



Transportation Deficit Report 2017



COLORADO
Department of
Transportation

Transportation Deficit Report 2017

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Overview

Pursuant to the Funding Advancement for Surface Transportation and Economic Recovery Act (FASTER) of 2009, the Colorado Department of Transportation (CDOT) presents its Transportation Deficit Report for 2017. The annual Deficit Report addresses the goals of repairing deficient highways and bridges and sustaining existing transportation system performance levels. Included in this report are:

- The estimated costs, budgets and resulting deficits for sustaining current conditions over the next 10 years.
- The estimated costs, budgets and resulting deficits for achieving certain fiscally constrained and aspirational goals (visions) of the Colorado Transportation Commission within the next 10 years. These goals are stipulated in CDOT’s revised Policy Directive 14, which was adopted by the commission in February 2015.
- The annual increases of the costs described above.
- Factors contributing to the costs, such as the rate and distribution of population growth and vehicle size and weight. Techniques and tools for mitigating cost factors also are discussed.

Also included in this report are key CDOT performance results for fiscal year 2016. These results are among the data used to estimate the cost to sustain conditions and to achieve fiscally constrained and aspirational goals (or “vision” conditions) over the next 10 years.

In developing its fiscal year 2018 budget proposal, CDOT relied on revenue forecasts available at the time. CDOT projects it will receive about \$217 million in revenue from FASTER fees¹ in fiscal year 2018. Pursuant to FASTER legislation, \$10 million of that will be used for statewide transit projects, and \$5 million will be apportioned to local governments in the form of grants for local transit projects.

Note to Readers

This report incorporates budget information including fiscal year 2018 draft program budgets approved by the Transportation Commission in November 2016. More recent data—such as drafts of planning budgets for asset management—are used when available. The transportation system’s performance is projected primarily in conjunction with annual budget development. Cost and revenue forecasts may change throughout the year.

¹ The \$217 million includes about \$105 million from the Bridge Safety Surcharge for the Colorado Bridge Enterprise, which operates as a government-owned business within CDOT.

Update

CDOT's "big three" asset categories—pavement, bridges and maintenance—comprise roughly half the department's annual budget. As such, the funding and performance of these programs are critical to meeting department goals. In reviewing this year's report, readers should note the following items that may affect the condition and budgets of these assets.

FAST Act

The latest federal transportation reauthorization bill, the [Fixing America's Surface Transportation \(FAST\) Act](#), was signed by President Obama in late 2015. The act distributes about 90 percent of federal transportation funds to states through a set formula. It's unclear how the new Trump administration's policies would affect current federal funding for Colorado and other states. Any change would require Congress to revisit the legislation.

A \$300 billion bill, FAST authorized federal highway, transit and rail programs from 2016-20. These programs fund much of the work of state transportation departments nationwide, including CDOT. Under the act, Colorado's annual funding for highway programs ranges from \$554 million in 2017 to \$592 million in 2020.

Senate Bill 228 Funding Uncertain

The Colorado Legislature in 2009 passed Senate Bill 228 (SB 228), which funds strategic transportation projects through five years of state General Fund transfers if certain economic triggers are met. Initial forecasts projected CDOT would receive about \$200 million per year for five years.

The first transfer of about \$200 million was received by CDOT in late fiscal year 2016. However, amounts that will be transferred going forward remain uncertain. For fiscal year 2017, the Legislature has allocated just \$158 million. And the state's September 2016 revenue forecast called for transfers of \$225 million to \$333 million for fiscal years 2018 and 2019 combined. However, the Governor in November 2016 released a proposed budget for fiscal year 2018 that would help close the state's budget shortfall by reducing SB 228 transfers for fiscal years 2017 and 2018 to \$79 million for each year. The amount that will be transferred for fiscal year 2020, the final year of funding, is unknown.

The uncertainty of these transfers harms CDOT's ability to plan for construction, because environmental impact studies and pre-construction activities must be accompanied by assurances of project funding.

Flood Recovery Efforts Continue in 2017

CDOT in early 2017 continues to repair damage from the September 2013 floods in northern and eastern Colorado. Almost 490 miles of CDOT roadway were affected by the flood event, and 39 roadways were temporarily closed. More than 200 bridges and culverts were damaged.

By the end of 2016, CDOT had completed 10 permanent repair projects, and 13 more are scheduled to be completed by summer 2018. In December 2016, CDOT received \$252 million in Federal Highway Administration Emergency Relief funding to complete full flood program repairs. This brings CDOT's total for such funding to \$702 million. As a result, design projects previously without construction funding can now move forward. Where required, CDOT, local agencies and the Office of Emergency Management are providing matching funds to federal funds to complete projects.

The department in November 2014 identified candidate projects for SB 228 funding. These projects have been incorporated into CDOT's 10-Year Development Program Plan, which highlights priorities for major investments over the next 10-years. The \$2.5 billion plan, for which no funding has been identified, is just part of more than \$9 billion in major highway upgrade or expansion needs identified by CDOT.

CDOT has committed \$180 million of the first \$200 million in SB 228 funding to the Central 70 project, which includes replacing the Interstate 70 viaduct in north Denver. Ten percent, or \$20 million, will fund transit projects. Separately, the Transportation Commission has said that SB 228 will be the likely source of funding for a \$140 million commitment to improve Interstate 25 North. These commitments will likely exhaust the first few years of SB 228 transfers. Should additional SB 228 funds become available, CDOT will consider funding projects in the 10-Year Development Program Plan.

Asset Management Refinements

The department's asset models, performance targets and performance metrics have changed significantly since the first Transportation Deficit Report was published in 2009. Cost estimates contained in this report are therefore not comparable to estimates from that period and earlier.

CDOT continues to refine its Asset Investment Management System (AIMS) model, which includes bridges, pavement and other assets. AIMS was used to calculate the estimates for bridge costs and conditions used in this year's Deficit Report, the third year the system has been used for this purpose. The department continues to improve the system's ability to optimize budgets across assets.

RAMP and TRANs Bonds

CDOT's conversion in recent years to cash-based accounting made it possible to support the department's \$1.5 billion Responsible Acceleration of Maintenance and Partnerships (RAMP) program. The program has supported the temporary expansion of funding allocated for highway construction projects done in partnership with local governments, operations projects that increase the efficient movement of highway traffic, and preservation projects ("asset management" projects). The department expects RAMP spending will largely end in 2017.

Also in 2017, retirement of CDOT's Transportation Revenue Anticipation Notes (TRANs bonds) is enabling funds that have been paying those obligations to be redirected to asset management. This will allow CDOT to replace some asset management funds supplied in recent years by RAMP. If CDOT uses the TRANs bonds funds for other purposes, deficits forecast in this report would grow larger, and asset condition would deteriorate more than projected.

Policy Directive 14

Goals and "vision" performance targets in this year's report were taken from the department's Policy Directive 14 (PD-14). The Transportation Commission adopted the latest version of the directive in February 2015.

Lag of Investment Impact

Investment—or lack thereof—in a given year may not instantly change the performance of the transportation system. Neglecting the pavement on newer road segments in a given year, for example, may not cause noticeable deterioration that year. The effects of that neglect, however, will ripple into subsequent years.

Repairing Highways

CDOT's Surface Treatment program maintains about 23,000 lane miles of the state highway system. The program, part of CDOT's Materials and Geotechnical Branch, ensures pavement quality through a range of techniques that include thin maintenance treatments, rehabilitation and reconstruction.

In general, pavement condition on the state highway system has been deteriorating since 2005. While some deterioration is expected to continue, recent declines have been less than projected. In fact, 80 percent of pavement on the state highway system had High or Moderate Drivability Life in 2016, up from 79 percent the previous year. (See sidebar for an explanation of Drivability Life.) However, this was due in part to technical updates to CDOT's pavement management system.

Under current funding projections—about \$210 million per year on average for the Surface Treatment program from fiscal years 2018-27—condition will dip and return to CDOT's goal of 80 percent High or Moderate Drivability Life shortly after 2036.

CDOT began evaluating pavement condition in terms of Drivability Life in 2013. Deficit Reports published before 2014 focused on the Remaining Service Life metric.

The move to Drivability Life was made to:

- Apply a system that recognizes financial resources and limitations.
- Achieve optimal treatments for each type of roadway and level of traffic, using a lowest life-cycle cost approach.
- Use a system that better reflects roadway quality as experienced by drivers.
- Increase the frequency of surface treatment on low-volume highways. Under the previous system, such highways would deteriorate until full reconstruction was required.

The Drivability Life metric helps engineers make project choices that maintain the road quality expected by the public.

As mentioned, CDOT's goal is for 80 percent of state highway pavement to have High or Moderate Drivability Life. The vision condition, or aspirational objective, is for 90 percent to have High or Moderate Drivability Life.

Drivability Life Ratings

CDOT's metric for evaluating pavement condition is Drivability Life. Drivability Life is an indication in years of how long a highway segment will have acceptable driving conditions based on an assessment of pavement smoothness, surface cracking, rutting and safety.

Pavement with High Drivability Life is predicted to have acceptable driving conditions for more than 10 years.

Pavement with Moderate Drivability Life is predicted to have four to 10 years of acceptable conditions.

Pavement with Low Drivability Life is predicted to have fewer than four years of acceptable conditions.

Having unacceptable driving conditions doesn't mean that a highway is impassable. However, drivers may need to endure rough rides, reduce speeds to navigate around potholes and other types of pavement damage, or otherwise compensate for deteriorating conditions.

Figure 1. Statewide Pavement Condition and Performance Targets by Category, 2016

State Highway System Categories	2016 Pavement Condition (Percentage of Pavement with High or Moderate Drivability Life)	Goal	Vision
National Highway System, (NHS) Non-Interstate*	85%	80%	90%
Interstate	94%	80%	90%
Entire State Highway System	80%	80%	90%

The chart above shows the percentage of pavement with High or Moderate Drivability Life for various categories of state highway. Drivability Life is a measure of the remaining time that pavement will have acceptable driving conditions.

*Does not include NHS outside of the State Highway System.

Forty-four percent of CDOT’s highways have a Drivability Life of between just four and eight years. Because of this, the department expects a large amount of roadway to move into the Low Drivability Life category in the next four to five years. This creates a significant decline in pavement condition during the early years of CDOT’s pavement forecast.

Optimized models show that the best long-range strategy for CDOT’s highways is a preservation strategy. Under this strategy, the agency will focus resources on keeping roads with High and Moderate Drivability Life in good condition by using less expensive maintenance treatments. At the same time, the department will slowly address more costly repairs on roads with Low Drivability Life.

See the graph on the following page for a look at pavement conditions achievable under different funding levels over the next 20 years.

Cost of Sustaining Condition and Achieving Goal

CDOT in 2016 met its goal for pavement condition. The cost of sustaining current conditions is therefore identical to achieving the department’s goal. Achieving this condition—80 percent High/Moderate Drivability Life—will require \$2.5 billion over the next 10 years, or an average annual budget of about \$250 million. Against the projected budget for the Surface Treatment program for the next 10 years, there is a deficit of \$397 million, or an average of about \$39.7 million per year. (See Figure 4 on page 10.)

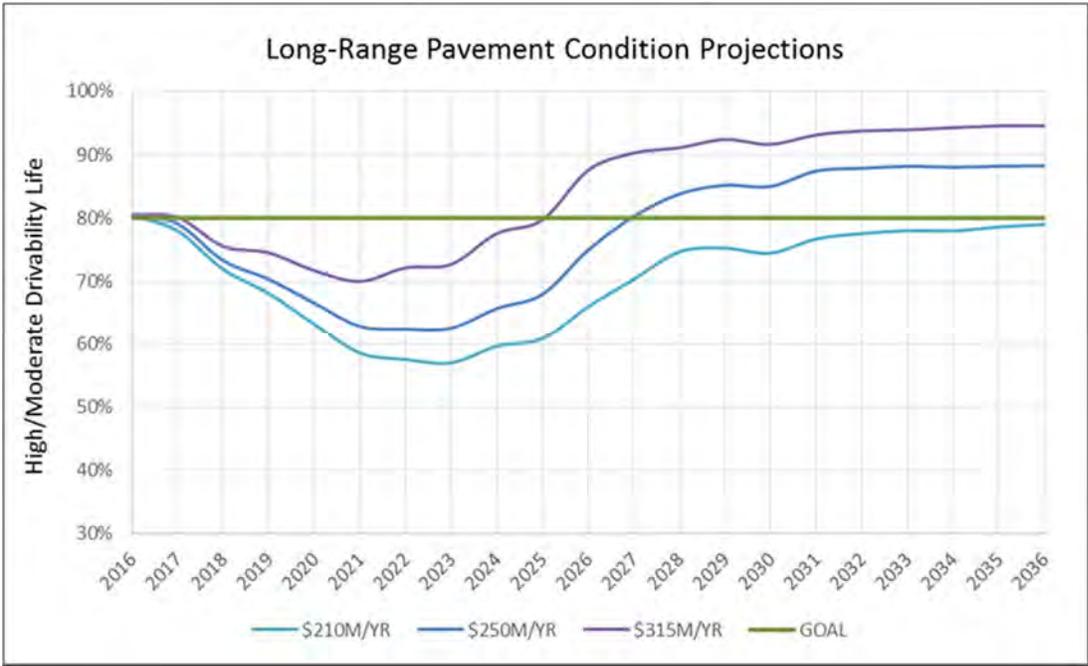


Figure 2: The chart at left shows pavement conditions on the state highway system possible under three different funding levels. Average annual budgets for the next 10 years (fiscal years 2018-27) are estimated at about \$210 million.

Under this estimate, conditions would dip to a low of 62 percent High/Moderate Drivability Life in fiscal year 2022, but return to 80 percent by fiscal year 2027. As previously mentioned, conditions are expected to fall in the near term, because 44 percent of CDOT’s highways have a Drivability Life of between just four and eight years, and the department is pursuing a preservation-first treatment approach. Under this approach, High and Moderate Drivability Life roads are prioritized over Low Drivability Life roads, due to the cost-effective nature of preservation treatments.



This stretch of pavement, on State Highway 2C at the northwest boundary of Rocky Mountain Arsenal National Wildlife Refuge, has a Drivability Life of zero years. Extensive surface cracking is one factor placing the pavement in the Low Drivability Life category.

Cost of Achieving Vision

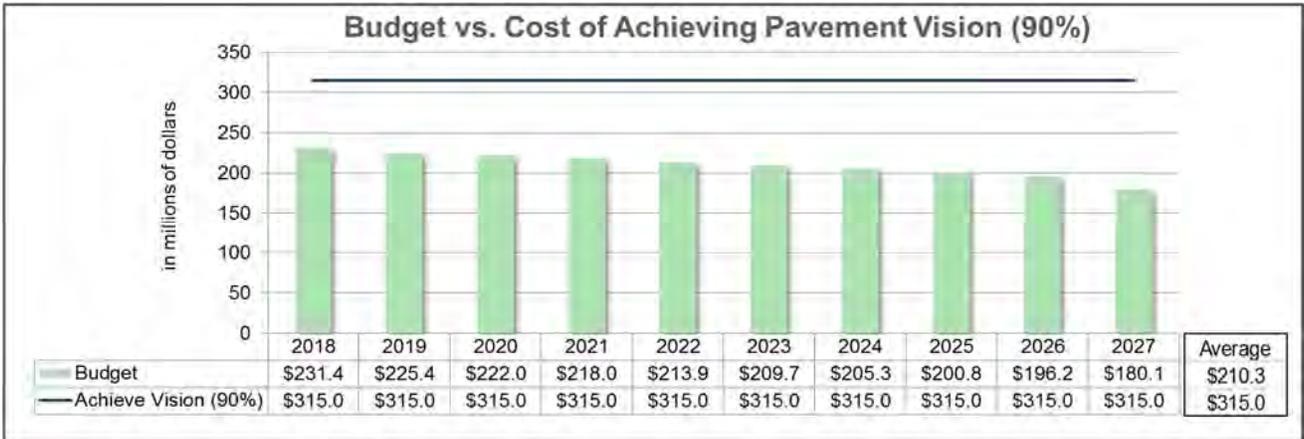
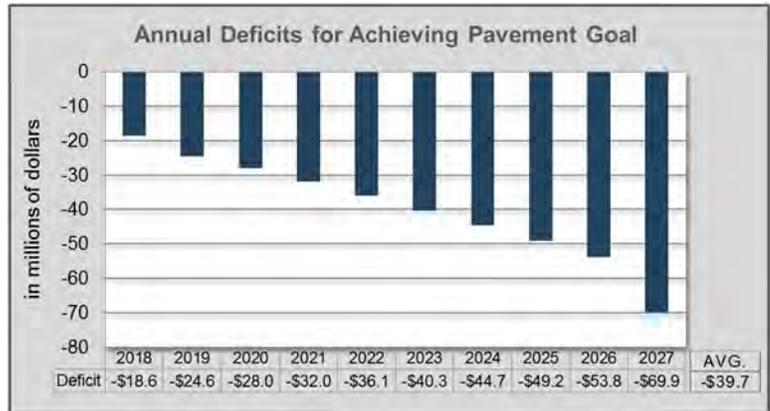
Achieving the department's vision of 90 percent High/Moderate Drivability Life will require about \$3.15 billion over the next 10 years, or an average annual budget of about \$315 million. Against the projected revenue allocation for the Surface Treatment program for the next 10 years, there is an anticipated deficit of about \$1.05 billion, or an average of \$105 million per year. (See Figure 6 on page 10.)



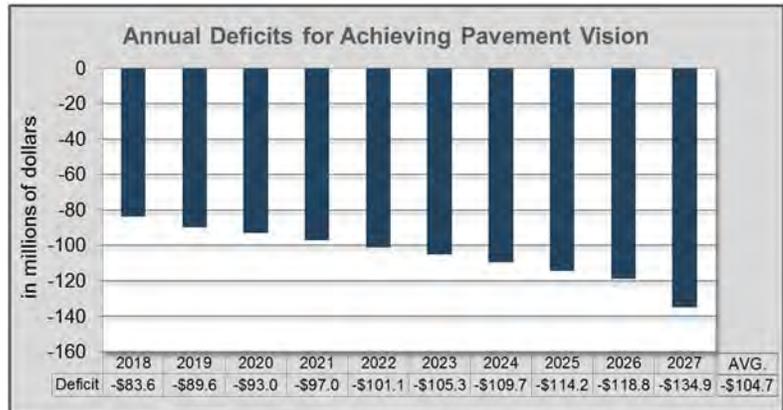
Timely concrete joint maintenance and crack sealing, such as on this stretch of Interstate 76 near Fleming, Colorado, is one of the most cost-effective ways to preserve and extend the life of concrete pavement.



Figures 3 (above) and 4 (right): The chart above shows the cost of achieving CDOT's goal for pavement condition on the state highway system within 10 years, as compared to anticipated funding. As shown at right, the deficit over 10 years is about \$397 million, or an average of \$39.7 million per year.



Figures 5 (above) and 6 (right): The chart above shows the cost of reaching CDOT's vision for pavement condition on the state highway system within 10 years, as compared to anticipated funding. As shown at right, the deficit over 10 years is \$1.05 billion, or an average of about \$105 million per year.



Treatment Type	Lane Mile Cost
	2016
Surface Seal	\$52,800
Ultra-thin overlay	\$140,800
Preventive Maintenance	\$49,280
Minor Rehabilitation	\$246,400
Major Rehabilitation	\$422,400
Reconstruction	\$992,640

Figure 7: Treatment costs used in CDOT's pavement models were unchanged from 2015 to 2016.

Factors Contributing to Costs

For a general discussion of inflationary pressures facing CDOT's construction program, see page 30. Below are factors that drive surface treatment costs.

Treatment and materials prices. Pavement costs are driven largely by the cost and available supply of Portland Cement, asphalt binder and aggregates. Asphalt binder prices fluctuate greatly and are somewhat correlated to petroleum prices. CDOT's Surface Treatment program saw no significant change in the cost of highway treatments from 2015 to 2016.

Population growth and distribution. Surface Treatment resources are allocated based on cost/benefit considerations and roadway characteristics, such as the volume of truck traffic. In addition, a growing population increases the annual average daily traffic on state highways and the wear and tear on pavement surfaces.

Colorado's population will grow to about 7.8 million by 2040. That's an increase of about 43 percent from 2015-40. There will be 4.45 million jobs by that time, an increase of 41 percent from 2015, according to Colorado State Demography Office estimates from 2016. Although CDOT expects the number of miles traveled per capita in Colorado to remain flat, the increase in population and employment means the demand for travel will increase by about 43 percent. Such growth puts unique demands on our transportation system.

Colorado's highest population growth is anticipated to occur mostly along the Front Range in Adams, Arapahoe, Boulder, Broomfield, Douglas, El Paso, Jefferson, Larimer and Weld counties (along with Mesa County) between 2010-40, according to the State Demography Office. Highway corridors located in the counties listed above and identified as

experiencing some level of traffic congestion (based on having a volume-to-capacity ratio greater than 0.85) include, but are not limited to:

- Interstate 25
- Interstate 70
- Interstate 76
- Interstate 225
- Interstate 270
- State Highway 7
- State Highway 470
- U.S. Highway 6
- U.S. Highway 24
- U.S. Highway 34
- U.S. Highway 36
- U.S. Highway 85
- U.S. Highway 287
- State Highway 83

Vehicle size and weight. Vehicle size and weight dictate the design requirements of highway segments and are even more significant determinants in surface-quality deterioration than population growth and distribution. Pavement thickness, in fact, is the direct result of anticipated truck freight traffic volume. A stretch of highway handling 80,000 cars and no trucks each day requires just seven inches of



A CDOT contractor places new asphalt pavement and compacts it to specified densities as part of the Grand Avenue Bridge project in Glenwood Springs.

Surface-Treatment Approach Varies by Road Category

CDOT prioritizes roads into four categories that define potential surface-treatment options. The best option is determined based on Drivability Life ratings, treatment costs, and site-specific design variables. This approach improves cost-effectiveness and increases the amount of road that can be treated, thereby improving the experience of the traveling public on the state's highways. The four categories are:

1. Interstates are CDOT's most important highways. These national networks provide interconnectivity across the state and nation. Interstate projects are built, rehabilitated and maintained according to Pavement Design Standards of the American Association of State Highway and Transportation Officials (AASHTO), ensuring they meet federal standards and provide reliable service.

2. High-Volume Highways are used by more than 4,000 vehicles per day (as calculated by Average Annual Daily Traffic, or AADT), or more than 1,000 trucks per day. These highways serve a large segment of the traveling public and provide critical routes for the transportation of goods and services across regional boundaries. These projects also follow AASHTO Pavement Design Standards.

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pavement. A stretch with a daily count of only 8,000 cars, but 4,000 trucks, requires eight inches. The impact of commercial vehicle traffic is a major factor in the calculation of costs to the Surface Treatment program.

Land-use policies and work patterns. Land-use patterns have a strong impact on travel demand and on the need for transportation infrastructure, maintenance, repair and improvements. Roadways are designed and constructed for their anticipated traffic loads. Any changing pattern of annual average daily traffic or of increased truck traffic due to commercial, manufacturing or energy development can alter the projected impacts. When land-use patterns change and result in redistribution or new access points, increasing traffic on roadways designed for fewer vehicles can cause unanticipated deterioration and redirection of maintenance resources. Sprawling development patterns can increase the number of vehicle miles traveled at rates faster than population growth. The result is an increase in demand on transportation infrastructure that exceeds the growth in resources available to provide and maintain it.

Looking Ahead

2016 was the fourth year CDOT used the Drivability Life metric for evaluating pavement condition. Lower-cost treatment strategies introduced at the same time as the metric are helping CDOT to increase the number of lane miles it treats each year.

Refinements to Drivability Life calculations are ongoing. For example, for the past five years, CDOT has forecast a significant—albeit temporary—decline in pavement condition in the near future. However, actual deterioration observed in recent years has been less than forecast. CDOT’s Pavement Management Technical Committee therefore is planning to recalibrate its forecasting models based on this trend.



CDOT manages highway pavement repairs based on traffic levels, investing in more thorough repairs on high-volume roads that require robust treatments, and using less expensive preservation strategies to serve customers on lower-volume roads. The photo at left, of U.S. 50 approaching Ridgway State Park, is an example of a medium-volume road.

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3. Medium-Volume Highways have AADT of between 2,000 and 4,000 and/or truck traffic between 100 and 1,000 vehicles. These projects are treated primarily with minor rehabilitation and preventive maintenance treatments. Major rehabilitation is considered when drivability is poor and project-level analysis reveals compromised pavement structure.

4. Low-Volume Highways have AADT of less than 2,000 and truck traffic of less than 100. These highways are maintained at acceptable drivability standards with preventive-maintenance treatments. Isolated repairs are used to address localized distresses that cannot be fixed with thin pavement preservation treatments. If formally approved by CDOT’s Chief Engineer, minor rehabilitation treatments may be used as needed to return the pavement to acceptable drivability condition.

Managing Bridges

CDOT's Bridge program maintains 3,427 major vehicular bridges on the state highway system.² These bridges have a total deck area of 33.2 million square feet. Both the number of bridges and the amount of deck area (riding surface) managed by CDOT change over time as new bridges are put into service and bridge ownership is transferred between the department and local agencies.

The department each year submits information on the condition of bridge-deck area to the Federal Highway Administration's National Bridge Inventory. The percentage of deck area on the state highway system rated Not Structurally Deficient in the past five years has been:

- 2012: 93 percent.
- 2013: 94 percent.
- 2014: 94 percent.
- 2015: 94 percent.
- 2016: 95 percent.

See the sidebar at right for an explanation of the Not Structurally Deficient metric.

The Transportation Commission's fiscally constrained goal for bridges is for 90 percent or more of deck area on the state highway system to be Not Structurally Deficient. This goal aligns with the minimum condition threshold set by the federal Moving Ahead for Progress in the 21st Century Act (MAP-21) for bridges on the National Highway System. CDOT will achieve the goal through preventive maintenance strategies, bridge repair/rehabilitation, and bridge replacements.

CDOT's vision, or aspirational objective, for bridge condition is for 95 percent of deck area on the entire state highway system to be Not Structurally Deficient. While the department is meeting that target, targets related to mitigating risks for bridges have not been achieved. (See page 17 for a discussion of risks.)

Improvement in bridge condition from 2012-16 is primarily due to replacements funded by the Colorado Bridge Enterprise, which operates as a government-owned business within CDOT.

Colorado Bridge Enterprise

The Colorado Bridge Enterprise was created by FASTER legislation to finance the repair and reconstruction of state-owned vehicle bridges. It does so using revenue from an annual bridge safety fee on vehicle

Reporting Bridge Condition

CDOT uses National Bridge Inventory standards established by the Federal Highway Administration to inventory, inspect, classify and report the condition of major vehicular bridges. The classification is based on a Sufficiency Rating of 0 to 100 and a status of Structurally Deficient, Not Deficient or Functionally Obsolete.

Structurally Deficient bridges do not meet minimum standards for condition or load-bearing capacity. They also often have one or more damaged or deteriorated structural members, such as a girder, truss or deck.

A Structurally Deficient bridge is a candidate for repair, major rehabilitation or replacement. The action considered depends on the portion of the bridge that caused the entire bridge to be classified as Structurally Deficient. Major rehabilitations include work such as replacement of the bridge deck, which is the riding surface of a bridge. Other examples include replacement of the superstructure, which comprises the supports immediately below the driving surface, and rehabilitation or strengthening of the substructure, which comprises the foundation and supporting posts and piers of the bridge.

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² Includes all bridges and culverts that span more than 20 feet and carry vehicular traffic.

registrations. The fee has been the primary source of revenue for the Bridge Enterprise since it began in 2009.

A bridge must be in "poor" condition to be eligible for Bridge Enterprise funding. Bridges in poor condition have a Sufficiency Rating of less than 50 (out of 100) and a status of Structurally Deficient or Functionally Obsolete. (See sidebar.)

From the creation of the Bridge Enterprise in 2009 until mid-December 2016, 200 bridges statewide had become eligible for funding through the Enterprise. Of those, 116 have received FASTER funding, 41 structures had other funding sources, and funding had not been determined for the remaining 43 bridges.

As of mid-December 2016, the status of the 200 bridges eligible to receive FASTER funding was as follows: 131 bridges had been repaired or replaced; 43 bridge projects were waiting to be scheduled or to have an action plan determined; 10 bridges were in construction; eight bridges were in the design stage; and eight bridge designs were completed and awaiting to go to construction.

A list and map of current FASTER bridge projects is at www.coloradodot.info/programs/BridgeEnterprise.



This bridge on the "Million Dollar Highway," part of U.S. Route 550, passes over Bear Creek Falls in the Uncompahgre National Forest near Ouray.

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Under the federal Moving Ahead for Progress in the 21st Century Act, no more than 10 percent of a state's bridge-deck area on the National Highway System can be Structurally Deficient. If a state misses this goal for three consecutive years, certain federal funds must be used by the state on projects for bridges on the NHS, according to an FHWA fact sheet.

CDOT's target for bridge condition aligns with this goal, so 90 percent Not Structurally Deficient is now the department's goal for deck area condition on the state highway system. This includes bridge deck area on the National Highway System in Colorado.

A major vehicular bridge that is Not Deficient will be a candidate for preservation actions many times in its service life. Preservation actions slow or temporarily arrest bridge deterioration. Most preservation actions stop or limit water containing de-icing chemicals from getting to structural members. Preservation actions include work such as fixing leaking expansion joints and resealing damaged bridge-deck seals.

Functionally Obsolete bridges do not meet current minimum geometric requirements and often have inadequate roadway shoulders, insufficient number

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CDOT anticipates the Bridge Enterprise will contribute much of the funding for the Interstate 70 viaduct replacement project east of downtown Denver. The current cost estimate for the portion of the project stretching from Interstate 25 to Chambers Road is \$1.17 billion. This includes the viaduct replacement, replacement of three additional Bridge Enterprise-eligible structures, and a new tolled express lane in each direction.

In the analyses that follow, about \$60 million per year for fiscal years 2018-27 was assumed to represent the Bridge Enterprise fund contribution and financing for the viaduct. Current financing proposals limit the maximum impact to bridge funds for this project to \$850 million (net present value). Remaining funding would come from Senate Bill 228 funds (see pages 3-4), a Transportation Infrastructure Finance and Innovation Act (TIFIA) loan, the Denver Regional Council of Governments (DRCOG) and the City of Denver.

Risk-Mitigation Goals for Bridges

While CDOT's primary performance metric for reporting bridge condition is the percentage of deck area that is Not Structurally Deficient, the department also has metrics and targets related to bridge risks. These targets are identified in the department's updated Risk-Based Asset Management Plan and the Transportation Commission-approved Policy Directive 14.

The cost of addressing these risks are included in CDOT's estimates of the cost to meet its goals and vision in the following pages. These risks include:

- **Bridges with vertical clearances lower than the minimum design requirement of 16.5 feet.** Such bridges are at risk from sustaining repeated hits from commercial vehicles.

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of lanes to handle current traffic, overhead clearances that are less than minimums, or inadequate widths for roadways or streams underneath. These bridges are candidates for widening or replacement. The action considered depends on why the bridge is classified as Functionally Obsolete. A Functionally Obsolete bridge is typically not a candidate for preservation actions, because it would typically be replaced instead. An exception is if the reason for it being Functionally Obsolete can't be addressed, such as an urban bridge that can't be widened due to high right-of-way costs.



A bridge on Interstate 70 over Black Gore Creek near Vail.

Bridge Risk Metric	Current Performance	Fiscally-Constrained Target	Aspirational Target
Percentage of bridges over Interstates, U.S. Routes and Colorado state highways with vertical clearances lower than 16.5 feet	19.8%	4.8%	2%
Percentage of bridges over Interstates, U.S. Routes and Colorado state highways with vertical clearances lower than 14.5 feet	1.7%	0.4%	0%
Percentage of CDOT-owned bridges that are load-restricted	1.6%	3%	1%
Percentage of CDOT-owned bridges that are load-posted	0.2%	0%	0%
Percentage of CDOT-owned bridges over waterways that are scour-critical	6.4%	5%	1%
Percentage of CDOT-owned bridges with leaking expansion joints	25.3%	15%	5%
Percentage of CDOT-owned bridges with unsealed/otherwise unprotected deck area	44.5%	30%	5%

Figure 8. Listed above are CDOT's risk-mitigation goals for bridges, which are taken from the department's Risk-Based Asset Management Plan.

- **Bridges with vertical clearances lower than the statutory maximum vehicle height of 14.5 feet.** These bridges restrict the movement of legal-sized commerce throughout our state.
 - **Load-restricted bridges**, which are bridges whose current capabilities to support extra-legal highway loads are inadequate. These bridges restrict extra-legal weight commerce (i.e., permitted overweight vehicles) movement throughout our state.
 - **Bridges requiring load posting**, which are bridges whose current capabilities to support legal loads are inadequate. These bridges restrict legal-load weight vehicle commerce movement throughout our state.
 - **Scour-critical bridges**, which are bridges whose foundations are at risk of failure due to erosion. Scour is the most common cause of bridge failure.
 - **Bridges with leaking expansion joints.**
 - **Bridges with unsealed or otherwise unprotected deck area.**



Vehicles on State Highway 128, southeast of Boulder, regularly travel over this concrete box culvert, which faces scour concerns. At the culvert outlet, water has eroded three feet from the bank of Coal Creek.

For CDOT's current performance on metrics related to bridge risks, see Figure 8 (*previous page*). Updates were made to these metrics this year based on a comprehensive review of all previously reported bridge performance measures. Some calculations were adjusted so that performance more accurately represents the intended measure. As a result, the reported performance for some metrics has changed substantially since last year's Deficit Report. CDOT's bridge program is currently reviewing performance targets for its risk metrics to reflect such changes.

For example, changes to definitions in a handbook from the American Association of State Highway and Transportation Officials led CDOT to update metrics for leaking expansion joints and unprotected deck area. The reported percentage of bridges facing these risks increased largely due to these updates. In addition, both metrics related to vertical clearance show significant increases. One metric was changed from showing bridges with vertical clearances less than 16 feet to bridges with clearances less than 16.5 feet, which is the minimum design requirement for bridges in Colorado.

Cost of Sustaining Condition

The cost to sustain the current bridge condition of 95 percent Not Structurally Deficient is about \$1.95 billion over 10 years, which would require an average annual budget of about \$195 million. Compared to forecast bridge program budgets, including the FASTER Bridge Enterprise Special Revenue Fund, CDOT projects a 10-year deficit of about \$419 million, or an average of \$41.9 million annually. (*See Figure 10 on page 20.*)

The cost estimate for sustaining bridge conditions includes investment to maintain the current percentage of bridges rated Not Structurally Deficient, but assumes no additional investment for CDOT's risk-mitigation targets.³ Included in the cost estimate is about \$60 million per year to help finance replacing the Interstate 70 viaduct.

This year's "sustain" analysis—as well as the "goal" and "vision" analyses that follow—includes updates to the Bridge Enterprise revenue forecast and the bridge condition forecasting model.

Cost of Achieving Goals

The cost to achieve CDOT's fiscally constrained goals for bridge condition and mitigation of bridge risks on the state highway system at the end of 10 years is about \$1.53 billion, or \$153 million per year. Compared to projected budgets, this forecasts a 10-year surplus of about \$47 million, or an average of \$4.7 million annually. (*See Figure 12 on page 20.*) This is due to the fact that CDOT is currently exceeding its main bridge condition goal for 90 percent

³ CDOT is not currently meeting its risk-mitigation targets for bridges (see Figure 8 on previous page). Sustaining current performance means no additional investment for those targets.

of deck area to be Not Structurally Deficient. Should such a budget surplus materialize, CDOT would direct those funds to additional risk-mitigation efforts.

Included in the 10-year cost estimate is about \$60 million per year to help finance replacing the Interstate 70 viaduct. Replacing the viaduct is a significant component of the cost of keeping deck area at the target level. Risk-mitigation costs of about \$72 million per year also are included.

The projected surplus is lower in this year's report compared to last year's primarily because of increased costs to address bridge risks. This increase was driven by a revision to risk-related performance metrics. For example, the projected cost to address low vertical clearance bridges increased significantly, partly because the metric now addresses bridges under 16.5 feet instead of previous estimates that only addressed bridges under 16 feet.

Cost of Achieving Visions

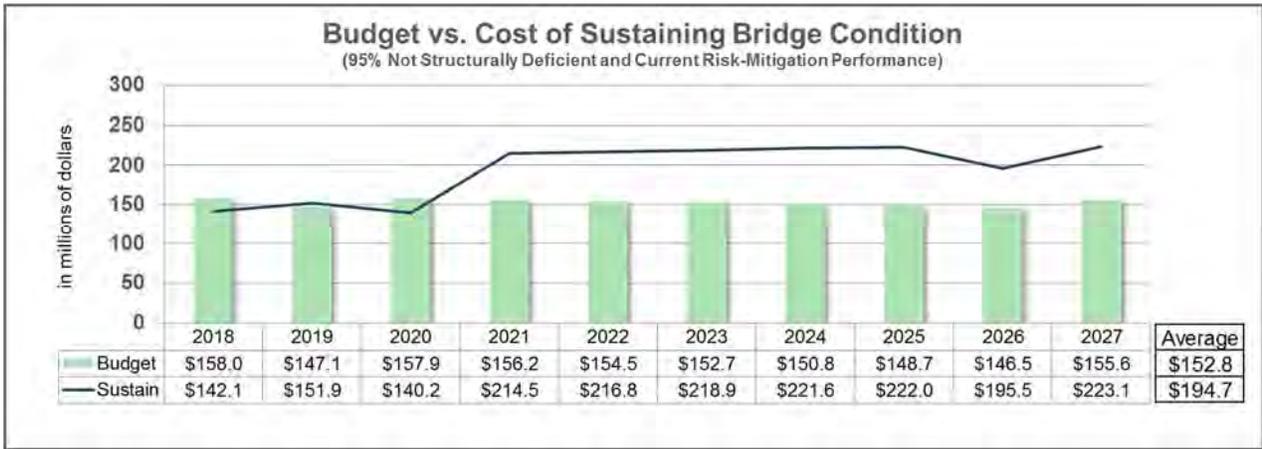
The cost to achieve CDOT's visions for bridge condition and mitigation of bridge risks is about \$2.89 billion over 10 years, which would require an average annual budget of about \$289 million. Compared to projected budgets, this forecasts a 10-year deficit of about \$1.36 billion, or an average of \$136 million annually. *(See Figure 14 on page 21.)*

Included in the 10-year cost estimate is about \$60 million per year to help finance replacing the Interstate 70 viaduct. Risk-mitigation costs of about \$94 million per year also are included.

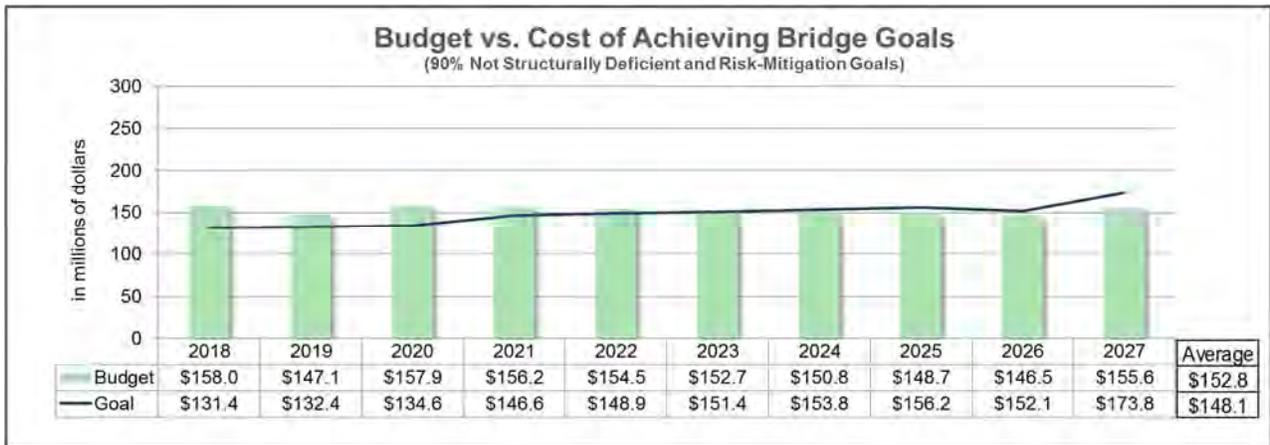
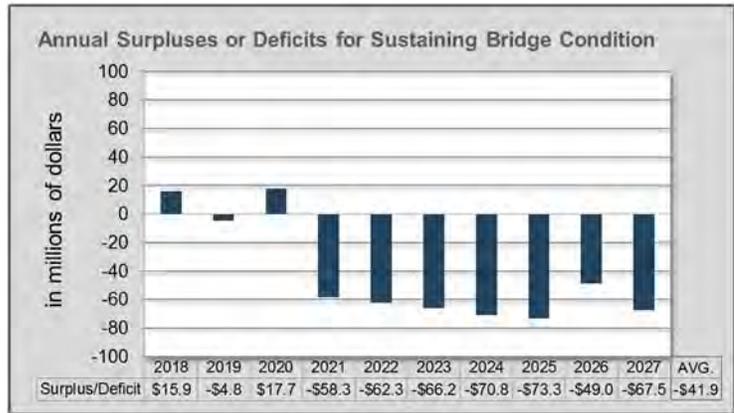
The projected deficit to achieve the bridge visions is higher in this year's report compared to last year's primarily because—as with the estimate to achieve CDOT's "goal" targets—the projected cost to address bridge risks increased.



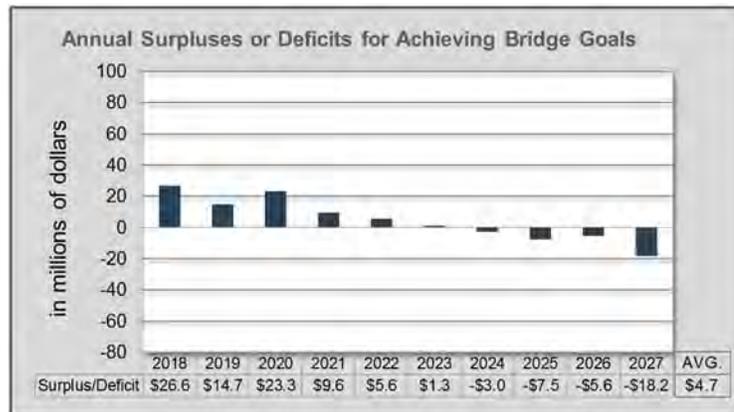
Joint damage on the Interstate 70 viaduct east of downtown Denver. About \$60 million per year for financing the viaduct's replacement is included in the cost estimates on the following two pages.

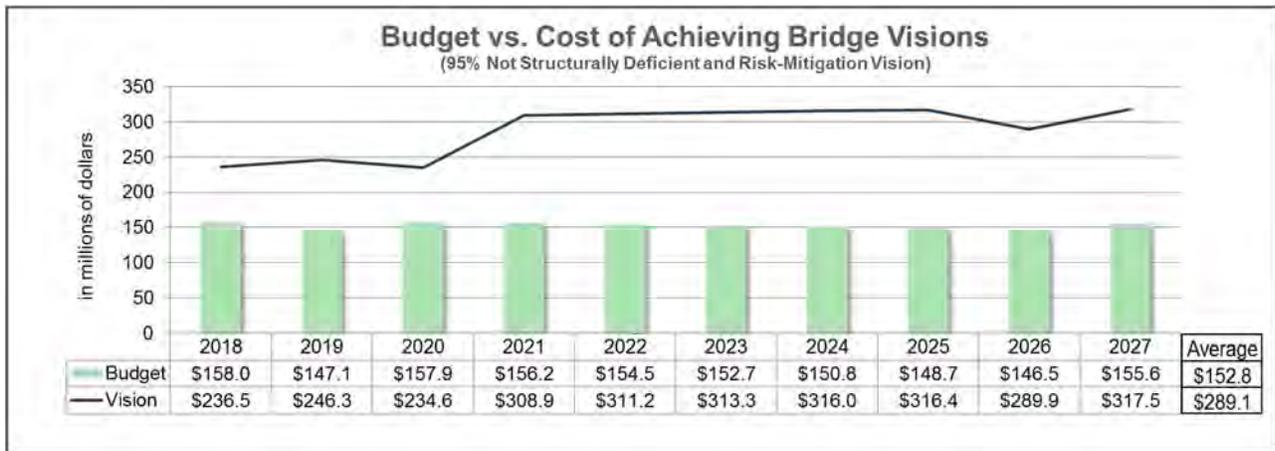


Figures 9 (above) and 10 (right): The chart above shows the cost of sustaining 2016 bridge conditions as compared to anticipated funding. As shown at right, the deficit over 10 years is about \$419 million, or an average of \$41.9 million per year.

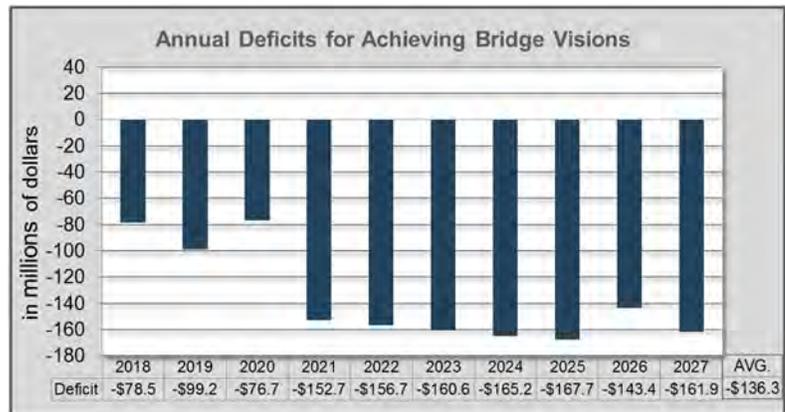


Figures 11 (above) and 12 (right): The chart above shows the cost of achieving the fiscally constrained goals for bridge condition, as compared to anticipated funding. As shown at right, the balance over 10 years is a projected surplus of about \$47 million, or an average of \$4.7 million annually. Should such funds remain after meeting the goals, the department will direct them toward meeting its vision targets for bridges.





Figures 13 (above) and 14 (right): The chart above shows the cost of meeting the bridge visions as compared to anticipated funding. As shown at right, the deficit over 10 years is about \$1.36 billion, or an average of about \$136 million per year.



Factors Contributing to Costs

For a discussion of inflation and CDOT's construction program, see page 30. Factors affecting costs for maintaining, repairing and replacing bridges include:

- Exposure to the elements.** Exposure of bridges to the elements is the most significant factor affecting bridge conditions. Bridges are designed to withstand high volumes of traffic operating under current and historical weight and size limits. Deterioration of bridges due to exposure affects their ability to carry high traffic volumes over time and can result in weight restrictions. Scour is the most common cause of bridge failure. CDOT faces a significant number of scour-critical bridges, which are bridges whose foundations are at risk of failure due to erosion. The Federal Highway Administration defines scour as "the result of the erosive action of flowing water, excavating and carrying away material from the bed and banks of streams."
- Population growth and distribution.** These factors have a substantial effect on the Annual Average Daily Traffic (AADT) that crosses a bridge. AADT is one of the primary factors that drive a bridge to become Functionally Obsolete. Growth in population and

where that population chooses to travel can result in changes in AADT and advance or delay the onset of Functional Obsolescence.

- **Vehicle size and weight.** Deterioration can result in posted weight limits that affect truck routes and the movement of commerce. CDOT issues tens of thousands of oversize or overweight permits annually, but non-permitted overweight vehicles can cause overstress damage to bridges if the load exceeds the bridge's carrying capacity. Non-permitted oversize vehicles can hit bridges and cause damage that lowers bridge condition and necessitates repair. For example, seven on-system bridges required essential repairs in fiscal year 2015 after sustaining such hits. CDOT performs inspections to identify bridges that require restrictions based on vertical clearance or vehicle weight.

- **Land-use policies and work patterns.** Land-use policies affect AADT, which is one of the many factors that determine a bridge's sufficiency rating and is indirectly used to determine Functional Obsolescence. A bridge's sufficiency rating is affected by shifts in AADT and truck traffic due to changes in commuting and commercial routes stemming from population growth and development.



A deteriorating overhang on a bridge on Interstate 70, near Lakeside Amusement Park in Denver. CDOT maintains this bridge that was built in 1966, ensuring that concrete does not fall on vehicles traveling underneath.

Annual Maintenance

Baseline budgets for CDOT's "big three" asset categories—pavement, bridges and maintenance—comprise roughly half the department's annual budget. Sustaining performance levels of the maintenance program is analyzed in this report much like the surface treatment and bridge programs.

The maintenance program, which is overseen by CDOT's Division of Highway Maintenance, has a proposed fiscal year 2018 budget of \$264 million, representing one of the department's largest annual investments. The program is designed to keep the state highway system open and safe for the traveling public.

CDOT assigns a letter grade to evaluate the performance of certain maintenance areas (*see sidebar for a description of all areas*), as well as a grade to evaluate overall maintenance service. CDOT achieved a C+ for overall maintenance in fiscal year 2016.

For fiscal years 2017 and 2018, the department forecasts overall Maintenance Levels of Service grades of C+ and B, respectively. These projections are estimates of what can be achieved with current funding levels. The goal in the Transportation Commission's Policy Directive 14 is a B-. The commission also sets a vision, or aspirational objective, in Policy Directive 14. Achieving the current vision—a B in overall Maintenance Levels of Service over the next 10 years—would require significantly more resources than the goal.

Separately, the commission has set performance targets for Snow and Ice Control. The goal for this maintenance area is a B, and the "aspirational objective", or vision, is a B+. CDOT achieved a level of service of B- for Snow and Ice Control for fiscal year 2016.

Maintenance Optimization

CDOT's maintenance division in 2015 launched an "optimization" project that included reviewing the maintenance program, its reporting structure, the locations of its facilities, and the number of lane miles per full-time equivalent (FTE) employee. Also part of the review was the maintenance budgeting system.

Analysis of the system included a review of maintenance condition assessments, the scales used to determine maintenance performance grades, and the methodology that allocates funding statewide. As part of this review, the maintenance division determined the current way of

How CDOT Rates Maintenance

CDOT's maintenance program is designed to keep the state highway system open and safe for the traveling public. Maintenance activities are separated into nine Maintenance Program Areas (MPAs):

The Roadway Surface area includes patching and sealing potholes and blading unpaved surfaces.

The Roadside Facilities area includes cleaning drainage structures, repairing eroded slopes and repairing guardrails.

The Roadside Appearance area includes controlling vegetation, sweeping roadway surfaces and trash removal.

The Traffic Services area includes maintaining roadway signs and striping, maintaining traffic signals and maintaining roadway lighting.

The Structure Maintenance area includes painting bridges, repairing expansion joints and patching decks.

The Snow and Ice Control area includes plowing snow and avalanche control.

The Equipment and Buildings area includes maintaining rest areas, storage sheds, laboratories, offices and more.

CONTINUED

linking budgets to performance was unsatisfactory for some maintenance areas. As a result, the division no longer uses letter grades to allocate funding for these areas. Affected areas include planning and scheduling, snow-and-ice control, equipment and buildings, and tunnel activities. The division will continue to measure snow removal performance and report the grade achieved, but the budget will not be allocated based on that grade.

The maintenance division recognizes the value of performance-based methodologies for budgeting and continues to analyze opportunities to incorporate performance into its budget model. This includes for maintenance areas whose budgets are not currently performance-based.

Cost of Sustaining Conditions

The cost of sustaining the fiscal year 2016 grade of C+ for Maintenance Levels of Service over the next 10 years is \$3.88 billion, requiring an average annual budget of \$388 million. Against anticipated program budgets, this forecasts a 10-year deficit of about \$981 million, or an average of \$98.1 million annually. (See Figure 16 on page 26.) This estimate includes sustaining snow-and-ice control at its fiscal year 2016 grade of B-.

Cost of Achieving Goal

The cost of achieving a B- for Maintenance Levels of Service over the next 10 years is \$4.07 billion, requiring an average annual budget of \$407 million. Against anticipated program budgets, this forecasts a 10-year deficit of about \$1.17 billion, or an average of \$117 million annually. (See Figure 18 on page 26.) This estimates include achieving CDOT's goal of a B for snow-and-ice control each year of the analysis.

Cost of Achieving Vision

The cost to achieve CDOT's vision of a B for Maintenance Levels of Service over the next 10 years is \$4.33 billion, requiring an average annual budget of \$433 million. Against anticipated program budgets, this forecasts a 10-year deficit of about \$1.43 billion, or an average of \$143 million annually. (See Figure 20 on page 27.) This estimate achieves a B in all individual Maintenance Program Areas every year of the 10-year analysis, with the exception of the snow-and-ice control area, which is maintained at the vision target of B+.

The 10-year deficit projections for maintenance are significantly higher than in last year's report, which is partly a result of the department's maintenance optimization project (see previous page). As part of the project, CDOT's Regional Transportation Directors recognized the need for stricter performance scales for maintenance assets that affect safety.

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The Tunnel Activities area includes tunnel operations.

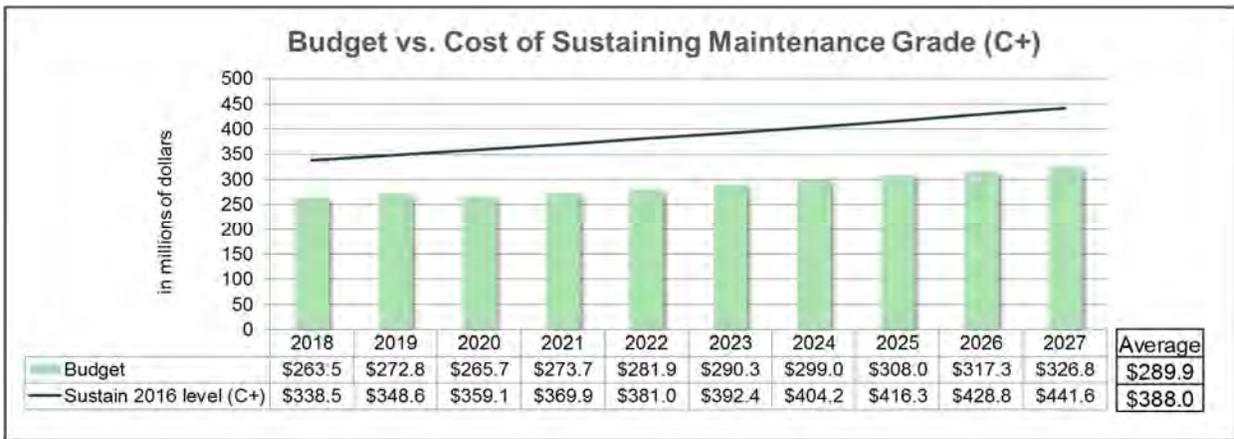
The Planning and Scheduling area includes performance budgeting and maintenance staff training.

CDOT measures the performance of maintenance service with a "report card" style grading system called Maintenance Levels of Service (MLOS). Certain maintenance areas are given a grade, and those grades help determine an overall grade for maintenance. Higher grades can be achieved with higher funding levels. The MLOS budget process consists of a survey of existing conditions, most recent costs and a recommendation of funding to reach the goal set by the Transportation Commission.

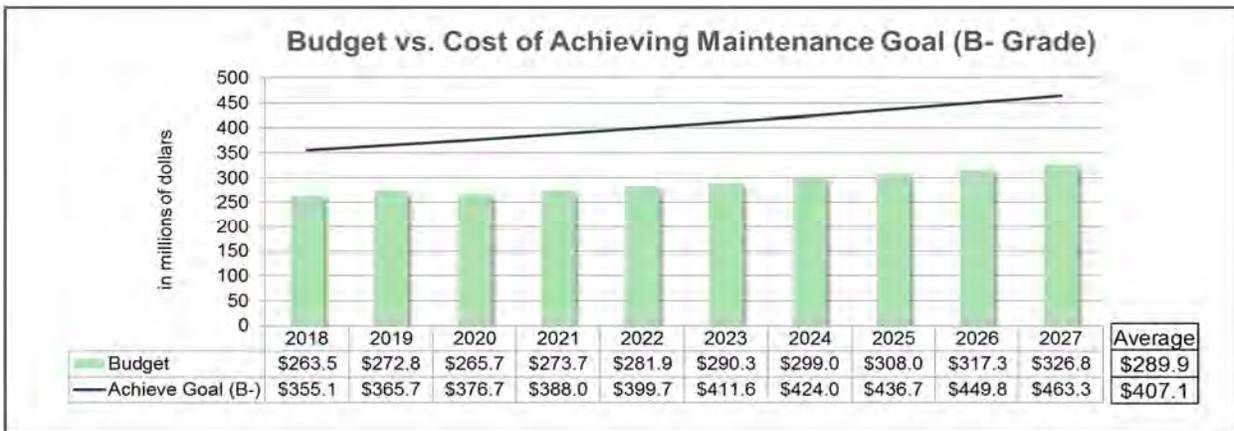
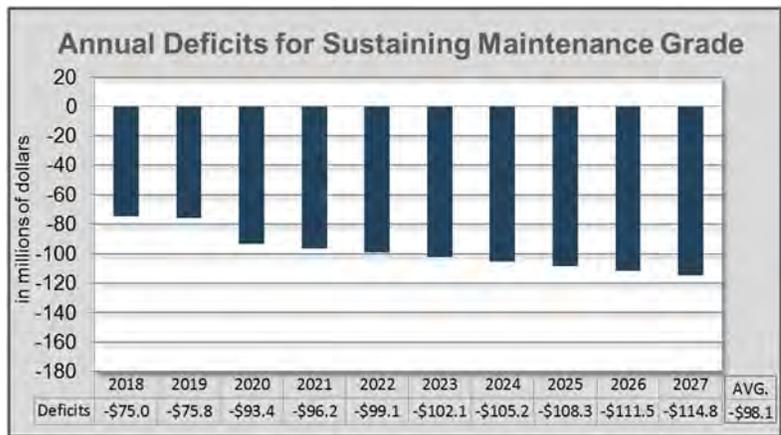
Most affected were scales for traffic services assets, which were adjusted to better align with those of other states. The traffic services maintenance area includes guardrail, traffic signals, signing and striping, roadway warning devices and Intelligent Transportation Systems (ITS) devices. For traffic services alone, achieving a B in fiscal year 2018 costs 82 percent more in estimates in this report than in last year's report. Additionally, changes related to the optimization project caused the cable guardrail grade to fall from a B- in fiscal year 2015 to a D in fiscal year 2016. For those same years, metal guardrail fell from a C+ to a C- , and impact attenuators fell from a C+ to an F. Such declines raise the projected cost of achieving performance targets.



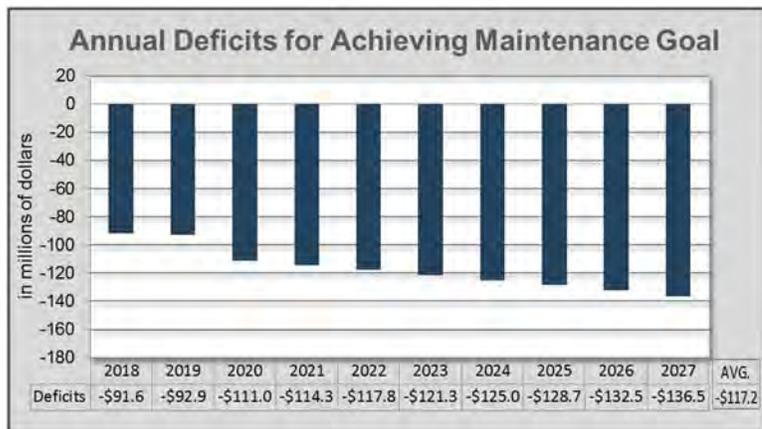
Maintenance forces clear snow from North Highway 177 in Denver.



Figures 15 (above) and 16 (right): The chart above shows the cost of sustaining a C+ for Maintenance Levels of Service, as compared to anticipated funding. As shown at right, the deficit over 10 years is about \$981 million, or an average of \$98.1 million per year.

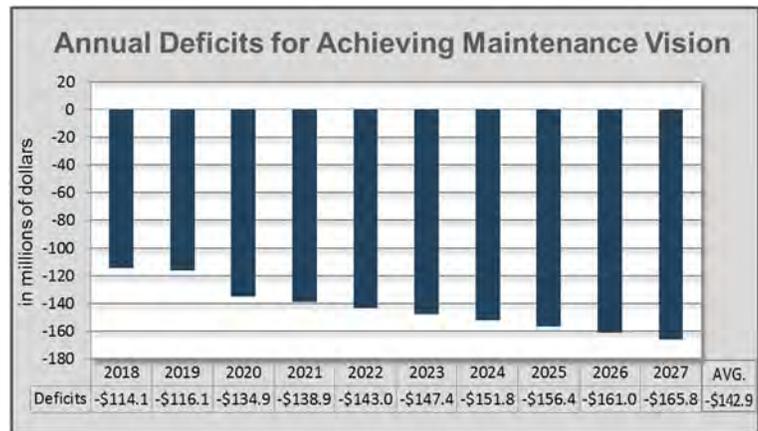


Figures 17 (above) and 18 (right): The chart above shows the cost of achieving the goal of B- for Maintenance Levels of Service, as compared to anticipated funding. As shown at right, the deficit over 10 years is about \$1.17 billion, or an average of \$117 million per year.





Figures 19 (above) and 20 (right): The chart above shows the cost of achieving the vision of B for Maintenance Levels of Service, as compared to anticipated funding. As shown at right, the deficit over 10 years is about \$1.43 billion, or an average of \$143 million per year.



Factors Contributing to Maintenance Costs

Several factors each year influence budget estimates, cost estimates, and deficit estimates for achieving various grades for Maintenance Levels of Service. As examples:

- The estimate of the cost to achieve a particular grade depends on the grade the previous year. If other factors are unchanged, achieving a high grade instead of low grade in a given year makes it less expensive to achieve a particular grade the subsequent year. For example, it is less expensive to achieve a B if one achieved an A the previous year than if one achieved a D.
- The cost to achieve an overall maintenance grade is dependent on the mix of grades achieved in individual Maintenance Program Areas.
- An annual inflation rate of 3 percent is used for the 10-year cost projections.
- Funding levels for the Surface Treatment and Bridge programs over time can significantly affect the Maintenance program. Maintaining roads and bridges that are in poor condition can be more expensive than doing the same for assets in better condition.

Weather heavily affects the cost of snow and ice removal and roadway surface conditions. Due to high snowfall, for example, the department may spend more on snow-and-ice control and still achieve a low Level of Service. Fuel prices and labor also are significant components of nearly all maintenance activities.

As depicted in Figure 21 (*below*), snow-and-ice control is almost a third of the total maintenance budget. There is no lasting positive effect on the infrastructure from snow-and-ice control measures. Rather, there is cumulative harm caused by scraping plow blades across pavement and damaging pavement markings. De-icing chemicals, such as magnesium chloride, also can accelerate the deterioration of infrastructure. Sand used by local jurisdictions carries over to highways and accelerates stripe deterioration. Conversely, funds that provide for new construction or reconstruction of transportation infrastructure have a positive impact on the maintenance program, because new infrastructure requires less maintenance than aging infrastructure.

Keeping roads clear of snow and ice is expected to cost the department \$79.1 million in fiscal year 2018, according to CDOT’s proposed budget. An additional \$10 million is set aside for snow-and-ice contingency needs and reallocated by the Transportation Commission if not used for that purpose. The cost to keep roads clear during winter storms has increased over the past 15 years due to factors including the expense of de-icing materials and snow-fighting technology such as RWIS (Road Weather Information System) and MDSS (Maintenance Decision Support System). The department has made such investments to increase future efficiencies. The average cost per plow mile was \$13.29 in fiscal year 2016, up from \$13.19⁴ in fiscal year 2015 and \$5.31 in 2001.

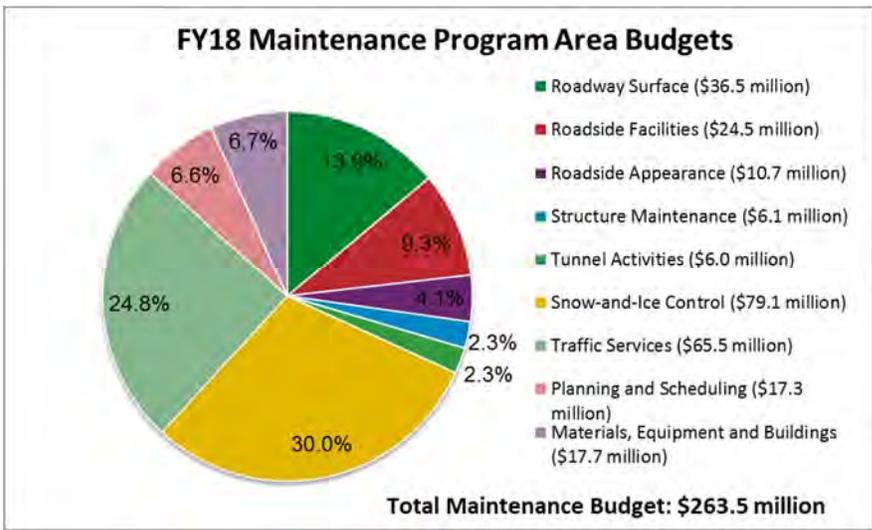


Figure 21. Maintenance Program Area Budgets

⁴ This cost has been revised since the 2016 Deficit Report.

Population growth and distribution. Population growth and growth in Vehicle Miles Traveled (VMT) are significant factors in the cost of maintenance efforts. Population distribution also plays a key role. Limited resources may in some circumstances be focused on high-volume segments in high population areas to alleviate mobility concerns.

Vehicle size and weight. A Maintenance Program Area heavily affected by vehicle size and weight is Roadway Surface, which undertakes projects smaller than those typically performed by CDOT's Surface Treatment program. Pavements are designed and constructed to accommodate an expected number of Equivalent Single Axle Loads (ESALs) of 18,000 pounds each over a specific period. The design assumes regular maintenance and typical environmental conditions. As the number, size and weight of vehicles increase, so does the deterioration rate of pavement. The rate of deterioration is accelerated by reductions in regular maintenance and increases in climate severity.

Land-use policies and work patterns. The impact of land-use policies on transportation infrastructure maintenance is the same as outlined in the Surface Treatment section of this report. Changes in land-use policies can result in more traffic on roadways designed for less volume, which can affect deterioration and further strain maintenance resources.



Figure 22. Spending on snow-and-ice control was unchanged in fiscal year 2016 compared to a year earlier, but was up significantly compared to 2012.

Corridor Vision

As part of the 2040 Colorado Statewide Transportation Plan, CDOT compared its 25-year needs to an estimate of transportation revenue available over the same period. Needs identified by CDOT for 2016-40 totaled \$46 billion. About \$20 billion of that is related to expanding or upgrading the transportation system. Meanwhile, estimated revenue was about \$21 billion, resulting in a funding gap of about \$25 billion for the 25-year period.

For the ten years from 2016-25, CDOT estimated needs of \$19 billion, with roughly \$9 billion of that composed of major investments related to expansion and upgrades to the state highway system. The anticipated funding gap to reach the \$19 billion is about \$8.8 billion. The roughly \$9 billion expansion and upgrades estimate is an aggregate figure that includes all of Colorado's Transportation Planning Regions. The estimate was determined by incorporating information from 2040 or 2035 Regional Transportation Plans for each of the state's Transportation Planning Regions and Metropolitan Planning Organizations; CDOT Region project lists and data; and from other project lists or transportation plans. This information has been consolidated in the CDOT Development Program inventory of major investment needs.

As described elsewhere in this report, CDOT's current revenue is insufficient to sustain the current condition of the transportation system. As such, the analysis of major investments related to expansion and upgrades included needs beyond what can be funded with existing resources. Expansion or upgrade investments increase the capacity of (or significantly improve the functioning of) the multi-modal transportation system by enhancing existing facilities or creating new infrastructure and services. Such investments are generally related to achieving a vision for transportation in Colorado, rather than routine investments that maintain existing conditions.

Rising Construction Costs

Construction costs rose about 6 percent from calendar years 2015 to 2016, according to the Colorado Construction Cost Index, which is based on bids for CDOT projects. Forces driving the increase include the sustained economic recovery and the nature of the state's construction market, which is dominated by just a few large contractors.

For the past five years, the top 10 winners of CDOT projects have accounted for about 27 percent of awarded projects, and the top 10 earners received 42 percent of the total dollars awarded. This affects prices significantly. For example, the limited capacity of the contractors means that projects advertised late in the contracting season (April to September) cost about 6 percent more than projects advertised early (October to March). In recent

years, the number of contractors who bid for all CDOT projects has declined slightly, while the average number of bidders for individual projects has decreased significantly.

Additionally, increasing demand in the real estate market in Colorado in recent years has created more outside opportunities for contractors. An increase in the number of building permits issued in Colorado generally coincides with a decline in the number of bids on CDOT projects. And a lower number of bidders on a project typically results in higher average bids. Consequently, in 2016, the awarded amount continued to increase relative to CDOT's engineering estimates.

Colorado's sustained economic recovery also is having a significant effect on bids for CDOT projects. Although the price of oil is historically low and likely will remain so for the remainder of 2017, the shortage of skilled workers in the construction industry and rising wages will increase construction costs. Colorado's unemployment rate, which was 3.0 percent as of December 2016, is at its lowest point since the most recent recession and 1.7 percentage points below the U.S. rate. And with the prospect of a new infrastructure bill in 2017 and the resulting increase in transportation funding, CDOT may face even higher bid prices.

To counter cost increases, CDOT in some cases has combined projects for cost efficiencies. The department also has reduced project scopes, advertised projects at strategic times to obtain lower bids, and employed alternative project-delivery methods.

Mitigating Costs

CDOT expects financial resources for adding lane capacity or other expansions will remain limited. The high cost of transportation infrastructure and limited state and federal budgets make it critical to extract the most benefit possible from the existing transportation system. The department is responding with multiple strategies to reduce costs, curb the growth of Vehicle Miles Traveled and increase mobility.

Increasing Operational Efficiencies

As part of such efforts, CDOT formed its Division of Transportation Systems Management & Operations (TSM&O) in 2013. The division focuses on implementing low-cost, high-value operational improvements that delay the need for highway expansion. Travel-time reliability and safety are greatly influenced by factors including traffic incidents and crashes, adverse weather, poor signal timing, bottlenecks, work zones and special events. Some strategies used to manage these factors are described below:

- CDOT's Traffic Incident Management program helps remove crashes and other incidents from the road. This helps highways return to pre-incident operating speeds. CDOT employs its Courtesy Patrol in the Interstate 70 Mountain Corridor and on Interstate 25 in the Denver metro area. The patrol locates and clears traffic-related incidents and provides roadside assistance. CDOT's Heavy Tow program removes distressed commercial motor vehicles from the Interstate 70 Mountain Corridor.
- CDOT implements programs for improved traveler information to help with operations, explain road closures, and provide real-time detour suggestions. The Colorado Traffic Management Center provides continuous camera coverage through www.cotrip.org. The center also operates the 511 phone line to provide updates on traffic conditions. Other information is provided through Twitter and Facebook. These programs can reduce travel demand at peak times as travelers modify their behaviors. The department uses Intelligent Transportation Systems (ITS) devices, such as roadway weather information systems (RWIS), to provide real-time weather and roadway information to travelers.
- CDOT manages traffic through variable speed limits, toll lanes and High Occupancy Vehicle (HOV) lanes. The department has operated the seven-mile Interstate 25 reversible lane north of Denver for several years. This lane has toll prices that depend on conditions. In July 2015, CDOT and a concessionaire opened managed lanes on U.S. Highway 36. In December 2015, CDOT opened tolled express lanes on Interstate 70.
- CDOT's Active Traffic Management (ATM) strategies increase vehicle throughput and safety on our highways through the use of integrated systems with new technologies, such as dynamic routing, ramp meters, adaptive signal control and transit signal priority.

Other Strategies

In addition to the operational tools mentioned, CDOT and other transportation agencies in Colorado are employing many other strategies to mitigate costs or increase the efficiency of our highways. These include:

Leveraging emerging technologies. Connected and autonomous vehicles represent great promise for increasing safety and have the potential to reduce congestion and mitigate the impacts of vehicle emissions. Some experts predict these systems could double or triple the capacity of existing roadways. Other experts suggest these vehicles may lead to behavioral changes that result in increased vehicle miles traveled.

Whatever the case, the upfront investment in roadway striping and other infrastructure for autonomous vehicles could further strain the budgets of transportation departments.

CDOT's RoadX program aims to use new innovations to achieve crash-free, injury-free, delay-free and technologically-transformed travel. RoadX projects will combine public and private efforts to implement innovative Intelligent Transportation Systems and prepare CDOT for the more widespread use of connected, automated and autonomous vehicles. One RoadX project, the SMART I-25 Managed Motorways Pilot Project, will deploy proven technology from Australia to coordinate ramp meters on 12 interchanges in the Denver metro area. It is estimated that this technology will optimize capacity along the Interstate by increasing vehicle throughput by more than 20 percent. In addition, the RoadX program will reach beyond the Interstate 25 corridor to develop peak-demand managed corridors throughout Colorado that use precise, real-time data to reduce congestion and improve safety for personal and commercial vehicles.

Encouraging transit. CDOT promotes transit service to help increase mobility, reduce congestion and mitigate factors that increase transportation costs. The department's Division of Transit & Rail, created by legislation in 2009, has been working to integrate transit into the state's transportation system. The first Statewide Transit Plan was completed in 2015. In Colorado, total transit ridership rose about 8 percent from 2011-15, from 117 million trips to about 126 million trips.

CDOT continues to be the recipient of Federal Transit Administration grants for Colorado's rural and small urban areas. These funds are distributed and administered by the Division of Transit & Rail to local transit providers statewide. The Division also administers \$15 million in FASTER transit funds, which includes \$10 million for statewide investment and \$5 million for regional investment.

In 2015, the department launched Bustang, an interregional transit service operated by a private vendor. Bustang provides express bus service along Interstate 25, connecting Fort Collins to Denver and Colorado Springs to Denver. In the Interstate 70 corridor, Bustang connects Glenwood Springs, Eagle County, Vail and Frisco to Denver. Bustang receives \$3 million annually in FASTER Statewide Funds to cover operations, maintenance and capital needs. The Bustang budget also includes fares collected during operation. Since launch, the service has exceeded projections for ridership, revenue and farebox performance. For the first four months of fiscal year 2017, Bustang collected enough fares to offset 54 percent of operating costs.

Encouraging vanpools. CDOT regularly encourages alternatives to single-occupancy vehicles. For example, CDOT's Division of Transit and Rail is

providing a total of about \$426,000 in fiscal years 2016 and 2017 to the North Front Range Transportation and Air Quality Planning Council for vanpool vehicle replacement.

Economic incentives. EcoPasses, sold by the Denver-based Regional Transportation District, offer unlimited rides on buses and light rail. The employer-sponsored annual passes can be paid for by employers or employees, or the cost can be shared. EcoPasses can reduce the number of commuting miles driven in personal vehicles. Savings in parking, fuel and vehicle costs are incentives for workers to use the passes. The passes can be bought with pre-tax money, which can lower payroll taxes and taxable income, according to the district's website.

Land-use policies. Increases in the growth of passenger vehicle travel is heavily influenced by land-use planning, but such planning is almost completely outside the control of state government. As people move increasingly farther from work centers and commercial nodes, the result is longer average trip lengths and greater infrastructure needs. Low-density development and inefficient development patterns that lack connectivity can limit the availability and use of transit, as well as bicycle and pedestrian facilities.

Telecommuting and teleconferencing. Telecommuting "occurs when paid workers reduce their commute by carrying out all, or part of, their work away from their normal place of business, usually from home or a telework center," according to the Federal Highway Administration's website. About 6.5 percent of Coloradans worked from home in 2014, compared to 4.4 percent for the entire United States, according to U.S. Census numbers.

According to the Federal Highway Administration's website, however, "there is little literature about the effectiveness of public sector programs to promote telework, and there appears to be no literature that links the costs of public investment in telework programs to resulting declines in [Vehicle Miles Traveled]."

Conclusion

The demand in Colorado for smooth pavement, sound bridges and regular highway maintenance is outpacing CDOT's revenue growth. Even maintaining current conditions would lead to deficits in the scenarios described in this report and leave little to no funding for expansion.

Specifically, CDOT projects a 10-year deficit of \$1.8 billion to maintain current performance for bridges, pavement and maintenance service levels. Reaching the department's "vision" targets for these assets would lead to a 10-year deficit of \$3.8 billion. CDOT also has established



CDOT manages 21 tunnels statewide. Maintenance activities include washing the structures, ensuring electrical and ventilation systems are operating properly, and more.

lower, more fiscally constrained targets for bridges, pavement and maintenance. Achieving these targets would result in a lower deficit—\$1.5 billion over 10 years—but bridges would deteriorate from 2016 conditions.

These deficit estimates have increased significantly from last year's report, largely due to updates to performance metrics for CDOT's maintenance and bridge programs. In particular, an "optimization" project for the maintenance program led to stricter scales for grading performance. For the traffic services maintenance area—which includes striping, traffic signals and other assets—the cost to achieve a B grade in fiscal year 2018 is more than 80 percent higher than in last year's report. Additionally, estimates for addressing bridge risks increased. For example, the estimates now include addressing bridges with vertical clearances under 16.5 feet. Previous reports only addressed bridges with clearances under 16 feet.

The ability of federal and state fuel taxes to provide sufficient transportation funding has been weakened by changing driving habits, greater fuel efficiency and inflation. These taxes have remained unchanged since the early 1990s, even as highway travel and population have soared.

Continued growth means that roads and bridges will sustain increasing wear and tear. This makes it critical to support these assets with funds that have been paying CDOT's obligations on Transportation Revenue Anticipation Notes

(TRANS bonds), which will be retired in 2017. Using these funds for other purposes would cause asset condition to deteriorate more than under the department's current assumptions.

Even after these dollars are redirected to asset management, CDOT's funding streams will be almost entirely devoted to maintaining the existing transportation network. New revenue must be secured to fund expansion projects. A potential funding source is Colorado's Senate Bill 228 of 2009. SB 228 provides funding for strategic transportation projects through five years of state General Fund transfers, provided certain economic triggers are met. Initial forecasts projected that CDOT would receive about \$200 million per year for five years. While CDOT received a full transfer of such funds in fiscal year 2016, the department faces significantly reduced projections for the remaining years.

Faced with such a constrained funding outlook, CDOT is seeking new revenue sources and technological innovations to improve Colorado's transportation network, such as facilitating the adoption of connected vehicles. The department also is conducting a pilot program to test road usage charging, a funding approach whereby drivers pay a fee based on the number of miles they travel instead of the gas tax. These solutions are just a few of the new approaches CDOT is exploring to meet the needs of our rapidly growing state.

For questions, please contact William Johnson, Performance and Asset Management Branch Manager, at will.johnson@state.co.us, or Toby Manthey, Performance Analyst, at toby.manthey@state.co.us.



Holiday travelers navigate a congested Interstate 70 West near Evergreen on Dec. 26, 2016.