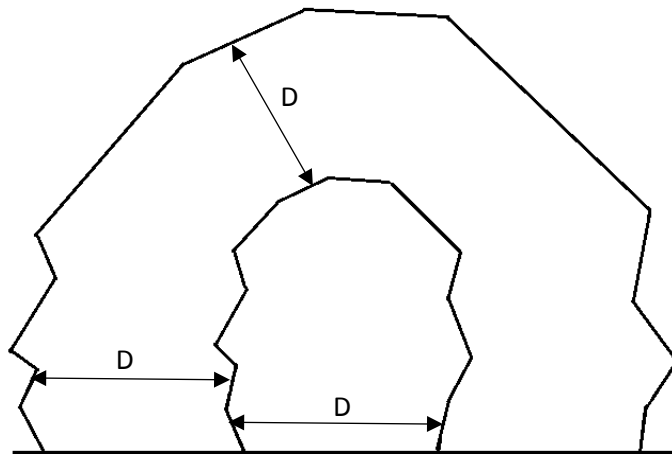
The area of the portal is the product of the width and height of the portal minus the area of the roadway opening. The area may include wingwalls which retain soil and rock near the portal but does not include walls leading up to the portal.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

This item shall include portal cuts with no man-made structure (for example; Mishawaka and Bear Creek). Portal quantity for unlined rock portals shall be calculated as the roadway width “D”, around the portal opening. Portal quantity for portal buildings shall be the full façade width by full height. Evaluation of portal cuts and terrain beyond distance “D” above the crown shall be documented within Approach Embankment.



When coding for unlined rock portals, see Appendix VIII: GSI to Condition State Conversion Charts for additional CDOT guidance on coding condition states based on rock properties.



CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------------------|---|---|--|--|
| General Condition | Good condition – no notable distress | Fair condition – isolated breakdowns or deterioration. | Poor condition – widespread deterioration or breakdowns without reducing load capacity. | <i>*Severe condition – warrants structural review.</i> |
| Settlement | None | Exists within tolerable limits or arrested with no observed structural distress. | Exceeds tolerable limits but does not warrant structural review. | <i>*Severe settlement leading to unstable conditions, warrants structural review</i> |
| Rockfall/ Slope Stability | <i>Area above the portal is stable with no loose rocks, blocks, or slabs. No shear zones are in evidence. No displacements visible along joints, cracks. Slope is stable.</i> | <i>Area above the portal has blocks or slabs that are tightly interlocked with the surrounding rock and are not in danger of separating from the parent rock mass. Any displacements along shear zones, joints or cracks appear to be old, i.e. to have come about prior to the existence of the tunnel. Slope is stable.</i> | <i>Area above the portal has blocks or slabs that are not tightly interlocked with the surrounding rock but are small, i.e. less than 1 ft. in diameter. Displacements along shear zones, joints or cracks have occurred since was constructed. Slope is unstable and in danger of movement.</i> | <i>*Area above the portal has blocks or slabs that are not tightly interlocked with the surrounding rock and are large, i.e. greater than 1 ft. in diameter. Displacements along shear zones, joints or cracks have occurred and are in danger of further movement. Slope is unstable and in danger of sliding or has already moved significantly. The condition warrants a structural review.</i> |
| Safety (CDOT) | Not impacted. | | | <i>*Defect poses safety concern for travelway below, warrants structural review.</i> |



| | | |
|------------------------------------|---|---|
| <p><i>Impact Damage (CDOT)</i></p> | <p><i>Impact damage has not resulted in loss of structural capacity and/or does not pose safety hazard. Rate impact damage to appropriate defect.</i></p> | <p><i>*Impact has resulted in loss of structural capacity and/or poses a safety hazard, warrants structural review.</i></p> |
|------------------------------------|---|---|

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



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|--------------------------------------|------------|--|
| 10061 – Concrete Ceiling Slab | NTI | Units: Square Feet (ft²) |
|--------------------------------------|------------|--|

DESCRIPTION

Record this element for all Concrete Ceiling Slabs. This element defines those structural slabs which separate the space above the roadway from the upper plenum.

The area of the ceiling slab is the product of the width length of the slab.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

This element may include a suspended ceiling which defines the upper limits of the upper plenum.

The roof of a tunnel would be considered part of the tunnel liner.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---|---|--|---|---|
| Delamination/ Spall/ Patched area/ Scale | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | <i>*Spall affects capacity of the element, warrants a structural review</i> |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | <i>*Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.</i> |
| Efflorescence | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaking, build-up, and/or rust present which is of concern to capacity, warrants a structural review</i> |
| Cracking | Width less than 0.012 in. or spacing greater than 3.0 ft. | Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft. | Width greater than 0.05 in. or spacing less than 1 ft. <i>Cracks exhibit sealant and sealant</i> | <i>*Severe structural cracking which is of concern to capacity of structure,</i> |



| | | | | |
|--|---------------------------------------|---|---|------------------------------|
| | <i>Cracks do not exhibit sealant.</i> | <i>Cracks exhibit sealant and sealant is in good condition.</i> | <i>is showing signs of distress or failing.</i> | warrants a structural review |
|--|---------------------------------------|---|---|------------------------------|

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



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|-----------------------------------|------------|--|
| 10069 – Other Ceiling Slab | NTI | Units: Square Feet (ft²) |
|-----------------------------------|------------|--|

DESCRIPTION

Record this element for all ceiling slabs composed of other materials. This element defines those structural slabs which separate the space above the roadway from the upper plenum.

The area of the ceiling slab is the product of the width length of the slab.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

The roof of a tunnel would be considered part of the tunnel liner.

COMMENTARY

There are no Other Ceiling Slabs in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------|--------------------------------------|--|---|---|
| General Condition | Good condition – no notable distress | Fair condition – isolated breakdowns or deterioration. | Poor condition – widespread deterioration or breakdowns without reducing load capacity. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel. |



| | | |
|-------------------------------------|------------|-------------------------|
| 10070 – Steel Ceiling Girder | NTI | Units: Feet (ft) |
|-------------------------------------|------------|-------------------------|

DESCRIPTION

Record this element for all Steel Ceiling Girders. This element defines the girders that support the structural ceiling slabs which separate the space above the roadway from the upper plenum.

The total quantity for ceiling girder is the sum of all the lengths of each tunnel ceiling girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------|---|--|---|--|
| Corrosion | None | Freckled rust. Corrosion of steel has initiated. | Section loss is evident or pack rust is present but does not warrant structural review. | <i>*Section loss is of the extent which impacts capacity, warrants structural review.</i> |
| Cracking | None | Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar. | Identified crack exists that is not arrested but does not warrant structural review. | <i>* Severe unarrested cracking Crack is likely to or has propagated into critical stress area, warrants structural review</i> |
| Connection | Connection is in place and functioning as intended. | Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended. | Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review. | <i>*Connection has failed (or failure of connector is imminent) which impacts connection capacity, warrants structural review</i> |
| Distortion | None | Distortion not requiring mitigation or mitigating distortion. | Distortion that requires mitigation that has not been addressed but does not require structural review. | <i>*Distortion is extensive and may impact capacity, warrants structural review</i> |



| | | | | |
|---------------------|-------------|--|--|---|
| <i>Misalignment</i> | <i>None</i> | <i>Slightly out of position or alignment not requiring mitigation.</i> | <i>Significantly out of position or alignment requiring mitigation but does not warrant structural review.</i> | <i>*Severely out of position or alignment, warrants structural review</i> |
|---------------------|-------------|--|--|---|

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



| | | |
|--|------------|-------------------------|
| 10071 – Concrete Ceiling Girder | NTI | Units: Feet (ft) |
|--|------------|-------------------------|

DESCRIPTION

Record this element for all Concrete Ceiling Girders. This element defines the girders that support the structural ceiling slabs which separate the space above the roadway from the upper plenum.

The total quantity for ceiling girder is the sum of all the lengths of each tunnel ceiling girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Concrete Ceiling Girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---|---|--|---|---|
| Delamination/ Spall/ Patched area/ Scale | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | <i>*Spall affects capacity of the element, warrants a structural review</i> |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | <i>*Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.</i> |
| Efflorescence/ Rust Staining | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaking, build-up, and/or rust present which is of concern to capacity, warrants a structural review</i> |
| Cracking | Width less than 0.012 in. or spacing greater than 3.0 ft. | Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft. | Width greater than 0.05 in. or spacing less than 1 ft. | <i>*Severe structural cracking which is of concern to capacity of structure,</i> |



| | | | | |
|---------------------|-------------|--|--|---|
| | | | | warrants a structural review |
| <i>Misalignment</i> | <i>None</i> | <i>Slightly out of position or alignment not requiring mitigation.</i> | <i>Significantly out of position or alignment requiring mitigation but does not warrant structural review.</i> | <i>*Severely out of position or alignment, warrants structural review</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



| | | |
|--|------------|-------------------------|
| 10072 – Prestressed Concrete Ceiling Girder | NTI | Units: Feet (ft) |
|--|------------|-------------------------|

DESCRIPTION

Record this element for all prestressed Concrete Ceiling Girders. This element defines the girders that support the structural ceiling slabs which separate the space above the roadway from the upper plenum.

The total quantity for ceiling girder is the sum of all the lengths of each tunnel ceiling girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Prestressed Concrete Ceiling Girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--|---|--|---|---|
| Delamination/ Spall/ Patched area/ <i>Scale</i> | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | <i>*Spall affects capacity of the element, warrants a structural review</i> |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | <i>*Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.</i> |
| Exposed Prestressing | None | Present without section loss. | Present with section loss, but does not warrant structural review. | <i>*Prestressing tendon is severely corroded with measurable section loss or is severed, warrants structural review</i> |
| Cracking | Width less than 0.004 in. or spacing greater than 3 ft. | Width 0.004 - 0.009 in. or spacing of 1.0 – 3.0 ft. | Width greater than 0.009 in. or spacing less than 1 ft. | <i>*Severe structural cracking which is of concern to capacity of structure,</i> |



| | | | | |
|---------------------------------|-------------|--|--|---|
| | | | | warrants a structural review |
| Efflorescence/ Rust Staining | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaking, build-up, and/or rust present which is of concern to capacity, warrants a structural review</i> |
| <i>Misalignment</i> | <i>None</i> | <i>Slightly out of position or alignment not requiring mitigation.</i> | <i>Significantly out of position or alignment requiring mitigation but does not warrant structural review.</i> | <i>*Severely out of position or alignment, warrants structural review.</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



| | | |
|-------------------------------------|------------|-------------------------|
| 10079 – Other Ceiling Girder | NTI | Units: Feet (ft) |
|-------------------------------------|------------|-------------------------|

DESCRIPTION

Record this element for all ceiling girders composed of other materials. This element defines the girders that support the structural ceiling slabs which separate the space above the roadway from the upper plenum.

The total quantity for ceiling girder is the sum of all the lengths of each tunnel ceiling girder.

PROCEDURE

Visual assessments may be supplemented non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Other Ceiling Girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------------|--------------------------------------|--|--|---|
| General Condition | Good condition – no notable distress | Fair condition – isolated breakdowns or deterioration. | Poor condition – widespread deterioration or breakdowns without reducing load capacity. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel. |
| <i>Misalignment</i> | <i>None</i> | <i>Slightly out of position or alignment not requiring mitigation.</i> | <i>Significantly out of position or alignment requiring mitigation but does not warrant structural review.</i> | <i>Severely out of position or alignment, warrants structural review</i> |



| | | |
|---|------------|--------------------|
| 10080 – Steel Hangers and Anchorages | NTI | Units: Each |
|---|------------|--------------------|

DESCRIPTION

Record this element for all Steel Hangers and Anchorages. Hangers are tension members that support ceiling girder, ceiling panels, or wall panels. The anchorages of the hangers are typically attached to the tunnel roof and ceiling panels.

The total quantity for hangers and anchorages is the sum of all the number of hanger and anchorage units.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

Distress observed on either hanger or anchorage should be considered in the condition assessment. Ultrasonic, or other Non-Destructive, testing results should be taken into consideration in the condition assessment if available.

COMMENTARY

Evaluation shall include cause related to deformation in order to ascertain impact on structural integrity of the individual components or structural system.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------|---|---|---|--|
| Corrosion | None | Freckled rust. Corrosion of steel has initiated. | Section loss is evident or pack rust is present but does not warrant structural review. | <i>*Section loss is of the extent which impacts capacity, warrants structural review.</i> |
| Cracking | None | Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar. | Identified crack exists that is not arrested but does not warrant a structural review. | <i>*Severe unarrested cracking Crack is likely to propagate into critical stress area, warrants structural review</i> |
| Connections | Connection is in place and functioning as intended. | Loose fasteners or pack rust without distortion is present but the connection is in place and | Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review. | <i>*Connection has failed (or failure of connector is imminent), warrants structural review</i> |



| | | | | |
|-----------------------|------------------|--|---|---|
| | | functioning as intended. | | |
| Bowing and Elongation | None | Isolated hangers are bowed or elongated. | Multiple adjacent hangers are bowed or elongated. Anchors have a gap <1/8 in. or are visibly elongated. | <i>*All adjacent hangers are severely bowed or elongated. Anchors have no gap or are severely elongated, warrants structural review</i> |
| Creep | None | Displacement is visible and anchorage has received structural review and has been mitigated. | Displacement is visible and anchorage has received structural review and does not require mitigation. | <i>*Displacement is evident, anchorage movement has not been mitigated, warrants structural review</i> |
| Anchorage area | Sound anchorage. | Cracking around anchorage areas, but concrete is sound. | Cracking or spalling around anchorage area and concrete is not sound. | <i>*Unsound anchorage area, loose anchor, or anchorage pulled out, warrants structural review</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



| | | |
|---|------------|--------------------|
| 10089 – Other Hangers and Anchorages | NTI | Units: Each |
|---|------------|--------------------|

DESCRIPTION

Record this element for all hangers and anchorages composed of other materials. Hangers are tension members that support ceiling girders or ceiling panels. The anchorages of the hangers are typically attached to the tunnel roof and ceiling panels.

The total quantity for hangers and anchorages is the sum of all the number of hanger and anchorage units.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

Distress observed on either hanger or anchorage should be considered in the condition assessment. Ultrasonic testing results should be taken into consideration in the condition assessment if available.

COMMENTARY

There are no Other Hangers and Anchorages in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-----------------------|--------------------------------------|--|---|--|
| General Condition | Good condition – no notable distress | Fair condition – isolated breakdowns or deterioration. | Poor condition – widespread deterioration or breakdowns without reducing load capacity. | <i>*Severe Condition, warrants structural review</i> |
| Connections | Sound | Isolated fasteners are loose at their connections. | Adjacent hangers are loose. Fasteners are missing from adjacent hanger connections at isolated locations. | <i>*Connection has failed (or failure of connector is eminent), warrants structural review</i> |
| Bowing and Elongation | None | Isolated hangers are bowed or elongated. | Multiple adjacent hangers are bowed or elongated. Anchors have a gap <1/8 in. or are visibly elongated. | <i>*All adjacent hangers are severely bowed or elongated. Anchors have no gap or are severely elongate, warrants structural review</i> |



| | | | | |
|----------------|------------------|--|---|--|
| Creep | None | Displacement is visible and anchorage has received structural review and has been mitigated. | Displacement is visible and anchorage has received structural review and does not require mitigation. | <i>*Displacement is evident, anchorage movement has not been mitigated, warrants structural review</i> |
| Anchorage area | Sound anchorage. | Cracking around anchorage areas, but concrete is sound. | Cracking or spalling around anchorage area and concrete is not sound. | <i>*Unsound anchorage area, loose anchor or anchorage pulled out, warrants structural review</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



| | | |
|-------------------------------------|------------|--|
| 10090 – Steel Ceiling Panels | NTI | Units: Square Feet (ft²) |
|-------------------------------------|------------|--|

DESCRIPTION

Record this element for all Steel Ceiling Panels. Ceiling panels separate the upper plenum from space above the tunnel roadway. Ceiling panels are typically supported by hangers.

The area of the ceiling panel is the product of the width and length of the panel.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------|---|--|---|--|
| Corrosion | None | Freckled rust. Corrosion of steel has initiated. | Section loss is evident or pack rust is present but does not warrant structural review. | <i>*Section loss is of the extent which impacts capacity, warrants structural review.</i> |
| Cracking | None | Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar. | Identified crack exists that is not arrested but does not warrant a structural review. | <i>* Severe unarrested cracking Crack is likely to or has propagated into critical stress area, warrants structural review</i> |
| Connection | Connection is in place and functioning as intended. | Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended. | Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review. | <i>*Connection has failed (or failure of connector is imminent) which impacts connection capacity, warrants structural review</i> |
| Distortion | None | Distortion not requiring mitigation or mitigated distortion. | Distortion that requires mitigation that has not been addressed but does not require structural review. | <i>*Distortion is extensive and may impact capacity, warrants structural review</i> |



| | | |
|---------------|----------------------|---|
| <i>Safety</i> | <i>Not impacted.</i> | <i>Defect poses a safety concern for travelway below.</i> |
|---------------|----------------------|---|

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



| | | |
|--|------------|--|
| 10091 – Concrete Ceiling Panels | NTI | Units: Square Feet (ft²) |
|--|------------|--|

DESCRIPTION

Record this element for all Concrete Ceiling Panels. Ceiling panels separate the upper plenum from space above the tunnel roadway. Ceiling panels are typically supported by hangers.

The area of the ceiling panel is the product of the width and length of the panel.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--|---|--|---|---|
| Delamination/ Spall/ Patched area/ <i>Scale</i> | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | <i>*Spall affects capacity of the element, warrants a structural review</i> |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | <i>*Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.</i> |
| Efflorescence/ Rust Staining | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaking, build-up, and/or rust present which is of concern to capacity, warrants a structural review</i> |
| Cracking ¹ | Width less than 0.012 in. or spacing greater than 3.0 ft. | Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft. | Width greater than 0.05 in. or spacing less than 1 ft. | <i>*Severe structural cracking which is of concern to capacity of structure, warrants a structural review</i> |



| | | |
|--------|----------------------|---|
| Safety | <i>Not impacted.</i> | <i>Defect poses a safety concern for travelway below.</i> |
|--------|----------------------|---|

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.

¹If prestressed Concrete Ceiling Panels exist, use the crack widths as defined in the defect table for prestressed concrete.

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------------------|---|---|---|--|
| Cracking (Prestressed) | Width less than 0.004 in. or spacing greater than 3 ft. | Width 0.004 - 0.009 in. or spacing of 1.0 – 3.0 ft. | Width greater than 0.009 in. or spacing less than 1 ft. | *Severe structural cracking which is of concern to capacity of structure, warrants a structural review |



| | | |
|-------------------------------------|------------|--|
| 10099 – Other Ceiling Panels | NTI | Units: Square Feet (ft²) |
|-------------------------------------|------------|--|

DESCRIPTION

Record this element for all ceiling panels composed of other materials. Ceiling panels separate the upper plenum from space above the tunnel roadway. Ceiling panels are typically supported by hangers.

The area of the ceiling panel is the product of the width and length of the panel.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Other Ceiling Panels in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------|--------------------------------------|--|---|---|
| General Condition | Good condition – no notable distress | Fair condition – isolated breakdowns or deterioration. | Poor condition – widespread deterioration or breakdowns without reducing load capacity. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel. |



| | | |
|-------------------------------------|------------|--|
| 10101 – Concrete Invert Slab | NTI | Units: Square Feet (ft²) |
|-------------------------------------|------------|--|

DESCRIPTION

Record this element for all Concrete Invert Slabs. This element defines those structural slabs which support the roadway and traffic loads.

The total area of the Invert Slab is the product of the width and length of the slab.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

The slab evaluation is three dimensional with the defects observed on the top surface, bottom surface, or both, and being captured using the defined condition states. Slab top or bottom surfaces that are not visible for inspection shall be assessed based on the available visible surface. If both top and bottom surfaces are not visible, the condition shall be assessed based on destructive and nondestructive testing or indicators in the materials covering the surfaces.

COMMENTARY

There are no Concrete Invert Slabs in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---|-------------------|--|---|---|
| Delamination/ Spall/ Patched area | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | <i>*Spall affects capacity of the element, warrants a structural review</i> |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | <i>*Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.</i> |
| Efflorescence/ Rust Staining | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaking, build-up, and/or rust present which is of concern to capacity, warrants a structural review</i> |



| | | | | |
|----------|--|---|--|---|
| Cracking | Width less than 0.012 in. or spacing greater than 3.0 ft. <i>Cracks do not exhibit sealant.</i> | Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft. <i>Cracks exhibit sealant and sealant is in good condition.</i> | Width greater than 0.05 in. or spacing less than 1 ft. <i>Cracks exhibit sealant and sealant is showing signs of distress or failing.</i> | <i>*Severe structural cracking which is of concern to capacity of structure, warrants a structural review</i> |
|----------|--|---|--|---|

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



| | | |
|----------------------------------|------------|--|
| 10109 – Other Invert Slab | NTI | Units: Square Feet (ft²) |
|----------------------------------|------------|--|

DESCRIPTION

Record this element for all Invert Slabs composed of other materials. This element defines those structural slabs which support the roadway and traffic loads.

The total area of the Invert Slab is the product of the width and length of the slab.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

The slab evaluation is three dimensional with the defects observed on the top surface, bottom surface, or both, and being captured using the defined condition states. Slab top or bottom surfaces that are not visible for inspection shall be assessed based on the available visible surface. If both top and bottom surfaces are not visible, the condition shall be assessed based on destructive and nondestructive testing or indicators in the materials covering the surfaces.

COMMENTARY

There are no Other Invert Slabs in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------|--------------------------------------|---|---|---|
| General Condition | Good condition – no notable distress | Fair condition- isolated breakdowns or deterioration. | Poor condition – widespread deterioration or breakdowns without reducing load capacity. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel. |



| | | |
|---------------------------------------|------------|--|
| 10111 – Concrete Slab-on-Grade | NTI | Units: Square Feet (ft²) |
|---------------------------------------|------------|--|

DESCRIPTION

Record this element for all Concrete Slabs-on-Grade. This element defines a slab that is supported continuously on a subbase material.

The area of the Slab-on-Grade is the product of the width and length of the slab.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

Refer to FHWA-03-031 for supplemental information on condition of surfaces.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---|--|--|--|--|
| Delamination/ Spall/ Patched area/ <i>Abrasion</i> | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. <i>Abrasion 1 in. or less deep</i> | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. <i>Abrasion greater than 1 in. deep</i> | <i>*Spall affects capacity of the element, warrants a structural review</i> |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | <i>*Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.</i> |
| Cracking | Width less than 0.012 in. or spacing greater than 3.0 ft. <i>Cracks do not exhibit sealant.</i> | Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft. <i>Cracks exhibit sealant and sealant is in good condition.</i> | Width greater than 0.05 in. or spacing of less than 1 ft. <i>Cracks exhibit sealant and sealant is showing signs of distress or failing.</i> | <i>*Severe structural cracking, warrants a structural review</i> |



| | | | | |
|------------|------|--|--|---|
| Settlement | None | Exists within tolerable limits or arrested with no observed structural distress. | Exceeds tolerable limits but does not warrant structural review. | <i>* Severe settlement leading to unstable conditions, warrants structural review</i> |
|------------|------|--|--|---|

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



| | | |
|------------------------------------|------------|--|
| 10119 – Other Slab-on-Grade | NTI | Units: Square Feet (ft²) |
|------------------------------------|------------|--|

DESCRIPTION

Record this element for all Slabs-on-Grade composed of other materials. This element defines a slab that is supported continuously on a subbase material.

The area of the Slab-on-Grade is the product of the width and length of the slab.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

Refer to FHWA-03-031 for supplemental information on condition of surfaces.

There are no Other Slab-on-Grade in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------|--------------------------------------|--|---|---|
| General Condition | Good condition – no notable distress | Fair condition- isolated breakdowns or deterioration. | Poor condition – widespread deterioration or breakdowns without reducing load capacity. | <i>*Severe Condition, warrants structural review</i> |
| Settlement | None | Exists within tolerable limits or arrested with no observed structural distress. | Exceeds tolerable limits but does not warrant structural review. | <i>* Severe settlement leading to unstable conditions, warrants structural review</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



| | | |
|------------------------------------|------------|-------------------------|
| 10120 – Steel Invert Girder | NTI | Units: Feet (ft) |
|------------------------------------|------------|-------------------------|

DESCRIPTION

Record this element for all Steel Invert Girders. This element defines the Invert Girders which support the Invert Slabs.

The total quantity for Invert Girder is the sum of all the lengths of each Invert Girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Steel Invert Girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------|---|--|---|---|
| Corrosion | None | Freckled rust. Corrosion of steel has initiated. | Section loss is evident or pack rust is present but does not warrant structural review. | <i>*Section loss is of the extent which impacts capacity, warrants structural review.</i> |
| Cracking | None | Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar. | Identified crack exists that is not arrested but does not warrant structural review. | <i>*Severe unarrested cracking Crack is likely to or has propagated into critical stress area, warrants structural review</i> |
| Connection | Connection is in place and functioning as intended. | Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended. | Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review. | <i>*Connection has failed (or failure of connector is imminent) which impacts connection capacity, warrants structural review</i> |
| Distortion | None | Distortion not requiring mitigation or mitigated distortion. | Distortion that requires mitigation that has not been addressed but does | <i>*Distortion is extensive and may impact capacity, warrants structural review</i> |



| | | | | |
|--|--|--|--------------------------------|--|
| | | | not require structural review. | |
|--|--|--|--------------------------------|--|

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



| | | |
|---------------------------------------|------------|-------------------------|
| 10121 – Concrete Invert Girder | NTI | Units: Feet (ft) |
|---------------------------------------|------------|-------------------------|

DESCRIPTION

Record this element for all Concrete Invert Girders. This element defines the Invert Girders which support the Invert Slabs.

The total quantity for Invert Girder is the sum of all the lengths of each Invert Girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Concrete Invert Girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---|---|--|---|---|
| Delamination/ Spall/ Patched area | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | <i>*Spall affects capacity of the element, warrants a structural review</i> |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | <i>*Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.</i> |
| Efflorescence/ Rust Staining | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaking, build-up, and/or rust present which is of concern to capacity, warrants a structural review</i> |
| Cracking | Width less than 0.012 in. or spacing greater than 3.0 ft. | Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft. | Width greater than 0.05 in. or spacing less than 1 ft. | <i>*Severe structural cracking which is of concern to capacity of structure,</i> |



| | | | | |
|--|--|--|--|------------------------------|
| | | | | warrants a structural review |
|--|--|--|--|------------------------------|

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



| | | |
|---|------------|-------------------------|
| 10122 – Prestressed Concrete Invert Girder | NTI | Units: Feet (ft) |
|---|------------|-------------------------|

DESCRIPTION

Record this element for all Prestressed Concrete Invert Girders. This element defines the Invert Girders which support the Invert Slabs.

The total quantity for Invert Girder is the sum of all the lengths of each Invert Girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Prestressed Concrete Invert Girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---|---|--|---|--|
| Delamination/ Spall/ Patched area | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | <i>*Spall affects capacity of the element, warrants a structural review</i> |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | <i>*Exposed rebar exhibits section loss and is in a critical area, warrants a structural review.</i> |
| Exposed Prestressing | None | Present without section loss. | Present with section loss, but does not warrant structural review. | <i>*Pre stressing tendon is severely corroded with measurable section loss or is severed, warrants structural review</i> |
| Cracking | Width less than 0.004 in. or spacing greater than 3 ft. | Width 0.004 - 0.009 in. or spacing of 1.0 – 3.0 ft. | Width greater than 0.009 in. or spacing less than 1 ft. | <i>*Severe structural cracking which is of concern to capacity of structure,</i> |



| | | | | |
|---------------------------------|------|---|------------------------------------|---|
| | | | | warrants a structural review |
| Efflorescence/ Rust Staining | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | <i>*Severe leaking, build-up, and/or rust present which is of concern to capacity, warrants a structural review</i> |

*Use these additional descriptions as a guide for determining Condition State 4 beyond the generic description found in the introduction of Section 3.1 above. If the condition merits a structural review or poses a direct safety concern, code it as a Condition State 4. If a structural review has been performed and the strength or serviceability of the tunnel is affected, the defect is to remain in Condition State 4.



| | | |
|------------------------------------|------------|-------------------------|
| 10129 – Other Invert Girder | NTI | Units: Feet (ft) |
|------------------------------------|------------|-------------------------|

DESCRIPTION

Record this element for all Invert Girders composed of other materials. This element defines the Invert Girders which support the Invert Slabs.

The total quantity for Invert Girder is the sum of all the lengths of each Invert Girder.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Other Invert Girders in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------|--------------------------------------|--|---|---|
| General Condition | Good condition – no notable distress | Fair condition – isolated breakdowns or deterioration. | Poor condition – widespread deterioration or breakdowns without reducing load capacity. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel. |



| | | |
|---|------------|-------------------------|
| 10130 – Strip Seal Expansion Joint | NTI | Units: Feet (ft) |
|---|------------|-------------------------|

DESCRIPTION

Record this element for all Strip Seal Expansion Joints. This element defines those expansion joint devices which utilize a neoprene type waterproof gland with some type of metal extrusion or other system to anchor the gland.

The total quantity for expansion joints is the sum of all the lengths of each joint.

PROCEDURE

No procedure documented within the SNTI

COMMENTARY

There are no Strip Seal Expansion Joints in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------------|---|---|--|---|
| Leakage | None | Minimal. Minor dripping through the joint. | Moderate. More than a drip and less than free flow of water. | Free flow of water through the joint. |
| Seal Adhesion | Fully adhered. | Adhered for more than 50% of the joint height. | Adhered 50% or less of the joint height but still some adhesion. | Complete loss of adhesion. |
| Seal Damage | None | Seal abrasion without punctures. | Punctured or ripped or partially pulled out. | Punctured completely through, pulled out, or missing. |
| Seal cracking | None | Surface crack. | Crack that partially penetrates the seal. | Crack that fully penetrates the seal. |
| Debris Impaction | No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint. | Partially filled with hard-packed material, but still allowing free movement. | Completely filled and impacts joint movement. | Completely filled and prevents joint movement. |



| | | | | |
|-------------------------------|---|---|---|--|
| Adjacent Deck or Header | Sound. No spall, delamination or unsound patch. | Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose. | Spall delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended. |
| Metal Deterioration or Damage | None | Freckled rust, metal has no cracks, or impact damage. Connections may be loose but functioning as intended. | Section loss, missing or broken fasteners, cracking of the metal or impact damage but joint is still functioning. | Metal cracking, section loss, damage or connection failure that prevents the joint from functioning as intended. |
| <i>Movement</i> | <i>Movement is not restricted, operating as intended within design criteria</i> | | <i>Movement has surpassed designed intentions, may pose risk of failure or restricted movement</i> | <i>Movement is restricted or joint has failed, joint not operating as intended.</i> |



| | | |
|------------------------------------|------------|-------------------------|
| 10131 – Pourable Joint Seal | NTI | Units: Feet (ft) |
|------------------------------------|------------|-------------------------|

DESCRIPTION

Record this element for all Pourable Joint Seals. This element defines those joints filled with a pourable seal with or without a backer.

The total quantity for expansion joints is the sum of all the lengths of each joint.

PROCEDURE

No procedure documented within the SNTI

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------------|---|---|--|---|
| Leakage | None | Minimal. Minor dripping through the joint. | Moderate. More than a drip and less than free flow of water. | Free flow of water through the joint. |
| Seal Adhesion | Fully adhered. | Adhered for more than 50% of the joint height. | Adhered 50% or less of the joint height but still some adhesion. | Complete loss of adhesion. |
| Seal Damage | None | Seal abrasion without punctures. | Punctured or ripped or partially pulled out. | Punctured completely through, pulled out, or missing. |
| Seal Cracking | None | Surface crack. | Crack that partially penetrates the seal. | Crack that fully penetrates the seal. |
| Debris Impaction | No debris to shallow cover of loose debris may be evident but does not affect the performance of the joint. | Partially filled with hard-packed material, but still allowing free movement. | Completely filled and impacts joint movement. | Completely filled and prevents joint movement. |
| Adjacent Deck or Header | Sound. No spall, delamination or unsound patch. | Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. | Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched | Spall delamination, unsound patched area or loose joint anchor that prevents the joint from |



| | | Patched are that is sound. | area that makes the joint loose. | functioning as intended. |
|-----------------|---|----------------------------|--|---|
| <i>Movement</i> | <i>Movement is not restricted, operating as intended within design criteria</i> | | <i>Movement has surpassed designed intentions, may pose risk of failure or restricted movement</i> | <i>Movement is restricted or joint has failed, joint not operating as intended.</i> |



| | | |
|---------------------------------------|------------|-------------------------|
| 10132 – Compression Joint Seal | NTI | Units: Feet (ft) |
|---------------------------------------|------------|-------------------------|

DESCRIPTION

Record this element for all Compression Joint Seals. This element defines those joints filled with a preformed compression type seal. This joint does not have an anchor system to confine the seal.

The total quantity for expansion joints is the sum of all the lengths of each joint.

PROCEDURE

No procedure documented within the SNTI

COMMENTARY

There are no Compression Joint Seals in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------------|---|---|--|---|
| Leakage | None | Minimal. Minor dripping through joints. | Moderate. More than a drip and less than free flow of water. | Free flow of water through the joint. |
| Seal Adhesion | Fully adhered. | Adhered for more than 50% of the joint height. | Adhered 50% or less of the joint height but still some adhesion. | Complete loss of adhesion. |
| Seal Damage | None | Seal abrasion without punctures. | Punctured or ripped or partially pulled out. | Punctured completely through, pulled out, or missing. |
| Seal Cracking | None | Surface crack. | Crack that partially penetrates the seal. | Crack that fully penetrates the seal. |
| Debris Impaction | No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint. | Partially filled with hard-packed material, but still allowing free movement. | Completely filled and impacts joint movement. | Completely filled and prevents joint movement. |



| | | | | |
|-------------------------|---|---|---|--|
| Adjacent Deck or Header | Sound. No spall, delamination or unsound patch. | Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose. | Spall delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended. |
| <i>Movement</i> | <i>Movement is not restricted, operating as intended within design criteria</i> | | <i>Movement has surpassed designed intentions, may pose risk of failure or restricted movement</i> | <i>Movement is restricted or joint has failed, joint not operating as intended.</i> |



| | | |
|---|------------|-------------------------|
| 10133 – Assembly Joint with Seal | NTI | Units: Feet (ft) |
|---|------------|-------------------------|

DESCRIPTION

Record this element for all assembly joints with seals. This element defines only those joints filled with an assembly mechanism that have a seal.

The total quantity for expansion joints is the sum of all the lengths of each joint.

PROCEDURE

No procedure documented within the SNTI

COMMENTARY

There are no Assembly Joint with Seal in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------------|---|---|---|---|
| Leakage | None | Minimal. Minor dripping through joints. | Moderate. More than a drip and less than free flow of water. | Free flow of water through the joint. |
| Seal Adhesion | Fully adhered. | Adhered for more than 50% of the joint height. | Adhered 50% or less of joint height but still some adhesion. | Complete loss of adhesion. |
| Seal Damage | None | Seal abrasion without punctures. | Punctured or ripped or partially pulled out. | Punctured completely through, pulled out, or missing. |
| Seal Cracking | None | Surface crack. | Crack that partially penetrates the seal. | Crack that fully penetrates the seal. |
| Debris Impaction | No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint. | Partially filled with hard-packed material, but still allowing free movement. | Completely filled and impacts joint movement. | Completely filled and prevents joint movement. |
| Adjacent Deck or Header | Sound. No spall, delamination or unsound patch. | Edge delamination or spall 1 in. or less deep or 6 in. or less | Spall greater than 1 in. deep or greater than 6 in. diameter. | Spall delamination, unsound patched area or loose joint |



| | | | | |
|-------------------------------|---|---|---|--|
| | | in diameter. No exposed rebar. Patched are that is sound. | Exposed rebar. Delamination or unsound patched area that makes the joint loose. | anchor that prevents the joint from functioning as intended. |
| Metal Deterioration or Damage | None | Freckled rust, metal has no cracks, or impact damage. Connections may be loose but functioning as intended. | Section loss, missing or broken fasteners, cracking of the metal or impact damage but joint is still functioning. | Metal cracking, section loss, damage or connection failure that prevents the joint from functioning as intended. |
| <i>Movement</i> | <i>Movement is not restricted, operating as intended within design criteria</i> | | <i>Movement has surpassed designed intentions, may pose risk of failure or restricted movement</i> | <i>Movement is restricted or joint has failed, joint not operating as intended.</i> |



| | | |
|-------------------------------------|------------|-------------------------|
| 10134 – Open Expansion Joint | NTI | Units: Feet (ft) |
|-------------------------------------|------------|-------------------------|

DESCRIPTION

Record this element for all Open Expansion Joints. This element defines only those joints that are open and not sealed.

The total quantity for expansion joints is the sum of all the lengths of each joint.

PROCEDURE

No procedure documented within the SNTI

COMMENTARY

There are no Open Expansion Joints in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------------|---|---|---|--|
| Debris Impaction | No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint. | Partially filled with hard-packed material, but still allowing free movement. | Completely filled and impacts joint movement. | Completely filled and prevents joint movement. |
| Adjacent Deck or Header | Sound. No spall, delamination or unsound patch. | Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose. | Spall delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended. |
| <i>Movement</i> | <i>Movement is not restricted, operating as intended within design criteria</i> | | <i>Movement has surpassed designed intentions, may pose risk of failure or restricted movement</i> | <i>Movement is restricted or joint has failed, joint not operating as intended.</i> |



| | | |
|--|------------|-------------------------|
| 10135 – Assembly Joint without Seal | NTI | Units: Feet (ft) |
|--|------------|-------------------------|

DESCRIPTION

Record this element for all Assembly Joints without Seals. This element defines only those assembly joints that are open and not sealed. These joints include finger and sliding plate joints.

The total quantity for expansion joints is the sum of all the lengths of each joint.

PROCEDURE

No procedure documented within the SNTI

COMMENTARY

There are no Assembly Joint without Seal in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------------------|---|---|---|--|
| Debris Impaction | No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint. | Partially filled with hard-packed material, but still allowing free movement. | Completely filled and impacts joint movement. | Completely filled and prevents joint movement. |
| Adjacent Deck or Header | Sound. No spall, delamination or unsound patch. | Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose. | Spall delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended. |
| Metal Deterioration or Damage | None | Freckled rust, metal has no cracks, or impact damage. Connections may be loose but functioning as intended. | Section loss, missing or broken fasteners, cracking of the metal or impact damage but joint is still functioning. | Metal cracking, section loss, damage or connection failure that prevents the joint from functioning as intended. |
| <i>Movement</i> | <i>Movement is not restricted, operating as intended within design criteria</i> | | <i>Movement has surpassed designed intentions, may pose</i> | <i>Movement is restricted or joint has failed, joint not</i> |



| | | | |
|--|--|---|-------------------------------|
| | | <i>risk of failure or restricted movement</i> | <i>operating as intended.</i> |
|--|--|---|-------------------------------|

| | | |
|----------------------------|------------|-------------------------|
| 10139 – Other Joint | NTI | Units: Feet (ft) |
|----------------------------|------------|-------------------------|

DESCRIPTION

Record this element for all other expansion joints. This element defines those roadway and tunnel expansion joint devices which utilize a neoprene type waterproof gland with some type of metal extrusion or other system to anchor the gland.

The total quantity for expansion joints is the sum of all the lengths of each joint.

PROCEDURE

No procedure documented within the SNTI

COMMENTARY

There are no Other Joints in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------------|---|---|---|--|
| Leakage | None | Minimal. Minor dripping through the joint | Moderate. More than a drip and less than free flow of water. | Free flow of water through the joint. |
| Debris Impaction | No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint. | Partially filled with hard-packed material, but still allowing free movement. | Completely filled and impacts joint movement. | Completely filled and prevents joint movement. |
| Adjacent Deck or Header | Sound. No spall, delamination or unsound patch. | Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose. | Spall delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended. |



| | | | | |
|-------------------------------|------|---|---|--|
| Metal Deterioration or Damage | None | Freckled rust, metal has no cracks, or impact damage. Connections may be loose but functioning as intended. | Section loss, missing or broken fasteners, cracking of the metal or impact damage but joint is still functioning. | Metal cracking, section loss, damage or connection failure that prevents the joint from functioning as intended. |
|-------------------------------|------|---|---|--|



| | | |
|-----------------------|------------|-------------------------|
| 10140 – Gasket | NTI | Units: Feet (ft) |
|-----------------------|------------|-------------------------|

DESCRIPTION

Record this element for all Gaskets. This element defines those Gaskets which are joints between segmental tunnel liners and can be made of lead, mastic, or rubber.

The total quantity for Gasket is the sum of all lengths of each Gasket.

PROCEDURE

No procedure documented within the SNTI

COMMENTARY

There are no Gaskets in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------------|---|---|---|---|
| Leakage | None | Minimal. Minor dripping through joints. | Moderate. More than a drip and less than free flow of water. | Free flow of water through the joint. |
| Seal Adhesion | Fully adhered. | Adhered for more than 50% of the joint height. | Adhered 50% or less of joint height but still some adhesion. | Complete loss of adhesion. |
| Seal Damage | None | Seal abrasion without punctures. | Punctured or ripped or partially pulled out. | Punctured completely through, pulled out, or missing. |
| Seal Cracking | None | Surface crack. | Crack that partially penetrates the seal. | Crack that fully penetrates the seal. |
| Debris Impaction | No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint. | Partially filled with hard-packed material, but still allowing free movement. | Completely filled and impacts joint movement. | Completely filled and prevents joint movement. |
| Adjacent Deck or Header | Sound. No spall, delamination or unsound patch. | Edge delamination or spall 1 in. or less deep or 6 in. or less | Spall greater than 1 in. deep or greater than 6 in. diameter. | Spall delamination, unsound patched area or loose joint |



| | | | | |
|-------------------------------|---|---|---|--|
| | | in diameter. No exposed rebar. Patched are that is sound. | Exposed rebar. Delamination or unsound patched area that makes the joint loose. | anchor that prevents the joint from functioning as intended. |
| Metal Deterioration or Damage | None | Freckled rust, metal has no cracks, or impact damage. Connections may be loose but functioning as intended. | Section loss, missing or broken fasteners, cracking of the metal or impact damage but joint is still functioning. | Metal cracking, section loss, damage or connection failure that prevents the joint from functioning as intended. |
| <i>Movement</i> | <i>Movement is not restricted, operating as intended within design criteria</i> | | <i>Movement has surpassed designed intentions, may pose risk of failure or restricted movement</i> | <i>Movement is restricted or joint has failed, joint not operating as intended.</i> |



3.3 Civil Section

This section defines tunnel civil elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

| Element Number | Element Name | Unit of Measure |
|---------------------------|---|---------------------------|
| Wearing Surface | | |
| 10151 | Concrete Wearing Surface | AREA (Feet ²) |
| 10158 | Asphalt Wearing Surface | AREA (Feet ²) |
| 10159 | Other Wearing Surface | AREA (Feet ²) |
| Traffic Barrier | | |
| 10160 | Steel Traffic Barrier | LENGTH (Feet) |
| 10161 | Concrete Traffic Barrier | LENGTH (Feet) |
| 10169 | Other Traffic Barrier | LENGTH (Feet) |
| Pedestrian Railing | | |
| 10170 | Steel Pedestrian Railing | LENGTH (Feet) |
| 10171 | Concrete Pedestrian Railing | LENGTH (Feet) |
| 10179 | Other Pedestrian Railing | LENGTH (Feet) |
| Roadway | | |
| 9520 | Approach Roadway Pavement | EACH |
| 9521 | Sidewalk/Curb | LENGTH (Feet) |
| 9522 | Approach Drainage System | EACH |
| 9523 | Unlined Rock Approach Embankment | EACH |
| 9524 | Shotcrete or Concrete Approach Embankment | EACH |
| 9530 | Approach Traffic Barrier | EACH |



| | | |
|---|------------|--|
| 10151 – Concrete Wearing Surface | NTI | Units: Square Feet (ft²) |
|---|------------|--|

DESCRIPTION

Record this element for all Concrete Wearing Surfaces. This element defines the tunnel roadway surface that carries the vehicles. The wearing surface is sacrificial and helps protect the structural slab from wear and damage.

The total area of the wearing surface is the product of the width and length of the surface from portal to portal.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

Refer to FHWA-RD-03-031 for supplemental information on condition of surfaces.

There are no Concrete Wearing Surfaces in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---|--|---|--|---|
| Delamination/ Spall/ Patched area/pothole | None | Delaminated. Spall less than 1 in. deep or less than 6 in. diameter. Patched area that is sound. Partial depth pothole. | Spalls 1 in. deep or greater or 6 in. diameter or greater. Patched area that is unsound or showing distress. Full depth pothole. | The wearing surface is no longer effective. |
| Crack | Width less than 0.012 in. or spacing greater than 3.0 ft. | Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft. | Width greater than 0.05 in. or spacing of less than 1.0 ft. | |
| Effectiveness | Fully effective. No evidence of leakage or further deterioration of the protected element. | Substantially effective. Deterioration of the protected element has slowed. | Limited effectiveness. Deterioration of the protected element has progressed. | |
| <i>Abrasion/Wear¹</i> | <i>No abrasion or wearing.</i> | <i>Abrasion or wearing is evident by shallow wheel lines worn into the overlay.</i> | <i>Wheel lines worn into the overlay are deep enough to affect drivability or</i> | |



| | | | | |
|--|--|--|--|--|
| | | <i>Underlying concrete is not exposed.</i> | <i>underlying concrete is exposed.</i> | |
|--|--|--|--|--|

¹For CDOT purposes abrasion or wear less than 1" deep should be considered shallow and abrasion or wear greater than 1" deep are considered deep enough to affect drivability.



| | | |
|--|------------|--|
| 10158 – Asphalt Wearing Surface | NTI | Units: Square Feet (ft²) |
|--|------------|--|

DESCRIPTION

Record this element for all Asphalt Wearing Surfaces. This element defines the tunnel roadway surface that carries the vehicles. The wearing surface is sacrificial and helps protect the structural slab from wear and damage.

The total area of the wearing surface is the product of the width and length of the surface.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

The Length of the surface shall be calculated consistent with Tunnel Length.

This element is also to be used for asphalt on Slab-on-Grade or an asphalt roadway.

Refer to FHWA-03-031 for supplemental information on condition of surfaces.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------|---|--|---|--|
| General Condition | Good condition – no notable distress | Fair condition- isolated breakdowns or deterioration. | Poor condition – widespread deterioration or breakdowns without reducing load capacity. | The wearing surface is no longer effective. <i>The wearing surface exhibits full depth failure.</i> |
| Effectiveness | Fully effective. No evidence of leakage or further deterioration of the protected element. <i>Leakage to have no bearing on Asphalt Wearing Surface.</i> | Substantially effective. Deterioration of the protected element has slowed. | Limited effectiveness. Deterioration of the protected element has progressed. | |
| Pothole | None | <i>Pothole less than or equal to 1 in. deep.</i> <i>Patched areas that are sound.</i> | <i>Pothole greater than 1 in. deep.</i> <i>Patched areas have moderate to heavy deterioration.</i> | |



| | | | | |
|---|---|--|--|--|
| <i>Cracking</i> | <i>Cracking less than or equal to 0.25 in. wide</i> | Width 0.25 in. – 0.75 in. or low density alligator/block cracking, <i>includes reflective cracking over slab on grade control joints.</i> | Width greater than 0.75 in. or high density alligator/block cracking <i>indicating failure of substrate.</i> | |
| <i>Abrasion/Wear /Rutting¹</i> | <i>No abrasion, wearing, or rutting.</i> | <i>Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure. Abrasion or wearing is evident by shallow wheel lines worn into the overlay. Underlying concrete is not exposed.</i> | <i>Coarse aggregate is loose or has popped out of the matrix due to abrasion or wear. Wheel lines worn into the overlay are deep enough to affect drivability.</i> | |

¹ For CDOT purposes abrasion, wear, or rutting less than 1" deep should be considered shallow and abrasion or wear greater than 1" deep are considered deep enough to affect drivability.



| | | |
|--------------------------------------|------------|--|
| 10159 – Other Wearing Surface | NTI | Units: Square Feet (ft²) |
|--------------------------------------|------------|--|

DESCRIPTION

Record this element for all wearing surfaces composed of other materials. This element defines the tunnel roadway surface that carries the vehicles. The wearing surface is sacrificial and helps protect the structural slab from wear and damage.

The total area of the wearing surface is the product of the width and length of the surface.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

Refer to FHWA-03-031 for supplemental information on condition of surfaces.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------|--|---|---|---|
| General Condition | Good condition – no notable distress | Fair condition- isolated breakdowns or deterioration. | Poor condition – widespread deterioration or breakdowns without reducing load capacity. | The wearing surface is no longer effective. |
| Effectiveness | Fully effective. No evidence of leakage or further deterioration of the protected element. | Substantially effective. Deterioration of the protected element has slowed. | Limited effectiveness. Deterioration of the protected element has progressed. | |



| | | |
|--------------------------------------|------------|-------------------------|
| 10160 – Steel Traffic Barrier | NTI | Units: Feet (ft) |
|--------------------------------------|------------|-------------------------|

DESCRIPTION

Record this element for all Steel Traffic Barriers. This element defines those tunnel barriers adjacent to a roadway. Horizontal members must be steel, however, posts may be made of steel, timber, concrete or other materials.

The total quantity for traffic barrier is the sum of all the lengths of each traffic barrier.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------|---|--|---|---|
| Corrosion | None | Freckled rust. Corrosion of steel has initiated. | Section loss is evident or pack rust is present but does not warrant structural review. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel. |
| Cracking | None | Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar. | Identified crack exists that is not arrested but does not warrant a structural review. | |
| Connection | Connection is in place and functioning as intended. | Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended. | Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review. | |
| Distortion | None | Distortion not requiring mitigation or mitigated distortion. | Distortion that requires mitigation that has not been addressed but does not warrant structural review. | |



| | | |
|---|------------|-------------------------|
| 10161 – Concrete Traffic Barrier | NTI | Units: Feet (ft) |
|---|------------|-------------------------|

DESCRIPTION

Record this element for all Concrete Traffic Barriers. This element defines those tunnel barriers adjacent to a roadway. All elements of the barrier must be concrete.

The total quantity for traffic barrier is the sum of all the lengths of each traffic barrier.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---|---|--|---|---|
| Delamination/ Spall/ Patched area | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel. |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | |
| Efflorescence/ Rust Staining | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | |
| Cracking | Width less than 0.012 in. or spacing greater than 3.0 ft. | Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft. | Width greater than 0.05 in. or spacing less than 1 ft. | |



| | | |
|--------------------------------------|------------|-------------------------|
| 10169 – Other Traffic Barrier | NTI | Units: Feet (ft) |
|--------------------------------------|------------|-------------------------|

DESCRIPTION

Record this element for all traffic barriers composed of other materials. This element defines those tunnel barriers adjacent to a roadway.

The total quantity for traffic barrier is the sum of all the lengths of each traffic barrier.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

COMMENTARY

There are no Other Traffic Barriers in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------|--------------------------------------|---|---|---|
| General Condition | Good condition – no notable distress | Fair condition- isolated breakdowns or deterioration. | Poor condition – widespread deterioration or breakdowns without reducing load capacity. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel. |



| | | |
|---|------------|-------------------------|
| 10170 – Steel Pedestrian Railing | NTI | Units: Feet (ft) |
|---|------------|-------------------------|

DESCRIPTION

Record this element for all Steel Pedestrian Railing. This element defines those tunnel railings adjacent to a walkway.

The total quantity for pedestrian railing is the sum of all the lengths of each pedestrian railing.

PROCEDURE

No procedure documented within the SNTI

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--------------|---|--|---|---|
| Corrosion | None | Freckled rust. Corrosion of steel has initiated. | Section loss is evident or pack rust is present but does not warrant structural review. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel. |
| Cracking | None | Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar. | Identified crack exists that is not arrested but does not warrant a structural review. | |
| Connections | Connection is in place and functioning as intended. | Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended. | Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review. | |
| Distortion | None | Distortion not requiring mitigation or mitigated distortion. | Distortion that requires mitigation that has not been addressed but does not warrant structural review. | |
| Out-of-Plumb | None | Minor tilt which is barely noticeable. | Excessive tilt that affects operations or near failure. | |





| | | |
|--|------------|-------------------------|
| 10171 – Concrete Pedestrian Railing | NTI | Units: Feet (ft) |
|--|------------|-------------------------|

DESCRIPTION

Record this element for all Concrete Pedestrian Railing. This element defines those tunnel railings adjacent to a walkway.

The total quantity for pedestrian railing is the sum of all the lengths of each pedestrian railing.

PROCEDURE

No procedure documented within the SNTI

COMMENTARY

There are no Concrete Pedestrian Railings in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---|---|--|---|---|
| Delamination/ Spall/ Patched area | None | Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound. | Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel. |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss, but does not warrant structural review. | |
| Efflorescence/ Rust Staining | None | Surface white without build-up or leaching without rust staining. | Heavy build-up with rust staining. | |
| Cracking | Width less than 0.012 in. or spacing greater than 3.0 ft. | Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft. | Width greater than 0.05 in. or spacing less than 1 ft. | |
| Out-of-Plumb | None | Minor tilt which is barely noticeable. | Excessive tilt that affects operations or near failure. | |



| | | |
|---|------------|-------------------------|
| 10179 – Other Pedestrian Railing | NTI | Units: Feet (ft) |
|---|------------|-------------------------|

DESCRIPTION

Record this element for all pedestrian railing composed of other materials. This element defines those tunnel railings adjacent to a walkway.

The total quantity for pedestrian railing is the sum of all the lengths of each pedestrian railing.

PROCEDURE

No procedure documented within the SNTI

COMMENTARY

There are no Other Pedestrian Railings in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------|--------------------------------------|---|---|---|
| General Condition | Good condition – no notable distress | Fair condition- isolated breakdowns or deterioration. | Poor condition – widespread deterioration or breakdowns without reducing load capacity. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel. |
| Out-of-Plumb | None | Minor tilt which is barely noticeable. | Excessive tilt that affects operations or near failure. | |



| | | |
|---|-------------|--------------------|
| 9520 – Approach Roadway Pavement | CDOT | Units: Each |
|---|-------------|--------------------|

DESCRIPTION

Record this element for all approach surfaces leading up to the tunnel.

The measurement each is for all approach pavements within 100 feet of the tunnel and wearing surface over Slab-on-Grade.

PROCEDURE

Worst condition state of the entire approach pavement system shall be coded for this element. Defects noted at the interface of the tunnel roadway surface the approach roadway are to be coded in this element.

COMMENTARY

Refer to FHWA-03-031 for supplemental information on condition of surfaces.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--|--|--|---|---|
| Delamination/Spall/ Pothole/Patched area | None | Delaminated. Spall or pothole 1 in. or less deep or 6 in. in diameter. Patched area that is sound. | Spall/pothole greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. | Approach roadway has passed limits of Condition State 3 and is no longer effective. |
| Exposed rebar (Concrete) | None | Present without measurable section loss | Present with measurable section loss but does not warrant structural review. | |
| Cracking ¹ | Insignificant cracks or moderate-width cracks that have been sealed. | Unsealed moderate width cracks or unsealed moderate alligator/map cracking. | Wide cracks or heavy alligator/map cracking. | |
| Settlement | None | Exists within tolerable limits or arrested with no observed structural distress. | Exceeds tolerable limits but does not warrant a structural review. | |



| | | | | |
|--|--|---|--|--|
| Abrasion/Wear /Rutting ² | <i>No abrasion, wearing, or rutting.</i> | Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete. Abrasion or wearing is evident by shallow wheel lines worn into the overlay. Underlying concrete is not exposed. | Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear. Wheel lines worn into the overlay are deep enough to affect drivability or underlying concrete is exposed. | |
|--|--|---|--|--|

¹Cracking limits are defined by material. See table below for recommended concrete and asphalt crack widths; this table is to be used in conjunction with the table above. Engineering judgement should be used when evaluating cracking and crack widths.

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------------------------|-------------------------------|---------------------------|-----------------------------|--|
| Cracking (<i>Concrete</i>) | Width 0.012 in. or less | Width 0.012 - 0.05 in. | Width greater than 0.05 in. | Passed limits of Condition State 3 and is no longer effective. |
| Cracking (Asphalt) | <i>Width 0.25 in. or less</i> | Width 0.25 in. - 0.75 in. | Width greater than 0.75 in. | Passed limits of Condition State 3 and is no longer effective. |

²For CDOT purposes abrasion, wear, or rutting less than 1” deep should be considered shallow and abrasion or wear greater than 1” deep are considered deep enough to affect drivability.



| | | |
|--------------------------------------|-------------|-------------------------|
| 9521 – Concrete Curb/Sidewalk | CDOT | Units: Feet (ft) |
|--------------------------------------|-------------|-------------------------|

DESCRIPTION

Record element for any sidewalk or curb along tunnel roadway.

The measurement is for the sum of all length of sidewalk and/or curb along tunnel.

PROCEDURE

Curbs are rated to a height less than 12 inches. Curbs greater than 12 inches are to be rated as Concrete Traffic Barrier.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---|--|--|--|--|
| Delamination/ Spall/ Patched area | None | Delaminated. Spall less than 1 in. deep or less than 6 in. diameter. Patched area that is sound. | Spalls 1 in. deep or greater or 6 in. diameter or greater. Patched area that is unsound or showing distress. Does not warrant structural review. | The condition warrants a structural review to determine the effect on strength or serviceability of the element; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge. |
| Exposed Rebar | None | Present without measurable section loss. | Present with measurable section loss but does not warrant structural review. | |
| Efflorescence/ Rust Staining | None | Surface white without build-up or leaching without rust staining. | Heavy build-up and/or rust staining. | |
| Cracking | Width 0.012 in. or less or spacing 6 ft. or greater. | Width 0.012-0.05 in. or spacing 3.0-6.0 ft. | Width greater than 0.05 in. or spacing less than 3.0 ft. | |
| Abrasion/Wear | No abrasion or wearing | Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete. | Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear. | |



| | | | | |
|-------------------------|------|--|--|--|
| Settlement ¹ | None | Exists within tolerable limits or arrested with no observed structural distress. | Exceeds tolerable limits but does not warrant structural review. | |
|-------------------------|------|--|--|--|

¹ For CDOT purposes settlement less than 0.5 in. deep is within tolerable limits and settlement greater than 2 in. deep may require review. Use engineering judgement when evaluating settlement and consider impact on adjoining elements.



| | | |
|--|-------------|--------------------|
| 9522 – Approach Roadway Drain/Catch Basin | CDOT | Units: Each |
|--|-------------|--------------------|

DESCRIPTION

Record this element for approach drains within 100 feet of tunnel portals.

The quantity is the sum of all approach drains.

PROCEDURE

If a drain is attached to the tunnels drainage system quantify under 10300 – Drainage and Pumping System.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------|--------------------------|--|--|------------------------------|
| Clogging | None to minor debris | Debris in catch basin but still functioning as intended | Debris inhibits flow to less than 50% of design capacity | Drain is no longer effective |
| Inlet/Pipe | No damage | Minor damage which does not affect the capacity of the drain | Moderate damage which inhibits flow to less than 50% of design capacity. | |
| Safety | None | None | Damage exists which is of little concern to roadway safety. | |



| | | |
|--|-------------|--------------------|
| 9523 – Unlined Rock Approach Embankment | CDOT | Units: Each |
|--|-------------|--------------------|

DESCRIPTION

Record this element for approach roadway embankment which is unlined leading up to the tunnel within 100 feet of the portal.

The quantity for Unlined Rock Approach Embankment is the sum of all quadrants containing unlined embankment within 100 feet of the portal. A quadrant is defined as the area above the portal structure or as defined in Other Portal and extending from the roadway centerline at for the specified distance along the approach cut or roadway.

COMMENTARY

At the time of issuance, it is the understanding of the authors that the CDOT Geo-Hazards Group manages the condition inspection and maintenance of all rock cuts along CDOT right of way. The element as it relates to the tunnel inspection shall be restricted to general classifications and description of the rock types and large features visible from the roadway and is not intended for detailed condition evaluation. The defects below may be used as a general guideline for identification and/or classification.

Rockfall retained by the element shall be documented and appropriate recommendations made to mitigate distortion and maintain functionality of overall system.

See Appendix VIII: GSI to Condition State Conversion Charts for additional CDOT guidance on coding condition states based on rock properties.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-----------------------|--|---|--|--|
| Loose or Cracked Rock | Cracks are present but have not allowed the rock to shift. | Cracks are present and areas of loose rock are less than 1 ft ² . | Cracked with areas of loose rock greater than 1 ft ² . | The condition warrants an auxiliary and in-depth review for further analysis and recommendation development. |
| Bolt Distress | Bolt is in place and functioning as intended. | Loose nuts are present but the bolts are in place and functioning as intended. | Missing nuts or broken bolts but does not warrant a structural review. | |
| Patched areas | None | Sound patches. | Unsound patches. | |
| Rock Fall Wire Mesh | Corrosion not present, no distortion, all anchorages and | Corrosion present without measurable section loss. All anchorages, attenuator cables, | Corrosion present with measurable section loss. Insignificant linkage failure resulting in | |



| | | | | |
|----------|---|--|---|-----------------------------------|
| | attenuator cables in good condition. | and linkages are sound. Minimal distortion due to rockfall. Functions as intended. | openings for rockfall less 6 inches in diameter. Anchorages, attenuator cables may be loose, but does not warrant review. | |
| Rockfall | No drummy rock. No blocks or slabs apparent. No shear zones are in evidence. No displacements visible along joints, cracks. | Any blocks or slabs are tightly interlocked with the surrounding rock and are not in danger of separating from the parent rock mass. Any displacements along shear zones, joints or cracks appear to be old, i.e. to have come about prior to the existence of the tunnel. Drummy areas are less than or equal to 1.0 ft. in diameter. | Any blocks or slabs that are not tightly interlocked with the surrounding rock are small, i.e. less than 1 ft. in diameter. Displacements along shear zones, joints or cracks have occurred since was constructed. Drummy areas are greater than 1.0 ft. in diameter. | |
| Leakage | Dry surface. | Wet surface to less than 10 drips per minute. | 10 to 30 drips per minute. | Greater than 30 drips per minute. |



| | | |
|--|-------------|--------------------|
| 9524– Shotcrete or Concrete Approach Embankment | CDOT | Units: Each |
|--|-------------|--------------------|

DESCRIPTION

Record this element for approach roadway embankment which is shotcrete or concrete leading up to the tunnel within 100 feet of the portal.

The quantity for Shotcrete or Concrete Approach Embankment is the sum of all quadrants containing shotcrete or concrete embankment within 100 feet of the portal.

PROCEDURE

COMMENTARY

Shotcrete can be largely aesthetic or structural in application. The application, intent, and substrate play large roles in the condition evaluation. Due to design and intent variations, deterioration mechanics of shotcrete differ from that of reinforced concrete. The table below reflects an evaluation criteria specific to Shotcrete.

Where it can be determined, defects related to the underlining rock properties should be noted.

All traditionally reinforced concrete sections of the element shall use the table for Concrete Tunnel Liner for condition state distribution.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---|-------------------|--|--|--|
| Delamination/ Spall/ Patched area | None | Delamination , poorly adhered shotcrete, or partial depth spall greater or equal to 2 SF. Patched or repaired area in good condition. | Delamination, poorly adhered shotcrete, or partial depth spall greater than 2 SF. Full depth spall. Patched or repaired area in poor condition. Does not warrant structural review. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel. |
| Internal Reinforcing | Not exposed | Exposed and/or corrosion is present without measurable section loss. | Corrosion is present with measurable section loss, but does not warrant structural review. | |



| | | | | |
|-----------------------------------|--|--|--|-----------------------------------|
| Rock Fall, or External, Wire Mesh | Corrosion not present, no distortion, all anchorages and attenuator cables in good condition. | Corrosion present without measurable section loss. All anchorages, attenuator cables, and linkages are sound. Minimal distortion due to rockfall. Functions as intended. | Corrosion present with measurable section loss. Insignificant linkage failure resulting in openings for rockfall less 6 inches in diameter. Anchorages, attenuator cables may be loose, but does not warrant review. | |
| Rock Bolt Distress | Bolt is in place and functioning as intended. | Loose nuts are present but the bolts are in place and functioning as intended. | Missing nuts or broken bolts but does not warrant a structural review. | |
| Efflorescence/ Rust Staining | None | Surface white without build-up or leaching without rust staining. | Heavy build-up <i>and/or</i> rust staining. | |
| Cracking | Insignificant cracks, width 0.03125 in. or less, or moderate-width cracks that have been sealed. | Unsealed moderate-width cracks, width 0.03125 - 0.0625 in., or unsealed moderate pattern (map) cracking. | Wide cracks, width greater than 0.0625 in., or heavy pattern (map) cracking. | |
| Distortion | None | Distortion not requiring mitigation or mitigated distortion. | Distortion that requires mitigation that has not been addressed but does not warrant structural review. | |
| Leakage ¹ | Dry surface | Wet surface to less than 10 drips per minute. | 10 to 30 drips per minute. | Greater than 30 drips per minute. |

¹ Leakage for this element includes water infiltrating or seeping through the element. Water passing over this element should not be included unless mitigation is needed.



| | | |
|--|-------------|--------------------|
| 9530 – Approach Traffic Barrier | CDOT | Units: Each |
|--|-------------|--------------------|

DESCRIPTION

Record this element for Approach Traffic Barriers within 100 ft of the tunnel portal.

The total quantity for Approach Traffic Barrier is the sum of all the lengths of each traffic barrier within 100 ft of the portal. This does not include barriers/rails that are part of an adjoining structure.

PROCEDURE

Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

When evaluating barriers consider CDOT approved barrier types and required effective heights. These will not impact the condition state of the element.

CONDITION STATE DEFINITIONS

For Approach Traffic Barriers constructed of steel use the defect table for 10160 – Steel Traffic Barrier.

For Approach Traffic Barriers constructed of concrete use the defect table for 10161 – Concrete Traffic Barrier.

For Approach Traffic Barriers constructed of both steel and concrete use both defect tables noted above with the corresponding material.

Use the table below for timber post defects.

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--------------------|--|--|---|--|
| Connection | Connection is in place and functioning as intended. | Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended. | Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review. | The condition warrants a structural review to determine the effect on strength or serviceability of the element; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge. |
| Decay/Section Loss | None. | Affects less than 10% of the member. | Affects 10% or more of the member but does not warrant structural review. | |
| Check/Shake | Surface penetration less than 5% of the member thickness | Penetrates 5% to 50% of the thickness of the | Penetrates more than 50% of the thickness of the member or more | |

Click to return to:

Section 3



| | | | | |
|------------------------------------|-------------------------|---|---|--|
| | regardless of location. | member and not in a tension zone. | than 5% of the member thickness in a tension zone. Does not warrant structural review. | |
| Crack (Timber) | None. | Crack that has been arrested through effective measures. | Identified crack exists that is not arrested, but does not require structural review. | |
| Split/ Delamination (Timber) | None. | Length less than the member depth or arrested with effective actions taken to mitigate. | Length equal to or greater than the member depth, but does not require structural review. | |
| Distortion | None. | Distortion not requiring mitigation or mitigated distortion. | Distortion that requires mitigation that has not been addressed but does not warrant structural review. | |
| Settlement | None. | Exists within tolerable limits or arrested with no observed structural distress. | Exceeds tolerable limits but does not warrant structural review. | |



3.4 Mechanical Systems Section

This section defines tunnel mechanical system elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

| Element Number | Element Name | Unit of Measure |
|-----------------------------|---------------------------------|-----------------|
| Ventilation Systems | | |
| 10200 | Tunnel Ventilation System | EACH |
| 10201 | Tunnel Ventilation Fan | EACH |
| 10202 | Adit Pressurization System | EACH |
| Tunnel Drainage Systems | | |
| 10300 | Drainage and Pumping Systems | EACH |
| 10301 | Pumps | EACH |
| 10310 | Waste Water Treatment System | EACH |
| 10320 | Drinking Water Treatment System | EACH |
| Emergency Generator Systems | | |
| 10400 | Emergency Generator System | EACH |
| Flood Gate | | |
| 10475 | Flood Gate | EACH |



| | | |
|-----------------------------------|------------|--------------------|
| 10200 – Ventilation System | NTI | Units: Each |
|-----------------------------------|------------|--------------------|

DESCRIPTION

Record this element for all Ventilation Systems. This element describes the components that provide the supply of fresh air to the tunnel while removing stale air and contaminants.

The total quantity for Ventilation System is the sum of all the ventilation systems.

PROCEDURE

The Ventilation System may include the following subcomponents: Fans – Fan Motors, Fan Controller, Airways, Sounds Attenuators, Dampers, Damper Motor, Damper Controller, Air Quality Monitoring Equipment (CO), Control Panels and Conduit.

Ventilation System inspection should also include a review of the maintenance records for each piece of equipment and note any special or frequent maintenance problems.

For this element, a separate Ventilation System is considered to be one system. Tunnels with twin bores may have separate ventilation systems and would be considered as two. Some tunnels may have a ventilation system at each portal that work independently and would also be considered as two.

COMMENTARY

In the event multiple ventilation systems exist which operate independently of one another, multiple quantities may be recorded for this element. In the event multiple systems are being used independently for supply and exhaust, code the system as one for acting together for the same area of roadway.

Utilize the defect table to rate the condition of each ventilation system. Utilize the sub element table to identify deficiencies which relate to the ventilation system.

Reliability is measured by percentage of time system is 100% functional over the previous 24 months. Reliability is coded as a result of meetings with operators and maintenance records of the system.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------------|--|---|---|---|
| System Condition | The system is in good condition-no notable distress. | The system is in fair condition-isolated breakdowns or deterioration. | The system is in poor condition-widespread deterioration or breakdowns reducing operational capacity, without impacting the | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is no impact on the |



| | | | | |
|---------------------------------|--|--|--|---|
| | | | serviceability of the element for tunnel. | serviceability of the element or tunnel. |
| <i>Reliability</i> | <i>> 95% of previous 24 months.</i> | <i>> 90% of previous 24 months.</i> | <i>> 75% of previous 24 months.</i> | <i>< 75% of previous 24 months.</i> |
| <i>Sub Element(s) Condition</i> | <i>Sub Elements exhibit minor deterioration or issues which do not have an effect on the system.</i> | <i>Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 which do not affect the overall serviceability of the ventilation system to the tunnel.</i> | <i>Sub Elements exhibit major deterioration which if left unattended will risk affecting serviceability of the ventilation system to the tunnel.</i> | <i>Sub Element or Elements condition affect the serviceability of the ventilation system to the tunnel.</i> |

Sub Element Table

| Sub Element | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--------------------|---|---|--|---|
| Fan | Utilize Element 10201 Condition State Table | | | |
| Airways | Ventilation airway is in good condition with no restrictions in air flow. | Ventilation airway exhibits minor deterioration with no restrictions in air flow. | Ventilation airway exhibits moderate deterioration and/or restrictions in air flow which do not affect the ability to provide adequate flow. | Ventilation airway exhibits deterioration and/or restrictions in flow which affect the serviceability of the airway to adequately ventilate the tunnel. |
| Sound Attenuators | Sound attenuator is in good condition. | Sound attenuator exhibits minor deterioration which does not affect operation. | Sound attenuator exhibits moderate deterioration which impacts operation of the sound attenuator but does not affect serviceability. | Sound attenuator condition impacts serviceability to the tunnel. |



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|---------------------------------------|---|---|--|--|
| Dampers | Damper is in good condition. Properly interlocked to fan. | Damper exhibits moderate deterioration but still operating as intended. | Damper not operating as intended but not affecting serviceability. | Damper frequently fails and impacts serviceability on the tunnel. |
| Damper Motors | None | Motor exhibits minor deterioration but operates as intended. | Motor exhibits moderate deterioration which if left unattended may impact serviceability. | Motor no longer operates and impacts serviceability. |
| Damper Controller | None. | Damper controller operates as intended with minor deterioration. | Damper controller does not operate as intended but does not impact serviceability. | Damper controller no longer operates and/or impacts serviceability. |
| Air Quality Monitoring Equipment (CO) | CO detection system is in good condition and currently calibrated per manufacturer's recommendations. | CO detection system is in fair condition which does not affect the ability to accurately read CO levels in the tunnel. System is still calibrated and working per manufacturer's recommendations. | CO detection system accurately reads CO levels in the tunnel; however, is not completely calibrated to the manufacturer's specifications or is unable to maintain calibration. | CO detection system no longer accurately measures CO levels in the tunnel. |
| Control Panels | None. | Control panel operates as intended with minor deterioration. | Control panel does not operate as intended but does not impact serviceability. | Control panel condition impacts serviceability on the tunnel. |
| Conduit | Conduits exhibit minor surface corrosion in isolated locations. | Conduits exhibit minor surface corrosion throughout with isolated locations of section loss which does not impact serviceability. | Conduits exhibit corrosion with section loss in more than 40% of the conduit, perforations or breaks present. Corrosion does not affect serviceability. | Conduit condition impacts serviceability of the ventilation system. |





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|---------------------|------------|--------------------|
| 10201 – Fans | NTI | Units: Each |
|---------------------|------------|--------------------|

DESCRIPTION

Record this element for all Fans. This element describes the components that produce a current of air which provides the supply of fresh air to the tunnel while removing stale air and contaminants.

The total quantity for fans is the sum of all the Fans.

PROCEDURE

The fans may include the following subcomponents: Fan Motors, Fan Controller, etc.

COMMENTARY

Utilize the defect table to rate the condition of each Fan. Utilize the sub element table to identify deficiencies which relate to the Fan.

Fan reliability is measured by percentage of time a Fan is 100% functional over the previous 24 months.

CONDITION STATE DEFINITIONS

| Equipment | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--|--|--|---|--|
| Fan Operation (includes fan belt, fan chain, fan bearing temperature and/or fan drive temperature) | Operates on all speeds and in all modes with no noticeable temperature rise. | Operates on all speeds and in all modes. Requires manual restart or manual control to achieve this. Drive(s) require some adjustment. More than normal play observed. (If belt – minor wear/deterioration to belt.) Less than 40 degree F temperature rise form ambient temperatures during <i>stable</i> operation. | Fan operates on at least one speed or only operates in manual mode. Drive(s) require major adjustment. Severe play and/or belt/chain noise is observed. (If belt – moderate wear/deterioration to belt.) Between 40 degree F and 80 degree F temperature rise form ambient temperatures during operation. | Fan will not operate on any speed. Over 80 degree F temperature rise form ambient temperatures during operation. |



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| Fan Condition | No notable distress | Isolated breakdowns or deterioration | The fan is in poor condition-widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel. | The fan warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel. |
| Reliability | > 95% of previous 24 months. | > 90% of previous 24 months. | > 75% of previous 24 months. | < 75% of previous 24 months. |
| Sub Element(s) Condition | Sub Elements exhibit minor deterioration or issues which do not have an effect on the system. | Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 which do not affect the overall serviceability of the ventilation system to the tunnel. | Sub Elements exhibit major deterioration which if left unattended will risk affecting serviceability of the ventilation system to the tunnel. | Sub Element or Elements condition affect the serviceability of the ventilation system to the tunnel. |

Sub Element Table

| Sub Element | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|----------------|--|---|---|---|
| Fan Motor | The motor is in good condition. Operates on all speeds and in all modes with no noticeable temperature rise. | The motor is in fair condition. Operates on all speeds and in all modes. Requires manual restart or manual control to achieve this. Drive(s) require some adjustment. | The motor is in poor condition. Operates on at least one speed or only operates in manual mode. | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel. |
| Fan Controller | Fan Controller is in good condition. Operates on all speeds and in all modes. | Controller is in fair condition. Operates on all speeds and in all modes. Requires manual restart or | Controller is in poor condition. Operates on at least one speed or only | Controller frequently fails and impacts serviceability on the fan. |

Click to return to:

Section 3



| | | manual control to achieve this. | operates in manual mode. | |
|----------------------------|--|--|--|---|
| Fan Drive | The drive is in good condition. Operates on all speeds and in all modes with no noticeable vibration or oil leakage. | The drive exhibits minor deterioration; leakage and/or vibrations; however, still provides adequate drive to the fan. | The drive exhibits moderate deterioration, leakage, and/or vibrations; belt is at risk of major breakdown. Further deterioration may impact serviceability of the fan. | Fan drive condition impacts serviceability on the tunnel or has failed. |
| Fan Wheel and Fan Bearings | The fan wheel and bearings are in good condition. | Fan wheel and bearings exhibit minor deterioration, leakage, or vibrations within tolerance. Deterioration is not affecting safe operation of the fan. | Fan wheel and bearings exhibit moderate deterioration, leakage, or vibrations which are outside tolerance. Deterioration if left unattended may impact serviceability. | Fan wheel and bearing condition impact serviceability of the fan. |
| Fan Housings | The fan housing is in good condition. | Fan housing exhibits minor deterioration which does not pose a threat to the safe operation of the fan. | Fan housing exhibits moderate deterioration, extent of which does not affect serviceability of the fan but poses a threat to safe operations. | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel. |
| Fan Base/Supports | The fan base or support is in good condition. | Fan base and/or support are in fair condition with minor deterioration which does not affect fan stability. | Fan base and/or support exhibits moderate deterioration which poses a risk to fan stability. | Fan base and/or support deterioration affects fan stability. The condition warrants evaluation to determine the effect on |



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| | | | | serviceability of the element or tunnel. |
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| 10202 – Adit Pressurization System | CDOT | Units: Each |
|---|-------------|--------------------|

DESCRIPTION

Record this element for all Adit Pressurization Systems. This element describes the components that increase the pressure in an adit egress pathway which prevents smoke from entering the adit via the tunnel.

The total quantity for Adit Pressurization Systems the sum of all the systems.

PROCEDURE

The Adit Pressurization System may include subcomponents.

COMMENTARY

Utilize the defect table to rate the condition of each Adit Pressurization System. Utilize the sub element table to identify deficiencies which relate to the Adit Pressurization System.

System reliability is measured by percentage of time the system is 100% functional over the previous 24 months.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--------------------------|---|---|---|--|
| Operation | Fan and damper fully operational. | Fan and damper fully operational but requiring minor repairs or adjustments. | Fan and damper fully operational but requiring major repairs or adjustments. | Fan or damper will not operate. System not available. |
| Reliability | > 95% of previous 24 months. | > 90% of previous 24 months. | > 75% of previous 24 months. | < 75% of previous 24 months. |
| Sub Element(s) Condition | Sub Elements exhibit minor deterioration or issues which do not have an effect on the system. | Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 which do not affect the overall serviceability of the system to the tunnel. | Sub Elements exhibit major deterioration which if left unattended will risk affecting serviceability of the system to the tunnel. | Sub Element or Elements condition affect the serviceability of the system to the tunnel. |

Sub Element Table

| Sub Element | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
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|-------------|-------------------|-------------------|-------------------|-------------------|

Click to return to:

Section 3



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|------------------------------|--|--|--|--|
| Adit Pressurization Fan | No notable distress | Isolated breakdowns or deterioration | The system is in poor condition-widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel. | The fan warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel. |
| Adit Pressurization Damper | Damper is in good condition. Properly interlocked to fan. | Damper exhibits moderate deterioration but still operating as intended. | Damper not operating as intended but not affecting serviceability. | Damper frequently fails and impacts serviceability on the tunnel. |
| Adit Pressurization Ductwork | Ductwork exhibits minor surface corrosion in isolated locations. | Ductwork exhibits minor surface corrosion throughout with isolated locations of section loss which does not impact serviceability. | Ductwork exhibits corrosion with section loss in more than 40% of the conduit, perforations or breaks present. Corrosion does not affect serviceability. | Ductwork condition impacts serviceability of the adit system. |



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| 10300 – Drainage and Pumping System | NTI | Units: Each |
|--|------------|--------------------|

DESCRIPTION

Record this element for all draining and pumping systems. This element includes storm drains, piping, pumps and water treatment equipment for the removal of water that may enter the tunnel from the portals, vent shafts, and cracks in the tunnel lining. Drainage at the tunnel facility also handles the drippings from vehicles traversing the tunnel and potential spills from trucks hauling liquid materials.

The total quantity for draining and pumping system is the sum of all the draining and pumping systems.

PROCEDURE

The Drainage and Pumping System may include the following subcomponents: Pumps – Sump Pumps, Pump Motors, Pump Controller, Piping, Drains, and Water Treatment Equipment.

For this element, a separate Drainage and Pumping System is considered to be one system. Tunnels with twin bores may have separate draining and pumping systems and would be considered as two. Some tunnels may have a Draining and Pumping System at each portal that work independently and would also be considered as two.

COMMENTARY

For the Drainage and Pumping System, the number of systems is equal to the number of primary drainage collection lines which may include roadway collection, seep collection, or other.

Pumps or series of pumps which are not required to evacuate roadway runoff from the bore may be considered as a singular system.

Utilize the defect table to rate the condition of each Drainage and Pumping System. Utilize the sub element table to identify deficiencies which relate to the Drainage and Pumping System.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------------|---|--|--|--|
| System Condition | The system is in good condition- no notable distress. | The system is in fair condition -isolated breakdowns or deterioration. | The system is in poor condition – widespread deterioration or breakdowns reducing capacity, without impacting the serviceability of the element or tunnel. | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel. |



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|-------------------------------------|--|--|--|---|
| <i>Sub Element(s) Condition</i> | <i>Sub Elements exhibit minor deterioration or issues which do not have an effect on the system.</i> | <i>Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 which do not affect the overall serviceability of the ventilation system to the tunnel.</i> | <i>Sub Elements exhibit major deterioration which if left unattended will risk affecting serviceability of the ventilation system to the tunnel.</i> | <i>Sub Element or Elements condition affect the serviceability of the ventilation system to the tunnel.</i> |
|-------------------------------------|--|--|--|---|

Sub Element Table

| Sub Element | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------------------------|--|--|--|--|
| Pumps | Utilize Element 10301 Condition State Table | | | |
| Waste Water Treatment System | Utilize Element 10310 Condition State Table | | | |
| Drinking Water Treatment System | Utilize Element 10320 Condition State Table | | | |
| Roadway Drains | Few or most drains exhibit minor debris with no loss of flow capacity. | Few drains exhibit debris which impedes on flow capacity, locations of drains are not in close proximity. | Few drains exhibit debris which impedes on flow capacity, locations of drains are within close proximity; however, does not affect serviceability. | Condition of roadway drains affects the serviceability of the structure. |
| Piping | Piping is in good condition. | Piping exhibits minor deterioration and/or minor surface corrosion with areas of isolated section loss or minor leaks. | Piping exhibits moderate deterioration and/or corrosion with section loss, with larger areas of leaking; not affecting serviceability. | Piping condition affects serviceability of the tunnel or is the extent which causes severe damage to other critical tunnel elements. |



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| 10301 – Pumps | NTI | Units: Each |
|----------------------|------------|--------------------|

DESCRIPTION

Record this element for all Pumps. This element includes the component that moves water that may enter the tunnel from the portals, vent shafts, and cracks in the tunnel lining.

The total quantity for Pumps is the sum of all the pumps.

PROCEDURE

The Pumps may include the following subcomponents: Sump Pumps, Pump Motors, Pump Controller, etc.

COMMENTARY

Utilize the defect table to rate the condition of each Pump. Utilize the sub element table to identify deficiencies which relate to the Pump.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--|--|--|---|--|
| Pump Operation (Includes Sump Pump, Pump Motor, Pump Controller, Pump Control Panel, Oil Leakage, Pump Leakage, Noise and Vibration and Temperature) | Operates at all speeds and in all modes. Shut-off valves operate freely and without binding. Fair amount of noise and vibration velocity of 100 in./s or less. No oil leakage observed at pump seal. No water leakage noted in immediate piping and valves. Motor temperature is within expected limits. | Operates at all speeds and in all modes in a reduced capacity. Shut-off valves operate with some resistance and binding but do not appear to fully open/seal. Slightly rough noise and vibration velocity between 100 and 300 in./s. Limited exterior staining from oil seepage at seals. Limited exterior water seepage from seals with seals appearing wet. Motor temperature is slightly increased during motor operation | Operates intermittently or haltingly. Shut-off valves difficult or impossible to operate. Rough noise and vibration velocity in excess of 300 in./s. Extensive exterior staining from oil seepage at seals. Measurable water seepage around that can be quantified in drips per minute. Motor temperature is moderately above what is expected and/or hot spots of temperature exist. | Pump will not operate. Pooling of oil on exterior surfaces of seals or significant reduction of interior lubricant level. A visible stream of water on exterior surfaces of seals or significant reduction of pump performance. Motor temperature is drastically increased and motor function is influenced. |
| <i>Reliability</i> | <i>> 95% of previous 24 months.</i> | <i>> 90% of previous 24 months.</i> | <i>> 75% of previous 24 months.</i> | <i>< 75% of previous 24 months.</i> |

Click to return to:

Section 3



| | | | | |
|-------------------------------------|--|--|--|---|
| <i>Sub Element(s) Condition</i> | <i>Sub Elements exhibit minor deterioration or issues which do not have an effect on the system.</i> | <i>Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 which do not affect the overall serviceability of the ventilation system to the tunnel.</i> | <i>Sub Elements exhibit major deterioration which if left unattended will risk affecting serviceability of the ventilation system to the tunnel.</i> | <i>Sub Element or Elements condition affect the serviceability of the ventilation system to the tunnel.</i> |
|-------------------------------------|--|--|--|---|

Sub Element Table

| Sub Element | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-----------------|--|--|---|---|
| Sump Pumps | Utilize Element 10301 Condition State Table | | | |
| Pump Motors | Motor is in good condition with no signs of distress, operates on all speeds, and operating temperature is within expected limits. | Motor operates on all speeds in a reduced capacity and motor temperature is slightly above the expected limits with minor leakage; corrosion or mineral buildup. | Motor operates intermittently or haltingly at temperatures moderately to severely above expected limits and/or moderate to severe: leakage; corrosion or mineral buildup. | The motor temperature has drastically increased and motor function is permanently influenced. Major re-build or replacement is required. |
| Pump Controller | Controller is in good condition with no signs of distress. Electronic/Electrical components function within expected limits. No moisture or corrosion. | Controller is in fair condition. Electronic/Electrical components function at a slightly reduced capacity requiring occasional re-set or adjustment. | Controller is in poor condition. Electronic/Electrical components function at moderate to severe reduced capacity requiring frequent re-sets or adjustments or moderate to severe moisture or corrosion in present. | The controller is no longer capable to send signals to the pump. Electronic/Electrical components exhibit severe evidence of: arcing; moisture; corrosion; discoloration; short circuit. Major re-build or replacement is required. |
| Sump Pit | The pit is in good condition exhibiting no signs of distress. | The pit is in fair condition exhibiting minor signs of | The pit is in poor condition exhibiting moderate to severe | The pit has failed and can no longer house a pump. Major re- |



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| | Sidewalls are sound, free of debris and mineral, and inlet ports are free and open. | distress. Minor signs of: sidewall deterioration; debris or mineral build-up; occasional inlet port clogging. | signs of: sidewall deterioration; debris or mineral build-up; frequent inlet clogging. | construction or replacement is required. |
| Discharge Pumping | Discharge pumping is in good condition showing no visible signs of distress. Pumps operate within expected limits and outlets are free of debris or restriction. | Discharge pumping is in fair condition. Pumps operate on all speeds in a reduced capacity or outlets exhibit minor buildup of debris /restriction. | Discharge pumping is in poor condition. Pumps operate intermittently or haltingly at moderately to severe temperature and/ or outlets exhibit moderate to severe buildup of debris/restriction. | Pumping discharge has failed. Pump failure and/or outlet failure has occurred. Discharge pumping cannot be performed. Major re-build or replacement is required |



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|---|-------------|--------------------|
| 10310 – Waste Water Treatment System | CDOT | Units: Each |
|---|-------------|--------------------|

DESCRIPTION

This element describes systems which treat waste water prior to discharge from the tunnel.

PROCEDURE

The total quantity for Waste Water Treatment System is the sum of all waste water treatment plants.

COMMENTARY

This element is not intended to quantify raw water treatment systems. As of the issuance of this manual, the only Waste Water Treatment System is inventoried with the Eisenhower Tunnel.

Utilize the defect table to rate the condition of each Waste Water Treatment System. Utilize the sub element table to identify deficiencies which relate to the Waste Water Treatment System.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--------------------------|---|---|---|--|
| System Condition | The system is in good condition- no notable distress. | The system is in fair condition – isolated breakdowns or deterioration. | The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity without impacting the serviceability of the element or tunnel. | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel. |
| Discharge Regulations | The system operates to design standards achieving full compliance of discharge permit requirements. | The system operates to design standards with infrequent permit violations (<3 per yr.) attributed to system deficiency. | The system inconsistently operates to design standards. Frequent permit violations (>3 per yr. and <6 per yr.) attributed to system deficiency and/or verifiable concerns achieving future permit requirements. | The system does not operate to design standards and/or repeated (>6 per yr.) permit violations or plant shut downs attributed to system deficiency. |
| Sub Element(s) Condition | Sub Elements exhibit minor deterioration | Sub Elements exhibit major deterioration | Sub Elements exhibit major deterioration | Sub Element or Elements condition |

Click to return to:

Section 3



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| | or issues which do not have an effect on the system. | with one or multiple elements in Condition State 3 which do not affect the overall serviceability of the ventilation system to the tunnel. | which if left unattended will risk affecting serviceability of the ventilation system to the tunnel. | affect the serviceability of the ventilation system to the tunnel. |
|--|--|--|--|--|

Sub Element Table

| Sub Element | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------------------------|--|--|--|--|
| Oil Water Separators | Oil/Water Separator is in good condition, consistently removing floating oil and lubricants from collected water prior to discharge. | Oil/Water Separator is in fair condition exhibiting minor breakdowns in removing floating oil and lubricants from collected water prior to discharge. | Oil/Water Separator is in poor condition exhibiting moderate to severe breakdowns in removing floating oil and lubricants from collected water prior to discharge. | Oil/Water Separator has failed. The separation process is no longer performed and major re-build or replacement is required. |
| Hydrocarbon Detection System | Detector is in good condition showing no signs of distress. Consistently detects accurate samples of hydrocarbon presence. | Detector in in fair condition showing minor signs of distress affecting the ability to consistently detect accurate samples and/or occasionally requires re-calibration to meet manufacturer's specifications. | Detector is in poor condition showing moderate to severe signs of distress frequently affecting the ability to perform accurate detection and/or requires frequent calibration to meet manufacturer's recommendations. | Detector has failed. Major re-build or replacement is required. |



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|---------------------------------------|-------------|--------------------|
| 10320 – Water Treatment System | CDOT | Units: Each |
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DESCRIPTION

This element describes systems which treat raw water in accordance with EPA and CDPHE for human consumption.

PROCEDURE

The total quantity for Water Treatment System is the sum of all the raw Water Treatment Systems.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------------|---|---|--|--|
| System Condition | The system is in good condition- no notable distress. | The system is in fair condition – isolated breakdowns or deterioration. | The system is in poor condition – widespread deterioration or breakdowns reducing the capacity without impacting the serviceability of the element or tunnel. | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel. |
| Regulations | The system operates to design standards achieving full compliance of CDPHE permit requirements. Fresh water is readily available. | The system operates to design standards with infrequent (<3 per yr.) CDPHE permit violations attributed to system deficiency. Fresh water is infrequently (<3 per yr.) unavailable. | The system inconsistently operates to design standards with frequent (<3_>6 per yr.) CDPHE permit violations attributed to system deficiency and/or verifiable concerns achieving future permit requirements. Fresh water is frequently (>3 per yr. and <6 per yr.) unavailable. | The system does not operate to design standards and/or repeated (>6 per yr.) permit violations or plant shut downs attributed to system deficiency. Fresh water is repeatedly (>6 per yr.) unavailable |



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|---|------------|--------------------|
| 10400 – Emergency Generator System | NTI | Units: Each |
|---|------------|--------------------|

DESCRIPTION

Record this element for all Emergency Generator Systems. These elements are the mechanical components of an emergency generator and power system which consist of fuel delivery, fuel storage, an engine cooling and exhaust systems. The emergency generator provides a back-up power source in the event of utility service failure to the tunnel. The mechanical systems support the proper operation of the generator to provide back-up power.

The total quantity for emergency generator is the sum of all the Emergency Generator Systems.

PROCEDURE

The Emergency Generator System may include the following subcomponents: Fuel Main Storage Tank, Fuel Day Tanks, Circulating Fuel Pumps, Fuel Tank Venting, Fuel Tank Sensors, Coolant Systems, Exhaust Manifold Insulation and Lagging, Exhaust Air Louver and Damper Actuator, Supply Air Louver and Damper Actuator, Generator, Generator Control Equipment, Control Panels, and Conduit.

For this element, a separate Emergency Generator System is considered to be one system. Tunnels with twin bores may have separate Emergency Generator Systems and would be considered as two.

COMMENTARY

*The intent of this element is to evaluate the condition of the **mechanical components only**. Evaluation of capacity and connection to electrical distribution is important and should be addressed within the commentary, Emergency Distribution System, and with appropriate Asset Recommendations.*

The total quantity to be inventoried is the number of generators that do not function in tandem. Generators connected in parallel would be considered one system. All components are to be evaluated regardless of parallel or series design.

If a system or sub-element is shared between multiple bores with different Tunnel Numbers, assign it to the bore it most belongs. Do not double count elements. Clarify within the report how elements and sub-elements are assigned and which are shared.

Utilize the defect table to rate the condition of each Emergency Generator System. Utilize the sub element table to identify deficiencies which relate to the Waste Water Treatment System.

System reliability is measured by percentage of time a generator system is 100% functional over the previous 24 months.

CONDITION STATE DEFINITIONS

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|------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Equipment | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------------|--------------------------|--------------------------|--------------------------|--------------------------|



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|---------------------------------|---|---|--|--|
| System Condition | The system is in good condition – no notable distress. | The system is in fair condition – isolated breakdowns or deterioration. | The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel. | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel. |
| <i>Reliability</i> | <i>100% of previous 24 months.</i> | <i>> 98% of previous 24 months.</i> | <i>> 95% of previous 24 months.</i> | <i>< 95% of previous 24 months.</i> |
| <i>Sub Element(s) Condition</i> | Sub Elements exhibit minor deterioration or issues which do not have an effect on the system. | Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 which do not affect the overall serviceability of the system to the tunnel. | Sub Elements exhibit major deterioration which if left unattended will risk affecting serviceability of the system to the tunnel. | Sub Element or Elements condition affect the serviceability of the system to the tunnel. |

Sub Element Table

| Sub Element | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------|---|--|---|---|
| Fuel System | The system is in good condition-no notable distress-system operates when normal power fails | The system is in fair condition-minor surface corrosion of the lines or tanks-no fuel leaks-system has isolated breakdowns when normal power fails | The system is in poor condition-widespread breakdowns - moderate to severe surface corrosion to the lines or tanks-fuel leaks are imminent without corrective measures -does not impact the serviceability of the element or tunnel | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel |

Click to return to:

Section 3



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| Coolant Systems | The system is in good condition-no notable distress | The system is in fair condition with isolated breakdowns or engine overheating - minor leakage | The system is in poor condition – widespread breakdowns or frequent engine overheating-moderate to severe leakage without impacting the serviceability of the element or tunnel | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel |
| Exhaust Manifold Insulation and Lagging | Material is in good condition-no notable distress | Material is in fair condition – isolated areas are loose or unraveled | The material is in poor condition – widespread areas of the exhaust are bare of insulation without impacting the serviceability of the element or tunnel | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel |
| Exhaust Air Louver and Damper Actuator | Louver and Actuator are in good condition- no notable distress | Louver and Actuator are in fair condition – minor surface corrosion and isolated breakdowns | Louver and Actuator are in poor condition – moderate to severe corrosion with widespread breakdowns without impacting the serviceability of the element or tunnel | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel |
| Supply Air Louver | Louver is in good condition – no notable distress | Louver is in fair condition – minor surface corrosion | Louver is in poor condition – moderate to severe surface corrosion – missing bird screen-gaps between wall and louver without | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation |



| | | | | |
|-----------------------------|---|--|--|---|
| | | | impacting the serviceability of the element or tunnel | has determined there is an impact on the serviceability of the element or tunnel |
| Generator/Motor | Motor is in good condition – no notable distress – operates under full load as designed | Motor is in fair condition – minor leakage – minor hot spots – occasionally requires more than one start attempt – occasionally fails to maintain full design load | Motor is in poor condition – moderate to severe leakage – moderate to severe hot spots – frequently requires more than one start attempt – frequently fails to maintain full design load without impacting the serviceability of the element or tunnel | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel |
| Generator Control Equipment | Control equipment is in good condition – no notable distress | Control equipment is in fair condition – occasionally fails to energize the generator on first attempt or requires occasionally manual transfer | Control equipment is in poor condition – frequently fails to energize the generator on first attempt or requires frequent manual transfer | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel |
| Control Panels and Conduit | Control panels and conduit are in good condition – no notable distress | Control panels are in fair condition – minor evidence of overheating, arcing, or discoloration of components. | Control panels and conduit are in good condition – no notable distress | Control panels are in fair condition – minor evidence of overheating, arcing, or discoloration of components. |



| | | |
|---------------------------|------------|--------------------|
| 10475 – Flood Gate | NTI | Units: Each |
|---------------------------|------------|--------------------|

DESCRIPTION

Record this element for all Flood Gates. These elements are actual gates, seals, mechanical components, and power supply of a Flood Gate system. The Flood Gates are typically located at each portal for each bore. The Flood Gates are usually used when the tunnel roadway is closed and the bores are threatened with taking on water at the portals.

The quantity is the sum of all the Flood Gates.

PROCEDURE

For this element, a separate Flood Gate is considered to be one gate. Some tunnels may have a Flood Gate at each portal that work independently and would be considered as two.

COMMENTARY

There are no Flood Gates in the state of Colorado at the issuance of this manual.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------------|--|---|--|--|
| System Condition | The system is in good condition – no notable distress. | The system is in fair condition – isolated breakdowns or deterioration. | The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel. | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel. |



3.5 Electrical and Lighting Systems Section

This section defines tunnel electrical systems elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

| Element Number | Element Name | Origin | Unit of Measure |
|--------------------------------|--|--------|-----------------|
| Electrical Distribution | | | |
| 10500 | Electrical Distribution System | NTI | EACH |
| 10501 | Incoming Power Regulators | CDOT | EACH |
| 10502 | Primary Transformers | CDOT | EACH |
| 10503 | Switchgear | CDOT | EACH |
| 10504 | Motor Control and Distribution Centers | CDOT | EACH |
| Emergency Distribution | | | |
| 10550 | Emergency Distribution System | NTI | EACH |
| Tunnel Lighting | | | |
| 10600 | Tunnel Lighting Systems | NTI | EACH |
| 10601 | Tunnel Lighting Fixtures | NTI | EACH |
| Emergency Lighting | | | |
| 10620 | Emergency Lighting Systems | NTI | EACH |
| 10621 | Emergency Lighting Fixtures | NTI | EACH |



| | | |
|---|------------|--------------------|
| 10500 – Electrical Distribution System | NTI | Units: Each |
|---|------------|--------------------|

DESCRIPTION

Record this element for all Electrical Distribution Systems. The Electrical Distribution System consists of the electrical equipment, wiring, conduit, and cable used for distributing electrical energy from the utility supply (service entrance) to the line terminals of utilization equipment.

The total quantity for Electrical Distribution System is the sum of all the Electrical Distribution Systems.

PROCEDURE

The Electrical Distribution System may include the following subcomponents: Switchgear, Unit Substations, Switchboard, Motor Control Centers, Starters, Transformers, Transfer Switches, Panelboards, Conduits and Raceways, and Electrical Outlets/Receptacles.

For this element, a separate Electrical Distribution System is considered to be one system. Tunnels with twin bores may have separate Electrical Distribution Systems and would be considered as two.

COMMENTARY

If a system or sub-element is shared between multiple bores with different Tunnel Numbers, assign it to the bore it most belongs. Do not double count elements. Clarify within the report how elements and sub-elements are assigned and which are shared.

Inspectors are to inspect all conduit, conduit supports, junction boxes, etc. located within the tunnel bore(s) associated with this element to ensure safety of the traveling public.

For this element, it is not just the equipment condition/functionality that controls the condition state rating. It can be governed by the physical condition of the system components such as conduit and/or wiring/cable associated with the Electrical Distribution System.

Utilize the defect table to rate the condition of each Electrical Distribution System. Utilize the sub element table to identify deficiencies which relate to the Electrical Distribution System.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------------|--|---|---|---|
| System Condition | The system is in good condition – no notable distress. | The system is in fair condition – isolated breakdowns or deterioration. | The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the |



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|---------------------------------|--|--|--|---|
| | | | serviceability of the element or tunnel. | serviceability of the element or tunnel. |
| <i>CDOT Guidance</i> | <i>System is fully operational and compatible with all tunnel elements.</i> | <i>System is operational with infrequent failures to elements but not affecting tunnel serviceability and compatible with all tunnel elements.</i> | <i>System is operational with frequent failures starting to affect serviceability and compatible with all life safety systems.</i> | <i>System frequently fails resulting in loss of distribution to elements. Not compatible with one or more life safety elements.</i> |
| <i>Sub Element(s) Condition</i> | <i>Sub Elements exhibit minor deterioration or issues which do not have an effect on the system.</i> | <i>Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 which do not affect the overall serviceability of the system to the tunnel.</i> | <i>Sub Elements exhibit major deterioration which if left unattended will risk affecting serviceability of the system to the tunnel.</i> | <i>Sub Element or Elements condition affect the serviceability of the system to the tunnel.</i> |

Sub Element Table

| Sub Element | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------------------|--|--|---|---|
| Incoming Power Regulators | Utilize Element 10501 Condition State Table | | | |
| Primary Transformers | Utilize Element 10502 Condition State Table | | | |
| Switchgear | Utilize Element 10503 Condition State Table | | | |
| Motor Control Centers | Utilize Element 10504 Condition State Table | | | |
| Secondary Transformers | Transformers are in good condition, no notable distress. | Transformers exhibit minor deterioration and wear, not resulting in power failure. | Transformers exhibit moderate deterioration and wear, possibly resulting in isolated power failures but tunnel power is active. | Transformers warrant evaluation to determine the effect on serviceability of the tunnel elements. No longer provides adequate power supply to tunnel. |



| | | | | |
|-------------------|---|---|---|--|
| Switchboard | Switchboard is in good condition exhibiting no signs of distress while providing consistent current distribution to electrical control equipment. | Switchboard is in fair condition exhibiting minor breakdowns when providing current distribution to electrical control equipment. Minor overheating and/or minor repairs or adjustments required. | Switchboard is in poor condition exhibiting moderate to severe breakdowns when providing current distribution to the electrical control equipment. Moderate to severe overheating and/or major repairs or adjustments are required. | The switchboard has failed. Major re-build or replacement is required. |
| Starters | The starter is in good condition exhibiting no signs of distress while providing consistent motor starts. | The starter is in fair condition exhibiting minor breakdowns when providing motor starts. Minor overheating and/or minor repairs or adjustments required. | The starter is in poor condition exhibiting moderate to severe breakdowns when providing motor starts. Moderate to severe overheating and/or major repairs or adjustments are required. | The starter has failed. Major re-build or replacement is required. |
| Transfer Switches | The switch is in good condition exhibiting no signs of distress while consistently initiating emergency power when primary power is lost and initiating emergency power shut down when primary power is regained. | The switch is in fair condition exhibiting minor breakdowns when transferring power. Minor overheating and/or minor repairs and or adjustments required. | The switch is in poor condition exhibiting moderate to severe breakdowns when transferring power. | The switch has failed. Major re-build or replacement is required. |
| Panelboards | The panel board is in good condition exhibiting no signs | The panel board is in fair condition exhibiting minor | The panel board is in poor condition exhibiting | The panel board has failed. Major re-build or |



| | | | | |
|--------------------------|--|--|--|---|
| | of distress while consistently distributing electrical power into separate circuits. | breakdowns while distributing electrical power into separate circuits. Minor overheating and/or occasional resets required. | moderate to severe breakdowns while distributing electrical power into separate circuits. Moderate to severe overheating and/or frequent resets required. | replacement is required. |
| Conduits and Raceways | The conduit and/or supports are in good condition exhibiting no signs of distress. | The conduit and/or supports are in fair condition. Exhibits minor: surface corrosion, loose supports, gaps or sags at the end joint. | The conduit and/or supports are in poor condition exhibiting moderate to severe: surface corrosion, loose supports, gaps or sags at the end joint, exposed wire. | The conduit and/or supports have failed affecting safety and serviceability of the element. Major repairs or replacement is required. |
| Electrical Incoming Line | Line is in good condition, no deficiencies. | Line is in fair condition with minor deterioration which has not led to loss of power to tunnel. | Line is in poor condition with moderate deterioration which has led to isolated failures but tunnel power is still active. | Incoming line frequently fails resulting in loss to tunnel power. |



| | | |
|---|-------------|--------------------|
| 10501 – Incoming Power Regulator | CDOT | Units: Each |
|---|-------------|--------------------|

DESCRIPTION

This element describes the device that regulates the voltage of incoming electrical power to the tunnel. The total quantity for voltage regulator is the sum of all the Incoming Power Regulators.

PROCEDURE

COMMENTARY

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------------|--|---|--|--|
| System Condition | The system is in good condition – no notable distress. No voltage fluctuations to electrical system. | The system is in fair condition – isolated breakdowns or deterioration. Minor voltage fluctuation to the electrical system. | The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel. Moderate voltage fluctuations to the electrical system. | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel. Severe voltage fluctuations that compromise other safety systems. |



| | | |
|-------------------------------------|-------------|--------------------|
| 10502 – Primary Transformers | CDOT | Units: Each |
|-------------------------------------|-------------|--------------------|

DESCRIPTION

This element describes the device that transforms incoming electrical power into voltages for distribution. The total quantity for Primary Transformers is the sum of all transformers.

PROCEDURE

COMMENTARY

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------------|--|--|---|---|
| System Condition | Transformers are in good condition, no notable distress. | Transformers exhibit minor deterioration and wear, not resulting in power failure. | Transformers exhibit moderate deterioration and wear, possibly resulting in isolated power failures but tunnel power is active. | Transformers warrant evaluation to determine the effect on serviceability of the tunnel elements. No longer provides adequate power supply to tunnel. |



| | | |
|---------------------------|-------------|--------------------|
| 10503 – Switchgear | CDOT | Units: Each |
|---------------------------|-------------|--------------------|

DESCRIPTION

This element describes the devices that provide electrical protection and distribution.

The total quantity for electrical incoming Switchgear is the sum of all Switchgear.

PROCEDURE

COMMENTARY

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------------|--|---|---|--|
| System Condition | The system is in good condition – no notable distress. | The system is in fair condition – isolated breakdowns or deterioration and/or replacement components are readily available. | The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel and/or replacement components are difficult to obtain | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel and/or replacement components are unavailable. |



| | | |
|---|-------------|--------------------|
| 10504 – Motor Control and Distribution Centers | CDOT | Units: Each |
|---|-------------|--------------------|

DESCRIPTION

This element describes the devices that distribute power through the bus bars and wiring.

The total quantity for Motor Control Center and Distribution Centers is the sum of Motor Control Center and Distribution Centers.

PROCEDURE

COMMENTARY

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------------|---|---|--|---|
| System Condition | The system is in good condition – no notable distress | The system is in fair condition – isolated breakdowns or deterioration and/or replacement components are readily available <i>System exhibits minor heat conditions above expected limits and/or occasional fan failure requiring MCC re-set and/or calibration.</i> | The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel and/or replacement components are difficult to obtain <i>Breaker, contactors or control power transformers exhibit moderate to severe heat conditions above expected limits and/or frequent fan failure requiring MCC re-set or major re-calibration.</i> | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel and/or replacement components are unavailable. <i>System has failed requiring major re-build or replacement.</i> |



| | | |
|--|------------|--------------------|
| 10550 – Emergency Distribution System | NTI | Units: Each |
|--|------------|--------------------|

DESCRIPTION

Record this element for all Emergency Distribution Systems. This system consists of the electrical equipment, wiring, conduit, and cable used for providing electrical power in case of utility service failure. Equipment included in this system consists of emergency generators and/or uninterruptible power supply (UPS) systems, transfer switches, and other equipment supplying emergency power.

The total quantity for Emergency Distribution System is the sum of all the Emergency Distribution Systems.

PROCEDURE

The Emergency Distribution System may include the following subcomponents: Uninterruptible Power Supply (UPS), batteries and battery charging equipment.

For this element, a separate Emergency Distribution System is considered to be one system. Tunnels with twin bores may have separate Emergency Distribution Systems and would be considered as two.

COMMENTARY

For the Emergency Distribution System, the number of systems is the number of systems that function independently, this may be a combination of UPS and generators. When an automatic transfer switch links the systems powered by the UPS to the generator(s) once running, this combination shall be considered a single system.

If a system or sub-element is shared between multiple bores with different Tunnel Numbers, assign it to the bore it most belongs. Do not double count elements. Clarify within the report how elements and sub-elements are assigned and which are shared.

Inspectors are to inspect all conduit, conduit supports, junction boxes, etc. located within the tunnel bore(s) associated with this element to ensure safety of the traveling public.

For this element, it is not just the equipment condition/functionality that controls the condition state rating. It can be governed by the physical condition of the system components such as conduit and/or wiring/cable associated with the Emergency Distribution System.

Utilize the defect table to rate the condition of each Emergency Distribution System. Utilize the sub element table to identify deficiencies which relate to the Emergency Distribution System.

CONDITION STATE DEFINITIONS

| | | | | |
|---------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------|--------------------------|--------------------------|--------------------------|--------------------------|



| | | | | |
|---------------------------------|--|--|--|--|
| System Condition | The system is in good condition – no notable distress. | The system is in fair condition – isolated breakdowns or deterioration. | The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel. | The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, impacting the serviceability of the element or tunnel. |
| <i>Sub Element(s) Condition</i> | <i>Sub Elements exhibit minor deterioration or issues which do not have an effect on the system.</i> | <i>Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 which do not affect the overall serviceability of the system to the tunnel.</i> | <i>Sub Elements exhibit major deterioration which if left unattended will risk affecting serviceability of the system to the tunnel.</i> | <i>Sub Element or Elements condition affect the serviceability of the system to the tunnel.</i> |

Sub Element Table

| Sub Element | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------------------------------|---|--|--|---|
| Uninterruptable Power Supply (UPS) | The UPS is in good condition exhibiting no noticeable distress when providing backup power. | The UPS is in fair condition. Exhibits minor breakdowns when providing backup power. | The UPS is in poor condition. Exhibits moderate to severe breakdowns requiring frequent repairs when providing backup power. | The UPS has failed. Requires major re-build or replacement. |
| Battery System | The battery is in good condition exhibiting no noticeable distress when providing DC power. | The battery is in fair condition exhibiting minor breakdowns when providing DC power. Remains at rated capacity. | The battery is in poor condition exhibiting moderate to severe breakdowns when providing DC power. Remains at 80% of rated capacity. | The battery has failed requiring replacement. |
| Battery Charger | The charger is in good condition | The charger is in fair condition | The charger is in poor condition | The charger has failed requiring |

Click to return to:

Section 3



| | exhibiting no notable distress. | exhibiting minor breakdowns. | exhibiting moderate to severe breakdowns. | major re-build or replacement. |
|-----------------------|---|--|--|---|
| Inverters | The inverter is in good condition exhibiting no signs of distress. Consistently converts DC current to AC current. | The inverter is in fair condition exhibiting minor: vibration; noise; overheating; discoloration; conductive build-up. The inverter occasionally fails to convert power requiring minor: reset; calibration or repair. | The inverter is in poor condition exhibiting moderate to severe: vibration; noise; overheating; discoloration; conductive buildup and/or frequently fails to convert power requiring moderate rest; calibration or repair. | The inverter has failed requiring major re-build or replacement. |
| Auto Transfer Switch | The switch is in good condition exhibiting no signs of distress while consistently initiating emergency power when primary power is lost and initiating emergency power shut down when primary power is regained. | The switch is in fair condition exhibiting minor breakdowns when transferring power. Minor overheating and/or minor repairs and or adjustments required. | The switch is in poor condition exhibiting moderate to severe breakdowns when transferring power. | The switch has failed. Major re-build or replacement is required. |
| High Voltage Tie Line | Tie line is in good condition – no notable distress. | Tie line exhibits minor deterioration not resulting in any impacts to serviceability. | Tie line exhibits moderate deterioration which may result in impact to serviceability but a redundant system is in place. | Tie line no longer functions as intended and results in impacts to serviceability for life safety situations. |



| | | |
|---------------------------------------|------------|--------------------|
| 10600 – Tunnel Lighting System | NTI | Units: Each |
|---------------------------------------|------------|--------------------|

DESCRIPTION

Record this element for all Tunnel Lighting Systems. These systems consist of the light fixtures, supports, bulb housings, lenses, light switches, junction boxes, wiring, conduit, cable, sensors, and controllers used to provide lighting for the tunnel.

The total quantity for Tunnel Lighting System is the sum of all the Tunnel Lighting Systems.

PROCEDURE

The Tunnel Lighting System may also include the following subcomponents: photo controls, and remote ballasts

For this element, a separate Tunnel Lighting System is considered to be one system. Tunnels with twin bores may have separate Tunnel Lighting Systems and would be considered as two.

COMMENTARY

Utilize the defect table to rate the condition of each Tunnel Lighting System. Utilize the sub element table to identify deficiencies which relate to the Tunnel Lighting System.

When possible, functional testing of lighting throughout a 24 hour cycle or stages, including emergency power, is recommended to compare versus design standards and output requirements.

Inspectors are to inspect all conduit, conduit supports, junction boxes, etc. located within the tunnel bore(s) associated with this element to ensure safety of the traveling public.

For this element, it is not just the equipment condition/functionality that controls the condition state rating. It can be governed by the physical condition of the system components such as conduit and/or wiring/cable associated with the Tunnel Lighting System.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|------------------|---|--|---|--|
| System Condition | The system is in good condition – no notable distress | The system is in fair condition – isolated breakdowns or deterioration | The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel. |



| | | | | |
|---------------------------------|--|--|--|---|
| <i>CDOT Guidance*</i> | <i>All zones are fully operational</i> | <i>Less than 10% of the system is not operational</i> | <i>Greater than 10% of the lighting system is not operational.</i> | <i>A zone is fully nonfunctional or inoperable fixtures are impacting the serviceability of the tunnel.</i> |
| <i>Sub Element(s) Condition</i> | <i>Sub Elements exhibit minor deterioration or issues which do not have an effect on the system.</i> | <i>Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 which do not affect the overall serviceability of the system to the tunnel.</i> | <i>Sub Elements exhibit major deterioration which if left unattended will risk affecting serviceability of the system to the tunnel.</i> | <i>Sub Element or Elements condition affect the serviceability of the system to the tunnel.</i> |

Sub Element Table

| Sub Element | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--------------------------|--|--|---|---|
| Tunnel Lighting Fixture | Utilize Element 10601 Condition State Table | | | |
| Photo Controls | The system operates to design standards. | Photo controls occasionally fail to make proper lighting adjustments. | Photo controls frequently fail to make proper lighting adjustments. | Photo controls no longer function. |
| Light Fixture Operation* | Less than 5% of light fixtures are not operational | 5%-10% of light fixtures are not operational | 10% or greater of light fixtures are not operational or a zone has several non-functional lights | <i>Elements condition affect the serviceability of the system to the tunnel. A zone is nonfunctional.</i> |
| Control System | The system operates to design standards. | The system requires software modification. Infrequent lighting outages and lighting system resets. | The system software modification is attainable but difficult. Frequent lighting outages and resets. | The system software modification is unavailable. Lighting system permanently on manual operation. |



| | | | | |
|---------------------------|--|--|--|--|
| Light Sensors/Time Clocks | The sensor operates to design standards. | The sensor requires modification. Infrequent lighting level mis-steps. | The sensor modification is attainable but difficult. Frequent light level mis-steps. | The sensor modification is unavailable. Lighting system permanently on manual operation. |
|---------------------------|--|--|--|--|

** Percentages are provided for guidance only, if several lights are out in a row and/or zones are non-functional and affect the serviceability of the tunnel, use inspector judgement to report the correct condition state based on the serviceability.*



| | | |
|--|------------|--------------------|
| 10601 – Tunnel Lighting Fixture | NTI | Units: Each |
|--|------------|--------------------|

DESCRIPTION

Record this element for all Tunnel Lighting Fixtures. This element includes the physical housing of the tunnel lights and their connections to the tunnel.

The total quantity for Tunnel Lighting Fixture is the sum of all the Tunnel Lighting Fixtures.

PROCEDURE

Component supports include anchorage to the supporting member and connecting hardware for the component housing.

When a lighting fixture serves the dual purpose of general tunnel lighting and emergency tunnel lighting, it is only counted under the Tunnel Lighting Fixture element. However, those fixtures will have an impact on both Tunnel Lighting System and Emergency Lighting System elements.

COMMENTARY

Lenses do not impact the condition state of this element based on feedback from NHI course instructors however their impact on the Tunnel Lighting System shall be documented within the system element and appropriate recommendations provided. If orientation and installation location of the fixture provides for water (not roadway splash) infiltration through a cracked or missing lens resulting in a lack of watertight enclosure, an Essential Repair Finding or other notification to CDOT may be necessary.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--------------------|----------------------------------|---|--|--|
| Component Supports | No deficient support conditions. | Loose anchorage or component housing connection hardware. | Missing anchorage or component housing connection hardware which does not result in an unstable situation. | Failed anchorage or component connection hardware which results in an unstable situation. |
| Corrosion | None | Freckled Rust. Corrosion of the steel has initiated. | Section loss is evident or pack rust is present but does not warrant structural review. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and |



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| | | | | serviceability of the element or tunnel. |
| Component Housing or Enclosure | No damages. | Single Crack. | Multiple Cracks. | Holes are present. |

| | | |
|---|------------|--------------------|
| 10620– Emergency Lighting System | NTI | Units: Each |
|---|------------|--------------------|

DESCRIPTION

Record this element for all Emergency Lighting Systems. These systems consist of the light fixtures, supports, bulb housings, lenses, light switches, junction boxes, wiring, conduit, cable, sensors, and controllers used to provide emergency lighting for the facility.

The total quantity for Emergency Lighting System is the sum of all the Emergency Lighting Systems.

PROCEDURE

The Emergency Lighting System may also include the following subcomponents: exit signs, batteries; and support space lighting, and remote ballasts.

For this element, a separate Emergency Lighting System is considered to be one system. Tunnels with twin bores may have separate Emergency Lighting Systems and would be considered as two.

COMMENTARY

Utilize the defect table to rate the condition of each Emergency Lighting System. Utilize the sub element table to identify deficiencies which relate to the Emergency Lighting System.

Inspectors are to inspect all conduit, conduit supports, junction boxes, etc. located within the tunnel bore(s) associated with this element to ensure safety of the traveling public.

For this element, it is not just the equipment condition/functionality that controls the condition state rating. It can be governed by the physical condition of the system components such as conduit and/or wiring/cable associated with the Emergency Lighting System.

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------|--|---|---|--|
| System Operations | The system is in good condition – no notable distress. | The system is in fair condition – isolated breakdowns or deterioration. | The system is in poor condition – widespread deterioration or | The condition warrants evaluation to determine the effect on |



| | | | | |
|---------------------------------|--|--|--|---|
| | | | breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel. | serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel. |
| <i>CDOT Guidance</i> | <i>All zones are fully operational.</i> | <i>Zones exhibit minor infrequent deterioration but still operational.</i> | <i>Isolated areas are inoperable but system is still sufficient for life safety situations.</i> | <i>System is no longer sufficient for life safety situations.</i> |
| <i>Sub Element(s) Condition</i> | <i>Sub Elements exhibit minor deterioration or issues which do not have an effect on the system.</i> | <i>Sub Elements exhibit major deterioration with one or multiple elements in Condition State 3 which do not affect the overall serviceability of the system to the tunnel.</i> | <i>Sub Elements exhibit major deterioration which if left unattended will risk affecting serviceability of the system to the tunnel.</i> | <i>Sub Element or Elements condition affect the serviceability of the system to the tunnel.</i> |

Sub Element Table

| Sub Element | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------------------------------|--|---|--|---|
| Emergency Lighting Fixture | Utilize Element 10621 Condition State Table | | | |
| Photo Controls | The system operates to design standards. | Photo controls occasionally fail to make proper lighting adjustments. | Photo controls frequently fail to make proper lighting adjustments. | Photo controls no longer function. |
| Emergency Lighting Fixture Operation* | Less than 5% of light fixtures are not operational | 5%-10% of light fixtures are not operational | 10% or greater of light fixtures are not operational or a zone has several non-functional lights | <i>Elements condition affect the serviceability of the system to the tunnel. A zone is nonfunctional.</i> |



| | | | | |
|----------------|--|--|---|---|
| Control System | The system operates to design standards. | The system requires software modification. Infrequent lighting outages and lighting system resets. | The system software modification is attainable but difficult. Frequent lighting outages and resets. | The system software modification is unavailable. Lighting system permanently on manual operation. |
|----------------|--|--|---|---|

** Percentages are provided for guidance only, if several lights are out in a row and/or zones are non-functional and affect the serviceability of the tunnel, use inspector judgement to report the correct condition state based on the serviceability.*



| | | |
|---|------------|--------------------|
| 10621 – Emergency Lighting Fixture | NTI | Units: Each |
|---|------------|--------------------|

DESCRIPTION

Record this element for all Emergency Lighting Fixtures. This element includes the physical housing of the emergency lights and their connections to the tunnel.

The total quantity for Emergency Lighting Fixture is the sum of all the Emergency Lighting Fixtures.

PROCEDURE

Component supports include anchorage to the supporting member and connecting hardware for the component housing.

When a lighting fixture serves the dual purpose of general tunnel lighting and emergency tunnel lighting, it is only counted under the Tunnel Lighting Fixture element. However, those fixtures will have an impact on both Tunnel Lighting System and Emergency Lighting System elements.

COMMENTARY

Lenses do not impact the condition state of this element based on feedback from NHI course instructors however their impact on the Emergency Tunnel Lighting System shall be documented within the system element and appropriate recommendations provided. If orientation and installation location of the fixture provides for water (not roadway splash) infiltration through a cracked or missing lens resulting in a lack of watertight enclosure, an Essential Repair Finding or other notification to CDOT may be necessary.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--------------------|----------------------------------|---|--|---|
| Component Supports | No deficient support conditions. | Loose anchorage or component housing connection hardware. | Missing anchorage or component housing connection hardware which does not result in an unstable situation. | Failed anchorage or component connection hardware which results in an unstable situation. |
| Corrosion | None | Freckled rust. Corrosion of the steel has initiated. | Section loss is evident or pack rust is present but does not warrant structural review. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact |



| | | | | |
|--------------------------------|-------------|---------------|------------------|---|
| | | | | strength and serviceability of the element or tunnel. |
| Component Housing or Enclosure | No damages. | Single Crack. | Multiple Cracks. | Holes are present. |

3.6 Fire/Life Safety/Security Systems Section

This section defines tunnel fire/life safety/security systems elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

| Element Number | Element Name | Unit of Measure |
|--------------------------|---------------------------------------|-----------------|
| Fire Detection | | |
| 10650 | Fire Detection System | EACH |
| Fire Protection | | |
| 10700 | Fire Protection System | EACH |
| 10701 | Water Line for Fire Protection | EACH |
| Emergency Communications | | |
| 10750 | Emergency Communications System | EACH |
| Operations and Security | | |
| 10800 | Tunnel Operations and Security System | EACH |



| | | |
|--------------------------------------|------------|--------------------|
| 10650 – Fire Detection System | NTI | Units: Each |
|--------------------------------------|------------|--------------------|

DESCRIPTION

Record this element for all Fire Detection Systems. These systems consist of control panels, initiating devices (heat and smoke detectors, pull-stations, etc.), notification appliances (strobes, horns, etc.), wiring, conduit, and cable used to detect a fire in the tunnel.

The total quantity for Fire Detection System is the sum of all the Fire Detection Systems.

PROCEDURE

The Fire Detection System may also include the following subcomponents: sensors, controls, and alarms.

For this element, a separate Fire Detection System is considered to be one system. Tunnels with twin bores may have separate Fire Detection Systems and would be considered as two.

COMMENTARY

Fire Detection System may include linear heat detectors, infrared, or CCTV and associated monitoring equipment. Inspector shall inspect and record physical condition of devices and mounting hardware in the tunnel.

Additionally, Inspector shall observe operation of Fire Detection System or collect records of testing operation from tunnel staff.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--|--|---|--|--|
| System Operations | The system is in good condition – no notable distress. | The system is in fair condition – isolated breakdowns or deterioration. | The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel. | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel. |
| Detection Sensor Operations (heat and smoke detectors) | All detection sensors are operational. | | Detection sensors are not operational in one zone. | Detection sensors are not operational in multiple zones. |



| | | | | |
|------------------------------------|---|--|---|--|
| <i>Component Supports</i> | <i>No deficient support conditions.</i> | <i>Loose anchorage or component housing connection hardware.</i> | <i>Missing anchorage or component housing connection hardware which does not result in an unstable situation.</i> | <i>Failed anchorage or component connection hardware which results in an unstable situation.</i> |
| <i>Device Housing or Enclosure</i> | <i>No damage, watertight, fixture is functioning as intended.</i> | <i>Single crack, minor damage to device enclosure/fixture.</i> | <i>Multiple defects, causing minor damage to the device enclosure/fixture.</i> | <i>Device enclosure/fixture is deteriorated and non-function or beyond is useful service life.</i> |



| | | |
|---------------------------------------|------------|--------------------|
| 10700 – Fire Protection System | NTI | Units: Each |
|---------------------------------------|------------|--------------------|

DESCRIPTION

Record this element for all Fire Protection Systems. These systems consist of fire extinguishers, fire standpipes, hose connections, storage tanks, fire hydrants, building sprinklers, pumping systems, piping, circulating pumps, and hose reels used as fire protection in the tunnel.

The total quantity for Fire Protection System is the sum of all the Fire Protection Systems.

PROCEDURE

The Fire Protection System may include the following subcomponents: main fire pump, pressure maintenance/jockey pump, dry pipe valve, valves and tamper switches, storage tanks, tunnel stand pipe, pressure relief and air release valves, backflow prevention, hose stations, hose reels, building sprinklers, fire department connections and fire hydrants.

For this element, a separate Fire Protection System is considered to be one system. Tunnels with twin bores may have separate Fire Protection Systems and would be considered as two.

COMMENTARY

Reliability is measured by percentage of time the system is 100% functional over the previous 24 months.

Utilize the defect table to rate the condition of each Emergency Lighting System. Utilize the sub element table to identify deficiencies which relate to the Emergency Lighting System.

CONDITION STATE DEFINITIONS

| Equipment | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------------------------|--|---|--|--|
| System Operations | The system is in good condition – no notable distress. | The system is in fair condition – isolated breakdowns or deterioration. | The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel. | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel. |
| <i>Reliability</i> | <i>> 99% of previous 24 months.</i> | <i>> 95% of previous 24 months.</i> | <i>> 90% of previous 24 months.</i> | <i>< 90% of previous 24 months.</i> |
| <i>Sub Element(s) Condition</i> | <i>Sub Elements exhibit minor deterioration</i> | <i>Sub Elements exhibit major deterioration</i> | <i>Sub Elements exhibit major deterioration</i> | <i>Sub Element or Elements condition</i> |

Click to return to:

Section 3



| | | | | |
|--|---|---|---|---|
| | <i>or issues which do not have an effect on the system.</i> | <i>with one or multiple elements in Condition State 3 which do not affect the overall serviceability of the system to the tunnel.</i> | <i>which if left unattended will risk affecting serviceability of the system to the tunnel.</i> | <i>affect the serviceability of the system to the tunnel.</i> |
|--|---|---|---|---|

Sub Element Table

| Sub Element | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--------------------------------|---|---|--|---|
| Water Line for Fire Protection | Utilize Element 10701 Condition State Table | | | |
| Fire Pumps | The pump is in good condition exhibiting no signs of distress. | The pump is in fair condition exhibiting minor: leakage, noise, vibration, and/or temperature is slightly above expected limits. Water pressure to the system is within expected limits. | The pump is in poor condition exhibiting moderate to heavy: leakage, noise, vibration, temperature above expected limits, and/or water pressure to the system is moderately to severely under expected limits. | Pump has failed. Major re-build or replacement is required. |
| Fire Hydrants | The hydrant is in good condition exhibiting no signs of distress. | The hydrant is in fair condition exhibiting minor: leakage, corrosion, oxidation, valve packing leakage, thread wear, cracks on the barrel. Valve operates with minor resistance. Water pressure is | The hydrant is in poor condition exhibiting moderate to heavy: leakage, corrosion, valve packing leakage, thread wear, cracks on the barrel. Valve operates with moderate to severe resistance. | The hydrant has failed. Major re-build or replacement is required. The hydrant is inaccessible. |

Click to return to:

Section 3



| | | | | |
|-----------------------------------|---|---|---|--|
| | | within expected limits. | Water pressure is moderately to severely below expected levels. | |
| Stand Pipes/Fire Dept Connections | The standpipe is in good condition exhibiting no signs of distress. | The standpipe is in fair condition exhibiting minor: leakage, Gasket deterioration, corrosion, valve packing leakage, thread wear, cracks in piping. Valve and/or control handles operate with minor resistance. Hose nozzle is free of debris. Water pressure is within expected limits. | The standpipe is in poor condition exhibiting moderate to heavy: leakage, Gasket deterioration; corrosion, valve packing leakage; thread wear; cracks in piping and/or valve and/or control handles operate with moderate to severe resistance and/or hose nozzle is plugged with debris and/or water pressure is moderately below expected levels. | The standpipe has failed. Major re-build or replacement is necessary. The standpipe is inaccessible. |
| Pipe/Hose/ Extinguisher Cabinets | The cabinet is in good condition exhibiting no signs of distress. | The cabinet is in fair condition exhibiting minor: corrosion, interior moisture/debris, loose anchors, miss-alignment; door resistance/sticking latches. | The cabinet is in poor condition exhibiting moderate to heavy: corrosion, interior moisture/debris, loose anchors, miss-alignment, door resistance/sticking latches. | The cabinet has failed or is inoperable. It is no longer able to safely house the fire equipment to expected levels. |



| | | | | |
|-----------------------------|---|--|---|--|
| <p>Fire Extinguisher</p> | <p>The extinguisher is in good condition exhibiting no signs of distress and service dates are compliant.</p> | <p>The extinguisher is in fair condition exhibiting minor: corrosion; leakage; nozzle sediment; seal wear. Pressure gauges are in the expected range; locking pin and tamper seal are intact; service dates are compliant.</p> | <p>The extinguisher is in poor condition exhibiting moderate to heavy: corrosion, leakage, nozzle sediment, seal wear, and/or pressure gauges are moderately out of the expected range, missing locking pin, broken tamper seal, or service dates are slightly out of compliance. Extinguisher is still functional.</p> | <p>The extinguisher has failed or is inoperable and can no longer extinguish fires. Replacement is required. The extinguisher is inaccessible.</p> |
| <p>Dry Standpipe System</p> | <p>The standpipe is in good condition exhibiting no signs of distress.</p> | <p>The standpipe is in fair condition exhibiting minor: leakage, Gasket deterioration, corrosion, valve packing leakage, thread wear, cracks in piping. Valve and/or control handles operate with minor resistance. Hose nozzle free of debris. Water pressure is within expected limits</p> | <p>The standpipe is in poor condition exhibiting moderate to heavy: leakage, Gasket deterioration, corrosion, valve packing leakage, thread wear, cracks in piping and/or valve and/or control handles operate with moderate to severe resistance and/or hose nozzle is plugged with debris and/or water</p> | <p>The standpipe has failed. Major rebuild or replacement is necessary. The standpipe is inaccessible.</p> |



| | | | | |
|-----------------------------|---|---|--|--|
| | | | pressure is moderately below expected levels. | |
| Fire Collection Spill Tanks | The tank is in good condition exhibiting no signs of distress. | The tank is in fair condition exhibiting minor: corrosion; leakage, internal mineral build-up, internal sludge build-up, or sidewall stress. | The tank is in poor condition exhibiting moderate to severe: corrosion, leakage, internal mineral build-up, internal sludge build-up, or sidewall stress. | Tank has failed. Major re-build or replacement is necessary. |
| Water Reservoir | The reservoir is in good condition exhibiting no signs of distress. | The reservoir is in fair condition exhibiting minor: recovery time delays, leakage, internal mineral build-up, internal sludge build-up, internal debris, or sidewall cracking. | The reservoir is in poor condition exhibiting moderate to severe: recovery time delays, leakage, internal mineral build-up, internal sludge build-up, internal debris, or sidewall cracking. | The reservoir has failed and can no longer contain water. Major construction or replacement is required. |



| | | |
|---|-------------|--------------------|
| 10701 – Water Line for Fire Protection | CDOT | Units: Each |
|---|-------------|--------------------|

DESCRIPTION

Record this element for all pressurized water lines for fire protection.

The total quantity for the Water Line for Fire Protection is the sum of the pressurized water lines for fire protection.

PROCEDURE

The Water Line for Fire Protection may include the following subcomponents: heat trace or other de-icing systems.

COMMENTARY

Fire hydrants and their connections to the water line shall be quantified and captured within the Fire Protection System.

Inspector should inspect and record physical condition of the water line in the tunnel, where visible. Where visual inspection is not plausible, video inspection and/or interviews with maintenance staff shall supplement findings. Capacity reductions due to mineral deposits and/or corrosion shall be considered.

This element does not include dry standpipe systems, standpipes, or fire hydrants.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--------------------|--|---|--|---|
| General Condition | No deficiencies, water line provides adequate fire protection for tunnel. | Minor deterioration of water line, minor leaks may exist. Output and condition adequate for fire protection within tunnel. | Moderate deterioration of the water line, more frequent leaks exist but pressure is still adequate for fire protection. Deterioration does not impact serviceability for tunnel. | Condition of water line impacts serviceability for fire protection of tunnel. Deterioration impacts travelway and/or leaks beyond tolerable limits. |
| Available capacity | Water is readily available. Less than 5% reduction in hydraulic capacity. | Water is infrequently (<3 per yr.) unavailable due to system deficiency. Between 5% and 10% reduction in hydraulic capacity. | Water is frequently (>3 per yr. and <6 per yr.) unavailable. Between 10% and 20% reduction in hydraulic capacity. | Water is repeatedly (>6 per yr.) unavailable. Greater than 20% reduction in hydraulic capacity. |



| | | |
|--|------------|--------------------|
| 10750 – Emergency Communication Systems | NTI | Units: Each |
|--|------------|--------------------|

DESCRIPTION

Record this element for all Emergency Communication Systems. The components of the Emergency Communication System include the communication device itself (i.e. intercom, radios, cell-phone), receivers, wiring, exchange devices, etc.

The total quantity for Emergency Communication System is the sum of all the Emergency Communication Systems.

PROCEDURE

The emergency communications system may also include the following subcomponents: signs, controllers, speakers, and audio input equipment.

For this element, a separate Emergency Communication System is considered to be one system. Tunnels with twin bores may have separate Emergency Communication Systems and would be considered as two.

COMMENTARY

Inspector should inspect all devices and mounting hardware for both physical and functional condition.

Inspector should operate system or observe operation of system with assistance of tunnel staff.

Inspectors are to inspect all conduit, conduit supports, junction boxes, etc. located within the tunnel bore(s) associated with this element to ensure safety of the traveling public.

For this element, it is not just the equipment condition/functionality that controls the condition state rating. It can be governed by the physical condition of the system components such as conduit and/or wiring/cable associated with the Emergency Communication System.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------|--|---|---|---|
| System Operations | The system is in good condition – no notable distress. | The system is in fair condition – isolated breakdowns or deterioration. | The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the |



| | | | serviceability of the element or tunnel. | serviceability of the element or tunnel. |
|------------------------------------|---|--|---|--|
| <i>Component Supports</i> | <i>No deficient support conditions.</i> | <i>Loose anchorage or component housing connection hardware.</i> | <i>Missing anchorage or component housing connection hardware which does not result in an unstable situation.</i> | <i>Failed anchorage or component connection hardware which results in an unstable situation.</i> |
| <i>Device Housing or Enclosure</i> | <i>No damage, watertight, fixture is functioning as intended.</i> | <i>Single crack, minor damage to device enclosure/fixture.</i> | <i>Multiple defects, causing minor damage to the device enclosure/fixture.</i> | <i>Device enclosure/fixture is deteriorated and non-function or beyond is useful service life.</i> |



| | | |
|--|------------|--------------------|
| 10800 – Tunnel Operations and Security System | NTI | Units: Each |
|--|------------|--------------------|

DESCRIPTION

Record this element for all Tunnel Operations and Security Systems. These systems consist of the communication equipment (CCTV cameras, telephones, radios, etc.) used to provide communication within and from the tunnel.

The total quantity for Tunnel Operations and Security System is the sum of all the Tunnel Operations and Security Systems.

PROCEDURE

The Tunnel Operations and Security System may also include the following subcomponents: closed-circuit camera system, cell phone antennas, door access, controller, and radio.

For this element, a separate tunnel operation and security system is considered to be one system. Tunnels with twin bores may have separate Tunnel Operations and Security Systems and would be considered as two.

COMMENTARY

Inspector should inspect all devices and mounting hardware for both physical and functional condition.

Inspector should observe operation of system with assistance of tunnel staff and/or review all testing protocol and testing records.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------------------|--|---|--|---|
| System Operations | The system is in good condition – no notable distress. | The system is in fair condition – isolated breakdowns or deterioration. | The system is in poor condition – widespread deterioration or breakdowns reducing operational capacity, without impacting the serviceability of the element or tunnel. | The condition warrants evaluation to determine the effect on serviceability of the element or tunnel or the evaluation has determined there is an impact on the serviceability of the element or tunnel |
| <i>Component Supports</i> | <i>No deficient support conditions.</i> | <i>Loose anchorage or component housing connection hardware.</i> | <i>Missing anchorage or component housing connection hardware which does not result in an unstable situation.</i> | <i>Failed anchorage or component connection hardware which results in an unstable situation.</i> |



| | | | | |
|------------------------------------|---|--|--|--|
| <i>Device Housing or Enclosure</i> | <i>No damage, watertight, fixture is functioning as intended.</i> | <i>Single crack, minor damage to device enclosure/fixture.</i> | <i>Multiple defects, causing minor damage to the device enclosure/fixture.</i> | <i>Device enclosure/fixture is deteriorated and non-function or beyond is useful service life.</i> |
|------------------------------------|---|--|--|--|



3.7 Signs Section

This section defines tunnel sign elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

| Element Number | Element Name | Unit of Measure |
|-------------------------|------------------------|-----------------|
| Traffic Guidance | | |
| 10850 | Traffic Sign | EACH |
| Pedestrian | | |
| 10870 | Egress Sign | EACH |
| Variable Message Boards | | |
| 10890 | Variable Message Board | EACH |
| Lane Signal | | |
| 10910 | Lane Signal | EACH |
| 10911 | Lane Signal Fixture | EACH |



| | | |
|-----------------------------|------------|--------------------|
| 10850 – Traffic Sign | NTI | Units: Each |
|-----------------------------|------------|--------------------|

DESCRIPTION

Record this element for all Traffic Signs. These elements consist of the Traffic Sign and supports. Signs for pedestrians, variable message signs and Lane Signals are not covered under this element.

The total quantity for Traffic Signs is the sum of all the Traffic Signs.

PROCEDURE

The MUTCD Chapter 2 contains the requirements for the shape and wording of regulatory, warning and guide signs on a highway or road. It also contains requirements for maintaining minimum retroreflectivity of signs.

COMMENTARY

Signs shall be inspected for conformity to the MUTCD, legibility, cleanliness, and reflectivity.

Signs for landmarks are not included under this element unless they may affect public safety.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--------------------|----------------------------------|---|---|---|
| Component Supports | No deficient support conditions. | Loose anchorage or component housing connection hardware. | Missing anchorage or component housing connection hardware which does not result in an unstable situation | Failed anchorage or component connection hardware which results in an unstable situation. |



| | | |
|----------------------------|------------|--------------------|
| 10870 – Egress Sign | NTI | Units: Each |
|----------------------------|------------|--------------------|

DESCRIPTION

Record this element for all Egress Signs. This element consists of Egress Signs and their supports that are not related to the Emergency Lighting System.

The total quantity for Egress Sign is the sum of all the Egress Signs.

PROCEDURE

The MUTCD Chapter 2 contains the requirements for the shape and wording of regulatory, warning and guide signs on a highway or road. It also contains requirements for maintaining minimum retroreflectivity of signs.

COMMENTARY

Egress signage guidelines exist within the MUTCD, NFPA, and NCHRP 20-59(47) providing for sign spacing and the proper symbology and retroreflectivity requirements. Documentation of conformance with industry recommendations shall be documented however may not affect condition evaluation.

Signs shall be inspected for legibility, cleanliness, and reflectivity.

Functionality of the egress door associated with the signage should be included in the commentary of this element. Door defects do not impact the condition state of the Egress Signage Element, however, should be included in the asset recommendations. Essential Repair Findings may be warranted if the door is locked or nonfunctional.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|----------------------|----------------------------------|---|---|---|
| Component Supports | No deficient support conditions. | Loose anchorage or component housing connection hardware. | Missing anchorage or component housing connection hardware which does not result in an unstable situation | Failed anchorage or component connection hardware which results in an unstable situation. |
| <i>Effectiveness</i> | <i>Fully effective.</i> | <i>Substantially effective.</i> | <i>Limited effectiveness.</i> | <i>Failed, not visible/ legible</i> |



| | | |
|---------------------------------------|------------|--------------------|
| 10890 – Variable Message Board | NTI | Units: Each |
|---------------------------------------|------------|--------------------|

DESCRIPTION

Record this element for all Variable Message Boards. This element consists of the Variable Message Board, supports, and associated electrical connections.

The total quantity for Variable Message Board is the sum of all the Variable Message Boards.

PROCEDURE

The MUTCD Chapter 2 contains the requirements for the shape and wording of regulatory, warning and guide signs on a highway or road. It also contains requirements for maintaining minimum retroreflectivity of signs.

COMMENTARY

As the SNTI provides for two Lane Signal elements to capture physical and functional condition each, this element shall encompass both the physical condition and functionality of the fixture and control system(s).

The Variable Message Board may include the following subcomponents: signals/fixtures, control station, control cabinets, conduit, and SKADA or other systems/equipment needed for communicating.

Functionality of both sides, when applicable, shall be included within the inspection. Operational and functional tests shall be performed congruent with inspections when possible. Inspectors shall review maintenance records and/or pixel tests when functional tests are not feasible.

It is recommended to coordinate washing of signs prior to inspection for proper condition state allocation.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--------------------|--|--|---|---|
| Component Supports | No deficient support conditions. | Loose anchorage or component housing connection hardware | Missing anchorage or component housing connection hardware which does not result in an unstable situation | Failed anchorage or component connection hardware which results in an unstable situation. |
| Sign Operation | Sign is functional and operates when tested. | Sign operates with minor decrease in light output, flicker, or reduced display area. | Sign operates with significant decrease in light output, flicker, and/or reduced display area. | Sign is not operational. |



| | | |
|----------------------------|------------|--------------------|
| 10910 – Lane Signal | NTI | Units: Each |
|----------------------------|------------|--------------------|

DESCRIPTION

Record this element for all Lane Signals. The components of the tunnel Lane Signal system include the Lane Signals themselves, their supports, and the control system.

The total quantity for Lane Signal is the sum of all the Lane Signals.

PROCEDURE

The Lane Signals may include the following subcomponents: signals/fixtures, control station, control cabinets and conduit.

The MUTCD Chapter 2 contains the requirements for the shape and wording of regulatory, warning and guide signs on a highway or road. It also contains requirements for maintaining minimum retroreflectivity of signs.

COMMENTARY

The Lane Signal element shall focus on the functionality of the fixture and control system.

The Lane Signals may include the following additional subcomponents: SKADA or other systems/equipment needed for communicating.

Functionality of both sides, when applicable, shall be included within the inspection. Operational and functional tests shall be performed congruent with inspections when possible. Inspectors shall review maintenance records and/or pixel tests when functional tests are not feasible.

It is recommended to coordinate washing of signs prior to inspection for proper condition state allocation.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-------------------|--|--|---|---|
| Support condition | No deficient support conditions. | Loose anchorage or component housing connection hardware | Missing anchorage or component housing connection hardware which does not result in an unstable situation | Failed anchorage or component connection hardware which results in an unstable situation. |
| Sign Operation | Sign is functional and operates when tested. | Sign operates with minor decrease in light output, flicker, or reduced display area. | Sign operates with significant decrease in light output, flicker, and/or reduced display area. | Sign is not operational. |



| | | |
|------------------------------------|------------|--------------------|
| 10911 – Lane Signal Fixture | NTI | Units: Each |
|------------------------------------|------------|--------------------|

DESCRIPTION

Record this element for all Lane Signal Fixtures. The components of the tunnel Lane Signal Fixtures include the fixtures themselves, the supports, and the wiring.

The total quantity for Lane Signal Fixture is the sum of all the Lane Signal Fixtures.

PROCEDURE

The Lane Signal Fixtures may also include the following subcomponents: fixtures and conduit.

The MUTCD Chapter 2 contains the requirements for the shape and wording of regulatory, warning and guide signs on a highway or road. It also contains requirements for maintaining minimum retroreflectivity of signs.

COMMENTARY

The Lane Signal Fixture element shall focus on the physical condition of the fixture, conduit, wiring, and other components.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--------------------|----------------------------------|--|---|---|
| Component Supports | No deficient support conditions. | Loose anchorage or component housing connection hardware | Missing anchorage or component housing connection hardware which does not result in an unstable situation | Failed anchorage or component connection hardware which results in an unstable situation |
| Corrosion | None | Freckled rust. Corrosion of the steel is initiated. | Section loss is evident or pack rust is present but does not warrant structural review. | The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel OR a structural review has been completed and the defects impact strength and |



| | | | | serviceability of the element or tunnel. |
|--------------------------------|-------------|---------------|------------------|--|
| Component Housing or Enclosure | No damages. | Single Crack. | Multiple Cracks. | Holes are present. |



3.8 Protective Systems Section

This section defines tunnel protective system elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

| Element # | Element Name | Unit of Measure |
|--------------------|---------------------------------------|---------------------------|
| Protective Coating | | |
| 10950 | Steel Corrosion Protective Coating | AREA (Feet ²) |
| 10951 | Concrete Corrosion Protective Coating | AREA (Feet ²) |
| 10952 | Fire Protective Coating | AREA (Feet ²) |
| 10953 | Tunnel Tile | AREA (Feet ²) |



| | | |
|---|------------|--|
| 10950 – Steel Corrosion Protective Coating | NTI | Units: Square Feet (Feet²) |
|---|------------|--|

DESCRIPTION

Record this element for all Steel Corrosion Protective Coating used in the tunnel. The element is for steel elements that have a protective coating system such as paint, galvanization, or other top coat steel corrosion inhibitor.

The total quantity for protective coatings is the product of the length and width of the entire exposed surface of the element.

PROCEDURE

Effectiveness is an evaluation made by the inspector to classify the degree to which the protection system is functioning to protect the steel beneath.

Protective coatings only apply to those elements listed under the structural and civil sections.

COMMENTARY

The parent Element Number is to be recorded for all protective coating elements. If more than one parent element exists separate condition state distribution tables should be provided.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|--|--|--------------------------|---|--|
| Chalking | None | Surface dulling. | Loss of pigment. | Not applicable. |
| Peeling/Bubbling/ Cracking | None | Finish coats only. | Finish and primer coats. | Exposure of bare metal. |
| Oxide Film Degradation Color/ Texture Adherence | Yellow-orange or light brown for early development. Chocolate-brown to purple-brown for fully developed. Tightly adhered, capable of withstanding hammering or vigorous wire brushing. | Granular texture. | Small flakes, less than ½ in. diameter. | Dark black color. Large flakes, ½ in. diameter or greater; or laminar sheets or nodules. |
| Effectiveness | Fully effective. | Substantially effective. | Limited effectiveness. | Failed, no protection of the underlying metal. |



| | | |
|--|------------|--|
| 10951 – Concrete Corrosion Protective Coating | NTI | Units: Square Feet (Feet²) |
|--|------------|--|

DESCRIPTION

Record this element for all Concrete Corrosion Protective Coating used in the tunnel. This element is for concrete elements that have a protective coating applied to them. These coatings include silane/siloxane water proofers, crack sealers such as High Molecular Weight Methacrylate (HMWM), or any top coat barrier that protects concrete from deterioration and reinforcing steel from corrosion.

The total quantity for protective coatings is the product of the length and width of the entire exposed surface of the element.

PROCEDURE

Effectiveness is an evaluation made by the inspector to classify the degree to which the protection system is functioning.

Protective coatings only apply to those elements listed under the structural and civil sections.

COMMENTARY

The parent Element Number is to be recorded for all protective coating elements. If more than one parent element exists separate condition state distribution tables should be provided.

Typically, CDOT structural coating guidelines for paint and textured concrete finishing qualify as a Concrete Corrosion Protective Coating.

Consideration of reflective cracking shall be provided for as direct means of ingress.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------|--------------------------|---|--|--|
| Wear | None | Underlying concrete not exposed, coating is showing wear from UV exposure, friction course missing. | Underlying concrete is not exposed; thickness of the coating is reduced. | Underlying concrete is exposed. Protective coating is no longer effective. |
| Effectiveness | Fully effective | Substantially effective. | Limited effectiveness. | Failed – no protection of underlying concrete. |



| | | |
|--|------------|--|
| 10952 – Fire Protective Coating | NTI | Units: Square Feet (Feet²) |
|--|------------|--|

DESCRIPTION

Record this element for all Fire Protective Coatings used in the tunnel. This element is the coating applied on the tunnel elements to protect these elements from fire.

The total quantity for protective coatings is the product of the length and width of the entire exposed surface of the element.

PROCEDURE

Fire protection includes fireproofing spray, etc.

Protective coatings only apply to those elements listed under the structural and civil sections.

COMMENTARY

The parent Element Number is to be recorded for all protective coating elements. If more than one parent element exists separate condition state distribution tables should be provided.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|---------------|--------------------------|--------------------------|--------------------------|--|
| Effectiveness | Fully effective | Substantially effective. | Limited effectiveness. | Failed – no protection of underlying concrete. |



| | | |
|----------------------------|-------------|--|
| 10953 – Tunnel Tile | CDOT | Units: Square Feet (Feet²) |
|----------------------------|-------------|--|

DESCRIPTION

Record this element for all Tunnel Tile serving as liners to portions of internal tunnel surfaces (such as tunnel liners, tunnel ceiling slabs, or other structural walls or ceilings). Tunnel Tile can be ceramic or other material and typically functions as a protective coating on the interior of the tunnel.

The area of a tunnel liner is the product of the length and the height or perimeter of the tiled areas of the internal surfaces.

PROCEDURE

Tile protective coatings only apply to those elements listed under the structural sections.

Visual assessments should be supplemented with sounding or non-destructive testing methods for all elements.

The parent Element Number is to be recorded for all protective coating elements. If more than one parent element exists separate condition state distribution tables should be provided.

Care should be taken to not damage Tunnel Tile in the evaluation process.

COMMENTARY

Defects that are judged to be reflective of the liner shall have condition state distribution impact both elements. Cracked and/or split tiles that do not follow grout lines are often reflective of cracking in the tunnel liner.

CONDITION STATE DEFINITIONS

| Defect | Condition State 1 | Condition State 2 | Condition State 3 | Condition State 4 |
|-----------------------|--------------------------|---|---|--------------------------------------|
| Delamination | None | Tile is delaminated or unsound with no evident distortion. | Tile is delaminated or unsound with portions of distortion or displacement. | Tile is not effective or is missing. |
| Cracking/ Chipping | None | Minor cracking, chipping, but does not inhibit performance of tile. | Cracking, chipping, or damage through the full tile and/or reduces the performance of the tile. | |
| Mortar (joint lines) | None/ no defects | Minor deterioration. or cracked but overall in-tact. | Mortar or bedding is missing, significantly damaged, or has | |



| | | | | |
|-------------------------------|---|--|---|--|
| | | | been removed from tile joints. | |
| Effectiveness/ Cleanliness | Fully effective. | Substantially effective. Includes reduced reflectivity due to presence of dirt, debris, efflorescence buildup, or other staining. | Limited effectiveness. Includes significantly reduced reflectivity due to presence of dirt, debris, efflorescence or other staining. | |
| Patched Areas | Replaced or patched areas of Tunnel Tile does not warrant down rating of Condition States as is common practice in concrete elements. | | | |

NOTE: Defects of the tile resulting from tunnel liner/parent element defects should also affect the condition state of the liner/parent element (examples include: cracking and efflorescence). Typically, through cracking of tile that does not go through the joint lines and is consistent throughout a section of tile is reflective cracking of the tunnel liner/parent element. Rust staining and leakage are both defects of the tunnel liner/parent element and should be captured under the liner/parent element condition states.

Section 4 Inspection and Safety Standards

- 4.1 Introduction CTIIM..... 4.3
- 4.2 CDOT Organization and Hierarchy 4.3
- 4.3 Inspector Qualifications..... 4.3
 - 4.3.1 Consultant Program Manager 4.4
 - 4.3.2 Team Leader 4.4
 - 4.3.3 General Inspectors..... 4.5
 - 4.3.4 Specialty Contractors or Discipline Specific Inspectors 4.5
- 4.4 Inspection Procedures, Techniques and Scheduling 4.6
 - 4.4.1 Mobilization, Planning, Scheduling..... 4.6
 - 4.4.2 Existing Tunnel Records 4.7
 - 4.4.3 Traffic Control 4.7
 - 4.4.4 Confined Space Entry..... 4.8
 - 4.4.5 Lockout Tag-out..... 4.8
 - 4.4.6 Night Inspection Work..... 4.8
 - 4.4.7 Pre-Inspection Preparation of Tunnel 4.9
- 4.5 Inspection Types and Frequencies 4.9
 - 4.5.1 Initial Inspection 4.10
 - 4.5.2 Routine Inspection..... 4.10
 - 4.5.3 Special Inspections 4.13
 - 4.5.4 In-Depth Inspections..... 4.14
 - 4.5.5 Damage Inspections..... 4.15
- 4.6 Health and Safety Procedures 4.15
 - 4.6.1 Night Inspection Safety..... 4.17
 - 4.6.2 Confined Space Safety 4.18
 - 4.6.3 Hazardous Materials..... 4.19
 - 4.6.4 Lockout/ Tag-Out..... 4.19
 - 4.6.5 Traffic Control Safety 4.19
 - 4.6.6 Overhead Power/Utility Lines..... 4.20
 - 4.6.7 Electrical/Arc Flash 4.21

Click to return to:



| | |
|---------------------------------|------|
| 4.6.8 | 4.23 |
| 4.7 Inspection Techniques | 4.24 |



4.1 Introduction – Inspection & Safety Standards

The TOMIE is the accepted manual to be followed and referenced by the inspection staff in partnership with this manual. The following sections of Chapter 4 will focus on the general practices regarding inspection and safety procedures, as well as, definitions regarding the tunnel system of Colorado. This chapter also addresses CDOT specific processes and requirements.

Tunnel inspection organization must be in accordance with Section 4.3 of the TOMIE Manual.

4.2 CDOT Organization and Hierarchy

The Colorado Department of Transportation organization is important to inspectors for obtaining documents such as previous tunnel reports, permits; notifying staff for upcoming inspections; and coordination with the appropriate personnel. Relative to the tunnel inspection program the following positions have significance. At the top of the hierarchy is the Executive Director, followed by the Deputy Director, and the Director of the Division of Highway Maintenance. The CDOT Tunnel Inspection Program Manager per 23 CFR Part 650 resides in Staff Bridge and this position directs the inspections of CDOT tunnels. The management for this program may be delegated by the CDOT Tunnel Inspection Program Manager to qualified delegates as necessary. The CDOT Tunnel Asset Manager reports to the Director of the Division of Highway Maintenance. CDOT is comprised of five Regions each managed by a Region Transportation Director (RTD) who is the ultimate authority in each Region. Region 1 has the unique position of a Deputy Director of Maintenance under the RTD.

There are eight (8) Maintenance Sections each managed by a Maintenance Superintendent supervised by the RTD (Region 1 is supervised by the Deputy Director of Maintenance). The Maintenance Superintendent has the authority (shared with the CDOT Tunnel Inspection Program Manager) to approve specific tunnel inspection schedules and staging.

The eight Maintenance Superintendents have Deputy Superintendents and numerous Supervisor Areas, each managed by a Labor, Trades, Craft Operator (LTC OPS). The LTC OPS is the field authority for daily operations and should be contacted for any tunnel inspections performed in their area. The LTC OPS have several Patrol Areas each supervised by a Transportation Maintenance worker III (TM III) that is a field *working supervisor*. The TM III's have lead workers (TM II) in each patrol that direct basic crew duties.

Program Engineers are assigned to every CDOT Tunnel and oversee the engineering requirements for the tunnels as needed. Resident Engineers are more sites specific and report to the Program Engineer.

See Appendix IX: CDOT Organization and Hierarchy for more information on current position personnel.

4.3 Inspector Qualifications

The following sections outline the roles and duties of the inspection team.



4.3.1 Consultant Program Manager

Inspection Program Managers must be a registered Professional Engineer (PE) or have at least 10 years of tunnel or bridge inspection experience. They also must be a Nationally Certified Tunnel Inspector (NCTI) completing the NHI Course 130110 or approved equivalent, and refresher course every 5 years.

The Consultant Program Manager:

- Communicates directly with the CDOT Program Manager.
- Confirms that all requirements of NTIS and the CTIIM are met.
- Develops the inspection safety plan to be approved by CDOT.
- Gives direction to the inspection Team Leader(s).
- Reviews and maintains all documents pertaining to the tunnel inspections prior to submittal to CDOT Program Manager.
- Maintains supporting documentation of completed training.
- Develops inspection schedules to be approved by CDOT.
- Is responsible to inform the CDOT Program Manager of any critical inspection or essential repair findings within the specified time frame set forth herein.
- Coordinates schedule with CDOT Program Manager.

For more information refer to Section 4.4.1 of the TOMIE manual.

4.3.2 Team Leader

Team leaders must be a NCTI and have the experience and knowledge of the specific tunnel elements. Professionally registered engineers may be required for more Complex tunnels such as EJMT, Hanging Lake, Wolf Creek, and Speer Blvd. at the discretion of the Program Manager.

Team leaders must meet one of the following requirements: registered professional engineer with 6 months of bridge or tunnel inspection experience, 5 years of bridge or tunnel inspection experience, or a combination of education and experience as described in the NTIS. The team leader must have also have taken the tunnel inspection safety course and maintained an updated refresher course every 5 years.

The Team Leader:

- Communicates directly with the consultant Program Manager.
- Reviews all available historical data prior to inspection.
- Administers the inspection safety plan.
- Prepares the inspection schedule.
- Assembles the inspection team and verifies inspector qualifications.
- Enforces the inspection safety plan and all safety practices.



- Conducts daily safety meetings prior to inspection.
- Coordinates the inspection with the; Consultant Program Manager, appropriate Maintenance Superintendent, Highway Supervisors, Resident Engineer, and Traffic Engineer (see organizational charts).
- Manages and assigns the daily activities of the inspection team.
- Determines equipment and material requirements.
- Directs inspection team on evaluating elements and reporting in accordance with CTIIM and NTIS.
- Immediately reports essential repair findings to the Consultant Program Manager.
- Quality checks the inspection data.
- Verifies the inspection reports are complete, accurate, and legible

Team leaders must be on-site for initial, routine, and In-Depth Inspections.

For more information refer to Section 4.4.2 of the TOMIE manual.

4.3.3 General Inspectors

General inspectors assist the Team Leader throughout the inspection process. This may consist of taking photographs, making sketches, tabulating inventory, performing inspection, assessing element ratings, and creating documentation.

Field inspectors should have the training and experience to inspect tunnels. Engineering backgrounds in Civil, Structural, Mechanical, and Electrical fields are preferred. Discipline specific specialists should be utilized whenever possible. It is recommended but not required that discipline leaders for these categories be NCTI as well. Each discipline is responsible for the inspection of the specific Elements related to their field. Design and maintenance expertise is useful but not required. In the event of Complex tunnel inspections, such as Eisenhower Johnson Memorial Tunnels, multiple team leaders for the different disciplines are recommended. The Team Leader is responsible for overseeing the entire inspection and integrating the findings of the other disciplines into the final deliverable.

For more information, refer to Section 4.4.3 of the TOMIE manual.

4.3.4 Specialty Contractors or Discipline Specific Inspectors

Specialty contractors may be required to inspect Complex or specialized tunnel systems. This type of inspector may be necessary for In-Depth Inspections of tunnel systems where specialized tests and procedures are necessary (as an example - medium voltage Switchgear).

It should be noted that Specialty contractors may require very specific certifications to perform their inspection work.

For more information, refer to Section 4.4.4 of the TOMIE manual.



4.4 Inspection Procedures, Techniques and Scheduling

This section shall be referenced and used in accordance with the TOMIE manual, CDOT specific procedures and definitions are outlined below. For inspection procedures regarding specific elements and materials see TOMIE Section 4.9. For CDOT specific tunnel procedures, scheduling, and details see Chapter 7 of this manual.

4.4.1 Mobilization, Planning, Scheduling

Approximately no less than thirty days prior to a tunnel inspection, the Consultant Program Manager will inform CDOT's Inspection Program Manager of the upcoming inspection.

At this time, the Program Manager or Team Leader will meet with the appropriate Maintenance Superintendent and Resident Engineer, or their designee, to pre-inspection coordination meeting. A site visit may be incorporated. At this meeting the personnel will discuss and document:

- Inspection schedule
- Specific tunnel element concerns /malfunctions
- Engineering concerns/impact damage
- Unique safety constraints/hazards
- Traffic control/Region Traffic Engineer review
- Emergency plan/first aid procedures
- Ventilation constraints/ventilation testing protocols EJMT/HLT/WC
- Testing power and control systems EJMT/HLT/WC
- Testing lighting
- Testing VMS/LUS EJMT/HLT/WC
- Wall panel removal EJMT
- Confined space permit requirements, safety procedures, and access
- Staging of equipment and vehicles
- Proper use of access equipment
- CDOT participation in the inspection
- Entry protocols into the ventilation buildings and plenums EJMT/HLT/WC
- Lock-out/tag-out /power down procedures, EJMT/HLT/WC
- Communication protocols/two-way radio usage/communication center protocols
- Recent or planned facility improvements
- Essential repair finding reporting



No more than one week following this meeting, a written inspection work plan and safety plan should be provided to the CDOT Program Manager, the Maintenance Superintendent, and the Resident Engineer.

For more information refer to Chapter 4.5 of the TOMIE manual.

4.4.2 Existing Tunnel Records

Prior to or during the tunnel inspection, the inspection team shall obtain and perform a review of all relevant documents pertaining to the tunnel to be inspected. A concentrated effort should be made to obtain this information from the appropriate Maintenance Superintendent Office, Resident Engineer Office, Traffic Engineer Office, and CDOT Staff Bridge. This information shall include, but not be limited to, past inspection reports for both simple and Complex tunnels, routine functional systems tests and maintenance reports, design and as built drawings, tests performed by specialty contractors on Complex systems, photographs, Incident Management Plans, and relevant projects or modifications. Attention should be given to those elements that have been identified to be monitored in previous inspection reports. This task is intended to assist the inspection team in planning their inspection and in efficiently conducting the inspection.

It is recommended that all maintenance activities and documentation be discussed with tunnel personnel to adequately inspect and code the tunnel systems and system components. It is important to coordinate with tunnel maintenance personnel for details on scheduled activities taking place before, during, and after the inspection takes place.

4.4.3 Traffic Control

Lane closures for tunnel inspection work must be in conformance with the MUTCD and the appropriate Region Lane Closure Strategy which can be accessed on the CDOT web page listed below. Lane closures that do not comply with the Lane Closure Strategy must have written approval from the Region Traffic Engineer. CDOT personnel may provide traffic control for the tunnel inspection and/or wish to utilize the lane closures for additional work. This should be determined in the pre-inspection meeting with the Maintenance Superintendent. Requests for Colorado State Patrol presence in the work zone should be made at the pre-inspection meeting. The appropriate CDOT LTC Ops (see Appendix VIII: CDOT Organization and Hierarchy) will be the contact for CDOT traffic control. The appropriate LTC Ops should be contacted following the pre-inspection meeting with the Superintendent for planning purposes. A follow-up contact with the LTC Ops should be made one week prior to the inspection to confirm the traffic control details. Contact with the LTC Ops will follow the same process if a vendor is utilized to provide traffic control. If use of a vendor is required, ensure all Traffic Control Plans (TCP) or Method of Handling Traffic (MHT) plans, permit, and approval requirements are met through the Region Traffic Engineer. All MHTs shall follow current CDOT M&S Standards, MUTCD and the Colorado Supplement to the MUTCD, and the CDOT Standard Plans and Specifications.

CDOT Lane Closure Strategies by region can be found at the link below.

<https://www.codot.gov/library/traffic/work-zone-safety-and-work-zone-traffic-operations/lane-closure-strategies>



4.4.4 Confined Space Entry

Confined space entry activities shall be performed in strict conformance with OSHA regulations. Confined space exposure/activities shall be discussed during the pre-inspection meeting with the Maintenance Superintendent and included in the written work/safety plan. Notification/communication protocols and the emergency response/first aid plan will be discussed at this meeting. Confined space entry at the Complex tunnels will require Control Room notification. Confined space entry at the simple tunnels will require the appropriate LTC Ops (or their designee) notification. See Chapter 7 organizational chart and tunnel specific confined space entry procedures.

4.4.5 Lockout Tag-out

Lockout/Tag out procedures shall be discussed during the pre-inspection meeting with the Maintenance Superintendent and included in the written safety/work plan. Lockout Tag-out activities shall be performed by authorized CDOT personnel only and must have the approval and supervision of the appropriate LTC Ops or their designee (see Chapter 7). Examples of when lock out/tag out procedures may occur include:

- Inspection of the plenums EJMT/HLT
- Switchgear Inspection EJMT/HLT
- Inspection of the ventilation fans/motors EJMT/HLT/WC

4.4.6 Night Inspection Work

Night inspection may be necessary when traffic conditions dictate. Notifications for night inspections will follow the same protocols outlined in Section 4.4.3 of this manual. The traffic control plan for night inspections must have written approval of the Region Traffic Engineer. The following items should be provided at a minimum when performing inspections at night on the roadway:

- Personal Protective Equipment (PPE) shall meet all the requirements of ANSI/ISEA/OSHA/MUTCD/ 29 CFR
- Hard hats and Class 3 safety vests and reflective leggings (night time closure)
- Properly illuminated work zone
- Reflective traffic control devices placed with appropriate tapers, transitions, and spacing in accordance with MUTCD
- Reflective work signs in accordance with MUTCD
- Crash protection (i.e. crash attenuator)
- Reflective traffic control devices for advanced warning
- Reduced vehicle speeds
- Amber vehicle beacons



- Colorado State Patrol presence should be requested in the initial meeting with the Maintenance Superintendent

4.4.7 Pre-Inspection Preparation of Tunnel

Pre-inspection preparation of the tunnels will vary depending on the type of inspection and the complexity of the tunnel. Preparation should be discussed during the pre-inspection meeting with the Maintenance Superintendent, followed immediately by a discussion with the appropriate LTC Ops (See Appendix VIII: CDOT Organization and Hierarchy). A follow-up discussion with the LTC Ops should occur at least one week prior to the inspection to ensure that preparations have occurred. A few examples of preparations may include:

- Tunnel Wash EJMT/HLT/Veterans/No Name
- Survey Control or Locating findings during inspection
 - CDOT may install permanent stationing within each tunnel in the future
- Scheduled Power Outage (In-Depth/Special Inspections) EJMT/HLT/WC
- Highway By-Pass/Full Tunnel Closure
- Ceiling Panel Removal EJMT
- Wall Panel Removal EJMT
- Wall Panel Connector Covers Removal EJMT

4.5 Inspection Types and Frequencies

Inspections will be one of five types: Initial, Routine, In-depth, Special, and Damage. Inspection requirements are outlined in the subsequent sections.

| Inspection Type | Application | Interval | Purpose |
|-----------------|---------------------------------------|---|---|
| Initial | New tunnel | Prior to opening | Establish a condition baseline and gather SI&A information |
| Routine | Default condition/ monitor changes | Every 24 months or less; can be 48 months with approval from FHWA | Monitor element condition states at regular intervals (Submission required to FHWA) |
| Special | Monitoring known deficiencies | Established by the CDOT Program Manager | Observe and monitor known deficiencies at more regular intervals; determine if condition state is progressing |



| | | | |
|----------|---|---|--|
| In-Depth | For more Complex structural or functional systems | Established by the CDOT Program Manager | Identify hard to detect deficiencies by using more stringent inspection procedures on a specific system. In-Depth inspection may only be a singular element or system. |
| Damage | Safety after damage | After an event damages the tunnel | Document damage due to an event, ensure tunnel is safe to remain in service and is performing as intended |

For more information, refer to Section 4.6 of the TOMIE manual.

4.5.1 Initial Inspection

Initial Inspections are performed on newly-constructed tunnels prior to opening to traffic. Existing tunnels shall receive an Initial Inspection within 24 months the implementation of NTIS (7/15).

The initial inspection is performed to establish a baseline for future inspections. Initial inspection of CDOT simple and Complex tunnels shall require the compilation of existing tunnel elements for each tunnel and the observation and recording of condition states in accordance with this manual. Initial inspections will be performed in the same manner as the Routine Inspection outlined below. **Additionally**, initial inspections shall include inventory requirements with detailed reports regarding the tunnel elements in accordance with: this specification, the TOMIE, SNTI, and NTI. The initial inspection shall develop a complete list of inventory items including a list of elements identified by quantity and condition. Diagrams, sketches, and photographs may be included to further illustrate the various systems.

For more information, refer to Section 4.6.1 of the TOMIE manual.

4.5.2 Routine Inspection

Routine Inspections are performed every 24 months as long as the facility is open to traffic. However, they may be extended to 48 months with written approval from FHWA. Routine inspections are to be initiated within two months before or after the established target date. The inspection target start dates should be established according to the inspection interval policy of the tunnel.

Routine inspections evaluate all tunnel elements and systems and are performed to evaluate changes in the tunnel condition from the initial recorded condition or previous routine inspection findings. Typically, visual and quantitative assessments are used. The use of Non-Destructive Testing methodologies such as percussion sounding and infrared thermography are recommended for routine inspections. Sounding of liner and/or concrete elements is anticipated to occur at areas of concern and randomly to 10 percent of the element surface area.

All the applicable elements and systems are evaluated during each routine inspection. Routine inspections consist of eight element categories: structural, civil, mechanical, electrical and lighting, fire and life safety, security systems, signs, and protective systems.



Routine structural inspections assess the condition of structural elements of the tunnel such as tunnel liner, cross passageway, plenums, and interior walls.

Routine civil inspections assesses the condition of elements of the traveled roadway such as roadway surface, barrier, and hand rail.

Routine mechanical inspections assess the condition of ventilation, hydraulic, and other mechanical equipment used for tunnel operations.

Routine electrical and lighting inspections assess the condition of specific electrical elements such as power distribution systems, lighting system, and Emergency Distribution Systems.

Routine fire, life, safety, and security system inspections assess elements such as Fire Detection System, Fire Protection System, Emergency Communication System, and tunnel operations, security, and steel/concrete corrosion coatings, and fire protection coatings.

Routine signs inspections assess elements such as Traffic Signs, the proper operation of VMS, and the proper operation of LUS.

Examples of Routine Inspection tasks may include:

Structural

- Visual structural inspection of the tunnel liner
- Limited sounding and sounding performed in all areas identified visually or through infrared photography as needed plus random sounding of non-visually identified locations.
 - Mechanical access equipment may be necessary
- Visual structural assessment of plenum walls and floors at EJMT, HLT
- Visual structural assessment of cross passageway at EJMT, HLT
- Visual structural assessment of the portals
- Visual structural assessment of interior walls
- Non-destructive testing of specific structural elements
- Visual structural assessment of the condition of the joints (longitudinal and circumferential) for segmental liners
- Visual structural assessment of accessories, such as dowels, bolts and Gaskets
- Visual structural assessment of steel corrosion as indicated by rust stains and spalling in the reinforced concrete liners
- Visual inspections of structures and slopes above the tunnel portal

Civil

- Visual assessment of the barrier
- Visual assessment of the walkway
- Visual assessment of the handrail
- Visual assessment of the roadway



Mechanical

- Visual observation of each ventilation fan operating on all speeds at EJMT, HLT, WC
- Visual inspection of the fan mounting bolts and anchors for tightness at EJMT, HLT, WC
- Visual inspection of the fan motor housings for corrosion, damage, and leaks at EJMT, HLT, WC
- Visual observation of fan damper condition and operation at EJMT, WC
- Test the emergency fan stop controls for operability at EJMT, HLT (if applicable and approved as necessary by tunnel superintendent)
- Auditory observation of fan operation for vibration, squeals and grinding on every motor speed at EJMT, HLT, WC
- Visual observation of the emergency generator including support systems include fuel supply, oil tank, cooling and exhaust systems, remote radiators and auditory operation at EJMT, HLT
- Interview CDOT staff regarding drainage deficiencies. Visually inspect identified inlet and outlet locations (if accessible)
- Interview CDOT staff regarding deficiencies of the water reservoir, water line, water treatment plant and drinking water system. Visually inspect identified areas at EJMT
- Visual inspection of the drainage pumps for operability, noise, vibration, temperature and leakage
- Visual observation of carbon monoxide detectors and interview CDOT staff for system deficiencies at EJMT, HLT
- Perform thermographic inspection on systems (NAC) as necessary to supplement inspections and condition state assessment
- pH data evaluation for the Water Line for Fire Protection, EJMT

Electrical and Lighting

- Interview CDOT staff for the overall performance of the electrical system. Visually inspect identified deficient elements.
- Visual observation of the emergency power system including the emergency generator and associated automatic transfer switch(es) at EJMT, HLT
- Visual inspection of medium voltage transformer gauges for proper readings at EJMT, HLT
- Interview CDOT staff for overall performance of circuit breakers, protective relays, and Switchgear for deficiencies. Visually inspect identified deficient elements at EJMT, HLT
- Interview CDOT staff for overall performance of the overall lighting system during normal and emergency operating conditions including UPS operation, if applicable
- Visual inspection of conduit, light fixture, and supports

Fire/Life Safety/Security Systems

- Visual verification that Fire Detection System is operational in each zone at EJMT, HLT
- Visual verification that fire protection is operational in each zone at EJMT



- Review fire extinguisher maintenance records for compliance
- Superintendent to provide operation and flow of isolated hydrant(s)
- Visual inspection of standpipes at HLT and hydrants at EJMT
- Visual and basic operational evaluation of fire protection pump and heating systems
- Interview CDOT staff for deficiencies of the security system (i.e SCADA, CCTV). Visually inspect identified areas at EJMT, HLT, WC
- Visual and basic connectivity evaluation of emergency call phone systems (EJMT, HLT)

Signs

- Visual inspection of VMS operability, supports, and housing at EJMT, HLT, WC
- Visual inspection of LUS operability, supports, and housing at EJMT, HLT
- Visual inspection of tunnel owned Traffic Signs
- Visual inspection of tunnel Egress Signs

Protective Systems

- Visual inspection of ceramic tile EJMT, HLT, WC
- Visual inspection of porcelain enameled panels EJMT
- Visual inspection of epoxy coated concrete

For more information, refer to Section 4.6.2 of the TOMIE manual.

4.5.3 Special Inspections

Special Inspections are performed to monitor a known or suspected deficiency and the frequency will be established by the CDOT Program Manager. This type of inspection is usually only necessary in older or more Complex tunnels.

Special Inspections are usually performed following other types of inspection where a specific deficiency has been identified or as requested by the tunnel owner. Special Inspections shall occur only with the written approval/request of the CDOT Program Manager and the appropriate Maintenance Superintendent. Special Inspections may occur in intervals or specific times of the calendar year based on seasonal changes such as snowmelt/run-off.

Examples of Special Inspection tasks may include:

- Visual assessment of water infiltration at WC
- Visual assessment of berm drainage system at EJMT
- Measurement of the berm flow rate at EJMT

For more information, refer to Section 4.6.5 of the TOMIE manual.

4.5.4 In-Depth Inspections

In-Depth Inspections are close-up or hands-on inspections of tunnel elements to identify specific deficiencies that may not be visible during routine inspections. An In-Depth Inspection may be performed on one, several, or all elements or functional systems. The level and frequency will be established by the CDOT Program Manager. In-Depth Inspections may be performed on a routine interval or after a routine or Special Inspection as follow-up action regarding a specific tunnel element. Non-destructive testing procedures may be required to perform an adequate assessment of the tunnel elements. The tunnel inspection program manager is to determine the frequency and level of inspection to be performed. In-Depth Inspections may often require the assistance of discipline specific specialists or specialty contractors that require specific credentials to perform the work (i.e. NETA).

Examples of In-Depth Inspections may include:

Structural

- Sounding of all suspect locations of liner and up to 30 percent of the liner surface area at random.
- Detailed Infrared Thermography
- Half-cell electrical potential method
- Carbonation depth measurement test
- Covermeter testing
- Radiographic testing used to detect voids in the concrete and the position of stressing ducts.
- Ultrasonic pulse velocity testing, mainly used to measure the sound velocity of the concrete and hence the compressive strength of the concrete. In combination with Schmidt hammer testing, it is possible to get more accurate data about concrete strength.

Electrical

- Test medium voltage transformers in accordance with current NETA or other applicable standards, EJMT, HLT, WC
- Test fan motors in accordance with current NETA MTS or other applicable standards at EJMT, HLT, WC (ie polarization of fan windings, surge comparison test)
- Perform tests on the emergency generator(s) in accordance with current NFPA standards at EJMT, HLT, WC
- Test relays in accordance with current IEEE or other applicable standards at EJMT, HLT, WC
- Test circuit breakers in accordance with current IEEE or other applicable standards at EJMT, HLT, WC

Lighting

- Measure lighting levels at roadway level and compare to design and/or current IESNA standard

Mechanical

- Ventilation analysis and/or verification of flow rate per fan specification and design



- Vibration analysis for rotational equipment
- Oil sampling for motor and/or bearing assemblies

Fire Life Safety/Protection Systems

- Fire Detection tests in accordance with current NFPA standards
- Fire Protection System tests in accordance with current NFPA standards

For CDOT purposes, In-Depth Inspections may be based on average daily traffic (ADT) or the complexity of the tunnel system. It is anticipated that complex tunnel systems or those with high ADT, such as EJMT, should generally have an In-Depth Inspection Frequency no longer than 48 months. The extent and elements incorporated shall be determined by the CDOT inspection program manager however NETA compliant testing of primary electrical and mechanical equipment is to occur every 4 years at both EJMT and HLT. Tunnel Superintendents in conjunction with the specialty contractor will be critical in defining the scope and systems to be evaluated.

Non-Complex tunnels may have an in-depth frequency between 48 and 96 months depending on the types of systems and ADT. The systems to be periodically inspected and the frequency of the inspections will be determined by the CDOT Program Manager.

For more information, refer to Section 4.6.4 of the TOMIE manual.

4.5.5 Damage Inspections

Damage Inspections occur after damage is incurred by a natural or human induced event. Some of the most common events are: impact, fire, flood, seismic, or blast events. Damage Inspections shall be performed at the request of the CDOT Program Manager. Elements that may require inspection include but are not limited to the liner, tunnel ceiling, tunnel lights, handrail, sidewalk and barrier, VMS and LUS, portal, and jet fans. These inspections should be scheduled as soon as is plausible after the damage has occurred. This is to ensure the tunnel is in serviceable condition and no safety hazards exist that may endanger the traveling public. In some cases, the tunnel may need to be closed until the inspection has taken place.

For more information, refer to Section 4.6.3 of the TOMIE manual.

4.6 Health and Safety Procedures

The safe inspection of CDOT vehicular tunnels is the highest priority of the inspection team. Public safety and inspector safety protocols shall be defined in the early planning stages of the inspection. These protocols shall be addressed explicitly in the written inspection safety plan, communicated with CDOT staff, and discussed daily by the inspection team prior to each day's inspection. CDOT specific safety rules shall be reviewed and followed.

All safety procedures shall be performed in accordance with the written safety plan. The procedures shall enforce CDOT safety rules, OSHA, MUTCD, confined space, and other regulatory guidelines. The safety procedures will provide worker and traveling public safety. The safety procedures shall emphasize



personal safety of the inspectors and is to include, but is not limited to: proper PPE, air quality testing, emergency rescue, and the proper use of communication devices.

Public safety shall include but is not limited to: safe roadway lane closures and mitigation of potential overhead risks to the travelling public.

Inspectors should be aware of the written safety plan and CDOT safety rules. CDOT lane closure policies and the MUTCD procedures shall be followed at all times. Inspectors shall always utilize proper personal protection equipment (PPE). The Inspectors shall be aware of potential electrical hazards, de-energizing policies, and lockout/tag-out procedures. The inspection team shall be familiar with the appropriate use of two-way radios and communication protocols with the tunnel operators or other appropriate CDOT staff. The inspectors will be aware and adhere to CDOT requirements regarding access to the roadway, plenums, ventilation buildings, etc. Prior to initiating inspection activities, the team will perform a risk assessment of the structure for unique hazards, confined space issues, and potential exposure to hazardous materials. Prior to inspection, the team shall be aware of the emergency plan, first aid/rescue procedures, and Carbon Monoxide exposure limits. The safety goal of the inspection team shall be zero accidents and zero injuries.

Be sure to compare employer safety regulations with CDOT. If more than one safety procedure pertains to a safety element in the inspection, use the more stringent procedure.

For more information refer to Section 4.7 of the TOMIE manual

Safe Working Environment

The Team Leader and the inspection team shall make safety the first priority. Close coordination with CDOT personnel prior to, and during, inspections will protect the inspectors and the travelling public from potential danger.

The Team Leader shall develop a Risk /Hazard Assessment that includes:

- Written rules
- Emergency Plan
- First Aid/Rescue Procedures
- Appropriate Personal Protection Equipment (PPE)
- Egress-Plenums/Crosscuts
- Radio Communication
- Confined Space Training
- Traffic Control
- OSHA Regulations
- Hazmat/ Hazardous Materials Exposure
- Necessary Tools/Equipment

- Overhead Hazards/Access Equipment
- Electrical and Mechanical Hazards – Lock-out/Tag-out
- Carbon Monoxide Hazmat Exposure Limits
- Clean Work Area/Housekeeping
- Identify Near Misses

For more information refer to Section 4.7 of the TOMIE manual.

General Inspection Safety and Safety Equipment

It is important that appropriate safety equipment is utilized for the type of environment and tasks to be performed. Personal protective equipment (PPE) is designed to protect the individual from injury and death. Most of this equipment needs to be fitted for the individual to be effective. Some examples of standard PPE are: hard hat, goggles, ear plugs, dust mask or respirator, safety vest, gloves, boots, knee pads, and safety belts or harnesses. Additional safety equipment that meets appropriate industry standards should also be furnished for the inspection team. Additional equipment includes but is not limited to: appropriate devices for traffic control, first aid kits, flashlights, two-way radios appropriate for use in tunnels, and air quality monitoring equipment. Proper use of this equipment should be provided by a qualified safety representative. In addition to using proper PPE, field attire should be sturdy and fit properly. It should be appropriate for the climate of the tunnel and for the tasks to be performed. Loose attire can catch in elements of the tunnel and cause severe injury; be sure attire fits closely but is comfortable. A tool pouch is recommended to free the hands and correctly fitting leather gloves that do not greatly reduce dexterity.

4.6.1 Night Inspection Safety

Inspection of CDOT tunnels may require work to be performed at night to minimize negative traffic impact. Nighttime work comes with inherent dangers, such as: reduced visibility, increased average speed of traveling vehicles due to lower traffic congestion, and decreased performance of workers and drivers. It is important that safety of the inspection team and traveling public are stressed during night inspection work to account for accident prevention.

These inspections require additional equipment to ensure visibility. Equipment may include: lighting stations or floodlights, additional PPE, proper retro-reflective channeling devices and signage, and flashing warning lights. Class 3 full body reflectivity which includes leg reflectors in association with reflective vests is required. For more information on Performance Class 3 reflectivity requirements refer to ANSI/ISEA 107. When temporary traffic control is required for nighttime inspections, adequate lighting must be used without producing a disabling glare for road users, flaggers, or workers. All flagger stations must be illuminated except in emergency situations. For more information on temporary nighttime traffic control requirements refer to MUTCD Part 6. All night inspection protocols shall be addressed in the written safety plan prior to inspection and follow all state, employer, and federal requirements. When the requirements do not agree use the more stringent regulations.



4.6.2 Confined Space Safety

Confined spaces are spaces which are not designed for continuous occupancy of a worker and/or have a restricted entry or exit. They also must be large enough and so configured that an employee can bodily enter and perform assigned work. One example of a confined space within a tunnel is the air plenum. Plenums may be defined as “permit-required” confined spaces based on the OSHA definition of a potential hazardous atmosphere from dust and exhaust emitted from vehicles. Please consult the OSHA handbook and tunnel specific safety regulations regarding potential confined spaces and “permit-required” confined spaces. Proper equipment must be used to ensure inspector safety. Equipment includes, but it not limited to, respirators, radios, and air monitors.

When entering a confined area, the inspectors shall perform pre-entry air tests to ensure oxygen levels are acceptable for safe entry and in compliance with OSHA 1910.146 App B. Ventilation may be needed continuously for the duration of work and shall be monitored to ensure oxygen and gases are at safe levels. The table below is adapted from OSHA 1910.146 and gives recommended minimum conditions for non-permitted confined spaces.

| Recommended Minimum Conditions for Entry of Non-Permit Confined Spaces: | |
|--|---|
| Hazard | Requirement |
| Oxygen | Minimum 19.5% and Maximum 23.5% |
| Flammable Gases | No greater than 10% of lower flammable limit (LFL) |
| Hydrogen sulfide (H2S) | No greater than 10ppm |
| Carbon monoxide (CO) | No greater than 25ppm |
| Other toxic substances | No greater than Permissible Exposure Limit (PEL) for substance |
| Flammable Dusts | Must not reduce visibility <5' Does not have a concentration that meets or exceeds its lower flammable limit (LFL) |
| Engulfment hazards | No engulfment hazard may be present |
| Hazardous flows | Must be secured and locked/tagged out |
| Hazardous energies | Must be secured and locked/tagged out |
| External hazards | External hazards must be controlled |

Confined space entry forms and regulations shall be filled out according to employer based requirements and compared to CDOT regulations for conformity and completeness. When the requirements do not agree use the more stringent regulations. Be sure to discuss necessary permits and hazards during the



preliminary planning if confined space inspections are required and fill out all necessary preliminary checklists. If other toxic substances exist be sure to check their permissible exposure limits using OSHA regulations, employer requirements, and CDOT regulations. Again, use the most conservative requirements.

This type of inspection should be performed in teams, the Authorized Entrant and the Attendant. It is important both know emergency procedures and the symptoms or warning signs of exposure to potential hazards or prohibited conditions. Training to certify Permit-Required Confined Spaces (PRCS) workers must be provided.

For more information refer to Section 4.7.7 of the TOMIE manual.

4.6.3 Hazardous Materials

Asbestos and lead may be present within tunnels built before the 1980s. The General Industry asbestos standard promoted by the Occupational Safety and Health Administration (OSHA) is 29 CFR 1910.1001 and the lead standard is contained in 29 CFR 1910.1025. Coordinate with tunnel maintenance staff for the presence of possible hazardous materials located within the travelway, plenums, or other areas of the tunnel. Hazardous materials may also include vehicles traveling through the tunnels un-restricted; such as oil or gas trucks, or any other vehicle carrying a hazardous or flammable material.

For more information refer to Section 4.7.5 of the TOMIE manual.

4.6.4 Lockout/Tag-Out

Lockout/tag-out is a safety procedure used to ensure dangerous and hazardous equipment and machinery is turned off and kept off during inspection work. Improper lockout/tag-out procedures can result in electrical shock, injury from mechanical equipment, chemical exposure, and death. Lockout/tag-out procedures should be developed during inspection planning and implemented in coordination with the CDOT tunnel facility personnel. Complex tunnels EJMT and Hanging Lake have existing lockout/tag-out procedures already in place; however, coordination of these procedures with the tunnel staff should take place prior to the inspection.

Each machine or piece of equipment powered by more than cord and plug shall have a written Lock-Out/Tag-Out procedure developed for it. Before any work is to be performed in/on equipment try the stop/start switch controlling electrical or electrically driven equipment to verify the circuit and equipment is de-energized and in a safe position.

Please consult OSHA regulation procedures CFR 1910.147.

For more information refer to Section 4.7.6 of the TOMIE manual.

4.6.5 Traffic Control Safety

Uniform traffic control is needed for the safe and efficient transportation of goods and people. The *Manual on Uniform Traffic Control Devices* (MUTCD) sets minimum standards, provides guidance, and ensures uniformity. All traffic control shall adhere strictly with the MUTCD and the current Colorado



Standard Plans and Specifications and CDOT M&S Standards. It is also required to follow the proper CDOT Region Lane Closure Strategy and the approved traffic control plan signed by the Region Traffic Engineer.

Traffic control shall be used in the event travel lanes or shoulders are to be closed during the time of inspection for access to tunnel elements. The use of crash attenuators, electronic messaging, and VMS should be utilized whenever possible. Certified law enforcement presence should be considered as an added safety precaution whenever possible. For times and lane closure guidelines of state highways, consult the reference Region specific *CDOT Lane Closure Strategy* documents. Many tunnels have specific lane closure strategies already in use; these can be found in the region specific documentation. Specific traffic control protocols shall be addressed in the written safety plan prior to inspection and follow all state, employer, and federal requirements. When necessary, obtain the needed permits for road closures.

4.6.6 Overhead Power/Utility Lines

Occupational Health and Safety (OHS) regulations require elevated structures, machinery, and traveling vehicles maintain a minimum distance from high voltage power lines to prevent electrocution. When working in a tunnel, identify the route for all services within the tunnel and verify safe operational distances for traffic and equipment. Refer to the table below for OSHA recommended safe approach distance for qualified personnel when working around overhead power and utility lines.

| Operating Voltage between Conductors of Overhead Power Lines | Safe Limit of Approach Distance for Operation of Equipment |
|--|--|
| Up to 50 kV | 10 Feet |
| Over 50 kV | Increase clearance by 4 inches for every 10 kV above 50 kV |

Table X

| Operating Voltage between Conductors of Overhead Power Lines | Safe Limit of Approach Distance for Vehicles in transit with structures lowered |
|--|---|
| Up to 50 kV | 4 Feet |
| Over 50 kV | Increase clearance by 4 inches (10 centimeters) for every 10 kV above 50 kV |

| Safe Limit of Approach Distance for Qualified Employees (from Table S-5, 29 CFR 1910.333) | |
|---|---------------------------|
| Voltage range (phase to phase) | Minimum approach distance |
| 300V and less | Avoid Contact |
| Over 300V, not over 750V | 1 ft. 0 in. |

Click to return to:

Section 4



| | |
|-----------------------------|---------------------|
| Over 750V, not over 2kV | 1 ft. 6 in. (46 cm) |
| Over 2kV, not over 15kV | 2 ft. 0in. |
| Over 15kV, not over 37kV | 3 ft. 0 in. |
| Over 37kV, not over 87.5kV | 3 ft. 6 in. |
| Over 87.5kV, not over 121kV | 4 ft. 0 in. |
| Over 121kV, not over 140kV | 4 ft. 6 in. |

Note: If insulating barriers are installed to prevent contact with the lines, and if the barriers are rated for the voltage of the line being guarded and are not a part of or an attachment to the vehicle or its raised structure, the clearance may be reduced to a distance within the designed working dimensions of the insulating barrier.

More stringent distances may be required by CDOT. Be sure to verify these distances during the preliminary planning if high voltage powerlines and equipment exist in the tunnel to be inspected. Use the more stringent policies/procedures when carrying out the inspection.

4.6.7 Electrical/Arc Flash

There are many hazards associated with working on and around electrical systems. Arc Flash is a type of electrical discharge that produces light and heat in the form of an electric arc. It has enough energy to cause significant injury, fire, damage, and death. Temperatures can exceed 35,000 degrees Fahrenheit, have exceptional force, and ionize the air around it. Arc blasts can also result from the vaporizing metal expanding with explosive force. Due to limited access, confined spaces, and high powered industrial equipment, tunnels often have elevated arc flash hazards. Safe distances for high voltage lines and equipment must be determined and proper PPE utilized. Use the National Electrical Code (NFPA 70E) risk categories to determine proper PPE requirements. All personnel visiting sites where electrical hazards exist or may exist shall be familiar with the shock and arc flash protection boundary distances to avoid exposure to potential electrical hazards. Refer to the table below for the National Electrical Code (NFPA 70E) recommended distances and safety precautions when working around live electrical lines.

| Limited Approach Boundary (For Shock Protection) Based on System Voltage | | |
|---|-----------------------------|----------------------------|
| Nominal system voltage range phase to phase* | Exposed movable conductor** | Exposed fixed circuit part |
| Less than 50 V | Not specified | Not specified |
| 50-300 V | 10 ft 0 in | 3 ft 6 in |



| | | |
|----------------|------------|------------|
| 301-750 V | 10 ft 0 in | 3 ft 6 in |
| 751 v – 15 kV | 10 ft 0 in | 5 ft 0 in |
| 15.1 – 36 kV | 10 ft 0 in | 6 ft 0 in |
| 36-1 – 46 kV 3 | 10 ft 0 in | 8 ft 0 in |
| 46.1 – 72.5 kV | 10 ft 0 in | 8 ft 0 in |
| 72.6 – 121 kV | 10 ft 8 in | 8 ft 0 in |
| 138 - 145 kV | 11 ft 0 in | 19 ft 0 in |
| 161 – 169 kV | 11 ft 8 in | 11 ft 8 in |
| 230 – 242 kV | 13 ft 0 in | 13 ft 0 in |
| 45 – 362 kV | 15 ft 4 in | 15 ft 4 in |
| 500 – 550 kV | 19 ft 0 in | 19 ft 0 in |
| 765 – 800 kV | 23 ft 9 in | 23 ft 9 in |

Table X: Section of NFPA 70E Table 130.2(C)

Note: The limited approach boundary is determined by the voltage of the electrical equipment. Work performed within the limited approach boundary is allowed only by Qualified Personnel and with an Energized Electrical Work Permit. (Reference: NFPA 70E table 130.2(C))

*For single phase systems, select the range that is equal to the system’s maximum phase-to-ground voltage times 1.732.

**A condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.

The above table has limitations. If a condition exists outside the descriptions, an engineering based arc flash analysis study should be completed by a professional using specification from The Institute of Electrical and Electronics Engineers (IEEE 1584-2002). Only trained and authorized personnel shall be allowed to energize or de-energize electrical circuits or perform work of an electrical nature on electrical equipment. Electrical inspections must be conducted in accordance with the United States Standard NFPA 70E Standard for Electrical Safety in the Workplace.

More stringent approach boundaries may be required by CDOT during the inspection. Be sure to verify these distances and coordinate with tunnel personnel during the preliminary planning if electrical systems require testing or personnel will be in close proximity. Use the most stringent policies/procedures when carrying out the inspection.



4.6.8 Mobile and Mechanical Equipment

Every piece of equipment has its own set of unique hazards. A risk assessment should be conducted before the inspection to identify risks associated with the equipment being used. For example, hazards associated with using a scissor lift are: operating bad weather or on unstable ground, crush or pinch points, overloading with heavy objects, removing guardrails during operation, failure of lifting mechanism, operator error, falls due to improper tie offs, and arc flash due to proximity with electrical systems.

Equipment should only be operated by those who have adequate training and experience with the equipment in use.

Common risk mitigation techniques for mobile equipment include:

- Never occupy the space under a suspended load, or within range of the swing arm.
- Establish clear communication methods with the operator
- Remain a safe distance from power lines (see Section 4.6.6)
- Establish eye contact with the operator and communicate intentions; wait for acknowledgement from the operator before moving
- Regular maintenance and inspections on equipment by qualified personnel
- Only work from equipment that is purpose-built as a work platform
- When not in use equipment should be properly locked and protected from unwanted movement, with the moving parts in a resting position

Prior to the inspection review hazards associated with the equipment to be used.

Mechanical equipment presents hazards such as:

- Pinch points – where two parts move together, one in a circular motion (ex. belt drives, gear drives, and feed rollers)
- Wrap points – an exposed component that rotates, usually a shaft
- Shear points – edges of two moving parts move past each other, or a moving part moves against a stationary part.
- Crush points – points where two objects move towards each other, or one moves towards a stationary object
- Pull-in points - points where objects are pulled into the equipment, usually for processing

Use proper lock-out/ tag-out procedures to mitigate these hazards during the inspection. During mechanical inspections only authorized CDOT personnel are to operate tunnel equipment.

Please refer to TOMIE section 4.8 for information on detailed Inspection Equipment.



4.7 Inspection Techniques

Please refer to TOMIE Section 4.9 for information on detailed Inspection Techniques.

Section 5 Inspection Findings, Data Capture and Report Deliverables

- 5.1 Data Collecting and Deliverables 5.2
 - 5.1.1 Recommended Complex Tunnel Report Content..... 5.2
 - 5.1.2 Recommended Simple Tunnel Report Content..... 5.3
 - 5.1.3 Cover Page 5.3
 - 5.1.4 Tunnel Information..... 5.3
 - 5.1.5 Introduction 5.3
 - 5.1.6 Purpose and Scope 5.3
 - 5.1.7 General System Descriptions..... 5.3
 - 5.1.8 Inspection Procedures 5.4
 - 5.1.9 Structure Inventory and Appraisal Report..... 5.4
 - 5.1.10 Vertical Clearance Measurements 5.4
 - 5.1.11 Inspection Findings 5.5
 - 5.1.12 Inspection Results..... 5.5
 - 5.1.13 Recommendations..... 5.5
 - 5.1.14 Appendices 5.6
 - 5.1.15 Photographs..... 5.6
 - 5.1.16 Sketches..... 5.6
 - 5.1.17 Field Records..... 5.7
 - 5.1.18 Auxiliary Report 5.7
- 5.2 Essential Repair Findings (ERF) 5.8
- 5.3 Condition State 4 Review Procedures 5.9



5.1 Data Collecting and Deliverables

Before planning and performing inspections, it is important to understand the necessary deliverables to be included in the final report. Because of differences in scale, more deliverables are recommended for Complex tunnels. Be sure to verify with CDOT if any additional information is desired for a specific inspection.

Draft reports shall be submitted to the CDOT Program Manager within the following timeframes:

Complex tunnels: 90 business days from the date of inspection completion

Simply tunnels: 45 business days from the date of inspection completion

Following return of comments by CDOT and/or the CDOT Program Manager, final reports shall be submitted to the CDOT Program Manager and/or the owner within the following timeframes:

Complex tunnels: 30 business days

Simple tunnels: 15 business days

For additional information please refer to Section 4.12 of the TOMIE manual.

5.1.1 Recommended Complex Tunnel Report Content

- Cover Page
- Tunnel Information
- Executive Summary
- Introduction
- Table of Contents
- List of Tables
- List of Figures, Drawings, and Sketches
- List of Photographs
- List of References
- Purpose and Scope
- General System Descriptions
- Inspection Procedures and Techniques
- Structure Inventory and Appraisal Report (SI&A)
- Vertical Clearance Measurements
- Inspection Findings
- Inspection Results – Structural and Civil, Mechanical, Electrical
- Recommendations
- Appendices



BrM or other software entries may be required for complex tunnels in addition to a report containing additional information.

5.1.2 Recommended Simple Tunnel Report Content

- Cover Page
- Tunnel Information
- Structure Inventory and Appraisal Report (SI&A)
- Vertical Clearance Measurements
- Inspection Findings
- Photographs
- Sketches
- Maintenance Recommendations
- Notes – Valuable information for access or other information that may be useful for the next inspection

5.1.3 Cover Page

The cover page should consist of: the Tunnel Number, the Tunnel Name, the date of the inspection.

5.1.4 Tunnel Information

Before the introduction for On-System tunnels a table should be included that provides tunnel and inspection information. This should include: the Tunnel Number, the Tunnel Name, the CDOT Region, the Maintenance Section, the CDOT Program Engineer, the CDOT Resident Engineer, and the CDOT Maintenance Supervisor.

5.1.5 Introduction

The introduction of the report should include location, history, geometry, construction, and finishes information. Anything unique to the tunnel being inspected should also be addressed.

5.1.6 Purpose and Scope

The purpose and scope section should give an overall objective for the report and the main areas focused on for the inspection. It should describe the depth of the inspection for each system.

5.1.7 General System Descriptions

General system descriptions should give brief descriptions of the element systems to be inspected, how they operate, and any special considerations for the inspection process. This section may include as-built drawings or plans, access difficulties due to design, critical element descriptions, or unique systems. Existing maintenance, recent repairs, or rehabilitation projects may also be addressed in this section.

5.1.8 Inspection Procedures

This section of the report includes the planning and safety process, the inspection teams and their credentials, and the inspection protocol. A description of the processes for maintaining safe working conditions, consistent inspection documentation, and specific inspection procedures implemented are to be included in this section. The majority of this inspection should be developed during the planning stages of the inspection process with CDOT personnel input and be implemented during the inspection. This section must be clear for use in future inspections.

5.1.9 Structure Inventory and Appraisal Report

The Structure Inventory and Appraisal Report is to include all tunnel inventory items covered in Section 2 of this manual including: identification items, age and service items, classification items, geometric data items, inspection items, load rating and posting items, navigation items, and structure type and material items. They will be presented in the proper format as provided in Section 2.

5.1.10 Vertical Clearance Measurements

Vertical clearance measurements should be taken at all tunnels. Photographs of the posting signs, if applicable, should be presented in each inspection report and the posted value documented on the vertical clearance sheet. The vertical clearance measurements are to be taken at the face of the non-mountable obstruction (ie. Barrier), face of curb, or 2' from the interface of the roadway and tunnel liner for circular, oval, and horseshoe shaped tunnels where curbs or barriers do not exist. A non-mountable barrier shall be defined in this manual as a curb or barrier 6" in height and greater. Minimum measurements should also be recorded for each line of striping, including fog and lane demarcations, and the are over each shoulder or lane. Measurements shall be taken at each portal and significant feature which may result in the minimum clearance value. Document the location or stationing of the measurements. An example template is provided in Appendix X produced from an automated workbook.

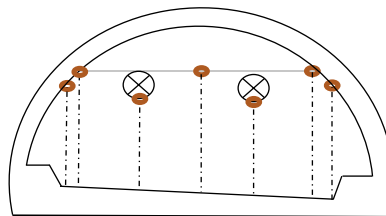


Figure X: Vertical Clearance Measurements

To determine if vertical clearance posting is needed review Table 1: Ranges for Minimum Vertical Clearance, from AASHTO: A Policy on Geometric Design of Highways and Streets.

| Type of Roadway | Rural (feet) | Urban (feet) |
|-----------------|--------------|--------------|
| Freeway | 14-16* | 14-16* |



| | | |
|-----------|-------|-------|
| Arterial | 14-16 | 14-16 |
| Collector | 14 | 14 |
| Local | 14 | 14 |

Table 1: Ranges for Minimum Vertical Clearance

*17 feet for sign trusses and pedestrian overpasses

On interstates, the vertical clearance should not be less than 16 feet for the entire roadway width and for other urban routes the vertical clearance should not be less than 14 feet, otherwise the roadway should be posted. Structures may be posted if they exceed the requirements.

5.1.11 Inspection Findings

The inspection finding report section is a summary of findings for each element. It will be in the form of an element level inspection report and contain: lists of Element Numbers and descriptions, quantity of the elements including the units, Condition State distribution of elements between states 1, 2, 3, and 4, and a detailed description of defects for each element and their location. Locations should be described in a manner that the defects can be easily found. The report will be in order of the Element Number and photographs and/or sketches will be provided for any elements with condition states of 3 or higher. If a structural review was performed on a defect, include the element, condition, review procedure, date of the review, and name of the reviewing Team Leader within the report.

Significant findings shall be classified as either a Critical Inspection Finding in accordance with the TOMIE or a CDOT specific Essential Repair Finding (ERF). The inspection Team Leader shall notify the CDOT Program Manager within 24 hours for a CIF and as directed by the CDOT Program Manager for an ERF. Section 5.2 will review necessary procedures for reporting ERFs. Ensure any ERF findings are clearly identified within and attached to the report.

Refer to Chapter 3 of this specification for more information on elements and condition states.

5.1.12 Inspection Results

The inspection report should be broken into subsections that include: structural, civil, mechanical, electrical and lighting, fire and life safety, security systems, signs, and protective systems. This section will describe the extent and types of defects found, as well as their general locations. It should also describe any special testing performed and the operational status for electrical and mechanical systems.

5.1.13 Asset Recommendations

Maintenance and/or project recommendations should be appropriate for the types of defects found and address if tunnel components meet current code requirements. To properly give rehabilitation and repair recommendations it is important to understand what types of routine maintenance is already being performed in the tunnel. A review of the maintenance records should be performed in the planning stages of the inspection process. A priority level, code associated with the task, and quantity will be given for



each maintenance item. If additional testing, In-Depth Inspections, or Special Inspections are recommended or required, they may also be coded within this section. If this is the case, ensure the proper procedures have been discussed with appropriate CDOT personnel. A list of CDOT maintenance codes and formatting requirements is given in Chapter 6 of this specification.

5.1.14 Appendices

Appendices should/may include: detailed work plan and scope, schedules, reports from special testing agencies, auxiliary report for buildings within the tunnel system, highly technical data related to the inspection, permits, field notes, inspection tools used, access equipment required, data sheets, as-built drawings, critical inspection areas, maintenance records, photographs, sketches, maps, useful information for planning future inspections, exc.

5.1.15 Photographs

Standard tunnel photographs shall be taken and ordered in the report as follows:

- Elevation looking in direction of inventory (Elevation looking East/North)
- Elevation looking in the reverse of inventory (Elevation looking West/South)
- General view looking in the direction of inventory of tunnel liner or travelway ceiling (General looking East/North)
- Approach roadway from inside the tunnel looking in inventory direction (Roadway looking East/North)
- Approach roadway from inside the tunnel looking in reverse inventory direction (Roadway looking West/South)
- General view of plenum(s) looking in the direction of inventory (General plenum looking East/North)
- All Minimum Vertical Clearance Signage, Hazmat Signage, or Load Posting Signage

Each photograph will also include a comment or description. Any general views of equipment and systems shall be placed after standard photographs followed by any deficiency photos. Deficiency photos shall be taken of elements or components of Condition State 3 or 4, specific maintenance items, and/or at the discretion of the inspection team leader. Deficiency photos are not required for every unit of an element; however, one is required for each type of defect for each element.

For example: if a large area of the tunnel liner is spalled, one photo of the typical conditions of the spall in the liner may be used to describe the defect condition state. If spalling also exists in the Concrete Ceiling Panels, another photo will be needed for the ceiling panel element.

5.1.16 Sketches

A standard simple sketch may be provided for each tunnel. This sketch will display the cross-section of the tunnel with standard dimensions such as height and width; it should also show a top view with the length of the tunnel in feet. This will provide a simple overall view of the tunnel. Many tunnels are not a straight path; however, the Tunnel Length is measured along the centerline of roadway between the exterior faces

of the portals and is recorded in inventory item G.1. The tunnel height and width, or diameter, are not recorded inventory items.

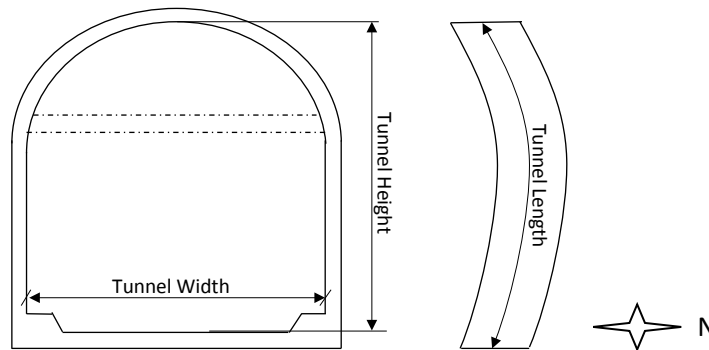


Figure X: Example of Simple Sketch

In-Depth Inspections may include sketches of defects plotted along the Tunnel Length. These sketches should record the defects length, width, and depth.

Please refer to Section 4.12 of the TOMIE Manual.

5.1.17 *Field Records*

Please refer to Section 4.12 of the TOMIE Manual.

5.1.18 *Auxiliary Report*

If portal buildings, booths, or ventilation buildings exist within the tunnel system an auxiliary report may be included. The report will assess the overall condition of the internal buildings and their effect on the serviceability of the tunnel.



5.2 Critical Inspection Finding / Essential Repair Findings

A Critical Inspection Finding (CIF) is defined in 23 CFR 650.305 as “A structural or safety related deficiency that requires immediate follow-up inspection or action.” As defined within the TOMIE Section 4.11.1, a Critical Finding is to be reported to the FHWA within 24 hours. Further clarification of qualifying defects indicates the following:

- Close the tunnel until the sever defect is removed or repaired, if the such defect may impact users or user safety
- Restrict the area from public access until the defect can be removed or repaired.
- Repair the structure member or address the functional or safety issue.

As such, any defect of a member or system that renders a portion of or the complete closure of a bore shall qualify as a CIF. Additionally if a finding poses an immediate and imminent safety hazard to the traveling public it is considered to qualify as a CIF.

Examples of Critical Inspection Findings may include but are not limited to:

- Delamination or incipient spall, in a Concrete Portal posing a direct safety hazard for traffic below
- Unarrested cracking in steel within tension zones of critical load bearing members
- Failure of emergency systems, or extremely poor conditions that affect the serviceability or safety of the tunnel
- Locked or nonfunctional egress doors

Essential Repair Findings (ERF) are supplemental and advanced notice to the owner however do not require notification to the FHWA via the CDOT Program Manager. Those inspection findings that are deemed by the Team Leader sufficient to warrant notification to owner beyond the inspection report shall be denoted as (ERF).

It is the responsibility of the Team Leader to inform the Consultant Program Manager and discuss the extent of the conditions. A structural review or systems analysis may be required at this point to determine if the strength and/or serviceability of the tunnel has been impacted. If necessary, the inspection Team Leader shall notify the tunnel superintendent, Consultant Program Manager, and appropriate maintenance personnel for the structure. The Consultant Program Manager will notify the CDOT Program Manager as soon as possible. All CIF's are to be submitted to the owner and/or CDOT Program Manager within 24 hours. It is the responsibility of the CDOT Program Manager to notify the FHWA Division Representative.

All CIF's and ERF's shall be documented via the template provided in Appendix XI. If necessary, email notification including all information within the template is acceptable for immediate notification provided follow up documentation is provided per the standard. All CIF's and ERF's shall be additionally documented via the CDOT tracking system developed by the Program Manager including follow up action taken by the owner when appropriate.



In general, a tunnel element with a portion in Condition State 4 is considered for either CIF or ERF. However, a rating of Condition State 4 does not necessarily qualify. If an CIF or ERF is filed, a Condition State 4 is warranted.

Examples of Condition State 4 that do not require supplemental notification are:

- Dripping or flowing water infiltration via the liner
- Steel or concrete protective coating has failed and is no longer protecting the underlying material

For more information on Essential Repair Findings (Critical Findings) refer to Section 4.11 of the TOMIE manual.

5.3 Condition State 4 Review Procedures

Any element defect that requires a review under Condition State 4, and is in Condition State 4, shall be reviewed by either the Team Leader and/or a professional engineer (PE) licensed in the State of Colorado. The review is to be documented in the inspection report in the element commentary section. The review information should include: a photograph of the defect, the date of the structural review, the extent of the damage for the element being reviewed, and the name of the Team Leader or PE who performed the review. This process will ensure this information is provided for future inspections and ease tracking of the defect over time. If the defect is deemed to not effect the serviceability of the tunnel, the quantity shall be placed in Condition State 3 and proper documentation provided as described to mitigate unnecessary further analysis. Ensure defect description and documentation is sufficient to monitor increase in severity in subsequent inspections to trigger repeat analysis, if necessary.

A Structural Review is defined within the Glossary included herein. Engineering judgement is an acceptable form of review provided the Team Leader or PE has appropriate training and expertise for the defect, element, or system being considered.

When a Condition State 4 is coded following a review, procedures for a CIF/ERF may be necessary. Follow the steps in Section 5.2 of this manual.

If an element is in Condition State 4 because of an immediate safety concern, ensure the reasoning is clearly communicated. Often an immediate safety concern does not imply large scale damage of the element or system but is a matter of location of the defect, such as over the roadway.

Examples of elements that may pose an immediate safety concern are:

- Delamination in the concrete or shotcrete liner of the tunnel directly over traffic that is in danger of breaking off and falling onto the roadway
- Rockfall danger in an unlined tunnel due to unstable blocks or slabs over the roadway
- Slope/ground instability at the portals
- Missing bolts or connectors on overhead equipment that creates unstable conditions

These elements may or may not warrant a structural review, however, because they pose an immediate safety concern to the traveling public the CDOT Staff Bridge Engineer, Program Manager, and



appropriate maintenance personnel should be notified. This process ensures safety issues are recognized and rectified in a timely manner.

Section 6 Asset Recommendations

| | |
|--|-----|
| 6.1 Introduction | 6.2 |
| 6.2 Functional Systems Test and Routine Maintenance | 6.2 |
| 6.3 Asset Recommendations per the Inspection..... | 6.3 |
| 6.3.1 Area of Repair | 6.3 |
| 6.3.2 NTIS/CDOT Element..... | 6.4 |
| 6.3.3 Action..... | 6.4 |
| 6.3.4 Category..... | 6.4 |
| 6.3.5 Priority | 6.5 |
| 6.3.6 Timeline | 6.7 |
| 6.3.7 Quantity and Type | 6.7 |
| 6.3.8 Auxiliary Tasks..... | 6.8 |
| 6.3.9 Estimated Cost..... | 6.8 |
| 6.3.10 Status | 6.8 |
| 6.3.11 Date Recommended | 6.9 |
| 6.3.12 Commentary of Recommendation | 6.9 |
| 6.4 Testing or Follow-Up Inspection Recommendations per the Inspection | 6.9 |



6.1 Introduction

An integral part of the inspection process is the inclusion of asset project and maintenance recommendations, hereafter called Asset Recommendations or recommendations. Recommendations assist owners in developing reactive and proactive programs to repair and maintain assets prolonging service life at desired performance and safety levels for the owner and traveling public while minimizing cost.

This section will introduce the components and methodology to the development and format of recommendations for CDOT assets as it pertains to the inspection process via Staff Bridge. The first section addresses current and existing routine maintenance, which tunnel operations staff facilitate regularly. The second section addresses how to code recommendations following an inspection and how it may be tracked. The third section addresses types of tests and procedures that may be recommended to gain further knowledge on a defect or system for the purpose of maintenance and/or condition assessment.

The purpose of this section is not to delineate how a tunnel should be maintained or repaired, rather organize how maintenance and repair should be recommended following an inspection.

For further information on recommended tunnel maintenance refer to Chapter 3 of the TOMIE manual.

6.2 Functional Systems Test and Routine Maintenance

The routinely scheduled maintenance duties at CDOT tunnels vary greatly depending on the Complexity of the tunnel. Tunnels with functional systems require considerably more routine functional tests, maintenance, and staff than those without to keep the tunnel operational. Age of the tunnel, average daily traffic, criticality, environment, and altitude all affect the level of maintenance provided.

In conjunction with the National Tunnel Inspection Standards will be measurable indices by which the FHWA will gauge compliance by state agencies. These will be referred to as metrics and as of the issuance of this manual, 15 are anticipated. Many of the metrics will be concerned with the inspection program, program staff qualifications, inspection timing, and thorough inspections similar to the National Bridge Inspection Standards. Due to the functional systems within tunnels however which require routine tests and maintenance actions at intervals less than the 24 month inspection frequency, the FHWA anticipates a metric to review the documented procedures as well as completeness and results.

CDOT personnel already perform preventative and on-demand maintenance. Utilizing the information provided in Appendix XII, described below, selection of actions and frequencies will assist in creation of a procedure for each tunnel or series of tunnels and standardized documentation of action taken throughout the state. A uniform documentation methodology will greatly aid the consistency and ease of review by both inspection staff and FHWA during annual compliance audits and Asset Management.

A thorough list of applicable functional systems tests, maintenance activities and their recommended frequencies has been compiled according to the documents listed below. The frequency documented identifies the most stringent and the document of origin. The applicable tunnel(s) has been identified according to each action in order to query the list for each tunnel or series of similar tunnels. I

- The Guide for the Preservation of Highway Tunnel Systems NCHRP 14-27 (Report 816)



- NETA – Frequency of Maintenance Tests
- IEEE
- TOMIE
- Best Practices for Roadway Tunnel Design, Construction, Maintenance, and Operations
- CDOT policies and current practices

Appendix XII: Maintenance Activities and Recommended Frequencies. This list is provided as a guide of common tunnel equipment maintenance procedures. These activities and frequencies may be modified by CDOT based on common practices, manufacturers recommendations, and facility needs. Routine maintenance activities should be documented and maintained for each piece of equipment based on the manufacturers recommendations. Example recording sheets have also been provided in Appendix XII.a: Example Maintenance Checklists.

The appendix material is still in development as of the issuance date

6.3 Asset Recommendations per the Inspection

The use of maintenance codes allows all inspection reports to be easily understood and compared with one another. This consistency provides improved accuracy of cost effective maintenance actions and the ability to observe when maintenance items were recommended and their status.

It is imperative for inspection personnel to consider both reactive and proactive recommendations during the course of the condition and operational evaluation of tunnel elements and systems. Beyond reactive, this may include systems upgrades to new technology, engineering or cost-benefit studies, safety improvements, and proactive measures to mitigate deterioration and increased future repair costs. For any element with Condition State 3 or 4, a recommendation shall be developed.

It may and often will be necessary to have overlapping recommendations to complete both reactive repair or proactive rehabilitation or replacement at a larger scale of the same defect, element, or system. This allows CDOT to weigh options and cost-benefit as well as risk in developing their asset management plan and fiscal needs.

When recommending an action for a particular defect, element, or system within the tunnel, the following fields must be populated and coded for each action.

6.3.1 Area of Repair

The following codes shall be used for coding of Area of Repair where the maintenance is recommended:

- Structural
- Civil
- Mechanical
- Electrical
- Fire Detection/Protection



- Life Safety
- Security Systems
- Signs
- Protective Systems

6.3.2 NTIS/CDOT Element

NTIS/CDOT Element code shall coincide with the element being repaired or maintained. This allows the recommendation to be “linked” to the specific tunnel element. Utilize the Element Numbers from Section 3 of this manual to code NTIS/CDOT Elements. In the event, multiple element codes are valid, use the most specific and appropriate element code for the recommendation.

Examples:

- 10001 – Cast-in Place Concrete Tunnel Liner
- 10601 – Tunnel Lighting Fixtures
- 10890 – Variable Message Board

6.3.3 Action

The Action code is based on a standardized set of CDOT specific repair codes used by CDOT Division of Maintenance to track items of repair and time within SAP. The list of action codes specific to tunnels is currently in development by Staff Bridge, Asset Management, and Division of Maintenance. A table of these codes will be included in the appendix when complete.

Actions and associated codes are in development, here are a few possible examples:

- 501.XX – Spall Repair
- 503.XX – Grease Motor
- 502.XX – Replace Lighting Fixture
- 505.XX – Repair Pipe Leak

6.3.4 Category

The category refers to the purpose and/or use of the recommendation. This code must be evaluated independently from Priority and Timeline codes. Listed below are the available codes for Category:

- Maintenance
Shall be utilized to identify repair requirements due to an element exhibiting localized defects. This may include repairs required due to normally anticipated deterioration mechanisms. Maintenance level repairs may include actions required to mitigate further deterioration.



- **Preventative**
Shall be utilized for cyclical preventative actions and may or may not be routinely scheduled due to length of cycle. Actions typically will pertain to products or components with anticipated service lives less than the structure or system design life. Examples may include cleaning, proactive joint replacement, application of concrete sealant, protective coatings, wearing surface replacement, motor drive belt, bearing grease, etc. This should not include actions which may affect structural or safety capacity and/or serviceability of the element, system, or structure.
- **Safety**
Shall be utilized to identify actions pertaining to a safety feature or defect that is a potential hazard to the traveling public or tunnel operation staff. This code is not to be utilized for structural or mechanical deficiencies that are already encompassed within the Repair category such as delaminated liner repairs that are over a roadway.
- **Rehabilitate**
Shall be utilized for projects intended to restore, add, or otherwise modify the capacity or serviceability of an existing element, system, or structure in an effort to significantly lengthen the service. This will likely involve engineering design. It shall not qualify as a replacement.
- **Replace**
Shall be utilized when elements, systems, or structure require replacement in their entirety and may involve replacement in kind, or of modified design.
- **Engineering**
Shall be utilized when engineering review/analysis is the primary requirement of the recommendation such as testing or analysis of systems, or in-depth or engineered analysis of a defect.
- **Not Applicable**
Shall be utilized in the event of all other categories deemed not suitable. For example, in the event of No Maintenance Required.

6.3.5 Priority

Priorities shall be set to maximize benefits in terms of cost and deterioration from maintenance as it relates to the service life, structural capacity and safety of the structure or associated elements. It is imperative that the Priority be evaluated independent from other Maintenance Elements including other recommendations and associated priorities for the same structure. Listed below are the available codes for Priority:

Relationship amongst diction:

Safety relates directly to the safety, real and not perceived, to the traveling public or inspection and maintenance personnel

Deterioration relates to degradation by normal deterioration mechanisms or wear and not potential external forces such as impact. Increases in deterioration over time results in: increase in repair cost and may lead to rehabilitation or replacement being required; decreased capacity (load or functional);

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Section 6



decrease in serviceability (affecting at the element or component is often defined as moderate while affecting the structure or system is often defined as high), and ultimately results in safety being of primary concern (load or functional).

Serviceability relates to the ability of an element, system, or structure to function without reduction to the safety of the traveling public.

Service life relates to the anticipated life in years of the element, system, or structure. Accelerated deterioration will lead to a reduced service life which will result at extreme conditions in a reduced serviceability and safety of the element, system, or structure.

- **Urgent**
Damage or immediate threat of damage creating an unsafe condition and/or imminent danger to the traveling public or key elements exist that degrade the physical condition and reduce the capacity of the structure or tunnel system. In the event an Urgent Priority is recommended, a CIF may also be required, see Section 5 for more information.
- **Critical**
An unsafe condition is present where danger to the traveling public is moderate. Devices or repairs are needed to protect an existing hazard. The condition has affected structural or system capacity to warrant a reduction in current serviceability. In the event a Critical Priority is recommended, an ERF may also be required, see Section 5 for more information.
- **High**
Conditions or advanced deterioration of key elements which has affected the current capacity, but not serviceability, and anticipated service life of the element, system, or structure requiring action to prolong the service life. If left uncorrected, the deterioration will likely accelerate resulting in increased repair costs and/or scope. Does not significantly affect safety at the time of inspection.
- **Moderate**
Conditions or deterioration exist which may affect the current capacity and/or shorten the service life of the element. If left uncorrected these conditions may accelerate deterioration of the element, system, or structure resulting in additional deterioration, maintenance, or increased repair cost and/or scope in the near future. Does not affect safety at the time of inspection.
- **Low**
Conditions or minor deterioration exist which may shorten the service life of the element but has minimal to no effect on the current capacity or serviceability of the element. If left uncorrected, these conditions may or may not accelerate deterioration of the localized defect resulting in a minor increase in future repair costs and/or scope. Does not affect safety at the time of inspection.
- **Monitor/Stable**
No maintenance is required immediately, or maintenance action cost-benefit is not efficient at this time. Conditions need to be noted for follow-up investigation to assure that conditions are



not worsening. Investigations recommended are to be done before the next inspection, this code is not to be used to address routine inspection procedures but may recommend for Special Inspection or monitoring.

- Non-Standard
Identify those items which are recommended for repair which are non-standard or impact current codes for the tunnel. This may include but is not limited to NFPA, ADA, or AASHTO standards.

6.3.6 *Timeline*

The recommended timeline shall be set in order to maximize the benefit from the maintenance to be performed and to mitigate cost increase due to subsequent deterioration. It is imperative that the Timeline be identified independent from the Priority. There will be inherent correlations; however, they should be viewed as independent. It will be unlikely to have the Timeline and Priority separated by extremes although possible. Listed below are the available codes for Timeline:

- Immediate
- Less than 1 year
- 1 to 2 years
- 2 to 5 years
- 5 to 10 years
- 10 to 20 years
- More than 20 years
- Not Applicable

6.3.7 *Quantity and Type*

The inspector shall use engineering judgment, references available, or measuring devices to quantify the material required for a given maintenance recommendation. In some cases, this may directly correlate to the condition state quantity for that element; however, that is not always the case. Listed below are the available codes for Quantity and Type:

- Cubic Yards (CY)
- Square Yards (SY)
- Cubic Feet (CF)
- Square Feet (SF)
- Lineal Feet (LF)
- Each (EA)
- Lump Sum (LS)



6.3.8 Auxiliary Tasks

The use of these tasks shall serve as a "flag" or notification to the tunnel owner of tasks and associated costs that may require inclusion into maintenance recommendations based on visual observations and site condition. This code will help adjust cost requirements based on situations that may impede repair or maintenance tasks. This code is separated into two parts to delineate the degree of conflict and level of effort required. Listed below are the available codes for Auxiliary Tasks:

Degree of Conflict

- Probable
- Possible
- Not Applicable

Level of Effort

- Access Difficulty
- Traffic Control
- Utility Conflict
- Environmental Conflict
- Right of Way Conflict
- Confined Space
- Other
- Not Applicable

6.3.9 Estimated Cost

Estimated Cost shall be based on information provided by the CDOT Tunnel Asset Management Team, most recent CDOT cost data book, CDOT Plant Maintenance Data, or engineering judgment. This estimate should not be attempted to include provision of auxiliary tasks as noted by the inspector. The cost shall be a product of the quantity and the standard unit cost provided by tunnel asset management.

Currently cost development is not included within the scope of inspection.

6.3.10 Status

The Status of each maintenance recommendation history is critical for tunnel owners to track recommendations provided by inspectors from year to year. Listed below are the available codes for Status:

- New
Used in the event a new recommendation has been added per the inspection.



- Existing
Used for existing recommendations which have not been completed or revised and are still valid for the current inspection.
- Revised
Used for existing recommendations which have been revised (including quantity, priority, and timeline) and are still valid for the current inspection.
- Completed
Used for non-cyclical recommendations which have been completed between inspections. After this code has been left as “Completed” for one cycle (typically 24 months) the maintenance recommendation is to be deleted.
- No Longer Valid
- Recurring
Used for maintenance recommendations that are new, existing, and/or completed but are recurring actions for the tunnel.

6.3.11 Date Recommended

- Utilize this field for the inspection date corresponding to the original date of recommendation. If it is recurring, use the most recent inspection date.

6.3.12 Commentary of Recommendation

The commentary for each recommendation must include: location, description of specific maintenance items to be improved, improvement, the type of defect, etc. If applicable, describe how the quantity for the maintenance item was derived.

6.4 Testing or Follow-Up Inspection Recommendations per the Inspection

Following an inspection, the condition of an element or the tunnel overall may warrant the need for follow-up action in the form of specific testing or follow-up inspections, such as a Special Inspection. These recommendations may be made in the recommendations section of the report (refer to previous section of the manual) but also must be discussed with tunnel owners, asset managers, and/or CDOT Program Manager.

Tunnel defects may be need or require a follow-up inspection or a regularly scheduled Special Inspection until the defect is mitigated or repaired. This type of inspection recommendation is required when an ERF has been filed. This will ensure the ERF is being addressed adequately for the CDOT Program Manager and possibly Team Leader for that inspection.

Tunnel deficiencies may also require further investigation to attain the cause or extent of the deficiency found in the field. One action that may take place is a meeting with the tunnel operator immediately following the inspection to verify any existing knowledge about the deficiency or possible causes which may exist in the area. If further investigation is needed the Team Leader or Consultant Project Manager



must follow up with the CDOT Project Manager to determine the testing procedure or type of Special Inspection needed for the situation.

Additional Testing or Follow-Up Inspection

- Special Inspection of Structural element
- Special Inspection of Civil
- Special Inspection of Mechanical
- Special Inspection of Electrical
- Special Inspection of Fire Detection/Protection
- Special Inspection of Life Safety
- Special Inspection of Security Systems
- Special Inspection of Signs
- Special Inspection of Protective Systems
- Testing for Geological Materials

The comments section for this item should include detailed information on the types of testing or investigation needed. Examples would be: infrared thermography of electrical systems, ground-coupled GRP investigation on sections of the tunnel liner, Special Inspection of the fan motors, Special Inspection of drainage system, exc. If an inspection is required after a repair has been performed on an ERF that should also be stated in this section, as well as the corresponding NTIS/CDOT Element from Section 6.3.2. A meeting should be held with the CDOT Program Manager and tunnel staff prior to coding this item to ensure the proper follow-up items are known and agreed upon. If an investigation or Special Inspection is not needed leave this item blank.



Section 7 Tunnel Specific Information

7.1 Introduction 7.2

7.2 Eisenhower and Johnson Memorial Tunnels..... 7.3

 7.2.1 Tunnel Information..... 7.3

 7.2.2 Unique Systems 7.3

 7.2.3 Emergency Response and Plan of Action 7.6

 7.2.4 Traffic Control Procedures..... 7.6

 7.2.5 Inspection Personnel 7.6

7.3 Hanging Lake Tunnels 7.7

 7.3.1 Tunnel Information..... 7.7

 7.3.2 Unique Systems 7.7

 7.3.3 Emergency Response and Plan of Action Provided by CDOT 7.8

 7.3.4 Traffic Control Procedures..... 7.9

 7.3.5 Inspection Personnel 7.9

7.4 Wolf Creek Tunnel 7.9

 7.4.1 Tunnel Information..... 7.9

 7.4.2 Unique Systems 7.9

 7.4.3 Inspection Personnel 7.10

 7.4.4 Traffic Control Procedures..... 7.10

7.5 Speer Blvd. Tunnel 7.11

 7.5.1 Unique Systems 7.11

7.6 Simple Tunnels..... 7.11

 7.6.1 Unlined Rock Tunnels 7.11

 7.6.2 Off-System Tunnels..... 7.11

 7.6.3 Traffic Control..... 7.11



7.1 Introduction

The following sections include overviews of specific or special inspection requirements and techniques, where applicable, and current CDOT practices for maintenance and testing of the tunnels systems. This section will outline unique procedures only. For information on standard testing and inspection procedures see Section 4.9 of the TOMIE Manual. For inspection staff requirements see Section 4.3 of this manual.

Full tunnel descriptions are located within each respective initial inspection report completed in either 2016 or 2017 following the implementation of the NTIS. CDOT tunnel classification, region, and staff identification are located in each respective inspection report and the CDOT organization charts located in Appendix IX: CDOT Organization and Hierarchy.

Complex tunnels in Colorado are limited to Eisenhower and Johnson Memorial Tunnels, Wolf Creek Tunnel, Hanging Lake Tunnels, and Speer Blvd. Tunnel. On-system simple tunnels are located in Regions 1, 3, 4, and 5 (see Appendix IV: Colorado Region Map). Simple off-system tunnels are located in Regions 1, 2, and 5.



7.2 Eisenhower and Johnson Memorial Tunnels

7.2.1 Tunnel Information

| | |
|---------------------------|-------------------|
| Tunnel No. | F-13-Y |
| Tunnel Alias | Eisenhower Tunnel |
| CDOT Region | 1 |
| Maintenance Section | 9 |
| Key CDOT Personnel | |
| Program Engineer | Steve Harelson |
| Resident Engineer | Neal Retzer |
| Maintenance Supervisor | Jeff Tatkenhorst |

| | |
|---------------------------|------------------|
| Tunnel No. | F-13-X |
| Tunnel Alias | Johnson Tunnel |
| CDOT Region | 1 |
| Maintenance Section | 9 |
| Key CDOT Personnel | |
| Program Engineer | Steve Harelson |
| Resident Engineer | Neal Retzer |
| Maintenance Supervisor | Jeff Tatkenhorst |

7.2.2 Unique Systems

Eisenhower Tunnel (F-13-Y) and Johnson Tunnel (F-13-X) are adjoining single bore complex tunnels. Many systems between the tunnels are shared. For full descriptions of the tunnels and their systems see the initial inspection reports.

The Plenums

Both Eisenhower and Johnson have supply and exhaust plenums that run the full bore lengths above the roadway. The plenums may be accessed from the ventilation buildings via the fan decks. A bulkhead

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exists at the mid-point of the plenums and a divider wall runs the full length to separate the supply and exhaust. Cross over doors exist in the bulkheads, egress hatches exist every 1,000 feet in the plenum floor, and supply/exhaust duct crossover doors exist every 1500 feet in the duct divider wall. The plenums are considered confined space entry and safety procedures must comply with Section 4.6.2 of this manual.

All related fans to the plenum, to be accessed, must be locked out by CDOT approved personnel using appropriate lockout/tag-out procedures prior to entry, see Section 4.6.4 of this manual. CDOT will typically maintain a single fan on low during the inspection. Communication with the EJMT control room is to be maintained at all times and the control room must be notified when personnel enter or exit the plenum.

The plenum divider wall is a critical inspection element due to the inspection difficulty of the hanger rods providing support for the concrete and steel ceiling panels. The supply/exhaust divider wall consists of 4 in. thick, precast, pre-stressed concrete panels. It should be thoroughly inspected for cracking, signs of movement, and changes in condition from previous reports. Movement or stresses within the divider walls may be indicative of defects with the embedded hanger rods. In 2010, five crack gauges were installed on the Eisenhower divider wall in the supply plenum for monitoring.

Tunnel False Ceiling

Suspended steel panel ceilings, also known as false ceilings, exist in the portal transition areas between the fan decks and the roadways of both Eisenhower and Johnson. The false ceiling areas can be accessed by ladder from either the Salt Room or through hatch doors in the wall of the large electrical room in the ventilation buildings. The false ceilings consist of steel hanger rods attached to steel channel ceiling girders which support steel ceiling panels. The gap between the ceiling panels and the floors of the plenum/fan deck ranges in height from 10' to 0'. The configuration of the panel floor and the significant amount of utilities make access in this area difficult.

The false ceilings are considered confined space entry and safety procedures must comply with Section 4.6.2 of this manual. At a minimum, dust masks are recommended. Communication with the control room should be maintained and the control room must be notified when personnel exit or enter the false ceiling area.

Inspectors should be familiar with the layout and numbering system used in previous reports for reporting consistency. CDOT staff should be notified of any loose divider wall hanger rod connections immediately. Hanger rods for the steel panels should be evaluated for loose connections, damage or pull through of the steel ceiling girder top flange and loose connections to the fan deck. It should be noted, that alterations in loading conditions has altered the need and resultant stresses in the hanger rods. Additionally, the false ceilings offer an opportunity to evaluate the building structure.

The false ceiling structure shall be inspected in conformance to 4.1.9.8 of the TOMIE Manual.

Waste Water Treatment Plant and Drinking Water Treatment System

The EJMT Waste Water Treatment Plant is located in the basement of the east ventilation building and is inventoried with the Eisenhower Tunnel. The Drinking Water Treatment System consists of an underground reservoir above the west portal building that feeds both portal buildings where the water



is treated and stored for consumption. The systems serve both Eisenhower and Johnson Tunnels, however, are inventoried with the Eisenhower Tunnel.

The plant operation and discharge permit limits should be reviewed and a visual inspection performed. Select functional/operational inspections of mechanical components to the plant should be considered. The Plant Operator and Tunnel supervisor should be interviewed regarding the system condition as part of the inspection process.

Sump pumps related to these systems should be inspected in accordance with Section 4.9.4.2 of the TOMIE Manual and reported as Element 10301 - Pumps.

Ventilation Buildings

The portal buildings exist on both sides of EJMT and house mechanical, electrical, and communication equipment, as well as offices for CDOT Tunnel Staff. A visual inspection of both the interior and exterior structural components of the portal buildings should be performed as part of the routine inspection. This shall include visual inspection of the ceilings, walls (interior and exterior), doors, windows and frames, stairs, roof, and floors. The front facades of the buildings are considered the portals and should be recorded in Element 10059 – Other Portal. This inspection may be limited to ground level, unless otherwise requested by CDOT, except at the portal facades where a manlift should be used for those portions above the roadway. Visual inspections should be accompanied with CDOT Tunnels Staff interviews on the building condition and ongoing maintenance including functionality of HVAC systems for employee and computer/server/systems controls equipment rooms.

Inspectors should be familiar with the layout and numbering system (plan gridlines) used in previous reports for reporting consistency. A report section on the portal building conditions should be provided in the final report. This section is currently reported with the Johnson Tunnel.

For information on inspection techniques see TOMIE Section 4.9.1.11 Miscellaneous Structural Checks.

Buttress Berm

The buttress berm is located above and between the east ventilation building and base of Loveland ski area. During the early years of tunnel construction, the berm received three large soil applications to stabilize the large landslide that occurred initially in 1963. The berm was equipped with inclinometers and extensometers to measure landslide movement which are no longer functional. The berm also has a buried horizontal 42” corrugated metal pipe and associated horizontal drains to collect mountain seepage.

The berm and landslide should be evaluated during each routine inspection to monitor for indications of movement and most notably any signs of global failure potential until otherwise directed by the CDOT Program Manager. Inspectors should be familiar with the historical documentation related to the berm and the EJMT Berm Evaluation dated November 28, 2017.

In-Depth Electrical Testing

In-depth testing of the electrical system is required every 48 months by specialty NETA certified technicians.

Visual and electrical testing must be compliant with NETA standards for all applicable equipment. The results should be reviewed by an electrical inspector and/or engineer and the testing report should be included in the appendix of the final report.

For information on inspection techniques see TOMIE Section 4.9.5 Electrical and Lighting Systems.

7.2.3 Emergency Response and Plan of Action

In the case of a fire within Eisenhower Johnson Memorial Tunnels (EJMT) the following safety procedures will take place.

- The Control Room Operator (CRO) will announce situation and location to all personnel by radio and phone. The M II will proceed to center section to bunker up and prepare for fire response.
- The CRO will advise portal attendants of fire and hold traffic to allow both tunnels to empty. Notifications will include: CSP, TOC, Summit/Clear Creek County, and Supervision using I-70 Incident Management guidelines.
- The CRO will turn on emergency exit strobes and use tunnel VMS to advise of the nearest exit. Response personnel will clear the remaining public from the fire scene by emergency exit by backing out or walking out tunnel entrances.

7.2.4 Traffic Control Procedures

Traffic control procedures shall be in conformance with Sections 4.4.3 and 4.6.5 of this manual and with the CDOT Region 1 Lane Closure Strategy. Follow the link below for the Colorado Department of Transportation Region 1 Lane Closure Strategy – Fourth Edition.

https://www.codot.gov/library/traffic/work-zone-safety-and-work-zone-traffic-operations/lane-closure-strategies/R1_Lane_Closure_Report.pdf

7.2.5 Inspection Personnel

For Eisenhower Johnson Memorial Tunnels, the inspection Team Leader should be a Professional Engineer registered in the state of Colorado and familiar with all structural, civil, and functional systems within the tunnel. Inspection leads are recommended for structural/civil, mechanical, and electrical disciplines. Geotechnical specialized inspectors are recommended for evaluation of the liner, embankments, and berm.

All Inspection team personnel qualifications shall conform to Section 4.3 of this manual and Section 4.4 of the TOMIE manual.



7.3 Hanging Lake Tunnels

7.3.1 Tunnel Information

| | |
|---------------------------|------------------------|
| Tunnel No. | F-08-AP |
| Tunnel Alias | Hanging Lake Tunnel EB |
| CDOT Region | 3 |
| Maintenance Section | 2 |
| Key CDOT Personnel | |
| Program Engineer | Roland Wagner (Acting) |
| Resident Engineer | Roland Wagner |
| Maintenance Supervisor | Mike Goolsby |

| | |
|---------------------------|------------------------|
| Tunnel No. | F-08-AQ |
| Tunnel Alias | Hanging Lake Tunnel WB |
| CDOT Region | 3 |
| Maintenance Section | 2 |
| Key CDOT Personnel | |
| Program Engineer | Roland Wagner (Acting) |
| Resident Engineer | Roland Wagner |
| Maintenance Supervisor | Mike Goolsby |

7.3.2 Unique Systems

The Hanging Lake Tunnels (F-08-AP and F-08-AQ) are adjoining single bore Complex tunnels. Many systems between the tunnels are shared. For full descriptions of the tunnels and their systems see the inspection reports.

Ceiling Structure

The ceiling structures of the Hanging Lake Tunnels are composed of corrugated metal plenum floor, bar joists, also known as open truss joists, and porcelain enamel glazed ceiling panels. The bar joists run

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transverse to the direction of the tunnel and are supported by longitudinally placed girders. Steel anchorage assemblies support the longitudinal girders embedded in the tunnel liner. These are the primary ceiling supports. Due to the metal plenum flooring panels and the vertical metal flashing, these elements are not visible for inspection.

Coordination with CDOT tunnel staff may be needed for removal of flooring panels and metal flashing for inspection of these elements and an In-Depth Inspection may be required for full evaluation.

Corrugated Metal Plenum Floor

Access within the plenums is provided by metal flooring panels attached to the tops of the ceiling structure bar joists with screws. The flooring panels often deform underfoot due to a relatively thin gauge of the floor material and many areas should be traveled with care.

During the plenum inspection, the conditions of the floor should be noted and provided as an ancillary section of the final reports.

Cinnamon Creak Complex

The Cinnamon Creek Complex is a building located at approximately the two-third point of the tunnels, from the west. It houses mechanical, electrical, and communication equipment, as well as offices for CDOT Tunnel Staff. A visual inspection of both the interior and exterior structural components of the Cinnamon Creek Complex should be performed as part of the routine inspection. This shall include visual inspection and analysis of the ceilings, walls (interior and exterior), doors, windows and frames, stairs, roof, floors, and vertical slopes around the structure exterior. This inspection may be limited to ground level, unless otherwise requested by CDOT. Visual inspections should be accompanied with CDOT Tunnels Staff interviews on the building condition and ongoing maintenance.

A report section on the portal building conditions should be provided in the final report. This section is currently reported with the Eastbound Tunnel (F-08-AP).

For information on inspection techniques see TOMIE Section 4.9.1.11 Miscellaneous Structural Checks.

In-Depth Electrical Testing

In-depth testing of the electrical system is required every 48 months by specialty NETA certified technicians.

Visual and electrical testing must be compliant with NETA standards for all applicable equipment. The results should be reviewed by an electrical inspector and/or engineer and the testing report should be included in the appendix of the final report.

For information on inspection techniques see TOMIE Section 4.9.5 Electrical and Lighting Systems.

7.3.3 Emergency Response and Plan of Action Provided by CDOT

When a fire is detected via CCTV, IR cameras, alarm, or phone, the Control Room Operator (CRO) will stop traffic into both tunnels at the portals. If the CRO observes or receives report of a fire they will begin the bore evacuation procedure and dispatch the response team over the P.A. systems. The CRO will then



dispatch 911 and advise them of the situation and request additional aid if necessary. CRO will then call tunnel supervisors and tunnel superintendent to inform of the situation.

7.3.4 Traffic Control Procedures

Traffic control procedures shall be in conformance with Sections 4.4.3 and 4.6.5 of this manual and with the CDOT Region 3 Lane Closure Strategy. Follow the link below for the Colorado Department of Transportation Region 3 Lane Closure Strategy – Fourth Edition.

https://www.codot.gov/library/traffic/work-zone-safety-and-work-zone-traffic-operations/lane-closure-strategies/R3_Lane_Closure_Report.pdf

7.3.5 Inspection Personnel

For the Hanging Lake Tunnels, the inspection Team Leader should be a Professional Engineer registered in the State of Colorado and familiar with all structural, civil, and functional systems within the tunnel. Inspection leads are recommended for structural/civil, mechanical, and electrical disciplines. Geotechnical specialized inspectors are recommended for evaluation of the liner and the rock embankments.

All inspection team personnel qualifications shall conform to Section 4.3 of this manual and Section 4.4 of the TOMIE manual.

7.4 Wolf Creek Tunnel

7.4.1 Tunnel Information

| | |
|---------------------------|------------------------|
| Tunnel No. | N-09-F |
| Tunnel Alias | Wolf Creek Pass Tunnel |
| CDOT Region | 5 |
| Maintenance Section | 7 |
| Key CDOT Personnel | |
| Program Engineer | Kevin Curry |
| Resident Engineer | |
| Maintenance Supervisor | David Vialpondo |

7.4.2 Unique Systems

The Wolf Creek Tunnel (N-09-F) is a single bore Complex tunnel with two-way traffic. For full descriptions of the tunnel and its systems see the inspection report.



Adits

Two shotcrete adits serve as emergency exits from the tunnel and are equipped with pressurization systems. When the door from the tunnel into the adit is opened, the system is designed to automatically turn on the adit fan and open the fan damper. An operational test of the pressurization system is required and all the system sub-components should be visually inspected. CDOT tunnels maintenance may be interviewed on reliability and any notable problems with the system.

The adits are recorded as Element 10033 – Shotcrete Cross Passageway and the pressurization system is recorded as Element 10202 – Adit Pressurization System.

7.4.3 Inspection Personnel

For Wolf Creek Tunnel, the inspection Team Leader should be a Professional Engineer registered in the State of Colorado and familiar with all structural, civil, and functional systems within the tunnel.. Inspection leads are recommended for structural/civil, mechanical, and electrical disciplines. Geotechnical specialized inspectors are recommended for evaluation of the liner and the rock embankments.

All inspection team personnel qualifications shall conform to Section 4.3 of this manual and Section 4.4 of the TOMIE manual.

7.4.4 Traffic Control Procedures

Traffic control procedures shall be in conformance with sections 4.4.3 and 4.6.5 of this manual and with the CDOT Region 5 Lane Closure Strategy. Follow the link below for the Colorado Department of Transportation Region 5 Lane Closure Strategy – Fourth Edition.

https://www.codot.gov/library/traffic/work-zone-safety-and-work-zone-traffic-operations/lane-closure-strategies/R5_Lane_Closure_Report.pdf



7.5 Speer Blvd. Tunnel

The Speer Blvd. Tunnel (D-01-CC-185) is the only Complex Off-System tunnel. It is owned and operated by the City and County of Denver and is the only tunnel in Colorado where the tunnel liner supports a direct traffic load. A Complex tunnel report format and tunnel informational table are not required for this tunnel. Additional information can be found in the inspection report.

7.5.1 Unique Systems

Liner Structure and Load Rating

The liner structure is composed of two parallel retaining (slurry) walls and a post-tensioned concrete tunnel lid that carries traffic over eastbound Speer Blvd. The condition state distribution for the tunnel lid should be determined based on the condition state tolerances for prestressed concrete.

Speer is the only tunnel within the Colorado inventory with a load rating. The load rating must be determined in accordance with Section 5.4 of the TOMIE, the CDOT Bridge Rating Manual, and the Manual for Bridge Evaluation. The load rating summary shall be included in the final report.

Roadway Above the Tunnel

Defects for the top of the tunnel structure should be recorded and documented. This includes the roadways, sidewalks, and curb and gutter. These defects may be noted as general comments within the report.

For information on inspection techniques see TOMIE Section 4.9.2 Civil Elements.

7.6 Simple Tunnels

7.6.1 Unlined Rock Tunnels

Many simple Unlined Rock Tunnels exist in Colorado. Geotechnical specialized inspectors are recommended for evaluation of the liner, rock quality, and potential hazards.

7.6.2 Off-System Tunnels

Owners of off-system tunnels should be notified prior and post the tunnel inspection. If available, maintenance staff may be interviewed on history of the tunnel, ongoing maintenance, and seasonal changes including rockfall frequency and volume. Inspection reports shall be provided to both the owner and CDOT.

7.6.3 Traffic Control

Traffic control shall be in conformance with Sections 4.4.3 and 4.6.5 of this manual.



Appendix I: Glossary

Appendix I.a: Acronyms

AASHTO – American Association of State Highway and Transportation Officials

AC – Alternating Current

AADT – Annual Average Daily Traffic

ADT – Average Daily Traffic

ADTT – Average Daily Truck Traffic

ANSI - American National Safety Institute

ASD - Allowable Stress Design

CCTV – Closed Circuit Television

CDOT – Colorado Department of Transportation

CO – Carbon Monoxide

CRO - Control Room Operator

CSP – Colorado State Patrol

CTIIM – Colorado Tunnel Inventory and Inspection Manual

CTMC – Colorado Transportation Management Center

DC – Direct Current

EJMT - Eisenhower/Johnson Memorial Tunnels

EHS – Environmental Health and Safety

ERF – Essential Repair Finding

ERP – Emergency Response Plan

FHWA – Federal Highway Administration

FIPS – Federal Information Processing Standard (standard codes for States)

gpm – gallons per minute

GPR - Ground-penetrating Radar

HLT - Hanging Lake Tunnel

HPMS - Highway Performance Monitoring System

HP – Horse Power

IEEE - Institute of Electrical and Electronics Engineers

kV – Kilovolts

Click to return to:



kW – Kilowatts

LFD - Load Factor Design

LRFR - Load and Resistance Factor

LRS - Linear Referencing System

LTC OPS – Labor Trades Crafts Operator Supervisory Position

LUS – Lane Usage Signal

MAP-21 - Move Ahead for Progress in the 21st Century Act

MUTCD - Manual on Uniform Traffic Control Devices

NCTI - Nationally Certified Tunnel Inspector

NDT – Non-destructive Testing

NETA - International Electrical Testing Association

NFPA – National Fire Protection Association

NHS – National Highway System

NTI – National Tunnel Inventory

NTIS – National Tunnel Inspection Standards

OSHA - Occupational Safety & Health Administration

OTIS - Colorado Department of Transportation’s Online Traffic Information System

PEI – Porcelain Enamel Institute

PPE – Personal Protection Equipment

PRCS - Permit-Required Confined Spaces

RF - Rating Factor

RTD – Region Transportation Director

SCADA – Supervisory Control and Data Acquisition System

SI&A – Tunnel Inventory Information

SNTI – Specifications for the National Tunnel Inventory

STRAHNET – Strategic Highway Network

TOC – Transportation Operations Center

TOMIE – Tunnel Operations, Maintenance, Inventory and Evaluation Manual

UPS – Uninterruptible Power Supply

VMS – Variable Matrix Sign

Click to return to:



WC - Wolf Creek Tunnel

Appendix I.b: Definitions

Abrasion – process of wearing or grinding away material

Air Plenum – void space to meet ventilation or HVAC purposes, provides pathway for return or supply of air

Alkali silica reactivity – an expansive reaction between the highly alkaline cement paste and reactive non-crystalline silica that results in swelling and expansion of the concrete

Approach roadway - roadway leading up to the tunnel within 100 feet of the portal; built on approach embankment

At-grade roadway - paved or unpaved travelways within the tunnel that carry vehicular traffic and are not suspended or supported by a structural system; on grade

Anchor bolt –shaft like piece of metal usually threaded on one end and fitted with a washer on one end, used to secure structures or machinery in a fixed position

Bearing – machine element that constrains relative motion to only the desired motion and reduces friction between moving parts; or a structural support element that transfers load from one structure to another while allowing limited movement

Chain Drag – series of short medium weight chains attached to T-shaped handle used as preliminary check for inspecting large areas for delamination

Chloride contamination – the presence of recrystallized soluble salts that cause accelerated corrosion of reinforcing steel

Check – crack in wood occurring with the grain and through the rings of annual growth

Chord – a line segment that joins two points on a curve

Complex tunnel - A tunnel characterized by advanced or unique structural elements or functional systems

Condition State – a rating given to an element in the structure based on its condition

Confined space – a space that is large enough to enter to perform work, but has limited access and is not designed for continuous occupancy.

Corrosion – disintegration of metal by oxidation

Crack – a break without complete separation of parts; fissure

Creep – inelastic deformation that increases with time as the stress is consistent

Cross Passageway - a bore typically oriented transverse to the tunnel bores, usually comprised of doors to allow egress between separated tunnel bores

Damage Inspection - an unscheduled inspection to assess structural damage resulting from environmental factors or human actions

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Defect – a physical condition that may negatively affect the original structural or operational capacity of a component

Deformation – distortion of a loaded structure, including plastic and non-recoverable movement

Delamination – subsurface separation of material into layers

Distortion – alteration of the original shape

Drummy Rock – weak, loose, or weathered rock that has a hollow sound when tapped

Efflorescence – white crystalline deposit on concrete or masonry caused by soluble salts brought to the surface by moisture

Element – a defined part of a tunnel system or structure that is needed for the tunnel to function as intended

Embankment – a raised bank intended to carry a load, or a raised area used to redirect water (bank)

Epoxy – synthetic resin that cures using a chemical reaction between components mixed together shortly before use

Erosion – the wearing away of soil or rock by moving water

Expansion joint – a joint designed to provide means for expansion and contraction movements in a structure

Facade – the principal front or face of a structure, usually decorative

Fatigue – the weakening of a material caused by cyclical loading

Fracture Critical Member (FCM) – a steel member in tension or with a tension component, whose failure would likely cause an entire portion of the structure to fail

Full-Transverse Ventilation – Ventilation system that uses two air ducts, one for the supply and one for the exhaust; tunnel bore is not generally used as part of the duct work in this method

Functional System – Non-structural systems, such as electrical, mechanical, fire suppression, ventilation, lighting, communications, monitoring, draining, Traffic Signals, emergency response (including egress, refuge room spacing, or carbon monoxide detection), or other traffic safety components

Galvanic action – electrical current between two unlike metals

Girder – flexural member used for horizontal support; usually composed of load bearing flanges separated by a supporting web

Guardrail – a safety feature element intended to redirect errant vehicle; or a rail that prevents people from falling or being hit by traffic

Gunite – Term commonly used for fine-aggregate shotcrete

Hands-on-inspection – Inspection within arm's length of the component

Hanger – a tension member serving to suspend an attached item

Click to return to:



Honeycomb – an area of concrete that was segregated during placement; mortar is separated from the aggregate; appears similar to a honeycomb

In-Depth Inspection – a close-up inspection of one, several, or all tunnel structural elements or functional systems to identify any deficiencies not readily detectable using routine inspection procedures; may be necessary at some locations; may occur more or less frequently than routine inspections

Initial inspection - The first inspection of a tunnel to provide all inventory and appraisal data and to determine the condition baseline of the structural and functional systems

Leaching – removing substance from a material by water passing through it

Legal load – The maximum legal load for each vehicle configuration permitted by law for the State in which the structure is located

Load rating - The determination of the live load carrying capacity within or above the tunnel using structural plans and supplemented by information gathered from a routine, in-depth or Special Inspection

Longitudinal Ventilation - simple ventilation system where mechanical fans, in conjunction with natural ventilation methods, push or pull air through the tunnel in the direction of the Tunnel Length

Mill scale – black iron oxide in iron or steel that has been forged or hot worked

National Tunnel Inspection Standards (NTIS) – Federal regulations establishing requirements for inspection procedures, frequency, personnel qualifications, inspection report deliverables, and preparation and maintenance of the tunnel inventory.

National Tunnel Inventory (NTI) – the collection of structure inventory and appraisal data collected to satisfy the requirements in the National Tunnel Inspection Standards

Natural ventilation– simple ventilation system where movement of air is controlled by meteorological conditions and the piston effect from vehicles

Necking –the elongation and contraction that occurs in an area when a ductile metal fails in tension

NFPA 502 – National Fire Protection Association’s Standard for Road Tunnels, Bridges, and other limited access highways, 2001 Edition. This standard provides fire protection and fire life safety requirements and establishes minimum requirements for each of the identified facilities.

Notch effect – stress concentration caused by an abrupt discontinuity or change in cross section

Oxidation – the chemical breakdown of a substance due to its reaction with oxygen

Pack Rust – corrosion forming in a tight or restricted area that tends to fill voids around close elements due to the increase in volume after oxidation

Permit-required confined space – a confined space that: contains or has the potential to contain a hazardous atmosphere, contains material with the potential to engulf someone, has internal configuration that can cause entrapment or asphyxiation, or contains any other serious safety or health hazard.

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Pop-outs – conical fragments that break out of the surface of a material leaving small holes

Portal – the entrance and exit of the tunnel exposed to the environment; may include bare rock, constructed tunnel entrance structure, or buildings

Program manager – the individual in charge of the program that has been assigned the responsibilities of tunnel inspection, reporting, and inventory

Routine inspection – regularly scheduled comprehensive inspection encompassing all tunnel structural elements and functional systems and consisting of observations and measurements needed to determine the physical and functional condition of the tunnel, to identify any changes from initial or previously recorded conditions, and to ensure that tunnel components continue to satisfy present service requirements

Rehabilitation - large scale restoration or repair developed with extended durations, substantial engineering input, and substantial cost

Scaling – the gradual deterioration of a concrete surface due to the failure of the cement paste, caused by chemical attack, poor water cement ratio during placement, or freeze/thaw cycles

Semi-Transverse Ventilation – ventilation system that uses mechanical fans and ductwork to equally distribute air; requires a plenum or ductwork usually located above the ceiling slab; many different types

Single Point Extraction – ventilation system used in conjunction with semi- and full-transverse systems; used to increase airflow

Special Inspection - inspection, scheduled at the discretion of the tunnel owner, used to monitor a particular known or suspected deficiency

Spring line – the horizontal line at which the intrados of an arch begins or originates

Spall – Depression in concrete caused by separation of a portion of the surface concrete, revealing a fracture parallel with or slightly inclined to the surface; a depression in the concrete caused by the separation of part of the surface concrete

Structural Review – the process that is followed when there is the need for assessment based on Condition State 4 definitions. Structural review shall be completed by either the Team Leader and/or a Professional Engineer in the state of Colorado.

Team leader – the individual responsible for planning, preparing, and performing inspections on individual tunnels

Tendon – cable, strand, or bar used as a prestressing cable

Tunnel – An enclosed roadway for motor vehicular traffic with vehicle access limited to portals, regardless of type of structure or method of construction. They do not include bridges or culverts inspected under the National Bridge Inspection Standards (23 CFR 650 – Subpart C – National Bridge Inspection Standards). Tunnels are structures that require, based on owner’s determination, special

Click to return to:



design considerations that may include lighting, ventilation, Fire Protection Systems, and emergency egress capacity

Tunnel inspector – individuals that assist the team leader with tunnel inspections

Ultrasonic testing – nondestructive testing of a materials integrity using sound waves

Wear – the gradual removal of surface material due to friction

Wearing Surface – the sacrificial portion of the exposed roadway that covers and protects the Invert Slab, other structural slab or serves as the roadway driving surface through a tunnel consisting of slab on grade or asphalt on grade.

Wingwall – wall extension or a smaller wall attached to a larger structure

Appendix I.c: References

AASHTO Manual for Bridge Evaluation

AASHTO Practical Guide to Cost Estimating

AASHTO Transportation Asset Management Guide

ACI 201.1R-08 Guide for Conducting a Visual Inspection of Concrete in Service

ACI 562-13 Concrete repair code

ANSI/NETA Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems

FHWA Highway and Rail Transit Tunnel Inspection Manual

FHWA Highway and Rail Transit Tunnel Maintenance and Rehabilitation Manual

FHWA Manual for Uniform Traffic Control

FHWA Specifications for the National Tunnel Inventory (SNTI)

FHWA Tunnel Operations, Maintenance, Inspection and Evaluation (TOMIE) Manual

FHWA Technical Manual for Design and Construction of Road Tunnels

International Infrastructure Management Manual

NCHRP Project 08-70 Uses of Risk Management and Data Management to Support Target-Setting for Performance-Based Resource Allocation by Transportation Agencies (NCHRP Report 706)

NCHRP Project 08-71 Estimating Life Expectancies of Highway Assets, Volumes 1 and 2 (NCHRP Report 713)

NCHRP Project 12-82 Developing Reliability-Based Bridge Inspection Practices (NCHRP Report 782)

NCHRP Project 14-21 Resource Allocation Logic Framework to Meet Highway Asset Preservation (NCHRP Report 736)

NCHRP Project 14-24 Communicating the Value of Preservation: A Playbook (NCHRP Report 742)

Click to return to:



NCHRP Project 14-27 Guide to the Preservation of Highway Tunnel Systems

NCHRP Project 20-57 Analytical Tools for Asset Management (NCHRP Report 545)

NCHRP Project 20-60 Performance Measures and Targets for Transportation Asset Management (NCHRP Report 551)

NCHRP Project 20-68A, Scan 09-05, Best Practices for Roadway Tunnel Design, Construction, Maintenance, Inspection and Operations

NCHRP Project 20-74 An Asset-Management Framework for the Interstate Highway System (NCHRP Report 632)

NFPA 25: Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems

NFPA 70: National Electric Code

NFPA 70B Recommended Practice for Electrical Equipment Maintenance, 2010 Edition

NFPA 72: National Fire Alarm and Signaling Code

NFPA 101: Life Safety Code

NFPA 110: Standard for Emergency and Standby Power Systems

NFPA 111: Standard on Stored Electrical Energy Emergency and Standby Power Systems

NFPA 502 Standard for Road Tunnels, Bridges and Other Limited Access Highways (2008 Edition)

OSHA Occupational Safety and Health Standards

PEI 501: Appearance Properties

PEI 502: Mechanical and Physical Properties

PEI 503: Resistance to Corrosion

PEI 504: High Temperature Properties

PEI 505: Electrical Properties

Underground Transportation Systems in Europe: Safety, Operations and Emergency Response

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Appendix II: Existing Colorado Tunnels

| Tunnel No. | Tunnel Name | County Code | Facility Carried | On or off System |
|-----------------|-------------------------|------------------|--------------------|------------------|
| B-15-E | Mishawaka | 069-Larimer | SH 14 | On-System |
| CHA371-02.50 | | 015-Chaffee | CR 371 | Off-System |
| CHA371-02.52 | | 015-Chaffee | CR 371 | Off-System |
| CHA371-02.55 | | 015-Chaffee | CR 371 | Off-System |
| CHA371-02.80 | | 015-Chaffee | CR 371 | Off-System |
| CSG-C.40-05.85T | | 041-El Paso | LOWER GOLD CAMP RD | Off-System |
| CSG-D.09-06.19T | | 041-El Paso | LOWER GOLD CAMP RD | Off-System |
| D-01-CC-185 | Speer Blvd | 031-Denver | SPEERSBD-0 | Off-System |
| D-15-AS | Boulder Canyon | 013-Boulder | SH 119 | On-System |
| D-27-MP-220 | Red Rocks | 031-Denver | Red Rocks Park Rd | Off-System |
| F-07-Q | No Name (WB) | 045- Garfield | I-70W | On-System |
| F-07-R | No Name (EB) | 045- Garfield | I-70E | On-System |
| F-08-AP | Hanging Lake (EB) | 045-Garfield | I-70E | On-System |
| F-08-AQ | Hanging Lake (WB) | 045-Garfield | I-70W | On-System |
| F-08-AT | Reverse Curve | 045-Garfield | I-70W | On-System |
| F-13-X | Johnson (EB) | 117-Summit | I-70E | On-System |
| F-13-Y | Eisenhower (WB) | 117-Summit | I-70W | On-System |
| F-15-AW | Clear Creek No. 3 | 059-Jefferson | US 6 | On-System |
| F-15-AX | Clear Creek No. 2 | 059-Jefferson | US 6 | On-System |
| F-15-AY | Clear Creak No. 1 | 059-Jefferson | US 6 | On-System |
| F-15-DM | Veteran's Memorial (WB) | 019- Clear Creek | I-70W | On-System |
| F-15-DN | Veteran's Memorial (EB) | 019- Clear Creek | I-70E | On-System |
| F-15-X | Clear Creek No. 6 | 019- Clear Creek | US 6 | On-System |

Click to return to:



| | | | | |
|-------------|-------------------|------------------|----------------|------------|
| F-15-Y | Clear Creek No. 5 | 019- Clear Creek | US 6 | On-System |
| FRCO 67-317 | | 043-Fremont | CR 67 | Off-System |
| FRCO-67-318 | | 043-Fremont | CR 67 | Off-System |
| H-03-BT | Beavertail WB | 077-Mesa | I-70W | On-System |
| H-03-BU | Beavertail EB | 077-Mesa | I-70E | On-System |
| L-06-P | Bear Creek | 091- Ouray | US 550 | On-System |
| N-09-F | Wolf Creek | 079-Mineral | US 160 | On-System |
| TELL-8-TUN | | 119-Teller | Gold Camp Road | Off-System |

Click to return to:



Appendix III: FIPS Place Codes

| <u>County</u> | <u>FIPS</u> | <u>County</u> | <u>FIPS</u> | <u>County</u> | <u>FIPS</u> | <u>County</u> | <u>FIPS</u> |
|---------------|-------------|---------------|-------------|---------------|-------------|---------------|-------------|
| Adams | 001 | Dolores | 033 | Lake | 065 | Pitkin | 097 |
| Alamosa | 003 | Douglas | 035 | La Plata | 067 | Prowers | 099 |
| Arapahoe | 005 | Eagle | 037 | Larimer | 069 | Pueblo | 101 |
| Archuleta | 007 | Elbert | 039 | Las Animas | 071 | Rio Blanco | 103 |
| Baca | 009 | El Paso | 041 | Lincoln | 073 | Rio Grande | 105 |
| Bent | 011 | Fremont | 043 | Logan | 075 | Routt | 107 |
| Boulder | 013 | Garfield | 045 | Mesa | 077 | Saguache | 109 |
| Chaffee | 015 | Gilpin | 047 | Mineral | 079 | San Juan | 111 |
| Cheyenne | 017 | Grand | 049 | Moffat | 081 | San Miguel | 113 |
| Clear Creek | 019 | Gunnison | 051 | Montezuma | 083 | Sedgwick | 115 |
| Conejos | 021 | Hinsdale | 053 | Montrose | 085 | Summit | 117 |
| Costilla | 023 | Huerfano | 055 | Morgan | 087 | Teller | 119 |
| Crowley | 025 | Jackson | 057 | Otero | 089 | Washington | 121 |
| Custer | 027 | Jefferson | 059 | Ouray | 091 | Weld | 123 |
| Delta | 029 | Kiowa | 061 | Park | 093 | Yuma | 125 |
| Denver | 031 | Kit Carson | 063 | Phillips | 095 | | |

City/Town/Municipality FIPS codes:

CDP = Census Designated Place

| <u>Municipality Name</u> | <u>DESIGNATION</u> | <u>FIPS</u> | <u>In County</u> | <u>County FIPS</u> |
|--------------------------|--------------------|-------------|------------------|--------------------|
| Berkley | CDP | 06172 | Adams | 001 |
| Acres Green | CDP | 00320 | Douglas | 035 |
| Aetna Estates | CDP | 00620 | Arapahoe | 005 |
| Aguilar | town | 00760 | Las Animas | 071 |
| Air Force Academy | CDP | 00870 | El Paso | 041 |
| Alamosa | city | 01090 | Alamosa | 003 |
| Alamosa East | CDP | 01145 | Alamosa | 003 |
| Allenspark | CDP | 01420 | Boulder | 013 |
| Alma | town | 01530 | Park | 093 |

Click to return to:



| | | | | |
|--------------------------|------|-------|--------------------------|---------------|
| Alpine | CDP | 01640 | Rio Grande | 105 |
| Altona | CDP | 01740 | Boulder | 013 |
| Amherst | CDP | 01915 | Phillips | 095 |
| Antonito | town | 02355 | Conejos | 021 |
| Applewood | CDP | 02575 | Jefferson | 059 |
| Arboles | CDP | 02905 | Archuleta | 007 |
| Aristocrat Ranchettes | CDP | 03015 | Weld | 123 |
| Arriba | town | 03235 | Lincoln | 073 |
| Arvada | city | 03455 | Adams, Jefferson | 001, 059 |
| Aspen | city | 03620 | Pitkin | 097 |
| Aspen Park | CDP | 03730 | Jefferson | 059 |
| Atwood | CDP | 03840 | Logan | 075 |
| Ault | town | 03950 | Weld | 123 |
| Aurora | city | 04000 | Adams, Arapahoe, Douglas | 001, 005, 035 |
| Avon | town | 04110 | Eagle | 037 |
| Avondale | CDP | 04165 | Pueblo | 101 |
| Bark Ranch | CDP | 04620 | Boulder | 013 |
| Basalt | town | 04935 | Eagle , Pitkin | 037, 097 |
| Battlement Mesa | CDP | 05120 | Garfield | 045 |
| Bayfield | town | 05265 | La Plata | 067 |
| Bennett | town | 06090 | Adams, Arapahoe | 001, 005 |
| Berthoud | town | 06255 | Larimer, Weld | 069, 123 |
| Bethune | town | 06530 | Kit Carson | 063 |
| Beulah Valley | CDP | 06602 | Pueblo | 101 |
| Black Forest | CDP | 06970 | El Paso | 041 |
| Black Hawk | city | 07025 | Gilpin | 047 |
| Blanca | town | 07190 | Costilla | 023 |
| Blende | CDP | 07245 | Pueblo | 101 |
| Blue River | town | 07410 | Summit | 117 |
| Blue Sky | CDP | 07420 | Morgan | 087 |
| Bonanza Mountain Estates | CDP | 07580 | Boulder | 013 |
| Bonanza | town | 07571 | Saguache | 109 |
| Boone | town | 07795 | Pueblo | 101 |
| Boulder | city | 07850 | Boulder | 013 |
| Bow Mar | town | 08070 | Arapahoe, Jefferson | 005, 059 |
| Brandon | CDP | 08290 | Kiowa | 061 |
| Branson | town | 08345 | Las Animas | 071 |
| Breckenridge | town | 08400 | Summit | 117 |
| Brick Center | CDP | 08530 | Arapahoe | 005 |
| Brighton | city | 08675 | Adams, Weld | 001, 123 |
| Brookside | town | 09115 | Fremont | 043 |
| Broomfield | city | 09280 | Broomfield | 014 |

Click to return to:



| | | | | |
|----------------------|------|-------|----------------------------|---------------|
| Brush | city | 09555 | Morgan | 087 |
| Buena Vista | town | 10105 | Chaffee | 015 |
| Burlington | city | 10600 | Kit Carson | 063 |
| Byers | CDP | 10985 | Arapahoe | 005 |
| Calhan | town | 11260 | El Paso | 041 |
| Campo | town | 11645 | Baca | 009 |
| Cañon City | city | 11810 | Fremont | 043 |
| Capulin | CDP | 11975 | Conejos | 021 |
| Carbondale | town | 12045 | Garfield | 045 |
| Cascade-Chipita Park | CDP | 12325 | El Paso | 041 |
| Castle Pines | CDP | 12387 | Douglas | 035 |
| Castle Pines North | city | 12390 | Douglas | 035 |
| Castle Rock | town | 12415 | Douglas | 035 |
| Cathedral | CDP | 12450 | Hinsdale | 053 |
| Catherine | CDP | 12460 | Garfield | 045 |
| Cattle Creek | CDP | 12470 | Garfield | 045 |
| Cedaredge | town | 12635 | Delta | 029 |
| Centennial | city | 12815 | Arapahoe | 005 |
| Center | town | 12855 | Rio Grande, Saguache | 105, 109 |
| Central City | city | 12910 | Clear Creek, Gilpin | 019, 047 |
| Chacra | CDP | 12945 | Garfield | 045 |
| Cheraw | town | 13460 | Otero | 089 |
| Cherry Creek | CDP | 13590 | Arapahoe | 005 |
| Cherry Hills Village | city | 13845 | Arapahoe | 005 |
| Cheyenne Wells | town | 14175 | Cheyenne | 017 |
| Cimarron Hills | CDP | 14587 | El Paso | 041 |
| City of Creede | town | 14765 | Mineral | 079 |
| Clifton | CDP | 15165 | Mesa | 077 |
| Coal Creek | CDP | 15302 | Boulder, Gilpin, Jefferson | 013, 047, 059 |
| Coal Creek | town | 15330 | Fremont | 043 |
| Coaldale | CDP | 15440 | Fremont | 043 |
| Cokedale | town | 15550 | Las Animas | 071 |
| Collbran | town | 15605 | Mesa | 077 |
| Colona | CDP | 15825 | Ouray | 091 |
| Colorado City | CDP | 15935 | Pueblo | 101 |
| Colorado Springs | city | 16000 | El Paso | 041 |
| Columbine | CDP | 16110 | Arapahoe, Jefferson | 005, 059 |
| Columbine Valley | town | 16385 | Arapahoe | 005 |
| Comanche Creek | CDP | 16465 | Arapahoe | 005 |
| Commerce City | city | 16495 | Adams | 001 |
| Conejos | CDP | 16715 | Conejos | 021 |
| Copper Mountain | CDP | 17150 | Summit | 117 |

Click to return to:



| | | | | |
|---------------------------|------|-------|-------------|-----|
| Cortez | city | 17375 | Montezuma | 083 |
| Cotopaxi | CDP | 17485 | Fremont | 043 |
| Craig | city | 17760 | Moffat | 081 |
| Crawford | town | 17925 | Delta | 029 |
| Crested Butte | town | 18310 | Gunnison | 051 |
| Crestone | town | 18420 | Saguache | 109 |
| Cripple Creek | city | 18530 | Teller | 119 |
| Crisman | CDP | 18585 | Boulder | 013 |
| Crook | town | 18640 | Logan | 075 |
| Crowley | town | 18750 | Crowley | 025 |
| Dacono | city | 19080 | Weld | 123 |
| Dakota Ridge | CDP | 19150 | Jefferson | 059 |
| De Beque | town | 19355 | Mesa | 077 |
| Deer Trail | town | 19630 | Arapahoe | 005 |
| Del Norte | town | 19795 | Rio Grande | 105 |
| Delta | city | 19850 | Delta | 029 |
| Denver | city | 20000 | Denver | 031 |
| Derby | CDP | 20275 | Adams | 001 |
| Dillon | town | 20440 | Summit | 117 |
| Dinosaur | town | 20495 | Moffat | 081 |
| Divide | CDP | 20605 | Teller | 119 |
| Dolores | town | 20770 | Montezuma | 083 |
| Dotsero | CDP | 21155 | Eagle | 037 |
| Dove Creek | town | 21265 | Dolores | 033 |
| Dove Valley | CDP | 21330 | Arapahoe | 005 |
| Downieville-Lawson-Dumont | CDP | 21390 | Clear Creek | 019 |
| Durango | city | 22035 | La Plata | 067 |
| Eads | town | 22145 | Kiowa | 061 |
| Eagle | town | 22200 | Eagle | 037 |
| East Pleasant View | CDP | 22575 | Jefferson | 059 |
| Eaton | town | 22860 | Weld | 123 |
| Eckley | town | 23025 | Yuma | 125 |
| Edgewater | city | 23135 | Jefferson | 059 |
| Edwards | CDP | 23300 | Eagle | 037 |
| El Jebel | CDP | 23795 | Eagle | 037 |
| El Moro | CDP | 24290 | Las Animas | 071 |
| Elbert | CDP | 23520 | Elbert | 039 |
| Eldora | CDP | 23575 | Boulder | 013 |
| Eldorado Springs | CDP | 23630 | Boulder | 013 |
| Elizabeth | town | 23740 | Elbert | 039 |
| Ellicott | CDP | 24235 | El Paso | 041 |
| Empire | town | 24620 | Clear Creek | 019 |

Click to return to:



| | | | | |
|------------------|------|-------|---------------|----------|
| Englewood | city | 24785 | Arapahoe | 005 |
| Erie | town | 24950 | Boulder, Weld | 013, 123 |
| Estes Park | town | 25115 | Larimer | 069 |
| Evans | city | 25280 | Weld | 123 |
| Evergreen | CDP | 25390 | Jefferson | 059 |
| Fairmount | CDP | 25550 | Jefferson | 059 |
| Fairplay | town | 25610 | Park | 093 |
| Federal Heights | city | 26270 | Adams | 001 |
| Firestone | town | 26600 | Weld | 123 |
| Flagler | town | 26765 | Kit Carson | 063 |
| Fleming | town | 26875 | Logan | 075 |
| Florence | city | 27040 | Fremont | 043 |
| Florissant | CDP | 27095 | Teller | 119 |
| Floyd Hill | CDP | 27175 | Clear Creek | 019 |
| Fort Carson | CDP | 27370 | El Paso | 041 |
| Fort Collins | city | 27425 | Larimer | 069 |
| Fort Garland | CDP | 27535 | Costilla | 023 |
| Fort Lupton | city | 27700 | Weld | 123 |
| Fort Morgan | city | 27810 | Morgan | 087 |
| Fountain | city | 27865 | El Paso | 041 |
| Fowler | town | 27975 | Otero | 089 |
| Foxfield | town | 28105 | Arapahoe | 005 |
| Franktown | CDP | 28250 | Douglas | 035 |
| Fraser | town | 28305 | Grand | 049 |
| Frederick | town | 28360 | Weld | 123 |
| Frisco | town | 28690 | Summit | 117 |
| Fruita | city | 28745 | Mesa | 077 |
| Fruitvale | CDP | 28800 | Mesa | 077 |
| Fulford | CDP | 28830 | Eagle | 037 |
| Garden | town | 29185 | Weld | 123 |
| Garfield | CDP | 29295 | Chaffee | 015 |
| Genesee | CDP | 29625 | Jefferson | 059 |
| Genoa | town | 29680 | Lincoln | 073 |
| Georgetown | town | 29735 | Clear Creek | 019 |
| Gerrard | CDP | 29845 | Rio Grande | 105 |
| Gilcrest | town | 29955 | Weld | 123 |
| Glendale | CDP | 30350 | Boulder | 013 |
| Glendale | city | 30340 | Arapahoe | 005 |
| Gleneagle | CDP | 30420 | El Paso | 041 |
| Glenwood Springs | city | 30780 | Garfield | 045 |
| Gold Hill | CDP | 30945 | Boulder | 013 |
| Golden | city | 30835 | Jefferson | 059 |

Click to return to:



| | | | | |
|----------------------|------|-------|-----------------|----------|
| Goldfield | CDP | 30890 | Teller | 119 |
| Granada | town | 31550 | Prowers | 099 |
| Granby | town | 31605 | Grand | 049 |
| Grand Junction | city | 31660 | Mesa | 077 |
| Grand Lake | town | 31715 | Grand | 049 |
| Grand View Estates | CDP | 31935 | Douglas | 035 |
| Greeley | city | 32155 | Weld | 123 |
| Green Mountain Falls | town | 32650 | El Paso, Teller | 041, 119 |
| Greenwood Village | city | 33035 | Arapahoe | 005 |
| Grover | town | 33310 | Weld | 123 |
| Guffey | CDP | 33420 | Park | 093 |
| Gunbarrel | CDP | 33502 | Boulder | 013 |
| Gunnison | city | 33640 | Gunnison | 051 |
| Gypsum | town | 33695 | Eagle | 037 |
| Hartman | town | 34520 | Prowers | 099 |
| Hasty | CDP | 34685 | Bent | 011 |
| Haswell | town | 34740 | Kiowa | 061 |
| Haxtun | town | 34960 | Phillips | 095 |
| Hayden | town | 35070 | Routt | 107 |
| Heeney | CDP | 35400 | Summit | 117 |
| Hidden Lake | CDP | 35860 | Boulder | 013 |
| Highlands Ranch | CDP | 36410 | Douglas | 035 |
| Hillrose | town | 36610 | Morgan | 087 |
| Hoehne | CDP | 36940 | Las Animas | 071 |
| Holly Hills | CDP | 37220 | Arapahoe | 005 |
| Holly | town | 37215 | Prowers | 099 |
| Holyoke | city | 37270 | Phillips | 095 |
| Hooper | town | 37380 | Alamosa | 003 |
| Hot Sulphur Springs | town | 37600 | Grand | 049 |
| Hotchkiss | town | 37545 | Delta | 029 |
| Howard | CDP | 37655 | Fremont | 043 |
| Hudson | town | 37820 | Weld | 123 |
| Hugo | town | 37875 | Lincoln | 073 |
| Idaho Springs | city | 38370 | Clear Creek | 019 |
| Idalia | CDP | 38425 | Yuma | 125 |
| Idledale | CDP | 38480 | Jefferson | 059 |
| Ignacio | town | 38535 | La Plata | 067 |
| Iliff | town | 38590 | Logan | 075 |
| Indian Hills | CDP | 38810 | Jefferson | 059 |
| Inverness | CDP | 38910 | Arapahoe | 005 |
| Jackson Lake | CDP | 39160 | Morgan | 087 |
| Jamestown | town | 39195 | Boulder | 013 |

Click to return to:



| | | | | |
|------------------|------|-------|------------------------------|---------------|
| Jansen | CDP | 39250 | Las Animas | 071 |
| Joes | CDP | 39745 | Yuma | 125 |
| Johnson Village | CDP | 39800 | Chaffee | 015 |
| Johnstown | town | 39855 | Larimer, Weld | 069, 123 |
| Julesburg | town | 39965 | Sedgwick | 115 |
| Keenesburg | town | 40185 | Weld | 123 |
| Ken Caryl | CDP | 40377 | Jefferson | 059 |
| Kersey | town | 40515 | Weld | 123 |
| Keystone | CDP | 40550 | Summit | 117 |
| Kim | town | 40570 | Las Animas | 071 |
| Kiowa | town | 40790 | Elbert | 039 |
| Kirk | CDP | 40900 | Yuma | 125 |
| Kit Carson | town | 41010 | Cheyenne | 017 |
| Kittredge | CDP | 41065 | Jefferson | 059 |
| Kremmling | town | 41560 | Grand | 049 |
| La Jara | town | 42055 | Conejos | 021 |
| La Junta | city | 42110 | Otero | 089 |
| La Junta Gardens | CDP | 42165 | Otero | 089 |
| La Salle | town | 43605 | Weld | 123 |
| La Veta | town | 44100 | Huerfano | 055 |
| Lafayette | city | 41835 | Boulder | 013 |
| Laird | CDP | 42000 | Yuma | 125 |
| Lake City | town | 42330 | Hinsdale | 053 |
| Lakeside | town | 42495 | Jefferson | 059 |
| Lakewood | city | 43000 | Jefferson | 059 |
| Lamar | city | 43110 | Prowers | 099 |
| Laporte | CDP | 43220 | Larimer | 069 |
| Larkspur | town | 43550 | Douglas | 035 |
| Las Animas | city | 43660 | Bent | 011 |
| Lazy Acres | CDP | 44270 | Boulder | 013 |
| Leadville | city | 44320 | Lake | 065 |
| Leadville North | CDP | 44375 | Lake | 065 |
| Lewis | CDP | 44595 | Montezuma | 083 |
| Leyner | CDP | 44695 | Boulder | 013 |
| Limon | town | 44980 | Lincoln | 073 |
| Lincoln Park | CDP | 45145 | Fremont | 043 |
| Littleton | city | 45255 | Arapahoe, Douglas, Jefferson | 005, 035, 059 |
| Lochbuie | town | 45530 | Adams, Weld | 001, 123 |
| Log Lane Village | town | 45695 | Morgan | 087 |
| Loughill Village | CDP | 45680 | Ouray | 091 |
| Loma | CDP | 45750 | Mesa | 077 |
| Lone Tree | city | 45955 | Douglas | 035 |

Click to return to:



| | | | | |
|---------------------|------|-------|---------------|----------|
| Longmont | city | 45970 | Boulder, Weld | 013, 123 |
| Louisville | city | 46355 | Boulder | 013 |
| Louviers | CDP | 46410 | Douglas | 035 |
| Loveland | city | 46465 | Larimer | 069 |
| Lynn | CDP | 47015 | Las Animas | 071 |
| Lyons | town | 47070 | Boulder | 013 |
| Manassa | town | 48060 | Conejos | 021 |
| Mancos | town | 48115 | Montezuma | 083 |
| Manitou Springs | city | 48445 | El Paso | 041 |
| Manzanola | town | 48500 | Otero | 089 |
| Marble | town | 48555 | Gunnison | 051 |
| Maybell | CDP | 49325 | Moffat | 081 |
| Maysville | CDP | 49490 | Chaffee | 015 |
| McCoy | CDP | 47345 | Eagle | 037 |
| Mead | town | 49600 | Weld | 123 |
| Meeker | town | 49875 | Rio Blanco | 103 |
| Meridian | CDP | 50012 | Douglas | 035 |
| Merino | town | 50040 | Logan | 075 |
| Midland | CDP | 50380 | Teller | 119 |
| Milliken | town | 50480 | Weld | 123 |
| Minturn | town | 50920 | Eagle | 037 |
| Moffat | town | 51250 | Saguache | 109 |
| Monte Vista | city | 51635 | Rio Grande | 105 |
| Montezuma | town | 51690 | Summit | 117 |
| Montrose | city | 51745 | Montrose | 085 |
| Monument | town | 51800 | El Paso | 041 |
| Morgan Heights | CDP | 51975 | Morgan | 087 |
| Morrison | town | 52075 | Jefferson | 059 |
| Mount Crested Butte | town | 52570 | Gunnison | 051 |
| Mountain Meadows | CDP | 52210 | Boulder | 013 |
| Mountain View | town | 52350 | Jefferson | 059 |
| Mountain Village | town | 52550 | San Miguel | 113 |
| Mulford | CDP | 52820 | Garfield | 045 |
| Naturita | town | 53120 | Montrose | 085 |
| Nederland | town | 53175 | Boulder | 013 |
| New Castle | town | 53395 | Garfield | 045 |
| Niwot | CDP | 53780 | Boulder | 013 |
| No Name | CDP | 53875 | Garfield | 045 |
| Norrie | CDP | 53945 | Pitkin | 097 |
| North La Junta | CDP | 54495 | Otero | 089 |
| North Washington | CDP | 54750 | Adams | 001 |
| Northglenn | city | 54330 | Adams, Weld | 001, 123 |

Click to return to:



| | | | | |
|-----------------|------|-------|------------|-----|
| Norwood | town | 54880 | San Miguel | 113 |
| Nucla | town | 54935 | Montrose | 085 |
| Nunn | town | 55045 | Weld | 123 |
| Oak Creek | town | 55155 | Routt | 107 |
| Olathe | town | 55540 | Montrose | 085 |
| Olney Springs | town | 55705 | Crowley | 025 |
| Ophir | town | 55870 | San Miguel | 113 |
| Orchard | CDP | 55925 | Morgan | 087 |
| Orchard | town | 55980 | Delta | 029 |
| Orchard Mesa | CDP | 56035 | Mesa | 077 |
| Ordway | town | 56145 | Crowley | 025 |
| Otis | town | 56365 | Washington | 121 |
| Ouray | city | 56420 | Ouray | 091 |
| Ovid | town | 56475 | Sedgwick | 115 |
| Padroni | CDP | 56695 | Logan | 075 |
| Pagosa Springs | town | 56860 | Archuleta | 007 |
| Palisade | town | 56970 | Mesa | 077 |
| Palmer Lake | town | 57025 | El Paso | 041 |
| Paoli | town | 57245 | Phillips | 095 |
| Paonia | town | 57300 | Delta | 029 |
| Parachute | town | 57400 | Garfield | 045 |
| Paragon Estates | CDP | 57445 | Boulder | 013 |
| Parker | town | 57630 | Douglas | 035 |
| Parshall | CDP | 57850 | Grand | 049 |
| Peetz | town | 58235 | Logan | 075 |
| Penrose | CDP | 58400 | Fremont | 043 |
| Peoria | CDP | 58510 | Arapahoe | 005 |
| Perry Park | CDP | 58592 | Douglas | 035 |
| Peyton | CDP | 58675 | El Paso | 041 |
| Phippsburg | CDP | 58758 | Routt | 107 |
| Piedra | CDP | 58960 | Hinsdale | 053 |
| Pierce | town | 59005 | Weld | 123 |
| Pine Brook Hill | CDP | 59240 | Boulder | 013 |
| Pitkin | town | 59830 | Gunnison | 051 |
| Platteville | town | 60160 | Weld | 123 |
| Poncha Springs | town | 60600 | Chaffee | 015 |
| Ponderosa Park | CDP | 60655 | Elbert | 039 |
| Portland | CDP | 60765 | Ouray | 091 |
| Pritchett | town | 61315 | Baca | 009 |
| Pueblo | city | 62000 | Pueblo | 101 |
| Pueblo West | CDP | 62220 | Pueblo | 101 |
| Ramah | town | 62660 | El Paso | 041 |

Click to return to:



| | | | | |
|---------------------|------|-------|-------------|-----|
| Rangely | town | 62880 | Rio Blanco | 103 |
| Raymer (New Raymer) | town | 63045 | Weld | 123 |
| Red Cliff | town | 63265 | Eagle | 037 |
| Red Feather Lakes | CDP | 63320 | Larimer | 069 |
| Redlands | CDP | 63375 | Mesa | 077 |
| Redstone | CDP | 63650 | Pitkin | 097 |
| Redvale | CDP | 63705 | Montrose | 085 |
| Rico | town | 64090 | Dolores | 033 |
| Ridgway | town | 64200 | Ouray | 091 |
| Rifle | city | 64255 | Garfield | 045 |
| Rock Creek Park | CDP | 64870 | El Paso | 041 |
| Rockvale | town | 64970 | Fremont | 043 |
| Rocky Ford | city | 65190 | Otero | 089 |
| Rollinsville | CDP | 65685 | Gilpin | 047 |
| Romeo | town | 65740 | Conejos | 021 |
| Roxborough Park | CDP | 66197 | Douglas | 035 |
| Rye | town | 66895 | Pueblo | 101 |
| Saddle Ridge | CDP | 66995 | Morgan | 087 |
| Saguache | town | 67005 | Saguache | 109 |
| Salida | city | 67280 | Chaffee | 015 |
| Salt Creek | CDP | 67445 | Pueblo | 101 |
| San Acacio | CDP | 67500 | Costilla | 023 |
| San Luis | town | 68105 | Costilla | 023 |
| Sanford | town | 67830 | Conejos | 021 |
| Sawpit | town | 68655 | San Miguel | 113 |
| Security-Widefield | CDP | 68847 | El Paso | 041 |
| Sedalia | CDP | 68875 | Douglas | 035 |
| Sedgwick | town | 68930 | Sedgwick | 115 |
| Segundo | CDP | 68985 | Las Animas | 071 |
| Seibert | town | 69040 | Kit Carson | 063 |
| Seven Hills | CDP | 69110 | Boulder | 013 |
| Severance | town | 69150 | Weld | 123 |
| Shaw Heights | CDP | 69480 | Adams | 001 |
| Sheridan | city | 69645 | Arapahoe | 005 |
| Sheridan Lake | town | 69700 | Kiowa | 061 |
| Sherrelwood | CDP | 69810 | Adams | 001 |
| Silt | town | 70195 | Garfield | 045 |
| Silver Cliff | town | 70250 | Custer | 027 |
| Silver Plume | town | 70360 | Clear Creek | 019 |
| Silverthorne | town | 70525 | Summit | 117 |
| Silverton | town | 70580 | San Juan | 111 |
| Simla | town | 70635 | Elbert | 039 |

Click to return to:



| | | | | |
|-------------------|------|-------|--------------------|----------|
| Smelertown | CDP | 71625 | Chaffee | 015 |
| Snowmass Village | town | 71755 | Pitkin | 097 |
| Snyder | CDP | 71790 | Morgan | 087 |
| South Fork | town | 72395 | Rio Grande | 105 |
| Southern Ute | CDP | 72320 | La Plata | 067 |
| Springfield | town | 73330 | Baca | 009 |
| St. Ann Highlands | CDP | 67040 | Boulder | 013 |
| St. Mary's | CDP | 67142 | Clear Creek | 019 |
| Starkville | town | 73715 | Las Animas | 071 |
| Steamboat Springs | city | 73825 | Routt | 107 |
| Sterling | city | 73935 | Logan | 075 |
| Stonegate | CDP | 74080 | Douglas | 035 |
| Stonewall Gap | CDP | 74275 | Las Animas | 071 |
| Strasburg | CDP | 74375 | Adams, Arapahoe | 001, 005 |
| Stratmoor | CDP | 74430 | El Paso | 041 |
| Stratton | town | 74485 | Kit Carson | 063 |
| Sugar City | town | 74815 | Crowley | 025 |
| Sugarloaf | CDP | 74980 | Boulder | 013 |
| Sunshine | CDP | 75585 | Boulder | 013 |
| Superior | town | 75640 | Boulder, Jefferson | 013, 059 |
| Swink | town | 75970 | Otero | 089 |
| Tabernash | CDP | 76190 | Grand | 049 |
| Tall Timber | CDP | 76325 | Boulder | 013 |
| Telluride | town | 76795 | San Miguel | 113 |
| The Pinery | CDP | 77235 | Douglas | 035 |
| Thornton | city | 77290 | Adams, Weld | 001, 123 |
| Timnath | town | 77510 | Larimer | 069 |
| Todd Creek | CDP | 77757 | Adams | 001 |
| Towaoc | CDP | 78280 | Montezuma | 083 |
| Towner | CDP | 78335 | Kiowa | 061 |
| Trail Side | CDP | 78345 | Morgan | 087 |
| Trinidad | city | 78610 | Las Animas | 071 |
| Twin Lakes | CDP | 79100 | Adams | 001 |
| Twin Lakes | CDP | 79105 | Lake | 065 |
| Two Buttes | town | 79270 | Baca | 009 |
| Upper Bear Creek | CDP | 79785 | Clear Creek | 019 |
| Vail | town | 80040 | Eagle | 037 |
| Valdez | CDP | 80095 | Las Animas | 071 |
| Valmont | CDP | 80370 | Boulder | 013 |
| Vernon | CDP | 80755 | Yuma | 125 |
| Victor | city | 80865 | Teller | 119 |
| Vilas | town | 81030 | Baca | 009 |

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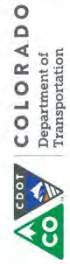
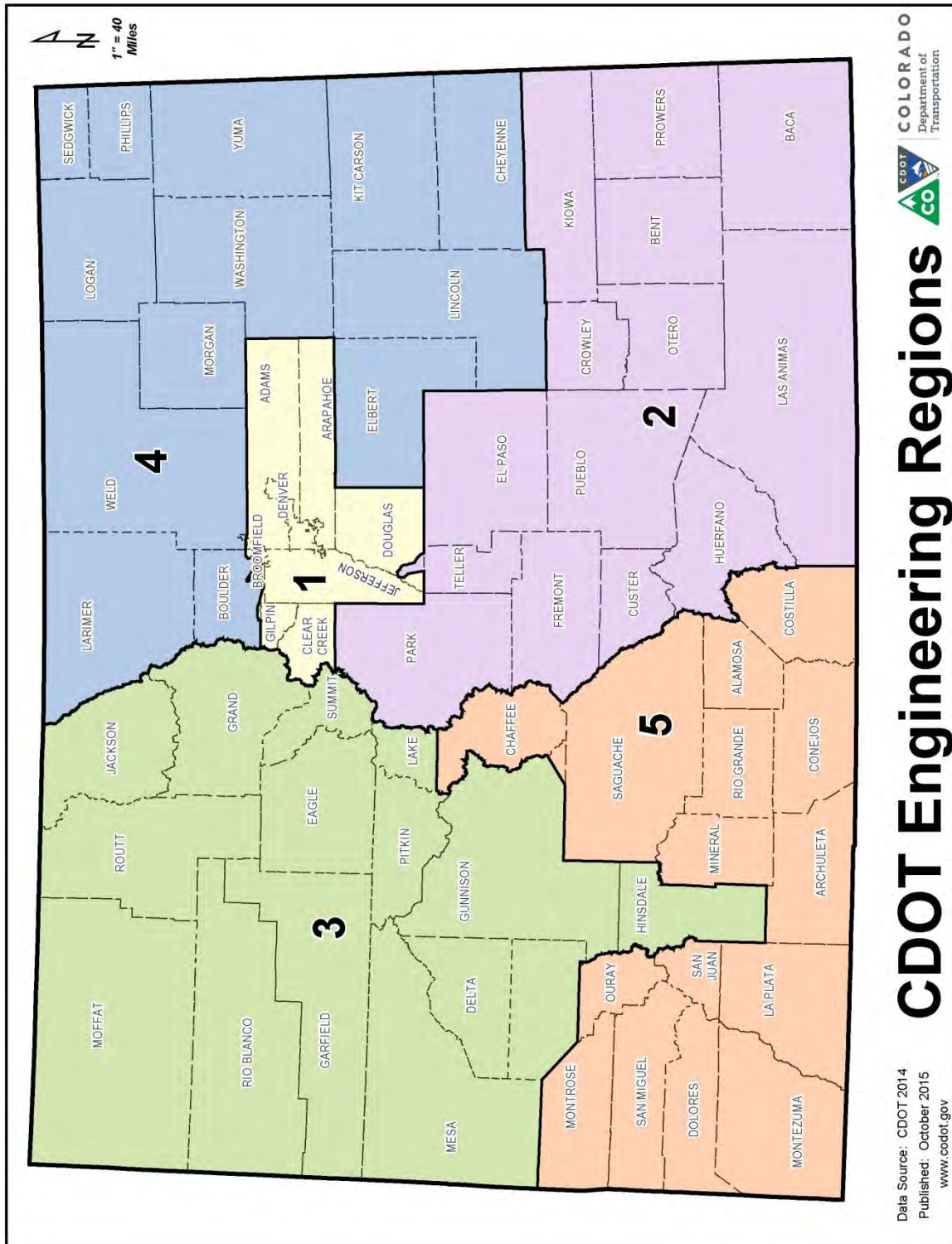


| | | | | |
|--------------------|------|-------|------------------|----------|
| Vineland | CDP | 81305 | Pueblo | 101 |
| Vona | town | 81690 | Kit Carson | 063 |
| Walden | town | 82130 | Jackson | 057 |
| Walsenburg | city | 82350 | Huerfano | 055 |
| Walsh | town | 82460 | Baca | 009 |
| Ward | town | 82735 | Boulder | 013 |
| Watkins | CDP | 82905 | Adams, Arapahoe | 001, 005 |
| Welby | CDP | 83120 | Adams | 001 |
| Weldona | CDP | 83175 | Morgan | 087 |
| Wellington | town | 83230 | Larimer | 069 |
| West Pleasant View | CDP | 84042 | Jefferson | 059 |
| Westcliffe | town | 83450 | Custer | 027 |
| Westcreek | CDP | 83500 | Douglas | 035 |
| Westminster | city | 83835 | Adams, Jefferson | 001, 059 |
| Weston | CDP | 84000 | Las Animas | 071 |
| Wheat Ridge | city | 84440 | Jefferson | 059 |
| Wiggins | town | 84770 | Morgan | 087 |
| Wiley | town | 85045 | Prowers | 099 |
| Williamsburg | town | 85155 | Fremont | 043 |
| Windsor | town | 85485 | Larimer, Weld | 069, 123 |
| Winter Park | town | 85705 | Grand | 049 |
| Wolcott | CDP | 85760 | Eagle | 037 |
| Woodland Park | city | 86090 | Teller | 119 |
| Woodmoor | CDP | 86117 | El Paso | 041 |
| Woody Creek | CDP | 86200 | Pitkin | 097 |
| Wray | city | 86310 | Yuma | 125 |
| Yampa | town | 86475 | Routt | 107 |
| Yuma | city | 86750 | Yuma | 125 |

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Appendix IV: Colorado Region Map



CDOT Engineering Regions

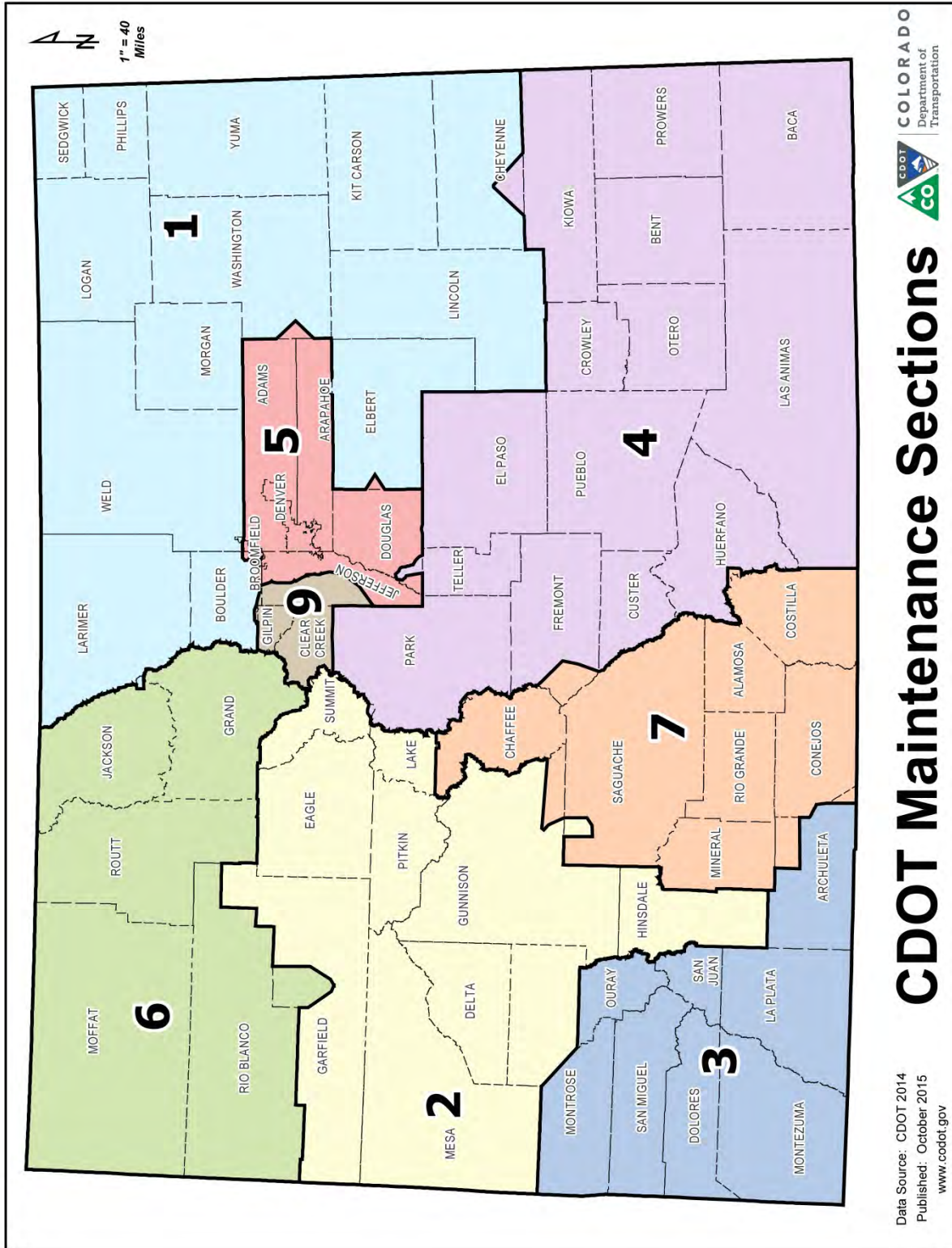
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Published: October 2015
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Appendix V: CDOT Maintenance Regions Map

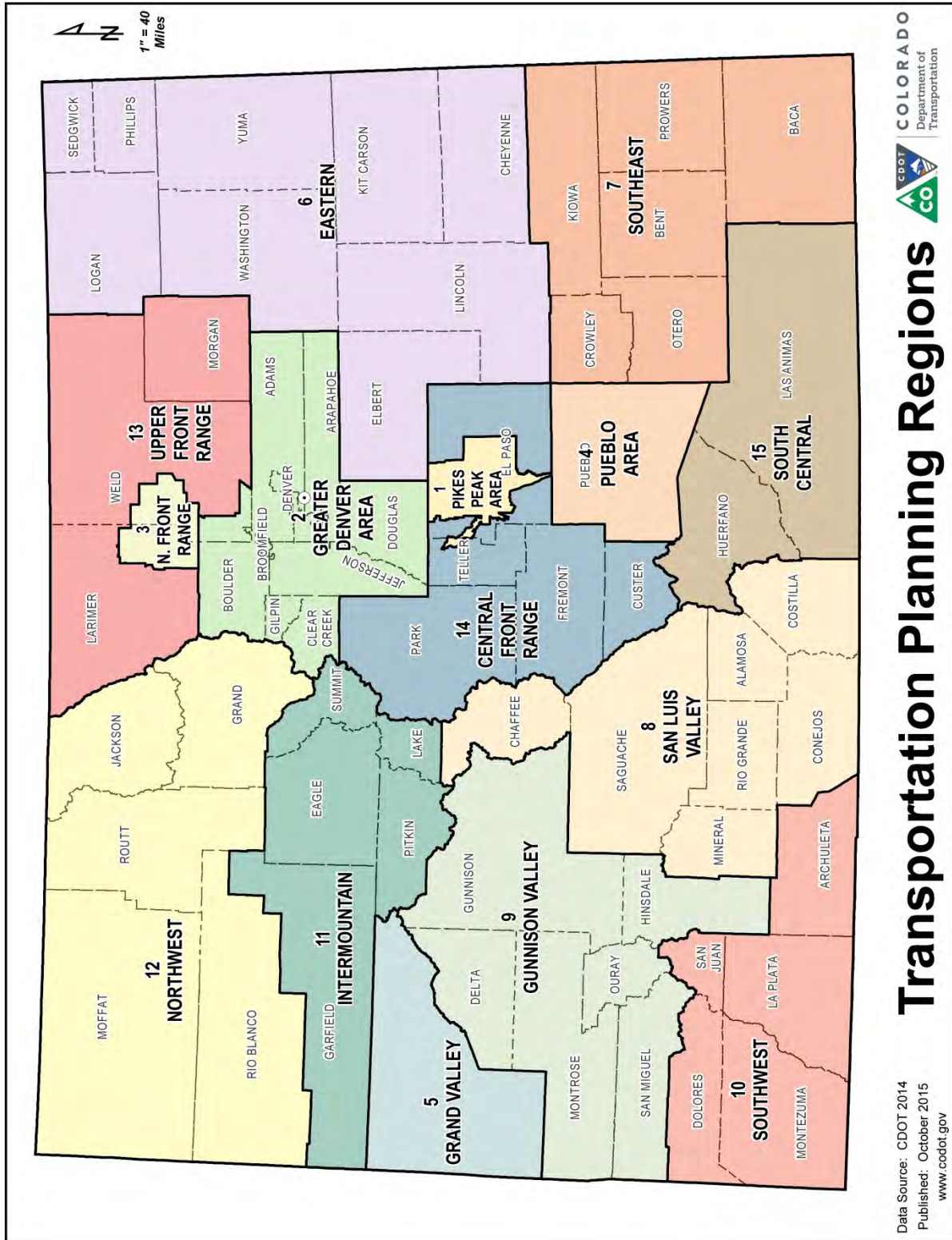


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Appendix VI: CDOT Transportation Planning Regions Map



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Appendix VII: Rules Governing the Use of Tunnels on Colorado State Highways, 2 CCR 601-8

DEPARTMENT OF TRANSPORTATION

Transportation Commission

RULES GOVERNING THE USE OF TUNNELS ON COLORADO STATE HIGHWAYS

2 CCR 601-8

[Editor's Notes follow the text of the rules at the end of this CCR Document.]

Statement of Basis and Purpose and Statutory Authority

The Transportation Commission has revised the Rules Governing the Use of tunnels on State Highways in order to update state and federal statutory references, clarify and simplify language, and provide an easily understandable guide for use of the tunnels on state highways and specifically the Eisenhower-Johnson Memorial Tunnels. Section 42-4-106(7)(a), C.R.S., provides the Transportation Commission with authority to adopt rules concerning the operation of any motor vehicle and commercial vehicle in any tunnel which is a part of the state highway system. Pursuant to § 42-4-106(7)(b), C.R.S., the Department may prohibit or regulate the operation of any motor vehicle and commercial vehicle which transports any article, deemed to be dangerous, in any tunnel which is part of the state highway system. Further, § 42-20-301(3), C.R.S., provides authority to the Transportation Commission to regulate hours of operation of the Eisenhower-Johnson Memorial Tunnels on Interstate 70.

These rules shall be interpreted consistently with the requirements of Title 49 CFR parts 100 to 177. Additionally, these rules should be read together with 8 CCR 1507-25 "Rules and Regulations Concerning the Permitting, Routing & Transportation of Hazardous and Nuclear Materials and the Intrastate Transportation of Agricultural Products in the State of Colorado." These rules are promulgated by the Department of Public Safety, Chief of the Colorado State Patrol pursuant to § 42-20-108 (1) and (2), C.R.S. These rules also regulate the safe transportation of nuclear materials by motor vehicle within the State of Colorado pursuant to

§ 42-20-403, 504 and 508, C.R.S., and exempt agricultural products from the rules pursuant to § 42-20-108.5, C.R.S.

The transport of hazardous materials is strictly governed by federal and state regulations and CDOT must adhere to these legal requirements. CDOT's Rules 3.03 and 3.04 are based on federal regulations which CDOT has no authority to modify.

Applicability. These rules apply to all Commercial Vehicles, Motor Vehicles and Persons utilizing the tunnels under the Colorado Department of Transportation's jurisdiction.

1.00 Definitions

- 1.01 "Commercial Vehicle" as set forth in § 42-4-235, C.R.S., shall mean (I) any self-propelled or towed vehicle bearing an apportioned plate or having a manufacturer's gross vehicle weight rating or gross combination rating of ten thousand one pounds or more, which vehicle is used in commerce on the public highways of this state or is designed to transport sixteen or more passengers, including the driver, unless such vehicle is a school bus regulated pursuant to section 42-4-1904, C.R.S., or any vehicle that does not have a gross vehicle weight rating of twenty-six thousand one or more pounds and that is owned or operated by a school district so long as such school district does not receive remuneration for the use of such vehicle, not including reimbursement for the use of such vehicle; (II) any motor vehicle designed or equipped to transport other motor vehicles from place to place by means of winches, cables, pulleys, or other equipment for towing, pulling, or lifting, when such motor vehicle is used in commerce on the public highways of this state; and (III) a motor vehicle that is used on the public highways and transports materials determined by the secretary of transportation to be hazardous under 49 U.S.C. Sec. 5103 in such quantities as to require placarding under 49 CFR parts 172 and 173.
- 1.02 "Department" or "CDOT" shall mean the Colorado Department of Transportation established pursuant to § 43-1-103, C.R.S.
- 1.03 "Enforcement Official" shall mean, and is limited to, a peace officer who is an officer of the Colorado State Patrol as described in § § 16-2.5-101 and 114, C.R.S., a certified peace officer who is a certified port of entry officer as described in § § 16-2.5-101 and 115, C.R.S., a peace officer who is an investigating official of the transportation section of the public utilities commission as described in § § 16-2.5-101 and 143, C.R.S., or any other peace officer as described in section § 16-2.5-101, C.R.S. [§ 42-20-103 (2), C.R.S.]
- 1.04 "Hazardous Materials" (also known as "Hazmat") shall mean those materials listed in Tables 1 and 2 of 49 CFR 172.504, excluding highway route controlled quantities of radioactive materials as defined in 49 CFR 173.403 (I), excluding ores, the products from mining, milling, smelting, and similar processing of ores, and the wastes and tailing therefrom, and excluding special fireworks when the aggregate amount of flash powder does not exceed fifty pounds. [§ 42-20-103 (3), C.R.S.]
- 1.05 "Motor vehicle" shall mean any self-propelled vehicle that is designed primarily for travel on the public highways and that is generally and commonly used to transport persons and property over the public highways or a low-speed electric vehicle; except that the term does not include low-power scooters, wheelchairs, or vehicles moved solely by human power.
- 1.06 "Person" shall mean an individual, a corporation, a government or governmental subdivision or agency, a partnership, an association, or any other legal entity; except that separate divisions of the same corporation may, at their request, be treated as separate persons. [§ 42-20-103 (6), C.R.S.]
- 1.07 "Staging" shall mean the parking of a Motor Vehicle or Commercial Vehicle at a specific location to facilitate its safe passage through the Eisenhower-Johnson Memorial Tunnel according to the specific timing requirements of Rule 3.05
- 1.08 "State Highway" shall consist of the federal-aid primary roads, the federal-aid secondary roads, and the interstate system, including extensions thereof within urban areas. [§ 43-2-201(1), C.R.S.]

1.09 "Tunnel" shall mean enclosed roadways with vehicle access that is restricted to portals regardless of type of structure or method of construction. Tunnels do not include highway bridges, railroad bridges or other bridges over a roadway. Tunnels are structures that require special design considerations that may include lighting, ventilation, fire protection systems, and emergency egress capacity based on the owners' determination.

2.00 General Requirements for Use of All CDOT Tunnels

2.01 These Rules apply to all facilities identified below in Rule 4.00.

2.02 Any Person operating a Motor Vehicle or Commercial Vehicle in any Tunnel on the State Highway System shall comply with all governing state and federal law and regulations. Any Motor Vehicle, Commercial Vehicle or Person failing to abide by all applicable law and regulations will be referred to law Enforcement Officials. No Person shall obstruct, harass, impair, attempt to influence, or otherwise interrupt the official government functions of the CDOT Tunnel staff. In the event such actions should occur the appropriate law enforcement agency will be contacted immediately.

2.03 CDOT, including Tunnel Personnel, may prohibit any Motor Vehicle or Commercial Vehicle or device, pursuant to § 42-4-106 (7), C.R.S., from using a Tunnel when the health or safety of the public warrants such action.

2.04 Pedestrians shall not be permitted in Tunnels without the express permission of the Department.

2.05 Electrical assisted bicycles, electric personal assistive mobility devices, low-power scooters, low-speed electric vehicles, motor driven cycles, motorcycles, or motor scooters, with a motor which produces five (5) horsepower or less, and bicycles or other means of conveyance are prohibited from using any Tunnel unless a special use permit has been granted by the Colorado State Patrol. [§ 42-1-102, (28.5) (28.7) (48.5)(a), and (48.6), C.R.S.]







2.06 The Department shall be authorized to schedule any closure of a segment of the State Highway system or at the request of the Colorado State Patrol in order to provide for the safety of the public and including but not limited to maintenance operations, avalanche control, rock fall mitigation, and roadway construction. The CDOT Maintenance Superintendent or his/her designee, in consultation with the CDOT Regional Transportation Director and the CDOT Director of Transportation Systems Management & Operations,, may exercise discretion related to the use of CDOT Tunnels as specified in these rules to address traffic mitigation or to provide for the health, safety and welfare of the public.

3.00 Requirements Specific to the Eisenhower-Johnson Memorial Tunnels (EJMT)





3.01 CDOT Personnel at the EJMT shall have the authority to:

- A. Direct Motor Vehicles or Commercial Vehicles to staging/parking areas and enlist the assistance of an Enforcement Official to review shipping papers or their equivalent to protect the health, safety and welfare of the public.
- B. Establish and post restricted access requirements (e.g., speed limit reductions, convoy escort operations, vehicle convoys, and Tunnel closures) granting or denying highway and/or Eisenhower-Johnson Memorial Tunnels (EJMT) access, when access would present a hazard to the Tunnels or to persons using the Tunnels.

- 3.02 All Commercial Vehicles, Motor Vehicles and Persons transporting placarded quantities of hazardous materials are required to use Loveland Pass (US 6) when the Pass is open.
- 3.03 Commercial Vehicles, Motor Vehicles and Persons are prohibited at all times from transporting the following placarded hazardous materials through the EJMT, and may not park in the parking lots outside of EJMT.

| PROHIBITED AT ALL TIMES FROM EJMT | |
|---|---|
|  | <p>Division 1.1 Placard</p> <p>Explosives With a Mass Explosion Hazard</p> |
|  | <p>Division 1.2 Placard</p> <p>Explosives With a Projection Hazard</p> |
|  | <p>Division 1.3 Placard</p> <p>Explosives With Predominantly a Fire Hazard</p> |
|  | <p>Division 1.4 Placard</p> <p>Explosives With No Significant Blast Hazard</p> |
|  | <p>Division 1.5 Placard</p> <p>Very Insensitive Explosives: Blasting Agents</p> |
|  | <p>Division 4.3 Placard</p> <p>Dangerous When Wet Materials</p> |







PROHIBITED AT ALL TIMES FROM EJMT

| | |
|---|--|
|  | <p style="text-align: center;">Division 5.2 Placard Organic Peroxides</p> |
|  | <p style="text-align: center;">Division 2.3 Inhalation Hazard</p> |
|  | <p style="text-align: center;">Division 6.1 Placard Poisonous Materials (inhalation hazards only)</p> |
|  <p>The HRCQ placard has the square background behind the point on point placard. Compare Class 7 Placard Radioactive Materials under Rule 3.04.</p> | <p style="text-align: center;">Highway Route-Controlled Quantity (HRCQ)</p> |

3.04 Materials Permitted to Use EJMT when Loveland Pass (US 6) is closed. Subject to the requirements of these rules and all state and federal laws, Commercial Vehicles, Motor Vehicles and Persons may transport the following hazardous materials through the EJMT only when Loveland Pass (US 6) is closed.

PERMITTED TO USE EJMT WHEN LOVELAND PASS (US 6) IS CLOSED



SUBJECT TO RESTRICTION

| | |
|--|---|
|  | <p align="center"> Division 1.6 Placard Extremely Insensitive Detonating Substances </p> |
|  <p align="center"> This is a point-on-point placard as distinguished from HRCQ placard which has a square background. HRCQ is prohibited at all times. </p> | <p align="center"> Class 7 Placard Radioactive Materials </p> |
|  | <p align="center"> Division 2.1 Placard Flammable Gases </p> |
|  | <p align="center"> Division 2.2 Placards Non-Flammable, Non Poisonous Gases </p> |
|  | <p align="center"> Class 3 Placards Flammable Liquids </p> |
|  | <p align="center"> Class 3 Placards Combustible Liquids </p> |

PERMITTED TO USE EJMT WHEN LOVELAND PASS (US 6) IS CLOSED

SUBJECT TO RESTRICTION

| | |
|---|---|
|  | <p>Division 4.1 Placard Flammable Solids</p> |
|  | <p>Division 4.2 Placard Spontaneously Combustible Materials</p> |
|  | <p>Division 5.1 Placard Oxidizing Substances</p> |
|  | <p>Division 6.1 Placards Poisonous or Toxic Materials (excludes inhalation hazards)</p> |
|  | <p>Division 6.2 Label Infectious Substances</p> |
|  | <p>Class 8 Placard Corrosive Substances</p> |
|  | <p>Class 9 Placard Miscellaneous Hazardous Materials</p> |

| | |
|---|--|
| PERMITTED TO USE EJMT WHEN LOVELAND PASS (US 6) IS CLOSED | |
| SUBJECT TO RESTRICTION | |
|  | Dangerous Placard Dangerous Hazardous Materials |
|  | ORM-D Label Other Regulated Materials |

3.05 Restrictions on Placarded Loads Carrying Hazardous Materials when Loveland Pass (US 6) is Closed.

A. Peak Period Operations. Peak Periods are those times of increased vehicle traffic determined by the Department to warrant restrictions on the transporting of placarded quantities of permitted hazardous materials.

1. No vehicles containing placarded quantities of hazardous materials are allowed to use EJMT during the following time frames:

Westbound

Saturday and Sunday mornings, from 7:01 a.m. to 9:59 a.m.

National Holidays when they fall on a Monday or Friday from 7:01 a.m. to 9:59 a.m.

Eastbound

Sunday afternoons, from 2:01 p.m. to 6:59 p.m.

National Holidays when they fall on a Monday or Friday, from 2:01 p.m. to 6:59 p.m.

Special Provisions for New Years Day and Christmas Day.

The day preceding and the day following the holiday may be included in the Peak Period restrictions. When Christmas Day or New Years' Day fall on a weekday, Peak Period restrictions may include Friday and Saturday eastbound.

2. National Holidays for purposes of these Rules are: New Year's Day (January 1); Martin Luther King, Jr. Day (3rd Monday of January); President's Day (3rd Monday in February); Memorial Day (last Monday in May); Independence Day (July 4); Labor Day (1st Monday in September); Thanksgiving Day (4th Thursday in November) and Christmas Day (December 25).

3. CDOT will provide real-time information specific to Commercial Motor Vehicles including placarded loads carrying Hazardous Materials, on Interstate 70 with details including road conditions, Loveland Pass closures, Hazmat holds at EJMT, and forecasts of Peak Period travel delays. When feasible, CDOT may route placarded quantities of hazardous materials through the EJMT during significant gaps in traffic when Loveland Pass (US 6) is closed during Peak Period restrictions.
 4. Loads carrying Placarded quantities of Hazardous Materials will be allowed to Stage outside of the 300 foot restriction to the EJMT and at least 5 feet from the State Highway in designated parking spaces. After these spaces are filled, Persons, Motor Carriers and Commercial Vehicles may use Herman's Gulch (Exit 218), Officer's Gulch (Exit 198) or other rest areas to Stage pending notification from CDOT Tunnel personnel that access is permitted.
- B. Off-Peak Period Operations when Loveland Pass (US 6) is Closed. Once authorization and specific direction is given by CDOT personnel, Motor Vehicles, Commercial Vehicles and Persons transporting placarded quantities of Hazardous Materials under this Rule may use the EJMT:
1. Seven days a week on the hour; and
 2. Between the hours of 11 p.m. and 6 a.m. on the half hour.
- 3.06 All Motor Vehicles, Commercial Vehicles and Persons transporting authorized Hazardous Materials through the EJMT shall:
- Travel at speeds no faster than 30 miles per hour;
 - Not pass other vehicles; and
 - Maintain a minimum distance of 800 feet from other vehicles.
- 3.07 Hazmat Routes
- 3.07.1 The EJMT is not located on a designated hazardous materials route section. The designated hazardous materials routes within the State of Colorado may be found at <http://dtdapps.coloradodot.info/staticdata/Downloads/StatewideMaps/HazMatMap.pdf>. See also <http://www.coloradodot.info/business/hazmat-routing>.

4.00 CDOT Tunnels and Snow Sheds

| Structure No. | Tunnel Name & Location | Description | Route | Mile Post | NHS (Y/N) |
|---------------|--|--|-------|-----------|-----------|
| H-03-BT | Interstate 70, MP 50.38, Beavertail Tunnels | Bore 13.75 miles east of Grand Junction in DeBeque Canyon | 070A | 50.38 | Y |
| H-03-BU | Interstate 70, MP 50.38, Beavertail Tunnels | Bore 13.75 miles east of Grand Junction in DeBeque Canyon | 070A | 50.37 | Y |
| F-07-Q | Interstate 70, MP 117.83, No Name Tunnels | Bores 1.5 miles East of SH 82-Grand Ave., Glenwood Springs | 070A | 117.81 | Y |
| F-07-R | Interstate 70, MP 117.83, No Name Tunnels | Bores 1.5 miles East of SH 82-Grand Ave., Glenwood Springs | 070A | 117.8 | Y |
| F-08-AP | Interstate 70, MP 125.7, Hanging Lake Tunnels | Glenwood Canyon, 8.1 miles east of Glenwood Springs | 070A | 125.23 | Y |
| F-08-AQ | Interstate 70, MP 125.7, Hanging Lake Tunnels | Bores, Glenwood Canyon, 8.1 miles east of Glenwood Springs | 070A | 125.24 | Y |
| F-08-AT | Interstate 70, MP 127.12 Reverse Curve | One bore West bound only, 10.5 miles east of Glenwood Springs | 070A | 127.09 | Y |
| F-13-X | Interstate 70, MP 213, Eisenhower/Johnson Memorial Tunnels | Bores, under the Continental Divide, 60 miles west of Denver | 070A | 213.61 | Y |
| F-13-Y | Interstate 70, MP 213, Eisenhower/Johnson Memorial Tunnels | Bores, under the Continental Divide, 60 miles west of Denver | 070A | 213.61 | Y |
| F-15-BN | Interstate 70, MP 242, Twin Tunnels | One bore each Tunnel, within the city limits of Idaho Springs (2.6 miles east of junction with SH 103) | 070A | 242.11 | Y |
| F-15-BO | Interstate 70, MP 242, Twin tunnels | One bore each Tunnel, within the city limits of Idaho Springs (2.6 miles east of junction with SH 103) | 070A | 242.11 | Y |
| F-17-FW | Interstate 225 MP 0.02 at Junction. with Interstate-25 SB MP 200 | Cut and cover Structure, Junction I-225 Southbound only with Interstate 25 Southbound only | 225A | | |
| F-15-AW | US 6 - MP259 to 270, | One bore each Tunnel, Five Tunnels in Clear Creek Canyon beginning 4 miles west of Golden for 15 miles | 006G | 264.76 | N |

| Structure No. | Tunnel Name & Location | Description | Route | Mile Post | NHS (Y/N) |
|---------------|---|--|-------|-----------|-----------|
| F-15-AX | US 6 - MP259 to 270, | One bore each Tunnel, Five Tunnels in Clear Creek Canyon beginning 4 miles west of Golden for 15 miles | 006G | 265.13 | N |
| F-15-AY | US 6 - MP259 to 270, | One bore each Tunnel, Five Tunnels in Clear Creek Canyon beginning 4 miles west of Golden for 15 miles | 006G | 270.37 | N |
| F-15-X | US 6 - MP259 to 270, | One bore each Tunnel, Five Tunnels in Clear Creek Canyon beginning 4 miles west of Golden for 15 miles | 006G | 258.94 | N |
| F-15-Y | US 6 - MP259 to 270, | One bore each Tunnel, Five Tunnels in Clear Creek Canyon beginning 4 miles west of Golden for 15 miles | 006G | 259.46 | N |
| N-09-F | US160 - MP 174.8 Wolf Creek Pass Tunnel | One bore, 31.15 miles east of Pagosa Springs (located on west side of Wolf Creek Pass) | 160A | 174.19 | Y |
| L-06-P | US 550 - MP 90.86 Bear Creek Tunnel | One bore, 1.2 miles south of Ouray in Ouray county | 550B | 90.84 | Y |
| B-15-E | SH 14 - MP 107.2 | One bore, 27.48 miles west of Fort Collins in Roosevelt National Forest | 014B | 107.23 | N |
| D-15-AS | SH 119 - MP 37.6 | One bore, in Boulder Canyon, 4.2 miles west of Junction with SH 7 & SH 93 | 119A | 37.69 | N |
| M-06-AG | US 550 – MP 88.16 East Riverside Snow Shed | Snow Shed | 550B | 88.16 | Y |
| O-09-K | US 160 – MP 168.47 Alberta Snow Shed | Snow Shed | 160A | 168.47 | Y |

5.00 Materials Incorporated by Reference

Copies of these Rules and of all other incorporated materials are available for public inspection during regular business hours at the Colorado Department of Transportation, Office of Policy and Government Relations, 4201 East Arkansas Avenue, Denver, Colorado 80222. Incorporated materials are also maintained at the State Publications Depository and Distribution Center, 201 East Colfax Avenue, Denver, Colorado 80203, and may be examined at any other state publications library via inter-library loan. The following regulations and materials are incorporated by reference; such incorporation does not include later amendments or editions of any incorporated material: Title 49 CFR parts 100 to 177, and 8 CCR 1507-25 "Rules and Regulations Concerning the Permitting, Routing & Transportation of Hazardous and Nuclear Materials and the Intrastate Transportation of Agricultural Products in the State of Colorado" dated 4.30.2013.

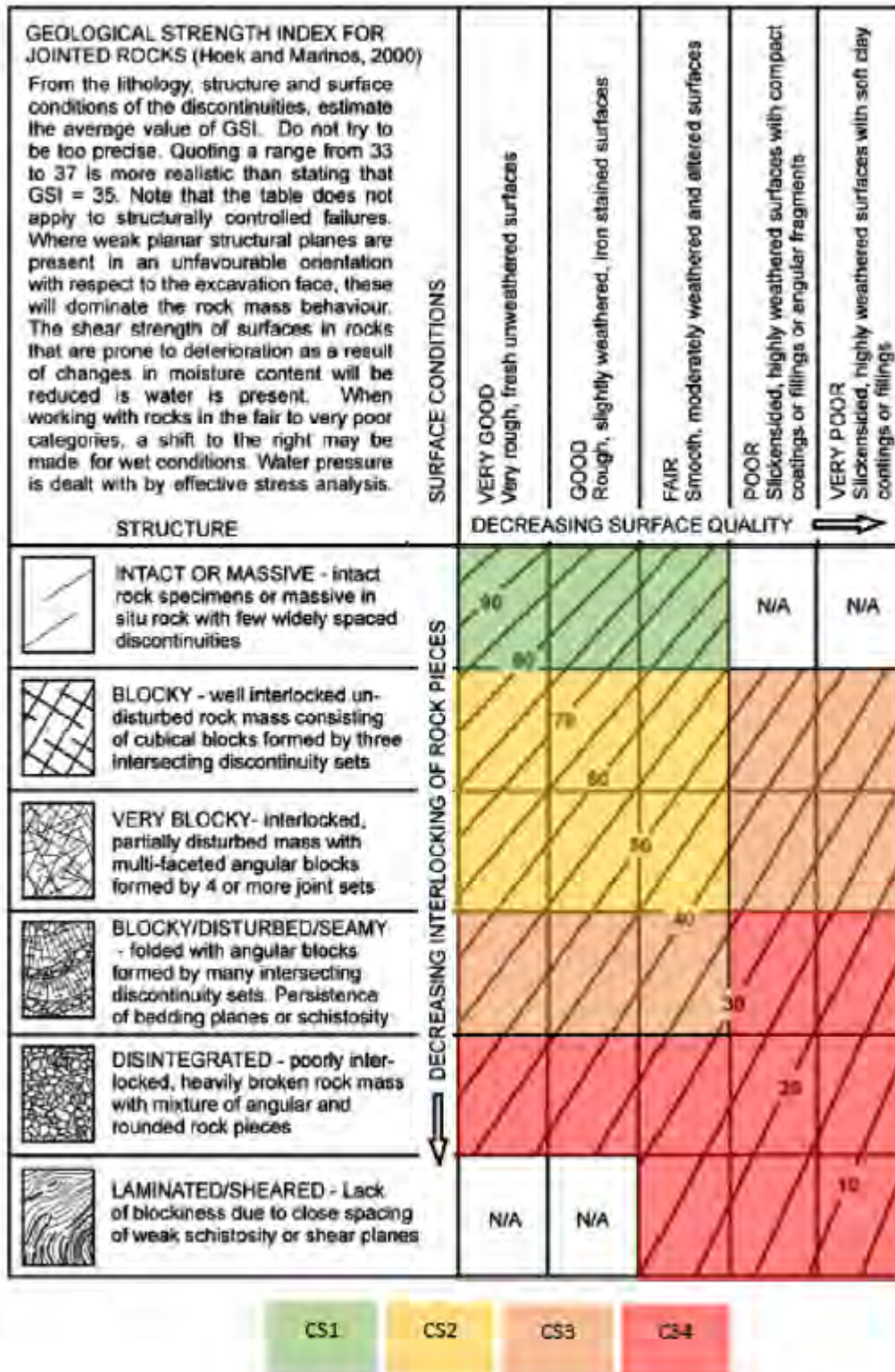
Editor's Notes**History**

Entire rule eff. 09/30/2008.

Entire rule emer. rule eff. 01/16/2014; expired 05/16/2014.

Entire rule eff. 06/30/2014.

Appendix VIII: GSI to Condition State Conversion Charts

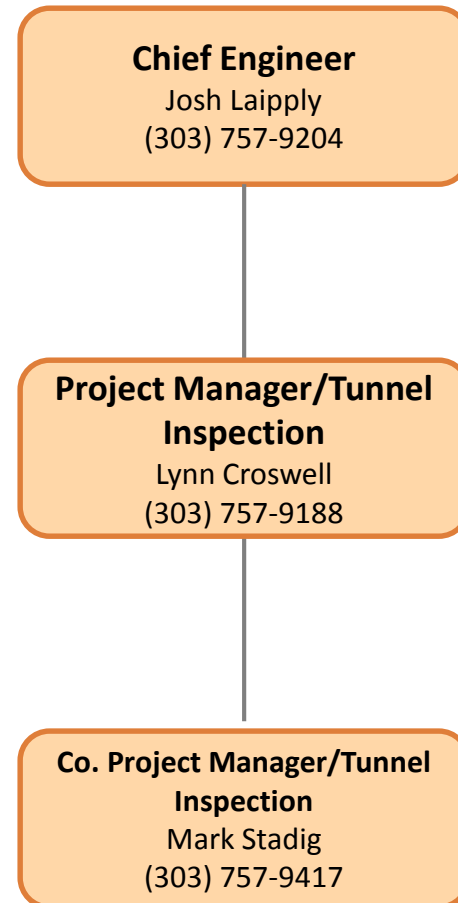


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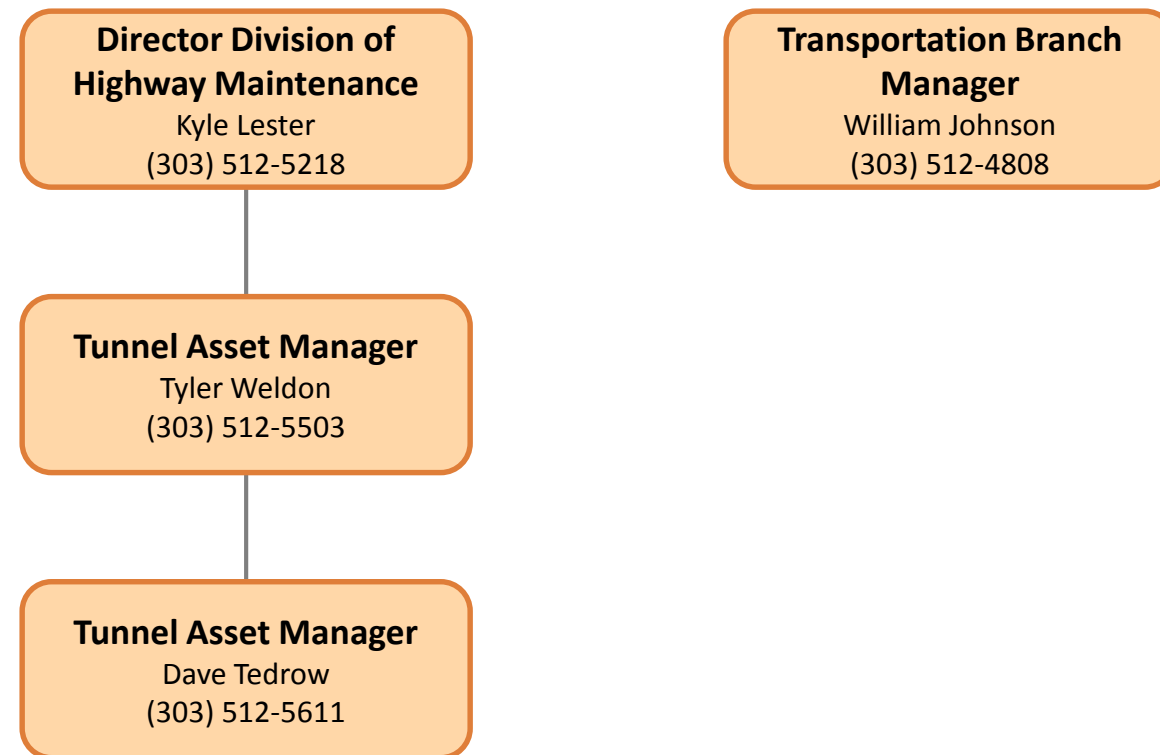


Appendix IX: CDOT Organization and Hierarchy

Tunnel Inspection Project



Tunnel Asset Management



On System Program Engineers in Tunnel Locations

Region 1 West Program Engineer
Steve Harelson
(720) 497-6901

Region 3 Central Program Engineer
Roland Wagner (acting)
(970) 384-3332

Region 4 North Program Engineer
Corey Stuart
(970) 350-2104

Region 5 Program Engineer
Kevin Curry
(970) 385-1436

Region 3 West Program Engineer
Jason Smith
(970) 683-6208

Region 4 South Program Engineer
Keith Scheaffer
(970) 350-2162

On System Traffic Engineers in Tunnel Locations

Region 1 Traffic Engineer

Alazar Tessfaye
(303) 365-7318

Region 3 Traffic Engineer

Zane Znamenacek
(970) 683-6275

Region 4 Traffic Engineer

Long Nguyen
(970) 350-2121

Region 5 Traffic Engineer

Julie Constan
(970) 385-1449

Region 1 Transportation Director
Paul Jesaitis
(303) 757-9919

Region 1 Deputy Director of Maintenance
Mike O'Neill
(303) 757-9253

CDOT Region 1, Maintenance Section 5

CDOT Region 1, Maintenance Section 9

Maintenance Superintendent Section 5
John Lorme
(303) 365-7110

Maintenance Superintendent Section 9
Jeff Tatkenhorst
(303) 278-2053

Office Manager
Tammi Tunis
(303) 365-7112

Office Manager
Vacant
(303)-512-5732

Deputy Superintendent Section 5
Vacant
(303) 365-7116

Deputy Superintendent Section 5
Jered Maupin
(303) 365-7046

Deputy Superintendent Section 5
Mike Williard
(303) 365-7102

Deputy Superintendent Section 9
Neal Retzer -
Clear Creek Tunnels ***
(303) 278-2053

Resident Engineer Section 9
Neal Retzer - Reg. 1 Tunnels ****
(303) 512-5730

LTC OPS I MARY AREA
Vacant
(303) 480-9870

LTC OPS I SAM AREA
Vacant
(303) 288-6598

LTC OPS I KING AREA
Mark Carrillo
(303) 433-4107

LTC OPS I LINCOLN AREA
Matt Russman
(303) 688-6230

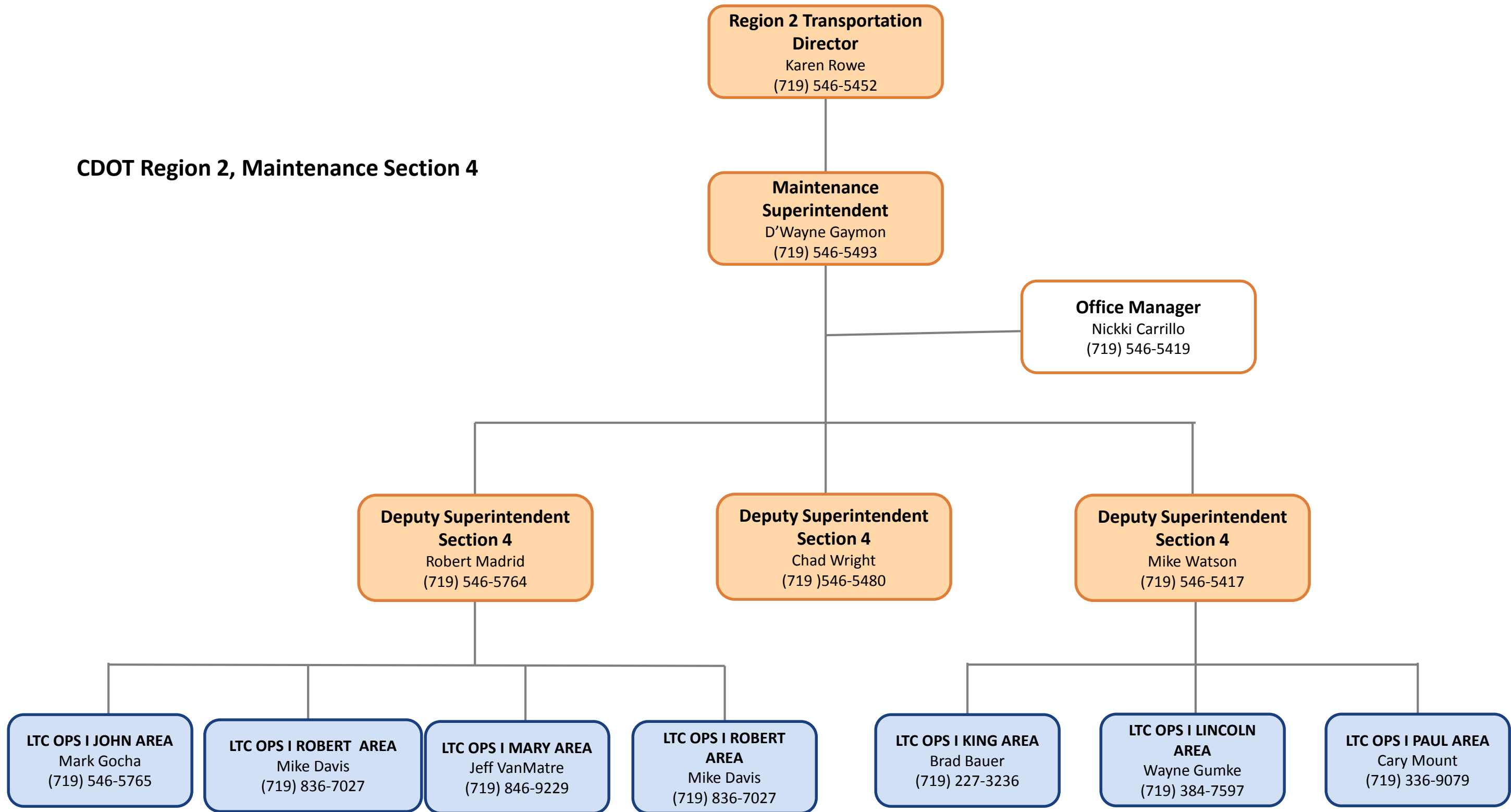
LTC OPS I JOHN AREA
Frank McCoy
(303) 512-5480

LTC OPS I PAUL AREA
John Wilson
(303) 512-5443
***Clear Creek Tunnels

LTC OPS I SPECIAL CREWS
Tom Hurst
(303) 512-5734
EJMT****

LTC OPS I OPERATIONS
John Wheatley
(303) 512-5736
EJMT****

CDOT Region 2, Maintenance Section 4



Region 3 Transportation Director
David Eller
(970) 683-6202

CDOT Region 3, Maintenance Section 2

CDOT Region 3, Maintenance Section 6

Maintenance Superintendent Section 2
Mike Goolsby
(970) 683-6306

Maintenance Superintendent Section 6
Mark Eike
(970) 826-5162

Office Manager
Dede Blake
(970) 683-6303

Office Manager
Janelle Berner
(970) 826-5161

Deputy Superintendent Section 2
John David ***
(970) 683-6304
Hanging Lake, Beavertail, No Name Tunnels

Deputy Superintendent Section 2
TJ Blake
(970) 683-6307

Deputy Superintendent Section 2
Mark Quintana
(970) 683-6305

Deputy Superintendent Section 6
Scott Marsh
(970)-826-5167

LTC OPS I HLT AREA **
Spencer Dickey
(970) 945-3843
Hanging Lake, No Name Tunnels ****

LTC OPS I SPEC CREW
Kane Schneider
(970) 683-6308

LTC OPS I JOHN AREA
Fred Cummings
(970) 683-7594
Beavertail Tunnel ****

LTC OPS I LINCOLN AREA
Eric Lanford
(970) 683-6401

LTC OPS I KING AREA
Donald Poole
(970) 384-3356

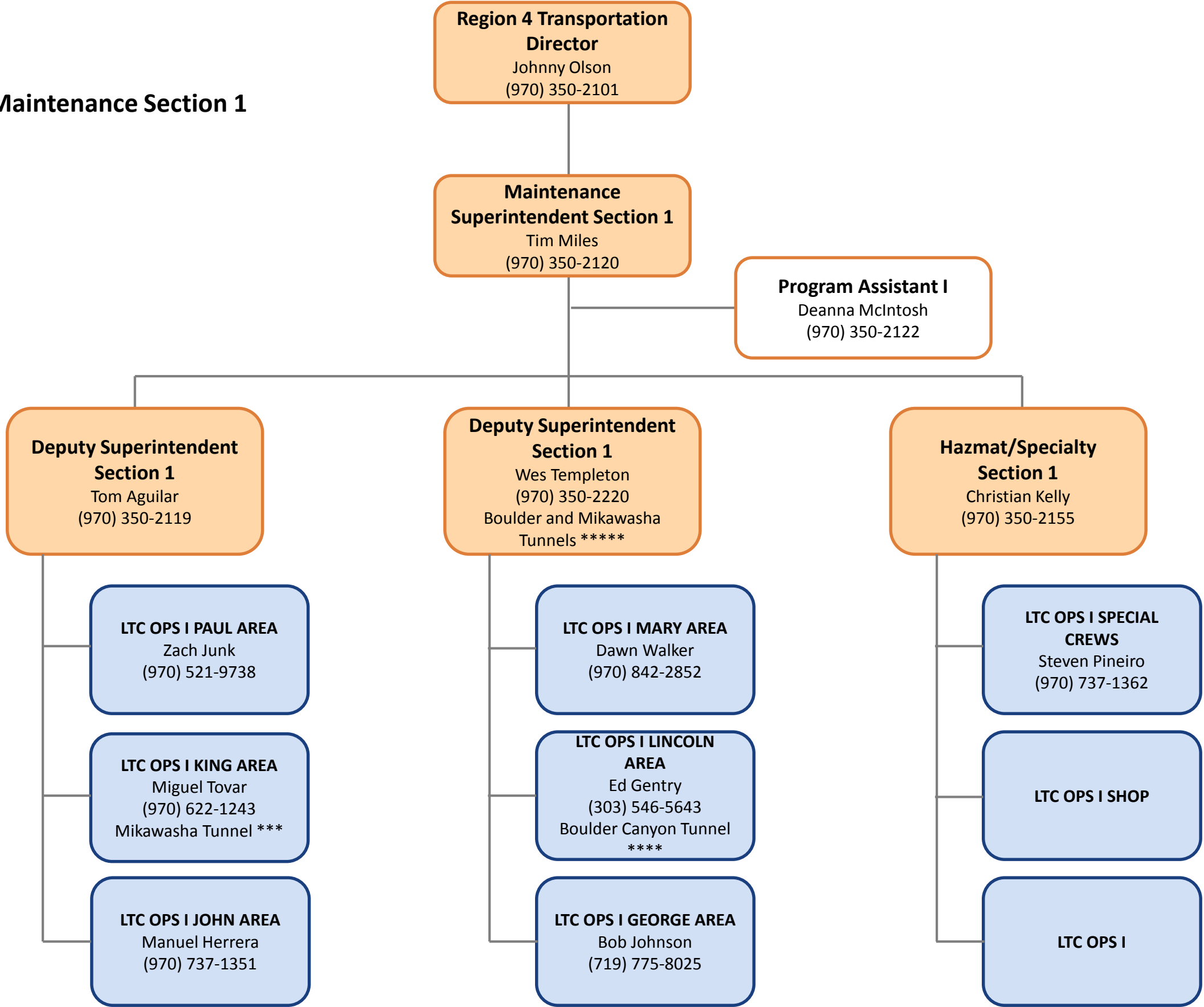
LTC OPS I PAUL AREA
Todd Anderson
(303) 512-5768

LTC OPS I MARY AREA
Randy McIntosh
(970) 328-9841

LTC OPS I KING AREA
Jason Simpson
(970) 724-9685

LTC OPS I JOHN AREA
Todd Weber
(970) 826-5166

CDOT Region 4, Maintenance Section 1



Region 5 Transportation Director
Mike McVaugh
(970) 385-1402

CDOT Region 5, Maintenance Section 3

CDOT Region 5, Maintenance Section 7

Maintenance Superintendent Section 3
Greg Stacy
(970) 385-1651

Maintenance Superintendent Section 7
David Vialpondo
(719) 587-6400
Wolf Creek Tunnel ***

Program Assistant I
Deb Reneker
(970) 385-1652

Office Manager
Desiree Peterson
(719) 587-6404

Deputy Superintendent Section 3
John Palmer
(970) 385-1661

Deputy Superintendent Section 7
Kenny Quintana
(719) 589-6402

LTC OPS I JOHN AREA
Kent Baxtrom
(970) 565-4760

LTC OPS I LINCOLN AREA
Vacant
(719) 530-8001

LTC OPS I MARY AREA
Steve Kelso
(970) 626-4378
Bear Creek Tunnel***

LTC OPS I PAUL AREA
Ronnie Medina
(719) 587-6584
Wolf Creek Tunnel ***

LTC OPS I KING AREA
Billy McDermott
(970) 382-9180

LTC OPS I JOHN AREA
Joe Romero
(719) 587-3286



Appendix X: Minimum Vertical Clearance Template

CDOT Vertical Clearance for Tunnels

Tunnel ID: Example

Date: _____

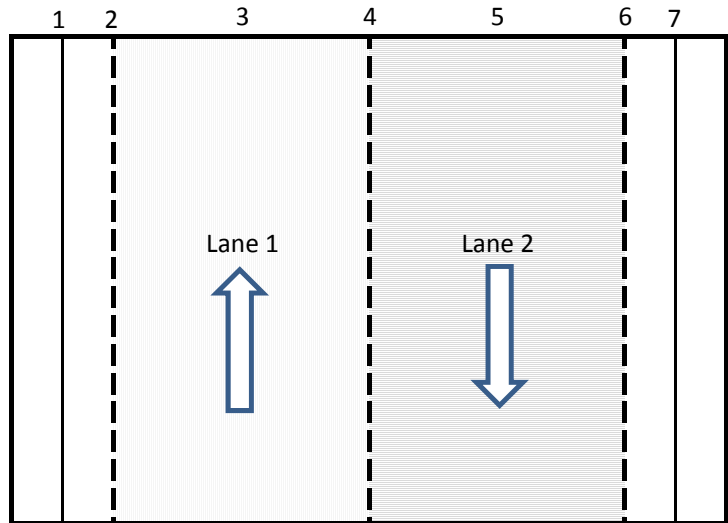
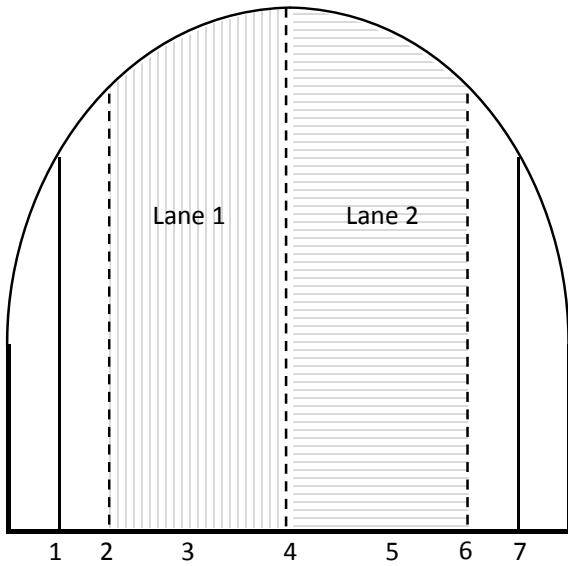
Sign Posting: -"

Tunnel Name: 2 Lane, No Barrier

Inspector: _____

Inventory Direction: 

Facility Carried: _____



*Determine Minimum along lines 1, 2, 4, 6, and 7

*Determine Minimum between lane lines of areas 3, and 5

| Point | Measurement | Station | CL Offset | Taken to |
|-------|----------------|----------------|------------------|-----------------|
| 1 | <u>9' 6"</u> | at <u>0+0</u> | - _____ to _____ | <u>Liner</u> |
| 2 | _____ | at _____ | - _____ to _____ | _____ |
| 3 | _____ | at _____ | - _____ to _____ | _____ |
| 4 | <u>18' 9"</u> | at <u>0+0</u> | - _____ to _____ | <u>Lighting</u> |
| 5 | _____ | at _____ | - _____ to _____ | _____ |
| 6 | <u>13' 11"</u> | at <u>2+23</u> | - _____ to _____ | <u>Rock</u> |
| 7 | _____ | at _____ | - _____ to _____ | _____ |

Minimum Clearance by Lane

| Lane | Station | CL Offset | Taken to |
|------|---------|-----------|----------|
| | | | |
| | | | |

Horizontal

| | Measurement | Location |
|----------------|-------------|----------|
| Right Lat | | |
| Left Lat | | |
| O/O | | |
| C/C | | |
| Right sidewalk | | |
| Left Sidewalk | | |

Tunnel ID:

Posting: Inventory:

Date:

Lanes: Tunnel Name:

Inspector:

Direction: Facility Carried:

Field Measurement Table

| Measurement Point | Clearance | | Station | Offset (from CL) | Taken To |
|-------------------|-----------|--------|---------|------------------|----------|
| | Feet | Inches | | | |
| 1 | 9 | 6 | 0+0 | | Liner |
| 4 | 18 | 9 | 0+0 | | Lighting |
| 4 | 20 | 2 | 0+0 | | Liner |
| 6 | 13 | 11 | 2+23 | | Rock |



Appendix XI: Critical Inspection and Essential Repair Finding Template

Example

ERF/CIF MEMO

To: Mr. Lynn Croswell, PE
Bridge Inspection Manager

From: Inspector Name
Tunnel Inspection Team Leader

Colorado Dept. of Transportation
4201 E. Arkansas Avenue, Room 107
Denver, CO 80222

Consultant Address

Project: NTIS Tunnel Inspections

Date: 8/17/2016

Reference: N-09-F ERF-01 2016 08 17

Critical Inspection Finding (CIF) Essential Repair Finding (ERF)

Structure: N-09-F
Alias: Tunnel – Wolf Creek (174.089)
Facility Carried: US 160 ML
Feature Intersected: Wolf Creek Pass
Owner: State Highway Agency
County: Mineral
Feature Intersected: Wolf Creek Pass

Inspection Date (Date of Finding): 08/17/2016
Color Code: Orange

Classification and Prioritization

When identifying a needed repair as essential, the Bridge Inspection Program Manager will classify the repair based on the appropriate time frame for addressing the problem as follows:

| | |
|--------|---|
| Orange | Accomplish repairs within the timeframe specified by the memo or within 30 days maximum. |
| Yellow | Recommend accomplishing repairs within the next 90 days. |
| Green | Recommend accomplishing repairs within the next year or as funding allows. |
| Blue | Monitoring by maintenance in lieu of repairs. The type and frequency of monitoring as specified by the repair notice. |

Reference: ERF_N-09-F 20160817-001

Inspection Findings:

Example – North Portal over southbound lane exhibits 15 SF of delaminated concrete along north fascia and underside of arch. Inspector unable to remove during inspection, but concrete is loose. Hollow area has been marked for removal with orange spray paint. See photo 1.

Recommendation:

Example - This condition requires immediate action. Recommendation is to close the southbound travel lane and remove the marked area at the north portal within 24 hours.

Action Required:

- Close the tunnel until the severe defect is removed or repaired, if the defect may impact users or user safety.
- Restrict the area from public access until the defect can be removed or repaired.
- Repair the structural member or address the functional or safety issue (as specified in the recommendation)

Reference: ERF_N-09-F 20160817-001

Photos:



Photo 1: Example - North portal, looking south

Consultant Company Name

Team Leader Name

Phone:

Fax:

Team Leader E-mail

c. Cc List



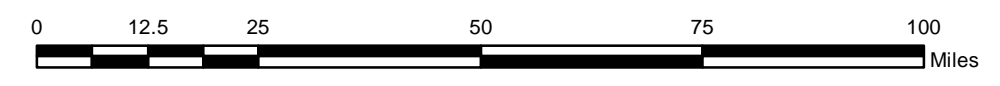
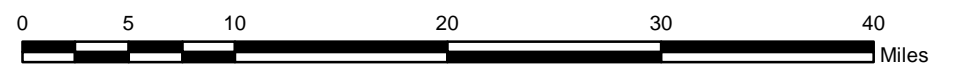
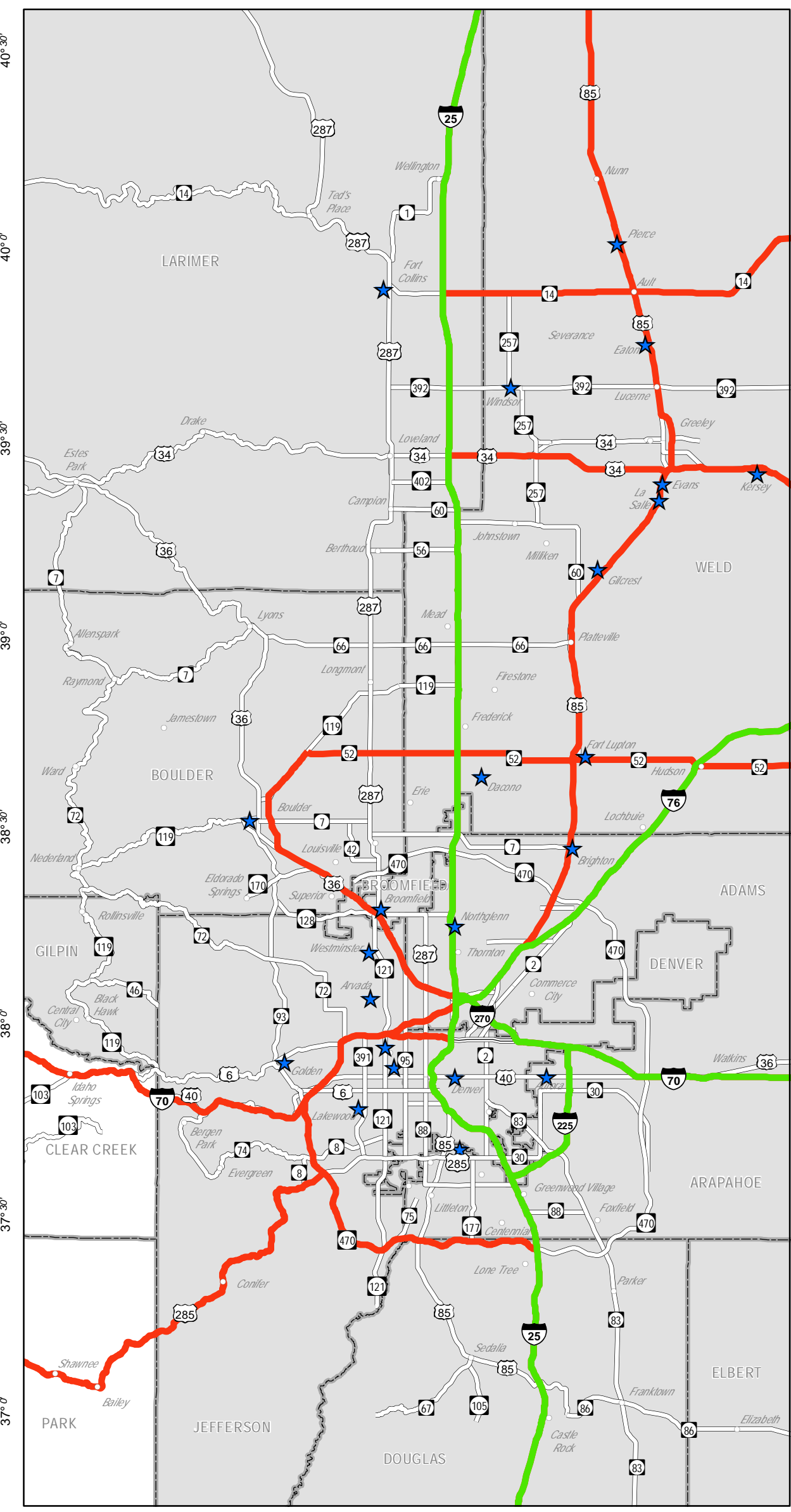
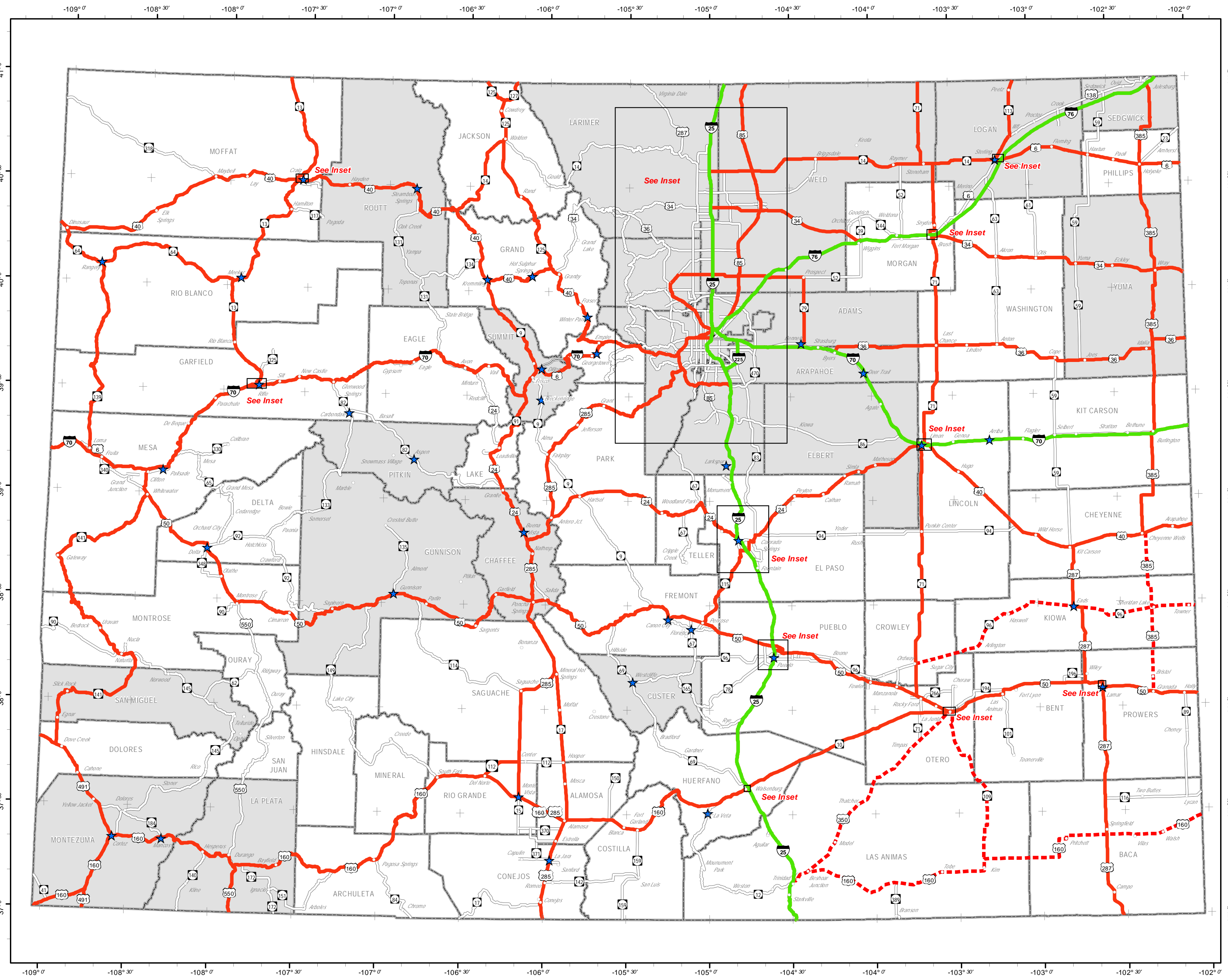
Appendix XII: Functional Systems Test and Routine Maintenance



Appendix XII.a: Functional Systems Test and Routine Maintenance

Colorado Hazardous and Nuclear Materials Route Restrictions 2013(a)

Routes Designated By:
Department of Public Safety
Division of State Patrol - Hazardous Materials Section



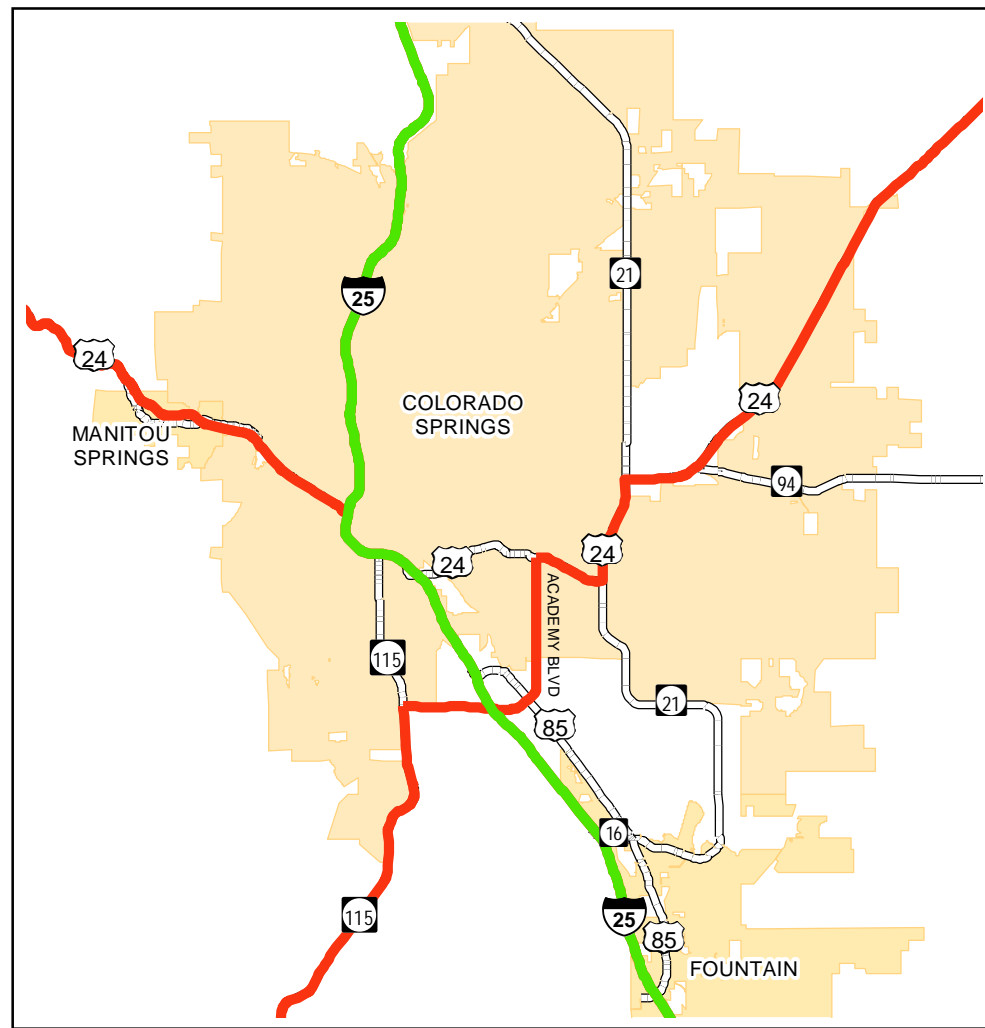
Map Created By:
Colorado Department of Transportation
Division of Transportation Development - GIS Section
Data Source: CDOT 2012
Published: November 2012

- Designated Nuclear and Hazardous Materials Route
- Designated Hazardous Materials Route
- - - Designated Gasoline, Diesel Fuel, and Liquefied Petroleum Gas Route
- Interstate Highways
- U.S. Highways
- State Highways
- Counties that require gasoline, diesel, and liquefied petroleum gas to comply with routing requirements.
- Municipalities that require gasoline, diesel, and liquefied petroleum gas to comply with routing requirements.

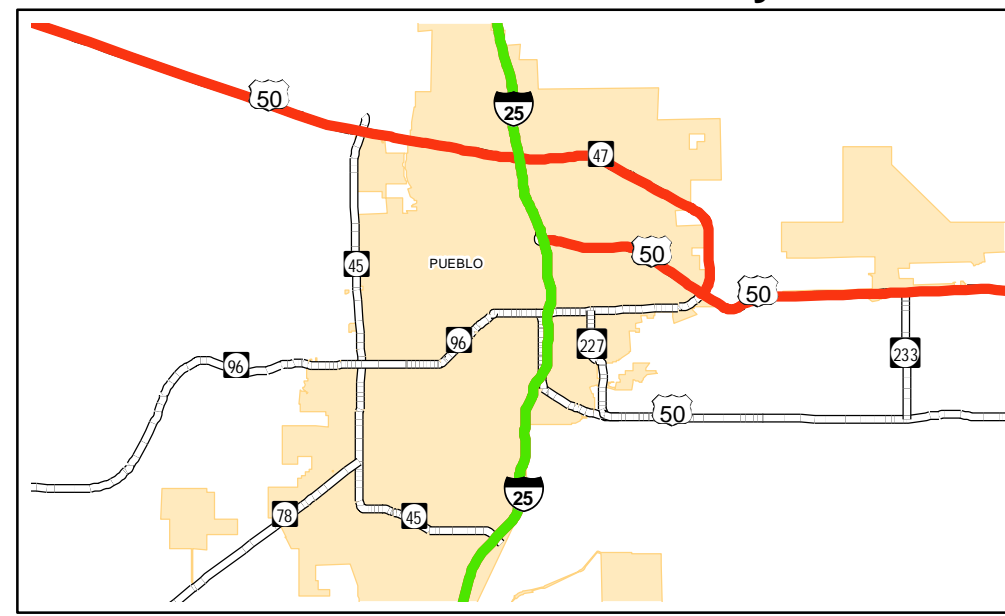
The information contained in this map is based on the most currently available data and has been checked for accuracy. CDOT does not guarantee the accuracy of any information presented, is not liable in any respect for any errors or omissions, and is not responsible for determining "fitness for use".



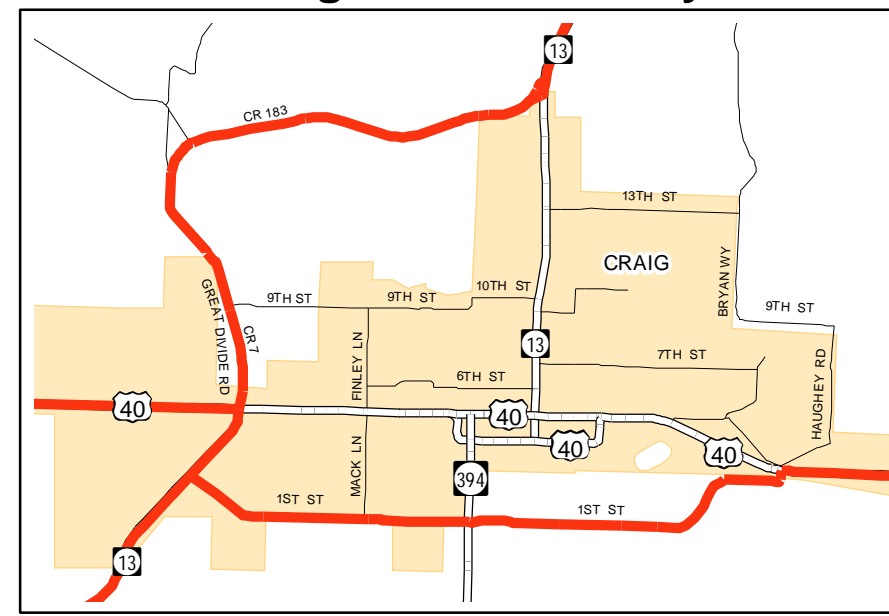
Colorado Springs / El Paso County



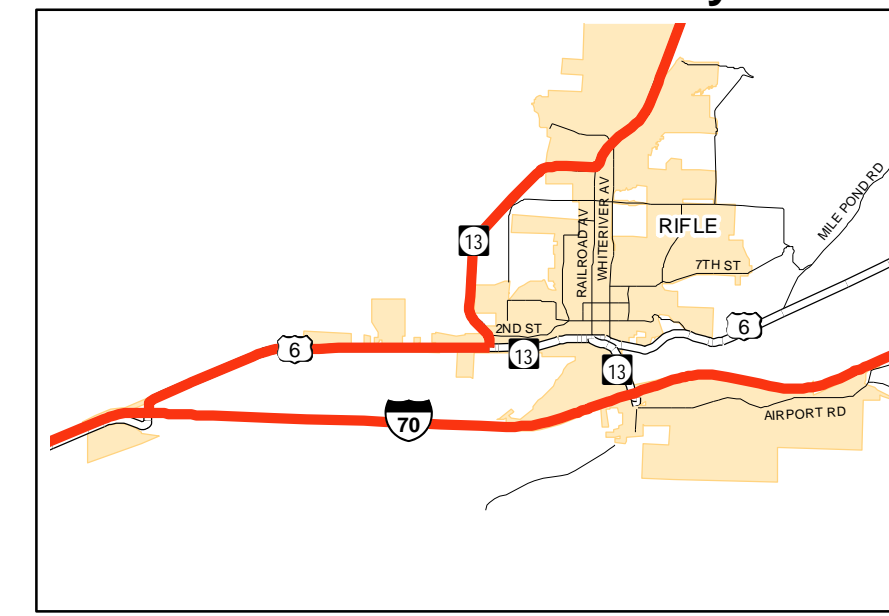
Pueblo / Pueblo County



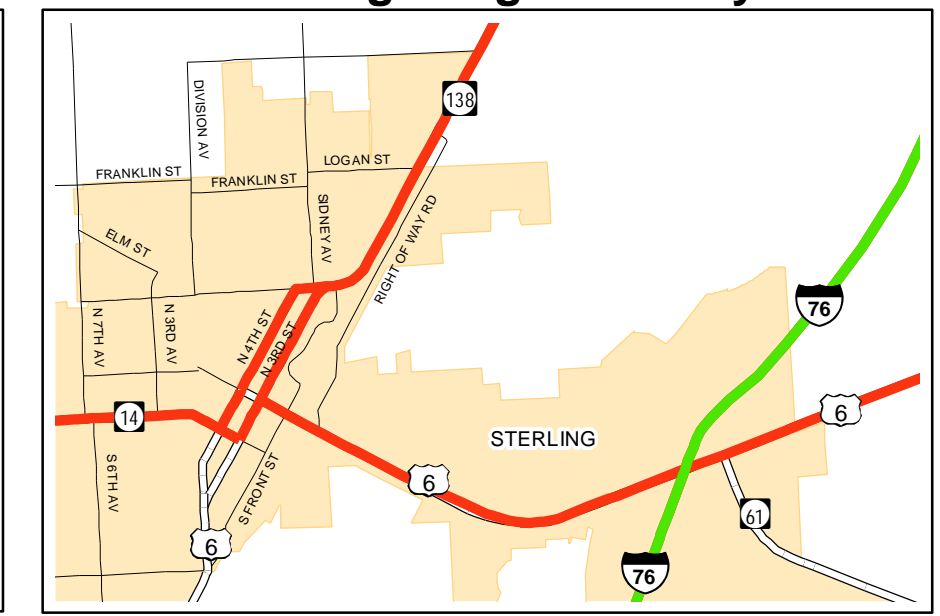
Craig / Moffat County



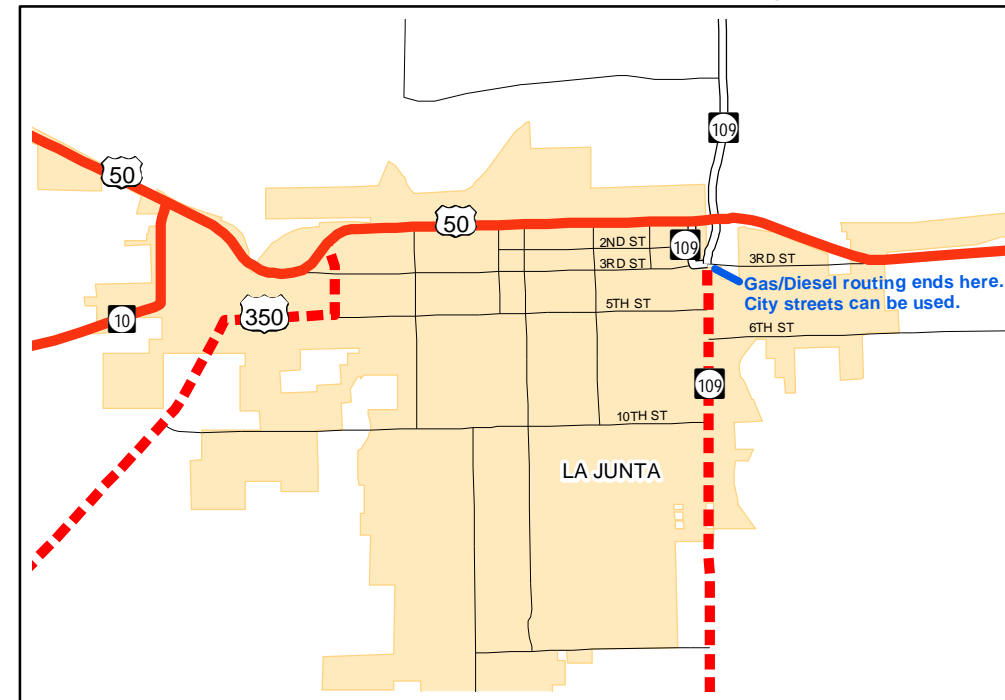
Rifle / Garfield County



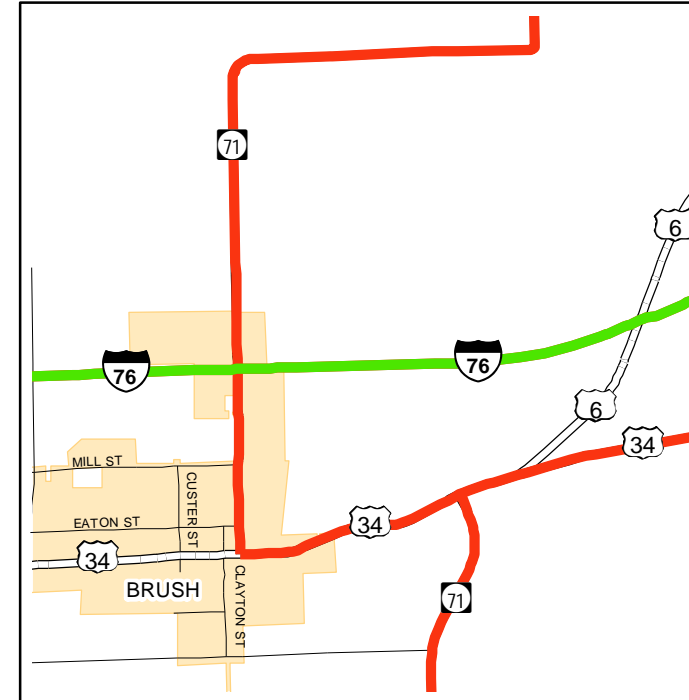
Sterling / Logan County



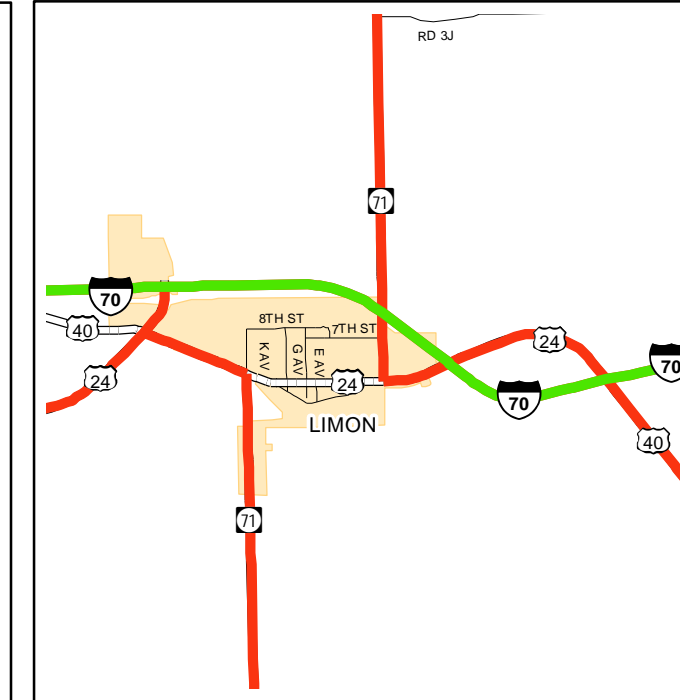
La Junta / Otero County



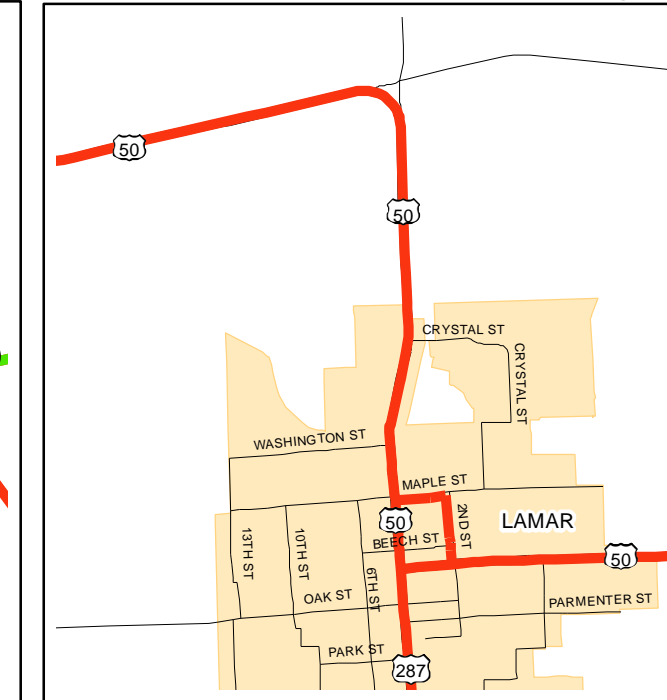
Brush / Morgan County



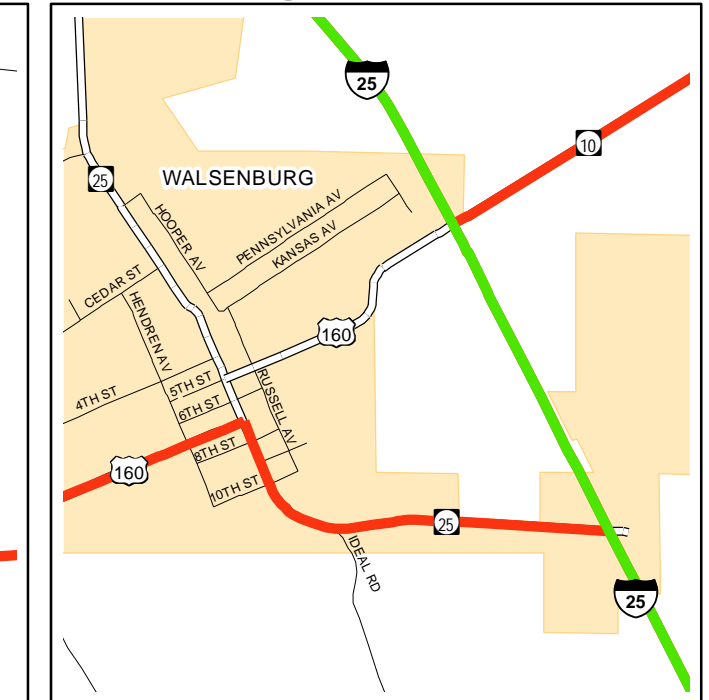
Limon / Lincoln County



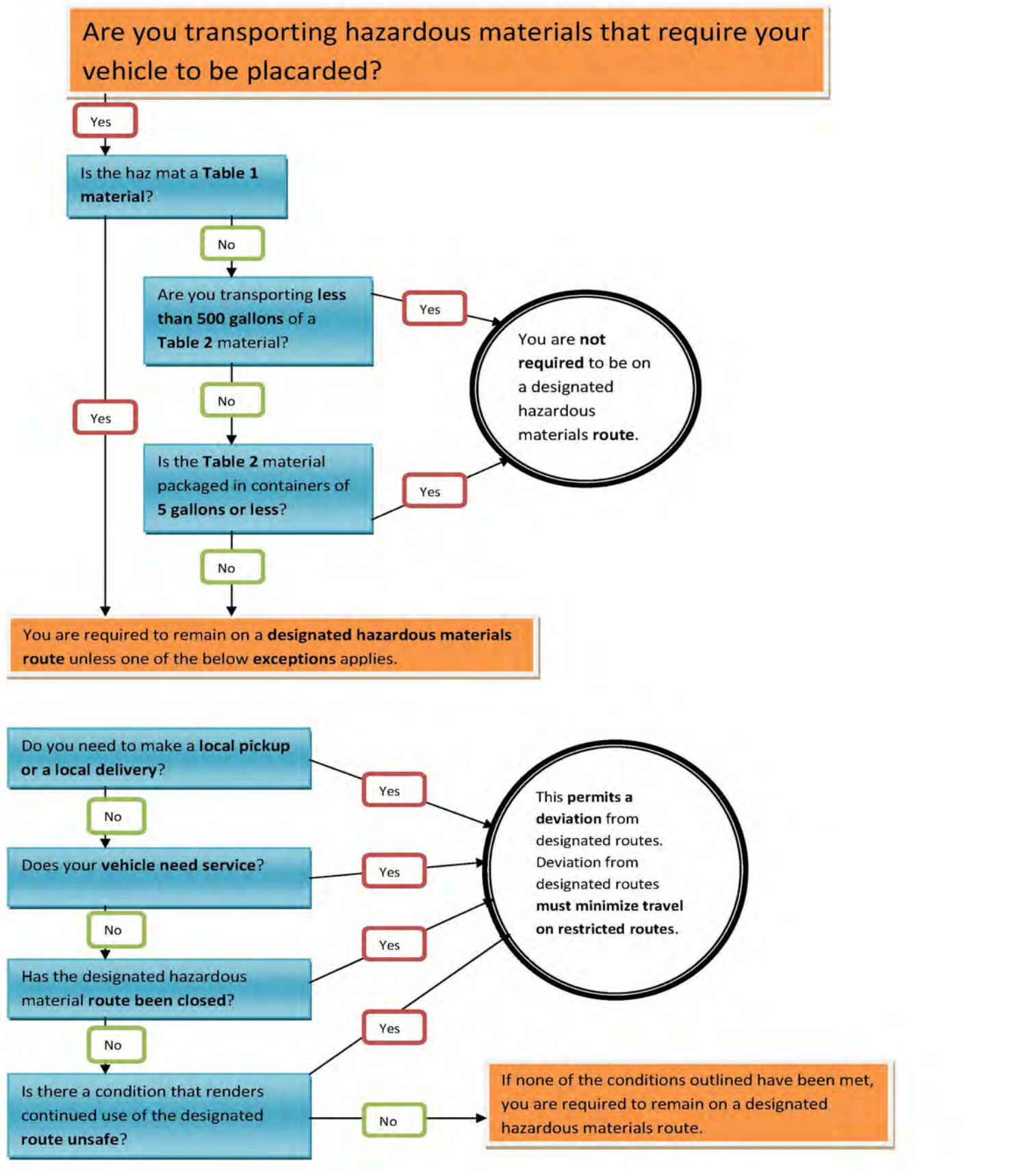
Lamar / Prowers County



Walsenburg / Huerfano County



Routing Decision Chart



Colorado State Patrol Communications Centers
 24 Hours Emergency Phone Numbers

| | |
|----------|----------------|
| Alamosa | (719) 589-5807 |
| Craig | (970) 824-6501 |
| Denver | (303) 239-4501 |
| Montrose | (970) 249-4392 |
| Pueblo | (719) 544-2424 |

Colorado State Patrol Hazardous Materials Unit
 (303) 273-1900
<http://csp.state.co.us/hazmat.html>

Nuclear Materials Routing Exceptions

Nuclear Materials are defined as a highway route controlled quantity of radioactive materials, in 42-20-402, CRS. When transporting a Nuclear Material, carriers are required to remain on designated nuclear material routes.

Carriers are not to deviate from designated nuclear materials routes except under certain circumstances:

- Carriers may deviate from designated routes in order to make local pick-ups or deliveries.
- Carriers may deviate from designated routes when continued use of the route is unsafe.
- Carriers may deviate from designated routes in order to refuel.
- Carriers may deviate from designated routes when the route is closed due to road conditions, road construction or maintenance operations.

When an emergency condition exists or when the designated nuclear materials route closed due to adverse weather conditions, or other circumstances, the Colorado State Patrol (CSP) may designate an alternative route. The CSP requires nuclear materials be escorted while off the designated route. Carriers must contact the nearest CSP Communications Center for instructions prior to deviating from a designated route.

There are exceptions to the definition of nuclear materials. These exceptions remove the materials described from the routing requirements discussed earlier. Nuclear Materials, as defined in 42-20-402, CRS, do not include:

- Nuclear materials used for research or medical purposes within Colorado. A Highway Route Control Quantity (HRCQ) of radioactive material used to irradiate medical supplies and equipment is not considered as being "used for medical purposes" and is therefore required to abide by the nuclear material routing rules.
- Radioactive materials transported as ores or products from mining, milling, smelting, or similar processing of ores, and mineral-bearing materials.
- Radioactive materials utilized in national security activities under the direct control of the Department of Defense; radioactive materials under the direct control of the Department of Energy used in carrying out atomic energy defense activities as defined in the federal "Nuclear Waste Policy Act of 1982," 42 USC 10101 et seq.

Finally, carriers transporting nuclear materials shall be familiar with the rules and regulations adopted by the Colorado State Patrol and published under 8 CCR 1507-25. Additionally, the carrier is required to comply with the provisions of 49 CFR 397.101(c).

Hazardous Materials Routing

As a general rule, vehicles carrying an amount of hazardous materials that require placards, must remain on designated hazardous materials routes. There are some exceptions to the rule:

- You may leave an authorized route in order to service a vehicle.
- You may leave an authorized route for local pickup or delivery of hazardous materials.
- You may leave an authorized route due to emergencies that would make continued use of the route unsafe.
- You may leave an authorized route when it is closed pursuant to 42-20-304, CRS.

A person transporting hazardous materials may make successive local pickups and deliveries without returning to the route between deliveries, when returning to the route is unreasonable.

Agricultural products other than Class 2 materials as defined in 49 CFR, over local roads between fields of the same farm, are exempted from the statutory requirements when transported by a farmer who is an intrastate private motor carrier and the movement of the agricultural product is in compliance with 49 CFR 173.5 and 42-20-108.5, CRS.

Some motor vehicles that are carrying hazardous materials, even amounts that may require placards, are not subject to the routing requirements. Vehicles carrying materials described in Table 2 of 49 CFR 172.504 in the following configurations:

- Quantities of less than 500 gallons of Table 2 hazardous materials.
- Table 2 hazardous materials in containers of five gallons or less.
- Table 2 hazardous materials when they are packaged as consumer commodities as defined in 49 CFR.

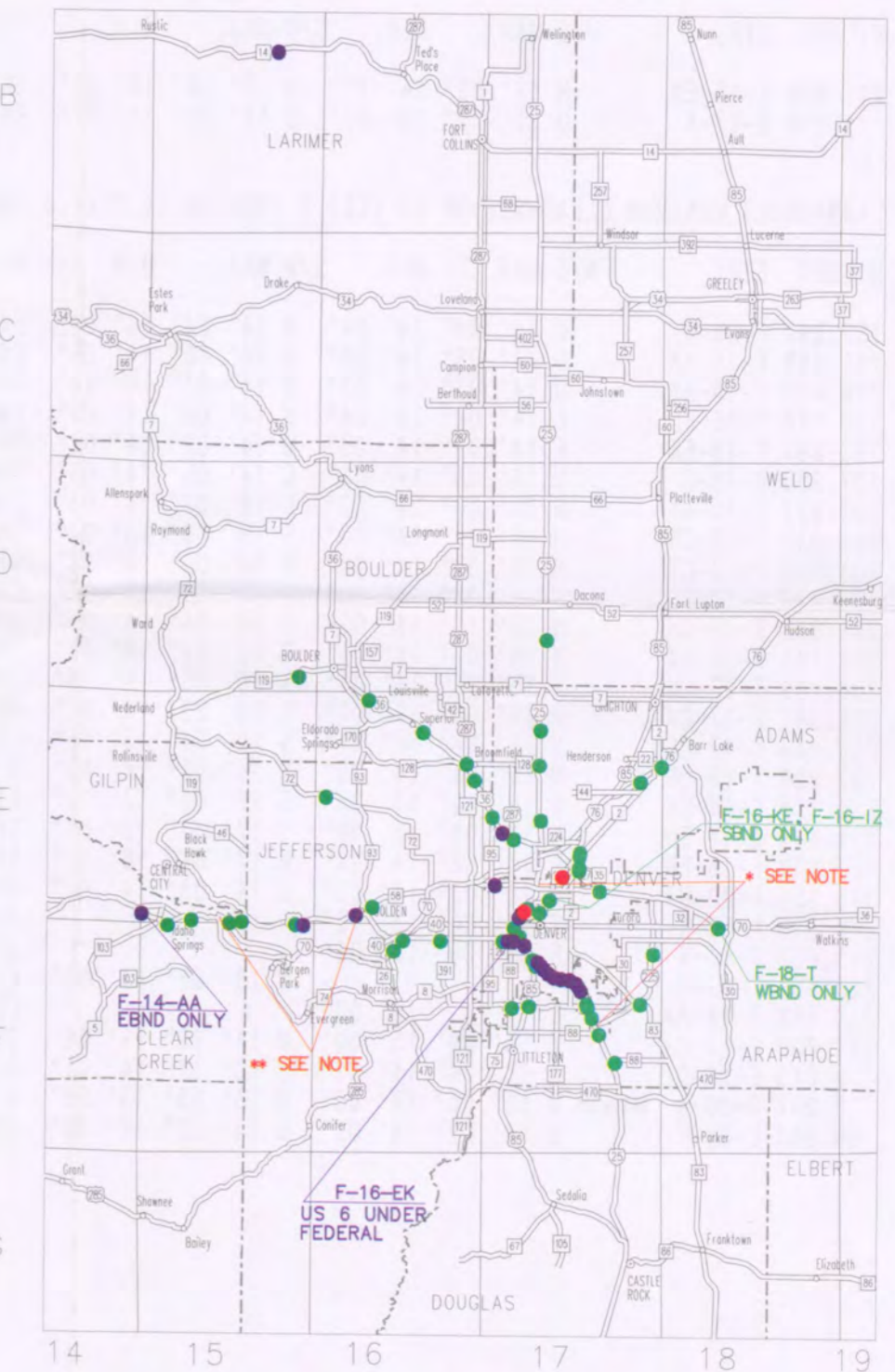
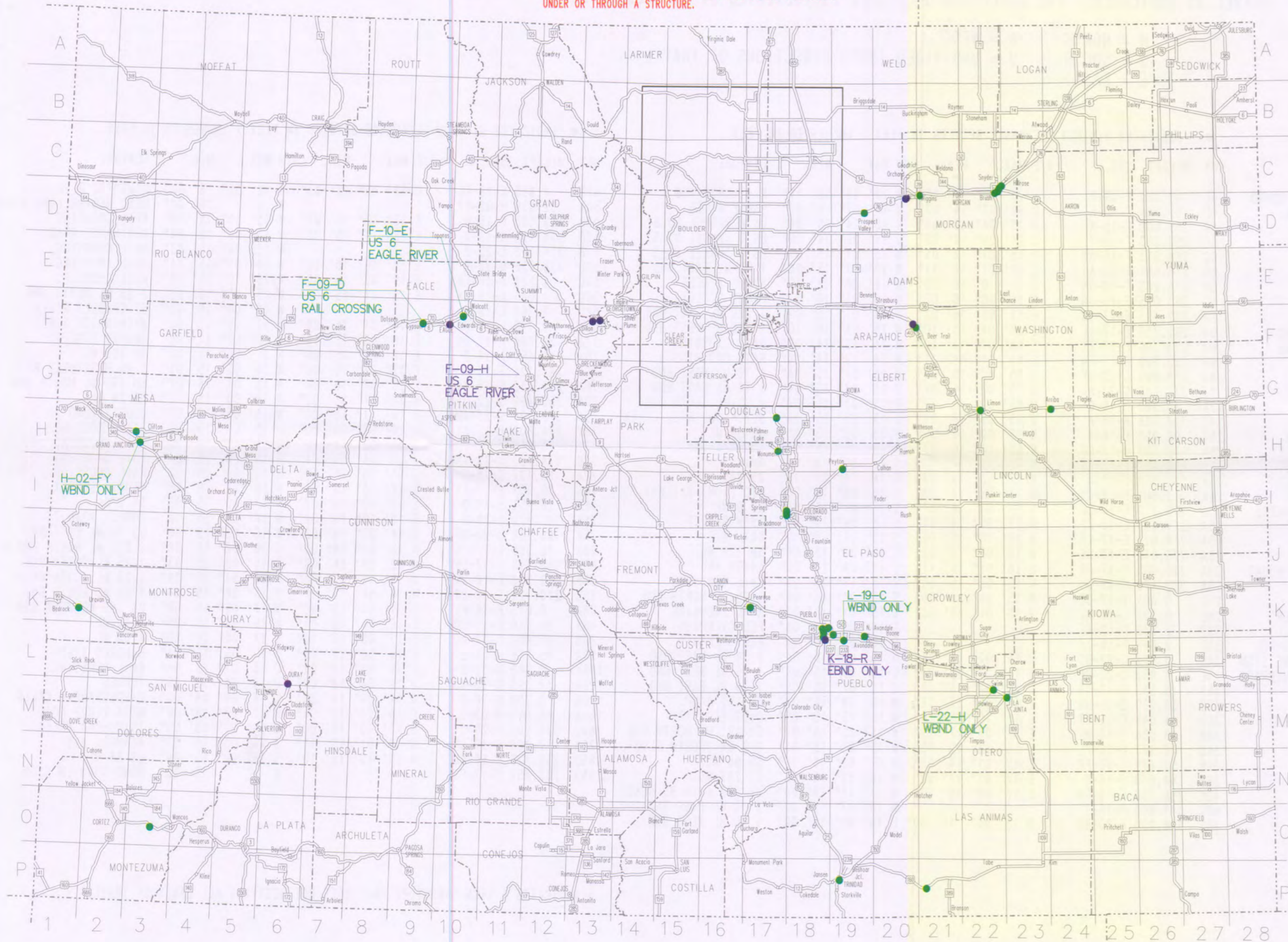
Additionally, motor vehicles that are transporting ores, the products from mining, milling, smelting, other similar processing of ores, and the wastes and tailings from those processes or special fireworks as defined in 49 CFR 173.88 when the aggregate amount of flash powder does not exceed fifty pounds, are exempted from the requirements of routing.

WARNING
 THE VERTICAL CLEARANCES SHOWN ARE FOR INFORMATION ONLY. IT IS THE RESPONSIBILITY OF THE OPERATOR OF THE EQUIPMENT TO CHECK THE LOAD AND STRUCTURE CLEARANCE BEFORE PROCEEDING UNDER OR THROUGH A STRUCTURE.

COLORADO STATE HIGHWAY SYSTEM HEIGHT RESTRICTION MAP
 SEE REVERSE SIDE FOR DETAILED CLEARANCES

May 1, 2000
 PREPARED BY
 COLORADO DEPARTMENT OF TRANSPORTATION

CLEARANCES ARE FOR MAINLINE ROUTES ONLY



• NOTE: No vehicles or loads greater than 13'0" are allowed on I-25 between W.P. 200.11 (Jct I-225 and I-25) and W.P. 213.85 (Jct I-70 and I-25). See Listing for structures exceeding 13 feet.

•• NOTE: No vehicles or loads greater than 13'0" are allowed on US 6 between W.P. 257.08 (Jct I-70 and SH 6) and W.P. 271.46 (Jct SH 58 and SH 6). See listing for structures exceeding 13 feet.

THE FOLLOWING LIST OF STRUCTURES HAVE A MINIMUM CLEARANCE IN THE DIRECTION OF TRAVEL AS INDICATED. THE DIRECTION OF TRAVEL IS INDICATED BY THE FOLLOWING:

N = NORTH W = WEST
 S = SOUTH U = UNDIVIDED (BOTH DIRECTIONS OF TRAVEL)
 E = EAST

● INDICATES MINIMUM CLEARANCE OF 13 FEET OR LESS

| HWY | MILEPT | STR. | N/E MAX. | MIN. | S/W MAX. | MIN. | FEATURE |
|------|---------|---------|-----------|---------|-----------|---------|--------------------|
| 25A | 211.465 | E-16-EW | N 16' 09" | 14' 11" | S 17' 05" | 13' 00" | SPEER BLVD N BOUND |
| 265A | 1.198 | E-17-A | U 11' 07" | 11' 07" | U 11' 07" | 11' 07" | RAIL CROSSING |

● INDICATES MINIMUM CLEARANCE OF 13 FEET 1 INCH TO 14 FEET 6 INCHES

| HWY | MILEPT | STR. | N/E MAX. | MIN. | S/W MAX. | MIN. | FEATURE |
|------|---------|---------|-----------------|---------|-----------|---------|---------------------|
| 6E | 150.240 | F-09-H | U 14' 04" | 14' 04" | U 14' 04" | 14' 04" | EAGLE RIVER |
| 6G | 265.189 | F-15-AX | U 14' 06" | 14' 06" | U 14' 06" | 14' 06" | US 6 TUNNEL NO 2 |
| 6G | 270.430 | F-15-AY | U 14' 03" | 14' 03" | U 14' 03" | 14' 03" | US 6 TUNNEL NO 1 |
| 6G | 283.576 | F-16-EL | E 14' 04" | 14' 04" | W 14' 06" | 14' 06" | KNOX COURT |
| 6G | 283.861 | F-16-EK | E 14' 03" | 14' 03" | W 14' 02" | 14' 02" | SH 88 ML |
| 14B | 107.250 | B-15-E | U 14' 05" | 14' 05" | U 14' 05" | 14' 05" | TUNNEL |
| 25A | 203.537 | F-17-AY | N 16' 00" | 14' 02" | S 16' 07" | 14' 03" | EVANS AVENUE |
| 25A | 204.037 | F-17-CW | N 16' 07" | 14' 00" | S 15' 08" | 13' 09" | SH 2 ML |
| 25A | 204.580 | F-17-CT | N 16' 00" | 14' 08" | S 16' 00" | 14' 04" | STEELE STREET |
| 25A | 205.616 | F-17-CS | N 15' 08" | 13' 10" | S 15' 10" | 13' 07" | FRANKLIN STREET |
| 25A | 205.919 | F-17-CN | N 16' 11" | 14' 02" | S 16' 04" | 14' 05" | DOWNING STREET |
| 25A | 206.149 | F-17-CX | N 16' 02" | 14' 04" | S 15' 11" | 14' 01" | EMERSON STREET |
| 25A | 206.209 | F-17-CK | N 16' 04" | 14' 05" | S 16' 05" | 14' 04" | LOUISIANA AVE |
| 25A | 206.341 | F-17-CM | N 16' 00" | 14' 02" | S 16' 02" | 14' 01" | WASHINGTON STREET |
| 25A | 206.619 | F-17-CL | N 16' 04" | 14' 04" | S 16' 04" | 13' 11" | LOGAN STREET |
| 25A | 207.990 | F-16-DS | N 16' 01" | 14' 00" | S 16' 02" | 14' 00" | I 25 ML |
| 25A | 211.109 | F-16-DA | N 15' 10" | 14' 05" | S 17' 00" | 13' 10" | 23RD AVE |
| 25A | 211.464 | E-16-EO | N 16' 09" | 14' 09" | S 17' 07" | 13' 05" | SPEER BLVD S BOUND |
| 36B | 53.932 | E-16-FP | E 15' 08" | 14' 04" | W 17' 04" | 16' 04" | 80TH AVE |
| 40E | 346.251 | F-20-BA | U 14' 03" | 14' 03" | U 14' 03" | 14' 03" | 80TH AVE |
| 50C | 1.330 | K-18-R | E 14' 00" | 13' 10" | | | ARKANSAS RIVER |
| 70A | 213.651 | F-13-X | E 13' 06" | 13' 06" | | | JOHNSON TUNNEL |
| 70A | 213.652 | F-13-Y | | | W 13' 06" | 13' 06" | EISENHOWER TUNNEL |
| 70A | 238.689 | F-14-AA | E * | 14' 00" | | | EBND EXIT LANE SIGN |
| 70Y | 274.900 | E-17-CJ | E 15' 00" | 15' 00" | W 14' 10" | 14' 06" | STOCK SHOW/OVERPASS |
| 95A | 9.013 | E-16-DI | N 17' 04" | 14' 01" | S 16' 11" | 14' 01" | I 70 ML |
| 144A | 0.001 | D-20-g | MINOR U 13' 05" | 13' 05" | U 13' 05" | 13' 05" | I 76 ML |
| 550B | 90.863 | L-06-P | U 14' 02" | 14' 02" | U 14' 02" | 14' 02" | US 550-TUNNEL |

● INDICATES MINIMUM CLEARANCE BETWEEN 14 FEET 7 INCHES TO 16 FEET

| HWY | MILEPT | STR. | N/E MAX. | MIN. | S/W MAX. | MIN. | FEATURE |
|-----|---------|---------|-----------|---------|-----------|---------|----------------------|
| 6E | 142.385 | F-09-D | E 16' 00" | 16' 00" | W 15' 11" | 15' 11" | RAIL CROSSING |
| 6E | 155.984 | F-10-E | U 14' 07" | 14' 07" | U 14' 07" | 14' 07" | EAGLE RIVER |
| 6G | 259.000 | F-15-X | U 15' 04" | 15' 04" | U 15' 04" | 15' 04" | US 6 TUNNEL NO 6 |
| 6G | 259.513 | F-15-Y | U 14' 09" | 14' 09" | U 14' 09" | 14' 09" | US 6 TUNNEL NO 5 |
| 6G | 264.813 | F-15-AW | U 15' 01" | 15' 01" | U 15' 01" | 15' 01" | US 6 TUNNEL NO 3 |
| 6G | 275.651 | F-16-AS | E 17' 01" | 16' 11" | W 15' 07" | 15' 06" | I 70 ML EAST BND |
| 6G | 278.233 | F-16-GN | E 17' 10" | 16' 00" | W 18' 00" | 15' 10" | SIMMS STREET |
| 6G | 283.095 | F-16-GG | E 16' 00" | 16' 00" | W 16' 03" | 16' 03" | PERRY STREET |
| 6H | 292.723 | E-17-IM | E 17' 05" | 16' 02" | W 18' 01" | 15' 09" | I 270 ML EAST BND |
| 6H | 292.724 | E-17-IL | E 17' 04" | 15' 10" | W 18' 04" | 15' 10" | I 270 ML WEST BND |
| 6H | 293.700 | E-17-EK | E 15' 01" | 14' 10" | W 14' 10" | 14' 09" | RAIL CROSSING |
| 6H | 293.969 | E-17-EM | E 14' 11" | 14' 11" | W 14' 10" | 14' 10" | RAIL CROSSING |
| 6J | 371.690 | C-22-BE | U 15' 07" | 15' 04" | U 15' 07" | 15' 04" | I 76 ML WEST BND |
| 6J | 371.691 | C-22-BG | U 15' 07" | 15' 04" | U 15' 07" | 15' 04" | I 76 ML EAST BND |
| 12A | 70.385 | P-18-Q | U 15' 07" | 15' 07" | U 15' 07" | 15' 07" | I 25 ML SOUTH BND |
| 24G | 327.328 | H-18-A | U 15' 09" | 15' 09" | U 15' 09" | 15' 09" | BLACK SQUIRREL CREEK |
| 25A | 99.950 | K-18-J | N 16' 09" | 16' 05" | S 15' 06" | 15' 05" | US 50 ML |
| 25A | 172.307 | H-17-CG | N 16' 10" | 16' 07" | S 16' 00" | 15' 07" | COUNTY ROAD |
| 25A | 200.492 | F-17-GT | N 17' 09" | 17' 02" | S 17' 06" | 15' 06" | QUINCY AVE |
| 25A | 201.578 | F-17-W | N 17' 00" | 14' 09" | S 16' 11" | 15' 10" | US 285 ML |
| 25A | 203.601 | F-17-CY | N 16' 06" | 16' 00" | S 15' 08" | 15' 08" | RTD LIGHT RAILWAY |
| 25A | 209.210 | F-16-DU | N 19' 04" | 16' 07" | S 17' 09" | 15' 00" | US 6 ML |
| 25A | 211.648 | E-16-EP | N 17' 05" | 14' 11" | S 18' 09" | 14' 09" | 15TH STREET |
| 25A | 219.023 | E-17-LE | N 16' 10" | 15' 06" | S 15' 11" | 15' 09" | 88TH AVE |
| 25A | 223.049 | E-17-HE | N 16' 08" | 16' 02" | S 15' 09" | 15' 05" | SH 128 ML |
| 25A | 226.085 | E-17-HR | N 16' 01" | 15' 11" | S 16' 04" | 16' 00" | 144TH AVE |
| 25A | 232.475 | D-17-J | N 15' 05" | 15' 05" | S 15' 11" | 15' 11" | RAIL CROSSING |
| 25D | 0.001 | I-17-DC | N 15' 09" | 14' 08" | S 15' 08" | 15' 03" | I 25 ML NORTH BND |
| 25D | 0.395 | I-17-AL | N 16' 01" | 15' 05" | S 15' 07" | 15' 07" | RAIL CROSSING |
| 33Z | 2.030 | F-16-KE | | | S 16' 00" | 15' 04" | PED OVERPASS |
| 33Z | 2.096 | F-16-IZ | | | S 16' 03" | 15' 11" | PED OVERPASS |
| 34E | 0.932 | C-22-BG | U 15' 07" | 15' 04" | U 15' 07" | 15' 04" | I 76 ML EAST BND |
| 34E | 0.933 | C-22-BE | U 15' 07" | 15' 04" | U 15' 07" | 15' 04" | I 76 ML WEST BND |
| 35A | 8.553 | E-17-GB | U 16' 07" | 15' 05" | U 16' 07" | 15' 05" | I 70 ML EAST BND |
| 36B | 39.260 | E-16-HW | E 16' 00" | 15' 11" | W 16' 08" | 16' 07" | SH 157 RAMP |
| 36B | 44.045 | E-16-FT | E 15' 10" | 15' 10" | W 15' 10" | 15' 09" | OVERHEAD PIPE |
| 36B | 48.036 | E-16-HV | E 18' 07" | 17' 11" | W 16' 05" | 15' 07" | SH 121 ML NORTH BND |
| 36B | 49.477 | E-16-FL | E 15' 06" | 15' 05" | W 15' 06" | 15' 05" | OLD WADSWORTH BLVD |
| 36B | 52.479 | E-16-FO | E 15' 01" | 14' 09" | W 17' 03" | 16' 11" | SH 95 ML |
| 36B | 54.858 | E-16-Q | E 17' 03" | 17' 02" | W 15' 11" | 15' 06" | US 287 ML |
| 40C | 296.156 | F-16-FW | E 17' 00" | 16' 00" | W 17' 11" | 16' 00" | US 287 + SH 88 NBND |
| 40C | 311.660 | F-18-T | | | W 15' 07" | 15' 07" | I 70 ML EAST BND |
| 40E | 346.250 | F-20-BB | U 15' 00" | 15' 00" | U 15' 00" | 15' 00" | I 70 ML WEST BND |

● INDICATES MINIMUM CLEARANCE BETWEEN 14 FEET 7 INCHES TO 16 FEET

| HWY | MILEPT | STR. | N/E MAX. | MIN. | S/W MAX. | MIN. | FEATURE |
|------|---------|---------|-----------|---------|-----------|---------|-----------------------|
| 47A | 1.865 | K-18-EL | N 16' 06" | 16' 01" | S 16' 03" | 16' 00" | BONFORTE BLVD |
| 50A | 32.039 | H-02-FY | W * | 16' 00" | W * | 16' 00" | NBND MEDIAN LANE SIGN |
| 50B | 319.085 | K-18-W | E 15' 08" | 15' 07" | W 15' 11" | 15' 10" | RAIL CROSSING |
| 50B | 329.135 | K-19-V | E 15' 11" | 15' 09" | W 16' 00" | 15' 09" | ORDINANCE ROAD |
| 50B | 374.115 | L-22-H | | | W 15' 04" | 15' 03" | RAIL CROSSING |
| 50B | 378.736 | M-22-R | E 15' 09" | 15' 06" | W 16' 01" | 15' 11" | RAIL CROSSING |
| 50C | 0.528 | K-18-ER | E 16' 02" | 16' 00" | W 15' 10" | 15' 10" | RAIL CROSSING |
| 50C | 1.041 | K-18-AX | E 15' 11" | 15' 03" | W 17' 05" | 16' 08" | I 25 ML NORTH BND |
| 50C | 7.768 | L-19-C | | | W 16' 00" | 16' 00" | ST CHARLES RIVER |
| 58A | 0.719 | E-16-FX | E 16' 01" | 15' 09" | W 17' 10" | 17' 00" | WASHINGTON STREET |
| 70A | 28.566 | H-02-DS | E 16' 08" | 15' 10" | W 17' 02" | 17' 01" | COUNTY ROAD 25 |
| 70A | 239.652 | F-14-E | E 16' 08" | 15' 09" | W 17' 06" | 17' 02" | SH 103 ML |
| 70A | 241.125 | F-14-Y | E 17' 07" | 15' 00" | W 16' 05" | 15' 01" | I 70 BUSSINESS RT |
| 70A | 259.830 | F-16-KW | E 19' 07" | 18' 06" | W 16' 04" | 15' 07" | SH 470 ML NORTH BND |
| 70A | 359.499 | G-22-BA | E 16' 04" | 16' 02" | W 16' 00" | 15' 11" | US 24 ML |
| 70A | 376.520 | G-23-AM | E 16' 11" | 16' 00" | W 16' 05" | 16' 02" | COUNTY ROAD 36 |
| 70Y | 274.800 | E-17-AI | U 15' 00" | 15' 00" | U 15' 00" | 15' 00" | RAIL CROSSING |
| 70Y | 275.410 | E-17-Z | E 15' 02" | 14' 10" | W 14' 11" | 14' 08" | RAIL CROSSING |
| 71D | 174.257 | C-22-AR | U 15' 04" | 15' 04" | U 15' 04" | 15' 04" | RAIL CROSSING |
| 72A | 13.137 | E-15-C | U 15' 00" | 15' 00" | U 15' 00" | 15' 00" | RAIL CROSSING |
| 76A | 15.051 | E-17-EX | E 17' 03" | 16' 11" | W 16' 07" | 16' 00" | PEORIA STREET |
| 76A | 16.954 | E-17-O | E 17' 10" | 16' 02" | W 17' 00" | 15' 09" | SH 2 ML |
| 76A | 47.972 | D-19-N | E 16' 10" | 16' 04" | W 16' 08" | 15' 09" | COUNTY ROAD 73 |
| 76A | 66.288 | D-20-AT | E 16' 03" | 16' 02" | W 16' 02" | 16' 00" | US 34 ML EAST BND |
| 83A | 70.566 | F-17-FE | N 18' 03" | 16' 00" | S 19' 02" | 16' 06" | I 225 ML NORTH BND |
| 85A | 140.798 | I-17-DD | N 15' 09" | 14' 08" | S 15' 08" | 15' 03" | I 25 ML SOUTH BND |
| 85B | 210.516 | F-16-DW | N 15' 11" | 15' 07" | S 16' 04" | 15' 09" | I 25 ML SOUTH BND |
| 85B | 210.721 | F-16-DT | N 16' 01" | 15' 11" | S 15' 06" | 15' 04" | I 25 ML NORTH BND |
| 88A | 6.013 | F-16-FY | E 17' 01" | 15' 06" | W 17' 02" | 15' 08" | US 285 ML WEST BND |
| 88A | 14.736 | F-17-CO | E 16' 04" | 15' 01" | W 16' 09" | 15' 03" | I 25 ML |
| 88B | 17.001 | F-17-DG | E 17' 05" | 16' 10" | W 17' 00" | 16' 00" | I 25 ML |
| 90A | 15.216 | K-01-C | E 15' 00" | 15' 00" | W 15' 08" | 15' 04" | DOLORES RIVER |
| 105A | 5.980 | H-17-W | U 15' 02" | 15' 02" | U 15' 04" | 15' 04" | RAIL CROSSING |
| 119A | 37.695 | D-15-AS | U 15' 04" | 14' 09" | U 15' 04" | 14' 09" | TUNNEL |
| 120A | 2.759 | K-16-Q | U 14' 09" | 14' 09" | U 14' 09" | 14' 09" | HARDSCRABBLE CREEK |
| 160A | 48.611 | O-03-C | E 16' 03" | 15' 06" | W 17' 03" | 16' 09" | MESA VERDE ROAD |
| 160C | 374.209 | P-20-G | U 15' 00" | 15' 00" | U 15' 00" | 15' 00" | TRINCHERA CREEK |
| 225A | 7.906 | F-17-GN | N 16' 01" | 15' 11" | S 16' 05" | 16' 01" | ALAMEDA AVE |
| 285D | 259.326 | F-16-FU | N 15' 10" | 15' 10" | S 16' 00" | 15' 09" | US 85 ML |
| 285D | 263.852 | F-17-FY | | | W * | 15' 10" | WBND TURN LN SIGN |

* INDICATES A SIGN STRUCTURE THAT DOES NOT RESTRICT ALL LANES OF TRAVEL


National Highway System: Colorado

U.S. Department of Transportation
Federal Highway Administration

- Eisenhower Interstate System
- Other NHS Routes
- Non-Interstate STRAHNET Route
- STRAHNET Connector
- Intermodal Connector
- Intermodal/STRAHNET Connector
- Unbuilt NHS Routes
- MAP-21 NHS Principal Arterials

Census Urbanized Areas
Department of Defense
Water

- Airport
- Intercity Bus Terminal
- Ferry Terminal
- Truck/Pipeline Terminal
- Multipurpose Passenger Facility
- Port Terminal
- Truck/Rail Facility
- AMTRAK Station
- Public Transit Station



0 25 50 Miles
0 50 100 Kilometers

FHWA: March 25, 2015

