

# **US 6 Bridges Design Build Project**

BR 0061-083

Sub Account Number 18838 (CN)

## **Master Plan Water Quality Report**

Prepared for:  
Colorado Department of Transportation  
Federal Highway Administration

Prepared by:  
Olson Associates

October 2012

## Water Quality Mater Plan Report Mitigation

Appropriate measures to minimize environmental harm from the Project have been identified. Mitigation measures for water resources in the FEIS and 2007 ROD were reviewed and carried forward if applicable, and mitigation measures were added for any resources with additional impacts. A summary of all mitigation measures for Phase 1 (including the US 6/Federal Boulevard interchange) as presented in the 2007 ROD, Phase 5 as presented in the FEIS, and the six new project elements are shown in Table 1 below. These mitigation measures are consistent with both the CDOT Mitigation Tracking Form in Appendix C and Book 2 Section 5 of the Project contract documents.

**Table 1. Summary of Previously and Currently Identified Water Resource Impacts and Mitigation**

Resource	EIS and ROD		US 6 Bridges Design Build Project: What Has Changed	US 6 Bridges Design Build Project	
	Impacts of Proposed Action	Mitigation		Impacts of Proposed Action	Mitigation
<b>Water Quality and Water Resources</b>	Short-term increase in sediment from construction.	Use construction BMPs to reduce temporary impacts.	Two new water quality ponds.	Improvement to water quality and stormwater management due to new ponds.	Implement appropriate temporary BMPs for erosion and sediment control according to the CDOT Erosion Control and Stormwater Quality Guide (CDOT, 2002), and develop a stormwater management plan (SWMP), which includes water quality monitoring by the construction contractor to ensure effectiveness of temporary construction BMPs.
	Increase in impervious drainage area.	On-site project area runoff will be controlled through water quality ponds or other BMPs to settle and improve water quality runoff releasing to the South Platte River.			
	Consolidation of stormwater runoff with fewer outfalls to the South Platte River.	Reduction of the overall number of outfalls into the South Platte River and installation of energy dissipaters, such as riprap, at outfalls to reduce erosion potential.			
	Improved quality of stormwater discharge due to construction of water quality ponds and best management practice (BMP) stormwater facilities.	Use pump stations to remove runoff at underpasses on grade separations and use water quality ponds to settle sediment and improve water quality releasing into the South Platte River.			
					Provide for permanent stabilization consistent with CDOT's MS4 permit through revegetation and permanent erosion controls measures.
					Identify hazardous spill containment structure locations and recommend BMPs based on their potential effectiveness in reducing hazardous waste discharge to the South Platte River. Comply with CDOT Standard Specification 207 and 208.

Resource	EIS and ROD		US 6 Bridges Design Build Project: What Has Changed	US 6 Bridges Design Build Project	
	Impacts of Proposed Action	Mitigation		Impacts of Proposed Action	Mitigation
					<p>Use storm sewer system, pump stations, or other approved methods to remove runoff at underpasses on grade separations and use water quality ponds or other approved water quality BMPs to settle sediment and improve water quality prior to releasing the runoff into the South Platte River.</p> <p>Reduce the overall number of outfalls into the South Platte River in compliance with CDOT's MS4 permit.</p> <p>Install energy dissipaters, such as riprap, or other equitable allowable BMPs, at outfalls to reduce erosion potential in accordance with Section 208 of the 2011 Standard Specification for Road and Bridge Construction.</p> <p>The 2012 Reevaluation and preliminary design identified the need for water quality ponds. Construct ponds or other equitable allowable permanent BMPs, for erosion and sediment control according the CDOT Erosion Control and Stormwater Quality Guide (CDOT, 2002).</p>

Resource	EIS and ROD		US 6 Bridges Design Build Project: What Has Changed	US 6 Bridges Design Build Project	
	Impacts of Proposed Action	Mitigation		Impacts of Proposed Action	Mitigation
<b>Floodplains</b>	<p>Temporary impacts during replacement of SB Santa Fe Drive and Alameda Avenue bridges over the South Platte River.</p> <p>Encroachment into floodplain from SB I-25 off ramp to Santa Fe Drive.</p>	<p>Design bridges to minimize the impact on floodplains of piers, abutments, and roadways, to the extent practicable.</p> <p>Restore bridge construction areas.</p> <p>Install storm sewer improvements to reduce flooding on I-25 under Alameda Avenue.</p> <p>Provide adequate floodplain width in areas of floodplain encroachment for overall “no rise” in floodplain.</p>	<p>Two new water quality ponds.</p>	<p>Water quality and stormwater management improvement due to new ponds</p>	<p>Design bridges to minimize the impact on floodplains from piers, abutments, and roadways, to the extent practicable.</p> <p>Restore construction areas to the pre-construction conditions in accordance with Book 2 Section 5.1.6. Vegetation</p> <p>Provide adequate floodplain width in areas of floodplain encroachment for overall “no rise” in floodplain.</p>

# **Master Plan Water Quality Report**

## **US 6 Bridges Design Build Project BR 0061-083 Sub Account No. 18838 (CN)**

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### **Denver, Colorado**

Prepared for  
Colorado Department of Transportation

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**Master Plan Water Quality Report  
US 6 Bridges Design Build Project  
BR 0061-083  
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**Table of Contents**

Table of Contents.....	i
1.0 INTRODUCTION.....	1
1.1 Location of Improvements.....	1
1.2 Description of Improvements.....	1
2.0 WATER QUALITY REQUIREMENTS.....	2
2.1 Adherence to the CDOT MS4 Permit and NDRD Requirements .....	2
2.2 Assumptions and Methodologies.....	2
3.0 WATER QUALITY DESIGN.....	3
3.1 Design Coordination .....	3
3.1.1 Adjacent Segments.....	3
3.1.2 Agency Coordination.....	3
3.2 Hydrology and Design Flow Development .....	3
3.3 Description of Water Quality Basins.....	4
3.4 Permanent Stormwater Best Management Practices.....	5
3.4.1 Water Quality Treatment.....	6
3.4.2 US 6 Water Quality Pond.....	8
3.4.3 6 <sup>th</sup> Avenue Interchange Water Quality Pond.....	8
3.4.4 Right of Way Concerns.....	9
4.0 MAINTENANCE AND OPERATION .....	9
4.1.1 US 6 Water Quality Pond.....	9
4.1.2 6 <sup>th</sup> Avenue Interchange Water Quality Pond.....	9

**Appendix A**

Water Quality Pond Stage Storage and Calculations  
MS4 Boundary Area Exhibit

**Appendix B**

Water Quality Concept Plan

**List of Figures**

Figure 1: Vicinity Map.....	2
Figure 2: Locations of BMPs .....	6

1 **Master Plan Water Quality Report**  
2 **US 6 Bridges Design Build Project**  
3 **BR 0061-083**  
4 **Sub Account Number 18838 (CN)**

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5 **1.0 INTRODUCTION**

6 This Water Quality Report presents the water quality concepts, design calculations, permanent  
7 stormwater best management practices (BMPs) for planned bridge and highway improvements  
8 of US 6 from Knox Court to the Burlington Northern Santa Fe (BNSF) Railroad bridge to be  
9 constructed as a design build project. This report is prepared in accordance with the Colorado  
10 Department of Transportation (CDOT) *Drainage Design Manual (DDM)*, the City and County of  
11 Denver (CCD) *Storm Drainage Design & Technical Criteria Manual (SDDTCM)*, the Urban  
12 Drainage Flood Control District (UDFCD) *Urban Storm Drainage Criteria Manual (USDCM)*, and  
13 standard engineering practices.

14 **1.1 Location of Improvements**

15 The overall project area, shown in Figure 1, is located in the south halves of Sections 4 and 5  
16 and the north halves of Sections 8 and 9, Township 4 South, Range 68 West of the Sixth  
17 Principal Meridian in the City and County of Denver, Colorado. The project will include highway  
18 improvements along US 6 from Knox Court to the BNSF Bridge east of Interstate 25 (I-25);  
19 along I-25 from approximately 700 feet north of the US 6 interchange to 1300 feet south of the  
20 interchange; along Federal Boulevard from 5<sup>th</sup> Avenue to 7<sup>th</sup> Avenue; along 5<sup>th</sup> Avenue from  
21 Federal Boulevard to Decatur Street; and reconstruction of Barnum Park East.

22 The receiving water for the project is the South Platte River.

23 **1.2 Description of Improvements**

24 The planned highway improvements consist of replacing the bridges at Federal Boulevard,  
25 Bryant Street, the South Platte River, I-25, and the BNSF Railroad, and associated highway and  
26 ramp improvements. Barnum Park East, located at the southeast corner of the Federal  
27 Boulevard/US 6 Interchange, will also be reconstructed with the project.



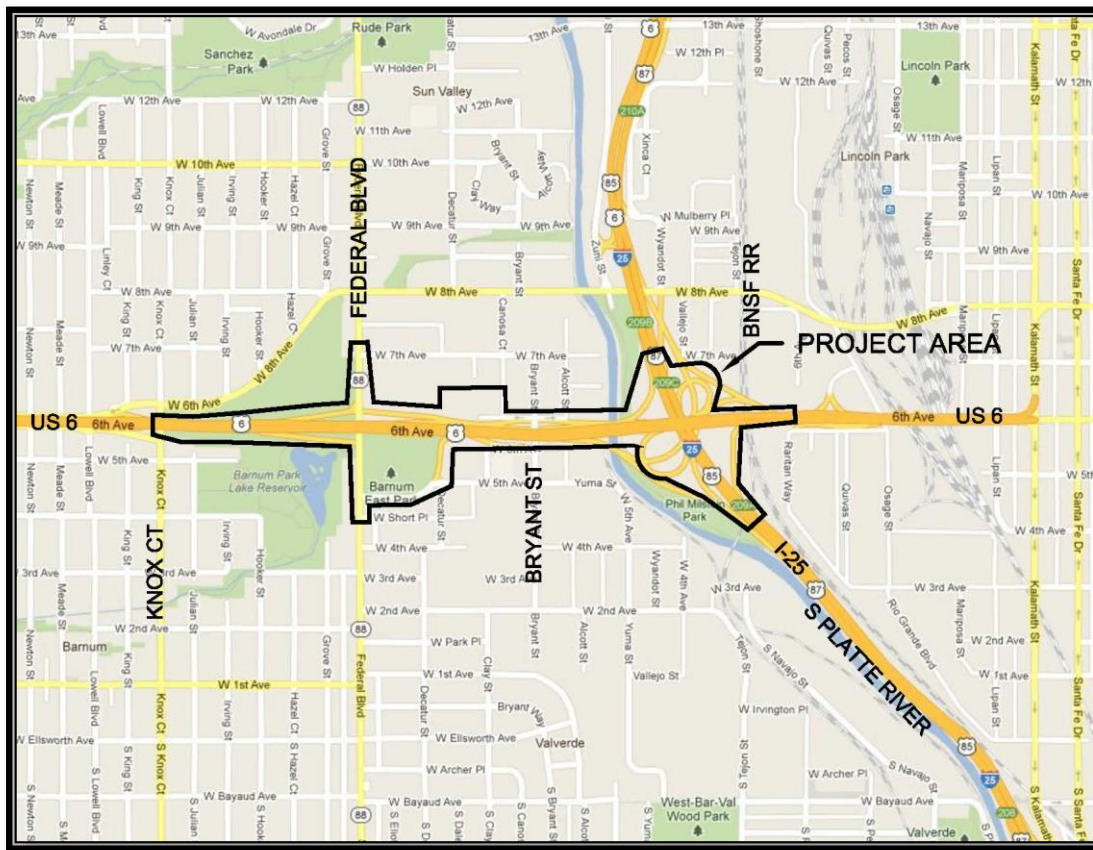


Figure 1: Vicinity Map

28  
29

## 30 2.0 WATER QUALITY REQUIREMENTS

### 31 2.1 Adherence to the CDOT MS4 Permit and NDRD Requirements

32 CDOT's MS4 permit and New Development and Redevelopment (NDRD) Stormwater  
33 Management Program require that BMPs be provided for significant highway redevelopment  
34 construction that will disturb more than 1 acre.

35 NDRD requires that development and redevelopment projects provide 100% water quality  
36 capture volume or BMPs to remove 80% of the total suspended solids.

### 37 2.2 Assumptions and Methodologies

38 "Offset area" is defined as non-project impervious area treated by permanent stormwater BMPs  
39 to offset project impervious area in a highly constrained area that cannot be treated. "Highly  
40 constrained" is defined as an area where water quality treatment cannot be provided due to  
41 public safety concerns, maintenance crew safety concerns, stormwater pumping requirements,  
42 utility conflicts, elevation constraints, space constraints, or other factors which limit the ability to  
43 install and maintain BMPs.

44 **3.0 WATER QUALITY DESIGN**

45 **3.1 Design Coordination**

46 3.1.1 Adjacent Segments

47 The EIS delineated a basin on I-25 to the south of this project, designated the “3<sup>rd</sup> Avenue  
48 Basin,” located on I-25 between the I-25 Bridge over the BNSF railroad and the I-25 & Alameda  
49 project. It proposed that the water quality flows from the 3<sup>rd</sup> Avenue basin be conveyed to the 6<sup>th</sup>  
50 Avenue Interchange Water Quality Pond. The 3<sup>rd</sup> Avenue basin will be constructed by others.  
51 However, the 6<sup>th</sup> Avenue Interchange Water Quality Pond, constructed with this project, will  
52 need to be sized to provide water quality capture volume for the 3<sup>rd</sup> Avenue basin.

53 3.1.2 Agency Coordination

54 Design approvals will be required from CDOT and CCD.

55 **3.2 Hydrology and Design Flow Development**

56 The Rational Method model was used to estimate the peak runoff rates for the water quality  
57 storm. This method is defined as:

58  $Q = CIA$

59 where: Q = Peak discharge in cubic feet per second (cfs)

60 C = Runoff coefficient

61 I = Rainfall intensity in inches per hour

62 A = Drainage area in acres

63 A Water Quality storm event with a one-hour point rainfall value of 0.6 inches was used for  
64 design, which is consistent with UDFCD and CCD criteria, instead of 0.5-inches in the CDOT  
65 criteria.

66 The time of concentration is required to select the appropriate rainfall intensity. The time of  
67 concentration was calculated using equations from Section 2.4 of the Runoff chapter of the  
68 USDCM. The resultant time found using these equations is compared to the time of  
69 concentration for urbanized basins, which is also calculated using an equation from Section 2.4.  
70 The lesser of the two times is used to determine the rainfall intensity, with a minimum allowable  
71 time of concentration equal to five minutes. Runoff coefficients were determined using the  
72 percent imperviousness, NRCS hydrologic soil group, and Table RO-3 from the USDCM.  
73 Equation 5.1 from the SDDTCM was used to determine the rainfall intensities for each sub-  
74 basin. Manning’s equation for full pipe flow was used to calculate pipe flow velocities and travel  
75 times. Figure 7.2 from the DDM was used to calculate overland flow travel times for the 100-  
76 year storm event.

77 **3.3 Description of Water Quality Basins**

78 The project area is divided into fifteen water quality basins, labeled WQ-1 through WQ-15.

79 At Knox Court, the west extent of the project, runoff from non-project area flows east into the  
80 project area. WQ-1 includes both non-project and project area, consisting of all the tributary  
81 area upstream of the proposed water quality diversions near the Weir Gulch culvert under US 6  
82 (see Section 3.4.2 for further discussion of the water quality diversions). This water quality basin  
83 is comprised of 2.29 acres of project impervious area and 31.83 acres of non-project impervious  
84 area.

85 Basin WQ-2 includes an area on US 6 between Knox Court and Federal Boulevard which  
86 discharges to Weir Gulch. This basin includes 2.68 acres of project impervious area and 0 acres  
87 of non-project impervious area.

88 Basin WQ-3 includes the project area drained by the US 6 – Federal to Bryant storm drain  
89 system. This basin includes US 6 from the Weir Gulch culvert under US 6 to Bryant Street,  
90 Federal Boulevard from West 5<sup>th</sup> Avenue to West 7<sup>th</sup> Avenue, W 5<sup>th</sup> Avenue from Federal to  
91 North Decatur Street, and Barnum Park East. WQ-3 includes 23.84 acres of project impervious  
92 area and 4.67 acres of non-project impervious area.

93 Basin WQ-4 is 0.34 acres of the eastbound collector/distributor ramp to Bryant Street. This  
94 basin is lower in elevation than the US 6 Water Quality Pond; therefore runoff from this area is  
95 not intercepted by the storm drain system and flows east.

96 The embankment of the US 6 Water Quality Pond is a grassy slope on the downstream side of  
97 the pond. This basin, WQ-5, contains 0.41 acres of pervious area and 0 acres of impervious  
98 area. No treatment is needed.

99 At the north extent of the project area on Federal Boulevard is 0.17 acres of impervious project  
100 area and 0 acres of non-project impervious area. Runoff from this area, WQ-6, flows north of the  
101 proposed inlets.

102 Basin WQ-7, which includes 0.48 acres of impervious project area and 0 acres of non-project  
103 impervious area, drains south to and is treated by the existing Barnum Lake Constructed  
104 Wetland Pond constructed with the Federal Boulevard Improvement Project: Alameda to 6<sup>th</sup>  
105 Avenue.

106 Basin WQ-8 includes the westbound US 6 frontage road, on the north side of US 6 between the  
107 US 6 Water Quality Pond and Alcott Street. This area is 0.73 acres of project impervious area  
108 and 0 acres of non-project impervious area. As it is lower in elevation than the storm drain  
109 system to US 6 Water Quality Pond, runoff flows east beyond the project limits.

110 US 6 between Bryant Street and the east abutment of the I-25 collector/distributor tunnel drains  
111 to the South Platte River. This basin, WQ-9, is comprised of 6.34 acres of project impervious  
112 area and 0 acres of non-project impervious area.

113 Basin WQ-10 includes the eastbound US 6 to southbound I-25 ramp, from Bryant Street to the  
114 South Platte River. This basin contains 1.13 acres of impervious project area and 0 acres of  
115 non-project impervious area.

116 I-25 between 8<sup>th</sup> Avenue and US 6, Ramps “A,” “B,” and “C,” and a portion of US 6 at the bridge  
117 over I-25 are included in Basin WQ-11. This basin contains 9.23 acres of project impervious  
118 area and 1.04 acres of non-project impervious area.

119 Basin WQ-12 consists of Ramp “D,” US 6 between the BNSF bridge and the I-25  
120 collector/distributor tunnel, a portion of I-25 between US 6 and the BNSF bridge to the south,  
121 and the area under the flyover ramp between Ramp “C” and I-25. This water quality basin  
122 consists of 5.66 acres of project impervious area and 1.01 acres of non-project impervious area.

123 Basin WQ-13 consists of 1.98 acres of project impervious area and 0 acres of non-project  
124 impervious area on US 6 from the BNSF bridge to the east extent of the project.

125 The embankment of the north and east sides of Ramp “B” is a grassy slope. This basin, WQ-14,  
126 contains 0.80 acres of pervious area and 0 acres of impervious area. No treatment is needed.

127 The embankment on the west and south sides of Ramp “C” is a grassy slope. This basin, WQ-  
128 15, contains 0.37 acres of pervious area and 0 acres of impervious area. No treatment is  
129 needed.

130 See Appendix B for the Water Quality Concept Plan.

### 131 **3.4 Permanent Stormwater Best Management Practices**

132 The US 6 Water Quality Pond and the 6<sup>th</sup> Avenue Interchange Water Quality Pond are proposed  
133 extended detention basins (EDB) that will be used to provide water quality for the project area.  
134 Locations for the water quality ponds are shown in Figure 2 below.

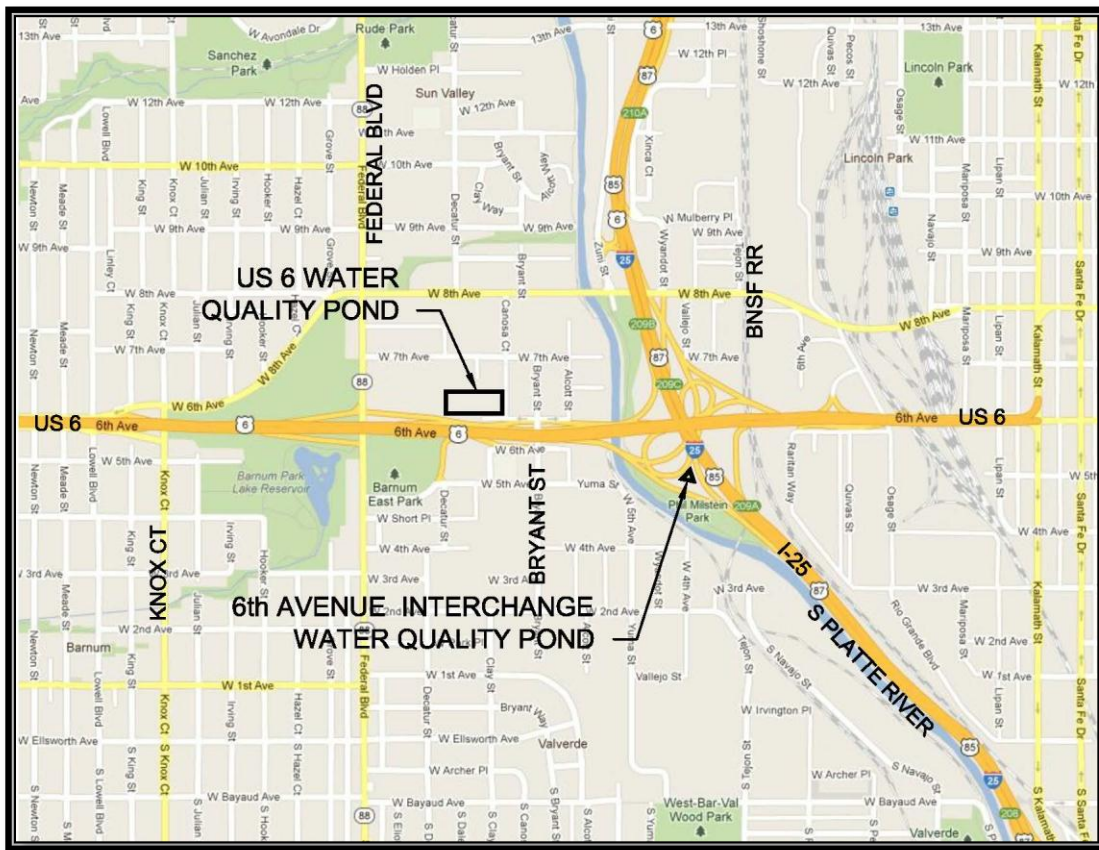
135 Due to site constraints, EDB and underground vaults are the only viable water quality treatment  
136 options. Vaults were not considered due to safety concerns to maintenance crews and the  
137 public. Infiltration basins, infiltration trenches, and filtering basins were not considered due to  
138 high groundwater levels. Wet ponds and constructed stormwater wetlands are not a viable  
139 option due to the lack of a constant source of flow.

140 Extended detention basins have an expected pollutant removal rate of 55-75% TSS removal, as  
141 stated in Table 4.7 of the New Development and Redevelopment Stormwater Management  
142 Program Manual, CDOT, February 2004.

143 There are no existing water quality features within the project area.

144





145

146

Figure 2: Locations of BMPs

147

### 3.4.1 Water Quality Treatment

148

Water quality treatment for Basins WQ-1 and WQ-3 will be provided by the US 6 Water Quality Pond. Basin WQ-12 will be treated by the 6<sup>th</sup> Avenue Interchange Water Quality Pond. See

149

Sections 3.4.2 and 3.4.3 for further discussion of these ponds.

150

151

Basins WQ-5, WQ-14, and WQ-15 are vegetated slopes with 0 acres of impervious area. No treatment is needed.

152

153

Basin WQ-11 includes area which cannot drain to the South Platte River via a gravity drainage system. High flows in the South Platte River are influenced by releases from Chatfield Reservoir. Releases from the reservoir and resulting high water surface elevations on the river can occur at any time; therefore an outfall from I-25 to the river that is set too low could result in a clear day flooding of I-25 and could prevent water quality discharges to the river. A series of interconnected ponds and a pump station are proposed to drain stormwater from the US 6 and I-25 interchange. Since pumping is required, this basin is considered to be highly constrained and water quality treatment is not provided. Refer to the US 6 Bridges Design Build Project Master Plan Hydrology and Hydraulics Report for further discussion of this storm drain and pumping system.

154

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160

I-25 interchange. Since pumping is required, this basin is considered to be highly constrained

161

and water quality treatment is not provided. Refer to the US 6 Bridges Design Build Project

162

Master Plan Hydrology and Hydraulics Report for further discussion of this storm drain and

pumping system.

163 Basin WQ-2 includes a portion of the storm drain systems in US 6 between Knox Court and  
164 Federal Boulevard which discharge to Weir Gulch. Within the boundaries of this area, the  
165 inverts of the storm drains are below the crown elevation of the Weir Gulch culvert. When the  
166 culvert is running full, water will backflow into the storm system. The water quality diversions  
167 have been placed uphill at elevations higher than the crown of Weir Gulch. Below this elevation,  
168 stormwater drains directly to Weir Gulch and is not treated. If the diversions are placed closer to  
169 the outfall to Weir Gulch in order to treat additional area, culvert flows will backflow into the  
170 storm drain system, into the diversions, and into the US 6 Water Quality Pond. WQ-2 is not  
171 treated.

172 The storm drain system in US 6 is at a minimum 0.5% slope to the US 6 Water Quality Pond  
173 from the eastbound collector/distributor ramp to Bryant Street. Basin WQ-4 represents the area  
174 from which runoff cannot be collected, as the elevations of the ramp are lower than this storm  
175 drain system. There is no room for an EDB. Maintenance of an underground BMP installed in  
176 the traffic lanes would create a hazardous condition for the public and maintenance crews. WQ-  
177 4 is not treated.

178 Basin WQ-6 represents an area at the northern extents of the project on Federal Boulevard near  
179 7<sup>th</sup> Avenue. The pavement within this basin will be overlaid, but this overlay area extends farther  
180 north (downstream) than the terminus of the planned curb replacement on Federal Boulevard.  
181 Inlets cannot be installed beyond the curb replacement boundaries. Therefore, runoff from this  
182 area cannot be intercepted by the storm drain system and flows off-site to the north. This area is  
183 not treated.

184 Basin WQ-7 is treated by the existing Barnum Lake Constructed Wetland Pond constructed with  
185 the Federal Boulevard Improvement Project: Alameda to 6<sup>th</sup> Avenue.

186 Basin WQ-8 is not treated because the elevations are lower than the storm drain system which  
187 diverts water quality flows to the US 6 Water Quality Pond. There is no room for an EDB.  
188 Maintenance of an underground BMP installed in the traffic lanes would create a hazardous  
189 condition for the public and maintenance crews.

190 Basin WQ-9 drains to the South Platte River. A water quality diversion pipe from this system  
191 cannot drain to either of the proposed EDBs at a minimum slope. There is no room for an EDB.  
192 Maintenance of an underground BMP installed in the traffic lanes would create a hazardous  
193 condition for the public and maintenance crews. This area is not treated.

194 Basin WQ-10 is the ramp from eastbound US 6 to southbound I-25 and is considered highly  
195 constrained. There is no room for an EDB. Maintenance of an underground BMP would create  
196 a hazardous condition for the public and maintenance crews. This area drains to the South  
197 Platte River and is not treated.

198 Runoff from basin WQ-13 flows to the east project limits on US 6 and is not treated. The  
199 highway is elevated in this area. Construction of an EDB or underground BMP is not possible  
200 on the steep slopes. Maintenance of an underground BMP installed in the traffic lanes would  
201 create a hazardous condition for the public and maintenance crews.

202 The untreated project impervious areas will be offset by the treated non-project areas using the  
203 "offset areas" principle. The total acres of impervious area required to be treated are 73.17  
204 acres. The total acres of treatment provided are 86.97 acres. The total area not treated is 23.71

205 acres. The total acres of impervious area treated in addition to what is required are 37.51 acres,  
206 which is a greater area than the area not treated.

#### 207 3.4.2 US 6 Water Quality Pond

208 The US 6 Water Quality Pond will treat project and non-project impervious area from the west  
209 end of the project area and will be used to provide “offset area” for portions of the project which  
210 are highly constrained and are unable to be treated. Approximately 57 acres of non-project area  
211 (from Vrain Street to Knox Court) will flow east onto the project area. Water quality flows will be  
212 diverted from WQ-1 to WQ-3 at four locations: Manholes 411R, 308R, 107C, and 111C1. The  
213 water quality flows will enter the US 6 – Federal to Bryant storm drain system, will then be  
214 diverted from the storm drain system at Manhole 6000C, and will outlet to the US 6 Water  
215 Quality Pond on the north side of the highway. Refer to the US 6 Bridges Design Build Project  
216 Master Plan Hydrology and Hydraulics Report for basin maps and storm drain system  
217 schematics.

218 The US 6 Water Quality Pond will be constructed on CDOT owned property, adjacent to and on  
219 the north side of US 6 and west of Canosa Court. This pond will have a total volume of at least  
220 2.45 acre-feet, which is the required WQCV for WQ-1 (1.33 acre-feet) and WQ-3 (1.12 acre-  
221 feet). The embankment should have 3:1 side slopes and the pond bottom should be graded at a  
222 2% slope to the outlet. The outlet invert is at elevation 5203.00. An outlet structure with a water  
223 quality plate should be designed to release water quality flows in 40 hours. The water quality  
224 pond will outlet to the US 6 – Federal to Bryant Storm Drain System outfall, which outfalls to the  
225 South Platte River. During large storm events, it is possible for water to backflow from the outfall  
226 into the US 6 Water Quality Pond. The outlet structure will need an overflow weir in order to  
227 release larger flows. An emergency spillway will be graded in on the east embankment of the  
228 pond. The embankment will tie to the US 6 retaining wall on the south side of the pond, and will  
229 have at least 1 foot of freeboard. The storm drain outfall into the pond is located on the south  
230 side of the pond, and will require a grouted boulder rundown into a forebay in order to dissipate  
231 energy. A trickle channel will convey flows at a 0.5% slope to the outlet structure.

232 Refer to the *Final Drainage Report for Federal Boulevard/US 6 Interchange Improvements* by  
233 Olsson Associates for discussion of existing drainage patterns of Federal Boulevard and 5<sup>th</sup>  
234 Avenue. Refer to the US 6 Bridges Design Build Project Master Plan Hydrology and Hydraulics  
235 Report for discussion of the storm drain system design.

236 See Appendix B for the Water Quality Concept Plan.

#### 237 3.4.3 6<sup>th</sup> Avenue Interchange Water Quality Pond

238 The 6<sup>th</sup> Avenue Interchange Water Quality Pond will be constructed in CDOT right-of-way, on  
239 the south side of Ramp “C,” adjacent to I-25. This pond will provide WQCV for the 3<sup>rd</sup> Avenue  
240 basin on I-25 to the south and WQ-12, for a total WQCV required of 1.01 acre-feet at elevation  
241 5207.76. The 3<sup>rd</sup> Avenue basin will have a water quality outfall in the southeast corner of the  
242 pond which will be constructed in the future by others. The outlet invert is at elevation 5201.23.  
243 An outlet structure should be designed to release water quality flows in 40 hours and will need  
244 an overflow weir for the minor and major storm event flows. The water quality pond will outlet to  
245 the South Platte River. An emergency spillway will be graded in at the southwest corner of the  
246 pond adjacent to Ramp “C,” at elevation 5207.76.

247 See Appendix B for the Water Quality Concept Plan.

248 3.4.4 Right of Way Concerns

249 The proposed BMPs are located in CDOT right of way or property owned by CDOT.

250 **4.0 MAINTENANCE AND OPERATION**

251 4.1.1 US 6 Water Quality Pond

252 The US 6 Water Quality Pond can be access from Canosa Court. The retaining wall on the  
253 north side of the highway will prevent maintenance personnel from accessing the pond from the  
254 highway.

255 The pond outlet works will need routine maintenance to clear the trash rack and orifice plate of  
256 debris. The pond bottom and trickle channel should be scraped and regraded as needed to  
257 remove sediment build-up. A minor amount of continuous maintenance will be necessary to  
258 keep vegetation established and not overgrown.

259 4.1.2 6<sup>th</sup> Avenue Interchange Water Quality Pond

260 The 6<sup>th</sup> Avenue Interchange Water Quality Pond can be accessed from Ramp "C," the  
261 southbound I-25 to eastbound US 6 ramp.

262 The pond outlet works will need routine maintenance to clear the trash rack and orifice plate of  
263 debris. The pond bottom and trickle channel should be scraped and regraded as needed to  
264 remove sediment build-up. A minor amount of continuous maintenance will be necessary to  
265 keep vegetation established and not overgrown.



## **Appendix A**

### Water Quality Pond Stage Storage and Calculations

**WQ Pond Contribution - WEST US 6 BASINS (WQ1)**

Basin	Area (Ac)	%I	A*%I
WB6-7	0.42	100.00	41.9
WB6-8	0.66	100.00	65.7
EB6-5	0.74	86.57	63.7
EB6-6	0.68	84.75	57.6
OS-11	4.57	29.56	135.1
OS-12	3.28	27.22	89.2
OS-13	0.54	89.56	48.4
OS-14	1.16	24.18	28.0
OS-15	0.47	0.00	0.0
OS-16	0.78	0.00	0.0
OS-17	0.53	100.00	53.0
OS-18	0.87	0.00	0.0
OS-20	12.65	60.25	762.2
OS-21	1.87	63.10	118.0
OS-22	2.95	60.45	178.3
OS-23	2.47	52.09	128.7
OS-24	0.37	100.00	37.0
OS-25	0.61	100.00	61.0
OS-26	9.87	53.06	523.7
OS-27	5.04	100.00	504.0
OS-28	4.67	58.70	274.1
OS-29	2.11	62.77	132.4
OS-30	1.76	62.23	109.5
	59.05	57.77	3412

**WQ Pond Contribution - US 6 POND (WQ3)**

Basin	Area (Ac)	%I	A*%I
SW1	0.73	100.00	73.2
SW2	0.61	56.18	34.3
SE1	0.84	97.63	82.4
SE2	1.41	100.00	140.7
P1	2.25	0.00	0.0
WB1	2.49	100.00	248.9
WB2	0.70	100.00	70.4
WB3	1.03	100.00	102.8
WB3A	0.07	100.00	6.8
WB4	1.05	100.00	104.7
WB5	0.65	100.00	65.4
WB5A	0.07	100.00	6.9
WB6-5	0.28	100.00	28.2
EB1	0.47	100.00	47.2
EB2	1.60	100.00	159.6
CD1	3.31	100.00	331.2
CD2	1.13	100.00	112.6
CD3	0.69	100.00	69.5
CD4	0.45	100.00	45.5
FR	0.69	100.00	68.8
NF1	0.23	100.00	22.7
NF2	0.29	96.51	27.6
NF3	0.36	75.62	26.9
NF4	0.40	65.62	26.3
NF5	0.25	100.00	24.7
NF6	1.11	85.73	95.5
NF7	0.54	97.95	52.7
NF8	1.02	90.56	92.1
NF9	0.32	98.76	31.9
NE	1.41	99.15	140.3
BPE1	1.83	73.10	133.8
BPE2	6.83	12.09	82.5
5TH1	1.12	69.64	78.0
5TH2	0.96	57.17	54.6
5TH3	0.47	37.07	17.6
5TH4	1.49	28.27	42.2
5TH5	1.32	28.27	37.4
5TH6	0.24	65.22	15.8
5TH7	0.10	100.00	9.9
OS-10	0.49	82.69	40.1
WEST BASINS	59.05	57.77	3411.7
	100.35	62.41	6263

**Water Quality Capture Volume  
Volume Formula per UDFCD (Volume 3)**

$$V_{WQCV} = (WQCV/12) * A * 1.2$$

$$WQCV = 1.0 * (0.91 * I^3 - 1.19 * I^2 + 0.78 * I)$$

Where:  $V_{WQCV}$  = storage volume  
WQCV = watershed inches of runoff (Figure EDB-2) = 0.24 in  
A = tributary area (acres)  
1.2 Factor = Multiplier of 1.2 to account for the additional 20% of required storage for sediment accumulation

$$V_{WQCV} = 2.45 \text{ ac-ft}$$

$$= \boxed{106,881 \text{ ft}^3}$$

**WQ Pond Contribution - WQ12 & 3rd Avenue Basin - 6th Avenue Interchange Water Quality Pond**

Basin	Area (Ac)	%I	A*%I	
WB6-1a	0.52	100.00	51.5	
WB6-2a	0.15	100.00	15.3	
EB6-1a	0.46	100.00	46.5	
VHE4	2.66	37.96	101.1	
VHE5	1.84	66.75	123.1	
VHE7	0.97	100.00	97.0	
VHW7	1.39	100.00	138.6	
VHW6	2.86	15.66	44.8	
RG-1	0.61	100.00	60.8	(Flyover Ramp)
3RD	17.19	100.00	1719.0	
	28.66	83.67	2398	

**Water Quality Capture Volume**

**Volume Formula per UDFCD (Volume 3)**

$$V_{WQCV} = (WQCV/12) * A * 1.2$$

$$WQCV = 1.0 * (0.91 * I^3 - 1.19 * I^2 + 0.78 * I)$$

Where:  $V_{WQCV}$  = storage volume  
 $WQCV$  = watershed inches of runoff (Figure EDB-2) = 0.35 in  
 $A$  = tributary area (acres)  
 1.2 Factor = Multiplier of 1.2 to account for the additional 20% of required storage for sediment accumulation

$$V_{WQCV} = 1.01 \text{ ac-ft}$$

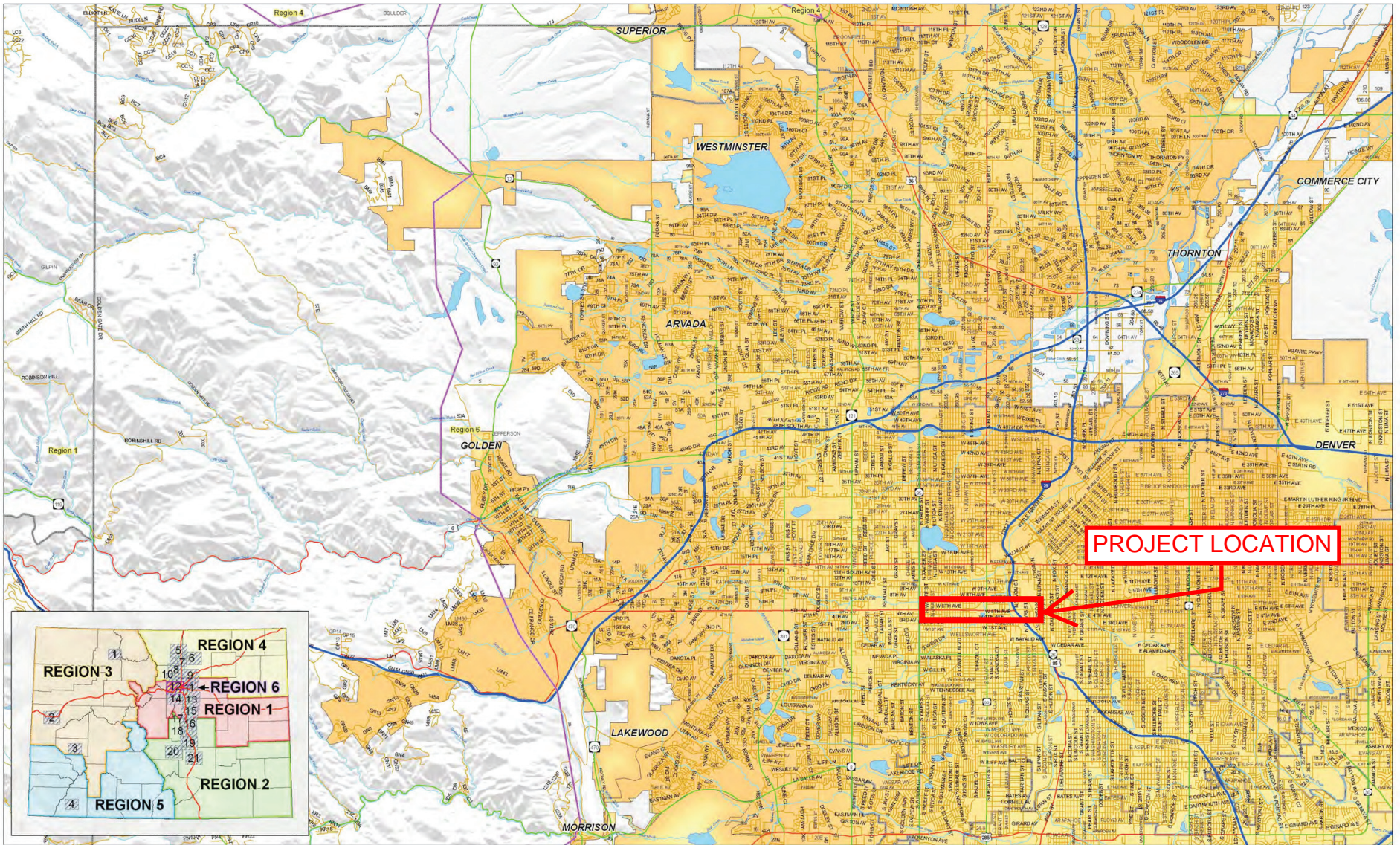
$$= 44,014 \text{ ft}^3$$



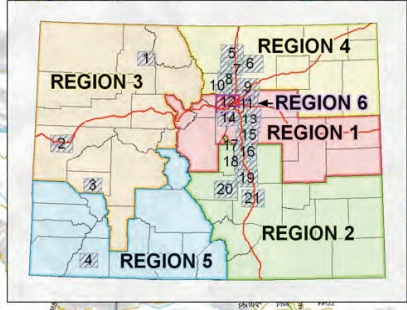




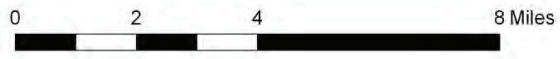
# CDOT MS4 Permit Coverage Area, Map 12



**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)



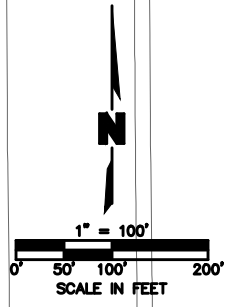
Phase I & II MS4 permit coverage areas as of November 2007.  
 Information sources:  
 urban area boundaries - 2000 census from CDOT GIS Section  
 Jurisdictional boundaries from CDOT GIS Section Data Management Unit as of 12/31/2006.  
 Cherry Creek Basin used to define MS4 area from PHU.



**Appendix B**

Water Quality Concept Plan

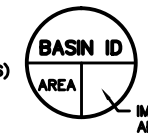




LEGEND	
	EXISTING STORM DRAIN
	ULTIMATE STORM DRAIN CONFIGURATION

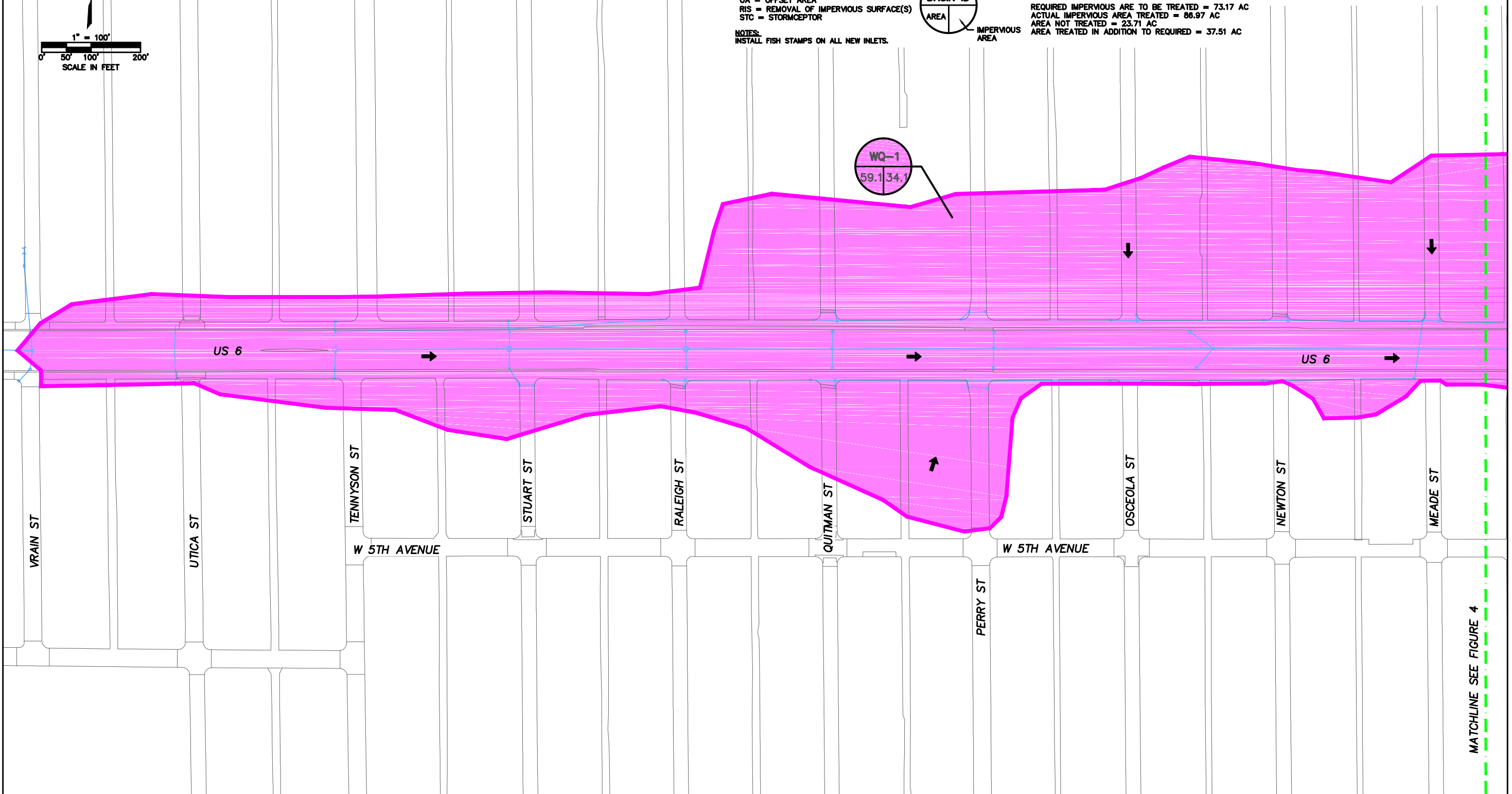
\*BMP = BEST MANAGEMENT PRACTICE  
 CWP = CONSTRUCTED WETLAND POND  
 EDB = EXTENDED DETENTION BASIN  
 NR = NOT REQUIRED  
 OA = OFFSET AREA  
 RIS = REMOVAL OF IMPERVIOUS SURFACE(S)  
 STC = STORMCEPTOR

NOTES:  
 INSTALL FISH STAMPS ON ALL NEW INLETS.



PERMANENT WATER QUALITY BMPs					
BASIN COLOR	BASIN ID	TYPE OF PERMANENT BMP*	REQUIRED IMPERVIOUS AREA TO BE TREATED (AC)	ACTUAL IMPERVIOUS AREA TREATED (AC)	COMMENTS
	WQ-1	EDB	2.29	34.12	US 6 WATER QUALITY POND
TOTAL - ALL WQ BASINS			73.17	86.97	

REQUIRED IMPERVIOUS ARE TO BE TREATED = 73.17 AC  
 ACTUAL IMPERVIOUS AREA TREATED = 86.97 AC  
 AREA NOT TREATED = 23.71 AC  
 AREA TREATED IN ADDITION TO REQUIRED = 37.51 AC



Computer File Information	
Creation Date: 12/12/2011	Initials: MEO
Last Modification Date: 08/22/2012	Initials: MEO
Full Path: F:\PROJECTS\011-2359\_WTRS\PRELIMINARY_PLANS	
Drawing File Name: 112359_US 6 BRIDGES WQ PLAN.DWG	
Acad Ver. 2011	Scale: 1:100 Units: FEET

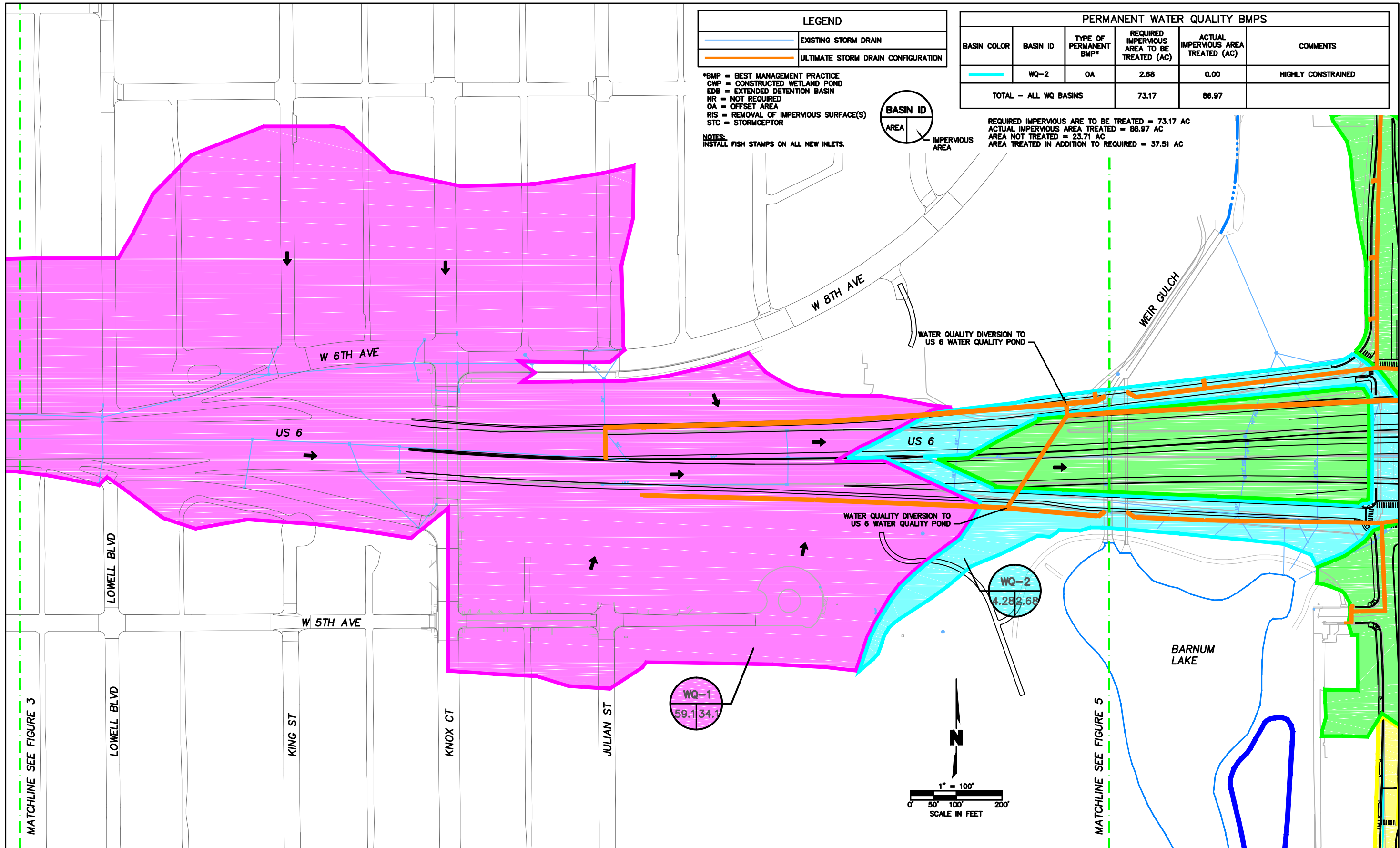
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(R-X)	
(R-X)	
(R-X)	

Colorado Department of Transportation  
  
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 Littleton, CO 80128  
 Phone: 303-972-9112 FAX: 303-972-9114  
 Region 6 TG

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No Revisions:	
Revised:	
Void:	

WATER QUALITY PLAN	
Designer:	M. ORLOFF
Detailer:	M. ORLOFF
Sheet Subset: WATER QUALITY	Subset Sheet: 3 of 6

Project No./Code	
Number	
18192	
Sheet Number	3



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Creation Date: 12/12/2011	Initials: MEO
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Acad Ver. 2011	Scale: 1:100 Units: FEET

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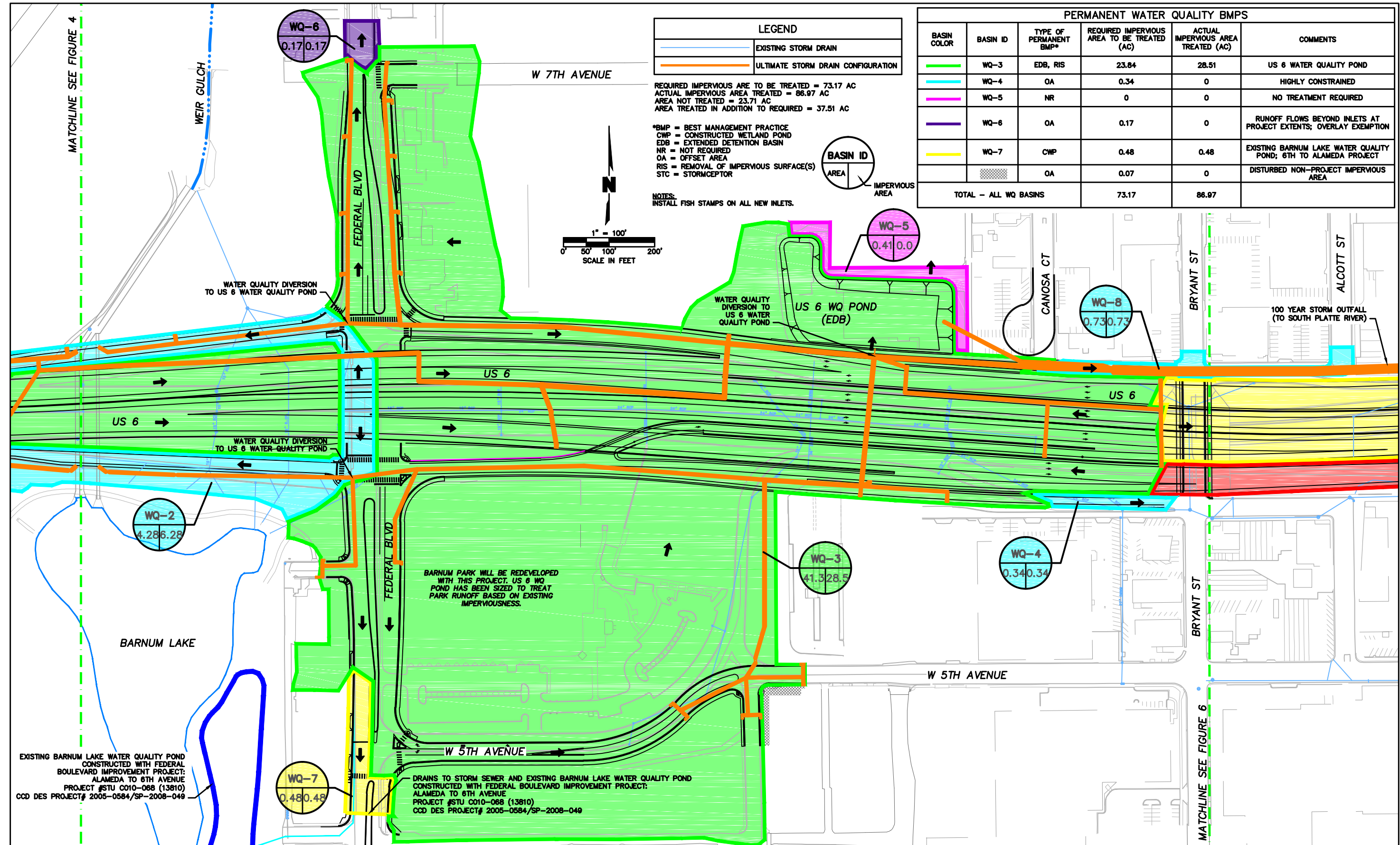
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 Phone: 303-972-9112 FAX: 303-972-9114  
 Region 6 TG

As Constructed  
 No Revisions:  
 Revised:  
 Void:

**WATER QUALITY PLAN**

Designer: M. ORLOFF  
 Detailer: M. ORLOFF  
 Sheet Subset: WATER QUALITY Subset Sheet: 4 of 6

Project No./Code  
 Number  
 18192  
 Sheet Number 4



**Computer File Information**

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**Index of Revisions**

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(R-X)		
(R-X)		

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 DEPARTMENT OF TRANSPORTATION

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No Revisions:

Revised:

Void:

**WATER QUALITY PLAN**

Designer: M. ORLOFF  
 Detailer: M. ORLOFF

Sheet Subset: WATER QUALITY Subset Sheet: 5 of 6

Project No./Code

Number

18192

Sheet Number 5

EXISTING BARNUM LAKE WATER QUALITY POND CONSTRUCTED WITH FEDERAL BOULEVARD IMPROVEMENT PROJECT: ALAMEDA TO 6TH AVENUE PROJECT #STU C010-068 (13810) CCD DES PROJECT# 2005-0584/SP-2008-049

DRAINS TO STORM SEWER AND EXISTING BARNUM LAKE WATER QUALITY POND CONSTRUCTED WITH FEDERAL BOULEVARD IMPROVEMENT PROJECT: ALAMEDA TO 6TH AVENUE PROJECT #STU C010-068 (13810) CCD DES PROJECT# 2005-0584/SP-2008-049

BARNUM PARK WILL BE REDEVELOPED WITH THIS PROJECT. US 6 WQ POND HAS BEEN SIZED TO TREAT PARK RUNOFF BASED ON EXISTING IMPERVIOUSNESS.

100 YEAR STORM OUTFALL (TO SOUTH PLATTE RIVER)

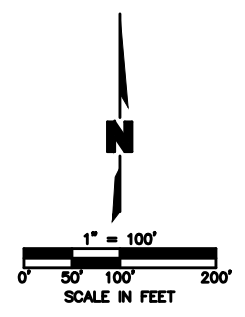
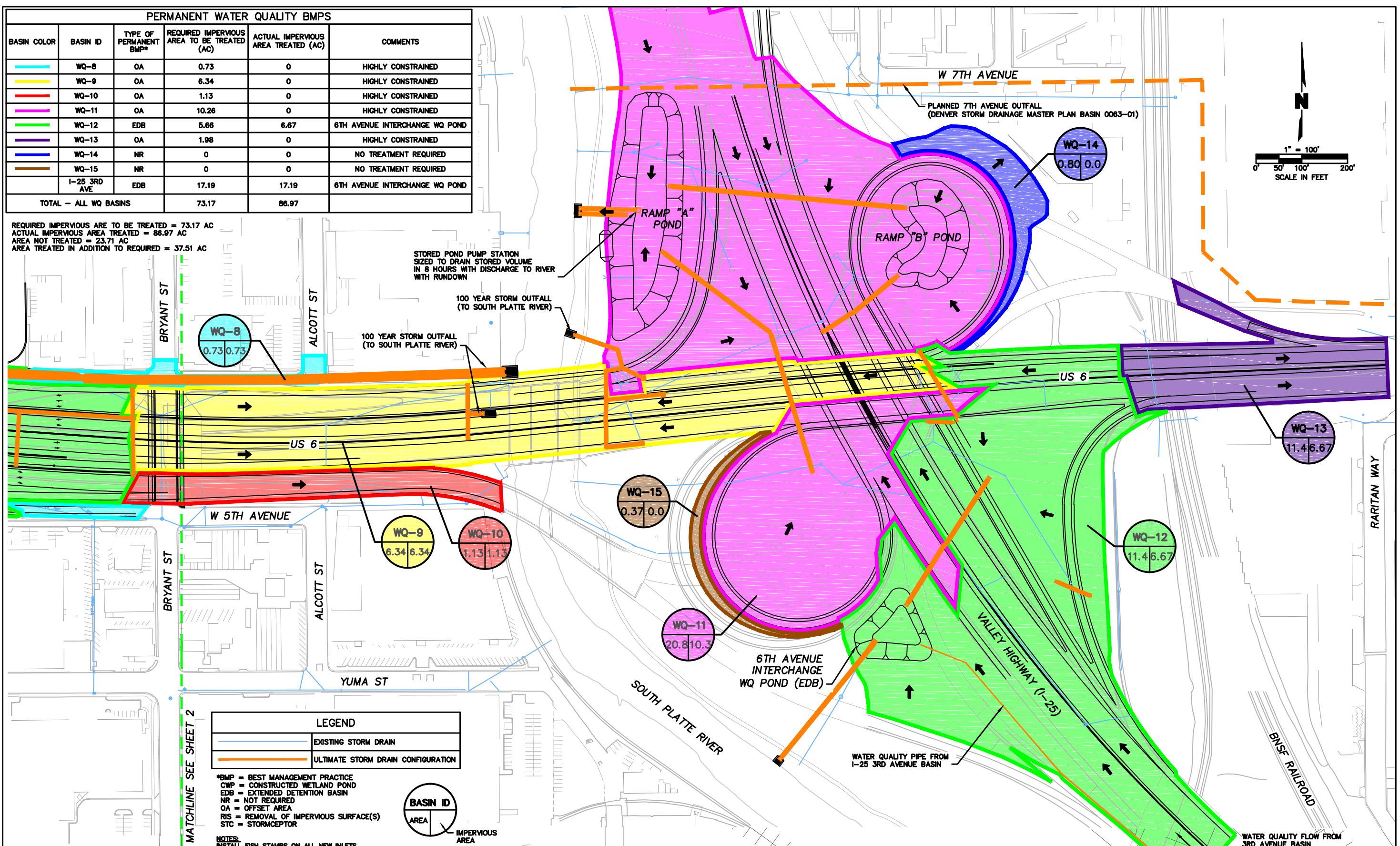
MATCHLINE SEE FIGURE 4

MATCHLINE SEE FIGURE 6



PERMANENT WATER QUALITY BMPS					
BASIN COLOR	BASIN ID	TYPE OF PERMANENT BMP*	REQUIRED IMPERVIOUS AREA TO BE TREATED (AC)	ACTUAL IMPERVIOUS AREA TREATED (AC)	COMMENTS
	WQ-8	OA	0.73	0	HIGHLY CONSTRAINED
	WQ-9	OA	6.34	0	HIGHLY CONSTRAINED
	WQ-10	OA	1.13	0	HIGHLY CONSTRAINED
	WQ-11	OA	10.26	0	HIGHLY CONSTRAINED
	WQ-12	EDB	5.66	6.67	6TH AVENUE INTERCHANGE WQ POND
	WQ-13	OA	1.98	0	HIGHLY CONSTRAINED
	WQ-14	NR	0	0	NO TREATMENT REQUIRED
	WQ-15	NR	0	0	NO TREATMENT REQUIRED
	I-25 3RD AVE	EDB	17.19	17.19	6TH AVENUE INTERCHANGE WQ POND
TOTAL - ALL WQ BASINS			73.17	86.97	

REQUIRED IMPERVIOUS ARE TO BE TREATED = 73.17 AC  
 ACTUAL IMPERVIOUS AREA TREATED = 86.97 AC  
 AREA NOT TREATED = 23.71 AC  
 AREA TREATED IN ADDITION TO REQUIRED = 37.51 AC



LEGEND	
	EXISTING STORM DRAIN
	ULTIMATE STORM DRAIN CONFIGURATION

\*BMP = BEST MANAGEMENT PRACTICE  
 CWP = CONSTRUCTED WETLAND POND  
 EDB = EXTENDED DETENTION BASIN  
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NOTES:  
 INSTALL FISH STAMPS ON ALL NEW INLETS.

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Revised:	
Void:	

WATER QUALITY PLAN	
Designer:	M. ORLOFF
Detailer:	M. ORLOFF
Sheet Subset: WATER QUALITY	Subset Sheet: 6 of 6

Project No./Code	
Number	
18192	
Sheet Number 6	