C.10. Traffic Signals Technical Plan

C.10.1. Introduction

The Traffic Signal Program (Program) is part of Colorado Department of Transportation's (CDOT) Traffic Asset and Operations Services unit and in the Division of Maintenance and Operations. The objective of this program is to develop statewide policies, procedures and guidelines on design, maintenance, life-cycle asset management, integration, and operation of traffic signals; manage various signal-related statewide funding programs and pools; and facilitate informed decision-making and project selection and prioritization. This includes implementation of advance technologies and innovative transportation solutions, integrating these and using them in conjunction with other ITS devices to more efficiently manage arterials and freeways as a smart system. The Program works collaboratively with CDOT Regions, FHWA, local agencies and MPOs to develop and implement policies, standards, and operational procedures.

The Program manages two funding pools, a Statewide Traffic Signal Pool (SGN) and a Statewide Traffic Signal Asset Management Pool (SGA). The SGN pool delivers funding to each Region on an annual basis. These funds are designated specifically for signal construction or signal system related improvements. The Regions rely on these funds to address safety, mobility and operational needs at locations with existing signals or where signals are warranted but not yet constructed. In a typical application, these funds are prioritized and directed to activities such as new traffic signal or ramp meter construction, equipment or system upgrades, signal expansion due to intersection widening, signal interconnect, and operational improvements including minor hardware or software upgrades to facilitate safety and improve corridor traffic operations.

The SGA pool delivers funding for capital replacement to each Region on an annual basis for traffic signal infrastructure which are in poor or severe condition. CDOT owns approximately 1,850 signals statewide and is responsible for the eventual replacement of these signals at the end of their useful life. FASTER Safety Asset Management Program funding may be used for projects that include repair or replacement of traffic signal boxes, controllers, assemblies and other associated signal infrastructure and projects that replace signal assets that are in deteriorating condition and do not meet the current standards as identified in the current version of Federal Highway Administration (FHWA) Manual on Uniform Traffic Control Devices (MUTCD), CDOT M&S Standards and other federal and state regulations.

CDOT's Traffic Signal Program collaborates with the Regions to identify, select and prioritize the replacement of statewide traffic signal assets. The program has established capital replacement guidelines, including performance measures and targets that are focused on high-level core criteria. These performance measures serve as a basis for Regions to develop lists of traffic signal capital replacement projects.

C.10.2. Regulatory Considerations

C.10.2.1. Regulations/Resolutions

The following list provides an overview of relevant federal and state regulations and requirements governing planning, policy, data, performance, funding, and project selection of traffic signals projects.

- Fixing America's Surface Transportation (FAST) Act
- 23 Code of Federal Regulations (CFR) Part 515 and 667
- Transportation Commission Resolution TC-18-03-12 and TC-17-10-12
- Policy Directive 14, 703, and 704
- Procedural Directive 704.1 and 1608.2

C.10.2.2. Guidelines

The additional guidelines provide insights to Traffic Signals related procedures and practices.

- FASTER Asset Management Funds
- CDOT M&S Standard Plans
- MUTCD, 2009 Edition
- American Association of State Highway and Transportation Officials (AASHTO) - A Policy on Geometric Design of Highways and Streets (2004 Greenbook)
- AASHTO Highway Capacity Manual (HCM)
- National Electrical Safety Code (NESC)
- Colorado Department of Regulatory Agencies (DORA)

C.10.3. Asset Inventory & Condition

C.10.3.1. Asset Inventory

CDOT owns approximately 1,850 traffic signals statewide. Approximately 50% of the signals are managed by CDOT and the other 50% are managed by local agencies under Senate Bill 8 (SB 8) signal maintenance agreements. It is assumed that CDOT is responsible for the eventual replacement of these traffic signals at the end of their useful life span. Historically, it is a common practice to assume signal as an aggregate unit, however, a typical traffic signal is comprised of functional traffic signal elements from overhead equipment to underground infrastructure, poles, mast arms, pedestals, detection devices, communication network and roadside cabinet, controller unit. A traffic signal is an integrated system of hardware, firmware, electrical and electronics components and communication devices required for a signal to properly function at an intersection. For asset management purposes, the signal inventory database consists of three separate components – traffic signal assembly, cabinets, and controllers.

Regularly updated statewide traffic signal inventory summaries are provided by the Performance and Asset Management Branch and may be viewed here. For example, an inventory of CDOT's traffic signal devices can be found in CDOT's Risk-Based Asset Management. Custom queries and reporting requests can be made through the Performance and Asset Management Branch.

C.10.3.2. Asset Conditions

Traffic signals have been viewed as an aggregate unit with a useful life span of 25 years. Although the traffic signal assembly (poles and mast arms), can last 30 years or longer when properly maintained and under normal conditions. Cabinets can be expected to have a useful life span of 20 years. Controllers can be expected to have a useful life span of 15 years. However, assuming the rapid technological advances in the transportation industry, cabinets and controllers have much shorter life cycles, due to electronics, technological function obsolescence, and other factors. CDOT Signal Asset Condition Assessment Guidelines is provide in CDOT's Risk-Based Asset Management Plan.

C.10.4. Performance

C.10.4.1. Metrics

Based on direction in PD 14, the Signals Asset Management Program uses "percent of signal infrastructure in severe condition" as its performance metric.

C.10.4.2. Targets

Based on direction in PD 14, the target of two percent or less of signal infrastructure in severe condition is used for CDOT signal assets. The target allows the Program to focus on signals with the greatest performance deficiency.

C.10.5. Funding

C.10.5.1. Funding Mechanisms

The primary source of revenue for the Program is the State Highway Fund (SHF). The SHF receives revenue from the Highway Users Tax Fund (HUTF), various other revenue and fees, and the General Fund. Recent Traffic Signal budgets and estimates are summarized in Table 5.

Table 5. Traffic Signal Program Budget (millions)

Actual FY 2016-17	Actual FY 2017-18	Budget FY 2018-19	Proposed FY 2019-20
$16.9	$15.5	$17.8	$16.1

Source: CDOT Office of Financial Management & Budget narrative FY19-20

C.10.5.2. Region Pool Distributions (4 Year Forecast)

CDOT's Traffic Signal Program delivers funding to each Region on an annual basis. To begin with, the allocated Signal Asset (SGA) Pool Funding is divided into six parts. Region 1 receives two parts and each other Regions receive one part. The planned allocation is adjusted throughout the year based on each Region's ability to encumber the funds on signal replacement projects. Funding not used by a Region in a given fiscal year is subject to retirement and may get swept at the end of the fiscal year.

C.10.6. Investment Strategies

CDOT has developed the Asset Investment Management System (AIMS) which predicts the long-term performance of each asset given various budget scenarios. The data generated by AIMS is used by CDOT decision-makers to determine the allocation of funds to invest in each asset for upcoming fiscal years. Information used by AIMS and decision-makers to make repair, rehabilitation, or replacement investment decisions is condition-based and includes such attributes as age, maintenance history, structural integrity, technological obsolescence, decreased functionality, span-wire signals, and numerous risk factors. The system facilitates discussion of priorities given the lack of sufficient funding to achieve performance targets for all assets.

C.10.7. Lifecycle Management & Project Selection

C.10.7.1. Lifecycle Management

As the overall signal asset is an aggregated system of overhead equipment, underground infrastructure and poles, signal controller, cabinet, communication network, and electronics, overall lifecycle planning can be challenging. Currently, CDOT attempts to use signal equipment until it's expected end of life or deemed a risk to the overall system. In lieu of replacing entire assembly, viable parts may be salvaged from retired assets to keep current assets operational.

C.10.7.2. Treatment Lists

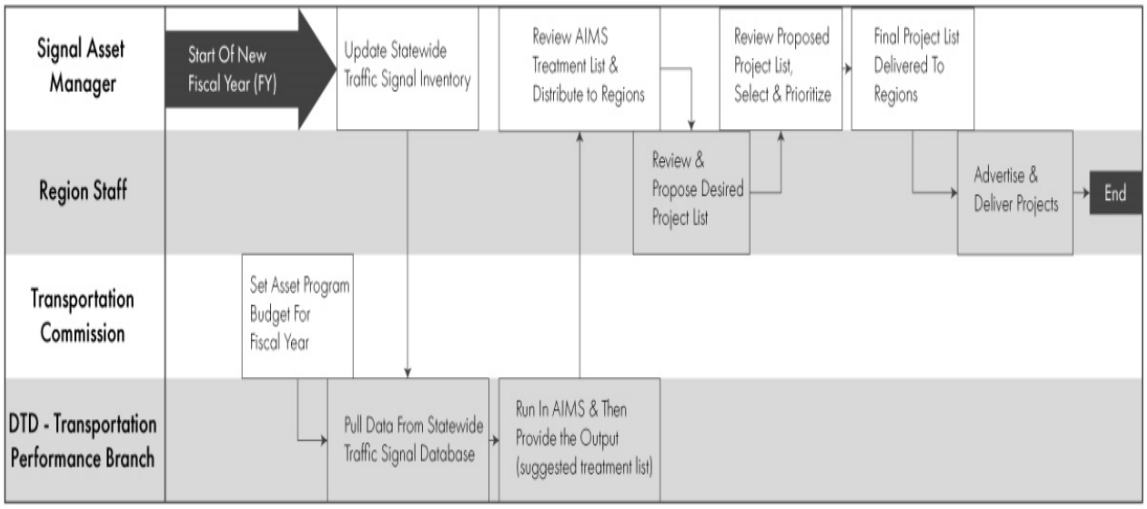
Current Signal Program Initiatives include statewide central traffic-signal-control-system upgrade, statewide advanced traffic-signal-controller upgrade, enhancing preventive maintenance activities, detection upgrade, implementation of automated traffic signal performance measures (ATSPMs), piloting and mainstreaming new and innovative technologies (CV/DSRC, traffic adaptive, traffic responsive, etc.), and enhancing condition-based asset management guidelines for signal asset.

Replacing existing signal assets in severe condition is the only treatment currently in use. Signal Program is actively working with CDOT Regions to identify any repair and/or rehabilitation activities being performed at the Region level and ways to incorporate it in the statewide signal asset database.

C.10.7.3. Project Selection Process

Project selection involves using AIMS to import signal data from statewide signal asset database. The database includes records for key signal components, acquisition costs, installation cost, and condition rating derived based on other data sets such as structural inspections, maintenance work order history logged in SAP, and visual assessments from photogrammetric runs. AIMS output provides a recommended list of treatments. Following region review of the AIMS output and submission of the desired traffic signal capital replacement projects to the Division of Maintenance & Operations (DMO), including evaluation, prioritization, and recommendation, the Region staff and DMO Traffic Signal Asset Steering Committee work together in a collaborative process to select traffic signals or signal components for replacement. Figure 4 illustrates CDOT's Signals Project Selection Flowchart.

Figure 4. Signals Project Selection Flowchart



C.10.8. Headquarters and Regions Roles

C.10.8.1. Headquarters Role

The Traffic Signal Program (Headquarters) is responsible for the state-wide project selection and prioritization process, with input from the Regions. Headquarters is responsible for coordinating maintenance or replacement activities with Regions. Headquarters administers the funds in coordination with Regions to maximize the planned budget allocations each fiscal year. Headquarters is also responsible for tracking any policy or procedural changes at the federal and state level and update the standards, as necessary. The Signals Asset Manager develops signals replacement guidelines, finalizes capital replacement list, and manages the statewide funding pool.

The Transportation Performance Branch pulls data from SAP or other databases, runs AIMS, and then provides optimal capital replacement list to the Signals Asset Manager.

C.10.8.2. Region Roles

The Regions conduct routine maintenance (sometimes through contract with local agency partners), annual evaluations of assets, develop list of signal priorities which is combined with the state-wide priority list. Regions implement and deliver approved eligible signals projects selected through the budgeting process but may also have to adapt and change schedules depending on budgets and construction factors. Region staff develop recommended capital replacement list, finalize the list working with the Signal Asset Manager and deliver the projects.