

**US 36 Managed Lane Project:
Federal Boulevard To Interlocken Loop With A
Potential Extension To McCaslin Boulevard**

***Attachment A:
Floodplain and Drainage Reports***

January 25, 2012

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INTRODUCTION

The US 36 Managed Lane Project represents one phase of planned improvements identified as Phase 1 of the Preferred Alternative in the US 36 Record of Decision (ROD). The US 36 Managed Lane Project is a multi-modal, toll integrated project that will include reconstruction of the US 36 mainline pavement from Federal Boulevard to Interlocken Loop, with a potential extension to McCaslin Boulevard. The project will also include widening to accommodate a new buffer-separated Managed Lane in each direction of US 36, replacement of the Wadsworth Parkway, Wadsworth Boulevard, and Lowell Boulevard bridges, construction of retaining walls and sound walls, installation of Intelligent Transportation Systems, and construction of portions of a commuter bikeway.

The purpose of this report is to discuss floodplain and drainage impacts which have changed from those evaluated in the Final Environmental Impact Statement (FEIS) or ROD. Changes could include new impacts that occur outside of the original US 36 EIS study area for this first phase of planned improvements. Additional changes to the FEIS environmental impacts (design related) have occurred since the release of the ROD in December 2009 because of ongoing design activities and refinements. The quantitative analysis of direct permanent impacts presented in the FEIS was based on conceptual roadway plans and assumed highway configurations while the current level of design for the US 36 Managed Lane Project has advanced to preliminary design. This NEPA re-evaluation is being conducted pursuant to the requirements of 23 CFR 771.129.

The attachment includes:

- ▶ Summary of floodplain impacts shown in **Table 1**.
- ▶ Coal Creek Design Alternative
- ▶ Airport Creek Design
- ▶ Rock Creek Design Alternative

SUMMARY OF FLOODPLAIN IMPACTS

Table 1: Existing Floodplain Impacted Areas (Acres)

SHAPE ID	Description	D-B PROJECT	ROD	Difference	Comments
		100 YEAR	100 YEAR		
SITE 1 *	Big Dry Creek	1.9170	4.0066	-2.0896	Used FEMA Floodplain (17516HYDR_100-YR Floodplain.dgn)
SITE 2 **	Airport Creek	2.3602	2.2202	0.1400	Used FEMA Floodplain (17516HYDR_100-YR Floodplain.dgn)
SITE 3	Rock Creek	3.4014	4.6618	-1.2604	Used FEMA Floodplain (17516HYDR_100-YR Floodplain.dgn)
SITE 4	Coal Creek	5.9569	7.7368	-1.7799	Used FEMA Floodplain (17516HYDR_100-YR Floodplain.dgn)

Total Difference = -4.9899

* The proposed improvements at Big Dry Creek are similar to the ROD with the exception of the looped bikeway connection west of US-36. Impact area reduction is due to design refinement and that the impact areas estimated in the ROD were overly conservative.

** The proposed channel and culvert improvements at Airport Creek will reduce the existing 100-year floodplain. Total area removed from the floodplain between US 36 and Wadsworth Blvd. is 5.69 acres.

COAL CREEK DESIGN ALTERNATIVE

Coal Creek is located within a FEMA-mapped floodplain and is designated Zone AE, AH and X within the vicinity of the Coal Creek and US 36 crossing. To develop a preferred alternative at the Coal Creek crossing, several hydraulic modeling alternatives were analyzed and compared against the established hydraulic design criteria, FEMA floodplain mapping, and existing conditions model developed and calibrated for the Project. Hydraulic modeling was performed utilizing HEC-RAS, version 4.0. Flow rates used to evaluate the Coal Creek crossing are derived from the FEMA Flood Insurance Rate Study (FIS) and presented in **Table 2** below.

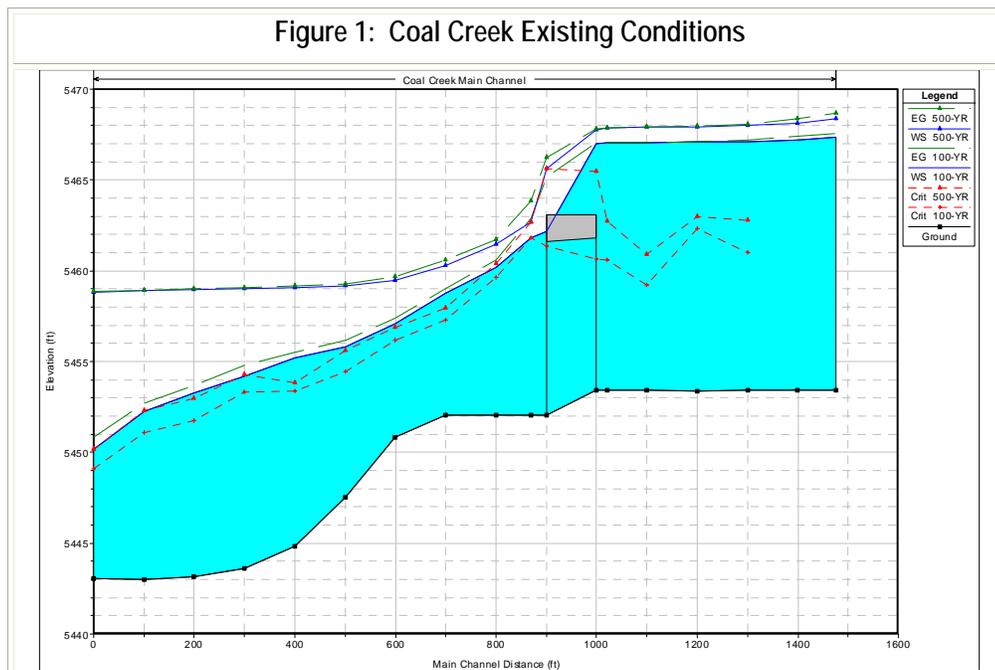
Table 2: Coal Creek Crossing

Location	Drainage Area	Peak Discharge			
		10-YR	50-YR	100-YR	500-YR
Denver-Boulder Turnpike	27.9 sq. mi.	1740	3070	3820	6030

A summary of the hydraulic models completed for the Project at the Coal Creek crossing is provided in the following sections. Each design alternative is presented with a brief explanation and summary of the pros and cons of each alternative. This analysis is intended to provide documentation on the alternatives considered at the Coal Creek Crossing as a part of the Project.

Coal Creek Existing Conditions

The existing conditions model was established based on existing topography, field visits, and field survey. The existing Coal Creek crossing consists of a 52-foot-long by 100-foot-wide single-span bridge. **Figure 1** below provides a profile summary of the modeling results for the 100-year and 500-year runoff events.



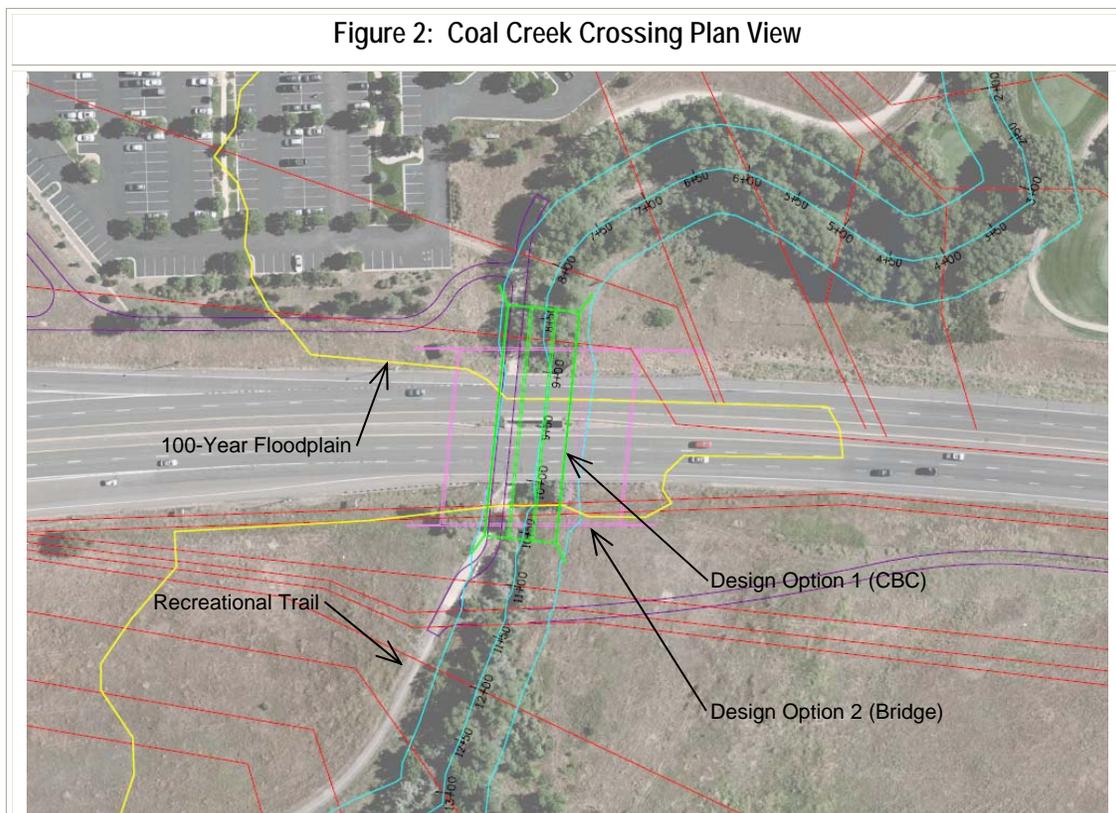
The existing model and supporting FEMA information provide support documentation detailing that US 36 is within the designated floodway and that overtopping of US 36 will occur during a 100-year flow event. The existing conditions model demonstrates that the existing crossing and bridge is hydraulically inadequate and will inundate US 36 during the design event.

Design Alternatives Considered

Several design alternatives were considered for the Coal Creek crossing to improve the existing conditions by:

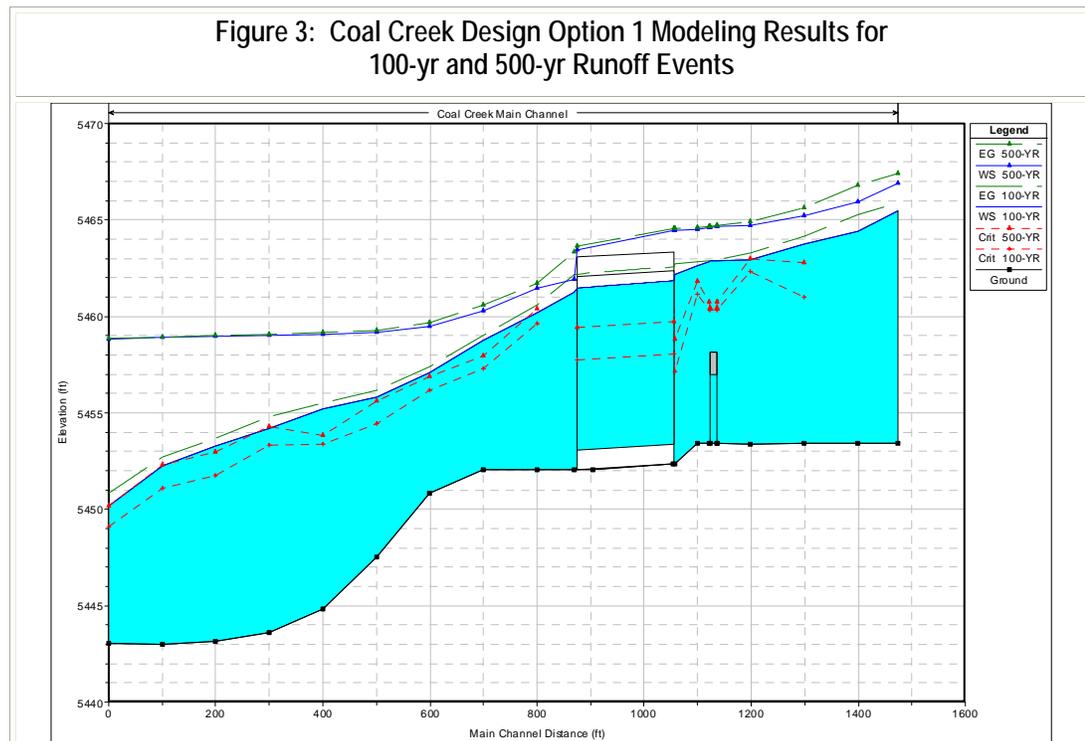
- ▶ eliminating the overtopping of US 36
- ▶ maintaining wildlife passage
- ▶ meeting minimum vertical clearance requirements for the recreational trail
- ▶ providing separation of the recreational trail and the creek low flow channel
- ▶ minimizing impacts to habitat and wetland areas
- ▶ limiting throw-away structures and the need for future upgrades
- ▶ keeping construction costs down

The design alternatives considered: replacing the bridge at the current location; moving the bridge and relocating the channel 350 feet east to the roadway sag point; and replacing the bridge with a multi-cell concrete box culvert at the roadway sag point. These alternatives were eliminated after further analysis because they did not satisfy the design requirements noted above. Although it is difficult to satisfy all the desired improvements, the following two design options were determined to be the most viable solutions for the Coal Creek crossing. **Figure 2** below provides an aerial image of the existing crossing at Coal Creek as well as cross section locations of the existing channel and the existing floodplain boundary.



Design Option 1

Design Option 1 involves replacing the existing Coal Creek bridge with a three-cell concrete box culvert at the existing crossing location. This alternative would require that approximately 50 feet of channel be improved upstream of the US 36 crossing to allow for a 2.3% slope into the culvert. In addition, a 3- to 4-foot vertical roadway profile adjustment will be required to accommodate the wildlife clearance, the 10-foot culvert height for trail vertical clearance, and to provide sufficient headwater to prevent overtopping. The new culvert crossing would consist of three 20- x 10-foot CBCs, which would serve as a recreational trail, wildlife crossing, and main low-flow channel. This design alternative maintains a HW/D ratio of 1.0. Refer to **Figure 2** for a visual representation of the CBC layout at Coal Creek. **Figure 3** below provides a profile summary of the modeling results for the 100-year and 500-year runoff events.



Advantages of Design Option 1

- ▶ Provides a permanent structure that does not need to be extended when future improvements take place; retaining walls approaching the structure can continue over the initial-build structure.
- ▶ Would remove US 36 from the floodway
- ▶ Channel improvements would not significantly impact habitat and wetlands located adjacent to the existing channel.
- ▶ Minimum vertical clearance requirement met for recreational trail and wildlife crossing.
- ▶ Recreational trail separated from channel low flows.

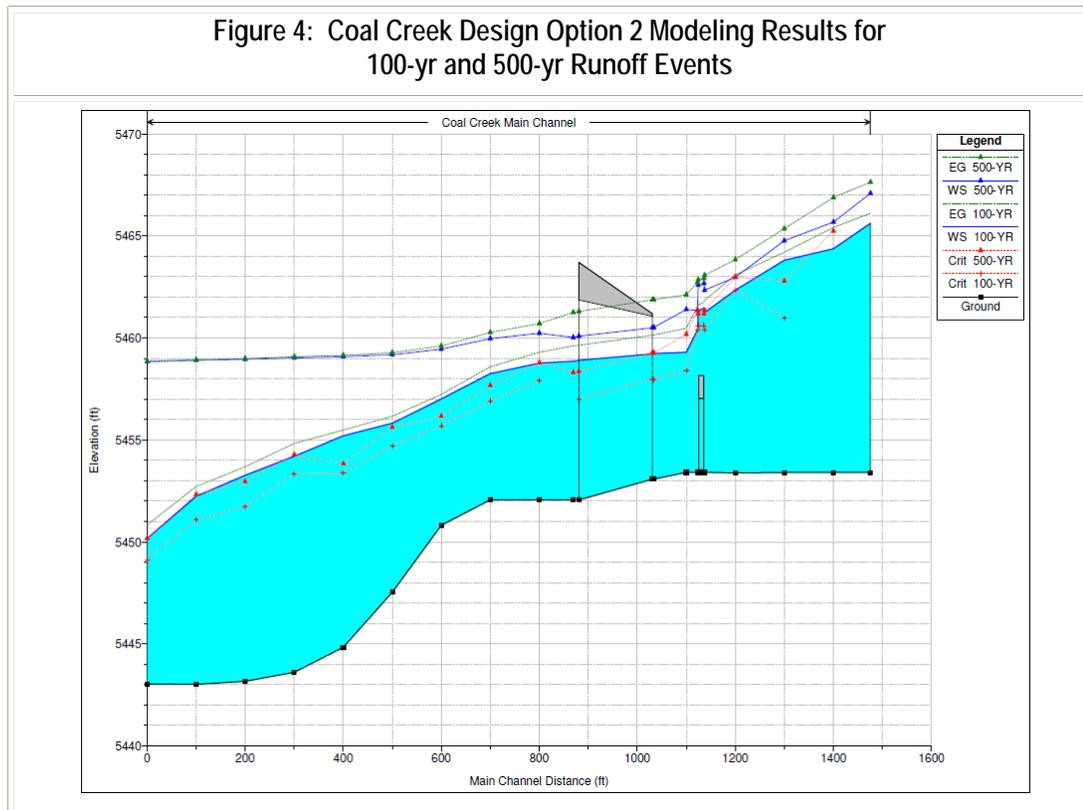
Disadvantages of Design Option 1

- ▶ Roadway profile adjustments are required (3 to 4 feet).
- ▶ Permitting through U.S. Army Corps of Engineers would be required.

Design Option 2

Design Option 2 involves replacing the existing bridge at the current location. This alternative provides a recreational trail, low flow channel, and a wildlife crossing within the existing corridor. Because of the vertical clearance requirements for trails and wildlife crossings, the roadway profile must be raised approximately 9- to 10-feet from the existing elevation. This rise in profile also satisfies the CDOT recommended freeboard from the bottom of girder to the 100-year Water Surface Elevation (WSEL). The new bridge crossing would span approximately 160 feet with a 73' wide channel bottom and the wildlife and recreational trail to either side, perched 2 feet above the channel bottom.

Refer to **Figure 2** for a visual representation of the Bridge layout at Coal Creek. **Figure 4** below provides a profile summary of the modeling results for the 100-year and 500-year runoff events.



Advantages of Design Option 2

- ▶ Would remove US 36 from the floodway.
- ▶ Minimum vertical clearance requirement met for recreational trail and wildlife crossing.
- ▶ Reduced WSEL downstream due to increased hydraulic capacity through the bridge.

Disadvantages of Design Option 2

- ▶ Roadway profile adjustments are required (9 to 10 feet).
- ▶ Structure would need to be widened when future improvements take place.
- ▶ The downstream channel improvements would have a greater impact to habitat and wetlands located adjacent to main channel. Permitting through U.S. Army Corps of Engineers would be required.

- ▶ High cost of a bridge structure and additional costs associated with providing additional embankment and retaining walls for 1500 feet of roadway approaches to accommodate the raised profile.

Summary of Coal Creek Design Alternatives

This attachment documents the design alternatives considered for the Coal Creek and US 36 crossing. Improvements considered with this analysis will remove US 36 from the floodway and will provide the required hydraulic capacity. A Letter of Map Revision (LOMR) and FEMA coordination will be required for both options to remove US 36 from the designated floodway.

Based on the relative advantages, impacts, and costs, Design Option 1 is the recommended alternative. The procurement documents require that a new crossing be provided at the location of the existing crossing. If the contractor proposes to relocate the crossing, they will be responsible for further environmental re-evaluations.

AIRPORT CREEK DESIGN ALTERNATIVE

Airport Creek was analyzed to determine if any flooding would occur as a result of the Project or if Project facilities would be within the designated floodplain. Airport Creek is located within a FEMA mapped floodplain and designated Zone A and AE. To assess the impact to Airport Creek, a hydraulic model was completed and an analysis performed. The hydraulic model was compared against the established hydraulic design criteria, FEMA floodplain mapping, and existing conditions model developed and calibrated for the Project. Hydraulic modeling was performed utilizing HEC-RAS, version 4.0. Flow rates used to evaluate Airport Creek are derived from the FEMA Airport Creek LOMR that was effective September 11, 2006. A summary of the flow rates presented within the LOMR are provided in **Table 3** below.

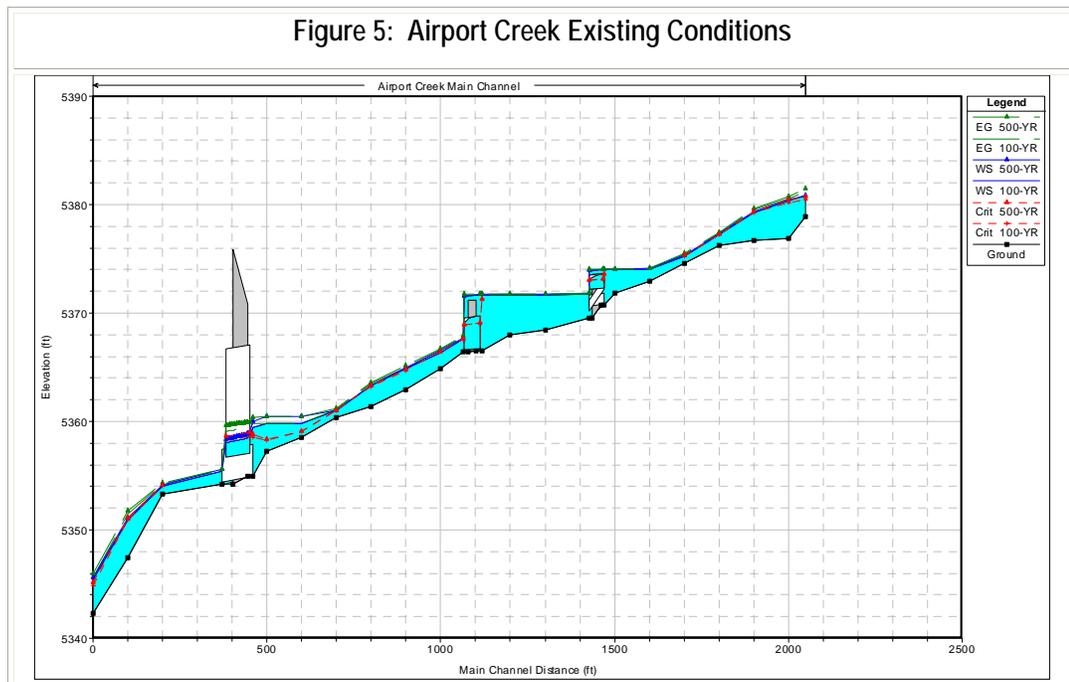
Table 3: Airport Creek Flow Rates

Location	Drainage Area	Peak Discharge			
		10-YR	50-YR	100-YR	500-YR
Upstream Limit of Study	0.4 sq. mi.	93	147	168	213

A regional detention facility is located upstream of US 36. The regional facility discharges to a 42-inch RCP that conveys flows across US 36 and discharges to an open channel downstream of US 36 (see Broomfield Urban Transit Village Arista Plans). A summary of each hydraulic model completed for the Project at Airport Creek is provided in the following sections. This analysis is intended to provide documentation for the design under consideration as a part of the Project at Airport Creek.

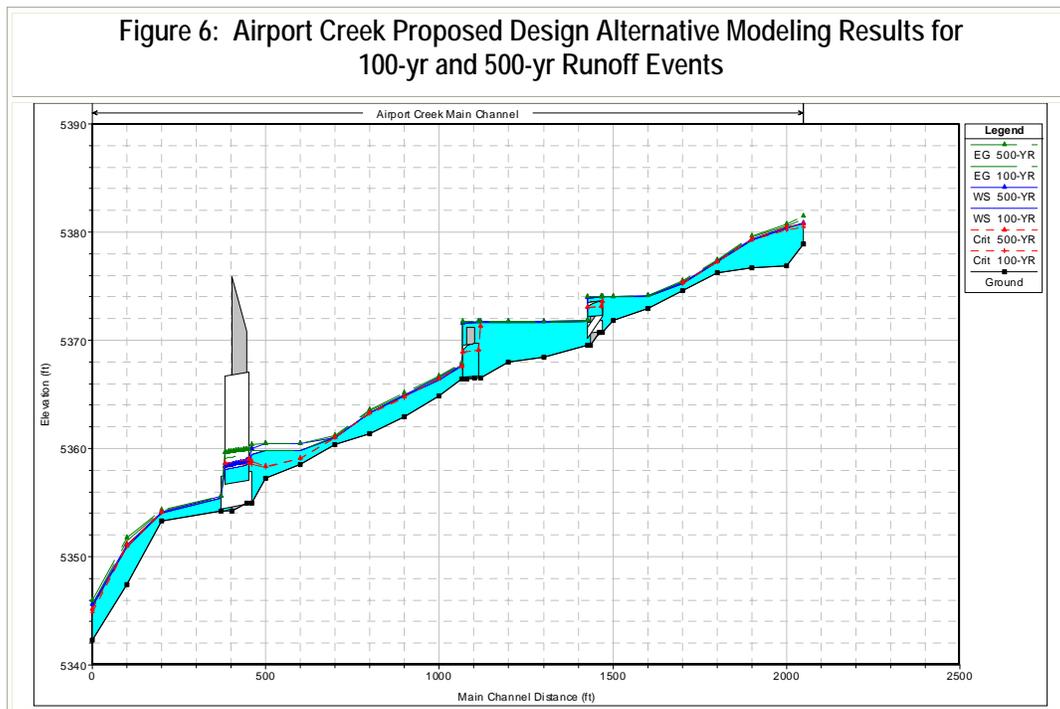
Airport Creek Existing Conditions

An existing conditions model was established based on existing topography, field visits, and field survey. Once the existing conditions model was completed, the model was calibrated by adjusting Manning's "n" values to obtain results similar to those presented in the FEMA LOMR and FIRM panel, dated September 11, 2006. The existing channel downstream of US 36 is not well defined and several properties are located within the floodplain with structures located near the main channel. **Figure 5** below provides a profile summary of the modeling results for the 100-year and 500-year runoff events.



Airport Creek Proposed Design

The proposed design consists of constructing a defined channel along the proposed water quality/detention facilities downstream of US 36. This design requires a channel with a 10-foot bottom width trapezoidal cross-section and 3:1 side slopes. Additional improvements consist of upsizing the existing 42-inch pipe to a 48-inch pipe under US 36 in a new alignment to better match the flow path of the historic channel, raising the profile of the maintenance road to prevent overtopping during the design event, and installation of three 36-inch RCP culverts under the maintenance road and Wadsworth Boulevard. Culverts under Wadsworth Boulevard and the maintenance road are necessary to improve the channel hydraulics, prevent flooding of the detention facilities, and to prevent overtopping of the roadways. This design alternative maintains a maximum HW/D ratio of 1.4 for the 100-year design event. **Figure 6** below provides a profile summary of the modeling results for the 100-year and 500-year runoff events.



Summary of Airport Creek Alternative

This attachment documents the design proposed for Airport Creek as a part of the Project. All improvements proposed along Airport Creek as a part of the Project are intended to accommodate drainage facilities to be located downstream of US 36. Improvements will necessitate the placement of fill within the floodplain and will require the completion of a LOMR and coordination with FEMA.

ROCK CREEK DESIGN ALTERNATIVE

Rock Creek is located within the FEMA mapped floodplain and designated Zone AE and X near Rock Creek and US 36 crossing. To develop a preferred alternative at the Rock Creek and US 36 crossing, two hydraulic modeling alternatives were analyzed and compared against the established hydraulic design criteria, FEMA floodplain mapping, and existing conditions model developed and calibrated for the Project. Hydraulic modeling was performed utilizing HEC-RAS, version 4.0. Flow rates used to evaluate the Rock Creek crossing are derived from the FEMA Flood Insurance Study (FIS) and are presented in **Table 4** below.

Table 4: Rock Creek Crossing

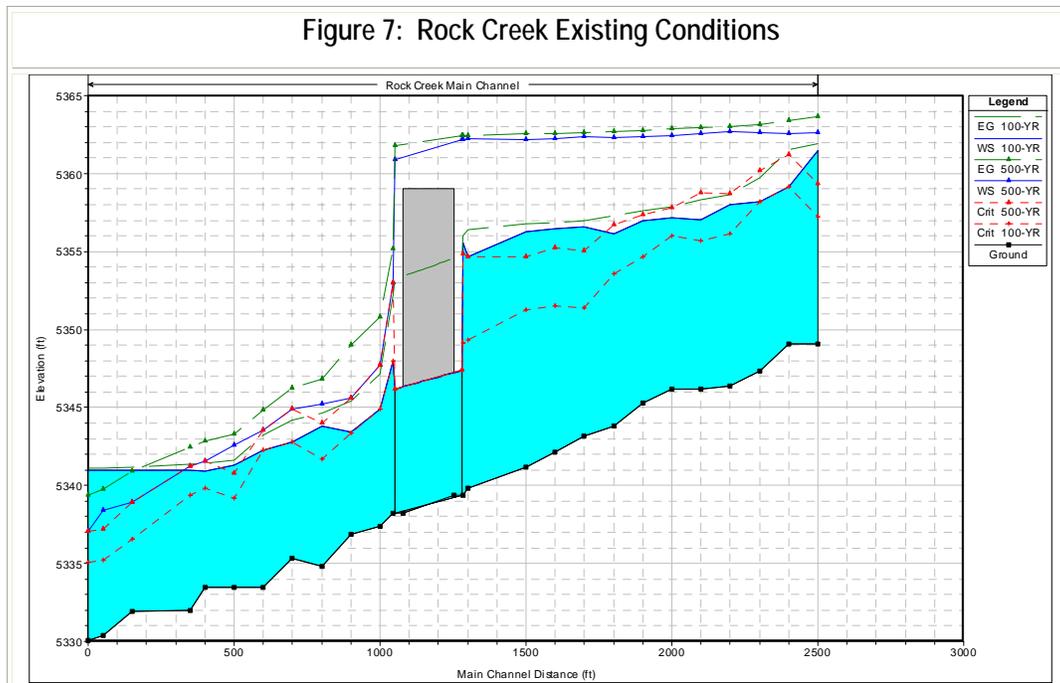
Location	Drainage Area	Peak Discharge			
		10-YR	50-YR	100-YR	500-YR
Denver-Boulder Turnpike	9.3 sq. mi.	1256	3229	4520	9176

A summary of each hydraulic model completed for the Project at the Rock Creek crossing is provided in the following sections. Each design alternative is presented with a brief summary

and the pros and cons of each alternative. This analysis is intended to provide documentation on the alternatives considered at the Rock Creek Crossing as a part of the Project.

Rock Creek Existing Conditions

The existing conditions model was established based on existing topography, field visits, and field survey. Once the existing conditions model was completed, the model was calibrated against the FEMA FIRM panel, dated August 18, 2004, by adjusting Manning’s “n” values. The existing Rock Creek crossing consists of two 14- x 8-foot Reinforced CBCs. **Figure 7** below provides a profile summary of the modeling results for the 100-year and 500-year runoff events.

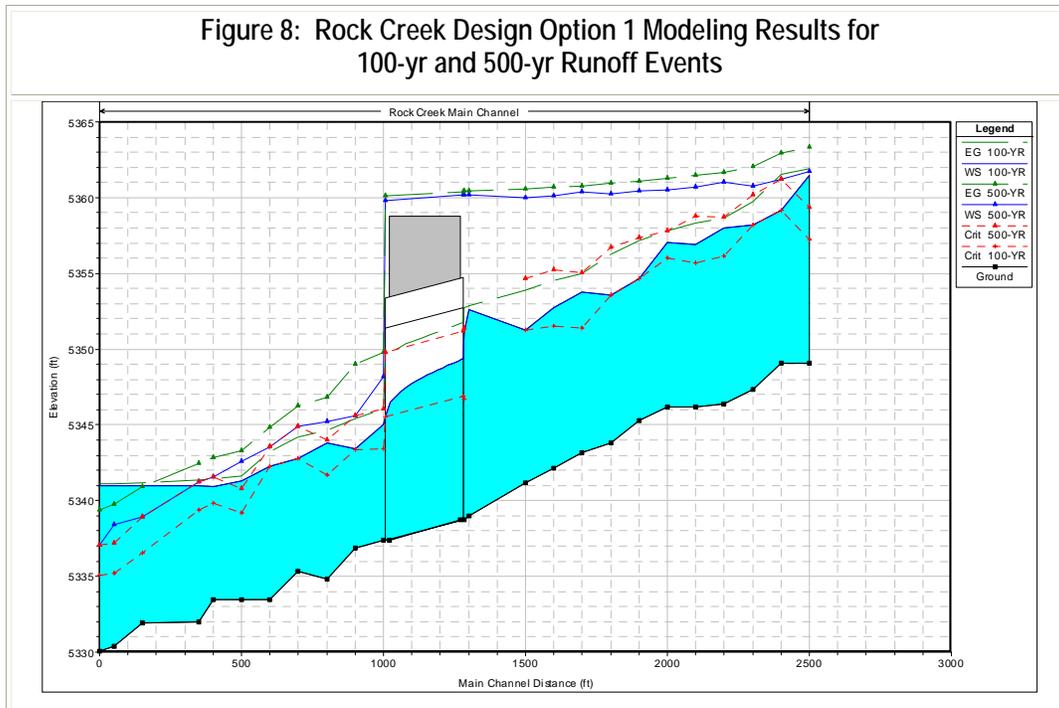


The existing model and supporting FEMA information shows that Rock Creek crossing with US 36 has a headwater to depth (HW/D) ratio greater than allowed by CDOT design guidelines. FEMA mapping of the existing condition shows US 36 within the 500-year floodplain with no overtopping during the design 100-year event. The undersized structure provides inadvertent detention; however, no known agreements are in place that will require the detention to be maintained.

Design Option 1

Design Option 1 consists of replacing the Rock Creek culvert at the existing location. This option requires two new culverts, a 14- x 14-foot CBC and a 20- x 16-foot CBC that would serve as a wildlife crossing. While the 20- x 16-foot culvert is intended to serve as a wildlife crossing, the crossing will not meet the desired openness ratio requirement for wildlife crossings due to limitations on span by CDOT requirements (20 feet maximum), limitations on height by vertical constraints, and the required length of the culvert. The openness ratio of the wildlife crossing is 0.35. This design alternative maintains a HW/D ratio of 1.0 for the 100-year design event.

Figure 8 below provides a profile summary of the modeling results for the 100-year and 500-year runoff events.



Design Option 1 is under consideration for the following reasons:

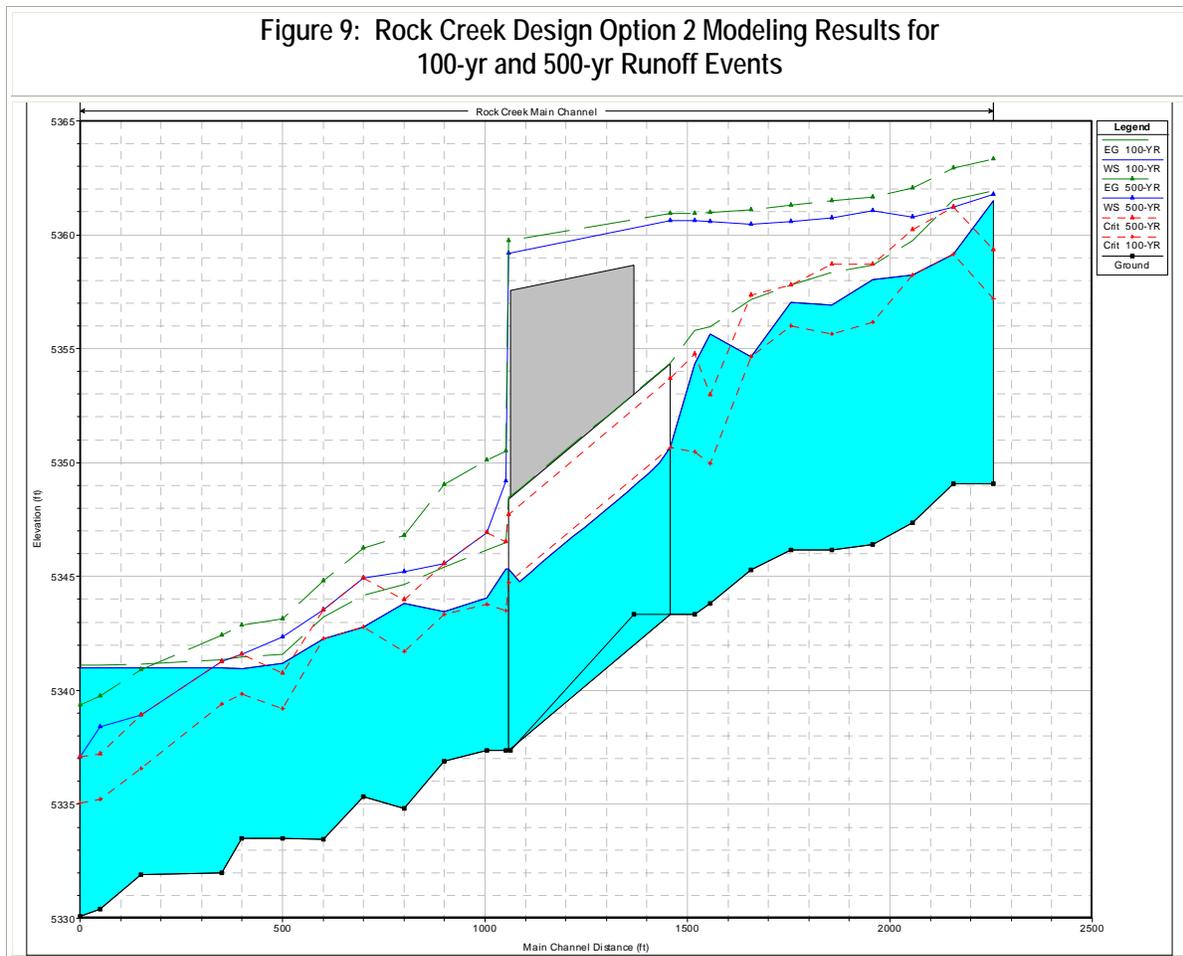
- ▶ Culvert design will result in HW/D = 1.0.
- ▶ No roadway profile adjustments are required.
- ▶ Wildlife crossing ratio is optimized.

Disadvantages of design Option 1 are as follows:

- ▶ Existing channel upstream of Rock Creek crossing is located within a pinch point which could limit the extension of the culvert in the future.
- ▶ Wildlife crossing does not provide an openness ratio of 0.9.

Design Option 2

Design Option 2 involves replacing the existing Rock Creek crossing with a culvert that has the entrance located approximately 500 feet upstream of the existing crossing location. This alternative would relocate the culvert outside of the channel pinch point and would require that the culvert has a 45-degree skew across the freeway to match the existing channel. The new culvert crossing would consist of two 20- x 11-foot CBCs, which would convey flows from the main channel and would serve as a wildlife crossing. This proposed crossing will not meet the desired openness ratio requirement for wildlife crossings, due to limitations on span by CDOT requirements, limitations on height by vertical constraints, and the required length of the culvert. The openness ratio of the wildlife crossing is 0.17. This design alternative maintains a HW/D ratio of 1.0 or less. **Figure 9** below provides a profile summary of the modeling results for the 100-year and 500-year runoff events.



Design Option 2 is under consideration for the following reasons:

- ▶ Relocated culvert would move the upstream end of the culvert out of the channel pinch point and allow for future extensions of the culvert if needed.
- ▶ Culvert design will result in HW/D = 1.0.
- ▶ No roadway profile adjustments are required.

Disadvantages of design Option 2 are as follows:

- ▶ Wildlife crossing does not provide an openness ratio of 0.9.
- ▶ Wildlife crossing not optimized at this location due to increased length and roadway profile at this location.
- ▶ LOMR and FEMA coordination will be required
- ▶ Coordination with U.S. Army Corps of Engineers for channel relocation. Individual 404 permits may be required as a part of the channel relocation.

Summary of Rock Creek Alternative

This attachment documents the design alternatives considered for the Rock Creek and US 36 crossing. No bridge options have been considered due to CDOT's desire not to construct a temporary structure that would need to be replaced when the future planned improvements are completed. All culverts options under consideration will not meet the wildlife crossing openness ratio requirements due to culvert length, span restrictions, and constraints on the vertical profile. Improvements considered with this analysis will improve the hydraulic capacity at the Rock Creek and US 36 crossing and will provide a HW/D ratio of 1.0.

The impacts documented in the re-evaluation assume Design Option 1, and this is the recommended alternative. The procurement documents require that a new crossing be provided at the location of the existing crossing. If the contractor proposes to relocate the crossing, they will be responsible for further environmental re-evaluations.

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**Appendix A:
Memo to FHWA Regarding Airport Creek Re-Evaluation**

STATE OF COLORADO

DEPARTMENT OF TRANSPORTATION

Region Six
US 36 Managed Lane Project
2000 South Holly Street
Denver, CO 80222
(303)757-9255 Fax (303) 757-9053



October 26, 2011

Mr. John C. Cater
Federal Highway Administration
Colorado Division Administrator
12300 W. Dakota Ave Suite 180
Lakewood, CO 80228

SUBJECT: Airport Creek and Right-of-Way Impacts - CDOT Project NH 0361-093 (SA 17516) US 36 Managed Lane Project, Westminster, Jefferson County

Dear Mr. Cater:

The purpose of this letter is to provide additional background and clarification to the Record of Decision (ROD) Re-evaluation, specifically related to the revised impacts at the Airport Creek area of the project and all other changes related to ROW impacts that were covered in the FEIS and ROD for this portion of the project. With the concurrence of this letter, CDOT would like to proceed with acquiring the ROW for this project.

Background: A regional detention facility was constructed in 2006-2007 for Airport Creek west of US 36 by the development in that area. The existing Airport Creek passes under US 36 from west to east in a 42" culvert. The residential properties east of US 36 are largely within the existing floodplain and are subject to impacts from the creek flows even in minor storm events.

The Final Environmental Impact Statement (FEIS)/ROD approach to this area was to not revise the existing conditions of Airport Creek downstream of US 36. The project water quality needs were to be addressed by acquiring an unimproved portion of the residential property north of the creek for a water quality pond, and acquiring a 700' long strip of land for an outfall from this pond east of Wadsworth Boulevard across another property to the Burlington Northern Santa Fe (BNSF) Railroad, where it would ultimately join the existing Airport Creek channel.

Design Changes: As design progressed during development of the Design/Build project and the need for more detention to address the drainage and flooding problems became apparent, the US 36 team was made aware that the property south of the FEIS pond location was in foreclosure, and that Broomfield and Urban Drainage and Flood Control Division (UD&FCD) were beginning the process of acquiring the property to formalize the Airport Creek channel within it, since this property and the property to the south experience frequent drainage problems. After some analysis, the US 36 team elected to pursue acquiring the properties to the south of and including the foreclosure property for the channel and a combined detention/water quality pond based on the following:

1. To lessen impacts to the creek channel and properties further downstream, enlarging the pond to include detention as well as water quality treatment was determined to be advantageous. The property take designated for a pond by the FEIS would have to have been increased to accommodate a larger pond.
2. Locating the combined use pond on the proposed properties works better from a design standpoint for routing the Airport Creek channel through and downstream closer to its historic path and getting water from the US36 Right-of-way (ROW) to the pond to be treated, since it is the natural low point of the terrain and roadway profile.

"Taking Care To Get You There"

3. The FEIS/ROD identified a sliver/partial acquisition of the southernmost property (Raymer) due to the new 112th Ave bridge and approach fill. The additional acquisition of this property ultimately relocating the resident allows the northern part of the Raymer parcel to be used for the pond. CDOT will follow the Uniform Act to minimize the impact to the property owner and resident.
4. Portions of these properties were already within the floodplain, with limited future development potential. In addition, using these properties for the creek channel and pond eliminates the ROW acquisitions in potentially developable properties as identified in the FEIS for the pond and outfall, which would have greater community impacts. Acquiring these properties in the floodplain preserves the land and provides an area that can accommodate fluctuations in water levels without costly impacts to private property.
5. One of the impacted properties was assessed as eligible to the National Register of Historic Places in the FEIS. A further review of the property determined that the property was not eligible due to recent changes made to the structure. The SHPO has concurred with this changed eligibility determination.

To summarize, the reason the FEIS design was no longer acceptable was related to the greater level of drainage design that was done which better defines the need for detention of water for quantity and quality purposes (treatment of water from a water quality standpoint) to address flooding and drainage problems. The current adjusted design was identified to address this need and for the reasons stated above. Other alternatives that were explored, such as enlarging the pond that was identified in the FEIS, were not advanced because a pond at this higher elevation would not have been effective for treating and detaining all the highway flows and would not have addressed the flooding issues associated with Airport Creek.

Impact changes: The following key resource impacts were affected by the change in approach at Airport Creek:

1. Right-of-Way: Four new residential total acquisitions (involving three relocations) will be required in order to correct the floodplain issues and construct the proposed pond at Airport Creek. Three of the residences are currently within the 100-year floodplain. All property acquisitions will be performed in compliance with the Uniform Act. Impacts to the two properties identified for the FEIS/ROD water quality pond and outfall will be eliminated.
2. Floodplain: The area of *existing* 100-year floodplain impacted at Airport Creek due to the pond and Wadsworth Boulevard construction is 2.36 acres versus 2.22 acres which would have been impacted due to the FEIS/ROD impacts, an increase of 0.14 acres. However, as a result of the proposed Airport Creek channel and culvert improvements under the existing roadways, 5.69 acres of land will actually be removed from the 100-year floodplain between US 36 and Wadsworth Boulevard. The FEIS/ROD improvements would not have removed land from the 100-year floodplain.
3. Wetlands: The change at Airport Creek resulted in a very small increase in impacts of 0.0016 acre.

Conclusions: None of these changes in impacts are considered to be significant impacts that were not evaluated in the FEIS. The proposed project impacts compared to anticipated impacts from equivalent Phase 1 ROD improvements is summarized below:

1. Right-of-Way: Although the number of residential relocations has increased by three at this location, the project has eliminated a relocation elsewhere on the corridor (near Lowell) reducing the relocation increase to two. The proposed project will impact 42 *fewer* occupied parcels due to refinements in the bikeway and drainage design. Overall ROW impacts compared to the ROD have reduced by 17.7 acres. These comparison totals include the impacts due to the new 112th Avenue overcrossing, which was not included in the ROD impacts.

2. Floodplain: The increase in existing floodplain impacts of 0.14 acres at Airport Creek is more than offset by a total reduction in floodplain impact by the proposed project of 5.3 acres, and the removal of 5.69 acres of land from the floodplain at Airport Creek.
3. Wetlands: The slight wetland impact increase of 0.0016 acre at Airport Creek is balanced by a reduction in wetland impact for the total overall project of 0.6 acre, reflecting a reduction from 21.0 acres, as indicated in the Section 404 permit, to 20.4 acres. For this reason, this minor increase in wetland impact at Airport Creek is not considered to be a new significant impact.

Therefore, through refining the design in preparation of the Request for Proposals (RFP) for the Design/Build project on US 36, some of the impacts are different, but overall, the impacts are within the same magnitude as what was approved in the ROD. This re-evaluation concludes that the changes in design at the Airport Creek area do not result in new significant impacts. The original FEIS therefore remains valid despite these minor adjustments.



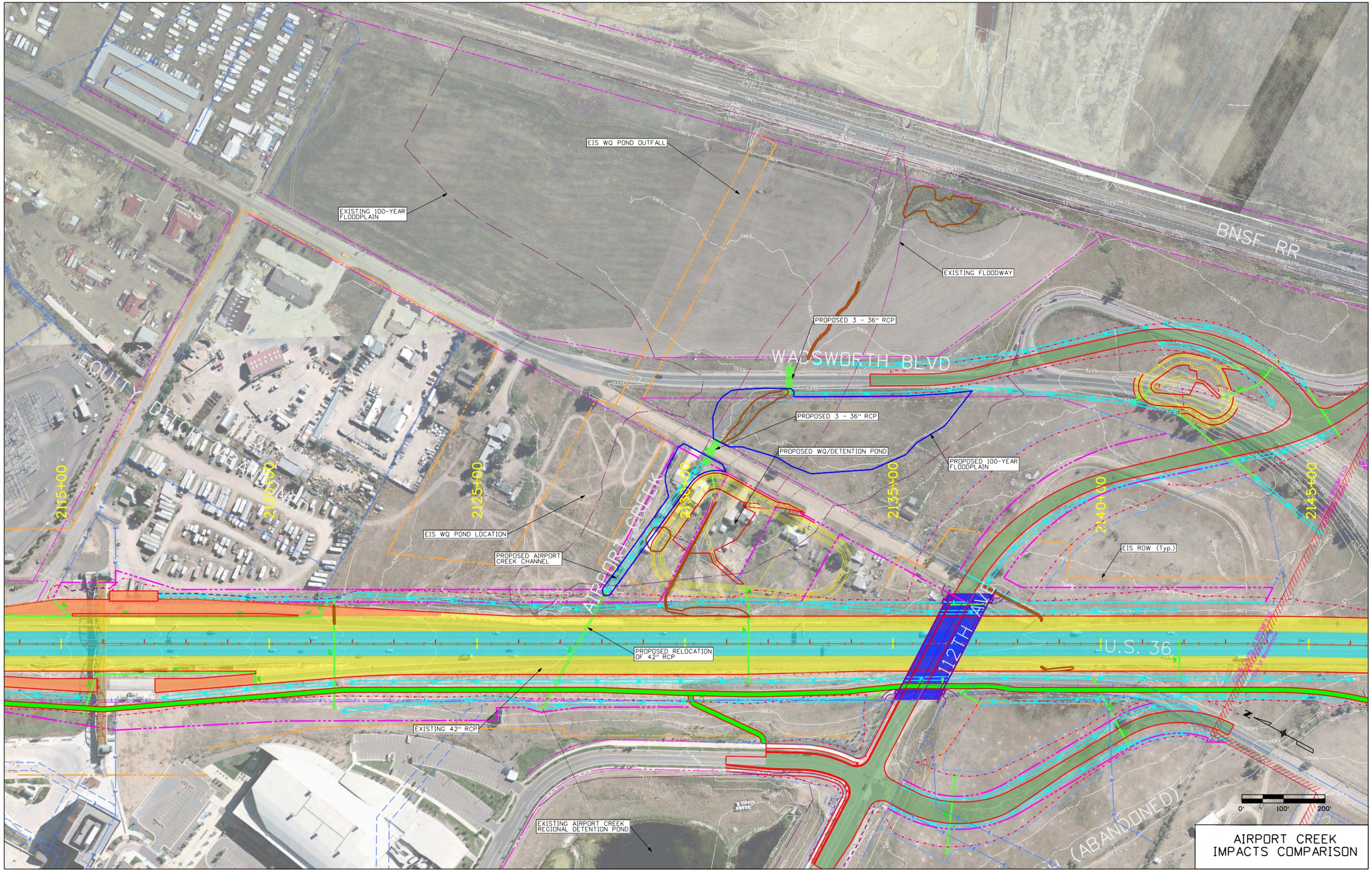
Mark Gosselin, P.E.
US36 Managed Lanes Assistant Project Director, CDOT

I concur: _____

John M. Cater, P.E.
Administrator, Colorado Division
Federal Highway Administration

Date

cc: David Singer, CDOT US 36 Environmental Project Manager
Greg Jamieson, CDOT Region 6 ROW Manager



AIRPORT CREEK
IMPACTS COMPARISON