

FINAL WATER QUALITY TREATMENT REPORT  
FOR  
ARAPAHOE ROAD BRIDGE OVER CHERRY CREEK  
CDOT PROJECT NO. FBR-088A/18147  
OCTOBER 17, 2012

PREPARED FOR:

COLORADO DEPARTMENT OF TRANSPORTATION  
REGION 6  
3320 SOUTH PARKER ROAD  
AURORA, COLORADO 80014

AND

HNTB CORPORATION  
1600 BROADWAY, SUITE 1300  
DENVER, CO 80202

PREPARED BY:

MULLER ENGINEERING COMPANY, INC.  
777 S. WADSWORTH BLVD, STE 4-100  
LAKEWOOD, COLORADO 80226-4355

MEC PROJECT NO. 11-022.02

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## I. INTRODUCTION

This report represents a summary of the water quality design associated with the Arapahoe Road Bridge over Cherry Creek project. The project is located within the northwest  $\frac{1}{4}$  of Section 29, the northeast  $\frac{1}{4}$  of Section 30, the southeast  $\frac{1}{4}$  of Section 19, and the southwest  $\frac{1}{4}$  of Section 20, Range 66 West, Township 5 South, Parker, Colorado Quadrangle in Aurora, Colorado. The project location is shown on *Figure 1*.

The Colorado Department of Transportation (CDOT) is proposing to replace the existing Arapahoe Road Bridge over Cherry Creek. At this location Arapahoe Road is within the City of Aurora; however, the project limits for the project will affect portions of the City of Centennial and Unincorporated Arapahoe County. In conjunction with the roadway improvements, the local storm sewer systems for Arapahoe Road within the project limits will be improved to meet current CDOT drainage criteria. Cherry Creek is the main outfall for all of the local drainage within the project limits.

Currently, stormwater within the project limits generally drains from the west to the east on Arapahoe Road to a low-point in the roadway profile approximately 550-feet east of the bridge at the intersection with Chambers Road. Stormwater inlets along Arapahoe Road capture a portion of the stormwater west of the bridge and discharge into a network of roadside swales that outfall directly into Cherry Creek. The stormwater that bypasses the inlets continues east on the roadway and is captured by the roadside swales that are located west of the bridge. Stormwater from the bridge deck and the roadway east of the bridge are captured by inlets at the low-point on the north and south sides of Arapahoe Road. The low point inlet on the north side of the road directs flow to an existing 42-inch storm sewer that outfalls directly into Cherry Creek. The low point inlet on the south side of the road directs flow to an existing box culvert that outfalls into a 500-foot long wetland bottom channel that outfalls into Cherry Creek.

The proposed improvements will raise the Arapahoe Road bridge over Cherry Creek to meet CDOT freeboard criteria and in doing so, creates a crest vertical curve on the bridge dividing the stormwater in the project limits and creating a new low point west of the bridge. Stormwater inlets will be installed at the new low point to capture stormwater west of the bridge and inlets at the existing low-point will require minor relocation to capture stormwater east of the bridge.

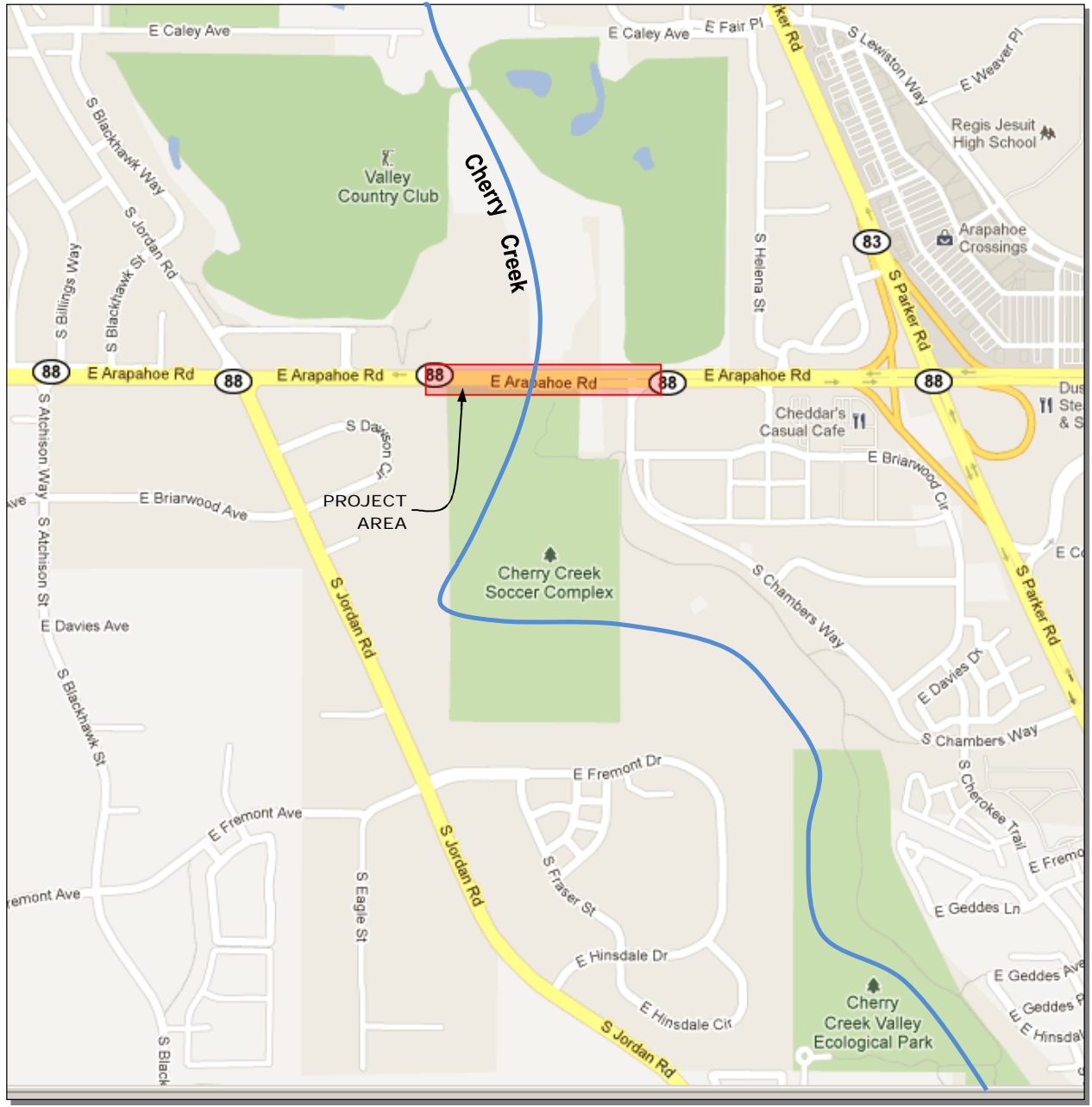
Offsite drainage systems will be combined with the proposed drainage system in two locations. The first offsite system is the Shoppes at Arapahoe Commons development located north of Arapahoe Road and west of the proposed bridge, within the City of Aurora. This system currently drains into a roadside swale north of the road, but will ultimately be tied-in to the proposed storm sewer system west of the bridge. The second offsite system is the Arapahoe Industrial Park No. 2 development, located south of Arapahoe Road and west of the proposed bridge, within the City of Centennial. This system currently drains into a roadside swale south of the road, but will ultimately be tied-in to the proposed storm sewer system west of the bridge. The outfall of a third offsite

system located south of Arapahoe Road, west of the proposed bridge will be rerouted to the south to accommodate the new bridge footprint and proposed Cherry Creek overbank grading. This third offsite system is also located within the City of Centennial.

A new section of the Cherry Creek Regional Trail will be constructed as part of this project. This will consist of a 10-foot wide concrete trail that will run north/south along the western Cherry Creek overbank and pass under the new Arapahoe Road bridge.

For a more detailed discussion of the existing and proposed stormwater drainage system, please refer to the Arapahoe Road Over Cherry Creek Bridge Hydraulics Report completed by Muller Engineering Company for this project.

# ARAPAHOE ROAD BRIDGE REPLACEMENT PROJECT



**FIGURE 1: PROJECT VICINITY MAP**  
NOT TO SCALE

## II. DISCUSSION OF CDOT MS4 / NDRD REQUIREMENTS

### Design Criteria

With the exception of the recreational trail, the impervious areas for this project are located entirely on CDOT right of way and therefore is covered by the CDOT MS4 permit and subject to the requirements therein (see CDOT MS4 Permit Coverage Map in Appendix A). The current version of the CDOT MS4 permit requires that 100% of the stormwater runoff from the impervious project area be treated for water quality and the water quality treatment facility should either capture 100% of the water quality capture volume and/or remove 80% of the Total Suspended Solids (TSS).

Design Criteria for permanent Best Management Practices (BMP's) are referenced from Volume 3 of the Urban Drainage and Flood Control District's (UDFCD) Urban Storm Drainage Criteria Manual (USDCM) and is typically applicable to permanent BMP's that capture 100% of the water quality capture volume. Permanent BMP's that treat 80% of the TSS are typically proprietary and it is up to the designer to write a specification that requires any proprietary permanent BMP used on the project to have the ability to treat the tributary area and imperviousness while complying with the removal rates required by the current CDOT MS4 permit.

This project is located within the Cherry Creek basin and therefore is subject to the review of the Cherry Creek Basin Water Quality Authority (CCBWQA). The CCBWQA reviews land disturbance projects for compliance with Control Regulation No. 72 and the CCBWQA's CR72.7 Stormwater Guidance Document. CCBWQA is a quasi-governmental agency and political subdivision of the State of Colorado whose mission is to improve, protect, and preserve the water quality of Cherry Creek and Cherry Creek Reservoir and to achieve and maintain State water quality standards for the Reservoir and related watershed. Control Regulation No. 72 provides limited direct responsibility to the CCBWQA to implement projects that reduce the inflow total phosphorus concentrations to Cherry Creek Reservoir. Control Regulation No. 72 allows alternatives for water quality capture volume (WQCV) BMPs where:

*"...the permittee may allow alternative BMPs that do not use WQCV approach or are in combination with the WQCV, if they are shown to have comparable or better nutrient concentration reduction characteristics for the given use when properly designed, implemented, and maintained...Specifically, the permittee may allow for the owner to use stream bank stabilization at the development site...to reduce the need for WQCV for the whole site." (@72.7(c)(6)(iii)).*

With Control Regulation No. 72 allowing stream bank stabilization as an alternative, CCBWQA defines stream reclamation to mean:

*"...additional measures or enhancements to channel or stream stabilization that typically includes riparian and floodplain vegetation planting or enhancements and a channel cross section that results in more frequent connection and flooding of the overbank area. Riparian vegetation promotes filtration of fine particles with attached nutrients, and over-bank flooding promotes additional filtration and to some extent infiltration both*

*which reduce nutrient loads and concentrations. Therefore, the benefits from stream reclamation include the reduction in sediment and nutrients (i.e.: phosphorus and nitrogen) transport from the main channel, but also reduction in nutrient loads from riparian and floodplain vegetation through more frequent floodplain inundation."*

#### Existing Water Quality Features

The wetland bottom channel at the outfall of the existing box culvert was designed as a water quality feature that treats stormwater that is collected by the box culvert system east of the proposed bridge. Within the project area, the box culvert collects stormwater from the southern half of the road from the west side of the existing bridge to the eastern project limit.

There is also an existing water quality pond that treats stormwater from a portion of the Shoppes at Arapahoe Commons development on the north side of Arapahoe Road, west of the existing bridge. This water quality pond will remain intact and the outflow from the pond will be rerouted to tie-in to the proposed storm sewer system west of the proposed bridge.

The north side of the existing roadway through the entire project area and the south side of the existing roadway west of the existing bridge within the project area have no dedicated water quality features as there have been no improvements to this section of Arapahoe Road since the initiation of the MS4 program. The existing drainage system collects storm water runoff via storm inlets and roadside swales directly into Cherry Creek. For a more detailed discussion of the existing storm sewer system, see the Arapahoe Road Over Cherry Creek Bridge Hydraulics Report completed by Muller Engineering Company for this project.


#### Design Objective

Beginning in 2010, the CCBWQA has been working with SEMSWA, UDFCD, Arapahoe County, and Aurora (collectively called "Parties") to plan, design, and implement stream reclamation along Cherry Creek from the Cherry Creek State Park southern boundary to the downstream end of Cherry Creek Valley Ecological Park, a distance of approximately 2.08 miles. The planning effort has resulted in an update to the current Cherry Creek drainage master plan for the 2.08-miles. The four phases of the project are expected to cost approximately \$11.7M to implement over the next 5-years, or so. The complete project is referred to as *Cherry Creek Stream Reclamation – State Park to Eco-Park* or "Stream Reclamation Project".


To meet post-construction BMP requirements for construction of the Arapahoe Road Bridge project, CDOT is proposing to participate in the cost of the above Stream Reclamation Project. Stream reclamation is an alternative to stormwater quality detention for post-construction BMPs required under CDOT's stormwater permit for new development and redevelopment. CDOT's stormwater discharge permit also requires each agency to comply with requirements of Control Regulation No. 72. CDOT would participate in the Stream Reclamation Project through a funding agreement with SEMSWA, referred to as the "*CDOT and SEMSWA Funding Agreement – Arapahoe Bridge Project*" (BMP Funding Agreement). SEMSWA would encumber CDOT's funds into a project account with UDFCD that will be established as part of a separate

intergovernmental agreement (IGA) between the Parties for the planning, design, and construction of the Stream Reclamation Project.

At the FIR level submittal for the Arapahoe Road Bridge Project, two water quality detention ponds (extended detention basins) were proposed to meet the stormwater permit requirements. Based on the above Stream Reclamation Project approach, these extended detention basins have been eliminated from the design. The estimated cost of the extended detention basins and related work will be the amount that CDOT contributes to the Stream Reclamation Project as part of the above-mentioned IGA.

Since the Stream Reclamation Project improvements will not be constructed until after the Arapahoe Road Bridge improvements, it was determined that some level of water quality treatment (or pre-treatment) should be implemented to treat outflows from the proposed drainage systems prior to these flows entering Cherry Creek. **Pre-treatment will be implemented in the form of a series of grass/wetland swales.** 

#### Summary of Treated Areas

The proposed project **disturbance area is 55 acres** and the total **impervious project area is 10.65 acres**. A crest vertical curve in the Arapahoe Road profile creates a drainage divide near the center of the Arapahoe Road Bridge over Cherry Creek. Approximately 5.10 acres of impervious project area along the roadway are located west of the divide and 4.81 acres of impervious project area along the roadway are located east of the divide. The remaining 0.74 acres of impervious area within the project area consists of the concrete Cherry Creek **Recreational Trail**. 

Of the 4.81 acres of impervious project area east of the divide, 1.80 acres will drain to the inlet at the low point on the south side of the road that conveys flow to the existing wetland bottom channel (this is less than the 2.4 acres of impervious area that currently drains to this inlet within the project area). The remaining 3.01 acres of impervious project area east of the divide will be collected on the north side of the road and conveyed through the eastern storm sewer that will outfall **into a pre-treatment swale and into the future Stream Reclamation Project.**

The entire 5.10 acres of impervious project area west of the divide will be collected by the western storm sewer and routed through the **pretreatment swales** and into the future Stream Reclamation Project.

Outside of the project area, approximately 2.98 acres will be tributary to the western storm sewer system from the Shoppes at Arapahoe Commons development at 100% impervious and approximately 10.8 acres will be tributary to the western storm sewer system from the Arapahoe Industrial Park No. 2 development at 100% impervious. The impervious area from the Arapahoe Industrial Park No. 2 development that will be collected by the western storm sewer will reduce the impervious area that is tributary to the southern storm sewer.

Also outside of the project area, a total of 11.7 acres will be tributary to the southern storm sewer at 100% impervious. Of this area, 10.8 acres is located within the Arapahoe Industrial



Park No. 2 development and the remaining 1.5 acres accounts for a future parking lot. No water quality facility exists for the areas tributary to the southern storm sewer. As part of this project, the areas tributary to the southern storm sewer will be treated by a pre-treatment swale and then by the future Stream Reclamation Project.

The impervious area associated with the Cherry Creek Regional Trail will be treated by pre-treatment swales and then the future Stream Reclamation Project.



There is an existing Xcel substation located north of Arapahoe Road, west of the proposed bridge. Runoff from the substation area is collected by an existing extended detention basin, which will outfall into a pre-treatment swale and then into the future Stream Reclamation Project.

A water quality map that summarizes the treated areas is presented in Appendix B.

### Recommended Design

There are a total of five storm sewer outfalls associated with the proposed project improvements: 1) western storm sewer outfall – 30-inch RCP, 2) eastern storm sewer outfall – 24-inch RCP, 3) southern storm sewer outfall – 30-inch RCP, 4) existing 42-inch storm sewer, and 5) the existing box culvert outfall into the existing wetland bottom channel. In addition, there is 3,000 LF of 10-foot wide concrete trail that makes up the Cherry Creek Regional Trail.

Based on a series of meetings, it was decided by the project participants that CDOT participate financially with the Parties in an undivided interest in the Cherry Creek Stream Reclamation – State Park to Eco-Park Project. The Stream Reclamation Project will take the place of more traditional water quality facilities and provide equal or better water quality protection compared to providing water quality detention ponds. The basis for this approach includes:

1. Control Regulation No. 72 allows stream bank stabilization as an alternate to BMPs that use WQCV when shown to have comparable or better nutrient concentration reduction characteristics.
2. The proposed Cherry Creek Stream Reclamation project will include additional measures or enhancements to channel or stream stabilization that include riparian and floodplain vegetation to provide additional filtration and infiltration of stormwater and, therefore, stream reclamation measures are more comprehensive and beneficial than stream bank stabilization alone.
3. The Authority has collected water quality data in Cottonwood Creek and Cherry Creek that shows that stream reclamation can provide equal or better nutrient reduction characteristics than water quality detention ponds (see next section).
4. The alternative plan to construct two water quality detention ponds is not consistent with and would interfere with the proposed Cherry Creek Stream Reclamation plan developed by the Parties. If CDOT were to construct the two water quality detention ponds, the ponds would have to be removed by the Parties in order to implement the Cherry Creek Stream Reclamation project.

5. The alternative plan to construct two water quality detention ponds would require the ponds to be placed on the City of Aurora's property. Since the City of Aurora does not allow detention ponds for development or redevelopment to occur in the floodplain, the alternate plan would require an exemption from Aurora's requirements under their stormwater discharge permit.
6. Water quality detention ponds require more intensive maintenance activities to preserve the pond functions than stream reclamation projects. Therefore, CDOT's participation in the Cherry Creek Stream Reclamation Project is a more efficient use of public funds and will further benefit water quality.

As previously discussed, the future Stream Reclamation Project is in the planning stages and as such, preliminary design concepts are currently being developed. In general, the Stream Reclamation Project will take a holistic approach to heal the degraded creek corridor, not only stabilizing the channel, but restoring the natural hydrology, water quality benefits, and habitat value of the corridor. The project will use grade control structures to **raise and re-establish the** baseflow water surface close to the adjacent vegetated benches of the primary channel, keeping the water table high to help sustain riparian vegetation, **promoting wide, shallow flow** conditions during high flow events, and keeping velocities low and infiltration into the sandy alluvium high. In addition, banks will be protected using bioengineering approaches. A series of drawings showing the preliminary design concepts for the Stream Reclamation Project are presented in Appendix C.

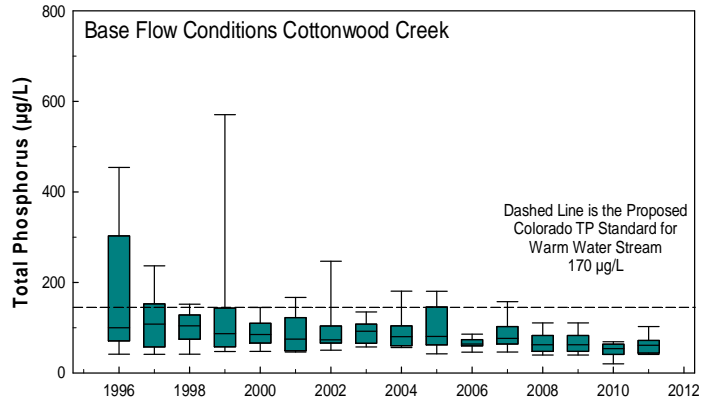
A series of pretreatment swales have been designed to collect stormwater from the proposed storm sewer outfalls. The swales will generally be located in the overbanks of Cherry Creek and will convey stormwater to the Cherry Creek active channel. The swales will consist of varying combinations of erosion control blanket, topsoil, riprap, seeding and plantings. Due to the close proximity of the swale inverts to the Cherry Creek water table, it is anticipated that the swales will **generate wetland growth**. This, in combination with the flat longitudinal slope and wide cross section, will promote infiltration and nutrient uptake to improve the quality of water prior to outfalling into Cherry Creek. Typical swale cross sections are contained in Appendix D.

A portion of the existing wetland bottom swale will be disturbed during installation of the utility relocations in the utility corridor upstream of the bridge. This channel will be restored to existing grades and revegetated with wetland seed/plants, such that it can continue to serve as a water quality feature for the contributing impervious area.

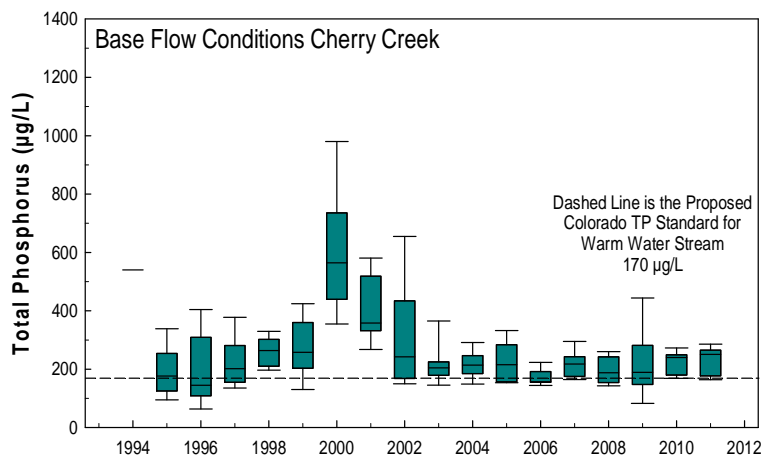
#### Expected Pollutant Removal Rates

Since the late 1980's CCBWQA has been constructing and monitoring non-point source pollutant reduction facilities (i.e.:PRF), such as stream reclamation projects, to control nutrient loads and concentrations in Cherry Creek, the Reservoir, and their tributaries. Data collected by CCBWQA in Cottonwood Creek where stream reclamation has been mostly completed show that these measures have reduced total phosphorus to below concentrations proposed by the Water Quality Control Commission (WQCC) in Control Regulation 85 (i.e.: 170-µg/l).

Cottonwood Creek data were presented in CCBWQA's annual report and the results presented to the WQCC during the triennial review hearing for Control Regulation No. 72 on May 14, 2012. Figure 7-24 from the annual report (figure to the right) shows the significant reduction in phosphorus concentrations that can occur when stream reclamation and watershed controls are implemented in a comprehensive manner.




Data collected by CCBWQA for Cherry Creek, where stream reclamation has only been completed in the middle reaches between the Reservoir and the Town of Parker, show that total phosphorus concentrations during base flows have decreased since 2000 during the period when watershed was experiencing unprecedented growth. Whereas base flow concentrations are still higher than the proposed standard, the median values have been significantly reduced as reflected in the data on the figure to the left. Two additional reaches of Cherry Creek have been reclaimed in 2012 and two more reaches are planned for construction in 2013 and are expected to further reduce phosphorus concentrations.



The current version of the CDOT MS4 Permit requires that permanent BMP's either capture 100% of the water quality capture volume, or remove 80% of the TSS. The minimum post-construction BMP requirement in Control Regulation No. 72 for new development and redevelopment is extended detention basins, which is a permanent BMP that includes WQCV. The International Stormwater BMP Database (<http://www.bmpdatabase.org/>) provides BMP performance information that is updated periodically and summarized in Table 2-2 of the UDFCD manual Volume 3. These data show that the total phosphorus median effluent (discharge) concentration for extended detention basins is 0.20-mg/l (200-µg/l). Since Cottonwood Creek data show that phosphorus concentrations are less than 170- µg/l the data demonstrates that stream reclamation does have comparable or better nutrient reduction characteristics as a BMP with WQCV characteristics.

The pretreatment swales will provide water quality treatment independent of the Stream Reclamation Project. As stated in the UDFCD manual Volume 3, "Grass Swales have low

longitudinal slopes and broad cross-sections that convey flow in a slow and shallow manner, thereby facilitating sedimentation and filtering (straining) while limiting erosion.” In addition to these treatment mechanisms, wetland vegetation is anticipated to be present in the swale bottoms, thus encouraging nutrient uptake into the plants. The following is a list of pollutants that can be treated using grass swales  a ranking of their effectiveness as referenced from the UDFCD manual Volume 3 (also based on the International Stormwater BMP Database):

Pollutant	Typical Effectiveness
Sediment / Solids	Good
Nutrients	Moderate
Total Metals	Good
Bacteria	Poor

#### Right of Way Needs/Concerns

The water quality improvements designed for this project will not require any right of way acquisition. Colorado Revised Statute 43-2-135 requires the City of Aurora to own, operate, and maintain any water quality facilities associated with this project. Through an alternatives analysis it was determined that the future Stream Reclamation Project would be utilized in combination with a series of pre-treatment swales, which will be located on City of Aurora property. Approval from the City of Aurora to implement the recommended water quality plan is in the process of being obtained. A temporary construction easement will be required to construct the improvements.

### III. OPERATION AND MAINTENANCE

Water quality improvements to be constructed as part of the Arapahoe Road Bridge Project consist of the pretreatment swales located downstream of all storm sewer outfalls. There are no operation requirements associated with the swales. Maintenance requirements include removal of sediment that may accumulate in the swale bottoms, unclogging of the cross culverts that pass swale flows under the regional trail, and repair of any erosion that may occur due to storm flows along Cherry Creek. The majority of the pretreatment swales can be accessed directly off of Arapahoe Road or by way of the Cherry Creek Regional Trail. All disturbed areas should be reseeded with similar native species.

Water quality improvements to be constructed after the Arapahoe Road Bridge Project consist of the improvements associated with the future Stream Reclamation Project. Design and construction of the future Stream Reclamation Project will be guided by the Parties. **Decisions related to the operations and maintenance of these future facilities will be determined and shared by the Parties as the project reaches completion of final design.**

#### IV. REFERENCES

Drainage Design Manual (including Chapter 19: New Development and Redevelopment Program), Colorado Department of Transportation, 2004

Urban Storm Drainage Criteria Manual, Volumes 1 and 2 (2001-2006) and Volume 3 (Update November 2010), Urban Drainage and Flood Control District

Colorado Department of Public Health and Environment, Water Quality Control Commission January 1, 2010. *Cherry Creek Reservoir Control Regulation 5 CCR 1002-72.*

CCBWQA April 27, 2011. *Control Regulation 5 CCR 1002-72 Stormwater Permit Requirements Guidance Document.*

CCBWQA June 16, 2011. *Stream Reclamation, Water Quality Benefit Evaluation – Interim Status Report.*

URS Corporation January 2004. *Cherry Creek Corridor Reservoir to Scott Road Major Drainageway Planning Preliminary Design Report.*

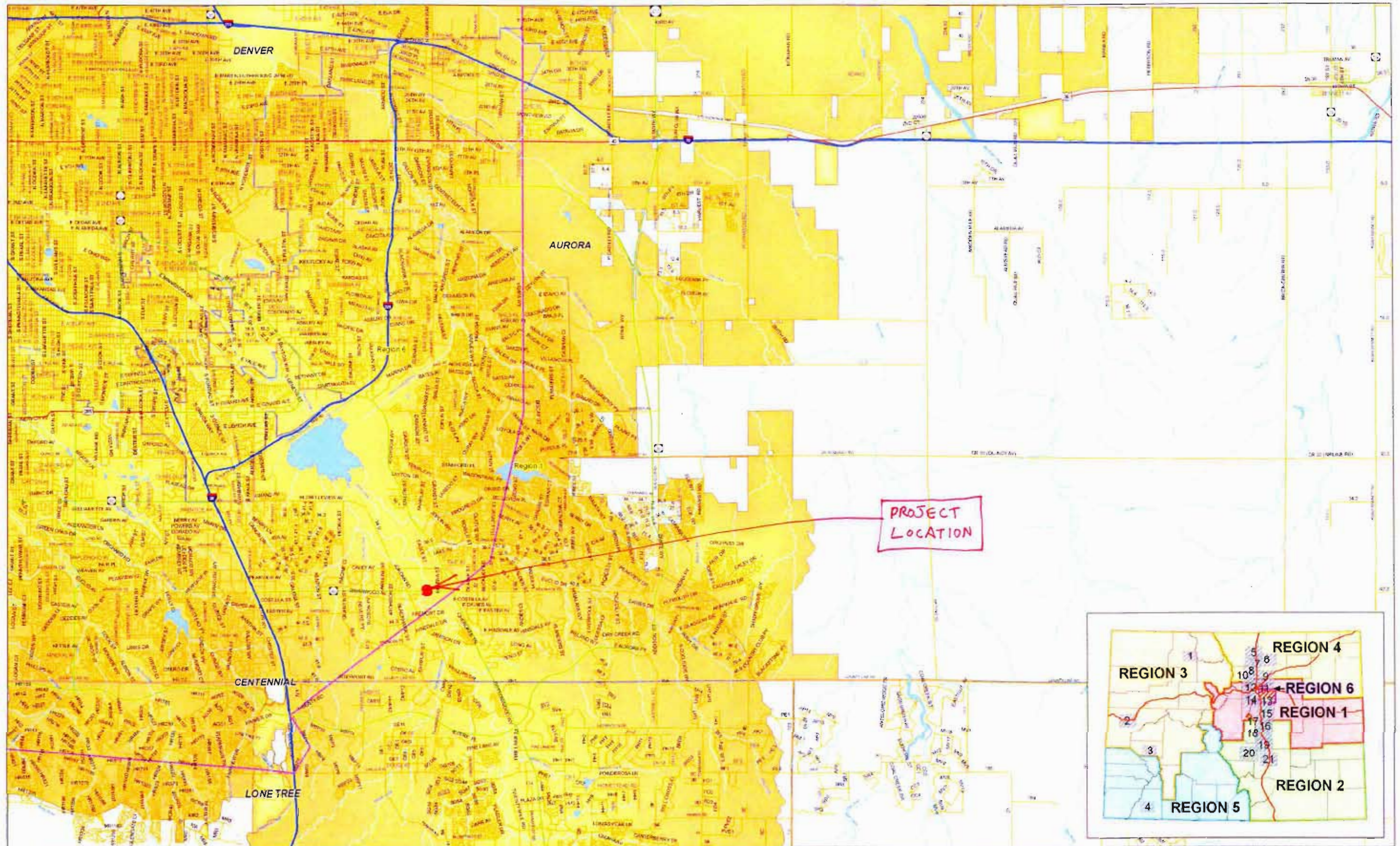
Cherry Creek Basin Water Quality Authority March 31, 2012. *2011 Annual Report on Activities Cherry Creek Basin Water Quality Authority.* See Figure 7-24 and 7-26.

CR72 @ 72.7.2(4)

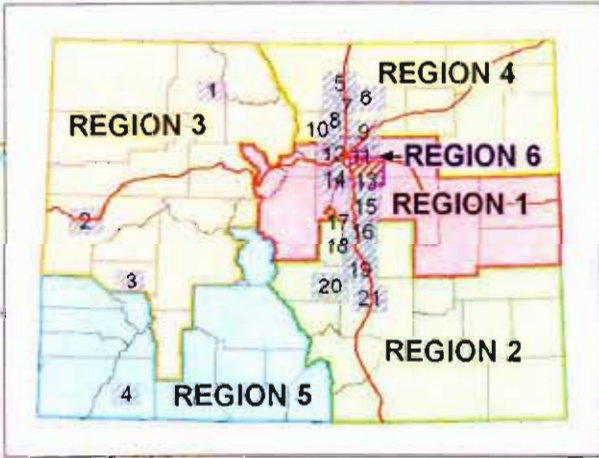
## APPENDIX A



# CDOT MS4 Permit Coverage Area, Map 13



PROJECT  
LOCATION



## Legend

- Rivers and Streams
- Interstate
- U.S. Hwy
- State Hwy
- Local Roads
- CDOT Regions
- Lakes
- County Boundary
- CDOT MS4 Coverage Area (after March 10, 2008)



Map 13 - MS4 permit coverage area, as of November 2007  
 Information source:  
 Urban area boundaries - 2006 census from CDOT GIS System  
 International boundaries from CDOT GIS System, Data Management Unit as of 12/11/2006  
 Cherry Creek basin used to identify MS4 area from RWQ

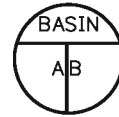


## APPENDIX B



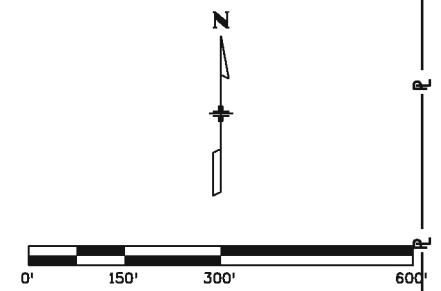
**LEGEND**

- LIMIT OF CONSTRUCTION
- LDA- LIMITS OF DISTURBED AREA
- RIGHT OF WAY



BASIN - BASIN ID  
 A - BASIN AREA (ACRES)  
 B - IMPERVIOUS AREA (ACRES)

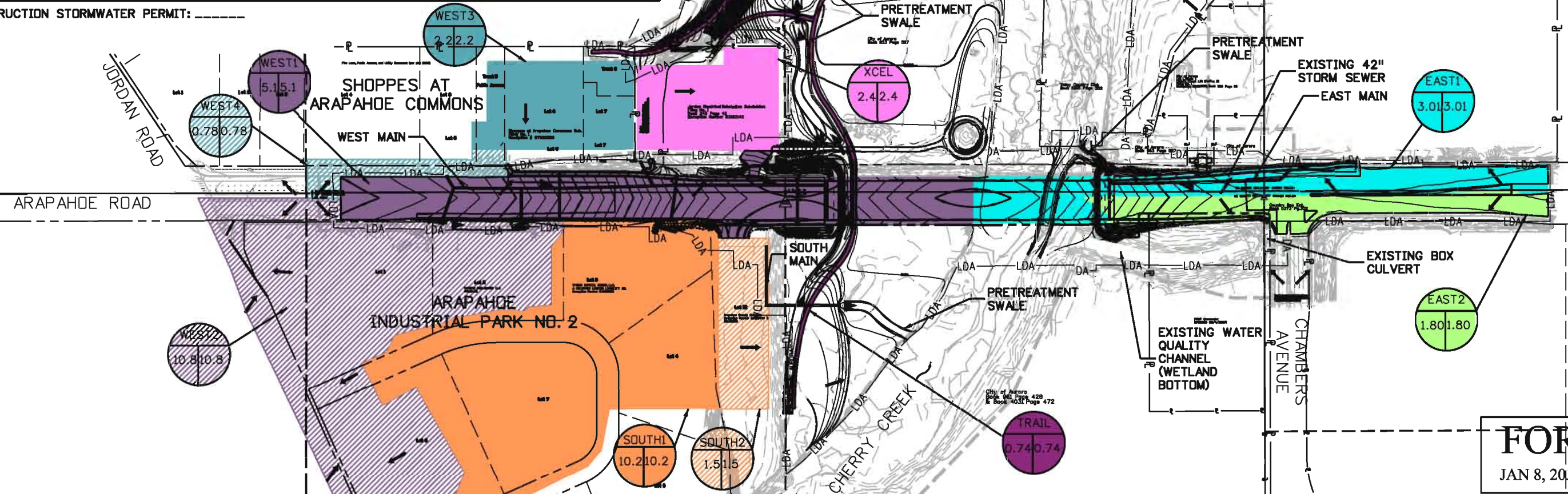
BASIN COLOR	BASIN ID	AREA REQUIRED: (IMPERVIOUS) AREA TO BE TREATED	AREA TREATED: (IMPERVIOUS) AREA PROVIDED	TYPE OF PERMANENT BMP	COMMENTS
	WEST1	5.1 ACRES	5.1 ACRES	PRETREATMENT SWALE / STREAM RECLAMATION	ONSITE AREA PROPOSED ARAPAHOE ROAD
	WEST2	N/A	10.8 ACRES	PRETREATMENT SWALE / STREAM RECLAMATION	OFFSITE AREA CITY OF CENTENNIAL
	WEST3	N/A	2.2 ACRES	ONSITE WATER QUALITY TREATMENT	OFFSITE AREA CITY OF AURORA
	WEST4	N/A	0.78 ACRES	PRETREATMENT SWALE / STREAM RECLAMATION	OFFSITE AREA CITY OF AURORA
	XCEL	N/A	2.4 ACRES	ONSITE WATER QUALITY TREATMENT	OFFSITE AREA CITY OF AURORA
	SOUTH1	N/A	10.2 ACRES	PRETREATMENT SWALE / STREAM RECLAMATION	OFFSITE AREA CITY OF CENTENNIAL
	SOUTH2	N/A	1.5 ACRES	PRETREATMENT SWALE / STREAM RECLAMATION	IMPERVIOUS TO ACCOUNT FOR FUTURE PARKING LOT
	EAST1	3.0 ACRES	3.01 ACRES	PRETREATMENT SWALE / STREAM RECLAMATION	ONSITE AREA PROPOSED ARAPAHOE ROAD
	EAST2	1.8 ACRES	1.80 ACRES	EXISTING WATER QUALITY SWALE	ONSITE AREA PROPOSED ARAPAHOE ROAD
	TRAIL	0.74 ACRES	0.74 ACRES	PRETREATMENT SWALE / STREAM RECLAMATION	ONSITE AREA PROPOSED REGIONAL TRAIL
<b>TOTAL</b>		<b>10.7 ACRES</b>	<b>37.8 ACRES</b>		



**NOTES:**

1. WEST 1, 2, 3, 4 BASINS DRAIN TO THE WEST MAIN STORM SEWER.
2. EAST 1 BASIN DRAINS TO THE EAST MAIN STORM SEWER.
3. EAST 2 BASIN DRAINS TO THE EXISTING BOX CULVERT.
4. SOUTH 1, 2 BASINS DRAIN TO THE SOUTH MAIN STORM SEWER.
5. XCEL AND TRAIL BASINS DRAIN DIRECTLY TO THE PRETREATMENT SWALES.

CDPS CONSTRUCTION STORMWATER PERMIT: -----



**FOR**  
 JAN 8, 2013

Print Date: 11/16/2012  
 File Name: 18147HYDR\_Water Quality Map.dgn  
 Horiz. Scale: 1:300      Vert. Scale: As Noted

**MULLER ENGINEERING CO., INC.**  
 777 S. Wadsworth Blvd. 4-100  
 Lakewood, CO 80226  
 303-988-4939

Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation  
 3320 South Parker Road  
 Aurora, CO 80014  
 Phone: 303-337-9519    FAX: 303-750-7452

**Region 6**      **JH**

As Constructed
No Revisions:
Revised:
Void:

**ARAPAHOE OVER CHERRY CREEK**  
**WATER QUALITY MAP**

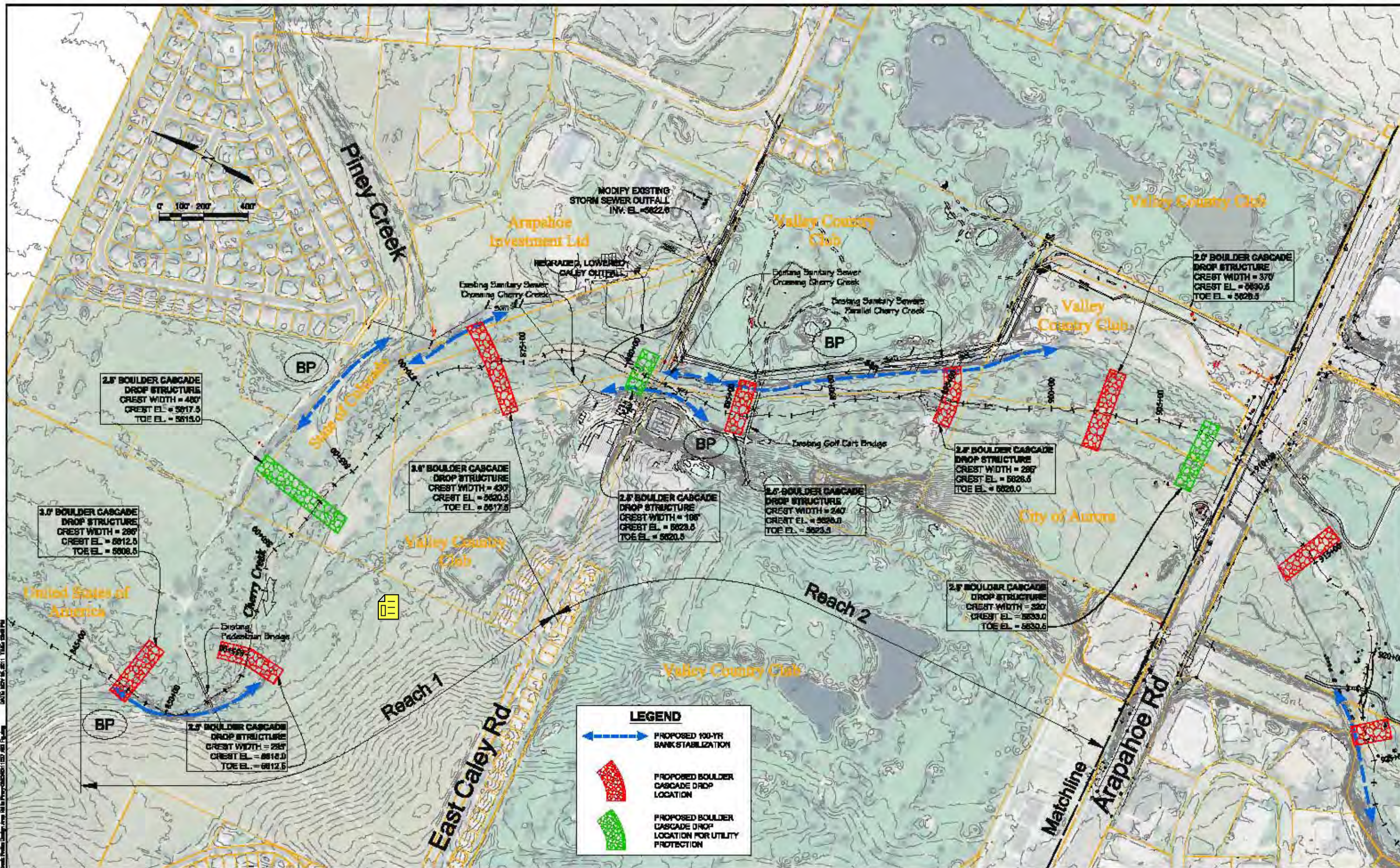
Designer: JAM    Structure Numbers  
 Detailer: JAM  
 Sheet Subset: WQ    Subset Sheets: 1 of 1

Project No./Code
FBR 088A-031
18147
Sheet Number

JoAnn 11:29:22 AM c:\codalib\pw\jammurray\central\18147HYDR\_Water Quality Map.dgn

## APPENDIX C





DATE: 11/15/11  
 DRAWN BY: JHK  
 CHECKED BY: JTW  
 PROJECT: CHERRY CREEK STREAM RECLAMATION

NO.	DATE	REVISION	APPV.

**MULLER ENGINEERING CO., INC.**  
 CONSULTING ENGINEERS  
 777 S. WADSWORTH BLVD., 4-100  
 LAKEWOOD, COLORADO 80226  
 (303) 968-4759

DESIGN: GSH  
 DRAWN: JHK  
 CHECK: JTW

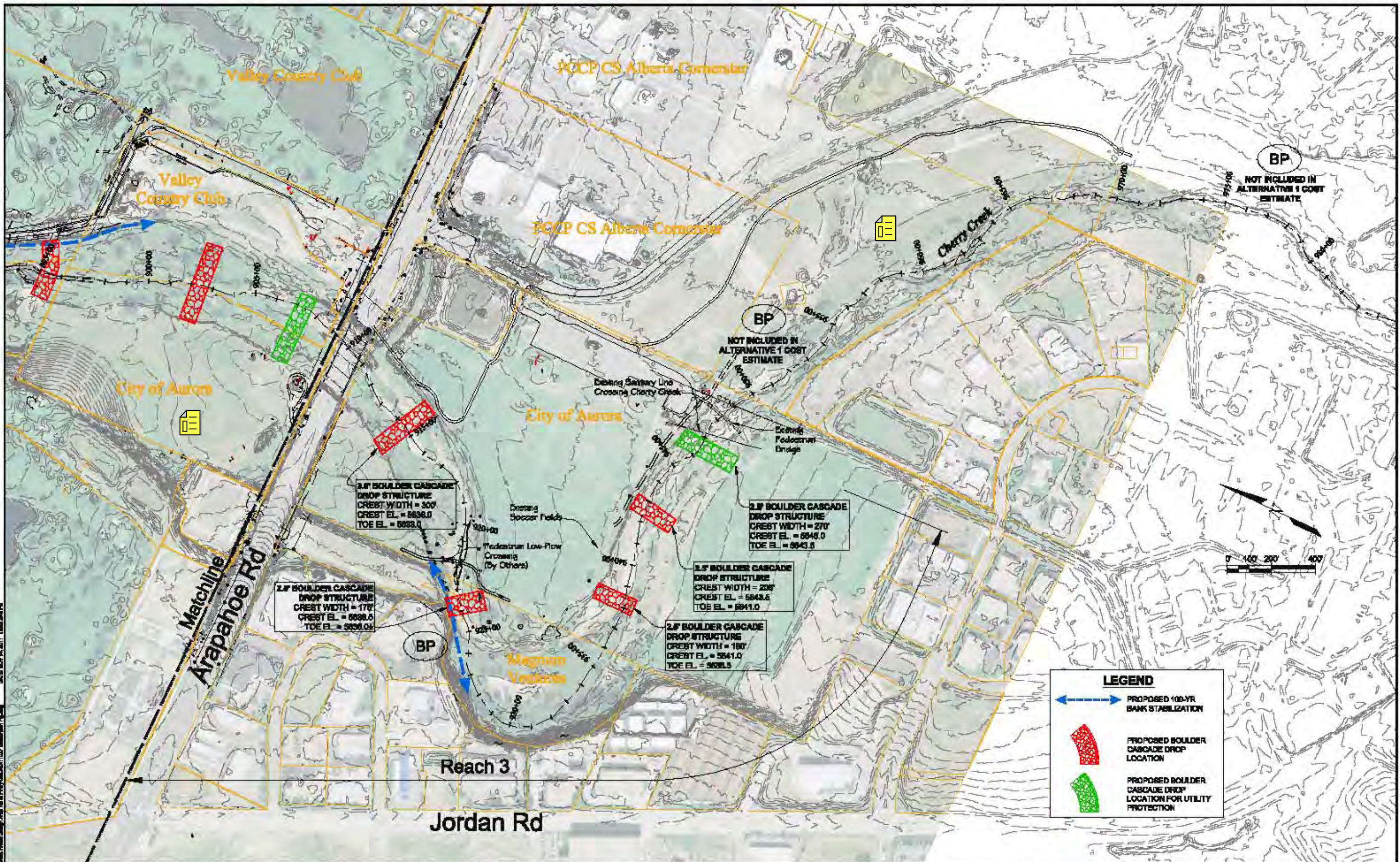
PREPARED FOR:

**CHERRY CREEK STREAM RECLAMATION**  
**ARAPAHOE ROAD TO PINEY CREEK**

**PROPOSED ALTERNATIVE**  
**PLAN 1**

DATE	11/15/11
DRAWING NO.	
SHEET NO.	





DATE: 11/15/11  
 DRAWN BY: JHK  
 CHECKED BY: JTW  
 PROJECT: CHERRY CREEK STREAM RECLAMATION - ARAPAHOE ROAD TO PINEY CREEK

**MULLER ENGINEERING CO., INC.**  
 CONSULTING ENGINEERS  
 777 S. WADSWORTH BLVD. 4-100  
 LAKEWOOD, COLORADO 80226  
 (303) 966-4759

DESIGN: GSH  
 DRAWN: JHK  
 CHECKED: JTW

PREPARED FOR:

**CHERRY CREEK STREAM RECLAMATION**  
**ARAPAHOE ROAD TO PINEY CREEK**

**PROPOSED ALTERNATIVE**  
**PLAN 2**

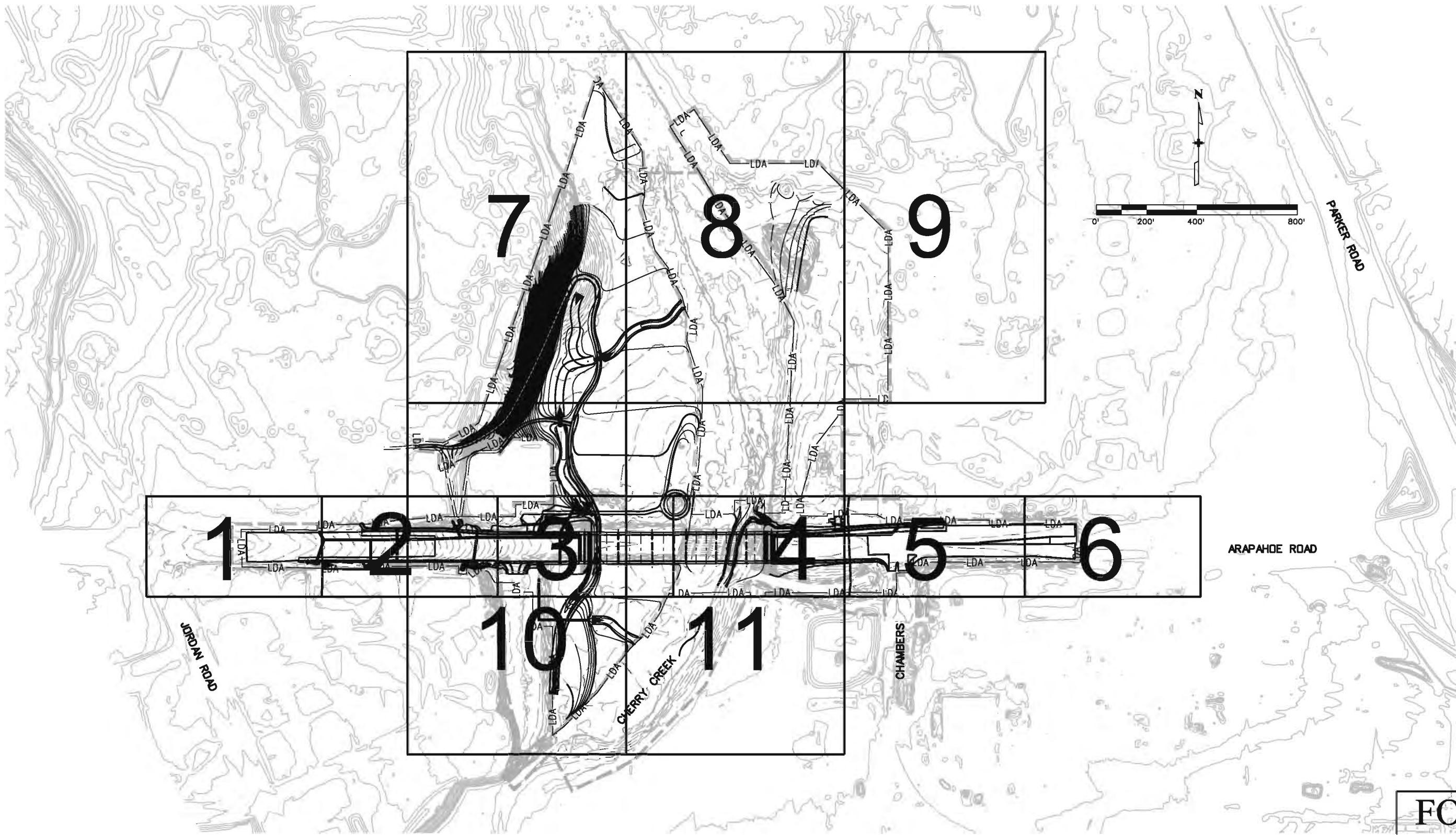
DATE: 11/15/11  
 DRAWING NO.:  
 SHEET NO.:

NO.	DATE	REVISION	APPV.

MEC PROJECT No. 11027.01



## APPENDIX D



**FOR**  
JAN 8, 2013

Print Date: 11/14/2012  
 File Name: 18147HYDR\_Site Plan.dgn  
 Horiz. Scale: 1:400      Vert. Scale: As Noted

**MULLER ENGINEERING CO., INC.**  
 777 S. Wadsworth Blvd. 4-100  
 Lakewood, CO 80226  
 303-988-4939

Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation  
  
 3320 South Parker Road  
 Aurora, CO 80014  
 Phone: 303-337-9519    FAX: 303-750-7452  
 Region 6      JH

**As Constructed**  
 No Revisions:  
 Revised:  
 Void:

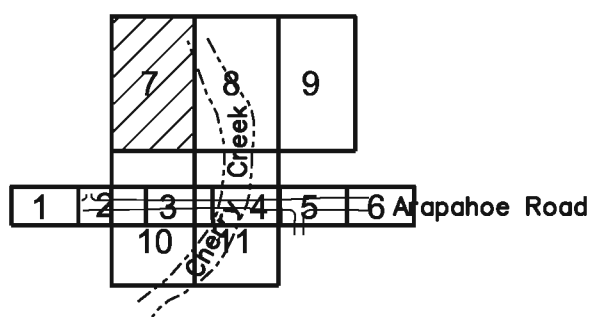
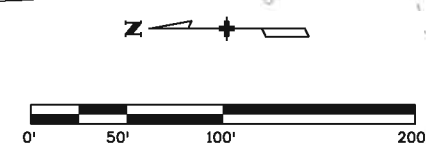
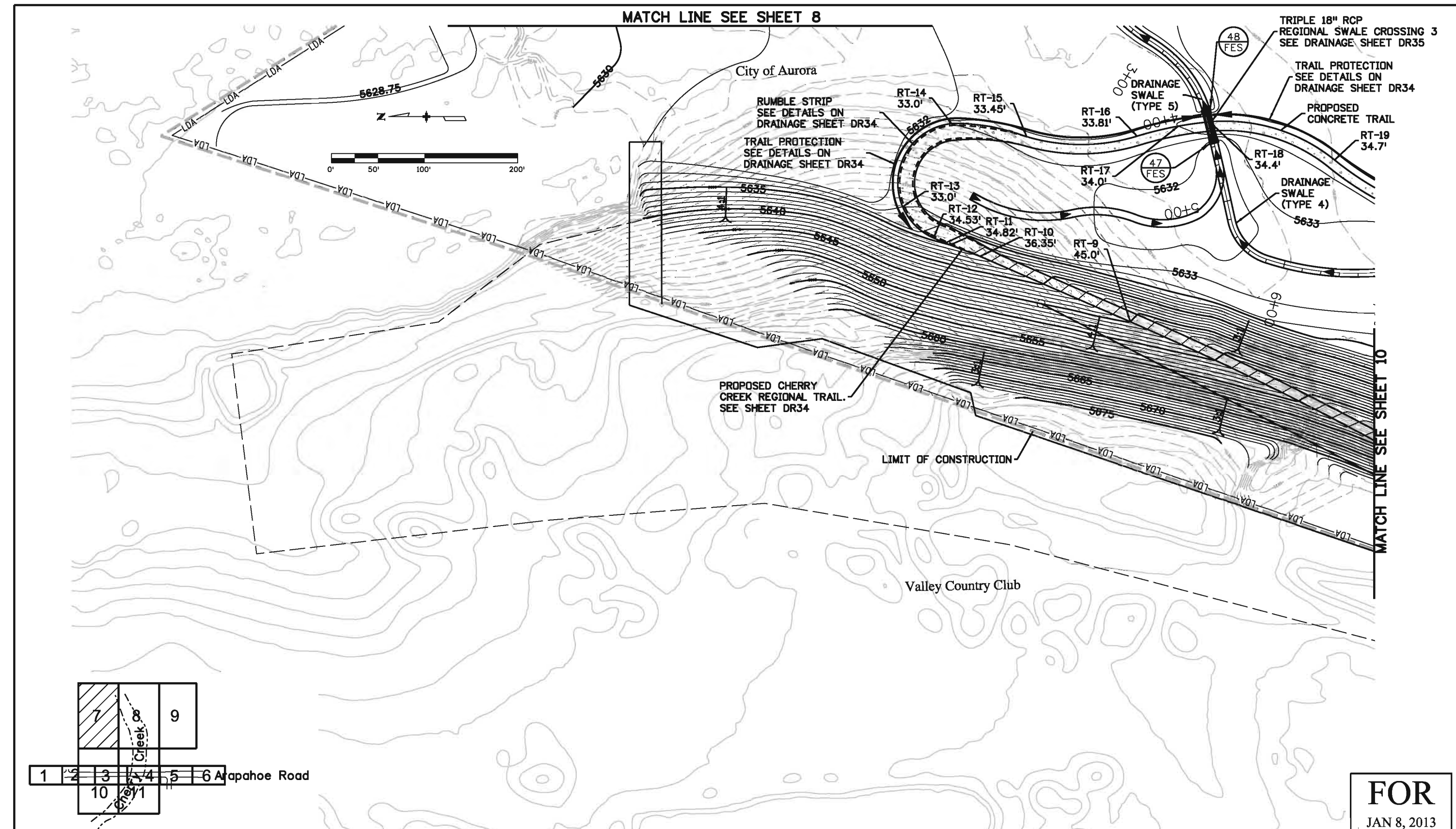
**ARAPAHOE OVER CHERRY CREEK  
 DRAINAGE INDEX PLAN**

Designer:	JAM	Structure Numbers	
Detailer:	JHK	Subset Sheets:	DR5 of DR37



**Project No./Code**  
 FBR 088A-031  
 18147  
 Sheet Number

JoAnn 9/22/01 AM c:\cadd\lib\pw\jomurray\central\div\dms54600\18147HYDR\_Site Plan.dgn

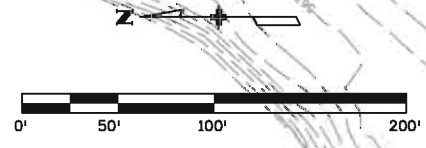
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**FOR**  
JAN 8, 2013

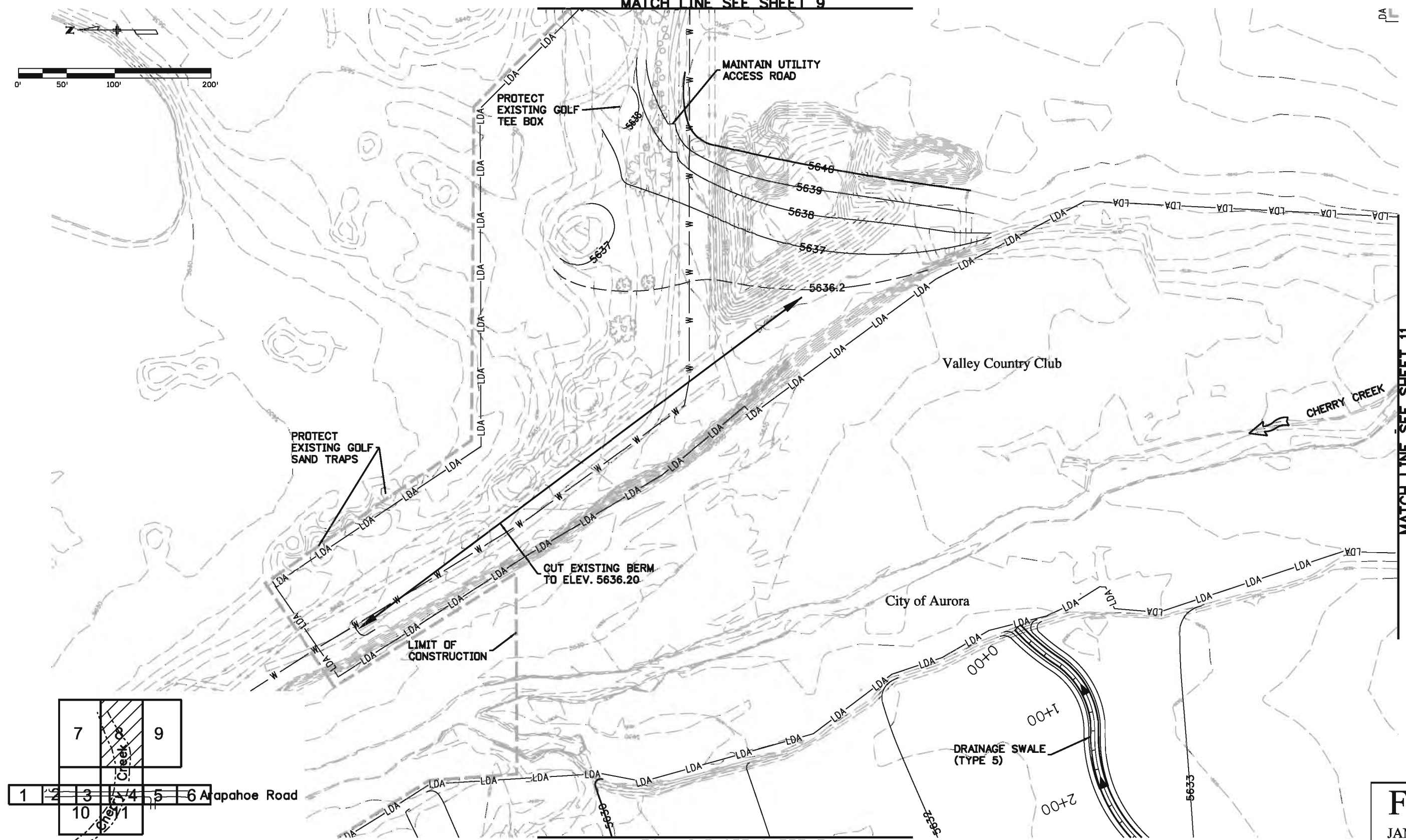
Print Date: 11/16/2012	<b>Sheet Revisions</b>			<b>Colorado Department of Transportation</b>		<b>As Constructed</b>		<b>ARAPAHOE OVER CHERRY CREEK CHERRY CREEK DRAINAGE PLAN SHEET 7</b>		<b>Project No./Code</b>	
File Name: 18147HYDR_Plan_Cherry_Creek_01.dgn	Date:	Comments	Init.	 3320 South Parker Road Aurora, CO 80014 Phone: 303-337-9519 FAX: 303-750-7452		No Revisions:		Designer: JPJ, JAM Detailer: JHK		FBR 088A-031	
Horiz. Scale: 1:100 Vert. Scale: As Noted						Revised:				Structure Numbers	
 <b>MULLER ENGINEERING CO., INC.</b> 777 S. Wadsworth Blvd. 4-100 Lakewood, CO 80226 303-988-4939				<b>Region 6</b> JH		Void:		Sheet Subset: DRAINAGE		Subset Sheets: DR12 of DR37	
Sheet Number											

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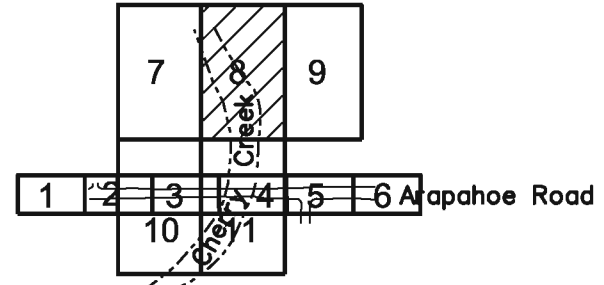


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LDA





MATCH LINE SEE SHEET 11



MATCH LINE SEE SHEET 7

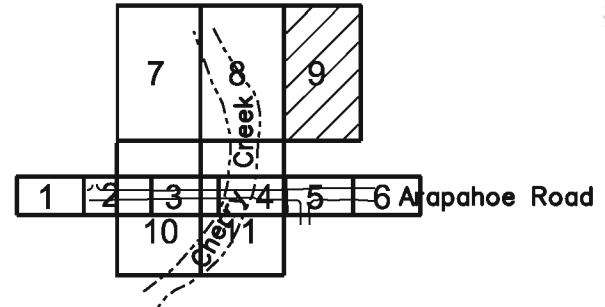
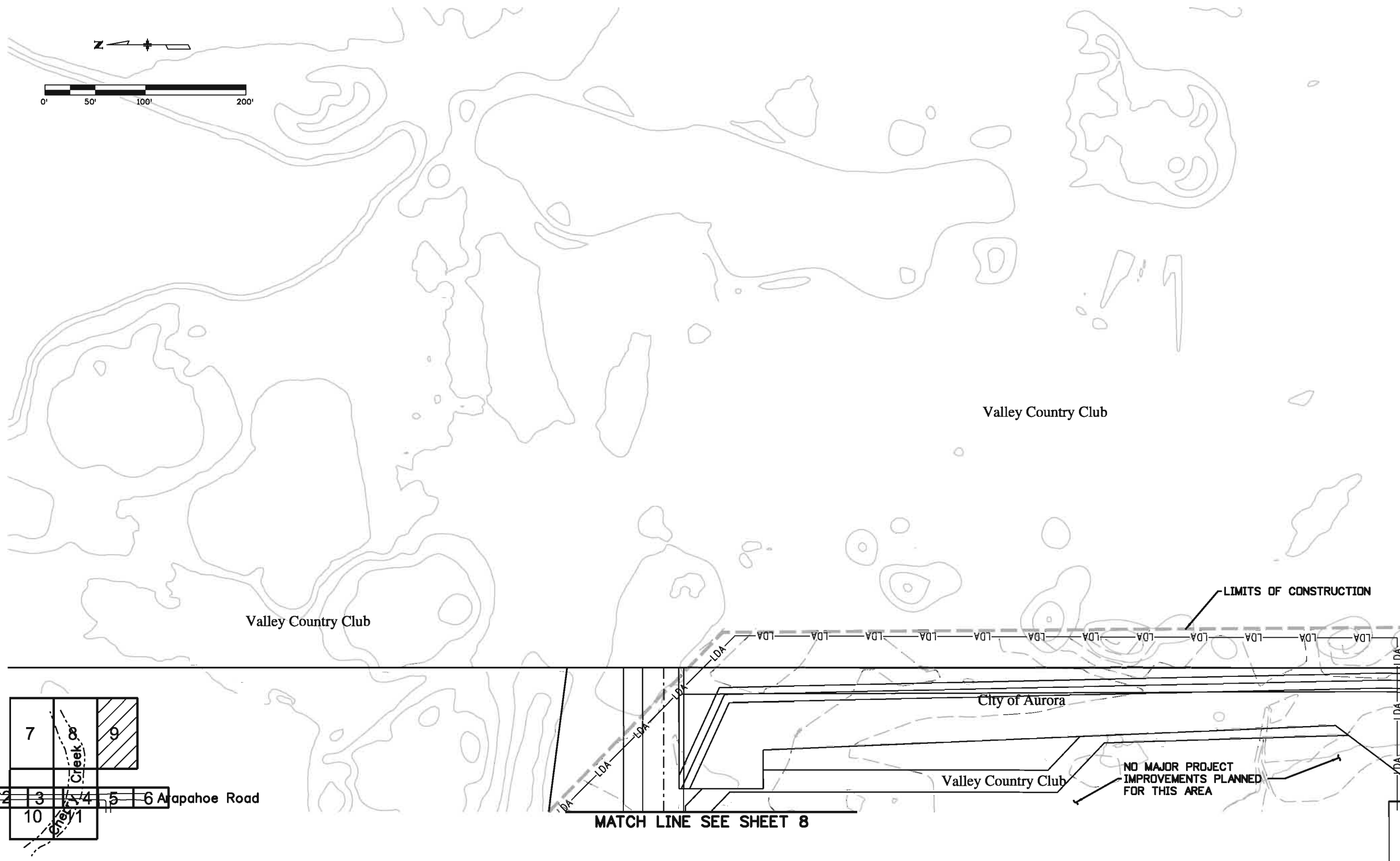
**FOR**  
JAN 8, 2013

Print Date: 11/16/2012		<b>Sheet Revisions</b>			Colorado Department of Transportation		<b>As Constructed</b>		<b>ARAPAHOE OVER CHERRY CREEK CHERRY CREEK DRAINAGE PLAN SHEET 8</b>			Project No./Code	
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Horiz. Scale: 1:100 Vert. Scale: As Noted							Revised:					Structure Numbers	
 <b>MULLER ENGINEERING CO., INC.</b> 777 S. Wadsworth Blvd. 4-100 Lakewood, CO 80226 303-988-4939					Region 6		Void:		Subset Sheets: DR13 of DR37			Sheet Number	

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JoAnn 11:13:52 AM c:\ecadlib\pw\jomurray\centrativ\dms54600\18147HYDR\_Plan\_Cherry\_Creek\_03.dgn

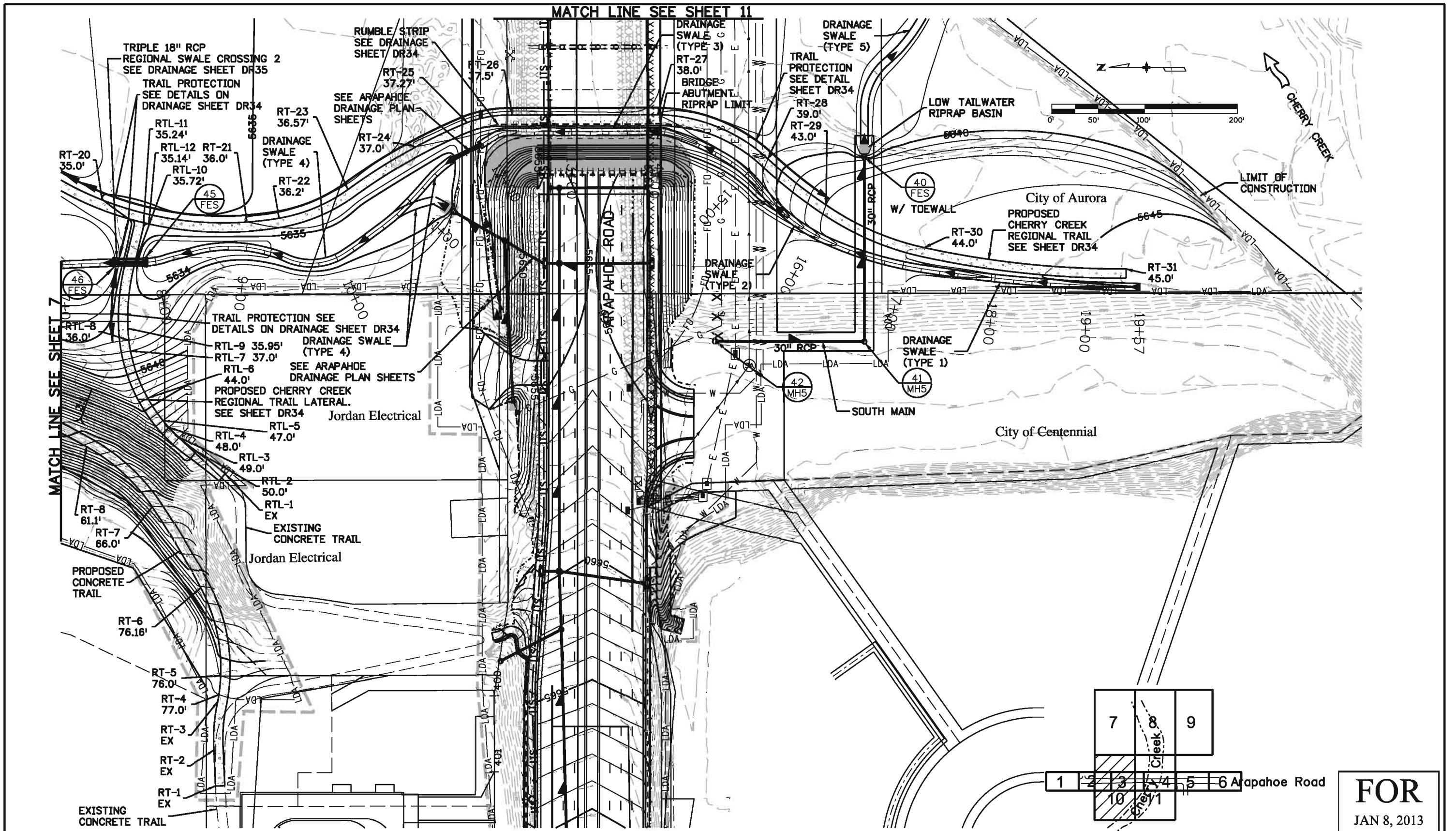


MATCH LINE SEE SHEET 8



NO MAJOR PROJECT IMPROVEMENTS PLANNED FOR THIS AREA

**FOR**  
JAN 8, 2013

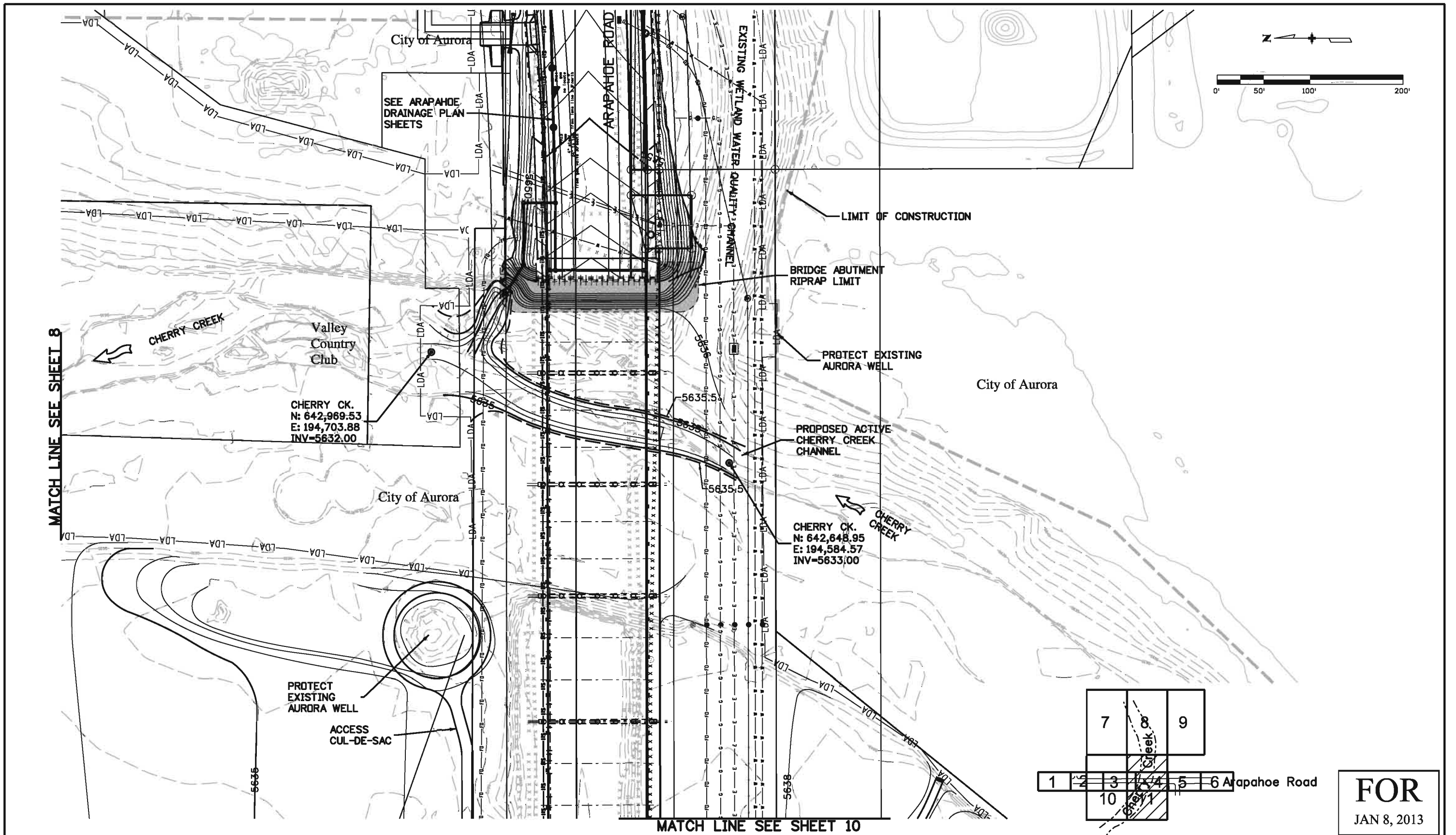
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Horiz. Scale: 1:100 Vert. Scale: As Noted					3320 South Parker Road Aurora, CO 80014 Phone: 303-337-9519 FAX: 303-750-7452  <b>Region 6</b>				
<b>MULLER ENGINEERING CO., INC.</b> 777 S. Wadsworth Blvd. 4-100 Lakewood, CO 80226 303-988-4939					<b>JH</b>				



**FOR**  
JAN 8, 2013

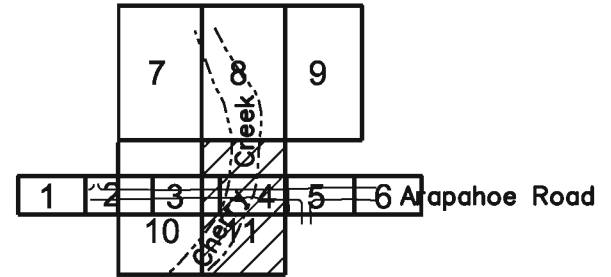
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Horiz. Scale: 1:100 Vert. Scale: As Noted						Revised:				Sheet Subset: DRAINAGE Subset Sheets: DR15 of DR37	
 <b>MULLER ENGINEERING CO., INC.</b> 777 S. Wadsworth Blvd. 4-100 Lakewood, CO 80226 303-988-4939				<b>JH</b>		Void:				Sheet Number	

JoAnn 11:16:50 AM c:\caddlib\pw\jomurray\centra\div\dms54600\18147HYDR\_Plan\_Cherry Creek\_04.dgn



MATCH LINE SEE SHEET 8

MATCH LINE SEE SHEET 10



**FOR**  
JAN 8, 2013

Print Date: 11/16/2012  
 File Name: 18147HYDR\_Plan\_Cherry Creek\_05.dgn  
 Horiz. Scale: 1:100 Vert. Scale: As Noted

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 303-988-4939

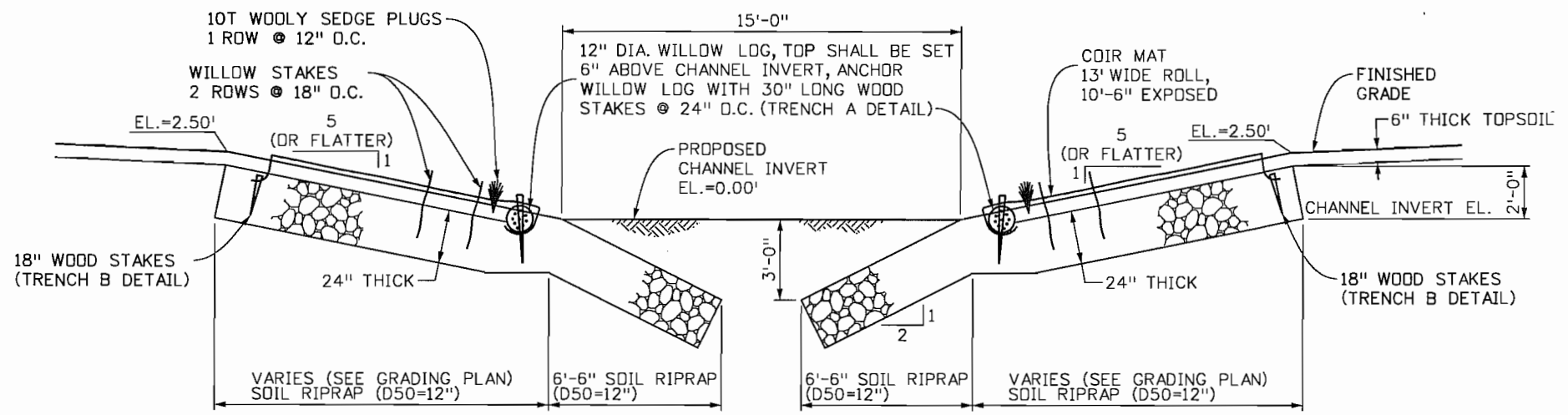
Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation  
 3320 South Parker Road  
 Aurora, CO 80014  
 Phone: 303-337-9519 FAX: 303-750-7452  
 Region 6 JH

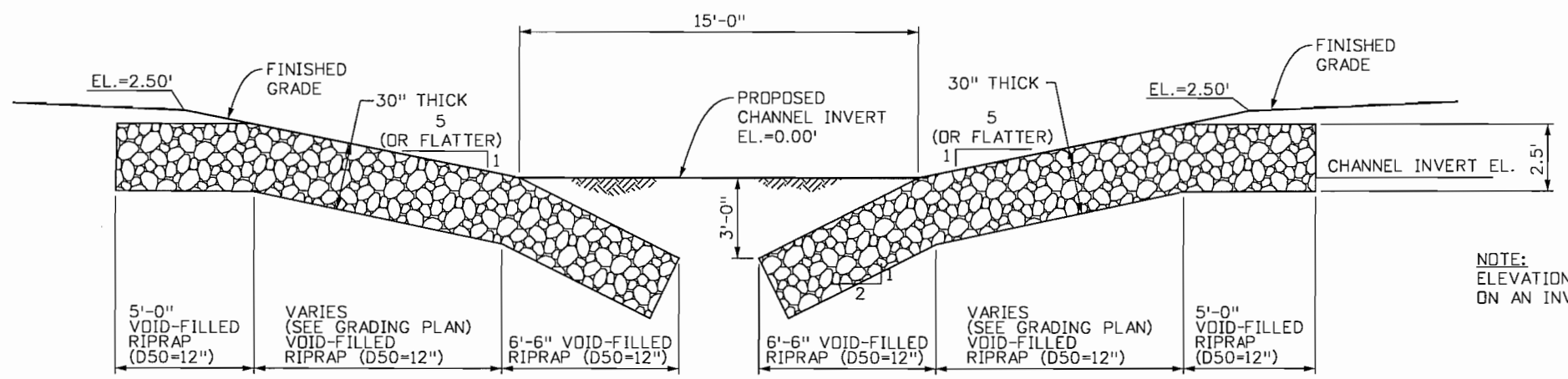
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Revised:
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ARAPAHOE OVER CHERRY CREEK CHERRY CREEK DRAINAGE PLAN SHEET 11	
Designer: JPJ	Structure Numbers
Detailer: JAM	
Sheet Subset: DRAINAGE	Subset Sheets: DR16 of DR37

<b>Project No./Code</b>
FBR 088A-031
18147
Sheet Number





**CHERRY CREEK CHANNEL SECTION (OUTSIDE OF BRIDGE)**  
SCALE: 1"=6'-0"



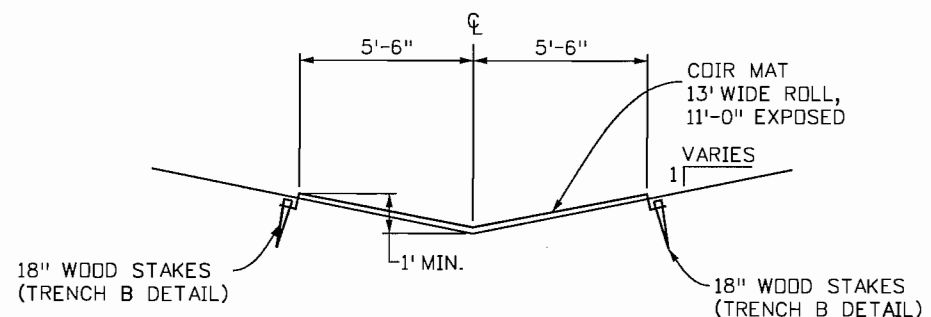
**CHERRY CREEK CHANNEL SECTION (UNDERNEATH BRIDGE)**  
SCALE: 1"=6'-0"

NOTE:  
ELEVATIONS ARE ARBITRARY AND BASED  
ON AN INVERT ELEVATION OF 0.00

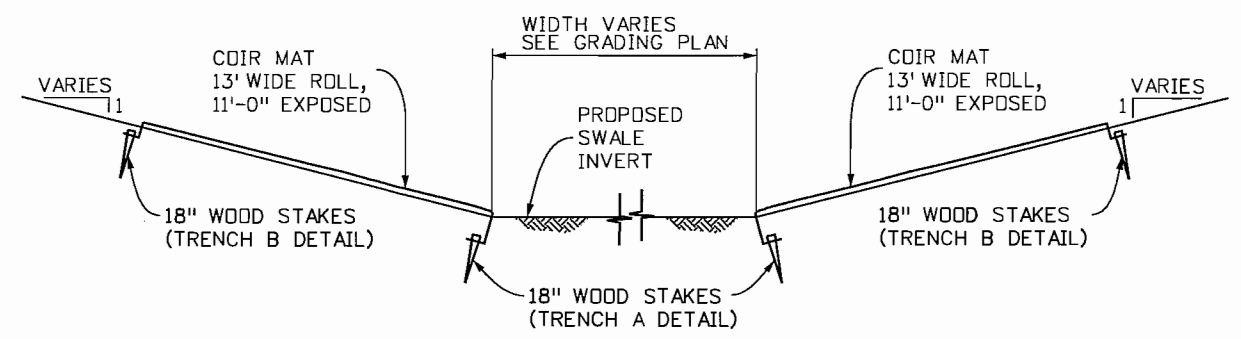
**FOR**  
JAN 8, 2013

Print Date: 11/14/2012	<b>Sheet Revisions</b>			Colorado Department of Transportation	As Constructed	ARAPAHOE OVER CHERRY CREEK		Project No./Code
File Name: 18147HYDR_Bank Pro Details.dgn	Date:	Comments	Init.			CHERRY CREEK BANK		
Horiz. Scale: 1:1	Vert. Scale: As Noted			 3320 South Parker Road Aurora, CO 80014 Phone: 303-337-9519 FAX: 303-750-7452 Region 6	No Revisions:	PROTECTION SECTIONS		18147
 <b>MULLER ENGINEERING CO., INC.</b> 777 S. Wadsworth Blvd. 4-100 Lakewood, CO 80226 303-988-4939					Revised:	Designer: AKS	Structure Numbers	Sheet Number
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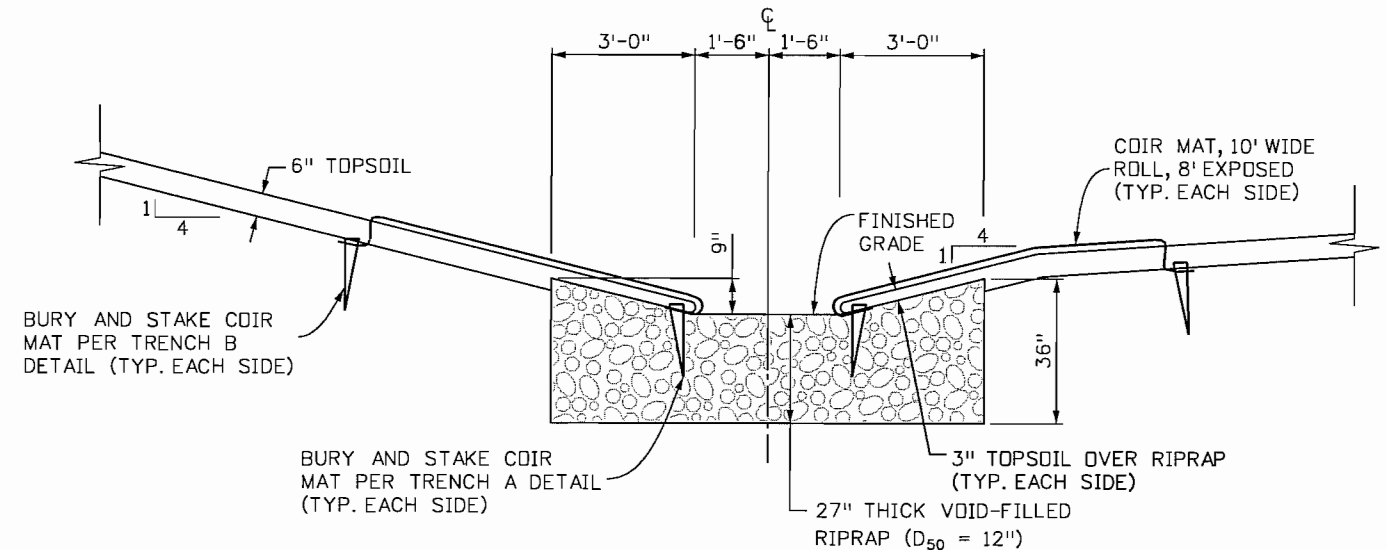
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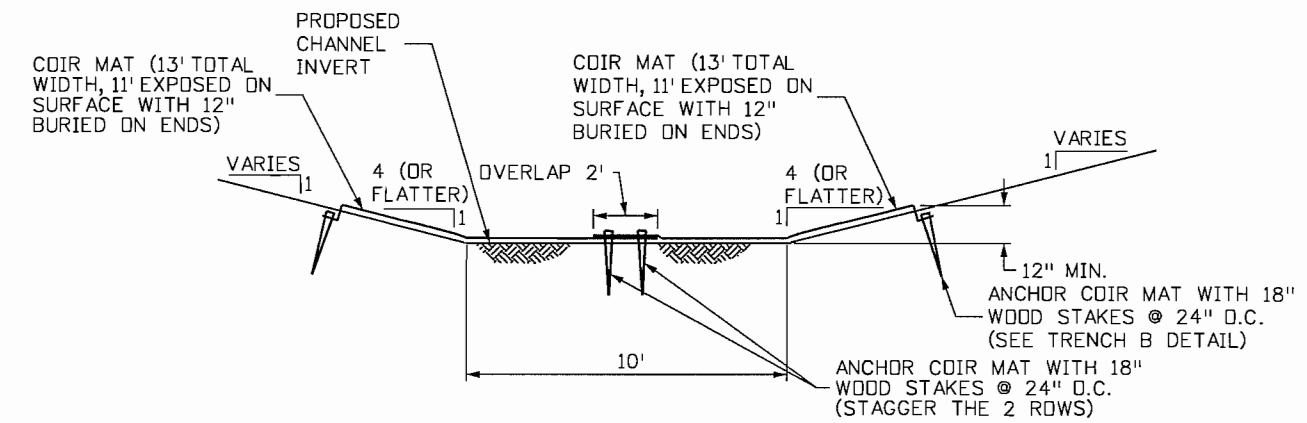
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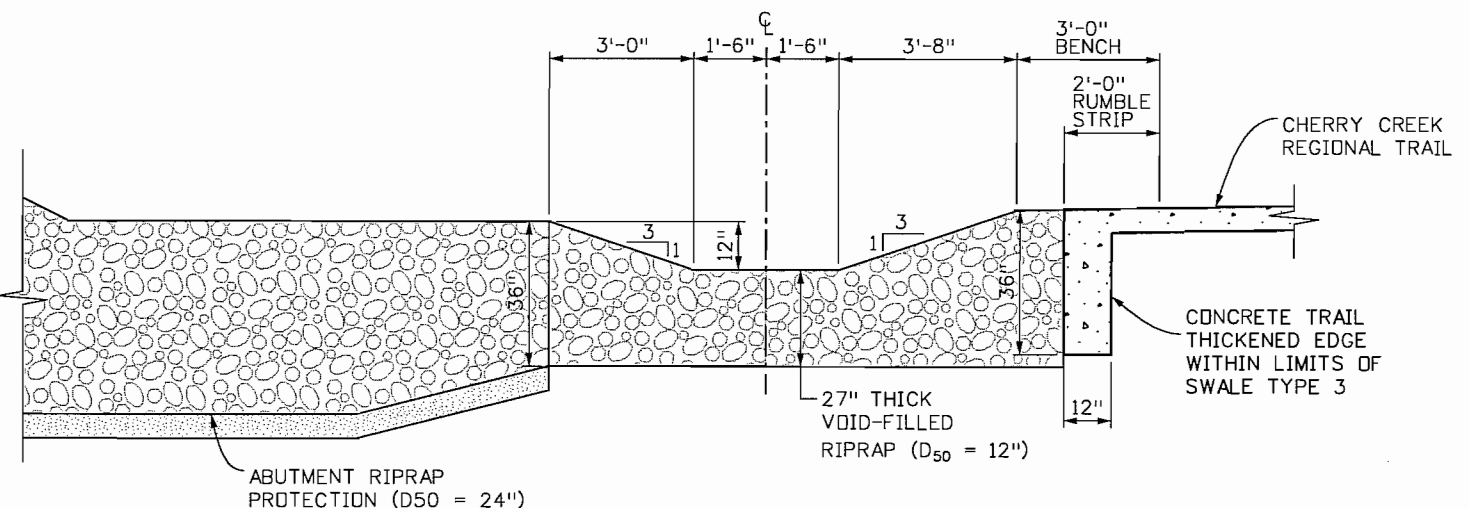
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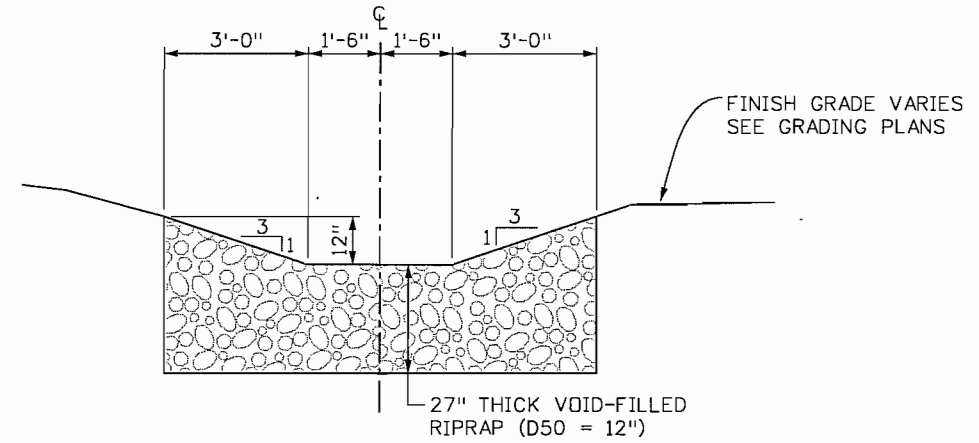
**SWALE TYPE 2**  
SCALE: 1"=4'-0"



**SWALE TYPE 5**  
SCALE: 1"=6'-0"



**SWALE TYPE 3**  
SCALE: 1"=4'-0"



**SWALE TYPE 6**  
SCALE: 1"=4'-0"

**FOR**  
JAN 8, 2013

Print Date: 11/14/2012  
File Name: 18147HYDR\_Swale Sections.dgn  
Horiz. Scale: 1:1  
Vert. Scale: As Noted  
**MULLER ENGINEERING CO., INC.**  
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Lakewood, CO 80226  
303-988-4939

Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation  
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Aurora, CO 80014  
Phone: 303-337-9519 FAX: 303-750-7452  
Region 6 JH

As Constructed  
No Revisions:  
Revised:  
Void:

ARAPAHOE OVER CHERRY CREEK  
SWALE PROTECTION SECTIONS  
Designer: AKS  
Detailer: JHK  
Sheet Subset: DRAINAGE  
Structure Numbers  
Subset Sheets: DR32 of DR37

Project No./Code  
FBR 088A-031  
18147  
Sheet Number

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