Master Plan
Water Quality Report

US 6 Bridges Design Build Project
BR 0061-083
Sub Account No. 18838 (CN)
Denver, Colorado

Prepared for
Colorado Department of Transportation

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1.0 INTRODUCTION

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

1.1 Location of Improvements

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

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

1.2 Description of Improvements

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

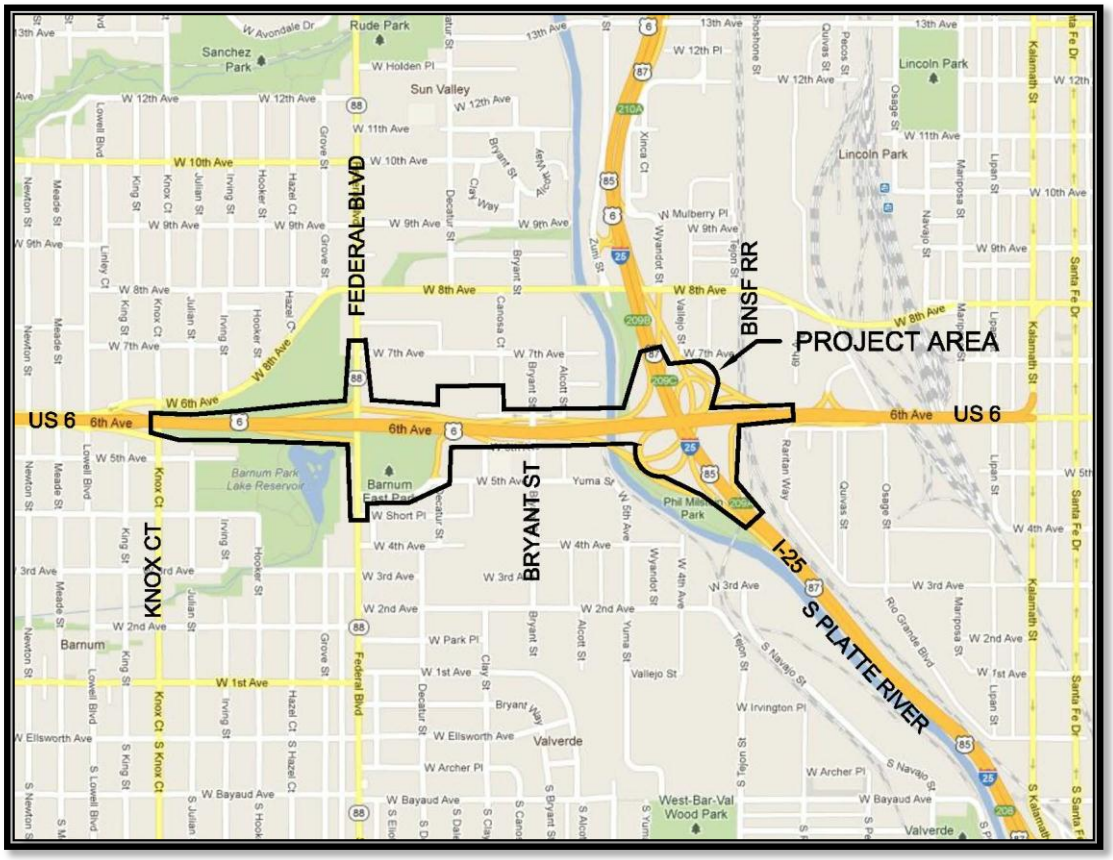


Figure 1: Vicinity Map

2.0 WATER QUALITY REQUIREMENTS

2.1 Adherence to the CDOT MS4 Permit and NDRD Requirements

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

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

2.2 Assumptions and Methodologies

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

3.0 WATER QUALITY DESIGN

3.1 Design Coordination

3.1.1 Adjacent Segments

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

3.1.2 Agency Coordination

Design approvals will be required from CDOT and CCD.

3.2 Hydrology and Design Flow Development

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

$$Q = CIA$$

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

C = Runoff coefficient

I = Rainfall intensity in inches per hour

A = Drainage area in acres

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

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

3.3 Description of Water Quality Basins

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

See Appendix B for the Water Quality Concept Plan.

3.4 Permanent Stormwater Best Management Practices

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

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

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

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

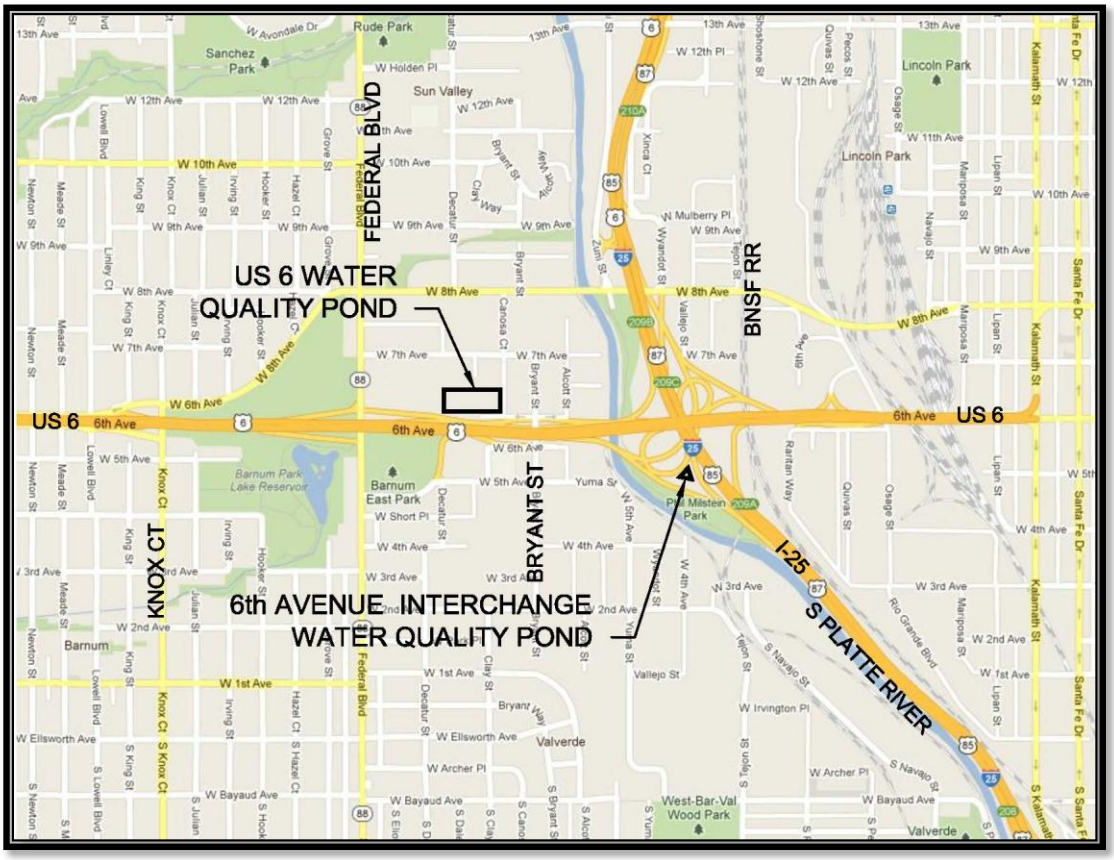


Figure 2: Locations of BMPs

3.4.1 Water Quality Treatment

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 6th Avenue Interchange Water Quality Pond. See Sections 3.4.2 and 3.4.3 for further discussion of these ponds.

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

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.

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

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

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

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

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

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

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

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

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

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

3.4.2 US 6 Water Quality Pond

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

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

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

See Appendix B for the Water Quality Concept Plan.

3.4.3 6th Avenue Interchange Water Quality Pond

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

See Appendix B for the Water Quality Concept Plan.

3.4.4 Right of Way Concerns

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

4.0 MAINTENANCE AND OPERATION

4.1.1 US 6 Water Quality Pond

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

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

4.1.2 6th Avenue Interchange Water Quality Pond

The 6th Avenue Interchange Water Quality Pond can be accessed from Ramp “C,” the southbound I-25 to eastbound US 6 ramp.

The pond outlet works will need routine maintenance to clear the trash rack and orifice plate of debris. The pond bottom and trickle channel should be scraped and regraded as needed to remove sediment build-up. A minor amount of continuous maintenance will be necessary to 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 ac-ft

= 106,881 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)

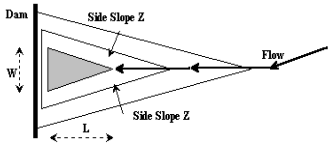
1.2 Factor = Multiplier of 1.2 to account for the additional 20% of required storage for sediment accumulation

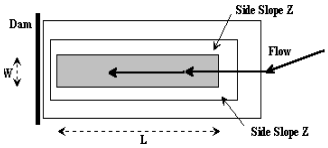
V_{WQCV}= 1.01 ac-ft

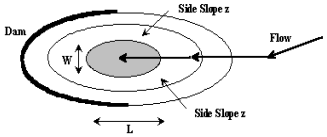
= 44,014 ft^3

STAGE-STORAGE SIZING FOR POLYGONAL, ELLIPTICAL, OR IRREGULAR PONDS

Project: US 6 BRIDGES
Basin ID: US 6 Water Quality Pond







Design Information (Input):

Width of Pond Bottom, W =		ft
Length of Pond Bottom, L =		ft
Dam Side-slope (H:V), Z_d =		ft/ft

Check Pond Shape

Right Triangle		OR…
Isosceles Triangle		OR…
Rectangle		OR…
Circle / Ellipse		OR…
Irregular	X	(Use Overide values in cells G32:G52)

Stage-Storage Relationship:

	MINOR	MAJOR	
Storage Requirement from Sheet 'Modified FAA':			acre-ft.
Storage Requirement from Sheet 'Hydrograph':			acre-ft.
Storage Requirement from Sheet 'Full-Spectrum':			acre-ft.

Labels for WQCV, Minor, & Major Storage Stages (input)	Stage ft (input)	Side Slope (H:V) ft/ft Below El.	Pond Width at Stage ft (output)	Pond Length at Stage ft (output)	Surface Area at Stage ft^2 (output)	Surface Area at Stage ft^2 User Overide	Volume Below Stage ft^3 (output)	Surface Area at Stage acres (output)	Volume Below Stage acre-ft (output)	Target Volumes for WQCV, Minor, & Major Storage Volumes (for goal seek)
	5203.00	(input)				0	0	0.000	0.000	
	5203.50		0.00	0.00		610	152	0.014	0.004	
	5204.00		0.00	0.00		3,666	1,221	0.084	0.028	
	5204.50		0.00	0.00		11,507	5,015	0.264	0.115	
	5205.00		0.00	0.00		18,318	12,471	0.421	0.286	
	5205.50		0.00	0.00		22,737	22,734	0.522	0.522	
	5206.00		0.00	0.00		26,783	35,114	0.615	0.806	
	5206.50		0.00	0.00		30,782	49,506	0.707	1.136	
	5207.00		0.00	0.00		34,819	65,906	0.799	1.513	
	5207.50		0.00	0.00		38,814	84,314	0.891	1.936	
	5208.00		0.00	0.00		42,575	104,662	0.977	2.403	
WQCV	5208.05		0.00	0.00		42,928	106,799	0.985	2.452	
	5208.50		0.00	0.00		46,106	126,832	1.058	2.912	
	5209.00		0.00	0.00		49,686	150,780	1.141	3.461	
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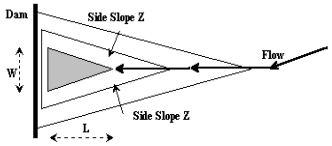
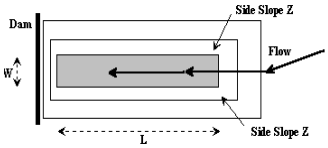
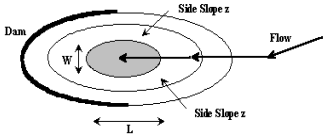
STAGE-STORAGE SIZING FOR POLYGONAL, ELLIPTICAL, OR IRREGULAR PONDS

Project: US 6 BRIDGES
Basin ID: 6th Avenue Interchange Water Quality Pond







Design Information (Input):

Width of Pond Bottom, W =		ft
Length of Pond Bottom, L =		ft
Dam Side-slope (H:V), Z_d =		ft/ft

Check Pond Shape

Right Triangle		OR…
Isosceles Triangle		OR…
Rectangle		OR…
Circle / Ellipse		OR…
Irregular	X	(Use Overide values in cells G32:G52)

Stage-Storage Relationship:

	MINOR	MAJOR	
Storage Requirement from Sheet 'Modified FAA':			acre-ft.
Storage Requirement from Sheet 'Hydrograph':			acre-ft.
Storage Requirement from Sheet 'Full-Spectrum':			acre-ft.

Labels for WQCV, Minor, & Major Storage Stages (input)	Stage ft (input)	Side Slope (H:V) ft/ft Below El. (input)	Pond Width at Stage ft (output)	Pond Length at Stage ft (output)	Surface Area at Stage ft^2 (output)	Surface Area at Stage ft^2 User Overide	Volume Below Stage ft^3 (output)	Surface Area at Stage acres (output)	Volume Below Stage acre-ft (output)	Target Volumes for WQCV, Minor, & Major Storage Volumes (for goal seek)
	5201.23					0	0	0.000	0.000	
	5201.50		0.00	0.00		339	46	0.008	0.001	
	5202.00		0.00	0.00		1,272	449	0.029	0.010	
	5202.50		0.00	0.00		3,581	1,662	0.082	0.038	
	5203.00		0.00	0.00		5,245	3,869	0.120	0.089	
	5203.50		0.00	0.00		6,293	6,753	0.144	0.155	
	5204.00		0.00	0.00		6,811	10,029	0.156	0.230	
	5204.50		0.00	0.00		7,350	13,570	0.169	0.312	
	5205.00		0.00	0.00		7,910	17,385	0.182	0.399	
	5205.50		0.00	0.00		8,491	21,485	0.195	0.493	
	5206.00		0.00	0.00		9,094	25,881	0.209	0.594	
	5206.50		0.00	0.00		9,718	30,584	0.223	0.702	
	5207.00		0.00	0.00		10,363	35,604	0.238	0.817	
	5207.50		0.00	0.00		11,030	40,953	0.253	0.940	
WQCV	5207.76		0.00	0.00		11,388	43,867	0.261	1.007	1.005 AF
	5208.00		0.00	0.00		11,718	46,640	0.269	1.071	
	5208.50		0.00	0.00		12,427	52,676	0.285	1.209	
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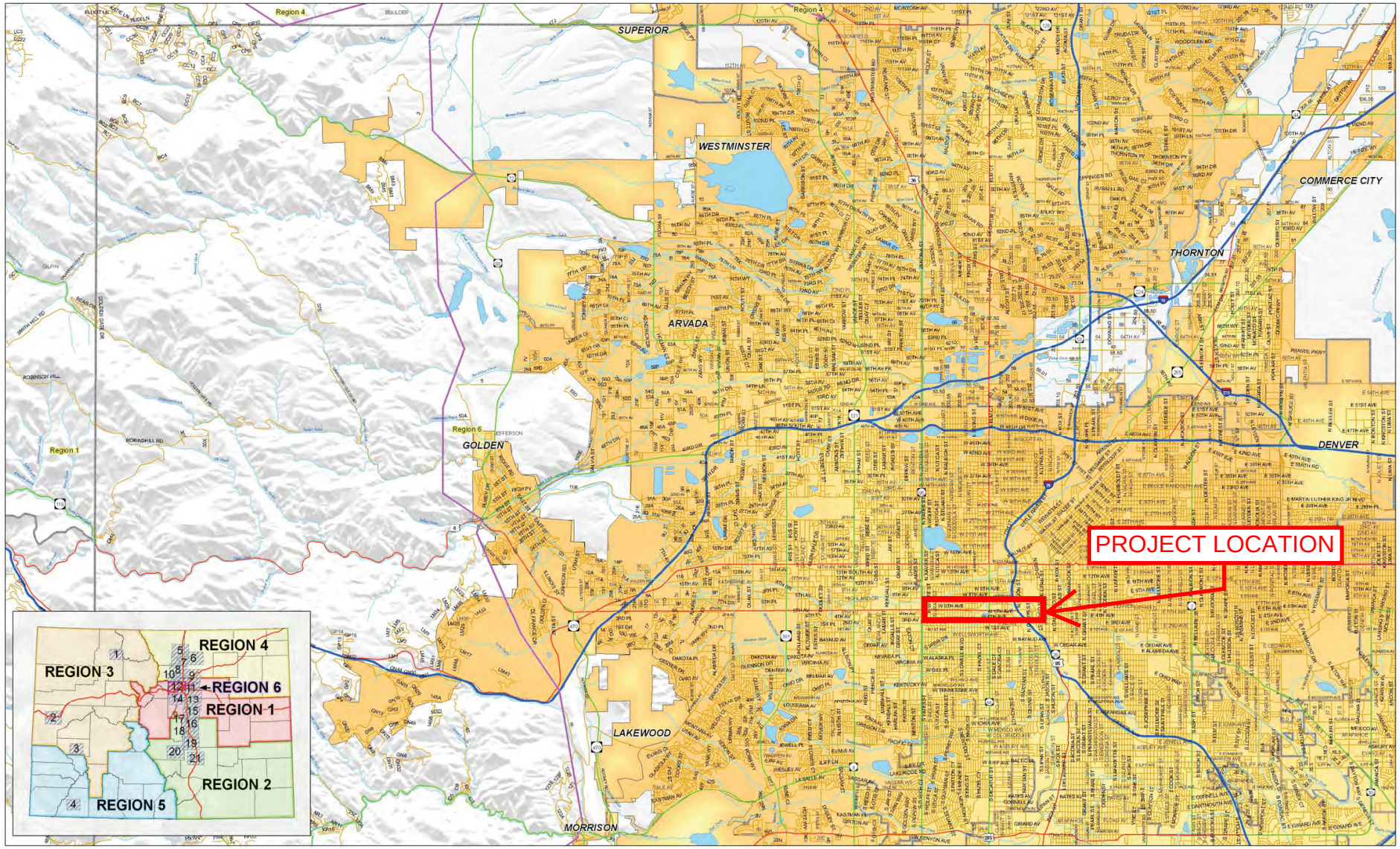
CDOT MS4 Permit Coverage Area, Map 12



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)

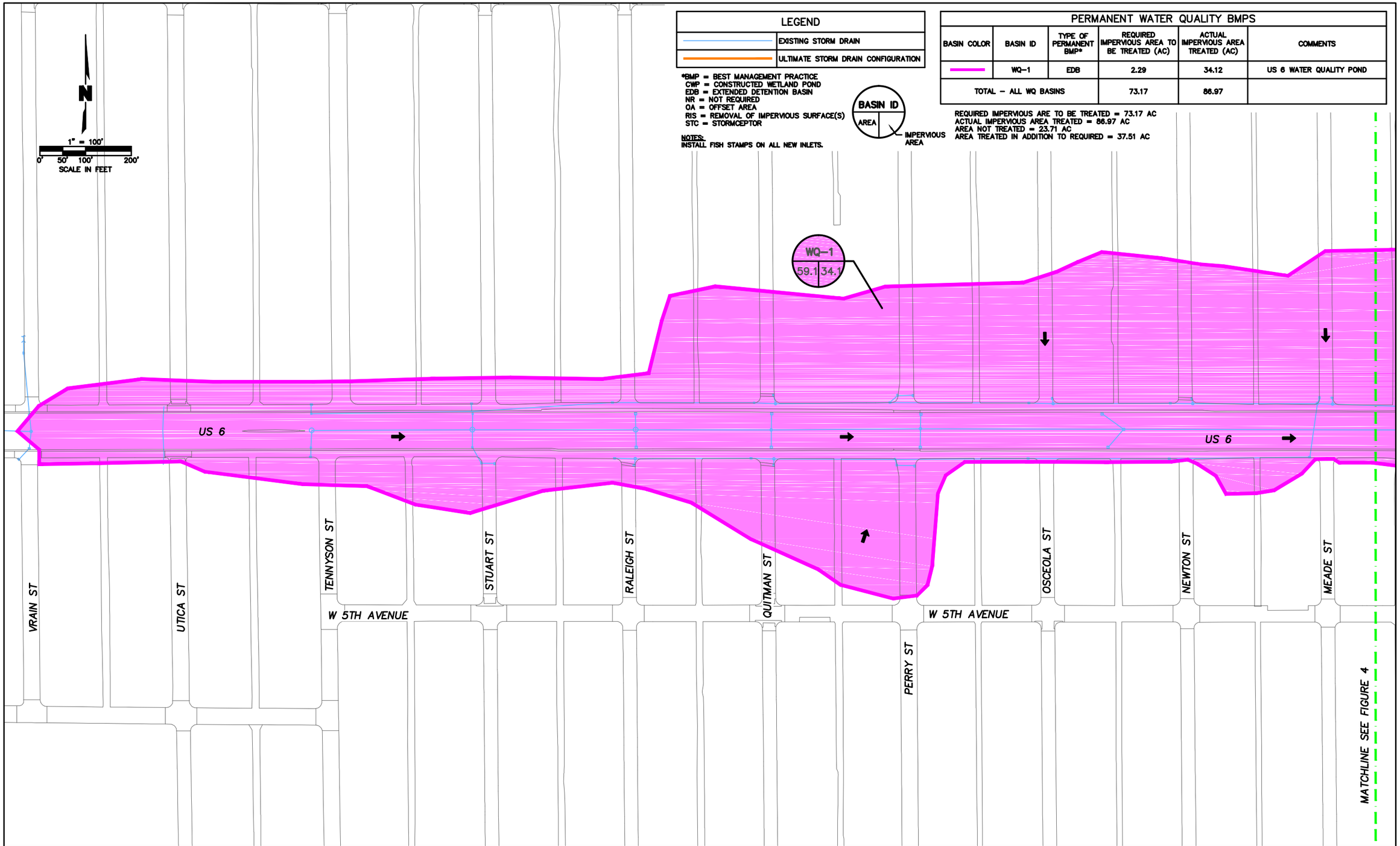
0 2 4 8 Miles

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 delimit MS4 area from FHU.

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.

BASIN ID
AREA — IMPERVIOUS AREA

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

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Last Modification Date: 08/22/2012	Initials: MEO
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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
R-X

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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

LEGEND	
	EXISTING STORM DRAIN
	ULTIMATE STORM DRAIN CONFIGURATION

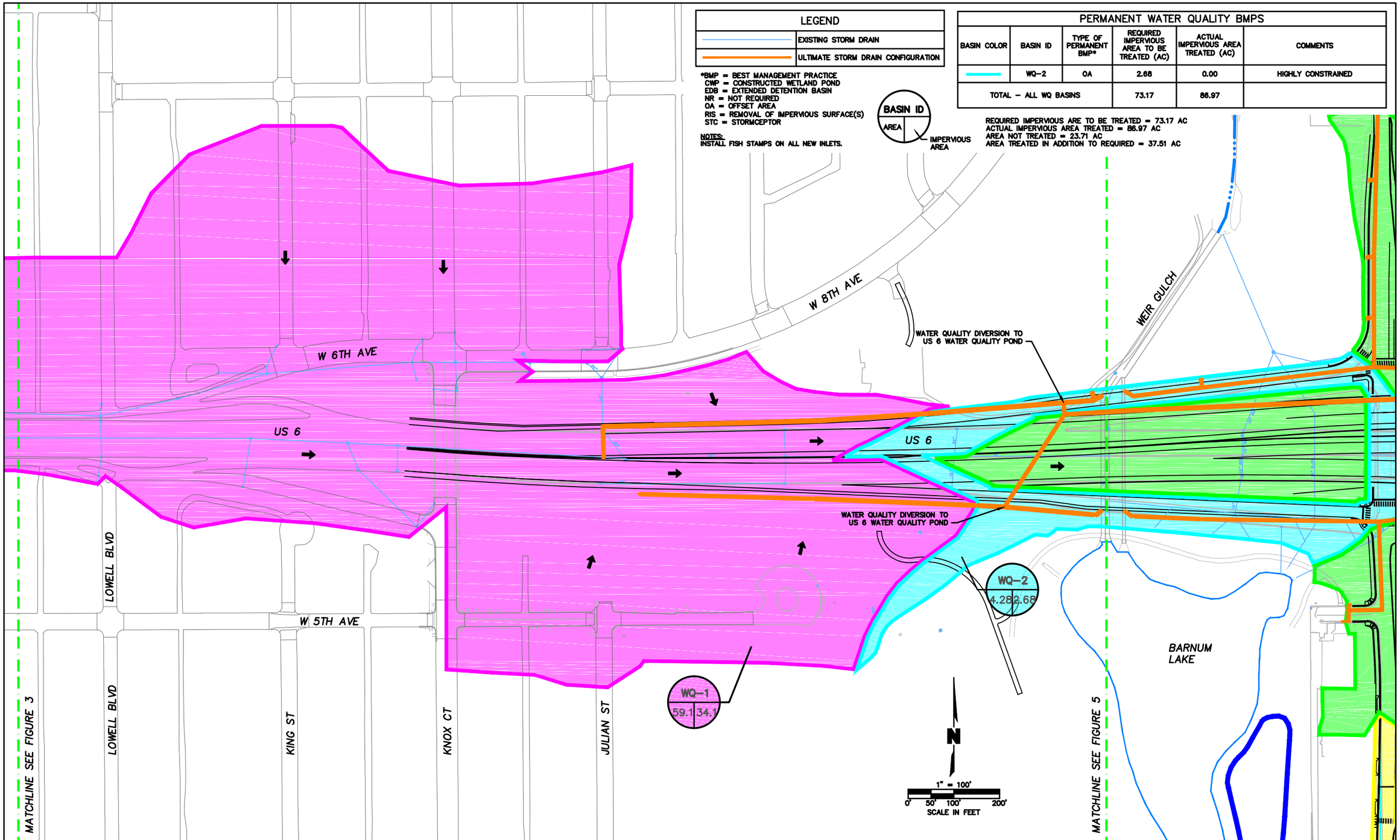
*BMP = BEST MANAGEMENT PRACTICE
CWP = CONSTRUCTED WETLAND POND
EDB = EXTENDED DETENTION BASIN
NR = NOT REQUIRED
OA = OFFSET AREA
RIS = REMOVAL OF IMPERVIOUS SURFACE(S)
STC = STORMCEPTOR

NOTES:
INSTALL FISH STAMPS ON ALL NEW INLETS.

BASIN ID
AREA — IMPERVIOUS AREA

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-2	OA	2.68	0.00	HIGHLY CONSTRAINED
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



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Acad Ver. 2011 Scale: 1:100	Units: FEET	R-X

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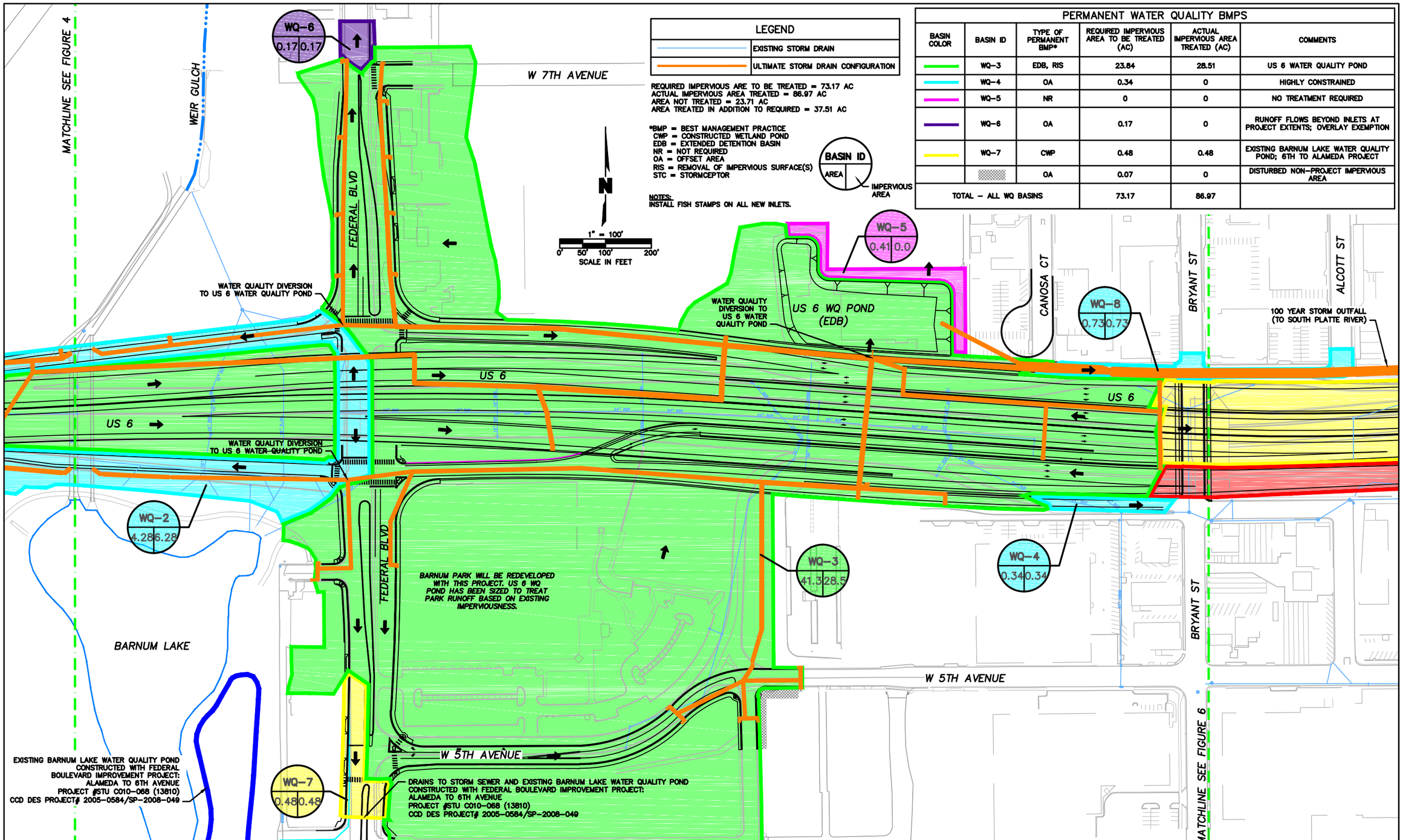
Void:

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



LEGEND

	EXISTING STORM DRAIN
	ULTIMATE STORM DRAIN CONFIGURATION

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

*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.

BASIN ID
AREA — IMPERVIOUS AREA

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-3	EDB, RIS	23.84	28.51	US 6 WATER QUALITY POND
	WQ-4	OA	0.34	0	HIGHLY CONSTRAINED
	WQ-5	NR	0	0	NO TREATMENT REQUIRED
	WQ-6	OA	0.17	0	RUNOFF FLOWS BEYOND INLETS AT PROJECT EXTENTS; OVERLAY EXEMPTION
	WQ-7	CWP	0.48	0.48	EXISTING BARNUM LAKE WATER QUALITY POND; 6TH TO ALAMEDA PROJECT
		OA	0.07	0	DISTURBED NON-PROJECT IMPERVIOUS AREA
TOTAL - ALL WQ BASINS			73.17	86.97	

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Void:

WATER QUALITY PLAN

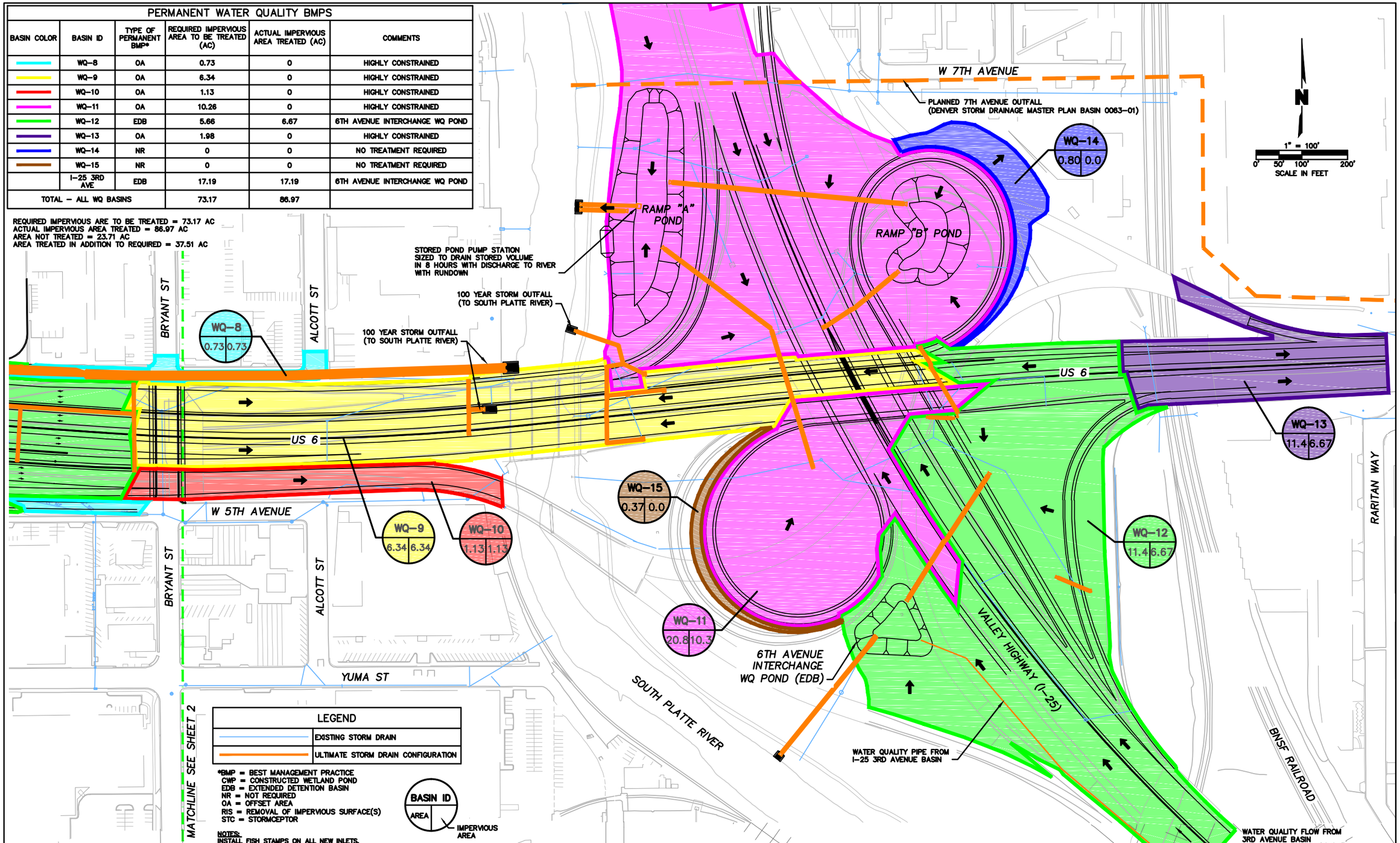
Designer: M. ORLOFF
Detailer: M. ORLOFF
Sheet Subset: WATER QUALITY
Subset Sheet: 5 of 6

Project No./Code Number
18192
Sheet Number 5

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



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Acad Ver. 2011	Scale: 1:100	Units: FEET

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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