Quality Assurance Panel Presentation

How to Ensure Quality and Incentive Pay on CDOT Projects - RMACES - February 23, 2017

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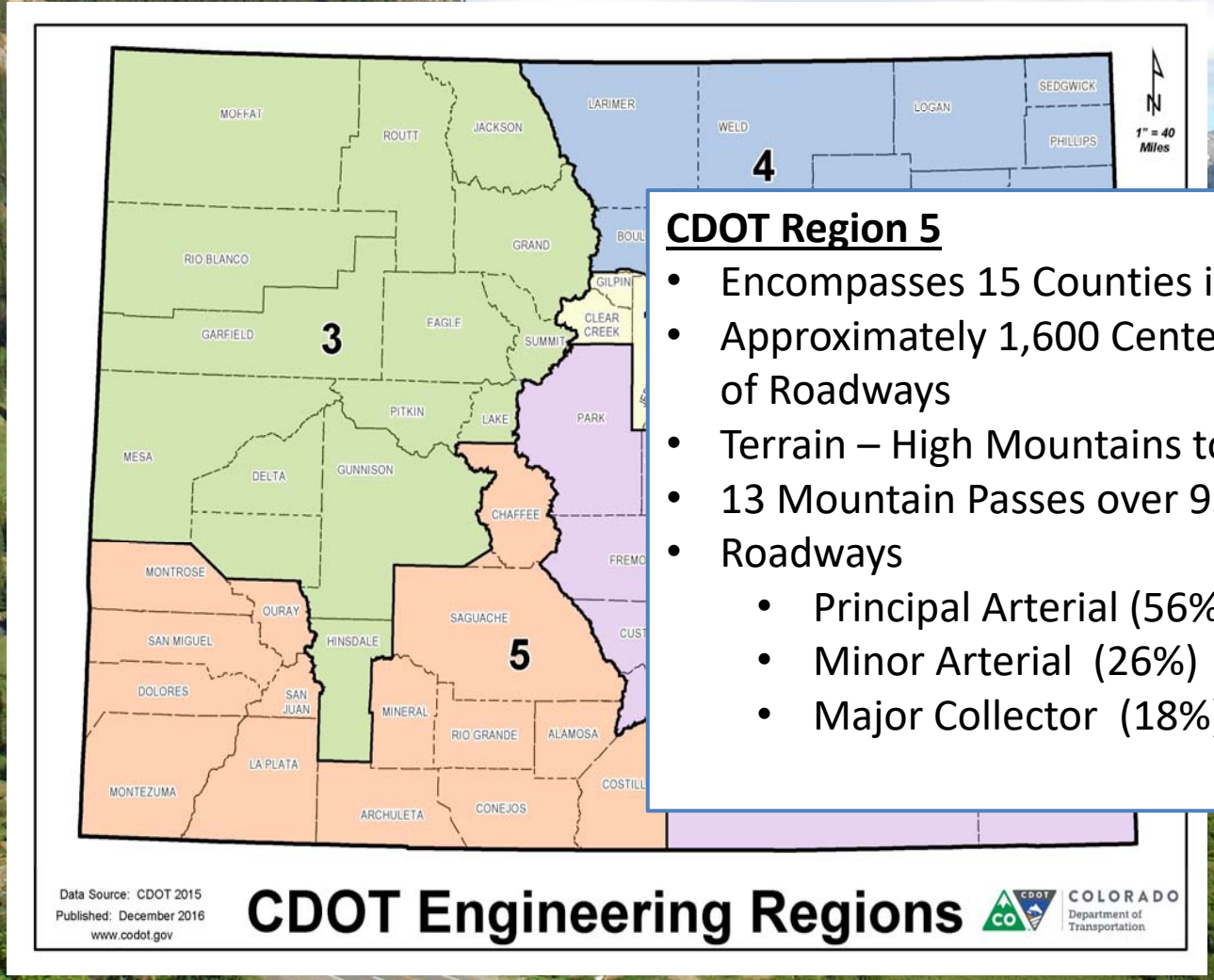

CDOT Region 5

- Encompasses 15 Counties in SW Colorado
- Approximately 1,600 Centerline Lane Miles of Roadways
- Terrain – High Mountains to Desert
- 13 Mountain Passes over 9500’ in elevation
- Roadways
  - Principal Arterial (56%)
  - Minor Arterial (26%)
  - Major Collector (18%)

Materials Mission

- Region 5 Materials' goal is to ensure that the highest quality roadway system is designed and constructed in the most cost-effective manner, and thus easily maintained.
- A critical part of achieving this goal is to encourage the Contractor's production and placement of high quality materials and workmanship.
- A natural effect of this goal is to assist the Contractor in his work to achieve the maximum benefit (incentive) of his effort to produce a high-quality and long-lasting project.
- We are committed to maintain the highest integrity in this process to include open communication, fairness, and consistency.

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CDOT Design Requirements

Project "A"

- Leveling (ST) PG 58-28:
  3/8" Nominal Max Aggregate
  2.0 – 3.0 Air Voids
  15.3 – 15.5 minimum VMA
- Top Mat (SX) PG 58-34:
  1/2" Nominal Max Aggregate
  3.0 – 4.0 Air Voids
  14.5 – 14.7 minimum VMA

Project "B"

- Leveling (ST) PG 58-28:
  3/8" Nominal Max Aggregate
  2.0 – 3.0 Air Voids
  15. 3 – 15.5 minimum VMA
- Top Mat (SX) PG 58-28:
  1/2" Nominal Max Aggregate
  3.0 – 4.0 Air Voids
  14.5 – 14.7 minimum VMA

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Optimum Mix Design Submitted

Project "A"

- Leveling (ST):
  - 7.00% AC content (7.00%)
  - 2.0% Air Voids (2.0%)
  - 16.2 VMA (15.0 – 17.4)
  - 2.40% Agg Absorption
- Top Mat (SX):
  - 6.00% AC content (6.00 %)
  - 3.1 Air Voids (3.1 %)
  - 14.7 VMA (13.5 – 15.9)
  - 2.40% Agg Absorption

Project "B"

- Leveling (ST):
  - 6.50% AC content (6.60%)
  - 2.3% Air Voids (2.0%)
  - 15.8 VMA (14.6 – 17.0)
  - 1.30% Agg Absorption
- Top Mat (SX):
  - 5.60% AC content (5.70%)
  - 3.4% Air Voids (3.1%)
  - 14.6 VMA (13.3 – 15.7)
  - 1.30% Agg Absorption

CDOT Form 43 targets shown in RED

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Optimum Mix Design Submitted

- Top Mat (SX):

6.00% AC content (6.00 %)
3.1 Air Voids (3.1 %)
14.7 VMA (13.5 – 15.9)
2.40% Agg Absorption

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3.4% Air Voids (3.1%)
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CDOT Form 43 targets shown in RED

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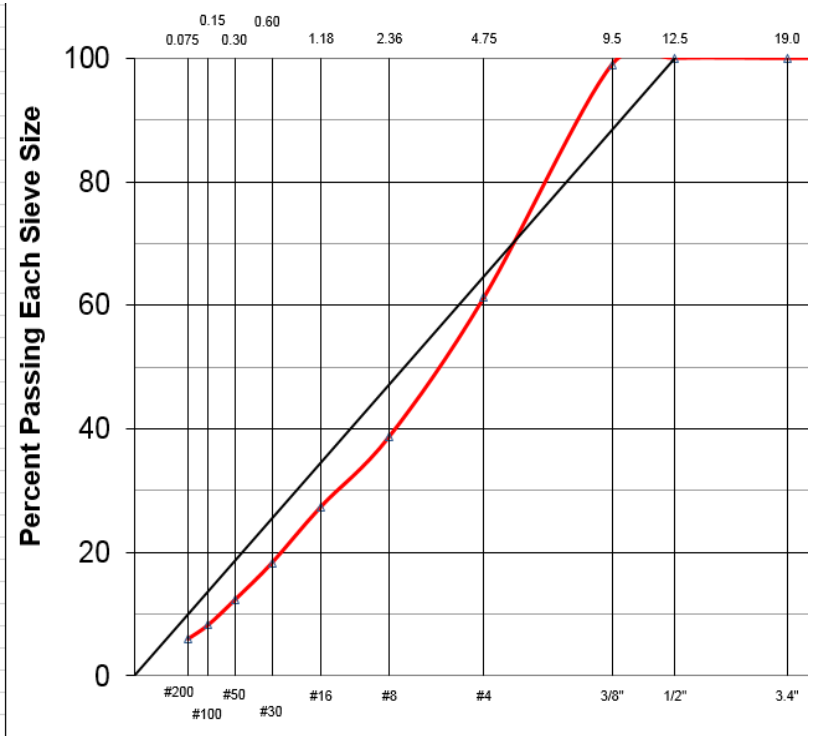
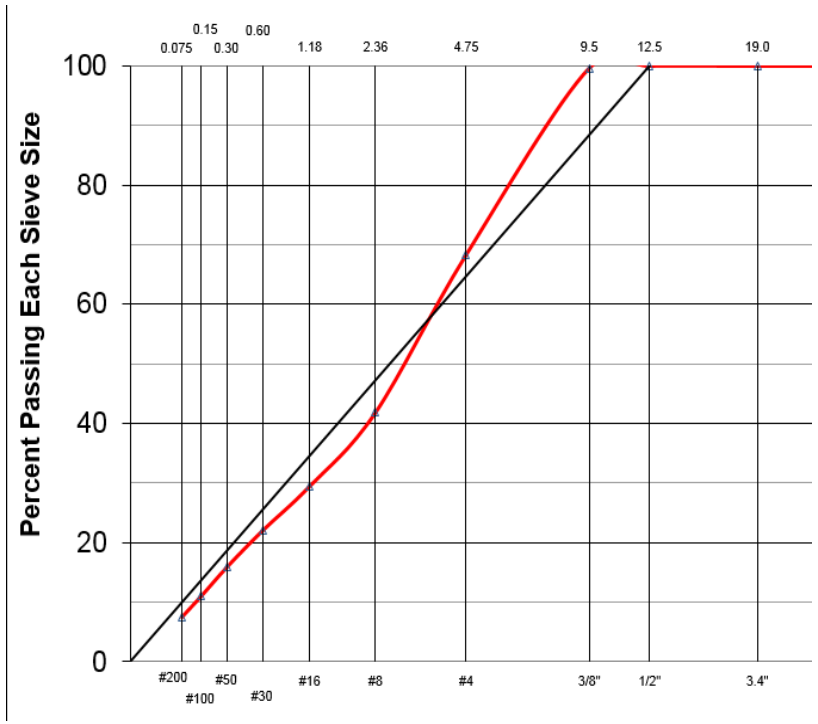
ST Mix Design Gradation Submitted

Project "A"



Project "B"



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ST Mix Production History

Project ”A”

- Production commences.
- Unable to produce desired Air Voids, request from Contractor to raise AC% from 7.00 to 7.40 with no change in gradation.
- Air Voids continue to vary – production stopped; new mix required.

Project “B”

- Production commences.
- Only one set of high AC% tests which put them in Red condition.
- Plant issue quickly resolved.
- ST mix leveling completed under one mix design with reasonable incentive.

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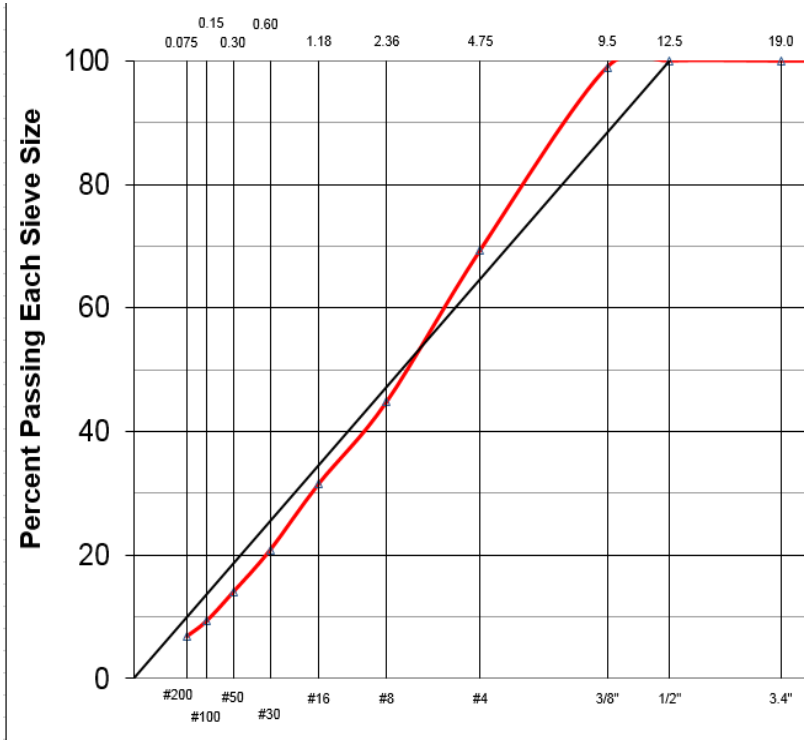
ST Mix Production History

Project "A"
Revised gradation



Project "A"

- Production ½ complete at this point
- New mix achieves target Air Voids but AC% demand is now 7.60%
- The high AC% required to achieve target Air Voids led to variability in production. This contributed to MQL float and a low final Pay Factor.

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ST Mix Issues

"A"

- Mix Design: highly absorptive aggregates combined with a gradation curve that showed little variance from the maximum density line generated a mix where the lab did not reflect field production.
- First request to correct assumed need for more AC. This attempt raised the production AC average outside the new AC tolerance.
- Lastly, volumetric targets achieved with the 3rd mix design having a finer gradation and a higher AC demand (7.60%).
- This mix was variable in production with AC% "red condition" MQL twice (out of spec range; once high and finishing low at completion).

"B"

- Mix Design: with a more reasonably absorptive aggregate and a gradation curve that shows a little more variance from the maximum density line this mix better reflected lab to field production.
- Short high AC "red condition" samples still produced Air Voids and VMA within tolerance ranges with these elements showing incentive; this mix not as sensitive to AC% variations.

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ST Mix Achievements

- Both projects in the end achieved CDOT quality requirements
  - Low Air Void placement (crack reflection resistance)
  - Protective layer between old mat and new surface course
  - Necessary multiple lift placement to achieve smoothness

ST Mix Failings

- Project “A” had trouble controlling the mixes during production
  - Gradation curve for these ST mixes on project “A” too tight and/or fine for consistent production control
  - Project “A” high fine aggregate absorption combined with the gradation issues contributed to variability
- Contractor achieves less incentive/more disincentive even though in the end CDOT quality requirements are met

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Optimum Mix Design Submitted

Project "A"

- Leveling (ST):

7.00% AC content (7.00%)
2.0% Air Voids (2.0%)
16.2 VMA (15.0 – 17.4)
2.40% Agg Absorption

Project "B"

- Leveling (ST):

6.50% AC content (6.60%)
2.3% Air Voids (2.0%)
15.8 VMA (14.6 – 17.0)
1.30% Agg Absorption

CDOT Form 43 targets shown in RED

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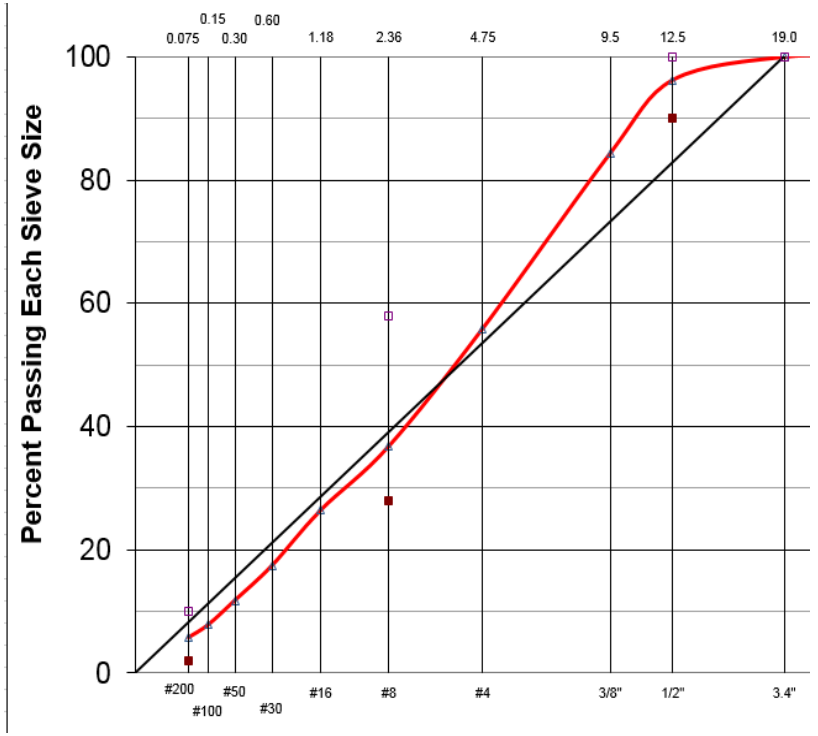
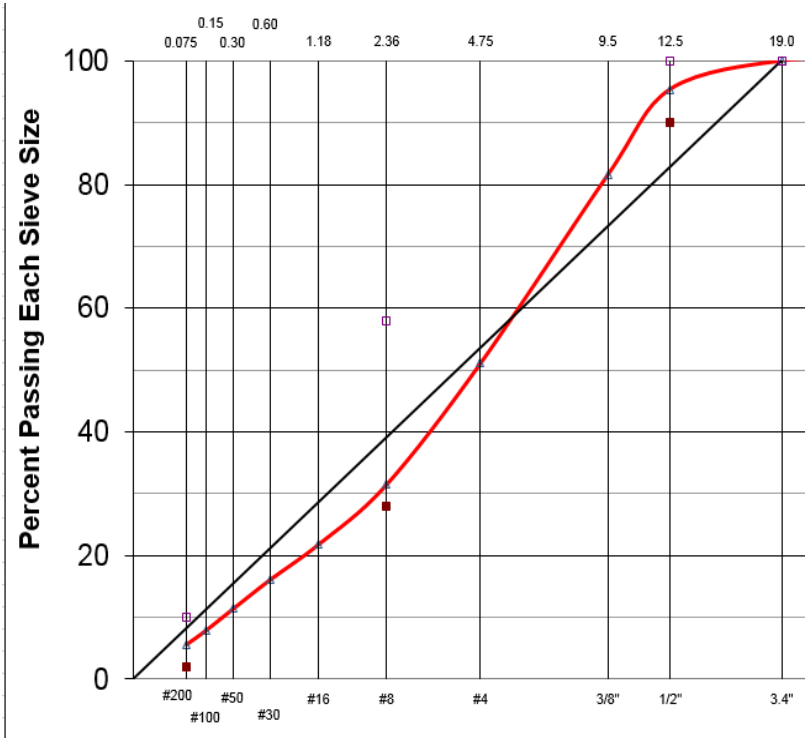
SX Mix Design Gradation Submitted

Project "A"



Project "B"



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SX Mix Production History

Project "A"

- Single mix design utilized to produce top mat from start to finish
- Mix Pay Factors above 1.0 for all elements
- Mat Density achieved maximum incentive allowed
- Jt. Density achieved near maximum incentive allowed

Project "B"

- Single mix design utilized to produce top mat from start to finish
- Mix Pay Factors above 1.0 for all elements
- Mat Density achieved near maximum incentive allowed
- Jt. Density achieved maximum incentive allowed

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SX Mix Achievements

- Both projects achieved CDOT quality requirements for SX top mat
  - Consistent Air Void production and placement
  - Mix properties contribute to superior Density construction for both mat and joint placement elements
  - Consistent production contributed to excellent, controlled placement to achieve smoothness
- Incentives were earned to reflect adherence to CDOT quality requirements

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Incentive/Disincentive Comparison

Project "A"

- Leveling ST mix (15,287 ton):
  - No Mat/Jt. Density paid
  - Mix properties paid: -$44,026 (-$2.88/ton)
- Top Mat SX mix (23,177 ton):
  - Mat/Jt: $58,443
  - Mix properties paid: $24,606 ($1.06/ton)
- Total Paid: $39,023

Project "B"

- Leveling ST mix (20,105 ton):
  - No Mat/Jt. Density paid
  - Mix properties paid: $12,282 ($0.61/ton)
- Top Mat SX mix (34,267 ton):
  - Mat/Jt: $36,623
  - Mix properties paid: $35,100 ($1.02/ton)
- Total Paid: $84,005

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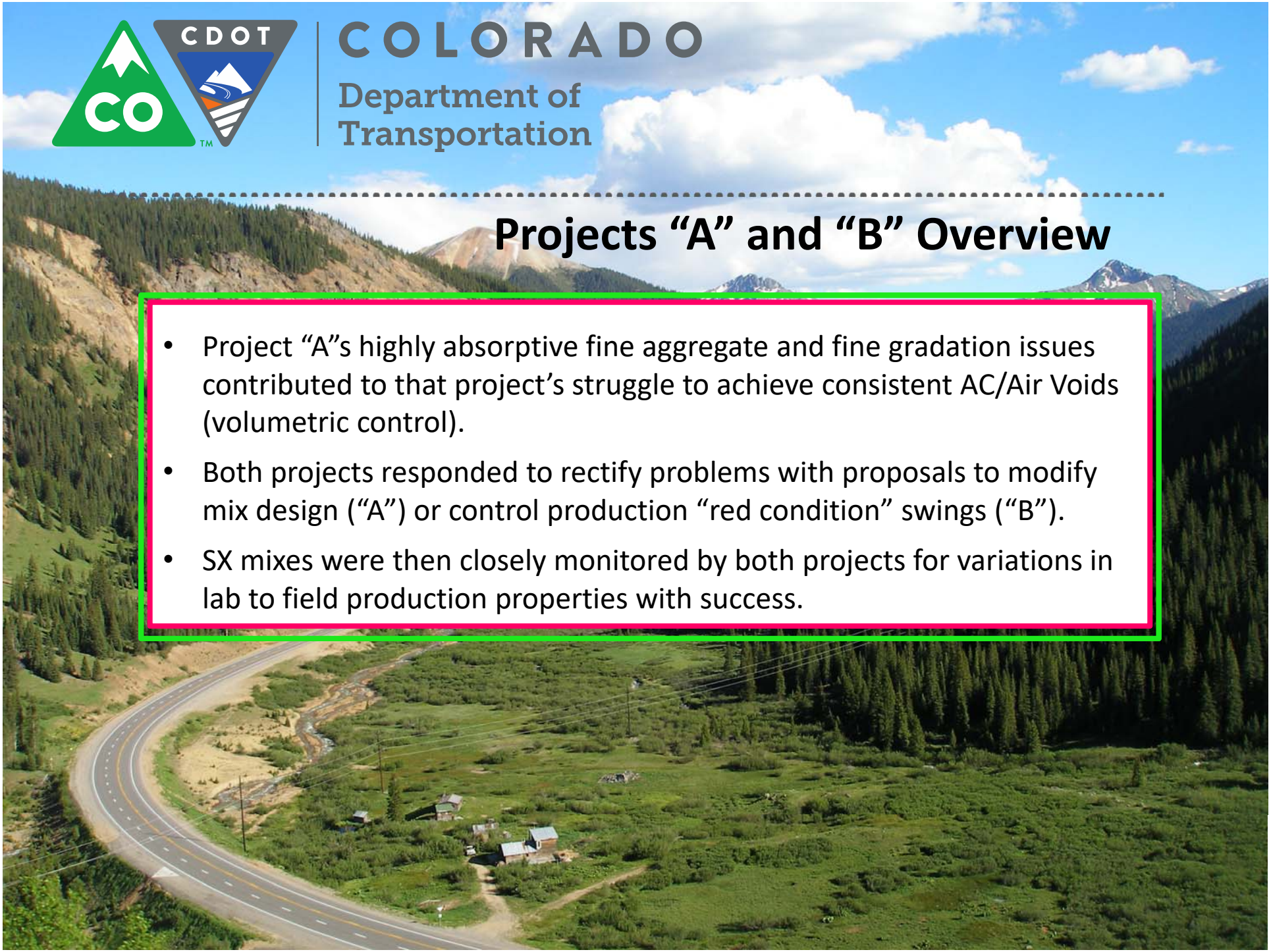
Projects “A” and “B” Overview

- Project “A”s highly absorptive fine aggregate and fine gradation issues contributed to that project’s struggle to achieve consistent AC/Air Voids (volumetric control).
- Both projects responded to rectify problems with proposals to modify mix design (“A”) or control production “red condition” swings (“B”).
- SX mixes were then closely monitored by both projects for variations in lab to field production properties with success.



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Summary

- Start with a well researched mix design
  - Highly absorptive aggregate increases AC demand and may also contribute to variability in production
- Understand your aggregate source prior to design assumptions
  - Project “A” was produced from an unfamiliar pit
  - Project “B” was produced from a very familiar pit
- Control your materials during production; use your process control
- Communicate often
  - Communicate regularly and timely with production issues
  - Do not hesitate to present honest evaluations of variability
  - Frequent communication allows for real-time, beneficial feedback, target setting, and sampling/testing from CDOT

- Finally, to note: both projects were actually designed (mix) and constructed by the same Contractor!

Questions and Comments?