SECOND CREEK (DOWNSTREAM OF DIA) AND DFA 0053 WATERSHEDS OUTFALL SYSTEMS PLANNING STUDY UPDATE

PRELIMINARY DESIGN REPORT

Prepared for:

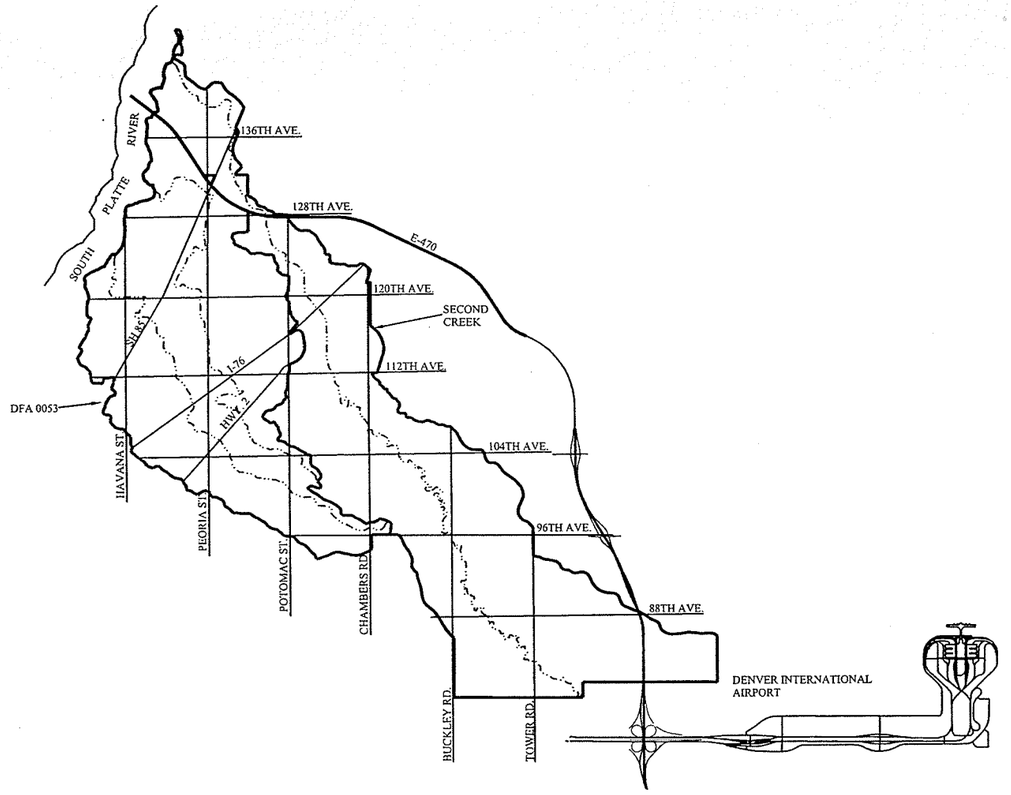
CITY OF BRIGHTON
22 South 4th Avenue - Brighton, Colorado 80601

CITY OF BRIGHTON

COMMERCE CITY

ADAMS COUNTY

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT



August 2004

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7175 West Jefferson Avenue
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SECOND CREEK (DOWNSTREAM OF DIA) AND DFA 0053 WATERSHEDS OUTFALL SYSTEMS PLANNING STUDY UPDATE

PRELIMINARY DESIGN REPORT

Prepared for:

City of Brighton
Commerce City
Adams County
and
Urban Drainage and Flood Control District
2480 West 26th Avenue, Suite 156B
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August, 2004

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EXECUTIVE SUMMARY

Introduction

The Outfall Systems Planning Study for *Second Creek (UD ID#3500) and Direct Flow Area (DFA) #0053* was authorized by the Urban Drainage and Flood Control District (UDFCD) under joint sponsorship with Adams County and the Cities of Brighton and Commerce City. The study was initiated to analyze the existing and future drainage conditions of the watershed, develop alternative drainageway planning concepts, and prepare a preliminary design of facilities. This report presents the preliminary design of drainage systems for a master plan of the watershed.

Throughout the study process Kiowa Engineering has met regularly with the sponsors to present findings and receive insight and direction. Other agencies with various interests in the watershed were also invited to attend the meetings: the Denver International Airport, the Department of Wildlife, the E-470 Authority, the U.S. Army Corps of Engineers, the EPA, the Cities of Denver and Aurora, and the Colorado Department of Transportation. Kiowa Engineering also met with Shea Homes, Amber Homes, CVL Consultants, Triangle Pointe Subdivision and other developers and land owners in the watershed to obtain the most recent future development plans. In all, eleven progress meetings and one public meeting were held to ensure the study's accuracy and that specific sponsor objectives were achieved.

Study Area

These watersheds are located in Adams County, Commerce City, and the City of Brighton and they are east-bank tributaries to the *South Platte River*. See Figure ES-1 for a vicinity map. This watershed is projected to rapidly urbanize with a mix of commercial and residential developments. The E-470 extension is complete through the study area and high-density development is expected to follow along this major transportation corridor. Nearly all of the area that is currently undeveloped is being planned for development in the near future.

Hydrology

Hydrologic analysis was performed for the 2-, 5-, 10-, 50-, and 100-year return periods for existing and future conditions. Analysis of the average annual (0.4-inch) rainfall event was also conducted. The CUHP computer model was used to compute runoff hydrographs at key locations throughout the study area. The UDSWMM computer model was used to route and combine the hydrographs along the drainageways. Peak flow rates from the hydrologic analyses are summarized in Chapter III with complete model output contained in Appendix B. In addition, road-crossing structures were inventoried and studied independently to determine hydraulic capacity. Results of the hydraulic analysis are shown in Chapter IV.

In 1990, an Outfall System Planning Study was completed for the entire *Second Creek* watershed and *DFA 0053*. The study defined hydrology and hydraulics and established a master plan for the watershed. At the time of the 1990 study, E-470 and DIA were in the planning stages, earlier versions of CUHP-SWMM were used, average subbasin sizes exceeded 130 acres, existing land uses were different, future land uses were rough approximations, and USGS contour mapping was used for model definition. This current study is an update to the 1990 study focusing on the area downstream of DIA and *DFA 0053*. Detailed 2-foot contour mapping is now available for more accurate model definition, existing and future land uses have been revised, the latest version 2000 of CUHP-SWMM has been used, and E-470 and DIA have been constructed and modeled accordingly. Upstream of DIA, the previous 1990 master plan models are used to establish inflow hydrographs to the updated study area.

Flood potential was reviewed and determined not to be a significant problem in the *Second Creek* watershed under current watershed conditions. Flood potential greatly increases with anticipated future development. In 1976, a Flood Hazard Area Delineation (FHAD) report was published. This report anticipated moderate future development and established the 100-year regulatory floodplain to eliminate future structural flood damages. Comparing results from this study with the 1976 FHAD found that flood magnitudes predicted at that time are slightly lower, but relevant to projected fully-developed conditions. Implementing flood detention, as recommended by this study, makes the FHAD an appropriate regulatory guide. Use of the 100-year FHAD floodplain as a regulatory guide has kept development out of the 100-year floodplain. The FHAD floodplain should continue to be used to guide future development near the major drainageways.

The primary drainage problems in this watershed are potential increased runoff from future development, decreased water quality from urban runoff, frequent road overtopping, frequent ditch overtopping and potential failure, lack of adequate outfall paths to the *South Platte River*, and increased erosion and sediment transport. Creating detention basins to store the added runoff and release it at a slower rate can offset increased runoff and flood peaks. Using water quality basins to capture the initial flush of runoff and settle out the sediments and pollutants can enhance water quality. Also, requiring developers to adhere to Best Management Practices as described in Volume III of the Urban Storm Drainage Criteria Manual can further reduce urban impacts on water quality. Undersized road crossings have been analyzed and larger road crossings have been sized to pass various frequency flood peaks. Formal flow paths have been identified to carry flood flows through the watershed to the *South Platte River*.

Adding crossing structures at the three irrigation canals (Fulton Ditch, Burlington Ditch, O'Brian Canal) is a significant component of the plan. Historically, the three canals have captured all low-flows and carried them out of the watershed. As flows increase in frequency and magnitude this will create a problem for ditch operations. Due to the infrequent occurrence of flows downstream of the canals, there is almost no sign of a conveyance channel to the *South Platte River*. Adding low-flow crossing structures to separate storm runoff from irrigation water will require an adequate downstream channel to carry the flows and prevent downstream flooding. A primary goal of the plan is to provide an adequate drainage system to carry runoff to the South Platte River and to safely convey 100-year flood flows.

The master plan allows emergency transportation through the watershed along all major transportation routes. 100-year capacity road crossings are not necessary at every crossing of the drainageways. Achieving 100-year capacities at North-South roads: US-85, I-76, Chambers Road, Tower Road; and East-West roads: 136th Avenue, 120th Avenue, 112th Avenue, 104th Avenue provides emergency access though the watershed.

A 5-year channel design is planned to carry flows past the O'Brian Canal, Burlington Ditch, and Fulton Ditch to the *South Platte River*. This capacity was deemed acceptable since the 100-year floodplain has been preserved and is available to carry 100-year flows without structural damages. Preserving the 100-year floodplain is a key part of the flood control plan and also supports the proposed trail system along

Second Creek and maintains a continuous open space corridor as desired by the project sponsors. No channel excavation is recommended upstream of the O'Brian Canal. The existing channel will be utilized to convey low-flows and allowed to naturally adjust within the preserved floodplain to more frequent runoff events.

A summary of the master plan is shown on Figures ES-2 and ES-3, and described as follows:

Table ES-1
Second Creek Master Plan Summary

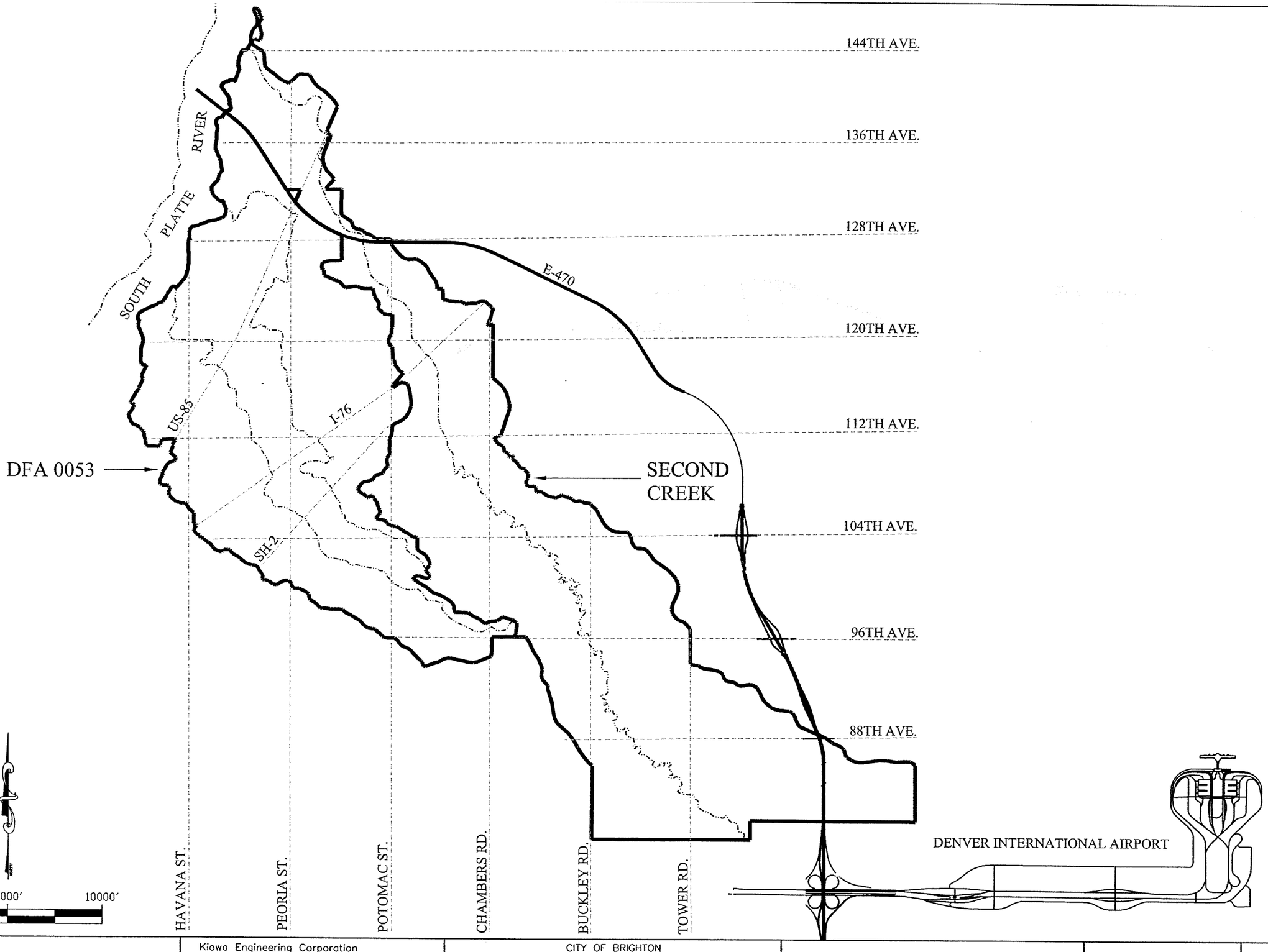
Outfall #	Name	Length (miles)	Catchment Area (sq.mi.)	Improvements	Estimated Total Cost $
3500	Second Creek	15.45	12.65	5-yr wetland bottom channel, Detention 330 (195 ac-ft) 336 (163 ac-ft) 366 (132 ac-ft), 3 Water Quality Basins (7.9 ac-ft), 5-yr Canal Crossings at Fulton, Burlington, O'Brian, Road Crossings at Brighton Road, US-85, 136th Avenue, Union Pacific RR, 132nd Avenue, Tucson Street, 124th Avenue, Potomac Street, Chambers Road, 104th Avenue, 88th Avenue, Tower Road, 14 drop structures, Preserve Floodplain	$46,021,547
3500-03.01	Reed Run	0.89	0.47	Water Quality Basin (4.4 ac-ft), 7 Check Structures, Preserve Floodplain	$890,450
3500-03.02	Drew Draw	0.63	0.40	Water Quality Basin (3.7 ac-ft), 10 Check Structures, Preserve Floodplain	$717,899
3500-03.03	Peachleaf Run	0.48	0.37	Water Quality Basin (4.1 ac-ft), 7 Check Structures, Preserve Floodplain	$631,998
3500-03.04	Gramma Gulch	1.08	0.89	Water Quality Basin (7.1 ac-ft), 13 Check Structures, Preserve Floodplain	$1,166,444
3500-03.05	Dragway Draw	1.00	0.57	Water Quality Basin (6.9 ac-ft), 14 Check Structures, Preserve Floodplain	$1,167,526
3501	West Fork	0.83	0.18	Water Quality Basin (7.1 ac-ft), 2 Check Structures, Preserve Floodplain	$920,519
3500-04.01	Sandbar Run	0.57	0.46	Water Quality Basin (5.3 ac-ft), 1 Check Structure, Preserve Floodplain	$648,740
		20.93			$52,165,123

DFA 0053 has no floodplain definition and out-of-bank flows could be problematic. A 100-year design capacity was chosen for conveyance and road crossing capacity. The master plan is cost effective through its emphasis on formalizing existing detention within the watershed where effective flood reduction is found. At several locations, runoff is stored behind road embankments in existing low-lying areas with undersized culvert crossings. Formalizing these areas with few additional structural changes creates an effective detention facility with minimal cost.

Table ES-2
DFA 0053 Master Plan Summary

Outfall #	Name	Length (miles)	Catchment Area (sq.mi.)	Improvements	Estimated Total Cost $
0053-01	Lockspur Drain	0.55	0.26	none	$0
0053-02	Fox Run	3.14	3.49	100-yr channel, Brighton Road Crossing, Detention 164 (192 ac-ft), Water Quality Basin (7.5 ac-ft), 124th Avenue Crossing, 1 check structure	$5,221,711
0053-02.01	Locust Run	1.99	2.09	100-yr channel, Road Crossings at 124th Avenue, 120th Avenue, I-76, SH-2, Canal Crossings at Burlington Ditch, O'Brian Canal,	$3,833,453
0053-02.02	Reign Creek	3.20	0.88	100-yr channel, Road Crossings at 120th Avenue, SH-2, O'Brian Canal Crossing, Detention 332 (60 ac-ft) 319 (22 ac-ft), 2 Water Quality Basins (7.4 ac-ft)	$5,392,692
0053-02.03	Tumbleweed Draw	1.00	0.30	100-yr channel, Detention 330 (3.1 ac-ft), Water Quality Basin (0.3 ac-ft)	$1,756,047
0053-03	Arabian Drain	0.25	0.16	100-yr channel, Brighton Road Crossing	$352,404
0053-04	Henderson Creek	5.09	4.60	100-yr channel, Road Crossings at Brighton Road, 120th Avenue, US-85, Union Pacific RR, Havana Street, 112th Avenue, 104th Avenue, Peoria Street, Canal Crossings at Fulton, Burlington, O'Brian, Detention 346 (142 ac-ft) 314 (21 ac-ft), 2 Water Quality Basins (11.3 ac-ft), 3 Check Structures	$12,300,914
0053-04.01	Saddle Creek	0.61	0.36	100-yr channel	$193,626
0053-04.02	Ragweed Draw	4.20	2.17	100-yr channel, Road Crossings at 112th Avenue, I-76, SH-2, BNSF RR, 104th Avenue, Potomac Street, O'Brian Canal Crossing, Detention 333 (92 ac-ft), Water Quality Basin (7.5 ac-ft), 3 Check Structures	$10,926,534
		20.03			$39,977,382

The total implementation cost for the improvements addressing foreseeable drainage problems within the two watersheds is estimated at $92.1 million [$52.2 million within *Second Creek*, $40.0 million within *DFA 0053*]. The 1990 master plan focused on a 100-year design and culminated in a final plan at a cost of $122.5 million [in 1990 dollars]. The updated plan has been reduced in scale with more preservation and utilization of existing hydrologic features for a total cost of $92.1 million. The need for most of these improvements is attributed to anticipated future development and much of the cost can be shared with future developers through regulatory guidelines used to mitigate the drainage impacts of the developments.



	Kiowa Engineering Corporation 7175 West Jefferson, Suite 3400 Lakewood, Colorado 80235 (303)-692-0369	CITY OF BRIGHTON CITY OF COMMERCE CITY ADAMS COUNTY URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	SECOND CREEK D/S OF DIA AND DFA 0053 OUTFALL SYSTEMS PLANNING STUDY UPDATE	*VICINITY MAP*	FIGURE ES-1

100-YEAR ROAD CROSSINGS:
BRIGHTON ROAD
US-85
136TH AVENUE
UNION PACIFIC RR
132ND AVENUE (10-YEAR)
TUCSON STREET (10-YEAR)
124TH AVENUE
POTOMAC STREET
CHAMBERS ROAD
104TH AVENUE
88TH AVENUE
TOWER ROAD

ARMORED SPILLOVER TO SOUTH PLATTE

5-YEAR FULTON DITCH CROSSING W/ ARMORED 100-YEAR SPILLOVER

5-YEAR BURLINGTON DITCH CROSSING W/ ARMORED 100-YEAR SPILLOVER

5-YEAR O'BRIAN CANAL CROSSING W/ ARMORED 100-YEAR SPILLOVER

SECOND CREEK

DENVER INTERNATIONAL AIRPORT

South Platte River

BRIGHTON ROAD

US-85

136TH AVE.

132ND AVE.

UP RR

E-470

I-76

124TH AVE.

120TH AVE.

112TH AVE.

104TH AVE.

TOWER RD.

96TH AVE.

88TH AVE.

TUCSON RD.

POTOMAC RD.

CHAMBERS RD.

PENA BLVD.

Drew Draw

Peachleaf Run

Reed Run

Granma Gulch

Sandbar Run

Dragway Draw

West Fork

Preserve Floodplain

WQCV 2.5 ac-ft

WQCV 3.7 ac-ft

WQCV 4.1 ac-ft

WQCV 4.4 ac-ft

WQCV 3.2 ac-ft

WQCV 2.2 ac-ft

WQCV 7.1 ac-ft

WQCV 5.3 ac-ft

WQCV 6.9 ac-ft

WQCV 7.1 ac-ft

WQCV 6.1 ac-ft

5-YEAR WETLAND BOTTOM CHANNEL
6 MILES (O'BRIAN CANAL TO SOUTH PLATTE)
WITH 14 DROP STRUCTURES

DETENTION #330
100-year
Ex Inflow = 4302 cfs
Fu Inflow = 8812 cfs
MP Inflow = 4083 cfs
Detention = 194.5 acft
MP Outflow = 3076 cfs
100yr Elev = 5113.1 ft

DETENTION #336
10-year
Ex Inflow = 659 cfs
Fu Inflow = 3211 cfs
MP Inflow* = 1128 cfs
Detention = 163.1 acft
MP Outflow = 634 cfs
10yr Elev = 5130.9 ft

DETENTION #366
2-year
Ex Inflow = 5 cfs
Fu Inflow = 1588 cfs
MP Inflow* = 479 cfs
Detention = 132.0 acft
MP Outflow = 120 cfs
2yr Elev = 5194.0 ft

0 4000' 8000'

	Kiowa Engineering Corporation 7175 West Jefferson, Suite 3400 Lakewood, Colorado 80235 (303)-692-0369	CITY OF BRIGHTON CITY OF COMMERCE CITY ADAMS COUNTY URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	SECOND CREEK D/S OF DIA AND DFA 0053 OUTFALL SYSTEMS PLANNING STUDY UPDATE	*SECOND CREEK MASTER PLAN*	FIGURE ES-2

DETENTION #364
Ex Inflow = 918 cfs
Fu Inflow = 1301 cfs
Detention = 192 acft
MP Outflow = 136 cfs
100yr Elev = 5033.3 ft

Formalize DETENTION #330
Ex Inflow = 74 cfs
Fu Inflow = 75 cfs
Detention = 31 acft
MP Outflow = 17 cfs
100yr Elev = 5092.2 ft

Formalize DETENTION #332
Ex Inflow = 274 cfs
Fu Inflow = 385 cfs
Detention = 60.4 acft
MP Outflow = 9 cfs
100yr Elev = 5093.6 ft

DETENTION #346
Ex Inflow = 1086 cfs
Fu Inflow = 2152 cfs
Detention = 141.7 acft
MP Outflow = 508 cfs
100yr Elev = 5056.9 ft

Formalize DETENTION #333
Ex Inflow = 491 cfs
Fu Inflow = 885 cfs
Detention = 92.2 acft
MP Outflow = 379 cfs
100yr Elev = 5100.1 ft

Formalize DETENTION #319
Ex Inflow = 274 cfs
Fu Inflow = 355 cfs
Detention = 21.5 acft
MP Outflow = 58 cfs
100yr Elev = 5114.2 ft

Formalize DETENTION #314
Ex Inflow = 143 cfs
Fu Inflow = 280 cfs
Detention = 20.7 acft
MP Outflow = 42 cfs
100yr Elev = 5123.0 ft

100-YEAR ROAD CROSSINGS:
BRIGHTON ROAD
124TH AVENUE
120TH AVENUE
112TH AVENUE
104TH AVENUE
US-85
SH-2
PEORIA STREET
POTOMAC STREET

LOCKSPUR DRAIN
FOX RUN
SOUTH PLATTE RIVER
ARABIAN DRAIN
HENDERSON CREEK
SADDLE CREEK
FULTON DITCH
DUNES RESERVOIR
DUNES DEVELOPMENT
Diversion Channel to #364
STILL WATER
RIVER RUN
TUMBLEWEED DRAW
LOCUST RUN
REIGN CREEK
O'BRIAN CANAL
Planned realignment of O'Brian Canal
RAGWEED DRAW
BURLINGTON DITCH
MORNING GLORY RUN
HAVANA STREET
BRIGHTON ROAD
124TH AVENUE
120TH AVENUE
112TH AVENUE
104TH AVENUE
96TH AVENUE
POTOMAC STREET
PEORIA STREET
US-85
I-76
SH-2

0 2000' 4000'

	Kiowa Engineering Corporation 7175 West Jefferson, Suite 3400 Lakewood, Colorado 80235 (303)-692-0369	CITY OF BRIGHTON CITY OF COMMERCE CITY ADAMS COUNTY URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	SECOND CREEK D/S OF DIA AND DFA 0053 OUTFALL SYSTEMS PLANNING STUDY UPDATE	*DFA 0053* *MASTER PLAN*	FIGURE ES-3

I. INTRODUCTION

1.1 Authorization, Purpose and Scope

The *Second Creek* and *DFA 0053* Watersheds Outfall Systems Planning Study Update was authorized by the Urban Drainage and Flood Control District (UDFCD) under joint sponsorship with the City of Brighton, Commerce City and Adams County. The specific tasks were performed in accordance with the terms of Agreement Number 01-08.07, dated November 26, 2001.

The purpose of this study is to update the existing master plan completed in 1990 (reference 1) by analyzing revised existing and future drainage conditions of the watershed, applying updated mapping, developing alternative drainageway planning concepts, and preparing a preliminary design of facilities with a focus on implementation.

Tasks for analyzing the existing and future drainage conditions, and developing and evaluating drainage improvement concepts:

1. Meet regularly with the sponsors to obtain information, present study findings, and discuss results of the planning tasks.

2. Contact agencies and/or individuals that have knowledge or specific interest in the study area.

3. Inventory and compile the existing drainage system.

4. Prepare hydrologic analyses for the existing and future development watershed conditions.

5. Conduct hydraulic analyses along the major drainageways to ascertain capacities of existing structures, determine location of flooding problems, and analyze hydraulic impacts of future peak discharges.

6. Develop drainageway improvement alternatives that address future drainage impacts while maintaining an emphasis on implementation.

7. Evaluate alternatives based on given criteria, estimated construction costs, potential flooding, planning constraints and/or other issues.

8. Prepare a written preliminary design report that defines a master plan of drainage improvements for the study area.

1.2 Mapping

Project mapping was provided by Landmark Mapping Ltd. under a separate agreement with the UDFCD. The project mapping was developed from aerial photography dated 1995, and prepared at a contour interval of two-feet. The vertical and horizontal controls are NAVD 1988 and NAD 1983-92 modified, respectively. The mapping is based on State Plane Zone, Colorado Central Zone (502) and covers the entire study area. Additional revisions to the mapping were performed in 1998 and 2001 to reflect development changes in the area since 1995.

1.3 Acknowledgments

Kiowa Engineering Corporation wishes to acknowledge the various individuals who assisted in the preparation of the study. A Technical Advisory Committee made up of the project sponsors and other interested individuals and agencies provided guidance during the study process. The Technical Advisory Committee met regularly during the course of the project study. Additional agencies and individuals were involved during the planning process. A listing of the agencies and individuals that were kept informed of the progress of the study is given in Appendix A. The members of the Technical Advisory Committee are:

Name	Representing
Mr. Ben Urbonas, PE Project Director	Urban Drainage and Flood Control District
Mr. John Doerfer	Urban Drainage and Flood Control District
Mr. Joe Smith, PE	City of Brighton
Mr. Andy Walsh, PE	City of Brighton
Mr. Mark Heidt	City of Brighton
Mr. Brent Soderlin, PE	Commerce City
Mr. Tom Acre	Commerce City
Mr. Besharah Najjar, PE	Adams County
Mr. Mark Omoto, PE	Adams County
Ms. Melissa Van der Poel, PE	Adams County

The following members of Kiowa's project team contributed to the preparation of this report:

Mr. Tom Fairley, PE	Principal-in-Charge
Mr. Brian Wozniak, PE	Project Manager
Mr. Steve Brown	Project Engineer
Mr. Damian Dazsuta	Junior Engineer
Ms. Holly Lake	Engineering Technician
Ms. Elizabeth Klein	Environmental Scientist

1.4 References

The following reports were reviewed during the course of preparing this report:

(1) "Second Creek and Direct Flow Area 0053 Outfall Planning Study, Preliminary Design", prepared by Kiowa Engineering Corporation for the UDFCD, Adams County, City of Brighton, Commerce City, City of Aurora, City and County of Denver, May 1990.

(2) "Adams County Storm Drainage Design and Technical Criteria", prepared by WRC Engineering Inc. for Adams County and UDFCD, February 1989.

(3) "Adams County Comprehensive Plan", prepared by Balloffet and Associates, Inc. for Adams County, adopted January, 1999.

(4) "City of Brighton 2020 Comprehensive Plan", prepared by the City of Brighton, February 2001.

(5) "New Lands Comprehensive Plan, Commerce City, Colorado", prepared by BRW, Inc. for Commerce City, April 1992.

(6) "1998 Comprehensive Plan, City of Aurora, Colorado", prepared by the City of Aurora, adopted January 1998.

(7) "Soils Survey of Adams County, Colorado", USDA Soil Conservation Service, October 1974.

(8) "Urban Storm Drainage Criteria Manual, Volumes I, II and III", Urban Drainage and Flood Control District, prepared by Urban Drainage and Flood Control District (UDFCD), June 2001.

(9) "Colorado Urban Hydrograph Procedure Computer Program" – CUHP-2000 Version, prepared by Boyle Engineering Consultants for UDFCD, 1985 (updated by UDFCD in 2000).

(10) "Urban Drainage Storm Water Management Model" – SWMM-2000 Version, prepared by Boyle Engineering Consultants for UDFCD, 1985 (updated by UDFCD in 2000).

(11) "HY8 Culvert Sizing Program", Federal Highway Administration and Pennsylvania State University, Version 3.2.

(12) "Colorado Department of Transportation 2002 Cost Data", prepared by Engineering Estimates and Market Analysis Unit, Colorado Department of Transportation, January 1, 2003.

(13) "Flood Insurance Study, Adams County, Colorado, and Incorporated Areas", prepared by Federal Emergency Management Agency, August 16, 1995.

(14) "Flood Hazard Area Delineation: Second Creek and Third Creek", prepared by Gingery Associates, Inc. for the UDFCD and Adams County, February 1976.

(15) "Hydraulic Analysis for Henderson Creek and Ragweed Draw", prepared by Stantec Consulting, Inc. for Melody Homes, Inc., September 2001.

(16) "Final Drainage and Erosion Control Report for Reunion/112th Avenue Regional Water Quality and Detention Facility Ultimate Conditions", prepared by JR Engineering, LLC for Shea Homes, August 2001.

(17) "Pond 229 (Model 852) Design/Construction Information and Modeling Data", prepared by The City and County of Denver for the City and County of Denver, January 2002.

(18) "Adams County Transportation Plan", prepared by Felsburg Holt & Ullevig for Adams County, April 1996.

(19) "Master Plan Drainage Study for Property Located at the NWC 80th and Tower Road Second Creek South", prepared by Van Dyke Engineering, Inc. for TD Development and Management, July 1995.

(20) "Final Drainage Report for Property Located at the NWC 80th and Tower Road Denver International Airpark, Subdivision Filing No.1", prepared by Van Dyke Engineering, Inc. for TD Development and Management, July 1995.

(21) "Final Drainage Report for Buffalo Estates Subdivision, Adams County, Colorado", prepared by Acklam Associates, Inc. for Jim Jackson, March 1999.

(22) "Phase III for North Range Village", prepared by Carroll and Lange, Inc. for Gateway American Properties, LLC, April 2000.

(23) "Preliminary Drainage Study for Buffalo Run Mesa", prepared by Jehn and Associates, Inc. for Hastings Holdings, Corp., February 2001.

(24) "Request for Flood Insurance Study Map Revision for Second Creek Johnson Auto Plaza Project, Brighton Colorado", prepared by Henkels and McCoy for Dick Johnson, March 2001.

(25) "Phase III Drainage Report for Foxton Village Subdivision", prepared by Carroll and Lange, Inc. for Gateway American Properties, LLC, January 2001.

(26) "Phase III Drainage Report for Fronterra Village Subdivision", prepared by Carroll and Lange, Inc. for Gateway American Properties, LLC, June 2001.

II. STUDY AREA DESCRIPTION

2.1 Watershed Description

The study area consists of the *Second Creek Downstream of DIA* and *Direct Flow Area [DFA] 0053* watersheds that are located in the City of Brighton, Commerce City and unincorporated Adams County (see Figure II-1). The total study area has a drainage area of 21 square miles and is an east bank tributary to the *South Platte River*. The study limits extend from just north of 140th Avenue, south to 80th Avenue, and from east of E-470 to the *South Platte River* on the west. Existing development within the study area includes three distinct areas: the rural residential development along Peoria Street, agricultural land found throughout the study area and along the *South Platte River*, and industrial land along Highway 85. The remainder of the watershed is undeveloped.

The residential development within in the watershed is mostly rural with low-density and low impervious values. The highest density residential development is a new subdivision at the northwest corner of Peoria and 112th Avenue and is characterized by a 50-percent imperviousness. There are several other residential areas under construction along 104th Avenue. These subdivisions are expected to have similar densities with approximately 50-percent imperviousness.

The topography of the watershed is sloped from the high ground near E-470 and 88th west to northwest toward the *South Platte River*. The highest point has an elevation of 5340 feet above sea level. The lowest point is at the downstream outfall to the *South Platte* and has an elevation of 4980 feet. The entire watershed is fairly flat except for the highest reaches south of 96th Avenue and along the upper reaches of the contributing subbasins.

Second Creek Downstream of DIA

Second Creek outfalls to the *South Platte River* approximately 1½ miles southwest of Brighton, Colorado. The *Second Creek* watershed has a total drainage area of 27 square miles at the *South Platte River*. The main channel extends upstream in a south-easterly direction, approximately 15 miles. Slopes along the main drainageway average 0.5 to 1 percent, while the upper tributary watershed slopes vary from 2 to 4 percent. Existing vegetation consists mostly of native rangeland grasses throughout the watershed with little woody vegetation.

This study update focuses on the lower 11.7 square miles of *Second Creek*. The upper 14.8 square miles are read into the hydrology models as input hydrographs generated by the original study effort (Kiowa, 1990). Each model condition reads the appropriate upstream inflow hydrograph as defined in the 1990 study, i.e., the existing condition models read in hydrographs defined for existing conditions, the future condition models read in future development hydrographs, and master plan models read in the 1990 master plan hydrographs which include the eight proposed detention facilities within and upstream of DIA. *Second Creek* downstream of DIA is a very narrow watershed with few sizeable tributaries contributing downstream of the West Fork tributary. This configuration impacts the hydrology and shapes the hydrograph. The runoff from the lower drainage area arrives quickly to the main channel due to the short travel distance. The main peak of *Second Creek* is generated by drainage from the upper half of the watershed. This peak arrives to the *South Platte River* significantly later than drainage from the lower half due to the longer travel distance. The result is a peak flow that decreases across the study area as it is routed downstream.

DFA 0053

The *Direct Flow Area 0053* watershed is a tributary area to the *South Platte River* with a total drainage area of 9.2 square miles. Slopes in this area are flat ranging from 0.1 to 1.5 percent. The watershed ranges in elevation from 4990 feet at the confluence with *South Platte* to 5250 feet at the highest point near 96th Avenue. Existing vegetation consists mostly of native rangeland grasses with some small areas of woody vegetation along the channels.

The watershed is partially developed, but much of the area is open space, agricultural fields, or gravel mining operations. Commercial development can be found along US-85 and old Brighton Road. A large residential subdivision is located at 112th Avenue and Peoria. The remainder of the watershed is undeveloped with small, scattered pockets of rural residential housing and farmsteads.

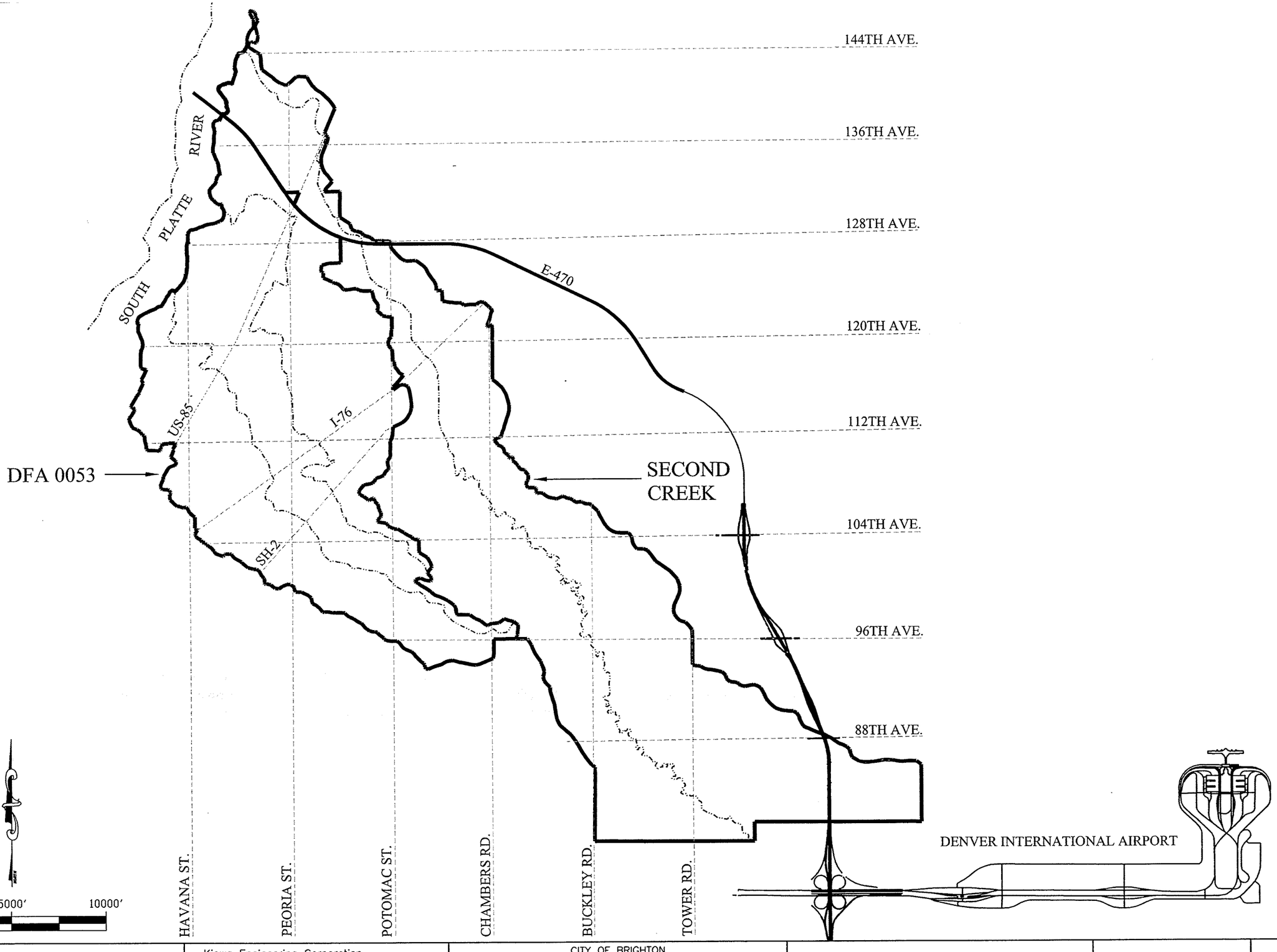
Due to the flatness of the area, specific drainage paths are difficult to define. *DFA 0053* was found to have four separate outfalls to the *South Platte River*. The previous study identified eight separate outfalls using 10-foot contour mapping. Of the various outfalls both studies agree that there are two main outfalls with the others being small local drainage to the river. Combined, the two main outfalls comprise 8.5 square miles of the total 9.2 square mile watershed.

2.2 Soils

Soil information was obtained from the Soils Survey of Adams County, Colorado (SCS, 1974). The significance of soil type for hydrologic analysis is in the infiltration rate. Soils are classified into four hydrologic classifications; namely, Types A, B, C, and D. Infiltration rates range from 5.0 inches per hour for Type A soils to 3.0 inches per hour for Type C and D soils. Soils in the study area are mainly Type B and C soils that can be characterized as loamy and clayey. Mapping of the soil groups found in this watershed is shown in Figure B-1 in Appendix B.

2.3 Wetlands Inventory

A detailed field investigation for wetlands, vegetative conditions, and wildlife habitat was conducted by Kiowa's environmental scientist. The investigation details the types of vegetation throughout the watersheds and areas of existing wetlands, as well as areas where there is potential for wetlands to establish. A detailed report of the wetlands investigation is provided in Appendix E. Specific vegetation species and wetland location mapping are included.



	Kiowa Engineering Corporation 7175 West Jefferson, Suite 3400 Lakewood, Colorado 80235 (303)-692-0369	CITY OF BRIGHTON CITY OF COMMERCE CITY ADAMS COUNTY URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	SECOND CREEK D/S OF DIA AND DFA 0053 OUTFALL SYSTEMS PLANNING STUDY UPDATE	*VICINITY MAP*	FIGURE II-1

III. HYDROLOGIC ANALYSIS

3.1 General

Hydrologic analyses were conducted to determine the 2-, 5-, 10-, 50- and 100-year peak flows for three separate development conditions. Existing (1) conditions are those that are found in the watershed today, as of 2001-2002. Future (2) conditions are projected future, fully developed conditions assuming ultimate build-out as projected at the present time (2002) with information provided by the project sponsors. Master Plan (3) conditions are future conditions with the proposed master plan improvements included in the models. Runoff from a storm producing 0.4", approximating the average annual event, was also analyzed. The *Colorado Urban Hydrograph Procedure* (version 2000) was used to develop runoff hydrographs from individual sub-watersheds, and *Storm Water Management Model* (version 2000) was used to route the individual hydrographs through a model of the drainageways.

The input data for CUHP includes rainfall depth, imperviousness, watershed area, length of the flow path, distance to watershed centroid, longitudinal slope, time of concentration, soil infiltration rate, and surface storage losses. Input data was prepared using guidelines and values recommended in the Urban Storm Drainage Criteria Manual (USDCM) and the CUHP users manual (UDFCD, 2001 and Boyle, 1985). Watershed area, length, existing impervious area, and watershed slope were measured from the two-foot contour interval project mapping provided by the UDFCD. Discussions of specific input parameters follow.

3.2 Design Rainfall

The design rainfall for the study area was determined from the latest UD-Raincurve Spreadsheet. Six-hour and two-hour rainfall depth adjustments have already been incorporated into the standard distributions in this table. In *Second Creek*, the total rainfall depths for the 2-, 5-, 10-, 50-, and 100-year recurrence interval storms are 1.37", 1.86", 2.20", 2.98" and 3.31", respectively. In *DFA 0053*, the total rainfall depths for the 2-, 5-, 10-, 50-, and 100-year recurrence interval storms are 1.10", 1.55", 1.84", 2.59" and 3.02", respectively. Table B-1 in Appendix B lists the detailed 5-minute rainfall distributions and totals used in this study.

3.3 Watershed Imperviousness

Hydrologic impervious information for each sub-watershed was developed for input into the CUHP hydrology model. The amount of impervious area within each sub-watershed was estimated for existing 2002 development and anticipated maximum future development. Figures B-2 and B-3 in Appendix B show the percent imperviousness values used in the hydrological models for these two conditions, respectively. Table III-1 describes the percent imperviousness for each of the different land uses. The upper portion of the study area is mainly undeveloped with large lot rural land, ranging from 5% to 15% imperviousness. The lower watershed areas are mixed rural residential, low-density residential subdivisions, and commercial, ranging from 15% to 90% imperviousness.

Impervious areas for existing conditions were compiled by examining aerial photography dated October 2001 and by field inspections to the area. Watersheds were delineated into various land-use categories to which the imperviousness values in Table III-1 were applied. An area-weighted percent imperviousness was then computed for each sub-watershed and used as input for the CUHP model. The future impervious cover was estimated by reviewing land use planning studies from the City of Brighton, Commerce City, Adams County, and recent development submittals (Brighton, 2001; BRW, 1992; Balloffet, 1999). Values of imperviousness were assigned to each projected land use category.

Table III-1
Uniform Impervious Values

Land Use Category	Imperviousness (percent)
Undeveloped, agricultural	5
Golf Course, parks	10
Large-lot Rural Residential	15
1-acre Rural Residential	20
1-acre Rural Estate	25
1/2 –acre Fringe Residential	30
1/3-acre Fringe Residential	35
Low-density Residential	40
Medium-density Residential, school	50
Mixed Use	65
Light Industrial	80
Industrial	90
Water	100

3.4 Sub-Watersheds

Sub-watersheds were evaluated using the digital two-foot contour mapping provided for the project. Major watershed and sub-watershed boundaries were established based on topographic and physical drainage boundaries, such as major roadways (e.g., E-470, US-85, 104th Avenue). Watershed boundaries were verified in the field. The watershed was divided into sub-watersheds with an average area less than 100 acres per sub-watershed to convey each design storm. Larger sub-watersheds were used in the less developed upper reaches with no single watershed exceeding 130 acres in size. Smaller sub-watersheds were necessary to evaluate the more complicated drainage of the more developed reaches. Area, length, length to centroid, and the slopes of each sub-watershed were measured from the project mapping. Data was entered into spreadsheets to calculate weighted slope per equation RO-9 in the USDCM. All slopes greater than four percent were first adjusted per Figure RO-10 in the Runoff Chapter of the USDCM before the weighted slope was calculated. Tables of CUHP parameter values are included in Appendix B.

3.5 Time of Concentration

Time of Concentration (T_c) was calculated for each sub-watershed with an area less than 90 acres as recommended in the Runoff Chapter of the USDCM. The UDFCD has determined that the use of the Rational Method (using the calculated T_c value) tends to overestimate runoff in urban areas for areas greater than 90 acres. Therefore, the criteria were adjusted to calculate T_c only for those sub-watersheds with areas less than 50 acres in urban areas. Urban areas are defined as those areas with an impervious value of 20% or greater. In non-urban areas the 90-acre criteria were applied.

3.6 Depression Losses/Retention Storage

Depression losses/retention storage for impervious areas was estimated to be 0.1 inches in accordance with Table RO-6 in the Runoff Chapter of the USDCM. This value was used for all sub-watersheds in the study area. For pervious areas, surface depression/retention losses of 0.40 inches were applied throughout the study area. This value is also in accordance with the USDCM.

Hydrologic parameters were developed for existing land use conditions and input into the CUHP computer model producing individual sub-watershed runoff hydrographs as output. Anticipated future land use conditions were compiled on project mapping. The hydrologic parameters were recalculated using the future imperviousness estimates and a second set of individual runoff hydrographs was output for future land use conditions. A summary of the CUHP input parameters and resulting computer output is provided in Appendix B.

3.7 SWMM-2000 Channel Routing

Hydrographs from individual sub-watersheds were routed through the drainageway system using the SWMM-2000 computer model (UDFCD, 2000). The drainage system was modeled using a system of channels, overflow sections, and direct flow elements. The conveyance element input parameters include length, slope, roughness coefficient, and cross-sectional geometry. The cross-sections were input to a spreadsheet that was used to calculate the roughness coefficient (Manning's 'n' value) for each channel segment based on Equation 2 in the SWMM manual. Slope was adjusted where necessary for non-uniform segments according to the SWMM manual. Schematics of the SWMM model are shown in Figure B-5 in Appendix B.

Existing channel elements were modeled using data from the 1990 study and verified with the digital project mapping. Length, change in elevation, and cross-sections were measured on the two-foot interval topographic mapping for each routing reach.

Future channel element cross-section, slope, and roughness were not modified from existing conditions for the purposes of determining the design hydrology. Specific alternatives may suggest significant changes to channel geometry. The hydraulic impact of those alternatives was maintained as a separate modeling effort included in the Alternatives chapters of this report.

3.8 Detention Storage

No existing detention was modeled in the existing and future hydrologic analyses. A few on-site detention facilities do exist in the study area; however, these facilities are not presently under public ownership, and therefore their future operation cannot be guaranteed. Inadvertent detention behind roadway embankments occurs at a several locations, but unless it is formalized, future development will likely eliminate the storage by adding culverts and increasing capacity under the roads; therefore, this detention was not included in the models. Refer to the Hydraulic Analysis chapter for a detailed look at road crossings in the watershed.

SWMM-2000 model input and output results are provided in Appendix C.

3. 9 Results of Hydrologic Analysis

In Appendix B, Figure B-7 shows the hydrograph comparison between existing and future development conditions for all frequencies for *Second Creek*. In reviewing this figure it can be seen that the anticipated future development results in significant impacts on peak flows and volumes across all frequencies. The greatest impacts are on the more frequent runoff events. This is also shown in Tables III-2 and III-3 (pages 8 and 9), which summarize the peak flow model results at various road crossings. Flows for the more frequent 2-year event typically increase by more than 2000%, while the 100-year more rare event increase by 100% (double).

The shape of the watershed also influences its hydrologic response. In its lower reaches *Second Creek* is a long and narrow watershed. It is especially narrow downstream of I-76. Flow rates generally increase between E-470 and 96th Avenue along *Second Creek* (mainly due to the contribution of West Fork tributary), and gradually decrease along the remaining length to the *South Platte River*. This is clearly shown in the discharge-profile curves found in Appendix B in Figures B-8 (existing), B-9 (future), and B-10 (master plan comparison). The decrease in flows may be explained by channel storage in the main channel of *Second Creek* and the timing of flows contributing from the narrow drainage area in the downstream portion. In the narrow area the travel time to the main channel is much shorter than upstream. This runoff reaches the main channel and moves downstream to the South Platter River prior to the arrival of the larger upstream peak.

The increases shown between existing (Fig. B-8) and future (Fig. B-9) conditions identify the need for a drainage plan in the watershed. Regional flood detention is the primary means of reducing peak flows by storing large volumes of flood runoff and releasing it at a slower rate. The master plan not only focuses on the 100-year flood, but also reduces peaks across all frequencies. Three regional detention facilities are included in the master plan.

The 88th Avenue detention facility (#366) is designed to reduce increases in the 2-year runoff event. Future development is expected to increase the 2-year peaks by 20 to 30 times existing levels, see Table III-2. This will have a significant impact on the drainageway downstream of DIA. Detention Facility 366 stores 132 acre-feet of volume during the 2-year event and reduces the peaks such that they are 3 to 6 times existing levels. Sensitivity analyses found that increasing storage could further reduce peaks near 88th Avenue, however, the peaks quickly rise downstream back to those produced by the master plan facility. Although there are still increases, they are more manageable and less destructive.

The Chambers Road detention facility (#336) is designed to reduce increases in the 10-year runoff event. Future development is expected to increase 10-year peaks by 4 times existing levels. Detention Facility 336 stores 163 acre-feet of volume during the 10-year event and reduces peaks back to existing levels.

The 112th Avenue/O'Brian Canal detention facility (#330) is designed to reduce increases in the 100-year runoff event to preserve the floodplain limits downstream. This facility also releases under the first irrigation canal crossing (O'Brian Canal) and dictates the 5-year flow rate for design of the downstream

channel. The two upstream detention facilities, combined with the numerous upstream facilities on DIA and Aurora, greatly reduce the 100-year peak such that there is little increase. This facility further reduces the peak flow rate such that the master plan 100-year peaks are 10% less than existing peaks. Additionally, this facility stores a significant volume such that the 5-year release rate is held below 500 cfs which allows the downstream irrigation crossings to be reduced in size, as well as the 6 miles of 5-year channel to the *South Platte River*.

The two main outfalls in *DFA 0053* also have discharge-profile curves shown in Appendix B. Figure B-11 shows the *Henderson Creek* discharge-profiles for existing, future, and master plan conditions. It can be seen that the future development will double peak flows for the 100-year flood. Adding detention at SH-2 (#314) and US-85 (#346) significantly reduces the peaks so that the outfall to the *South Platte River* is reduced below existing magnitudes.

Figure B-12 shows the same discharge-profiles for *Fox Run*. This figure indicates that the future peaks will increase by 50% from current 100-year levels. Upstream detention on the tributaries to *Fox Run* helps to reduce peak inflows at US-85. Detention #364 over-detains flood volume so that the peaks at the outfall to the *South Platte River* are below existing magnitudes.

Table III-2
Hydrology Results Second Creek

Drainageway	Description	Design Point	Area ac	Existing Conditions Q_{100} cfs	Q_{50} cfs	Q_{10} cfs	Q_5 cfs	Q_2 cfs	Future Conditions Q_{100} cfs	Q_{50} cfs	Q_{10} cfs	Q_5 cfs	Q_2 cfs	Comparison: Future Increases Over Existing Q_{100} cfs	Q_{10} cfs	Q_2 cfs
Second Creek	DIA Study Limit	173	9963.6	3317	2102	512	143	5	8053	6126	2981	2259	1451	143%	482%	28920%
Second Creek	Tower Rd.	171	10568.4	3431	2144	518	139	7	8147	6162	3026	2293	1474	137%	484%	20957%
Second Creek	88th Ave.	166	11272.4	4408	2723	650	167	5	9260	6965	3378	2547	1588	110%	420%	31660%
Second Creek	96th Extension	180	12576.0	4575	2790	676	261	157	9285	6922	3381	2541	1571	103%	400%	901%
Second Creek	104th Ave.	146	14030.1	4356	2634	661	168	71	8910	6626	3226	2410	1455	105%	388%	1949%
Second Creek	Chambers Rd.	136	14255.4	4337	2621	659	167	80	8868	6598	3211	2399	1445	104%	387%	1706%
Second Creek	O'Brian Canal/112th	130	15088.0	4302	2598	658	166	73	8812	6561	3194	2388	1435	105%	385%	1866%
Second Creek	Burlington Ditch	505	15340.8	4273	2574	653	163	70	8742	6515	3168	2368	1421	105%	385%	1930%
Second Creek	BNSF RR	506	15487.4	4249	2557	649	162	67	8696	6477	3151	2356	1412	105%	386%	2007%
Second Creek	I-76	165	15518.8	4246	2558	649	162	67	8694	6483	3153	2357	1413	105%	386%	2009%
Second Creek	120th Ave.	117	15630.1	4237	2550	647	161	63	8681	6476	3152	2359	1411	105%	387%	2140%
Second Creek	Potomac St.	116	15992.4	4218	2530	640	160	61	8665	6469	3155	2367	1402	105%	393%	2198%
Second Creek	124th Ave.	188	16016.7	4217	2529	640	159	60	8659	6470	3153	2365	1401	105%	393%	2235%
Second Creek	E-470	111	16263.7	4167	2497	629	157	57	8563	6401	3117	2338	1383	105%	396%	2326%
Second Creek	Fulton Ditch	109	16375.7	4147	2485	625	156	53	8531	6376	3104	2326	1375	106%	397%	2494%
Second Creek	US-85	108	16435.2	4121	2467	618	155	52	8469	6327	3080	2307	1363	106%	398%	2521%
Second Creek	Old Brighton Rd.	102	16757.8	3981	2378	585	149	45	8149	6103	2958	2207	1305	105%	406%	2800%
Second Creek	South Platte River	101	16960.0	3981	2377	585	149	45	8154	6101	2956	2205	1304	105%	405%	2798%
	* 8866.6 acres drains to study limit from Upper Second Creek															
Reed Run	Headwater	179	193.3	147	95	26	5	0	417	327	165	121	76	184%	535%	7600%
Reed Run	Chambers Rd	192	262.4	174	103	28	5	1	427	321	143	103	61	145%	411%	6000%
Drew Draw	Headwater	148	117.8	161	106	32	6	2	399	315	166	125	78	148%	419%	3800%
Drew Draw	Private Rd.	149	210.6	278	176	52	8	3	610	475	242	179	110	119%	365%	3567%
Peachleaf Run	Headwater	186	119.7	179	120	41	7	3	434	345	191	145	89	142%	366%	2867%
Peachleaf Run	Private Rd.	150	233.6	270	170	53	8	3	568	439	215	158	100	110%	306%	3233%
Gramma Gulch	Headwater	158	112	131	90	33	12	2	412	341	198	155	98	215%	500%	4800%
Gramma Gulch	Tower Rd.	157	348.2	387	258	91	28	4	933	752	419	330	204	141%	360%	5000%
Gramma Gulch	Private Drive	159	474.2	470	297	91	26	2	987	769	386	298	172	110%	324%	8500%
Dragway Draw	Headwater	514	37.8	39	26	8	0	0	72	57	29	22	0	85%	263%	0%
Dragway Draw	Design Point	168	163.8	184	123	40	9	3	512	425	274	227	160	178%	585%	5233%
West Fork	DIA Study Limit	942	-	1270	838	198	60	2	2983	2347	1082	865	586	135%	446%	29200%

Table III-3
Hydrology Results DFA 0053

Drainageway	Description	Area ac	Design Point	Existing Conditions Q_{100} cfs	Q_{50} cfs	Q_{10} cfs	Q_5 cfs	Q_2 cfs	Future Conditions Q_{100} cfs	Q_{50} cfs	Q_{10} cfs	Q_5 cfs	Q_2 cfs	Comparison: Future Increases Over Existing Q_{100} cfs	Q_{10} cfs	Q_2 cfs
Lockspur Drain	Old Brighton Rd.	48.6	168	35	25	9	5	0	36	26	9	5	0	3%	0%	0%
Lockspur Drain	South Platte River	165.8	189	453	369	209	162	101	453	369	209	163	101	0%	0%	0%
Reign Creek	Highway 2	206.1	119	274	194	67	40	16	355	262	109	73	39	30%	63%	144%
Reign Creek	O'Brian Canal	323.2	127	271	179	57	31	11	368	301	192	160	114	36%	237%	936%
Reign Creek	I-76	376.3	132	274	176	55	30	10	385	291	140	105	67	41%	155%	570%
Reign Creek	Burlington Ditch	433.9	140	288	184	54	29	10	455	336	148	108	64	58%	174%	540%
Reign Creek	120th Ave.	564.5	144	365	242	86	55	24	569	403	167	118	64	56%	94%	167%
Tumbleweed Draw	I-76	39.7	130	74	51	13	4	2	75	53	15	7	4	1%	15%	100%
Locust Run	Highway 2	77.4	121	170	125	48	28	5	250	192	93	65	32	47%	94%	540%
Locust Run	O'Brian Canal	131.2	129	252	177	60	33	6	384	304	177	141	97	52%	195%	1517%
Locust Run	I-76	175.4	131	216	144	41	20	2	319	239	111	82	47	48%	171%	2250%
Locust Run	Burlington Ditch	197.8	141	199	129	35	17	1	279	201	91	66	36	40%	160%	3500%
Locust Run	120th Ave.	585.0	153	417	274	82	44	10	811	614	297	223	130	94%	262%	1200%
Fox Run	120th Ave.	7.7	155	11	8	3	2	0	36	29	19	16	11	227%	533%	1100%
Fox Run	124th Ave.	1465.0	160	904	588	175	93	25	1477	1061	477	340	186	63%	173%	644%
Fox Run	Fulton Ditch	1626.9	163	1009	658	197	105	31	1721	1232	567	408	226	71%	188%	629%
Fox Run	US-85	1825.9	164	989	636	183	93	23	1546	1109	516	369	207	56%	182%	800%
Fox Run	Oakland St.	1929.0	167	968	624	177	91	45	1521	1099	519	366	200	57%	193%	344%
Fox Run	Old Brighton Rd.	2145.3	169	960	618	173	112	47	1473	1071	498	349	192	53%	188%	309%
Fox Run	South Platte River	2234.9	187	976	627	186	121	48	1469	1068	496	348	191	51%	167%	298%
Arabian Drain	124th Ave.	96.0	175	236	179	81	56	24	470	379	239	195	133	99%	195%	454%
Arabian Drain	Fulton Ditch	109.4	173	36	28	13	9	5	35	27	13	9	4	-3%	0%	-20%
Arabian Drain	Old Brighton Rd.	172.2	172	215	171	90	69	38	227	180	96	71	40	6%	7%	5%
Arabian Drain	South Platte River	197.8	186	164	122	54	38	18	166	124	55	39	19	1%	2%	6%
Ragweed Draw	Potomac St.	385.9	106	349	230	64	31	3	497	354	157	112	57	42%	145%	1800%
Ragweed Draw	104th Ave.	745.0	112	480	311	86	43	6	751	524	249	185	99	56%	190%	1550%
Ragweed Draw	Highway 2	839.7	116	511	330	91	42	4	829	587	256	183	96	62%	181%	2300%
Ragweed Draw	O'Brian Canal	917.8	124	511	327	88	40	5	802	574	262	182	121	57%	198%	2320%
Ragweed Draw	I-76	1052.2	133	533	340	92	42	10	885	640	305	218	146	66%	232%	1360%
Ragweed Draw	112th Ave.	1150.7	139	532	334	88	40	7	886	649	323	257	182	67%	267%	2500%
Morning Glory Run	Peoria St.	137.6	113	92	62	22	13	2	197	152	73	54	25	114%	232%	1150%
Morning Glory Run	Highway 2	206.1	114	143	98	33	20	4	280	213	103	75	37	96%	212%	825%
Morning Glory Run	O'Brian Canal	270.1	122	195	130	40	21	3	396	311	181	146	100	103%	353%	3233%
Morning Glory Run	I-76	465.9	134	207	134	38	21	3	537	427	237	190	124	159%	524%	4033%
Henderson Creek	109th St.	499.2	137	227	147	42	21	3	497	377	198	156	99	119%	371%	3200%
Henderson Creek	112th Ave.	793.6	138	399	269	98	59	17	1354	1141	741	612	436	239%	656%	2465%
Henderson Creek	US-85	2465.9	146	1086	714	228	129	42	2152	1618	805	621	381	98%	253%	807%
Henderson Creek	120th Ave.	2686.7	178	1178	778	252	143	45	2264	1679	820	622	370	92%	225%	722%
Henderson Creek	Old Brighton Rd.	2824.3	176	1176	777	253	142	47	2255	1667	819	617	364	92%	224%	674%
Henderson Creek	South Platte River	3199.4	185	1361	921	337	226	113	2586	1906	937	700	410	90%	178%	263%

IV. HYDRAULIC ANALYSIS

4.1 Floodplain Description

The 100-year floodplain for *Second Creek* was determined in the 1976 Flood Hazard Area Delineation (FHAD) report (Gingery, 1976). The FHAD hydrology was based upon a fully-developed condition projected from 1975 comprehensive land use planning maps. This included some high density development but did not include the E-470 corridor. The average percent impervious value used in the FHAD is 24% compared to the current projected value of 49%. The peak discharges used in the FHAD are generally within forty percent of the existing conditions, forty percent of the future conditions, and twenty percent of the future conditions with the upstream Master Plan detention. In the FHAD study, hydrologic data was computed using the CUHP/SWMM and HEC-2 computer programs. For this study, the peak discharges that incorporate upstream Master Plan detention will be used for alternatives analysis. Due to the relative magnitude between the two studies, the previously published floodplain will not be altered by this study. In the 1976 study, there were ten structures identified within the 100-year floodplain.

Table IV-1 summarizes the peak discharges from the 1976 Flood Hazard Area Delineation (FHAD), and also presents the results of this study for comparison. Comparisons of the flows along *Second Creek* revealed that the flows reported in this study and the 1976 FHAD study compare moderately well. The differences between the two models can generally be attributed to differences in future land use projections.

Several roadway crossing structures have been built over *Second Creek* and *DFA 0053*. Most of the crossings were already in place by 1976. The FHAD study in 1976 evaluated the structures within *Second Creek* and established hydraulic capacity standards for sizing future crossings. Locations of the crossing structures are shown in Figure IV-2. *DFA 0053* was not included in the FHAD study.

FEMA published Flood Insurance Rate Maps dated August 16, 1995 (FEMA, 1995). The *Second Creek* floodplain is labeled as Zone A, which indicates no base flood elevations were determined. In comparing the shape of the floodplains between the FHAD and the FIRM, they appear similar, implying that the FHAD may be the basis for the FIRM. The Flood Insurance Study booklet for *Second Creek* only references approximate methods. For the purpose of this study and future regulation of the floodplain, it is recommended that the FHAD be used in identifying the floodplain limits for *Second Creek*.

Table IV-1
Comparison to FHAD Floodplain Data

Location	FHAD Q_{100} (cfs)	Existing Q_{100} (cfs)	Future Q_{100} (cfs)	Master Plan Q_{100} (cfs)
Brighton Road	1265*	3981	8149	3027
US-85	2660*	4121	8469	3087
UPRR	11840	4121	8469	3087
Fulton Ditch	2980	4147	8531	3097
124th Avenue	6200	4217	8659	3115
I-76	6000	4246	8694	3078
O'Brian Canal	6000	4302	8812	3076
104th Avenue	5700	4356	8910	4310
88th Avenue	5000	4408	9260	5156
Tower Road	4700	3431	8147	3602

*FHAD includes diverted flows to Third Creek

Significant increases in runoff have yet to be been seen by the descriptions provided by landowners within the watershed. The bulk of the development and urbanization impacts to the watershed are expected to occur over the next several years. E-470 is nearing completion through the watershed and urban development is already under construction. The timeliness of this study is crucial to establish drainage criteria prior to development. It is the goal of this master plan to create a drainage plan that most effectively reduces the impacts from impending development and that allows the sponsors a viable means for implementation.

4.2 Drainage Structure Inventory

Several roads cross the drainage channels throughout the study area. Hydraulic calculations were prepared for each of the main roadway crossings. Capacities were determined and presented in terms of frequency. Table IV-2 summarizes the road crossing capacities throughout the study area. Detailed descriptions of the crossings are described in the following section.

Second Creek Main Channel

Road Crossing: Design Point
US-85: 108
Field measurements were taken defining the opening as a 30-foot span box culvert. Hydraulic analysis indicates that the opening has the capacity to pass the 2-year storm. At the 10-year event the road would overtop by 0.1 feet, and at the 100-year event it would overtop by 0.5 feet.

132nd Ave: 109
Field measurements were taken defining the opening as an 18-inch CMP with 1.5 feet of cover. Hydraulic analysis indicates that the opening does not have the capacity to carry the 2-year storm. At the 2-year flood event the road would overtop by 0.7 feet and at the 100-year event would overtop by 2.2 feet. When overtopping, the flows would travel west along 132nd to the low spot in the road.

E-470: 111
Field measurements were taken defining the opening as a 205-foot span and 9 foot high box culvert. Hydraulic analysis indicates that the opening has the capacity to pass the 100-year storm. No overtopping of this structure is expected.

124th Ave: 188
Field measurements were taken defining the opening as a 24-inch CMP with 3.1 feet of cover. Hydraulic analysis indicates that the opening does not have the capacity to carry the 2-year storm. At the 2-year flood event the road would overtop by 1.2 feet and at the 100-year event would overtop by 3.0 feet.

120th Ave: 117
Field measurements were taken defining the opening as an 86-foot span bridge. Embankments are armored with riprap and sloped 2 to 1 with a 66-foot wide natural channel bottom. The bridge is 10 feet above the channel. Hydraulic analysis indicates that the opening has the capacity to carry the 100-year storm. No overtopping of this structure is expected.

I-76: 165
Field measurements were taken defining the opening as an 84-foot span bridge. The bridge is 5.0 feet above the channel. Hydraulic analysis indicates that the opening has the capacity to pass the 100-year storm. No overtopping of this structure is expected.

I-76: 506
Field measurements were taken defining the opening as a 62-foot span bridge. Hydraulic analysis indicates that the opening has the capacity to carry the 100-year storm. No overtopping of the structure is expected.

Chambers Road: 136
Field measurements were taken defining the opening as a 28-foot span bridge. Embankments are armored with riprap and sloped 3 to 1 with a 14-foot wide natural channel bottom. The bridge is 7.5 feet above the channel. Hydraulic analysis indicates that the opening has the capacity to carry the 10-year storm. At the 50-year flood event the road would overtop by 0.7 feet and at the 100-year event would overtop by 1.0 foot.

104th Ave: 146
Field measurements were taken defining the opening as a 27.6-foot span bridge. The bridge is 7.0 feet above the channel. Hydraulic analysis indicates that the opening has the capacity to carry the 2-year storm. At the 5-year flood event the road would overtop by 1.2 feet and at the 100-year event would overtop by 3.8 feet.

88th Ave: 166
Field measurements were taken defining the opening as a 16-foot span bridge. The measurement used was the one surveyed, instead of the measurement from the FHAD report. The bridge is 10.0 feet above the channel. Hydraulic analysis indicates that the opening has the capacity to carry the 5-year storm. At the 10-year flood event the road would overtop by 0.3 feet and at the 100-year event would overtop by 2.6 feet.

Tower Road: 171
Field measurements were taken defining the opening as a 72-inch CMP with 5 feet of cover. Hydraulic analysis indicates that the opening does not have the capacity to carry the 2-year storm. At the 2-year flood event the road would overtop by 1.2 feet and at the 100-year event would overtop by 2.9 feet.

Table IV-2
Second Creek Drainage Structure Inventory [Future Unimproved Hydrology]

Road Crossing	Imminent Overtopping Capacity (cfs)	(freq)	Q_{100} (cfs)	Size (1)	Type
Brighton Road	0	0-year	8149	Buried	CMP
US-85	1406	2-year	8469	Tpl 9'x10'	Box Culvert
136th Avenue	1963	2-year	8469	Twin 4'x23'	Box Culvert
UPRR	1034	1-year	8469	1.5'x64'	Span Bridge
132nd Avenue	6	0-year	8531	18"	CMP
E-470	22571	100-year +	8563	162'	Span Bridge
124th Avenue	18	0-year	8659	24"	CMP
Potomac Street	15	0-year	8665	2'x6.5'	Box Culvert
120th Avenue	18425	100-year +	8681	86'	Span Bridge
I-76	18248	100-year +	8694	84'	Span Bridge
I-76	12742	100-year +	8694	61'6"	Span Bridge
BNSFRR	8768	100-year	8696	Tpl 13.5'x20.5'	Box Culvert
Chambers Road	1759	2-year	8868	28'	Span Bridge
104th Avenue	1323	2-year	8910	27'-7"	Span Bridge
88th Avenue	1553	2-year	9260	16'	Span Bridge
Tower Road	216	0-year	8147	72"	CMP

(1) all box culvert dimensions shown as Height' x Width'

Table IV-3
Second Creek Drainage Structure Inventory [Master Plan Improved Hydrology]

Road Crossing	Imminent Overtopping Capacity (cfs)	(freq)	Q_{100} (cfs)	Size (1)	Type
Brighton Road	3714	100-year	3027	4x 7'x14'	Box Culvert
US-85	4389	100-year	3087	Tpl 9'x10' + 3x 8'x16'	Box Culvert
136th Avenue	3756	100-year	3087	Tw 4'x23' + 3x 6'x12'	Box Culvert
UPRR	4252	100-year	3087	4x 7'x14'	Box Culvert
132nd Avenue	630	10-year	3097	Twin 4'x8'	Box Culvert
E-470	22571	100-year +	3104	162'	Span Bridge
124th Avenue	3719	100-year	3115	5x 7'x13'	Box Culvert
Potomac Street	3719	100-year	3117	5x 7'x13'	Box Culvert
120th Avenue	18425	100-year +	3088	86'	Span Bridge
I-76	18248	100-year +	3078	84'	Span Bridge
I-76	12742	100-year +	3078	61'6"	Span Bridge
BNSFRR	8768	100-year +	3075	Tpl 13.5'x20.5'	Box Culvert
Chambers Road	4320	100-year	4280	4x 8'x16'	Box Culvert
104th Avenue	4320	100-year	4310	4x 8'x16'	Box Culvert
88th Avenue	5580	100-year	5156	5x 8'x16'	Box Culvert
Tower Road	3766	100-year	3602	4x 7'x12'	Box Culvert

(1) all box culvert dimensions shown as Height' x Width'

DFA 0053

Potomac Street: 106
Field measurements were taken defining the opening as a double 24-inch CMP with 1 foot of cover. However, only 1 pipe exits since the other pipe is filled with debris. Hydraulic analysis indicates that the opening with one pipe plugged does not have the capacity to carry the 2-year storm. At the 2-year flood event the road would overtop by 0.1 feet and at the 100-year event would overtop by 0.7 feet.

Highway 2: 114
Field measurements were taken defining the opening as a twin 24-inch CMP with 4 feet of cover. Hydraulic analysis, ignoring inadvertent detention, indicates that the opening has the capacity to carry the 2-year storm. At the 5-year flood event the road would overtop by 0.1 feet and at the 100-year event would overtop by 0.3 feet.

Considering the existing inadvertent detention held by the roadway embankment, the 100-year event does not overtop the road. Under future conditions 22.3 acre-feet would be stored covering 8 acres. This allows the peak to be reduced from 280 cfs to 31 cfs with 2.5 feet of freeboard remaining before overtopping occurs. Formalizing this detention is part of the master plan.

Highway 2: 116
Field measurements were taken defining the opening as a 24-inch CIP with 2 feet of cover. Hydraulic analysis indicates that the opening does not have the capacity to carry the 2-year storm. The 100-year event would overtop the road by 0.7 feet.

The existing inadvertent detention held by the roadway embankment does not significantly reduce peak flows. Therefore, the master plan recommends increasing conveyance to 100-year capacity by adding two 4'x6' and one 4'x8' RCBC.

Highway 2: 119
Field measurements were taken defining the opening as a 30-inch CMP with 2 feet of cover. Hydraulic analysis indicates that the opening has the capacity to carry the 10-year storm. At the 50-year flood event the road would overtop by 0.2 feet and at the 100-year event would overtop by 0.4 feet.

Highway 2: 120
Field measurements were taken defining the opening as a 24-inch CMP with 1 foot of cover. Hydraulic analysis indicates that the opening does not have the capacity to carry the 2-year storm. At the 2-year flood event the road would overtop by 0.1 feet and at the 100-year event would overtop by 0.3 feet. Field observation shows that the pipe entrance is presently filled with debris and unable to pass any flows.

Highway 2: 121
Field measurements were taken defining the opening as a 30-inch CMP with 1 foot of cover. Hydraulic analysis indicates that the opening has the capacity to carry the 10-year storm. At the 50-year flood event the road would overtop by 0.2 feet and at the 100-year event would overtop by 0.4 feet.

I-76: 131
Field measurements were taken defining the opening as a 9-foot 3-inch span and 13-feet 8-inch high box culvert. Hydraulic analysis indicates that the opening has the capacity to pass the 100-year storm. No overtopping of this structure is expected. The box culvert is a new structure.

I-76: 132
Field measurements were taken defining the opening as a 24-inch CMP with 3 feet of cover. Hydraulic analysis indicates that the opening does not have the capacity to carry the 2-year storm. The 100-year event would overtop by 0.3 feet.

Table IV-4

DFA 0053 Drainage Structure Inventory [Future Unimproved Hydrology]

Road Crossing	Imminent Overtopping Capacity (cfs)	Imminent Overtopping Capacity (freq)	Q_{100} (cfs)	Size (1)	Type
Brighton Road (169)	19	0-year	1473	24"	CMP
Brighton Road (172)	12	0-year	227	30"	CMP
112th Avenue (138)	4	0-year	1354	12"	CMP
112th Avenue (139)	31	0-year	886	2.4'	Oval Conc.
120th Avenue (153)	10	0-year	811	18"	CMP
120th Avenue (178)	4	0-year	2264	12"	CMP
Potomac Street (106)	36	0-year	497	24"	CMP
I-76 (131)	1173	100-year +	319	9'3"	Box Culvert
I-76 (132)	17	0-year	385	24"	CMP
I-76 (134)	1100	100-year +	537	12'	Box Culvert
SH-2 (114)	37	2-year	280	Twin 24"	CMP
SH-2 (116)	23	0-year	829	24"	CMP
SH-2 (119)	25	0-year	355	30"	CMP
SH-2 (121)	23	0-year	250	24"	CMP

(1) all box culvert dimensions shown as Height' x Width'

I-76: 134

Field measurements were taken defining the opening as a 12-foot box culvert. The culvert is 10 feet above the channel. Hydraulic analysis indicates that the opening has the capacity to pass the 100-year storm. No overtopping of this structure is expected.

112th Ave: 138

Field measurements were taken defining the opening as a 12-inch CMP with 1 foot of cover. Hydraulic analysis indicates that the opening does not have the capacity to carry the 2-year storm. At the 2-year flood event the road would overtop by 3.5 feet and at the 100-year event would overtop by 5.9 feet. Field observation shows that the pipe is currently filled with debris and unable to pass any flows.

112th Ave: 139

Field measurements were taken defining the opening as a 28-inch wide by 24-inch high oval concrete pipe. The water enters through a storm grate level with the ground due to the terrain having very little slope and exits into an existing detention pond. Hydraulic analysis indicates that the opening does not have the capacity to carry the 2-year storm. At the 2-year flood event the road would overtop by 0.4 feet and at the 100-year event would overtop by 1.2 feet.

120th Ave: 153

Field measurements were taken defining the opening as an 18-inch CMP with 0.5 feet of cover. Hydraulic analysis indicates that the opening does not have the capacity to carry the 2-year storm. At the 2-year flood event the road would overtop by 0.1 feet and at the 100-year event would overtop by 1.9 feet. Field observation shows that the pipe is currently filled with debris and unable to pass any flows.

Old Brighton Road: 169

Field measurements were taken defining the opening as a 24-inch CMP with 3 feet of cover. Hydraulic analysis indicates that the opening does not have the capacity to carry the 2-year storm. At the 2-year flood event the road would overtop by 0.4 feet and at the 100-year event would overtop by 3.1 feet. Field observation shows that the pipe is filled with debris and unable to pass any flows.

Table IV-5

DFA 0053 Drainage Structure Inventory [Master Plan Improved Hydrology]

Road Crossing	Imminent Overtopping Capacity (cfs)	Imminent Overtopping Capacity (freq)	Q_{100} (cfs)	Size (1)	Type
Brighton Road (169)	729	100-year	729	3x 4'x7'	Box Culvert
Brighton Road (172)	227	100-year	227	2x 3'x5'	Box Culvert
112th Avenue (138)	1353	100-year	1353	5x 4'x7'	Box Culvert
112th Avenue (139)	500	100-year	500	2x 4'x7'	Box Culvert
120th Avenue (153)	799	100-year	799	3x 4'x7'	Box Culvert
120th Avenue (178)	613	100-year	613	2x 4'x8'	Box Culvert
Potomac Street (106)	497	100-year	497	2x 4'x6'	Box Culvert
I-76 (131)	1173	100-year +	319	9'3"	Box Culvert
I-76 (132)	10	100-year	9	18"	RCP
I-76 (134)	1100	100-year +	522	12'	Box Culvert
SH-2 (114)	42	100-year	42	Twin 24"	CMP
SH-2 (116)	829	100-year	829	3x 4'x8' + 4'x6'	Box Culvert
SH-2 (119)	58	100-year	58	30"	CMP
SH-2 (121)	250	100-year	250	2x 3'x5' + 3'x4'	Box Culvert

(1) all box culvert dimensions shown as Height' x Width'

Old Brighton Road: 172

Field measurements were taken defining the opening as a 30-inch CMP with 2.5 feet of cover. Hydraulic analysis indicates that the opening does not have the capacity to carry the 2-year storm. At the 2-year flood event the road would overtop by 0.1 feet and at the 100-year event would overtop by 0.4 feet. Field observation shows that the pipe is filled with debris and unable to pass any flows.

120th Ave: 178

Field measurements were taken defining the opening as a 12-inch CMP with 1 foot of cover. Hydraulic analysis indicates that the opening does not have the capacity to carry the 2-year storm. At the 2-year flood event the road would overtop by 1.1 feet and at the 100-year event would overtop by 5.3 feet.

4.5 Channel Stability Analysis

In urban and developing areas, channel stability is a common problem. As impervious areas increase there are significant increases in base flows, as well as in the frequently occurring storm water low flows and runoff peaks. Maximum velocities in easily eroded soils are only 2.5 to 3 feet per second. In this watershed, soils are not classified as easily eroded and should be able to carry a maximum velocity of 5

to 7 feet per second. However, velocities can reach 8 fps during a 2-year storm and exceed 10 fps during a 10-year flood event making the channels susceptible to erosion.

Velocities, soils, ground cover, frequency of flows, and channel slope all are factors that impact channel erosion. Channel slope is a critical parameter in longitudinal slope stability. Through experience the UDFCD has established criteria identifying 0.4% as the typical stable design slope required in urban areas throughout the Denver metropolitan region. The average slope in *Second Creek* is 0.34%. This slope generally allows for stable channels. Some select check structures are needed at steep sections and near road crossings.

The Alternatives section of this report addresses the study goal of maintaining a stable channel under fully-developed conditions.

V. ALTERNATIVES DEVELOPMENT and EVALUATION

5.1 Introduction

The development of alternatives and evaluation of each is covered in detail in the Phase A report from this study entitled "*Second Creek* (downstream of DIA) and *DFA 0053* Watersheds Outfall Systems Planning Study Update Alternatives Development and Evaluation Report". This chapter will summarize the Phase A efforts and the process that led to the selection of the Master Plan.

Historically, development within the study area has been minimal. However, nearly all of the existing agricultural and natural land within the study area is either under construction or being planned for development, as well as a significant portion within *DFA 0053*. The E-470 extension crosses through the northern part of the study area. The bridge opening over *Second Creek* has been adequately sized to have minimal impact on the 100-year flood event. The introduction of E-470 into the region will bring intense urban development consisting of commercial, high-density residential complexes, and mixed-use areas.

In the future it is anticipated that the City of Brighton and Commerce City will encompass nearly all of the unincorporated Adams County area remaining within the study area. Development plans and construction activities are already underway throughout the study area (Stantec, 2001; JR Engineering, 2001; Van Dyke, 1995; Acklam, 1999; Carroll and Lange, 2000-01; Jehn, 2001; Henkels and McCoy, 2001). As much information as could be collected was used to project future land development densities. Most of this information was derived from the latest Comprehensive Plans (Balloffet, 1999; City of Brighton, 2001; BRW, 1992) provided by the sponsors and verified by their individual planning departments. Generally, land uses are projected to increase from an average existing imperviousness of 10% to a projected future imperviousness of 49%.

The impact of future development on the watershed without mitigation will nearly double 100-year flows and increase more frequent flood magnitudes by 10 to 30 times existing levels. This increase in runoff will not only provide an increased threat of flooding and structural damages in the future, but also have significant negative impacts on water quality and stream stability. Alternatives have been developed to offset the impacts of future development by focusing on reducing flood magnitudes, increasing conveyance capacities, removing pollutants from the runoff, and stabilizing the stream against erosion.

5.2 Criteria

Drainageway alternatives that mitigate existing and future problems were developed for *Second Creek* and *DFA 0053*. The Urban Storm Drainage Criteria Manual (UDFCD, 2001), as well as local criteria (WRC, 1989), were used to guide the development of the alternative drainageway plans. In addition, the floodplain regulations of Adams County, Commerce City, and the City of Brighton also apply for the administration of the *Second Creek Downstream of DIA* and *DFA 0053* watersheds. Development within the floodplain is currently controlled through existing floodplain regulations and the 100-year floodplain as defined by the 1976 FHAD study. Floodplain regulation is common to all alternatives and will continue as part of all improvement plans.

5.3 Evaluation Parameters

Coordination meetings were held during the study to address overall goals and specific concerns of those agencies and individuals participating in the study. A survey of design criteria was presented to the sponsors and each sponsor ranked the criteria by order of priority. This effort identified the following list of factors for consideration when evaluating each of the alternatives:

- Flood Control
- Implementation
- Construction Cost
- Constructability
- Operation and Maintenance
- Water Quality
- Open Space/ Wildlife Habitat
- Recreation/ Trails/ Wetlands
- Erosion Control
- Transportation
- Aesthetics
- Land Use

5.4 Problem Areas

Second Creek

The problems identified in this watershed are mostly anticipated future problems. In *Second Creek* the O'Brian Canal receives all of the watershed low flows. Since there is no crossing structure, the canal captures all low flows and carries them to Barr Lake. Initial overflows passing the O'Brian Canal spill into the Burlington Ditch and are carried to the north. Once the Burlington capacity is exceeded flows spill into the Fulton Ditch and are carried out of the watershed. Historically, it has taken a significant flood event in order for flows from *Second Creek* to reach the *South Platte River*. In the past it was common for the channel to remain dry during the summer, but with impending urban development the frequency of flow in the channel will increase, most likely to the point where the channel will always have some base flow. At the time that the O'Brian Canal, Burlington Ditch, and Fulton Ditch were constructed, inflows from *Second Creek* were considered rare and minimal so no crossing structures were constructed. However, as *Second Creek* flows become greater and more common, they create a problem for the ditch companies that could result in frequent overtopping, erosion, and bank failure. Due to the low occurrence of flows, there is little to no sign of a defined channel downstream of the O'Brian Canal to the *South Platte River*.

Currently, there are no known flooding problems within *Second Creek*. The 1976 FHAD was published ahead of much of the existing development and established an appropriate 100-year floodplain for regulation. Many of the road-crossing culverts are undersized in the upper part of the watershed and roadway overtopping is common. A few road crossings have no culverts at all and rely on overtopping to move flows downstream. In anticipation of impending urbanization many recent transportation projects (such as I-76 and 120th Avenue) have including replacing inadequate drainage structures with large box culverts and bridges to allow full future 100-year capacity.

There are no existing regional detention facilities within the *Second Creek* study area downstream of Denver International Airport (DIA). DIA has one temporary detention facility within the watershed. A larger permanent facility will be built as part of future expansion. Construction plans have been approved for a large residential development along 112th Avenue for an interim retention basin just upstream of the O'Brian Canal.

Future problems are expected to consist of increased flood flows, more frequent flooding, erosion of channels and roadways, increased sediment transport, and reduced water quality. The alternatives considered in this chapter address these concerns and attempt to offset the negative impacts of urban development within the study area.

DFA 0053
The greatest problem within *DFA 0053* is the lack of well-defined drainage paths and crossings of the three irrigation canals. As with *Second Creek*, historic flows within the watershed have been minimal. Low flows have been captured by the irrigation canals and carried out of the watershed. Consequently, most road crossing structures are extremely small and undersized for future flows.

Again, future problems are expected to consist of increased flood flows, more frequent flooding, erosion of channels and roadways, increased sediment transport, and reduced water quality. The alternatives considered in this chapter were developed to offset the negative impacts of urban development.

5.5 Preliminary Screening of Improvement Alternatives

Offsetting increased runoff is a primary focus of this study. The main alternatives consist of on-site and regional flood control detention facilities. High volumes will likely dictate that several facilities be designed to work as a system. Progressively checking peak flows through a series of detention facilities as runoff moves downstream may be the best approach. Detention alternatives will look at 100-year flood control, and also focus on controlling 2-year, 5-year, and 10-year flood events as well. It is not economically or physically feasible to fully eliminate the impacts of urbanization on runoff volumes. However, maintaining flood peaks near existing levels for multi-frequencies provides great benefits and reduces potential drainage problems downstream.

Urban development brings with it a variety of pollutants that have not previously been associated with the watershed. Installing water quality basins or other Best Management Practices (BMPs) to remove the bulk of these pollutants will be analyzed as part of the master plan.

As the watershed continues to develop, low flows will increase in their frequency of occurrence, duration, and magnitude; therefore, channel stability and floodplain preservation concepts were identified. Selective channel lining, low-flow protection, and grade-control are the most common alternatives to address stream stabilization. Another concept is to allow the natural channel to continue to evolve by preserving a wide floodplain area. A common element in all alternatives considered is to provide access for future maintenance requirements.

The number of possible improvement alternatives is extensive. The preliminary screening process is used to rule out those alternatives that do not meet the evaluation parameters. Many possible improvement concepts can be ruled out by testing whether the concept fits within a natural environment as found in the study area. Specifically, many typical "urban" drainage improvements are based on minimum right-of-way requirements and tend to be more costly. The availability of right-of-way in this area is not presently a restriction. Improvements that provide benefits in terms of the evaluation parameters listed above were kept, while those which have no benefit, are not possible, or those that do not fit in with the surrounding environment were not further investigated. This approach insures that all types of potential improvements are considered for each reach, but only those that are feasible and desirable are evaluated in greater detail.

Frequent flood detention, infrequent flood detention, water quality basins, routing paths, diversions, longitudinal slope stabilization and regulatory alternatives were identified which were feasible to implement, and which provided benefits to each drainageway in terms of the evaluation parameters listed above. Each alternative concept and its potential for use in the *Second Creek* and *DFA 0053* watersheds are discussed below.

DETENTION

Flood Control – *Second Creek*

The analysis of detention facilities concentrates on multi-frequency effectiveness. The 2-year, 10-year, and 100-year frequencies were all evaluated in formulating the function of the outlet structures. These facilities should effectively control both the frequent and infrequent flood events. All detention facilities considered must lie within public right-of-way or easements, and must be maintained by a public agency. Any proposed facilities that are shown on private lands must carry with them adequate assurances of long-term operation and maintenance to be considered for implementation. Regional detention facilities are those that receive an upstream drainage area of 130 acres or more. On-site detention facilities are those that receive less than 130 acres. The proposed detention facilities aim to store sufficient flood volumes to maintain peak flows downstream at or below existing peak levels.

Flood Control – *DFA 0053*

Within *DFA 0053*, there are four outfalls to the *South Platte River*. Two of these outfalls encompass 92% of the total watershed area. Detention alternatives were concentrated along these two main outfalls to mitigate future peak flows to existing magnitudes. The other outfalls have small drainage areas and mitigating future impacts can be accomplished through on-site detention.

Water Quality

Improvement of urban stormwater quality is an important issue in watershed planning, especially in highly urbanized drainage areas. Many pollutants are associated with sediments present in stormwater runoff. Airborne pollutants contribute to these by deposition onto the urban landscape. Other sources of pollutants include lawn chemicals, oil and grease, pet feces, lawn clippings, and other items often found on urban land surfaces. Some of these pollutants can be limited by programs such as erosion control at construction sites, educational programs to inform the public as to proper use of lawn chemicals, oil recycling programs, and seasonal collection of leaf litter and debris as part of normal street sweeping programs. Even with these programs in place, normal erosion along drainageways can generate large quantities of sediment that can settle out along downstream channel reaches.

Several methods for the control of stormwater quality have been identified for use in this region. The UDFCD, in cooperation with many cities and counties in the Denver region, have developed a manual of Best Management Practices (BMPs) (UDFCD, 2001). Channels may be lined to prevent erosion, drop/check structures can be used to control degradation and erosion of channel grades, and on-site water-quality facilities and erosion control during and after construction can be implemented to address runoff from newly developed areas.

The implementation of water quality basins is recommended with each of the proposed detention facilities. On-site and regional water quality facilities have been sized at various locations throughout the watersheds. The required size of each facility is directly proportional to upstream drainage area. A maximum tributary area of one-half to one square mile is recommended for water quality basins. A summary of the required water quality capture volume for each sub-basin based on various optional detention times applicable to different BMPs is presented in Table V-2.

DRAINAGEWAYS

Channelization

Channel alternatives were designed based on peak flow rates for each reach from the hydrologic models. Manning's equation, with the appropriate "n" value, was used to size and set the slope of the channels. Channel hydraulic parameters were checked to insure the channels would comply with UDFCD criteria. A constructed channel is recommended downstream of the O'Brian Canal to convey the irrigation ditch low-flow bypasses. No channelization alternatives are proposed upstream of the O'Brian Canal as the floodplain has been preserved and the sponsors desire to maintain a natural drainageway through the watershed. Preservation of a natural channel with maintenance measures as required will be the recommended approach. All defined channels, both natural and constructed, will require access for periodic maintenance. A system of proposed trails will parallel the drainageways to provide the necessary access. In *DFA 0053*, a significant focus of alternatives is to establish dedicated flow paths for the outfalls to the *South Platte River*.

Full channelization options are channels that fully convey the 100-year peak flow rate. The floodplain is reduced and contained within the channel limits. Due to proper floodplain regulation and the timeliness of this study being in front of development, this is not a favorable option. For this study, the practical channel alternatives are riprap, grass lined, wetland, or stabilized natural vegetation channels. A summary of design criteria for these channel types is provided in Table V-1.

Riprap-lined channels provide reduced right-of-way, relatively high velocity criteria, and allow for deep cross-sections. Higher roughness of the riprap allows for a steeper channel that still maintains a sub-critical flow regime. A steeper channel requires fewer drop structures.

Grass-lined channels have the benefit of not requiring expensive riprap lining material along the entire length of the channel. However, the criteria for grass-lined channels requires that the velocities are kept below 5 fps, the depth at full flow remains below 5', and side slopes must be 4:1 or flatter. To meet these requirements, grass-lined channels require a relatively wide right-of-way and frequent drop structures in steep areas. Multi-frequency channels generally have a hard-lined low-flow channel with a grass-lined overflow area that contains the 100-year peak flows. Grass-lined channels in areas where a significant base flow exists must include some provision for erosion control.

Wetland channels are shallow, slow-flowing channels that are intended to provide an area for wetland vegetation to thrive, as well as providing an adequate conveyance for flood flows. In mature conditions the wetland vegetation should fill the channel, except for a meandering low-flow section, which can be allowed to form naturally. Perennial base flow is generally required in order to keep the wetland species alive. Wetland channels must be designed to be stable for both the initial condition where the vegetation has not yet been established, and the mature condition where the vegetation significantly affects the channel roughness and capacity. In order to maintain slow velocities, the longitudinal slope of wetland channels must be flat, which requires more grade-control structures than other channel types. In general, wetland channels are more expensive, but provide excellent mitigation opportunities.

The topography near the *South Platte River* is very flat. All channels were designed with a minimum slope of 0.4-percent to reduce sediment deposition. Due to the flatness of this area, the need for erosion control and bank protection is reduced. Project sponsors have a strong interest in this corridor and would like to see channels designed as natural in appearance as possible. Grass-lined and wetland channels were analyzed in the alternatives.

Table V-1
Summary of Technical Criteria

Facility		Criteria
Grass-Lined Channel	Maximum Velocity	5 fps
	Maximum Flow Depth	5 feet
	Minimum Roughness	.035
	Maximum Side Slope	4H : 1V
Riprap Channel	Maximum Velocity	7 fps
	Maximum Flow Depth	7 feet
	Minimum Roughness	.030
	Maximum Side Slope	2½H : 1V
Low-Flow Sections	Maximum Velocity	5 fps
	Maximum Flow Depth	2 feet
	Design Capacity	5-year discharge
	Minimum Roughness	.035
Wetland-Bottom Sections	Maximum Velocity	2 fps
	Maximum Flow Depth	4 feet
	Design Capacity	2-year discharge
	Minimum Roughness	.080
Roadway Crossings	Local or Collector	10-year
	Major Arterial	100-year
	Concrete Pipe Culvert Roughness	.013
	Concrete Box Culvert Roughness	.015
	CMP Roughness	.024

Longitudinal Slope Stabilization

As the watershed develops, the frequency of runoff will increase, causing erosion to increase and sediments to be transported downstream. At some point, the channel will naturally erode to a stable slope. From past experience, the UDFCD has identified a stable slope in urban areas in the Denver region generally as 0.4%. If this were allowed to develop in the *Second Creek* watershed the channel would become deep, posing a hazard and degrading water quality for years to come. To prevent channel degradation, drop or check structures are used to stabilize longitudinal slopes. To determine quantity and location of the structures requires establishing a set of design parameters. Typically check structures are smaller and can accommodate a vertical drop of 3 to 4 feet. Drop structures are larger and can be designed to handle a drop of up to 8 feet. To locate the placement of each structure requires estimating a stable slope for use in the design. Using a design slope of 0.4%, will be used in the areas that have an upstream drainage area of one square mile or greater. A maximum slope of 0.8% will be used in the design of areas with upstream drainage areas less than or equal to 130 acres. For the reaches in between these design parameters, a design slope of 0.6% will be applied.

Detailed structural design for these structures is not determined during this stage of the study. The most common check structures are made of concrete with riprap placed upstream and downstream of the structure. Other designs incorporate riprap, grouted boulders, or sheet pile. For the purpose of cost estimating the common concrete structure is assumed. Drop structure design can also vary. The two most common designs are concrete vertical structures or grouted sloping boulder structures. For the purpose of cost estimating the grouted sloping boulder structures are assumed.

Bank Stabilization

Bank stabilization will be required where specific erosion problem areas have been noted in the field or identified by local residents from the area. Not a great deal of erosion was observed during the field visits to the study area. Minor erosion near roadways was observed in a few locations. Other areas of erosion may stabilize over the long term with or without the implementation of longitudinal slope stabilization. Monitoring of the channel will be an ongoing requirement as it is expected to change as the watershed develops for several years to come.

Revegetation

Criteria for "bioengineered" vegetation should be in the form of performance specifications. This requires that vegetation be designed to withstand specific velocity, depth, and roughness criteria. All disturbed areas should be revegetated with plant species recommended by the local government in which the proposed improvements are to be located. Areas in the bottoms of wetland channels should be planted with wetland-type vegetation and upland areas planted with dry-land grass species according to UDFCD or local sponsor practices. Detention basin areas should be planted with dry land species except for the permanent pool fringe area where wetland/riparian vegetation could be used. Existing trees and desirable vegetation should be saved wherever possible. Large cottonwoods and/or willow trees should be protected during construction activities.

Maintenance

All drainageways and other stormwater facilities will require periodic maintenance to ensure operation as designed. Routine mowing, debris pick up, and repair of minor erosion are the commonly needed maintenance measures. Use of native-type grasses helps reduce mowing requirements and is encouraged. Signs and educational programs can help reduce debris dumping in drainageways.

Routine inspection of check structures, riprapped areas, and crossing structures is required to detect deficiencies prior to flood events and potential damages after flood events. To be considered eligible for UDFCD maintenance assistance, all facilities must be designed to current UDFCD criteria.

Following initial construction of the master plan facilities will require substantial maintenance in the following years. As the channel continues to change and stabilize each year after master plan implementation, maintenance requirements should diminish.

5.6 Summary of Alternatives Considered

Numerous alternatives were considered for reducing flood peaks, increasing roadway capacities, increasing channel conveyance, enhancing water quality, and stabilizing erosion. These alternatives were screened and limited to the most viable options. These are covered in detail in the Alternatives Development and Evaluation report.

Future conditions hydrology, assuming the 1990 master plan in place upstream of DIA, was used to develop alternatives.

Water quality was analyzed based on two concepts. The first concept was to place large regional facilities on *Second Creek* with 1 square mile maximum upstream drainage areas. The other option was to place several smaller water quality basins at each significant outfall to the main channel and treat the runoff prior to its release into *Second Creek.* Due to smaller required land areas and easier implementation (outside of the 100-year floodplain), the smaller-basin plan was selected.

Various conveyance capacities were evaluated for all road crossings and channels. The minimum required capacity to meet jurisdiction regulations was chosen. In general, the 10-year conveyance capacity was used as a minimum and the 100-year conveyance was used where needed at major crossings. Since much of the watershed is currently undeveloped, road crossings are few and generally limited to the major arterial roadways. Therefore, most of the crossings require 100-year capacities.

5.7 Recommended Alternative

Based on the cost estimates prepared for the alternatives, a recommended plan was brought forward to preliminary design. This plan was meant to serve as a guideline to the project sponsors in choosing the final alternatives for preliminary design. The preliminary design of the selected plan includes more specific cost estimates, a re-analysis of the hydrology and hydraulics of the proposed structures and their influence on the 100-year floodplain.

The recommended plan for detention was to generally reduce flows at 88th Avenue focusing on the 2-year event, at Chambers Road focusing on the 10-year event, and at 112th Avenue focusing on the 100-year event with a 5-year controlled release rate under the O'Brian Canal. On *DFA 0053* detention facilities were selected where implementation costs were minimized and flood reduction was effective at reducing downstream flows to existing levels. Several structural improvements were proposed in the reaches for channel stabilization. Road crossings were upgraded to meet current standards. Water quality improvements recommended that a total of 18 water quality basins be implemented at specific locations throughout the watershed.

Table V-2

Second Creek Water Quality Capture Volumes (ac-ft)

Basin #	I (imp.value)	6-hour WQCV (in)	12- hour WQCV (in)	24-hour WQCV (in)	40-hour WQCV (in)	Area (sq. mi.)	Area (acres)	6-hr Storage (acre-feet)	12-hr Storage (acre-feet)	24-hr Storage (acre-feet)	40-hr Storage (acre-feet)	Basin #	I (imp.value)	6-hour WQCV (in)	12- hour WQCV (in)	24-hour WQCV (in)	40-hour WQCV (in)	Area (sq. mi.)	Area (acres)	6-hr Storage (acre-feet)	12-hr Storage (acre-feet)	24-hr Storage (acre-feet)	40-hr Storage (acre-feet)
1	1.000	0.350	0.400	0.450	0.500	0.188	120.4	3.512	4.013	4.515	5.017	55	0.496	0.144	0.164	0.185	0.205	0.154	98.3	1.178	1.346	1.514	1.682
2	0.088	0.042	0.048	0.054	0.060	0.121	77.6	0.270	0.309	0.348	0.386	56	0.640	0.175	0.200	0.225	0.250	0.129	82.5	1.205	1.377	1.549	1.721
3	0.830	0.244	0.279	0.313	0.348	0.059	37.7	0.766	0.876	0.985	1.095	57	0.650	0.178	0.203	0.229	0.254	0.159	101.7	1.507	1.722	1.938	2.153
4	0.614	0.169	0.193	0.217	0.241	0.121	77.1	1.084	1.239	1.393	1.548	58	0.650	0.178	0.203	0.229	0.254	0.175	112.1	1.662	1.899	2.137	2.374
5	0.422	0.130	0.148	0.167	0.186	0.097	62.2	0.673	0.770	0.866	0.962	59	0.650	0.178	0.203	0.229	0.254	0.089	56.9	0.843	0.963	1.084	1.204
6	0.075	0.036	0.042	0.047	0.052	0.106	68.0	0.206	0.235	0.265	0.294	60	0.357	0.118	0.135	0.151	0.168	0.084	53.7	0.527	0.602	0.677	0.753
8	0.085	0.041	0.047	0.052	0.058	0.093	59.4	0.202	0.231	0.259	0.288	61	0.431	0.132	0.150	0.169	0.188	0.097	61.8	0.677	0.774	0.871	0.967
9	0.411	0.128	0.146	0.164	0.183	0.127	81.1	0.864	0.987	1.111	1.234	62	0.324	0.111	0.127	0.143	0.159	0.192	122.7	1.136	1.298	1.461	1.623
10	0.050	0.025	0.029	0.033	0.036	0.048	30.4	0.064	0.073	0.082	0.092	64	0.470	0.139	0.159	0.178	0.198	0.067	42.9	0.496	0.567	0.637	0.708
11	0.131	0.059	0.067	0.075	0.084	0.164	104.9	0.512	0.585	0.658	0.731	65	0.950	0.313	0.358	0.403	0.447	0.049	31.3	0.816	0.932	1.049	1.165
12	0.050	0.025	0.029	0.033	0.036	0.099	63.3	0.133	0.153	0.172	0.191	66	0.445	0.134	0.153	0.172	0.192	0.111	70.9	0.792	0.905	1.018	1.131
14	0.850	0.253	0.290	0.326	0.362	0.123	78.9	1.666	1.904	2.142	2.380	67	0.551	0.155	0.177	0.199	0.221	0.189	120.8	1.556	1.778	2.000	2.223
15	0.850	0.253	0.290	0.326	0.362	0.184	117.9	2.491	2.847	3.203	3.559	68	0.850	0.253	0.290	0.326	0.362	0.197	126.2	2.666	3.047	3.428	3.809
16	0.850	0.253	0.290	0.326	0.362	0.073	46.5	0.982	1.122	1.263	1.403	69	0.245	0.093	0.106	0.120	0.133	0.176	112.7	0.875	1.000	1.125	1.250
17	0.850	0.253	0.290	0.326	0.362	0.105	67.3	1.421	1.624	1.827	2.030	70	0.050	0.025	0.029	0.033	0.036	0.118	75.3	0.159	0.181	0.204	0.227
18	0.400	0.126	0.144	0.162	0.180	0.128	82.1	0.861	0.984	1.107	1.230	71	0.547	0.154	0.176	0.198	0.219	0.109	69.7	0.892	1.020	1.147	1.275
19	0.050	0.025	0.029	0.033	0.036	0.075	47.8	0.101	0.115	0.130	0.144	72	0.814	0.236	0.270	0.303	0.337	0.203	129.8	2.551	2.915	3.279	3.644
20	0.416	0.129	0.147	0.166	0.184	0.050	31.8	0.341	0.390	0.439	0.488	73	0.376	0.121	0.139	0.156	0.173	0.203	130.1	1.316	1.504	1.692	1.880
21	0.559	0.156	0.178	0.201	0.223	0.134	85.7	1.115	1.274	1.433	1.593	74	0.654	0.179	0.204	0.230	0.256	0.115	73.7	1.098	1.255	1.412	1.569
22	0.510	0.146	0.167	0.188	0.209	0.098	62.4	0.761	0.870	0.979	1.088	75	0.850	0.253	0.290	0.326	0.362	0.090	57.3	1.210	1.383	1.556	1.729
23	0.529	0.150	0.172	0.193	0.214	0.081	51.8	0.648	0.740	0.833	0.925	76	0.598	0.165	0.188	0.212	0.236	0.086	54.9	0.754	0.862	0.969	1.077
24	0.107	0.050	0.057	0.064	0.071	0.201	128.4	0.533	0.609	0.685	0.761	77	0.741	0.206	0.236	0.265	0.295	0.116	74.1	1.274	1.456	1.638	1.820
25	0.500	0.144	0.165	0.186	0.206	0.071	45.5	0.548	0.626	0.705	0.783	78	0.594	0.164	0.187	0.211	0.234	0.144	92.2	1.259	1.439	1.618	1.798
26	0.500	0.144	0.165	0.186	0.206	0.051	32.3	0.389	0.445	0.500	0.556	79	0.488	0.142	0.162	0.183	0.203	0.209	133.9	1.585	1.811	2.038	2.264
27	0.650	0.178	0.203	0.229	0.254	0.045	28.8	0.427	0.488	0.550	0.611	80	0.290	0.104	0.119	0.133	0.148	0.075	48.0	0.415	0.475	0.534	0.594
28	0.500	0.144	0.165	0.186	0.206	0.177	113.5	1.365	1.560	1.755	1.950	81	0.840	0.248	0.284	0.319	0.355	0.118	75.2	1.557	1.779	2.002	2.224
29	0.287	0.103	0.118	0.133	0.147	0.105	67.3	0.578	0.661	0.743	0.826	82	0.769	0.217	0.248	0.279	0.310	0.203	129.7	2.345	2.680	3.015	3.350
30	0.336	0.114	0.130	0.146	0.162	0.153	97.7	0.925	1.057	1.189	1.322	83	0.850	0.253	0.290	0.326	0.362	0.161	103.0	2.175	2.486	2.797	3.108
31	0.500	0.144	0.165	0.186	0.206	0.052	33.0	0.398	0.454	0.511	0.568	84	0.900	0.281	0.321	0.361	0.401	0.069	43.9	1.028	1.174	1.321	1.468
32	0.517	0.148	0.169	0.190	0.211	0.067	43.1	0.531	0.607	0.682	0.758	85	0.656	0.180	0.205	0.231	0.256	0.116	74.4	1.113	1.272	1.431	1.590
33	0.500	0.144	0.165	0.186	0.206	0.110	70.3	0.846	0.967	1.087	1.208	86	0.552	0.155	0.177	0.199	0.221	0.187	119.8	1.544	1.765	1.985	2.206
34	0.446	0.134	0.154	0.173	0.192	0.193	123.7	1.386	1.584	1.782	1.980	87	0.650	0.178	0.203	0.229	0.254	0.133	85.4	1.266	1.447	1.627	1.808
35	0.459	0.137	0.156	0.176	0.195	0.187	119.8	1.364	1.558	1.753	1.948	88	0.150	0.065	0.075	0.084	0.093	0.038	24.4	0.133	0.152	0.171	0.190
36	0.318	0.110	0.126	0.141	0.157	0.072	46.0	0.421	0.481	0.542	0.602	89	0.154	0.067	0.076	0.086	0.095	0.052	33.6	0.187	0.214	0.240	0.267
37	0.410	0.128	0.146	0.164	0.182	0.124	79.4	0.845	0.966	1.087	1.208	90	0.592	0.163	0.187	0.210	0.233	0.068	43.5	0.592	0.677	0.761	0.846
38	0.447	0.135	0.154	0.173	0.192	0.093	59.4	0.666	0.761	0.856	0.951	91	0.650	0.178	0.203	0.229	0.254	0.121	77.6	1.151	1.315	1.480	1.644
39	0.544	0.153	0.175	0.197	0.219	0.126	80.5	1.027	1.173	1.320	1.467	92	0.392	0.124	0.142	0.160	0.178	0.063	40.5	0.420	0.480	0.540	0.600
40	0.500	0.144	0.165	0.186	0.206	0.074	47.2	0.568	0.649	0.730	0.811	93	0.296	0.105	0.120	0.135	0.150	0.104	66.9	0.585	0.669	0.753	0.836
41	0.500	0.144	0.165	0.186	0.206	0.108	68.8	0.828	0.946	1.064	1.183	94	0.825	0.241	0.275	0.310	0.344	0.073	46.7	0.938	1.072	1.206	1.340
42	0.372	0.121	0.138	0.155	0.172	0.181	116.0	1.166	1.333	1.500	1.666	95	0.753	0.211	0.241	0.271	0.301	0.202	129.1	2.267	2.590	2.914	3.238
43	0.486	0.142	0.162	0.182	0.202	0.193	123.5	1.458	1.666	1.874	2.082	96	0.460	0.137	0.156	0.176	0.195	0.086	54.7	0.624	0.713	0.802	0.892
44	0.328	0.112	0.128	0.144	0.160	0.193	123.8	1.154	1.319	1.484	1.648	97	0.586	0.162	0.185	0.208	0.232	0.107	68.2	0.921	1.053	1.185	1.316
45	0.415	0.129	0.147	0.165	0.184	0.139	89.0	0.954	1.091	1.227	1.363	98	0.850	0.253	0.290	0.326	0.362	0.175	112.2	2.370	2.708	3.047	3.385
46	0.346	0.116	0.132	0.149	0.165	0.136	87.2	0.840	0.960	1.080	1.200	99	0.050	0.025	0.029	0.033	0.036	0.105	67.1	0.141	0.162	0.182	0.202
47	0.554	0.155	0.177	0.199	0.221	0.072	46.2	0.597	0.683	0.768	0.853	100	0.488	0.142	0.162	0.183	0.203	0.093	59.3	0.702	0.802	0.902	1.003
48	0.524	0.149	0.170	0.191	0.213	0.184	118.0	1.465	1.674	1.883	2.092	654	0.488	0.142	0.162	0.183	0.203	0.118	75.7	0.896	1.024	1.152	1.280
49	0.500	0.144	0.165	0.186	0.206	0.145	93.0	1.119	1.279	1.439	1.599	661	0.488	0.142	0.162	0.183	0.203	0.162	103.7	1.228	1.403	1.578	1.754
50	0.493	0.143	0.163	0.184	0.204	0.178	114.1	1.360	1.555	1.749	1.943	662	0.488	0.142	0.162	0.183	0.203	0.194	124.4	1.473	1.683	1.893	2.104
51	0.050	0.025	0.029	0.033	0.036	0.190	121.6	0.256	0.293	0.330	0.366	678	0.488	0.142	0.162	0.183	0.203	0.059	37.5	0.444	0.507	0.571	0.634
52	0.490	0.142	0.163	0.183	0.204	0.201	128.4	1.524	1.742	1.959	2.177	680	0.488	0.142	0.162	0.183	0.203	0.176	112.9	1.336	1.527	1.718	1.909
53	0.050	0.025	0.029	0.033	0.036	0.159	101.5	0.214	0.245	0.275	0.306												
54	0.446	0.134	0.153	0.173	0.192	0.123	78.7	0.881	1.006	1.132	1.258							**12.69**	**8122.9**	**101.2**	**115.6**	**130.1**	**245.7**

Table V-3

DFA 0053 Water Quality Capture Volumes (ac-ft)

Basin #	I	6-hour WQCV (in)	12- hour WQCV (in)	24-hour WQCV (in)	40-hour WQCV (in)	Area (sq. mi.)	Area (acres)	6-hour Storage (acre-feet)	12-hour Storage (acre-feet)	24-hour Storage (acre-feet)	40-hour Storage (acre-feet)
1	0.61	0.167	0.190	0.214	0.238	0.042	26.8	0.373	0.426	0.479	0.532
2	0.05	0.025	0.029	0.033	0.036	0.083	53.4	0.113	0.129	0.145	0.161
3	0.05	0.025	0.029	0.033	0.036	0.116	74.1	0.156	0.179	0.201	0.223
4	0.30	0.106	0.121	0.136	0.151	0.125	79.8	0.705	0.806	0.907	1.008
5	0.32	0.110	0.125	0.141	0.157	0.188	120.2	1.099	1.256	1.413	1.570
6	0.52	0.147	0.169	0.190	0.211	0.049	31.3	0.385	0.440	0.495	0.550
7	0.37	0.120	0.137	0.154	0.171	0.104	66.6	0.665	0.760	0.855	0.951
8	0.29	0.104	0.119	0.133	0.148	0.181	115.8	1.001	1.144	1.287	1.430
9	0.25	0.095	0.108	0.122	0.135	0.046	29.6	0.234	0.267	0.300	0.334
10	0.28	0.102	0.117	0.132	0.146	0.114	73.1	0.624	0.713	0.802	0.891
11	0.61	0.168	0.192	0.216	0.240	0.139	89.2	1.250	1.428	1.607	1.785
12	0.27	0.099	0.113	0.127	0.142	0.195	124.8	1.030	1.178	1.325	1.472
13	0.30	0.106	0.121	0.136	0.151	0.111	71.2	0.629	0.719	0.809	0.899
14	0.37	0.121	0.138	0.155	0.172	0.107	68.3	0.686	0.784	0.882	0.980
15	0.54	0.152	0.174	0.196	0.218	0.053	33.6	0.427	0.488	0.549	0.610
16	0.51	0.146	0.167	0.188	0.208	0.095	60.5	0.736	0.841	0.946	1.051
17	0.35	0.117	0.134	0.150	0.167	0.095	60.5	0.590	0.674	0.759	0.843
18	0.30	0.106	0.121	0.136	0.151	0.045	28.8	0.255	0.291	0.328	0.364
19	0.30	0.106	0.121	0.136	0.151	0.113	72.1	0.637	0.728	0.819	0.910
20	0.30	0.106	0.121	0.136	0.151	0.019	12.3	0.108	0.124	0.139	0.155
21	0.30	0.106	0.121	0.136	0.151	0.121	77.5	0.685	0.783	0.881	0.979
22	0.90	0.281	0.321	0.361	0.401	0.100	64.3	1.506	1.721	1.936	2.152
23	0.90	0.281	0.321	0.361	0.401	0.089	57.0	1.335	1.525	1.716	1.907
24	0.90	0.281	0.321	0.361	0.401	0.122	78.4	1.835	2.098	2.360	2.622
25	0.90	0.281	0.321	0.361	0.401	0.063	40.4	0.946	1.081	1.216	1.351
26	0.90	0.281	0.321	0.361	0.401	0.061	38.8	0.909	1.039	1.169	1.299
27	0.90	0.281	0.321	0.361	0.401	0.034	21.8	0.511	0.584	0.657	0.730
28	0.90	0.281	0.321	0.361	0.401	0.069	44.2	1.036	1.184	1.332	1.480
29	0.90	0.281	0.321	0.361	0.401	0.084	54.0	1.264	1.445	1.625	1.806
30	0.12	0.054	0.062	0.070	0.077	0.062	39.5	0.178	0.204	0.229	0.255
31	0.30	0.106	0.121	0.136	0.151	0.069	44.0	0.388	0.444	0.499	0.555
32	0.05	0.025	0.029	0.033	0.036	0.083	53.4	0.112	0.129	0.145	0.161
33	0.75	0.208	0.238	0.267	0.297	0.102	65.1	1.128	1.289	1.450	1.611
34	0.74	0.205	0.235	0.264	0.293	0.090	57.9	0.991	1.132	1.274	1.415
35	0.70	0.193	0.221	0.248	0.276	0.127	81.4	1.309	1.496	1.684	1.871
36	0.90	0.281	0.321	0.361	0.401	0.098	62.8	1.470	1.680	1.890	2.099
37	0.90	0.281	0.321	0.361	0.401	0.052	33.5	0.784	0.896	1.008	1.120
38	0.90	0.281	0.321	0.361	0.401	0.206	131.8	3.086	3.527	3.968	4.409
39	0.90	0.281	0.321	0.361	0.401	0.154	98.6	2.310	2.640	2.970	3.300
40	0.33	0.113	0.130	0.146	0.162	0.090	57.6	0.544	0.621	0.699	0.777
41	0.57	0.159	0.182	0.205	0.227	0.035	22.3	0.296	0.339	0.381	0.423
42	0.78	0.222	0.254	0.286	0.318	0.173	110.8	2.054	2.348	2.641	2.934
43	0.42	0.129	0.148	0.166	0.185	0.181	116.0	1.248	1.427	1.605	1.783
44	0.25	0.094	0.108	0.121	0.135	0.204	130.4	1.025	1.172	1.318	1.465
45	0.50	0.145	0.166	0.187	0.207	0.053	34.0	0.411	0.470	0.529	0.588
46	0.32	0.110	0.126	0.142	0.158	0.190	121.3	1.115	1.274	1.434	1.593
47	0.31	0.108	0.123	0.139	0.154	0.048	31.0	0.279	0.319	0.359	0.399
48	0.30	0.107	0.122	0.137	0.152	0.157	100.6	0.894	1.022	1.150	1.278
49	0.90	0.281	0.321	0.361	0.401	0.156	99.9	2.339	2.673	3.007	3.341
50	0.32	0.110	0.126	0.142	0.157	0.180	115.1	1.056	1.206	1.357	1.508
51	0.30	0.107	0.122	0.137	0.152	0.076	48.5	0.431	0.492	0.554	0.615
52	0.30	0.107	0.122	0.137	0.152	0.111	70.8	0.630	0.720	0.810	0.900
53	0.19	0.079	0.090	0.101	0.112	0.125	79.7	0.522	0.597	0.671	0.746
54	0.77	0.216	0.247	0.277	0.308	0.064	40.7	0.731	0.836	0.940	1.045
55	0.85	0.253	0.290	0.326	0.362	0.012	7.8	0.164	0.187	0.210	0.234
56	0.56	0.157	0.179	0.202	0.224	0.069	43.9	0.573	0.655	0.737	0.819
57	0.82	0.237	0.270	0.304	0.338	0.128	81.8	1.613	1.843	2.073	2.304
58	0.84	0.248	0.284	0.319	0.355	0.115	73.4	1.520	1.737	1.954	2.171
59	0.65	0.178	0.203	0.229	0.254	0.061	39.3	0.582	0.665	0.748	0.831
60	0.66	0.182	0.208	0.234	0.260	0.091	58.0	0.878	1.004	1.129	1.255
61	0.38	0.122	0.139	0.156	0.174	0.072	46.2	0.469	0.536	0.603	0.670
62	0.16	0.067	0.077	0.086	0.096	0.121	77.6	0.433	0.495	0.557	0.619
63	0.50	0.144	0.164	0.185	0.205	0.077	49.2	0.588	0.672	0.756	0.840
64	0.62	0.171	0.196	0.220	0.244	0.087	55.8	0.796	0.909	1.023	1.137
65	0.23	0.090	0.103	0.116	0.129	0.149	95.5	0.718	0.820	0.923	1.025
66	0.55	0.154	0.176	0.198	0.220	0.075	47.8	0.612	0.700	0.787	0.875
67	0.74	0.205	0.234	0.263	0.292	0.161	103.2	1.760	2.011	2.263	2.514
68	0.05	0.025	0.029	0.033	0.036	0.076	48.6	0.103	0.117	0.132	0.146
69	0.37	0.120	0.137	0.154	0.172	0.115	73.3	0.734	0.839	0.943	1.048
70	0.43	0.131	0.150	0.169	0.187	0.114	72.7	0.794	0.907	1.021	1.134
71	0.21	0.084	0.096	0.108	0.120	0.109	69.8	0.489	0.559	0.628	0.698
72	0.45	0.134	0.154	0.173	0.192	0.098	63.0	0.705	0.806	0.907	1.007
73	0.31	0.108	0.123	0.139	0.154	0.021	13.4	0.121	0.138	0.155	0.172
74	0.82	0.239	0.273	0.307	0.341	0.092	58.9	1.172	1.339	1.507	1.674
75	0.76	0.213	0.244	0.274	0.305	0.150	96.0	1.707	1.950	2.194	2.438
76	0.68	0.188	0.214	0.241	0.268	0.129	82.7	1.292	1.477	1.662	1.846
77	0.31	0.109	0.125	0.140	0.156	0.086	55.3	0.502	0.574	0.646	0.717
78	0.61	0.169	0.193	0.217	0.241	0.078	49.9	0.701	0.801	0.902	1.002
79	0.68	0.187	0.213	0.240	0.267	0.164	105.0	1.633	1.867	2.100	2.333
80	0.22	0.087	0.100	0.112	0.124	0.067	42.8	0.311	0.355	0.399	0.444
81	0.24	0.092	0.105	0.118	0.131	0.203	129.9	0.996	1.139	1.281	1.423
82	0.15	0.066	0.076	0.085	0.095	0.063	40.1	0.221	0.253	0.284	0.316
83	0.30	0.107	0.122	0.137	0.153	0.064	41.0	0.365	0.417	0.469	0.521
84	0.52	0.148	0.169	0.190	0.211	0.039	24.8	0.306	0.350	0.393	0.437
85	0.29	0.104	0.119	0.134	0.148	0.161	103.2	0.894	1.021	1.149	1.277
86	0.05	0.025	0.029	0.033	0.036	0.040	25.5	0.054	0.061	0.069	0.077
87	0.15	0.067	0.077	0.086	0.096	0.140	89.8	0.501	0.573	0.644	0.716
88	0.22	0.086	0.099	0.111	0.123	0.048	30.5	0.220	0.251	0.282	0.314
89	0.58	0.161	0.184	0.208	0.231	0.183	116.8	1.571	1.796	2.020	2.245
90	0.05	0.025	0.029	0.033	0.036	0.068	43.4	0.091	0.105	0.118	0.131
9.17						**5871.0**		**73.25**	**83.71**	**94.18**	**104.64**

VI. PRELIMINARY DESIGN

6.1 Introduction

The preliminary design phase of the study began with the Selected Plan provided by the project sponsors. Previously, the project sponsors each received a copy of the Alternatives Development and Evaluation Report that described various alternatives considered throughout the watershed and provided a single recommended plan for implementation. Comments were received from the project sponsors that generally adopted the recommended plan with some re-analysis of detention and water quality basin locations and road crossing capacity adjustments. A copy of the sponsor's Selected Plan has been provided in Appendix A.

6.2 Master Plan Hydrology

Master Plan hydrology reflects anticipated future (fully-developed) impervious conditions. It is assumed that the detention facilities described in the 1990 master plan upstream of DIA will be constructed. The upstream detention greatly reduces future increases on 100-year flows, but the more frequent events are significantly higher than existing rates.

Proposed detention facilities were analyzed in more detail and included in the master plan hydrology models. Flows rates for the master plan conditions include proposed detention storage and release rates.

6.3 Public Meeting

A public meeting was held on March 16, 2004 at 7:00 p.m. at the Second Creek Elementary School.

Discussions were held on *DFA 0053* in regard to Detention #364 and the alignment of the diversion channel to it. The property owner of the proposed diversion channel was in attendance and felt that the alignment along Fulton Ditch would work for this property. The landowner had some concern with access to an irrigation pond located on the property adjacent to the ditch. Access to the pond will need to be provided as part of the diversion channel design. Another concern was raised about the ownership and maintenance of the Detention #364 facility. Since this will be a dry-bottom basin, it will require mowing and weed control. A question of who exactly will be responsible for this maintenance was brought forward. E-470 currently owns the site and may be willing to maintain it in the future as part of its trail system. If not, the site would fall into Adams County or City of Brighton jurisdiction and a maintenance plan could be arranged with Urban Drainage and Flood Control District.

The *Second Creek* alignment between the O'Brian Canal and Burlington Ditch was brought into question. Exhibits used in the meeting showed an alignment generally through the middle of the property. This land is currently used for agriculture and has a significant irrigation system in place. It was learned that the historic *Second Creek* alignment follows the O'Brian Canal alignment and crosses the Burlington Ditch further to the north. To accommodate the property owner the proposed channel was realigned through this property to follow the historic path. This added approximately 200 feet of length to the channel but required no additional costs to the proposed plan.

Other discussions found that the Union Pacific Railroad may be interested in providing a separation grade near the *Second Creek* crossing. Also, it was learned that the existing railroad crossing has a concrete bottom and has accumulated a significant amount of sediment. Further explorations of the crossing may find that the existing structure is capable of passing the master plan flows. These investigations are beyond the scope of this study and will be recommended at final design to determine if the existing bridge can be salvaged or requires replacement.

6.4 Preliminary Design

Plan and profile sheets for the preliminary design of the master plan improvements are presented in Appendix F. The first sheet in the set is an index map that allows for quick location and specific master plan drainage improvements. Drainageway improvements have been designed to fit their locations and anticipated peak flow rates. Specific information and detailed cost estimates for each improvement are provided on the commentary page opposite each plan and profile sheet in Appendix F.

As part of creating additional conveyance capacity and separating storm runoff from ditch flow, the 1990 master plan called for lowering the existing channel by an average of 8' downstream of the O'Brian Canal. Lowering the channel will also be required as part of this updated study in order to construct low-flow crossings of the three irrigation canals. In general the existing invert will be lowered by 4 to 5 feet to accommodate a 5-year capacity wetland bottom channel. Lowering the invert could produce 100-year capacity at several of the larger crossings, e.g., SH-85, 136th Avenue, and UPRR. However, since the structural details of the existing road crossing structures are not known, it cannot be assumed that existing structures can be safely modified to accommodate a drop in channel invert elevations. For this study, all existing structures are assumed to have solid bottoms incapable of having the inverts lowered. Some existing structures may be salvaged in their existing form as overflow structures with new structures sized adjacently to increase capacity. The structural integrity of the older structures is unknown and may further dictate that existing structures be replaced.

Flood detention, water quality improvement, grade control for longitudinal slope stabilization, provision of a defined flow path, and increased roadway capacity are the key structural elements in the master plan. Key non-structural elements of the master plan are formalization of existing detention facilities and preserving right-of-way for flood-carrying capacity, wildlife corridors, and future trails in the watershed. The total cost, including land value, is estimated at $92.1 million for all of the improvements in all of the reaches.

The following section describes the master plan components in the watershed. Table VI-1 presents the summary of detention facilities on *Second Creek* and Table VI-2 on *DFA 0053*. The estimated total construction cost of the Master Plan for each reach on *Second Creek* and *DFA 0053* is presented in the following section. Total project costs will include five percent of the structure cost for utility re-location, and 35 percent of the structure cost and utility relocation for administration, engineering and contingencies.

SECOND CREEK DETENTION

The master plan calls for a series of three regional detention facilities, each designed for a different frequency level of flood reduction. The impact of the master plan detention facilities is evident in the peak flow comparisons for Second Creek in Table VI-4. The uppermost facility (88th Avenue) will capture and reduce the 2-year event and allow greater flows to pass downstream. The middle facility (Chambers Road) will generally allow the 2-year event to pass through while collecting and reducing the 10-year event. Flows greater than the 10-year will spill over through a controlled spillway. The most

downstream facility (112th Avenue/O'Brian Canal) will collect the remaining 100-year peaks and reduce them to historic levels.

Detention 366. The regional detention facility at 88th Avenue is the most upstream facility and it is designed for 2-year control. The existing 2-year flow at this point is 6 cfs. Due to downstream contributing areas, the peak increases immediately downstream of 88th Avenue. Through sensitivity analysis it was found that releasing flows between 6 cfs to 100 cfs had almost no difference on peaks at the *South Platte River*. Release rates larger than 100 cfs were found to increase the peak downstream. Limiting the outlet to a 36" RCP reduces the 2-year peak from 479 cfs to 120 cfs. A storage volume of 132 acre-feet is required to achieve the flow reduction. Designing the facility for 2-year flood control requires relatively frequent overtopping to pass larger flood events. A 500' controlled spillway is required just above the 2-year pool to allow larger flows to pass downstream. Some reduction in the 100-year peak is also achieved as flows are reduced from 5156 cfs to 4854 cfs. The 100-year depth of flow through the spillway is 2.1 feet.

It should be emphasized that this design is a "preliminary" design. Numerous alternatives in design are possible to achieve the same hydraulic function producing the same downstream regional benefits. For example, using the 88th Avenue roadway for the emergency spillway is a potential alternative design. Also, during the study there were many discussions about using a 96th Avenue location instead. This is nearly an equal alternate. Presently there is no 96th Avenue crossing of Second Creek, but it is likely to occur at some future time. Incorporating the 2-year detention facility in the design of a 96th Avenue crossing is a viable alternate to the 88th Avenue facility.

Detention 336. Regional flood control at Chambers Road is the second in the series of detention facilities and controls the 10-year flood event. The existing 10-year peak is 659 cfs. If unchecked, this peak will increase to 3211 cfs with projected development. Including detention and peak reduction from the proposed upstream facilities results in a design inflow of 1128 cfs. Using a 4'x10' RCBC to outlet 10-year flows enables this facility to return peaks back to existing levels with a release rate of 634 cfs. Again a 500' controlled spillway is required just above the 10-year pool to allow larger flows to pass downstream. The 100-year depth of flow through the spillway is 1.6 feet.

Detention 330. The most downstream facility is located at 112th Avenue/O'Brian Canal and is designed to control the 100-year flood event. The future 112th Avenue embankment will also serve as the detention facility embankment with a 100-year release. Storing 194.5 acre-feet enables future flows to be reduced 25% below existing levels. Just downstream of the detention outlet flows must cross the O'Brain Canal. The canal has water rights to 200 cfs from Second Creek. The O'Brian Canal requires twin 48" RCPs to provide 200 cfs to the canal. The pipes will be gated to allow the canal to refuse the 200 cfs when necessary. A 5-year low flow culvert passes flows under the canal with a 250' armored spillway to pass the 100-year flows. The 100-year depth of flow through the spillway is 1.9 feet.

Table VI-1
Master Plan Watershed Detention (*Second Creek* 100-year Data)

Location	Design Point	*Existing (cfs)*	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)
112th Avenue	330	*4302*	4083	194.5	5113.1	3076
Chambers Road	336	*4337*	4280	257.3	5132.6	4117
88th Avenue	366	*4408*	5156	236.5	5196.1	4854
Chambers Road 10-year Design	336	*659*	1128	163.1	5130.9	634
88th Avenue 2-year Design	366	*5*	479	132.0	5194.0	120

SECOND CREEK WATER QUALITY

Mitigating the adverse effects of urban development on water quality is achieved through several water quality basins throughout the watershed. Water quality features are included on DIA, therefore the storm runoff entering the study area is considered "clean". The master plan focuses on placing water quality basins at each significant outfall to *Second Creek*. Releasing "clean" runoff to the main channel preserves the water quality within *Second Creek*, which is carried through the watershed to the South Platte River.

Constructing a wetland bottom channel along the lower 6 miles of *Second Creek* also enhances water quality. The wetland channel is designed with heavy vegetation and slow moving water. This works to filter out pollutants and solids releasing clean water downstream. Implementing BMPs through regulatory guidelines further helps to eliminate the origin of many pollutants and prevents them from reaching the drainageways at the source.

SECOND CREEK CHANNEL IMPROVEMENTS

The need to provide separation of storm water from irrigation water at the three canal crossings generates the need for 6 miles of improved channel from the *South Platte River* to the O'Brian Canal. The study identified a 5-year capacity for the irrigation canal crossings. Therefore, a 5-year channel is required to convey the bypassed flows. The flatness of the area accommodates a wetland bottom channel which enhances wildlife and water quality. Five-year flows through this reach are generally constant near 500 cfs. The required channel has a bottom width of 46 feet, 4:1 side slopes and a maximum depth of 4 feet. Urban Drainage spreadsheets were used in the design of the channel reaches.

Upstream of the O'Brian Canal, the channel will be preserved in its natural condition. The floodplain has been preserved along the entire reach of *Second Creek* for overflow conveyance and structures have been kept outside of the floodplain since 1976 by the FHAD study. The need to reduce the 100-year floodplain by constructing a 100-year channel is not necessary. Flows exceeding the capacity of a 5-

year channel are relatively infrequent (on average 1 occurrence every 5 years) and should not pose a frequent nuisance.

Channel stability can be achieved through a series of drop structures to stabilize the longitudinal slope. Limiting the channel to a maximum velocity to 2.0 feet per second generates the need for several small drop structures throughout the channel.

SECOND CREEK ROAD CROSSINGS

Due to the limited development in the watershed, there are relatively few road crossings. Most of the crossings are arterial routes and require 100-year conveyance capacities. Where local roads cross the creek, a 10-year capacity was used instead. In total there are 19 road crossings of *Second Creek* as well as three additional canal crossings.

SECOND CREEK IRRIGATION CROSSINGS

The three canal crossings, Fulton Ditch, Burlington Ditch, and O'Brian Canal, have been designed with 5-year conveyance capacities. Larger flows will overtop and enter the canal. A separation structure will be placed in the canal to limit the canal flow to that defined by each canal company. Larger flows will be forced over the downstream embankment through a controlled armored weir section.

DFA 0053 DETENTION

Most of the master plan detention facilities in *DFA 0053* are existing detention sites that are not recognized as formal, functioning facilities. Many can be created with no additional structural improvements. Placing these sites within public ownership and providing maintenance to guarantee future functions is often enough to allow these sites to be recognized as formal detention facilities. Table VI-2 lists the seven proposed detention facilities along the various reaches of *DFA 0053*.

Detention 364. During the construction of E-470, a borrow pit was excavated near US-85 and remains open with no known use. Flows from Fox Run (which include Locust Run, Tumbleweed Draw, and Reign Creek) can be diverted into this facility with capacity to capture the 100-year future runoff and release it to historic levels. There is currently no release for runoff that enters the borrow pit. Adding a 36-inch RCP allows downstream peaks to be reduced such that the outfall to the South Platte River is at its existing magnitude. This detention facility also allows the downstream channel to be smaller, as well as, the crossing structures at UPRR, US-85, Brighton Road, and Fulton Ditch. A water quality forebay can also be incorporated in this facility for regional water quality enhancement.

Detention 346. There is an existing retention facility along US-85 between 112th and 120th Avenues. Modifying the facility to a permanent detention basin allows adequate capacity to reduce the 100-year future peak back to existing levels all the way to the South Platte River. The site will require a raised embankment along Havana Street to prevent overtopping of the roadway and a twin 4'x6' RCBC to outlet under US-85. Excavation within the storage area can be utilized to provide material for the embankment. Reducing the flood peak also allows the US-85, 120th/Fulton Ditch, and Brighton Road to be reduced in size. A water quality forebay can also be incorporated in this facility for regional water quality enhancement.

Three additional detention facilities are located along I-76. Each of these is an existing area of inadvertent detention and requires little additional construction to function as regional detention.

Detention 330. A 24-inch pipe was found at the Tumbleweed Draw crossing of I-76 near the 116th Avenue alignment. Due to the small drainage area upstream, the small 24-inch RCP has a 10-year capacity. Inadvertent detention also exists at the upstream face of I-76. The low ground, possibly an old borrow pit from construction activities, effectively reduces the future 100-year peak to existing 10-year levels. Formalizing this facility enables the existing 24-inch pipe to provide a 100-year release without overtopping. A water quality forebay can also be incorporated in this facility for regional water quality enhancement.

Detention 332. On Reign Creek near the 112th Avenue alignment, a 24-inch CMP also crosses I-76. On the upstream side, a large low area holds a significant volume of runoff. Due to elevation constraints, the 24-inch CMP will be replaced with an 18-inch RCP. This pipe will extend 3000 feet downstream where it daylights to the proposed channel invert near 114th Avenue. This site has excess storage volume such that the 100-year peak can be reduced to 9 cfs. Since the construction of I-76, historically, little runoff has been able to cross the highway embankment.

Detention 333. A third low area at the I-76 highway embankment was found near 108th Avenue. No crossing structure was found and the area presently functions as a retention site. Retention is not a design option in this study. Existing flows increase from 491 cfs to 885 cfs with anticipated development. Adding a twin 4'x8' RCBC under I-76 and storing 92 acre-feet of runoff allows peak flows to be reduced to 379 cfs. No excavation is required for 100-year storage. A water quality forebay can also be incorporated in this facility for regional water quality enhancement.

Two additional effective regional detention sites are found at Highway 2/BNSFRR.
Detention 314. Along Henderson Creek (Morning Glory Run) Highway 2/BNSFRR has a twin 24-inch CMP crossing with 2-year capacity. Accounting for the inadvertent detention provides 23 ac-ft of flood storage covering 8 acres and provides 2.4 feet of freeboard with a release rate of 31 cfs. This returns the future 100-year peak to existing 10-year levels. This facility will also include water quality storage.

Detention 319. On Reign Creek at the SH-2 crossing there is a natural low area upstream of the embankment. Formalizing the detention and utilizing the existing 30-inch CIP beneath Highway2/BNSFRR releases 58 cfs with 1 foot of freeboard at the crossing. A small 1-foot earth berm is required to contain the 100-year pool to the south. This facility will also include water quality storage.

DFA 0053 WATER QUALITY

Mitigating the adverse effects of urban development on water quality is achieved through several water quality basins throughout the watershed. Water quality basins are included at each regional detention facility. In addition, several lakes are found near the South Platte River. Each of these lake functions as a water quality facility by depositing solids and releasing "clean" water downstream. Every drainageway passes through one of these facilities prior to entering the South Platte River. Therefore, water leaving the DFA is considered "clean" as it enters the South Platte.

DFA 0053 CHANNEL IMPROVEMENTS

Due to the many obstacles to drainage across the study area there are no defined channels. Runoff has historically been captured and stored behind roadway embankments and collected by irrigation canals and abandoned gravel pits. Future development will increase runoff and exceed the capacities of the current system resulting in roadway overtopping and bank failures. The sponsors have selected a 100-

year design capacity for formalized channels throughout the watershed. The channel will be grass-lined with drop structures where required to maintain stability. The required channels vary greatly depending on slope and flow, but they all are designed with 4:1 side slopes and a maximum depth of 5 feet and a maximum velocity of 7 feet per second. Urban Drainage spreadsheets were used in the design of the channel reaches.

Table VI-2
Master Plan Watershed Detention (DFA 0053 100-year Data)

Location	Design Point	*Existing (cfs)*	Inflow (cfs)	Storage (acre-feet)	Elevation (feet)	Outflow (cfs)
US-85	346	*1086*	2152	141.7	5056.9	508
US-85/E-470	364	*918*	1301	192.0	5033.3	136
I-76	330	*74*	75	31.0	5092.2	17
I-76	332	*274*	385	60.4	5093.6	9
I-76	333	*491*	885	92.2	5100.1	379
SH-2	314	*143*	280	20.7	5123.0	42
SH-2	319	*274*	355	21.5	5114.2	58

DFA 0053 ROAD CROSSINGS
Most of the existing road crossings are arterial routes and require 100-year conveyance capacities. Where local roads cross the creek a 10-year capacity was used instead.

DFA 0053 IRRIGATION CROSSINGS
The three canal crossings, Fulton Ditch, Burlington Ditch, and O'Brian Canal, have been designed with 100-year conveyance capacities. This is more feasible on the DFA versus *Second Creek* due to the smaller magnitude of flows required to pass the canals. Smaller upstream drainage areas and numerous detention facilities help to keep flows to a level in which 100-year culverts are feasible to pass storm runoff under the irrigation canals.

6.5 Cost Estimates

Cost estimates were prepared by sizing the master plan improvements using criteria presented in the Urban Storm Drainage Criteria Manual (UDFCD, 2001). By estimating the quantity and installation cost of required materials and applying unit costs as presented in Table VI-3, cost estimates were developed for all structural improvements. Unit costs have been updated to reflect the most current available published values.

Unit costs of each element were developed from the 2002 Colorado Department of Transportation Cost Data (CDOT, 2003). Drainage improvement costs include channels, culverts, detention facilities, water quality basins, and stream stabilization. Right-of-way acquisition costs were determined separately. In addition to cost estimates for construction activities, 5% has been added to account for utility relocation, and 35% has been added to account for administration, contingencies, legal review and engineering. These additional costs apply to the drainage improvement costs, but were not applied to the right-of-way acquisition costs.

Details of the detention facility and water quality basin cost estimates are provided in Appendix B. The surface area for each facility was determined via the project mapping. Clear and grub, excavation, topsoil, and seed and mulch were estimated based on the required disturbed area. Low flow channel lengths were measured for each facility and specific outlet structure sizes were determined to achieve desired release rates. Rip rap quantities were applied to each facility for erosion protection. Utility relocation, administration, contingencies, and engineering, and right-of-way were also added to the construction subtotals to arrive at the total estimated cost for the detention facilities. Water quality basin costs were estimated in a similar manner. However, rather than utilizing the project mapping for each specific location, an average depth of 3 feet was used to determine surface area. Also a uniform outlet structure cost of $15,000 was applied for each basin.

The total preliminary design plan cost is $92,142,505 and includes channel improvements, detention facilities, water quality basins, culverts, stream stabilization, utility relocation, administration, engineering, contingencies, and right-of-way. Removing the $43,906,539 right-of-way land value leaves an implementation cost with contingencies of $48,235,966, of which $34,028,900 is direct construction cost. Cost summary tables are shown in Table VI-6 and VI-7, and individual reach cost estimates are shown on the commentary sheets describing each plan and profile sheet.

6.6 Implementation

The list of recommended alternatives was compiled using cost estimates and determining an acceptable frequency level of protection. In the areas that have already developed, the sponsors will need to provide funding for construction of the selected improvements. In the areas that have not yet developed, criteria have been established that will require implementation during future development as it occurs. Acquiring right-of-way along the major drainageways is important in preserving the flood-carrying capacity of the channels, allowing natural erosion to occur without damaging structures, preventing structures from being built in the path of flood flows or on erodible banks, and providing a trail system for recreational use and access for future maintenance of the channels. Funding for land acquisition and structural improvements may be staged over several years or incorporated into local regulatory requirements.

Since a majority of the watershed is currently undeveloped, most of the specific master plan improvements can be implemented as the areas around the proposed structures are developed. Proposed detention and water quality basins need to be implemented as the upstream areas develop. Grade control structures can be implemented as development occurs along a particular section of channel. The channel to the *South Platte River* should be constructed prior to enlarging any of the road crossings or adding low-flow crossings to the irrigation canals.

The difficulty in this watershed is that development is occurring from upstream to downstream. Generally, the improvements need to be constructed from downstream to upstream. The canal crossings should only be installed after the 6 miles of 5-year channel is in place downstream.

A large part of the master plan requires enlarging road crossings to 100-year capacity. This is a significant expense. Enlarging road crossings can be staged to parallel development. Most of the master plan road crossings require multiple box culverts. To spread the cost of implementation, the boxes may

Table VI-4

Second Creek Master Plan Comparisons w/ Existing and Future

				Existing Conditions					Future Conditions					Comparison: Master Plan Increases Over Existing					
				Q_{100}	Q_{50}	Q_{10}	Q_5	Q_2	Q_{100}	Q_{50}	Q_{10}	Q_5	Q_2	Q_{100}		Q_{10}		Q_2	
Drainageway	**Description**	**Design Point**	**Area ac**	**cfs**	**cfs**	**cfs**	**cfs**	**cfs**	**cfs**	**cfs**	**cfs**	**cfs**	**cfs**	**cfs**	**%**	**cfs**	**%**	**cfs**	**%**
Second Creek	DIA Study Limit	173	9963.6	3317	2102	512	143	5	8053	6126	2981	2259	1451	3286	-1%	969	89%	303	5960%
Second Creek	Tower Rd.	171	10568.4	3431	2144	518	139	7	8147	6162	3026	2293	1474	3602	5%	1106	114%	408	5729%
Second Creek	88th Ave.	166	11272.4	4408	2723	650	167	5	9260	6965	3378	2547	1588	5156	17%	1615	148%	479	9480%
Second Creek	96th Extension	180	12576.0	4575	2790	676	261	157	9285	6922	3381	2541	1571	4779	4%	1274	88%	237	51%
Second Creek	104th Ave.	146	14030.1	4356	2634	661	168	71	8910	6626	3226	2410	1455	4310	-1%	1136	72%	321	352%
Second Creek	Chambers Rd.	136	14255.4	4337	2621	659	167	80	8868	6598	3211	2399	1445	4280	-1%	1128	71%	336	320%
Second Creek	O'Brian Canal/112th	130	15088.0	4302	2598	658	166	73	8812	6561	3194	2388	1435	4083	-5%	635	-3%	362	396%
Second Creek	Burlington Ditch	505	15340.8	4273	2574	653	163	70	8742	6515	3168	2368	1421	3074	-28%	635	-3%	363	419%
Second Creek	BNSF RR	506	15487.4	4249	2557	649	162	67	8696	6477	3151	2356	1412	3075	-28%	635	-2%	363	442%
Second Creek	I-76	165	15518.8	4246	2558	649	162	67	8694	6483	3153	2357	1413	3078	-28%	635	-2%	365	445%
Second Creek	120th Ave.	117	15630.1	4237	2550	647	161	63	8681	6476	3152	2359	1411	3088	-27%	645	0%	371	489%
Second Creek	Potomac St.	116	15992.4	4218	2530	640	160	61	8665	6469	3155	2367	1402	3117	-26%	699	9%	392	543%
Second Creek	124th Ave.	188	16016.7	4217	2529	640	159	60	8659	6470	3153	2365	1401	3115	-26%	700	9%	392	553%
Second Creek	E-470	111	16263.7	4167	2497	629	157	57	8563	6401	3117	2338	1383	3104	-26%	704	12%	393	589%
Second Creek	Fulton Ditch	109	16375.7	4147	2485	625	156	53	8531	6376	3104	2326	1375	3097	-25%	704	13%	394	643%
Second Creek	US-85	108	16435.2	4121	2467	618	155	52	8469	6327	3080	2307	1363	3087	-25%	703	14%	392	654%
Second Creek	Old Brighton Rd.	102	16757.8	3981	2378	585	149	45	8149	6103	2958	2207	1305	3027	-24%	689	18%	380	744%
Second Creek	South Platte River	101	16960.0	3981	2377	585	149	45	8154	6101	2956	2205	1304	3026	-24%	691	18%	380	744%
	* 8866.6 acres drains to study limit from Upper Second Creek																		
Reed Run	Headwater	179	193.3	147	95	26	5	0	417	327	165	121	76	417	184%	165	535%	76	7600%
Reed Run	Chambers Rd	192	262.4	174	103	28	5	1	427	321	143	103	61	427	145%	143	411%	61	6000%
Drew Draw	Headwater	148	117.8	161	106	32	6	2	399	315	166	125	78	399	148%	166	419%	78	3800%
	Private Rd.	149	210.6	278	176	52	8	3	610	475	242	179	110	610	119%	242	365%	110	3567%
Peachleaf Run	Headwater	186	119.7	179	120	41	7	3	434	345	191	145	89	434	142%	191	366%	89	2867%
	Private Rd.	150	233.6	270	170	53	8	3	568	439	215	158	100	568	110%	215	306%	100	3233%
Gramma Gulch	Headwater	158	112	131	90	33	12	2	412	341	198	155	98	412	215%	198	500%	98	4800%
	Tower Rd.	157	348.2	387	258	91	28	4	933	752	419	330	204	933	141%	419	360%	204	5000%
	Private Drive	159	474.2	470	297	91	26	2	987	769	386	298	172	987	110%	386	324%	172	8500%
Dragway Draw	Headwater	514	37.8	39	26	8	0	0	72	57	29	22	0	72	85%	29	263%	13	2900%
	Design Point	168	163.8	184	123	40	9	3	512	425	274	227	160	512	178%	274	585%	160	5233%
West Fork	DIA Study Limit	942	-	1270	838	198	60	2	2983	2347	1082	865	586	1739	37%	542	174%	144	7100%

Table VI-5

DFA 0053 Master Plan Comparisons w/ Existing and Future

				Existing Conditions					Future Conditions					Comparison: Master Plan Increases Over Existing					
		Area	Design	Q_{100}	Q_{50}	Q_{10}	Q_5	Q_2	Q_{100}	Q_{50}	Q_{10}	Q_5	Q_2	Q_{100}		Q_{10}		Q_2	
Drainageway	**Description**	**ac**	**Point**	**cfs**	**cfs**	**cfs**	**cfs**	**cfs**	**cfs**	**cfs**	**cfs**	**cfs**	**cfs**	**cfs**	**%**	**cfs**	**%**	**cfs**	**%**
Lockspur Drain	Old Brighton Rd.	48.6	168	35	25	9	5	0	36	26	9	5	0	36	3%	9	0%	0	0%
Lockspur Drain	South Platte River	165.8	189	453	369	209	162	101	453	369	209	163	101	453	0%	209	0%	101	0%
Reign Creek	Highway 2	206.1	119	274	194	67	40	16	355	262	109	73	39	355	30%	109	63%	39	144%
Reign Creek	O'Brian Canal	323.2	127	271	179	57	31	11	368	301	192	160	114	362	34%	191	235%	113	927%
Reign Creek	I-76	376.3	132	274	176	55	30	10	385	291	140	105	67	363	32%	138	151%	66	560%
Reign Creek	Burlington Ditch	433.9	140	288	184	54	29	10	455	336	148	108	64	191	-34%	72	33%	27	170%
Reign Creek	120th Ave.	564.5	144	365	242	86	55	24	569	403	167	118	64	310	-15%	98	14%	31	29%
Tumbleweed Draw	I-76	39.7	130	74	51	13	4	2	75	53	15	7	4	75	1%	15	15%	4	100%
Locust Run	Highway 2	77.4	121	170	125	48	28	5	250	192	93	65	32	250	47%	93	94%	32	540%
Locust Run	O'Brian Canal	131.2	129	252	177	60	33	6	384	304	177	141	97	384	52%	177	195%	97	1517%
Locust Run	I-76	175.4	131	216	144	41	20	2	319	239	111	82	47	319	48%	111	171%	47	2250%
Locust Run	Burlington Ditch	197.8	141	199	129	35	17	1	279	201	91	66	36	279	40%	91	160%	36	3500%
Locust Run	120th Ave.	585.0	153	417	274	82	44	10	811	614	297	223	130	799	92%	296	261%	130	1200%
Fox Run	120th Ave.	7.7	155	11	8	3	2	0	36	29	19	16	11	36	227%	19	533%	11	1100%
Fox Run	124th Ave.	1465.0	160	904	588	175	93	25	1477	1061	477	340	186	1250	38%	410	134%	157	528%
Fox Run	Fulton Ditch	1626.9	163	1009	658	197	105	31	1721	1232	567	408	226	1524	51%	508	158%	210	577%
Fox Run	US-85	1825.9	164	989	636	183	93	23	1546	1109	516	369	207	1359	37%	455	149%	185	704%
Fox Run	Oakland St.	1929.0	167	968	624	177	91	45	1521	1099	519	366	200	492	-49%	251	42%	135	200%
Fox Run	Old Brighton Rd.	2145.3	169	960	618	173	112	47	1473	1071	498	349	192	729	-24%	266	54%	104	121%
Fox Run	South Platte River	2234.9	187	976	627	186	121	48	1469	1068	496	348	191	859	-12%	284	53%	99	106%
Arabian Drain	124th Ave.	96.0	175	236	179	81	56	24	470	379	239	195	133	470	99%	239	195%	133	454%
Arabian Drain	Fulton Ditch	109.4	173	36	28	13	9	5	35	27	13	9	4	35	-3%	13	0%	4	-20%
Arabian Drain	Old Brighton Rd.	172.2	172	215	171	90	69	38	227	180	96	71	40	227	6%	96	7%	40	5%
Arabian Drain	South Platte River	197.8	186	164	122	54	38	18	166	124	55	39	19	166	1%	55	2%	19	6%
Ragweed Draw	Potomac St.	385.9	106	349	230	64	31	3	497	354	157	112	57	497	42%	157	145%	57	1800%
Ragweed Draw	104th Ave.	745.0	112	480	311	86	43	6	751	524	249	185	99	751	56%	249	190%	99	1550%
Ragweed Draw	Highway 2	839.7	116	511	330	91	42	4	829	587	256	183	96	829	62%	256	181%	96	2300%
Ragweed Draw	O'Brian Canal	917.8	124	511	327	88	40	5	802	574	262	182	121	802	57%	262	198%	121	2320%
Ragweed Draw	I-76	1052.2	133	533	340	92	42	10	885	640	305	218	146	885	66%	305	232%	146	1360%
Ragweed Draw	112th Ave.	1150.7	139	532	334	88	40	7	886	649	323	257	182	500	-6%	272	209%	166	2271%
Morning Glory Run	Peoria St.	137.6	113	92	62	22	13	2	197	152	73	54	25	197	114%	73	232%	25	1150%
Morning Glory Run	Highway 2	206.1	114	143	98	33	20	4	280	213	103	75	37	280	96%	103	212%	37	825%
Morning Glory Run	O'Brian Canal	270.1	122	195	130	40	21	3	396	311	181	146	100	287	47%	159	298%	94	3033%
Morning Glory Run	I-76	465.9	134	207	134	38	21	3	537	427	237	190	124	522	152%	234	516%	123	4000%
Henderson Creek	109th St.	499.2	137	227	147	42	21	3	497	377	198	156	99	465	105%	191	355%	97	3133%
Henderson Creek	112th Ave.	793.6	138	399	269	98	59	17	1354	1141	741	612	436	1353	239%	741	656%	436	2465%
Henderson Creek	US-85	2465.9	146	1086	714	228	129	42	2152	1618	805	621	381	1904	75%	719	215%	338	705%
Henderson Creek	120th Ave.	2686.7	178	1178	778	252	143	45	2264	1679	820	622	370	613	-48%	391	55%	218	384%
Henderson Creek	Old Brighton Rd.	2824.3	176	1176	777	253	142	47	2255	1667	819	617	364	612	-48%	393	55%	214	355%
Henderson Creek	South Platte River	3199.4	185	1361	921	337	226	113	2586	1906	937	700	410	1034	-24%	453	34%	240	112%

Table VI-6

Second Creek Master Plan Cost Estimates by Reach

Location		Construction Cost	Utilities	AEC	Floodplain Land Value	Total
Second Creek						
main channel	Sheet 1	$949,720	$47,486	$349,022	$542,520	$1,888,748
main channel	Sheet 2	$2,258,975	$112,949	$830,173	$916,575	$4,118,672
main channel	Sheet 3	$1,698,215	$84,911	$624,094	$842,325	$3,249,545
main channel	Sheet 4	$1,962,070	$98,104	$721,061	$930,270	$3,711,504
main channel	Sheet 5	$1,044,995	$52,250	$384,036	$973,995	$2,455,275
main channel	Sheet 6	$2,658,412	$132,921	$976,966	$4,640,328	$8,408,627
main channel	Sheet 7	$1,407,255	$70,363	$517,166	$4,969,602	$6,964,386
main channel	Sheet 8	$921,580	$46,079	$338,681	$922,680	$2,229,020
main channel	Sheet 9	$145,000	$7,250	$53,288	$957,000	$1,162,538
main channel	Sheet 10	$145,000	$7,250	$53,288	$957,000	$1,162,538
main channel	Sheet 11	$193,400	$9,670	$71,075	$957,000	$1,231,145
main channel	Sheet 12	$1,804,430	$90,222	$663,128	$4,109,061	$6,666,841
main channel	Sheet 13	$145,000	$7,250	$53,288	$957,000	$1,162,538
main channel	Sheet 14	$567,765	$28,388	$208,654	$805,365	$1,610,172
Tributaries						
Reed Run	Sheet 15	$311,900	$15,595	$114,623	$448,332	$890,450
Drew Draw	Sheet 16	$275,000	$13,750	$101,063	$328,086	$717,899
Peachleaf Run	Sheet 17	$240,000	$12,000	$88,200	$291,798	$631,998
Gramma Gulch	Sheet 18	$417,500	$20,875	$153,431	$574,638	$1,166,444
Dragway Draw	Sheet 19	$442,500	$22,125	$162,619	$540,282	$1,167,526
West Fork	Sheet 20	$307,500	$15,375	$113,006	$484,638	$920,519
Sandbar Run	Sheet 21	$217,500	$10,875	$79,931	$340,434	$648,740
Totals:		$18,113,717	$905,686	$6,656,791	$26,488,929	$52,165,123

Utility Relocation — represent 5% of the Construction Costs

AEC — Administration, Engineering, Contingencies - represent 35% of the Construction Costs + Utilities

Table VI-7
DFA 0053 Master Plan Cost Estimates by Reach

Location		Construction Cost	Utilities	AEC	Floodplain Land Value	Total
Henderson Creek	Sheet 25	$619,444	$30,972	$227,646	$346,200	$1,224,262
Henderson Creek	Sheet 26	$2,004,383	$100,219	$736,611	$2,497,362	$5,338,575
Henderson Creek	Sheet 27	$846,705	$42,335	$311,164	$828,150	$2,028,354
Henderson Creek	Sheet 28	$930,408	$46,520	$341,925	$1,287,972	$2,606,825
Henderson Creek	Sheet 29	$479,434	$23,972	$176,192	$423,300	$1,102,898
Saddle Creek	Sheet 30	$69,930	$3,497	$25,699	$94,500	$193,626
Ragweed Draw	Sheet 31	$1,186,290	$59,315	$435,962	$718,500	$2,400,066
Ragweed Draw	Sheet 32	$1,817,236	$90,862	$667,834	$2,537,808	$5,113,740
Ragweed Draw	Sheet 33	$768,500	$38,425	$282,424	$861,750	$1,951,099
Ragweed Draw	Sheet 34	$512,719	$25,636	$188,424	$734,850	$1,461,629
Arabian Drain	Sheet 35	$113,160	$5,658	$41,586	$192,000	$352,404
Fox Run	Sheet 36	$634,570	$31,729	$233,204	$538,500	$1,438,003
Fox Run	Sheet 37	$1,206,186	$60,309	$443,273	$659,400	$2,369,169
Fox Run	Sheet 38	$475,160	$23,758	$174,621	$741,000	$1,414,539
Locust Run	Sheet 39	$868,637	$43,432	$319,224	$835,650	$2,066,943
Locust Run	Sheet 40	$783,570	$39,179	$287,962	$655,800	$1,766,510
Reign Creek	Sheet 41	$481,214	$24,061	$176,846	$325,440	$1,007,561
Reign Creek	Sheet 42	$815,723	$40,786	$299,778	$998,400	$2,154,687
Reign Creek	Sheet 43	$704,278	$35,214	$258,822	$1,232,130	$2,230,444
Tumbleweed Draw	Sheet 44	$597,636	$29,882	$219,631	$908,898	$1,756,047
Totals:		$15,915,183	$795,759	$5,848,830	$17,417,610	$39,977,382

Utility Relocation — represent 5% of the Construction Costs
AEC — Administration, Engineering, Contingencies - represent 35% of the Construction Costs + Utilities

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January 19, 1998

Mr. Ben Urbonas, P.E.
Chief, Master Planning Program
Urban Drainage And Flood Control District
2480 West 26th Avenue, Suite 156 B
Denver, Colorado 80211

BY HAND DELIVERY

Re: Legal opinion in regard to alternative and planned drainage facilities in general as contained in alternatives development and evaluation reports

Dear Ben:

You have asked me to provide you with a legal opinion that you may use to initially evaluate in general all alternatives development and evaluation reports for compliance with the law of the State of Colorado applicable to drainage. What follows is such an opinion which will need to be supplemented by a short legal opinion in regard to each report to either indicate that no further comment is necessary or that certain other factors, other than those noted herein, will need to be considered before proceeding to the selection and construction of drainage improvements contained in that specific report.

In order to properly evaluate these reports you first must take note of the following comments in regard to the law of drainage in Colorado:

I. GENERAL LEGAL DRAINAGE PRINCIPLES

Natural drainage conditions may be altered by an upper (dominant) owner provided the water is not sent down in a manner or quantity to do more harm than formerly to the lower

(servient) owner, Hankins v. Borland, 163 Colo. 575, 431 P.2d 1007 (1967). Colorado follows the "rule of reasonableness" as related to drainage matters and in each drainage situation, the court will look at the relationship of the parties and at who is doing what to whom in order to determine "what is reasonable under the circumstances". Prior to the Hankins case, the Colorado Supreme Court ruled in Ambrosio v. Perl-Mack, 143 Colo. 49, 317 P.2d 803 (1960), that downstream owners had to accept additional runoff from an upstream developer.

As the engineering technology has become more precise in drainage matters, it is possible to determine from the actual development and from land use decisions that will determine future development what the additional (more than natural) runoff will be because landowners make their land impermeable.

The Colorado Legislature in 1973 recognized this and adopted Sec. 30-28-113(4)(b) which requires developers in unincorporated areas to detain greater than historical flows. As a matter of drainage practice, cities as well as counties and the Urban Drainage District work to identify with precision "who is doing what" to whom so that the cost of drainage solutions to problems created by future development can be placed on those who would change the use of land from permeable to impermeable. Runoff from existing development is also computed and the need, if any, to solve existing drainage problems can be determined and costs of solutions estimated.

Drainage matters historically were resolved between or among property owners. However, as urbanization (multiple property owners) has taken place, governments have become involved for several reasons. In some cases, the government itself helped create additional runoff by making improvements. In other cases, government approved land use changes without regard to the problems of additional runoff. In still other situations, government got involved because constituents (owners) wanted government help in the difficult and expensive field of determining (identifying) where the additional runoff was coming from and the paying of costs of solutions. For whatever the reason, whenever government gets involved, it can be expected to be treated like a private party. 2 Farnham, Water and Water Rights, pp. 975 and 977, adopted by the Colorado Supreme Court in City of Boulder v. Boulder and White Rock Ditch Co., 73 Colo. 426, 216 P. 553 (1923). A municipality can be held to its negligence. It can also determine whether to become involved at all, if it did not create the problem.

An update of these legal principles has yielded the conclusion that the law of drainage as set forth above has not really changed to any substantially degree over the years. Both the Hankins and Ambrosio cases continue to be cited by the Colorado courts when dealing with the law of drainage. In the case of Metro Docheff v. City of Broomfield, 623 P. 2d 69 (Colo. App.

1980) the Colorado Court of Appeals held that: "Although we recognize the right of the owner of higher land to a drainage easement over the lower land of others, . . . the discharge of water will be enjoined as a continuing trespass if the drain sends the water down 'in a manner or quantity to do more harm than formerly.'" In the case of Hoff v. Ehrlich, 511 P. 2d 523 (Colo. App. 1973) the Colorado Court of Appeals was faced with the question of the propriety of a servient owner blocking drainage from a dominant estate in order to protect the servient owner's land. The Court held that: "The owner of the dominant estate has a legal and natural easement or servitude in the lower or servient estate for the drainage of surface water flowing in its natural course and manner . . . When an interruption in the natural flow or passage of surface waters is caused by the servient owner to the detriment or injury of the estate of the dominant owner, the court should issue a mandatory injunction for the opening of the easement which has been blocked . . . [the servient owner] may not act to the extent that damage is caused thereby to the dominant landowner . . . in order for the owner of the servient estate to be afforded a remedy, it must be evident that the water was sent down in a manner or quantity causing more harm than it formerly had done."

If a government permits the development which in turn causes "more harm than formerly", then the government, as well as the developers, may be held liable. (Cases consistently move toward governmental, as well as developers' liability.) See Metro Docheff, *supra*, which held as follows: "The trial court found that the city had accepted the streets and storm drains for maintenance and control and, therefore, had exclusive control over the water collected in the subdivision. It determined that by approving the subdivision and drainage plan and accepting control, the city interfered with the natural conditions and thereby caused surface water to be collected and discharged upon plaintiff's land 'in a greater quantity or in different manner than had previously occurred under natural conditions."

Recently, governmental entities have raised in their defense of drainage cases the Governmental Immunity Act. In two recent cases, that defense has not been successful. In Burnworth v. Adams County, 826 P. 2d 368 (Colo. App. 1991) the Colorado Court of Appeals held that actions ". . . against public entities arising from the maintenance of a sewer, a storm sewer, or a storm drainage system." were not prohibited by the Governmental Immunity Act. In the case of Scott v. City of Greeley, 931 P. 2d 525 (Colo. App. 1996), the Colorado Court of Appeals again denied protection under the Governmental Immunity Act to a public entity when it argued that the damage complained of was the result of a design flaw rather than from the operation of a facility. The facts were that the City designed and constructed a new storm water line which was 42" and connected it to a line which was only 15". This caused the water to back up, or surcharge, through the storm drains and manhole covers, overtopping the curb and flooding adjacent property. In addition to the denial of protection to the entity under the

Governmental Immunity Act, the Court also rejected the City's defense that the connection to the smaller pipe was only temporary.

Any improvements upstream must be made taking into consideration the outlet capability downstream. (Long line of case law.) See Hankins, *supra*, which states: "The trial court has found that the water which these defendants have sent into the Borland drain is in greater quantity and more rapid in time — a finding fully justified by the evidence. Under such circumstances it is the court's duty to determine what the dominant owners must do in order to prevent their increased waste water from damaging the servient owner."

Colorado generally imposes strict liability on owners of dams (regional detention ponds). (Long line of cases.)

Interfering with natural drainageways or channels is generally looked upon with disfavor by Colorado Courts. However, builders of irrigation canals, railroads, and highways in other times were not aware or were unconcerned with the problems they might be creating in the future by artificially blocking natural drainageways. Sometimes the very passage of time (at least eighteen years) provides an argument that the blockage should be allowed to be continued because parties have relied and should be able to continue to rely on this "protection". Generally, the laws of nature prevail in these situations and artificial structures such as canals, railroads and highways do not rise to the status of permanent dams which require spillways and other features under the jurisdiction in the State of Colorado of the State Engineer.

With the enactment of federal environmental (including water quality) provisions, the quality of the runoff may also have an effect, as well as on other ecological matters.

Natural waters are subject to the doctrine of prior appropriation in Colorado and what may have become a water right must also be considered with any plan for the "handling" of surface runoff in natural waterways.

Finally, any drainage, "facility" built by a government must be maintained. "If you're not going to maintain it, then don't build it!" is the theme of a long line of cases.

II. GENERAL COMMENTS ON COMMONLY PROPOSED FACILITIES AND CONSTRUCTION TECHNIQUES

1. It is my understanding that the purpose of all reports in regard to this subject is to

examine alternatives which will, if implemented, improve upon and/or formalize the drainage that is within the study area.

2. In general, consideration must be given to any potential adverse effects of the selected alternative on properties within the study area and downstream of the study area.

3. If any selected facilities would increase or materially change the direction of the flows across downstream property in a study area, the downstream property has a right to claim damages and/or protection from such a material increase or change in flow. Thus, care should be taken to make sure that increased flows from upstream facilities are accommodated by sufficiently increasing the size of the downstream channels and conduits. If in final design, the selected alternative still has the effect of placing water on the residents and land owners in the area that they either never had or in a quantity larger than what they have had previously, the same must be revised to eliminate that result or the selected alternative must not be constructed.

4. If re-alignment of a channel is the selected alternative, careful consideration should be given to the channel's geometry, alignment and ability to carry flood flows so as not to create additional potential damages to surrounding landowners.

5. If the selected alternative is the collection of overland flows from a specific area and returning those flows to a drainage structure of some kind, care should be taken not to adversely impact landowners in the area.

6. If a selected alternative involves the redirection of flows from their historic path, prior to its finalization in the design process, caution should be taken that this redirection will not cause any increase in damage to those adjacent or downstream of the proposed redirection.

7. If any selected alternative, when it is finalized in the design process, is changed to include a plan for the diversion of runoff from one watershed to another; extreme caution should be used in implementing that portion of the selected alternative since the participants may be faced with the imposition of strict liability for any damage that occurs from any size storm event if it can be shown that the same would not have been suffered if the diversion had not occurred.

8. If the construction of crossing structures over irrigation canals are part of the selected alternative for the project, caution must be taken in regard to the capacity of those crossing structures. The structures, when designed for the design event, should not cause any more water than presently exists to flow into those canals.

9. The intentional routing, as opposed to inadvertent inflows, of flood flows into an irrigation ditch should be eliminated from any plan if at all possible unless a written agreement from the owner of the irrigation ditch is obtained permitting the use of the ditch to carry those flood flows. The participants have no control over the available capacity of the ditch at the time it would be necessary to carry flood flows so the ditch cannot realistically be used to control the flows downstream.

10. If an alternative is being selected that relies upon inadvertent detention and the participants do not intend to formalize such detention by written agreement, it is my opinion that the effect of that non-formalized inadvertent detention cannot be taken into consideration in the final design.

11. If a selected alternative includes the formalization of inadvertent detention it will be necessary for at least one of the participants to formalize that detention by entering into a written agreement with the owner of the facility causing the detention. The agreement must prohibit the owner from operating or modifying the facility in a way that would have the effect of lessening the inadvertent detention of the facility necessary to implement the selected alternative. Further, the owner must either agree to maintain the facility so that the same does not lose its current inadvertent detention or agree to permit at least one of the participants to maintain the facility.

12. If the owner of the facility will not agree to maintain the inadvertent detention facility, at least one of the participants should confirm in writing to all of the participants that the participant is committed to maintaining the inadvertent detention facility in a manner that assures the necessary inadvertent detention to implement the alternative. This should be done prior to the implementation of any of the alternatives involving inadvertent detention. The level of maintenance must at least permit the facility to function as relied upon in flooding events and not fail structurally during the design and larger events.

13. Any formalized detention facilities that are utilized in the final design of a project will need to be the subject of a written agreement between the owner and at least one participant that the facility will be maintained in a manner that assures the necessary flood storage to implement the design and that adequate maintenance will be performed by either the owner or the participant so that the facility will function as designed in flooding events and that it will not fail structurally during the design and larger events.

The participating entities must agree amongst themselves, in writing, that any one of the participants may enforce the terms of the agreement with the owner of the facility if the responsible participant does not. This agreement must include the maintenance of no more than

Kiowa Engineering Corporation

Memorandum

To: Project Participants
From: Brian Wozniak
Date: March 20, 2002
Project: *Second Creek Downstream of DIA and DFA #0053*
Subject: Progress Meeting No.2

The second progress meeting for Second Creek and DFA #0053 was held on March 12th in the Urban Drainage conference room. The attendance sheet is attached. The purpose of this meeting was to review gathered information, identify the interests of outside agencies, review preliminary hydrology and submit the hydrology models to Urban Drainage for approval.

Outside Agencies in Attendance
CDOT, E-470, BNSF R.R., L.C. Fulenwider, Inc., Kirby Smith and Associates (consultant for L.C. Fulenwider, Inc) CLC Associates, and Shea Homes. These attendees provided representation from development interests and the major transportation corridors within the study area. Of primary concern to all parties were the results of the new hydrology in comparison to the previous master plan hydrology.

Additional concern was voiced on the inability to implement some of the components of the previous master plan. Namely, Detention S-266, which was brought through the construction design phase by Shea Homes. When they tried to implement the facility they encountered several roadblocks from various regulatory agencies. A key point of this study will be to identify a specific implementation plan so that proposed improvements can be constructed.

Also, concern was expressed as to how changes in the upstream part of the master plan (outside of the limits of this study) will be treated in modeling and alternative analysis for this study. Kiowa has working models of the previous plan and will be able to test changes in the off site part of the watershed and measure the impacts to the downstream reaches.

CDOT, BNSF R.R., and E-470 have all offered to provide information on their various drainage facilities, including specific sizes and locations of the drainage crossing structures.

Preliminary Hydrology
Kiowa presented a "calibration comparison" between the new hydrology and the previous hydrology. Using the same land use assumptions the results were compared at various locations across the study area. It was found that the 100-year frequency results were nearly identical between the two studies. However, the 2-year and 5-year return-period storm events showed that the new hydrology provides significantly lower flow values. This was attributed to the difference in routing between the two studies. The new hydrology model contains between 50% and 100% more routing length than the previous study. This added length provides considerably more channel storage, which is most visible in the more frequent flood events. When current land use assumptions are used, the new hydrology is greater than the previous hydrology due to increased percent impervious values in effect as existing conditions today.

Kiowa submitted all of its hydrology modeling and parameter calculations to Urban Drainage for review.

Next Meeting
The next meeting was scheduled for 1:30 p.m. April 2, 2002 at Urban Drainage. In this meeting Kiowa will summarize the final hydrology and present a list of possible alternative approaches and a preliminary screening to identify the most practical.

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Besharah Najjar	Adams County	303-853-7126
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Dean Smith	E-470 Public Hwy. Authority	303-537-3728
Gene Eliassen	BNSF RR	303-480-6586
Mark Throckmorton	L.C. Fulenwider, Inc	303-295-3071
KIRBY SMITH	KIRBY SMITH + ASSOC./VAN SCHAACK HOLDINGS LTD.	303-694-9484
KURT MAHNKEN	CLC ASSOC.	303 770 5688
Steve Brown	Kiowa Engineering	303-692-0369
Tom Acre	Commerce City	(303) 289-3758
John Doerfer	UDFCD	303-455-6277
Tom Fairley	Kiowa Eng.	303 692-0369
TERRY TEAGUE	SHEA HOMES	303 791 8180

Kiowa Engineering Corporation

Memorandum

To: Project Participants

From: Brian Wozniak

Date: April 4, 2002

Project: *Second Creek Downstream of DIA and DFA #0053*

Subject: Progress Meeting No.3

The third progress meeting for Second Creek and DFA #0053 was held on April 2nd at Urban Drainage. The attendance sheet is attached. The purpose of this meeting was to review preliminary hydrology, review the previous master plan, and begin discussion on possible alternatives for analysis in the current study.

Preliminary Hydrology

Kiowa presented the results of the current hydrology and made comparisons back to the previous study. The previous study had the watershed divided into two separate models: Upper Second Creek and Lower Second Creek. The Lower Second Creek model covers the same area as the current study which includes all of Second Creek downstream of DIA. The Upper Second Creek outflow is read into the Lower model via three storm hydrographs which are read into the model at Second Creek main channel, West Fork to Second Creek, and one small tributary between the two. The results of the two studies compare very closely at the outfall to the South Platte River. Urban Drainage is currently in the process of reviewing the hydrology parameters and models.

1988 Master Plan

Kiowa has retained the master plan modeling of eight detention basins from the Upper Second Creek model. The storage in these facilities is included in the three hydrographs that are used as input to the Lower Second Creek model for alternatives analysis. A summary of the results showed that the future, non-detained flows are near 8000 cfs at the outfall to the South Platte. With the master plan Upper Second Creek detention facilities (eight of them) this peak is reduced to 5000 cfs. With the two additional master plan detention facilities (at 112th and 88th Avenues) this peak is reduced to 3000 cfs. The previous master plan also includes extensive channel improvements and road crossing structure replacements.

2002 Alternatives Analysis

The current study will look at alternative locations for detention sites downstream of DIA. In addition to 88th and 112th Avenues, 96th, Chambers and 104th will also be analyzed for regional detention. Kiowa will also model on-site detention using the CUHP option 3. MDCIA was discussed in detail. Although this approach may be recommended, until municipalities adopt it as a standard, implementation will be difficult. The downstream design goals still need to be identified. The previous master plan reduced flows downstream of the O'Brian Canal to 3000 cfs in order to minimize the required channel size to the South Platte River. Existing flows, assuming an O'Brian Canal crossing, are near 4000 cfs at the South Platte. If we provide detention to achieve 4000 cfs downstream, then a larger channel and larger road crossing structures will be required. Storm sewers and street flow will also be analyzed in the upper reaches and sized to a length where they become impractical. Once any storm sewer system is daylighted, conveyance will remain open from that point downstream (other than road/canal structures).

Additional Analysis

The 100-year floodplain will be overlayed within ACAD on the project mapping. Kiowa will contact Thornton, Commerce City, South Adams County, Denver, and Brighton to determine if any of these municipalities have plans to make use of any of the existing gravel pits along the South Platte for an augmentation water supply source. Kiowa will also contact the present owners to gain insight to potential future uses for these sites.

Next Meeting

The next meeting was scheduled for 1:30 p.m. April 23, 2002 at Urban Drainage

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4-2-02 Second Creek

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Andy Walsh	City of Brighton	303 655 2046
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Kiowa Engineering Corporation

Memorandum

To: Project Participants

From: Brian Wozniak

Date: April 30, 2002

Project: *Second Creek Downstream of DIA and DFA #0053*

Subject: Progress Meeting No.4

The fourth progress meeting for Second Creek and DFA #0053 was held on April 23rd at Urban Drainage. The attendance sheet is attached. The purpose of this meeting was to review the results of possible alternatives for on-site detention, regional detention, channel sizing/stabilization, and diversions.

The meeting began with discussion on two development sites within DFA 0053. The first is at the NW corner of 104th and Peoria. The future Peoria Road alignment will likely be moved west along 104th and dissect this property. The O'Brian Canal and Burlington Ditch also pass through this site. Diversion of the Burlington into the O'Brian and back out north of the site was discussed. Additional diversions of upstream drainage to the site was also discussed. Minimizing the number of crossings of the O'Brian would be beneficial. On-site detention will be required until a full downstream conveyance system is established. Possible sites for detention include the Peoria Road embankment and south of 104th Avenue.

The second development site is at the SW corner of 112th and Peoria. The master plan calls for an open channel through the middle of this site. The developer will be required to provide on-site detention until future downstream conveyance is made available. In-line detention would require inclusion of all upstream drainage area to the site. Off-line detention on each side of the channel can be sized for runoff from the development site only.

The E470 crossing of Second Creek has been sized to pass 6500 cfs. E470 would like to be informed of the final runoff rates determined for this crossing.

A public meeting to be held with the city council of Commerce City is tentatively scheduled for 8 weeks out. The draft AD&E report should be completed near 6 weeks with the final review completed by 10 weeks. The meeting was cut short due to another scheduled meeting. The following summarizes the items not covered in the meeting:

Regional Detention Analysis
88th Avenue is a 1988 master plan regional detention facility. The required volume was described as 277 acft over an area of 60 acres. For comparison purposes 96th Avenue (57 ac), 104th Avenue (80 ac), and Chambers Road (110 ac) were analyzed for effective storage. Since the hydrology model was not completely revised prior to the meeting, these sites were not tested in the models. An additional site just south of the power lines will also be tested.

Channel Sizing Analysis
A design goal for future flows needs to be determined. Should the goal be to pass 3000 cfs downstream of the O'Brian Canal (as in the 1988 master plan), a 180-ft channel top width (137 ac) will be required. If the channel is sized to pass 4000 cfs (equal to existing condition flows), then a 230-ft top width (175 ac) will be required. If the channel is sized for 5000 cfs (to reduce required upstream detention), then a 280-ft top width (214 ac) will be required. Existing crossing structures will be analyzed to help guide the design goal decision.

On-site Detention Analysis
The MDCIA option in CUHP was used to estimate the effect of on-site detention. There are three levels available within the MDCIA option. Level 1 has almost no impact on flow reduction. Level 2 reduced 100-year peaks by 3% and 2-year peaks by 27%. Level 3 reduced 100-year peaks by 14% and 2-year peaks by 64%. Further discussions are required to determine how appropriate this analysis is in representing on-site detention.

Next Meeting
The next meeting is scheduled for 3:30 p.m. May 13, 2002 at Urban Drainage.

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Second Creek Meeting 4 4/23/02

NAME	REPRESENTING	PHONE
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Andy Walsh	City of Brighton	303 655 2046
Luke Wittemyer	104 + Peoria (NWC)	303 377-0939
Shawn Smith	112th & Peoria	303 485-6769
Dean Smith	E470 Public Highway Authority	303-537-3728
Kirby Smith	Kirby Smith & Assoc (Van Schaalis Holdings)	303-694-9484
Brent Soderlin	Commerce City	303-289-8176
Tom Acre	Commerce City CP/DS	(303) 289-3758
John Doerfer	Urban Drainage	(303) 455-6277

Kiowa Engineering Corporation

Memorandum

To: Project Participants

From: Brian Wozniak

Date: May 16, 2002

Project: *Second Creek Downstream of DIA and DFA #0053*

Subject: Progress Meeting No.5

The fifth progress meeting for Second Creek and DFA #0053 was held on May 13th at Urban Drainage. The attendance sheet is attached. The purpose of this meeting was to discuss potential alternatives, including: on-site detention, regional detention, channel sizing/stabilization, and diversions.

The meeting began with discussion on the upcoming abandoning of Buckley Road between 96th and 88th. The adjacent racetrack is scheduled to close in 2004 with restoration of the area back to natural conditions. The Rocky Mountain Arsenal has been in discussion with the property owner of the 320 acres east of Buckley to have this parcel added to the wildlife preserve. This land use would work favorably with a future regional detention facility that could be located at the 96th Avenue extension over Second Creek or anywhere south of there. It is also a favorable land use with the future Second Creek trail system.

The Second Creek trail system is a high priority of the local governments. The trail system design has concerns with crossing Highway 85, E-470, Fulton Ditch, Burlington Ditch, O'Brian Canal, railroads, as well as the 96th – 88th area. If a drainage design could be proposed that would include crossings for the trail system, it would benefit both efforts. The trail design prefers to have the trail located above the 10-year flood elevation. The Second Creek trail system is currently in right-of-way acquisition. They anticipate final design within one year. Construction within Brighton is expected in the next 3-10 years, and in Commerce City within the 5 years.

Kiowa Engineering has recently completed its final revisions to the hydrology model and is making the submittal to Urban Drainage for model approval. The following table summarizes the model results for various frequencies at key locations within the study area (note: these values differ slightly from those presented in the meeting):

	Existing Conditions		Future Conditions (no imp.)	
Location	**100-yr**	**10-yr**	**100-yr**	**10-yr**
Tower Road	3431	320	8147	3026
West Fork Confluence	4377	364	9312	3414
88th Avenue	4408	363	9260	3378
96th Avenue	4575	425	9287	3384
104th Avenue	4355	417	8903	3226
112th Avenue	4301	420	8803	3193
I-76	4245	396	8685	3153
120th Avenue	4235	395	8673	3151
E-470	4165	385	8554	3116
US-85	4119	380	8460	3079
South Platte	3974	367	8132	2950

Next Meeting

The next meeting is scheduled for 1:30 p.m. May 28, 2002 at Urban Drainage. This should be the final meeting prior to publishing the draft Alternatives Development and Evaluation Report. An overview of the alternatives evaluation process will be presented.

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Second Creek

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Brent Soderlin	Commerce City	303-289-8176
John Doerfer	Urban ~~Flow~~ Drainage	
Tom Fairley	Kiowa Eng.	303 692 0369
Eric Weis	ADAMS COUNTY	303 287 7114
KIRBY SMITH	Kirby Smith & Assoc./ VAN SCHAACK HOWINGS	303-694-9484

Kiowa Engineering Corporation

Memorandum

To: Project Participants

From: Brian Wozniak

Date: June 4, 2002

Project: *Second Creek Downstream of DIA and DFA #0053*

Subject: Progress Meeting No.6

The sixth progress meeting for Second Creek and DFA #0053 was held on May 28th at Urban Drainage. The purpose of this meeting was to discuss specific detention alternatives at 96th Avenue and the property to the south, implementation, major road crossing drainage capacities, and design goals for downstream channel sizes.

Results of the regional detention analysis at 96th Avenue were discussed. Assuming all upstream (offsite) master plan detention is constructed, future flows into 96th Avenue would be 4580 cfs. An in-line detention facility at the future 96th Avenue embankment, with a storage volume of 176 ac.ft., will reduce the peak outflow to 3678 cfs. If the storage volume is increased to 445 ac.ft., the peak outflow is further reduced to 2278 cfs (a 50% reduction). Additional alternatives and sites will be analyzed, including off-line, side-channel detention where possible.

Combining the available detention at the 112th Avenue facility further reduces peak flows downstream of the O'Brian Canal. Both interim and ultimate conditions were analyzed. Various combinations of alternative detention facilities will be analyzed and summarized for the next meeting. These include regional sites at Chambers and 104th, as well as, facilities at the five main tributary outfalls to Second Creek.

Downstream road crossing capacities were discussed, and are summarized as follows:

Location	Existing Capacity	Future 100-yr	100-yr w/ u/s M.P.
Tower Road	362	8147	3360
88th Avenue	1553	9260	4383
96th Avenue	n/a	9287	4580
104th Avenue	1671	8903	4448
Chambers Road	2215	8868	4433
I-76	7686	8685	4394
120th Avenue	9385	8673	4394
Potomac Road	111	8665	4412
124th Avenue	24	8659	4410
E-470	21,000	8554	4373
132nd Avenue	11	8531	4366
US-85	1410	8460	4344

Alternatives will consider the cost of reducing flows to match existing road crossing capacities versus the cost of increasing or replacing road crossings and allowing higher peak flows and larger downstream channels. Implementing downstream channels may need to be staged with an interim 5-year channel and an ultimate 100-year channel. Downstream design flows should look at a range of flows from a minimum of 1500 cfs to 2000 cfs, up to 4500 cfs.

Next Meeting

The next meeting is scheduled for 1:30 p.m. June 18, 2002 at Urban Drainage. This meeting should summarize all of the alternatives consider and present the effectiveness of various combinations of alternatives.

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URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

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Steve Burkholder, City of Lakewood
Noel Busck, City of Thornton
Ken Fellman, City of Arvada
Stephanie Foote, City/County of Denver
Kathy Green, City of Aurora
B. H. Hoffmaster, Engineer
Michelle Lawrence, Jefferson County
Kathleen MacKenzie, City/County of Denver
W. Mike Maxwell, Douglas County
Jim McShane, Town of Columbine Valley
Deborah Ortega, City/County of Denver
Art Patton, Engineer
Susan Spence, Town of Superior
Karen Stuart, City/County of Broomfield

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July 25, 2002

Brian Wozniak
Kiowa Engineering Corporation
7175 West Jefferson Avenue
Suite 3400
Lakewood, CO 80235

Subject: Second Creek Downstream of DIA
Hydrology Review

Dear Brian:

We reviewed the hydrology information you submitted for this outfall system planning study. The hydrologic parameters as submitted on June 18, 2002 are approved. You may proceed with modeling of existing and future conditions hydrology, as well as the alternatives.

Thank you for providing all the information required to review and approve the finalized hydrology. If you have any questions, please feel free to contact me.

Sincerely,

John T. Doerfer
Project Hydrologist
Master Planning Program

JTD/mc
cc: Brent Soderlin, City of Commerce City
Eric Weis, Adams County
Andy Walsh, City of Brighton

Kiowa Engineering Corporation

Memorandum

To: Project Participants

From: Brian Wozniak

Date: June 18, 2002

Project: *Second Creek Downstream of DIA and DFA #0053*

Subject: Progress Meeting No.7

The seventh progress meeting for Second Creek and DFA #0053 was held on June 18th at Urban Drainage. The purpose of this meeting was to discuss the design goals for the master plan, specific detention alternatives with multi frequency release rates, and implementation.

Downstream design release rates were discussed. Commerce City is in a unique situation. Upstream, Denver and Aurora, are required to release to historic rates. However, if Commerce City allows historic release rates this could be a problem downstream at the O'Brian Canal where there is no crossing structure and downstream of the O'Brian where there is no conveyance channel to release to. After discussion it was determined that Commerce City should not be required to detain more than historic rates. If a problem exists downstream due to lack of conveyance, it is considered to be a historic problem. Releasing to historic rates is all that can be required from each jurisdiction.

Due to the flatness of the area, future vertical erosion is not expected to be a significant problem. Most likely the channel will move laterally which will require more bank stabilization than slope stabilization.

The ideal flood control plan would be a series of smaller facilities rather than one large detention facility. To maintain historic release rates at all frequencies each detention facility should be design to control a specific flood frequency. Three locations were selected for analysis: 88th Avenue, Chambers Road, and 112th Avenue. Each of the three would concentrate on reducing a different frequency event. 88th Avenue would control the 2-year event, Chambers Road the 10-year, and 112th Avenue the 100-year event.

Commerce City is highly interested in detention. Development pressures may push "implementation" to the City's first priority.

Looking at channelization options, it was determined that a natural drainageway is most ideal. Preserving the natural channel and allowing some minor erosion and meandering is acceptable to the sponsors. A formal channel will need to be excavated downstream of the O'Brian Canal since no channel exists now and opening the irrigation canals could cause flooding and erosion problems downstream and have a significant impact on South Platte River water quality. However, upstream of the O'Brian Canal there is an established low flow channel that can be preserved as is.

Jurisdictional boundaries should be shown on report figures.

Next Meeting
The next meeting is scheduled for 1:30 p.m. July 23, 2002 at Urban Drainage. In this meeting we review the draft AD&E report.

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6-18-02

Kiowa Engineering Corporation

CLIENT _____ JOB NO. _____ PAGE _____
PROJECT _____ DATE CHECKED _____ DATE _____
DETAIL _____ CHECKED BY _____ COMPUTED BY _____

SECOND CREEK

NAME	Representing	Phone
Brian Wozniak	Kiowa Eng	(303) 692-0369
Dirk Kappel	Carroll + Lange	303-337-8017
Brent Soderlin	Commerce City	303-289-8176
Tom Fairley	Kiowa Engineering	303 692-0369
Bill McCombie	Jeffs & Assoc	303 403-2407
Bill Klaess	Buffalo Highlands LLC	303 355-7706
Tom Acre	Commerce City	303 289-3758
John Doerfer	UDFCD	303 455 6277
Kirby Smith	KSA, LLC / VanSchaack Holdings Ltd.	303-694-9787

Kiowa Engineering Corporation

Memorandum

To: Project Participants

From: Brian Wozniak

Date: July 24, 2002

Project: *Second Creek Downstream of DIA and DFA #0053*

Subject: Progress Meeting No.8

The eighth progress meeting for Second Creek and DFA #0053 was held on July 23rd at Urban Drainage, attendance sheet attached. The purpose of this meeting was to discuss the DRAFT Alternatives Development and Evaluation report.

Kiowa Engineering distributed copies of the DRAFT AD&E report and explained the Alternatives Development and Alternatives Evaluation chapters. Discussions were held on the recommended plan and whether certain lands were available for flood detention storage. Road capacities were reviewed and the selection process explained.

Unit costs and estimated construction costs were discussed in detail. Although this is a Phase A report, the sponsors would like to see a little more detail in breaking down individual component costs by separating the right-of-way cost from the construction cost.

Additional initial comments are:

- Add Highway 2/BNRR detention analysis to Table V-3 (clarify which locations overtop the roadway)
- Show berm required to "hold in" Second Creek flows at Union Pacific RR crossing
- Add match lines to figures in Chapter VI
- Adjust land value to $1/s.f. for a more representative of land value in this area, esp. for floodplain lands

Each of the sponsors was given a DRAFT report for review. Aside from editorial corrections, sponsors should review the alternatives and design capacities at specific areas. Applying the sponsors' in depth knowledge of the properties within the watershed will also help to refine the report to a FINAL version.

Schedule

August 19th: sponsors submit "editorial" comments to Urban Drainage

August 30th: sponsors submit substantial "plan" comments to Urban Drainage

Shortly after all comments are received by Urban Drainage the Selected Plan letter will be written and sent to Kiowa Engineering for notice to proceed on Phase B – Preliminary Design.

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DETAIL _____ CHECKED BY _____ COMPUTED BY _____

NAME	Representing	Phone
Brian Wozniak	Kiowa Eng	(303) 692-0369
Eric Weis	Adams County	(303) 287-5249
Tom Fairley	Kiowa Eng.	303 692 0369
Brent Soderlin	Commerce City	303-289-8176
Tom Acre	Commerce City	303-289-3758
Joe Frank	Jehn Eng.	303-473-6036
Bill Klaess	Buffalo Run Mesa LLC	303 355 7706
John Doerfer	UDFCD	303-455-6277

Selected Plan for
Second Creek (Downstream of DIA)
and DFA 0053 Watersheds
Outfall Systems Planning Study Update

November 14, 2003

The plan selected by Adams County, the City of Commerce City, the City of Brighton and the Urban Drainage and Flood Control District to be shown in the Preliminary Design Report is described in two parts. The first part discusses the selected plan and the general direction for the remainder of this project. The second part provides additional issues and topics that need to be addressed in the final report. Kiowa Engineering is requested to complete the final report containing a preliminary design for the following selected plan.

GENERAL

1. The Selected Plan is the *Recommended Plan* as described in the *Second Creek (Downstream of DIA) and DFA 0053 Watersheds Outfall Systems Planning Study Alternative Evaluation Report* dated October 2002 with modifications as described herein. The plan for Second Creek is based on three (3) large detention basins in series. The furthest upstream controls the 2-year event, the middle basin controls the 10-year event, and the furthest downstream controls the 100-year event. The channel located downstream from the detention basins is designed for the 5-year discharge with residual overflow within a preserved floodplain. The plan for the six (6) DFA 0053 watersheds includes regional detention on the two (2) major outfall systems, and local on-site detention for the remaining four (4) watersheds. Recommended locations for grade-control structures and culvert crossings are also included in the plan.

Executive Summary

2. Include an Executive Summary in the Preliminary Design Report. This summary should be directed to the general public and, at a minimum, contain:

   a. A brief summary of the planning process including the purpose of the study, number of progress and public meetings, alternatives analysis, and preliminary design.
   b. A vicinity map showing watershed location and brief description of the study area.
   c. A brief summary of hydrology that compares existing flows to future and master plan flows, and to previous studies of the watershed, if any.
   d. A map showing the area, drainageways, and all major improvements.
   e. A brief description of the major drainageway improvements and decisions made by project sponsors during the development of this plan.
   f. A brief summary of specific design criteria and implementation aspects of the plan.
   g. A tabular and narrative summary showing costs for capital improvements, engineering/administrative/contingencies, land values, all sorted by drainageway reach, tributary, or outfall system. The reach length (miles), tributary catchment area (square miles), and their totals should also be included in the table.

Plan and Profile Drawings

3. Incorporate the following note on each drawing:
   "*This drawing is for master planning purposes and represents preliminary and conceptual engineering. Alternatives to this outfall system will be considered by local reviewing agencies and the Urban Drainage and Flood Control District provided the alternative offers equal hydraulic capacity and stream stability. The alternative must comply with all requirements of the local jurisdiction and the Urban Drainage and Flood Control District. This drawing shall not be used for construction purposes.*"

4. Incorporate the following note on each drawing:
   "*Adams County, City of Commerce City, and City of Brighton manage and regulate all land development and redevelopment within the 100-year floodplains of these watersheds so as to prevent future flood damages by following the recommendations of this plan.*"

ADDITIONAL DIRECTION

5. Prepare grading plans and volumetric calculations for Detention Basin S-219 in the upstream off-site area based on supplementary topographic data provided at 1-foot contour interval. Determine whether the 513 acre-foot volume can be obtained and whether flow rates assumed at the upstream study limit remain reasonable. Provide a written report on the preliminary design developed for this facility for inclusion as an appendix in the final report.

6. A detention facility located immediately upstream of 96th Avenue (extended) on Second Creek should be considered as a substitute for the 2-year detention basin included in the recommended plan at 88th Avenue. Design an embankment and release structure (based on an emergency spillway and downstream crossing sized to pass the 100-year discharge with no overtopping of 96th Avenue). Include features in the design that would be conducive to stormwater quality improvement and maintenance. Based on site data provided by the City of Commerce City on preferred location for the flood pool and channel of Second Creek in this vicinity, prepare grading plans and volumetric calculations for the 88th Avenue or 96th Avenue facility as preferred by sponsors for inclusion in the preliminary design.

7. Determine the feasibility of routing flows on Henderson Creek under 120th Avenue

at the location of the present Fulton Ditch crossing. A plan by Adams County for improvements to 120th Avenue should be considered in this assessment. Drainage facilities on Henderson Creek should be sized for 100-year conveyance capacity.

8. On Reach 2 of Ragweed Draw, one regional detention facility is located upstream of I-76, and a second regional detention facility is located upstream of Highway 2. Alternate locations may be feasible upstream of the O'Brian Canal and upstream of 104th Avenue. Determine if these alternate sites, or a single combined site at either location, provide comparable discharge levels to the downstream reach. Based on a decision by project sponsors, include the preferred location for detention in the preliminary design report.

9. Determine the feasibility of routing flows from Reign Creek Reach 2 and Locust Run Reach 2 to the regional detention facility located upstream of I-76. For the analysis of alternates locations noted in Item No. 8 above, determine which of the alternates are feasible and those that are excluded.

10. The channel capacity for Reach 2 of Ragweed Draw should be sized for 100-year conveyance capacity.

11. Buckeye Run and Saddle Creek can be eliminated from preliminary design because gravel mining has obliterated the channel.

12. Reign Creek south of 120th Avenue was relocated to a discharge point east of the Union Pacific Railroad. Relocate the crossing structure on 120th Avenue to this location based on information provided by the City of Commerce City. Substitute on-site detention for the regional detention facility upstream of Highway 2 on Reign Creek Reach 2. All other drainage facilities on Reign Creek should be sized for 100-year conveyance capacity.

13. Determine the feasibility of routing Locust Run Reach 2 to the regional detention facility located upstream of I-76 at the base of Reign Creek Reach 2. Crossings at 120th and 112th Avenues on Locust Run Reach 1 should be 100-year capacity.

14. Channel capacity for Morning Glory Run should be sized for 100-year conveyance capacity. Peoria Street and 104th Avenue crossings should be 100-year capacity.

15. The sheet layout for DFA 0053 outfall systems can be oriented as a grid system or by longitudinal profile. As an early action item, present examples of each method for a portion of area and proceed after a decision by project sponsors on the preferred method.

16. Sand Bar Run was identified as a tributary to Second Creek (in the vicinity of BFI) in the 1990 master plan. Add this identification in the preliminary design report. UDFCD identification numbers need to be added to the names and labels for all tributaries and outfall systems in text, tables, figures and sheets in the final report.

17. Existing utilities, parcel ownership, and Right-of-Way information in the vicinity of drainage infrastructure should be gathered as part of the preliminary design. To the extent feasible, parcel boundary information within Adams County should be shown on drawings. Floodplain boundaries should be shown on plan sheets.

18. For crossings under railroad tracks, use jacking of pipes or boxes as the preferred method of construction for description and cost estimation purposes.

19. Suggest the phasing of improvements that minimize the potential for flooding damages when the recommended improvements are implemented in phases.

20. Costs for annual maintenance of channels, storm sewers, flood-detention basins, and water-quality facilities should be reported in the preliminary design.

Kiowa Engineering Corporation

Memorandum

To: Project Participants

From: Brian Wozniak

Date: January 28, 2004

Project: *Second Creek Downstream of DIA and DFA #0053*

Subject: Progress Meeting No.11

The eleventh progress meeting for Second Creek and DFA #0053 was held on January 28th at Urban Drainage. The purpose of this meeting was to final alternatives for the master plan, schedule the public meeting and move forward to the draft Preliminary Design report.

Attendees:
Chris Sveeun ..... City of Commerce City
Melissa van der Poel ..... Adams County
John Doerfer ..... Urban Drainage
Tom Fairley, Brian Wozniak ..... Kiowa Engineering
Luke Wittemyer ..... Storage Containers
Patrick Quinney ..... CVL Consultants
Ken Goff ..... Amber Homes

The meeting began with a discussion on Pond 219. The new location is capable of detaining the 500 acre-feet as shown in the 1990 OSP; however, it requires a long diversion channel on the west to capture the same (97%) upstream area. John Doerfer suggested that an alternate separate detention facility be shown at the western most tributary to reduce the length of the diversion channel. Kiowa will amend its summary report to include this alternative as well. The summary report will be included in the final report as an appendix.

Kiowa began discussions on DFA 0053 with the alignment of Reign Creek. After reviewing drainage reports from River Run Filing 3 and Stillwater, it was determined that some historical drainage patterns have been altered. Historically high ground ran north-south through the center of the Stillwater development. Today, the 82 acres have been graded to flow west to Ragweed Draw. This change pushes Reign Creek to the east side of Peoria Street where it joins with Locust Run just north of 120th Avenue. After reviewing this information, it was decided to redefine the hydrology models to show these current drainage patterns.

Adams County provided Kiowa with the new 120th alignment over the South Platte River. Kiowa still needs to obtain the Dunes Water Storage information for inclusion in the draft report. Commerce City was asked to provide this information.

Regional detention along I-76 and Highway 2 was the next topic of discussion. Kiowa presented more detailed analysis of four facilities (two at I-76, two at Highway 2). These facilities are favorable. Property owners were present and planned on some detention at the same sites but at a smaller magnitude. The OSP sites are regional detention facilities and serve more area than the local drainage. At the time of construction alternatives to the master plan can be suggested so long as the same downstream benefit is achieved.

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Regional detention at US-85 was also presented and shown to preserve peak flows to existing levels at the South Platte River. These facilities also reduce the size of required structures immediately downstream such as the Fulton Ditch and US-85 crossings and downstream channels.

Public participation was discussed and planned for the second week of March. Kiowa will prepare and distribute the draft report by early March. The next progress meeting is scheduled for March 9th at 1:30 p.m. at Urban Drainage. The draft report will be discussed as well as preparations for the public meeting.

Table B-1

Rainfall Distributions (inches)

Time	2-hour < 10 sq.mi. (DFA 0053)					6-hour between 20 and 30 sq.mi. (*Second Creek*)				
(minutes)	100-year	50-year	10-year	5-year	2-year	100-year	50-year	10-year	5-year	2-year
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.026	0.029	0.032	0.027	0.019	0.026	0.029	0.032	0.027	0.019
10	0.078	0.078	0.059	0.050	0.038	0.078	0.078	0.059	0.050	0.038
15	0.120	0.112	0.130	0.117	0.080	0.120	0.112	0.130	0.117	0.080
20	0.209	0.179	0.239	0.205	0.152	0.209	0.179	0.193	0.166	0.123
25	0.365	0.336	0.398	0.335	0.238	0.296	0.272	0.322	0.271	0.192
30	0.653	0.560	0.191	0.174	0.133	0.529	0.454	0.155	0.141	0.108
35	0.365	0.269	0.089	0.078	0.060	0.296	0.218	0.089	0.078	0.060
40	0.209	0.179	0.068	0.059	0.048	0.209	0.179	0.068	0.059	0.048
45	0.162	0.112	0.060	0.048	0.029	0.162	0.112	0.060	0.048	0.029
50	0.131	0.112	0.051	0.048	0.029	0.131	0.112	0.051	0.048	0.029
55	0.104	0.072	0.051	0.040	0.029	0.104	0.072	0.051	0.040	0.029
60	0.104	0.072	0.051	0.040	0.029	0.104	0.072	0.051	0.040	0.029
65	0.104	0.072	0.051	0.040	0.029	0.104	0.072	0.051	0.040	0.029
70	0.052	0.054	0.051	0.040	0.019	0.052	0.054	0.051	0.040	0.019
75	0.052	0.054	0.051	0.034	0.019	0.052	0.054	0.051	0.034	0.019
80	0.031	0.040	0.040	0.029	0.019	0.031	0.040	0.040	0.029	0.019
85	0.031	0.040	0.030	0.029	0.019	0.031	0.040	0.030	0.029	0.019
90	0.031	0.031	0.030	0.029	0.019	0.031	0.031	0.030	0.029	0.019
95	0.031	0.031	0.030	0.029	0.019	0.031	0.031	0.030	0.029	0.019
100	0.031	0.031	0.030	0.020	0.019	0.031	0.031	0.030	0.020	0.019
105	0.031	0.031	0.030	0.020	0.019	0.031	0.031	0.030	0.020	0.019
110	0.031	0.031	0.030	0.020	0.019	0.031	0.031	0.030	0.020	0.019
115	0.031	0.031	0.027	0.020	0.010	0.031	0.031	0.027	0.020	0.010
120	0.031	0.031	0.021	0.017	0.010	0.031	0.031	0.021	0.017	0.010
125-180						0.012	0.017	0.014	0.014	0.013
185-360						0.011	0.011	0.008	0.008	0.006
Total	3.02	2.59	1.84	1.55	1.10	3.31	2.98	2.20	1.86	1.37

Table B-2
1990 and 2002 Model
Flows at
Selected Design Points

LOCATION	CONVEYANCE ELEMENT	1990 EXISTING CONDITIONS 100-year PEAK (CFS)	50-year PEAK (CFS)	10-year PEAK (CFS)	5-year PEAK (CFS)	2-year PEAK (CFS)	CONVEYANCE ELEMENT	2002 BASELINE CONDITIONS 100-year PEAK (CFS)	50-year PEAK (CFS)	10-year PEAK (CFS)	5-year PEAK (CFS)	2-year PEAK (CFS)
South Platte	119	4241	N/A	666	188	5	119	3900	2300	463	115	0
SH-85	108	4471	N/A	724	218	6	108	4051	2398	505	125	0
E-470	111	4497	N/A	732	223	5	111	4097	2428	517	128	0
120th	117	4566	N/A	755	234	5	117	4169	2483	545	132	0
I-76	165	4587	N/A	763	237	5	165	4180	2490	548	134	0
O'Brian Canal	130	4699	N/A	821	248	6	130	4238	2532	570	136	0
104th	146	4701	N/A	818	252	6	146	4297	2574	581	140	1
96th	180	4608	N/A	808	253	6	180	4526	2743	596	149	3
88th	166	4370	N/A	770	246	6	166	4378	2696	589	155	3
Tower Road	171	4204	N/A	737	239	7	171	3413	2126	477	129	2
E-470	509	2732	N/A	453	138	4	509	2904	1866	450	119	2

LOCATION	CONVEYANCE ELEMENT	1990 FUTURE CONDITIONS 100-year PEAK (CFS)	50-year PEAK (CFS)	10-year PEAK (CFS)	5-year PEAK (CFS)	2-year PEAK (CFS)	CONVEYANCE ELEMENT	2002 FUTURE CONDITIONS 100-year PEAK (CFS)	50-year PEAK (CFS)	10-year PEAK (CFS)	5-year PEAK (CFS)	2-year PEAK (CFS)
South Platte	119	8128	N/A	3103	2367	1556	119	8132	6091	2950	2202	1303
SH-85	108	8327	N/A	3168	2407	1586	108	8460	6323	3079	2307	1364
E-470	111	8337	N/A	3154	2385	1568	111	8554	6397	3116	2338	1384
120th	117	8374	N/A	3151	2369	1553	117	8673	6472	3151	2359	1412
I-76	165	8388	N/A	3152	2367	1551	165	8685	6479	3153	2357	1413
O'Brian Canal	130	8461	N/A	3172	2373	1552	130	8803	6557	3193	2388	1436
104th	146	8493	N/A	3151	2331	1502	146	8903	6623	3226	2410	1456
96th	180	8571	N/A	3158	2316	1480	180	9287	6926	3384	2544	1573
88th	166	8556	N/A	3143	2301	1459	166	9260	6965	3378	2547	1588
Tower Road	171	8647	N/A	3170	2315	1445	171	8147	6162	3026	2293	1474
E-470	509	7997	N/A	3017	2242	1371	509	7876	6002	2937	2260	1479

SECOND CREEK

* Use Rational Formula in Urban areas if 90 ac or less, in Undeveloped areas (<20% imp) if 50 acres of less

Existing Land Use Conditions CUHP Input

Check for Q=CIA *	Subarea ID	Area (sq.mi)	Length (mi)	Centroid (mi)	Impervious (%)	Slope (ft/ft)	Tc (min)	Storage Pervious	Storage Impervious	Infiltration Initial	Decay Rate	Infiltration Final
	57	0.159	0.942	0.293	5.00	0.022	101.09	0.40	0.1	3.24	0.0018	0.516
	58	0.175	0.852	0.323	5.00	0.022	93.21	0.40	0.1	3.02	0.0018	0.502
	59	0.089	0.531	0.223	5.00	0.016	75.77	0.40	0.1	3.46	0.0018	0.531
	60	0.084	0.554	0.192	5.00	0.013	88.07	0.40	0.1	4.08	0.0018	0.572
	61	0.097	1.042	0.291	5.00	0.011	147.20	0.40	0.1	3.75	0.0018	0.550
urban	62	0.192	0.212	0.073	53.68	0.007	16.22	0.40	0.1	3.27	0.0018	0.518
Q=CIA	64	0.067	0.545	0.191	5.00	0.031	27.06	0.40	0.1	4.41	0.0018	0.594
Q=CIA	65	0.049	0.384	0.195	5.00	0.011	74.18	0.40	0.1	4.22	0.0018	0.581
	66	0.111	0.456	0.292	5.00	0.027	56.23	0.40	0.1	4.01	0.0018	0.567
	67	0.189	0.749	0.209	5.00	0.014	103.33	0.40	0.1	3.66	0.0018	0.544
	68	0.197	0.639	0.258	5.00	0.015	88.89	0.40	0.1	3.46	0.0018	0.531
	69	0.176	0.826	0.617	5.00	0.013	112.63	0.40	0.1	3.38	0.0018	0.525
	70	0.118	0.703	0.069	5.00	0.018	86.54	0.40	0.1	3.00	0.0018	0.500
	71	0.109	0.562	0.123	5.00	0.034	56.73	0.40	0.1	3.00	0.0018	0.500
	72	0.203	0.637	0.263	5.00	0.042	56.17	0.40	0.1	3.00	0.0018	0.500
	73	0.203	0.764	0.395	5.00	0.020	89.33	0.40	0.1	3.33	0.0018	0.522
	74	0.115	0.565	0.044	5.00	0.013	84.46	0.40	0.1	3.00	0.0018	0.500
	75	0.090	0.281	0.185	5.00	0.019	47.01	0.40	0.1	3.58	0.0018	0.538
	76	0.086	0.479	0.290	5.00	0.020	63.95	0.40	0.1	3.28	0.0018	0.519
	77	0.116	0.231	0.079	5.00	0.033	34.39	0.40	0.1	3.00	0.0018	0.500
	78	0.144	0.699	0.160	5.00	0.019	85.27	0.40	0.1	3.34	0.0018	0.523
	79	0.209	0.959	0.462	5.00	0.005	209.82	0.40	0.1	4.50	0.0018	0.600
	80	0.075	0.473	0.180	5.00	0.032	54.01	0.40	0.1	4.34	0.0018	0.589
	81	0.118	0.288	0.202	5.00	0.026	41.85	0.40	0.1	3.13	0.0018	0.509
	82	0.203	0.629	0.290	5.00	0.017	86.31	0.40	0.1	3.91	0.0018	0.561
	83	0.161	0.530	0.323	5.00	0.021	68.73	0.40	0.1	3.86	0.0018	0.557
Q=CIA	84	0.069	0.473	0.101	5.00	0.007	101.10	0.40	0.1	4.45	0.0018	0.597
	85	0.116	0.562	0.289	5.00	0.030	60.01	0.40	0.1	3.38	0.0018	0.525
	86	0.187	0.577	0.241	5.00	0.026	66.72	0.40	0.1	3.75	0.0018	0.550
	87	0.133	0.630	0.071	5.00	0.008	120.90	0.40	0.1	3.96	0.0018	0.564
Q=CIA	88	0.038	0.340	0.139	5.00	0.010	71.03	0.40	0.1	4.04	0.0018	0.569
Q=CIA	89	0.052	0.733	0.053	5.00	0.008	133.65	0.40	0.1	4.50	0.0018	0.600
Q=CIA	90	0.068	0.267	0.408	5.00	0.025	40.73	0.40	0.1	3.86	0.0018	0.558
	91	0.121	0.504	0.343	5.00	0.016	74.22	0.40	0.1	3.13	0.0018	0.509
Q=CIA	92	0.063	0.259	0.137	9.38	0.020	43.79	0.40	0.1	4.20	0.0018	0.580
	93	0.104	0.642	0.128	5.00	0.017	86.73	0.40	0.1	3.30	0.0018	0.520
Q=CIA	94	0.073	0.120	0.112	5.00	0.022	33.10	0.40	0.1	4.17	0.0018	0.578
	95	0.202	0.771	0.343	5.00	0.024	84.25	0.40	0.1	3.63	0.0018	0.542
	96	0.086	0.341	0.181	5.00	0.029	44.32	0.40	0.1	4.50	0.0018	0.600
	97	0.107	0.851	0.525	5.77	0.012	124.08	0.40	0.1	3.42	0.0018	0.528
	98	0.175	0.238	0.258	5.00	0.021	44.24	0.40	0.1	4.50	0.0018	0.600
	99	0.105	0.440	0.329	5.00	0.023	58.99	0.40	0.1	4.09	0.0018	0.573
	100	0.093	0.546	0.300	5.00	0.004	142.17	0.40	0.1	4.50	0.0018	0.600
	654	0.118	0.923	0.219	5.00	0.011	135.58	0.40	0.1	3.69	0.0018	0.546
	661	0.162	0.986	0.393	5.00	0.011	144.52	0.40	0.1	3.54	0.0018	0.536
	662	0.194	0.901	0.452	5.00	0.023	97.21	0.40	0.1	3.96	0.0018	0.564
Q=CIA	678	0.059	0.430	0.318	5.00	0.022	59.44	0.40	0.1	3.82	0.0018	0.555
	680	0.176	0.661	0.213	5.00	0.011	105.12	0.40	0.1	3.54	0.0018	0.536

SECOND CREEK

Future Land Use Conditions CUHP Input

* Use Rational Formula in Urban areas if 90 ac or less, in Undeveloped areas (<20% imp) if 50 acres of less

Check for Q=CIA *		Subarea ID	Area (sq.mi)	Length (mi)	Centroid (mi)	Impervious (%)	Slope (ft/ft)	Tc (min)	Storage Pervious	Storage Impervious	Infiltration Initial	Decay Rate	Infiltration Final
	Urban	1	0.188	0.289	0.167	100.0	0.001	28.49	0.4	0.1	4.50	0.0018	0.60
		2	0.121	0.421	0.088	8.8	0.004	111.30	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	3	0.059	0.406	0.151	83.0	0.008	31.90	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	4	0.121	0.327	0.197	61.4	0.008	29.61	0.4	0.1	3.83	0.0018	0.56
Q=CIA	Urban	5	0.097	0.308	0.207	42.2	0.002	29.04	0.4	0.1	3.95	0.0018	0.56
		6	0.106	0.727	0.204	7.5	0.004	186.95	0.4	0.1	3.00	0.0018	0.50
		8	0.093	0.786	0.411	8.5	0.003	203.14	0.4	0.1	3.38	0.0018	0.53
Q=CIA	Urban	9	0.127	0.453	0.236	41.1	0.008	33.30	0.4	0.1	3.00	0.0018	0.50
Q=CIA		10	0.048	0.315	0.215	5.0	0.004	107.11	0.4	0.1	4.06	0.0013	0.74
		11	0.164	0.587	0.443	13.1	0.005	131.27	0.4	0.1	3.94	0.0018	0.56
		12	0.099	0.435	0.227	5.0	0.003	125.21	0.4	0.1	3.54	0.0015	0.63
Q=CIA	Urban	14	0.123	0.411	0.191	85.0	0.010	32.05	0.4	0.1	3.48	0.0017	0.57
	Urban	15	0.184	0.546	0.158	85.0	0.007	36.03	0.4	0.1	3.50	0.0018	0.53
Q=CIA	Urban	16	0.073	0.516	0.122	85.0	0.006	35.14	0.4	0.1	4.36	0.0018	0.59
Q=CIA	Urban	17	0.105	0.504	0.175	85.0	0.010	34.79	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	18	0.128	0.160	0.409	40.0	0.009	24.71	0.4	0.1	4.50	0.0018	0.60
Q=CIA		19	0.075	0.148	0.063	5.0	0.005	54.63	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	20	0.050	0.296	0.080	41.6	0.010	28.67	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	21	0.134	0.323	0.177	55.9	0.009	29.47	0.4	0.1	4.51	0.0018	0.61
Q=CIA	Urban	22	0.098	0.314	0.038	51.0	0.010	29.22	0.4	0.1	4.57	0.0016	0.66
Q=CIA	Urban	23	0.081	0.528	0.207	52.9	0.005	35.49	0.4	0.1	4.50	0.0018	0.60
		24	0.201	0.509	0.086	10.7	0.009	95.32	0.4	0.1	4.51	0.0018	0.61
Q=CIA	Urban	25	0.071	0.407	0.141	50.0	0.017	31.93	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	26	0.051	0.550	0.113	50.0	0.013	36.14	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	27	0.045	0.242	0.119	65.0	0.025	21.82	0.4	0.1	4.50	0.0018	0.60
	Urban	28	0.177	0.607	0.197	50.0	0.011	37.81	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	29	0.105	0.634	0.149	28.7	0.009	38.60	0.4	0.1	4.50	0.0018	0.60
	Urban	30	0.153	0.666	0.185	33.6	0.016	39.53	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	31	0.052	0.287	0.152	50.0	0.001	28.41	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	32	0.067	0.188	0.189	51.7	0.008	25.53	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	33	0.110	0.316	0.250	50.0	0.001	29.28	0.4	0.1	4.50	0.0018	0.60
	Urban	34	0.193	0.853	0.411	44.6	0.012	45.02	0.4	0.1	4.50	0.0018	0.60
	Urban	35	0.187	0.810	0.284	45.9	0.010	43.75	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	36	0.072	0.459	0.164	31.8	0.020	32.16	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	37	0.124	0.860	0.308	41.0	0.003	45.22	0.4	0.1	4.43	0.0018	0.60
Q=CIA	Urban	38	0.093	0.556	0.253	44.7	0.025	35.18	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	39	0.126	0.360	0.178	54.4	0.019	30.56	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	40	0.074	0.304	0.121	50.0	0.017	28.91	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	41	0.108	0.488	0.160	50.0	0.014	34.32	0.4	0.1	4.50	0.0018	0.60
	Urban	42	0.181	0.623	0.124	37.2	0.007	38.28	0.4	0.1	4.11	0.0018	0.57
	Urban	43	0.193	0.558	0.234	48.6	0.020	36.38	0.4	0.1	4.50	0.0018	0.60
	Urban	44	0.193	1.794	0.832	32.8	0.000	72.62	0.4	0.1	3.96	0.0018	0.56
Q=CIA	Urban	45	0.139	0.840	0.382	41.5	0.055	32.21	0.4	0.1	4.15	0.0018	0.58
Q=CIA	Urban	46	0.136	0.962	0.172	34.6	0.002	48.21	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	47	0.072	0.268	0.049	55.4	0.008	27.87	0.4	0.1	4.50	0.0018	0.60
	Urban	48	0.184	0.449	0.278	52.4	0.017	33.17	0.4	0.1	4.50	0.0018	0.60
	Urban	49	0.145	0.249	0.140	50.0	0.017	27.31	0.4	0.1	4.50	0.0018	0.60
	Urban	50	0.178	0.415	0.235	49.3	0.015	32.18	0.4	0.1	4.50	0.0018	0.60
		51	0.190	0.502	0.219	5.0	0.019	69.99	0.4	0.1	4.10	0.0018	0.57
	Urban	52	0.201	0.930	0.461	49.0	0.017	47.28	0.4	0.1	4.02	0.0018	0.57
		53	0.159	0.353	0.210	5.0	0.019	55.67	0.4	0.1	4.03	0.0018	0.57
Q=CIA	Urban	54	0.123	1.048	0.418	44.6	0.046	40.36	0.4	0.1	3.65	0.0018	0.54
	Urban	55	0.154	1.178	0.459	49.6	0.013	54.57	0.4	0.1	3.58	0.0018	0.54
Q=CIA	Urban	56	0.129	0.663	0.228	64.0	0.014	39.43	0.4	0.1	3.31	0.0018	0.52

SECOND CREEK

Future Land Use Conditions CUHP Input

* Use Rational Formula in Urban areas if 90 ac or less, in Undeveloped areas (<20% imp) if 50 acres of less

Check for Q=CIA *		Subarea ID	Area (sq.mi)	Length (mi)	Centroid (mi)	Impervious (%)	Slope (ft/ft)	Tc (min)	Storage Pervious	Storage Impervious	Infiltration Initial	Decay Rate	Infiltration Final
	Urban	57	0.159	0.942	0.293	65.0	0.022	47.64	0.4	0.1	3.24	0.0018	0.52
	Urban	58	0.175	0.852	0.323	65.0	0.022	44.99	0.4	0.1	3.02	0.0018	0.50
Q=CIA	Urban	59	0.089	0.531	0.223	65.0	0.016	35.58	0.4	0.1	3.46	0.0018	0.53
Q=CIA	Urban	60	0.084	0.554	0.192	35.7	0.013	36.26	0.4	0.1	4.08	0.0018	0.57
Q=CIA	Urban	61	0.097	1.042	0.291	43.1	0.011	50.58	0.4	0.1	3.75	0.0018	0.55
	Urban	62	0.192	0.212	0.073	32.4	0.007	26.22	0.4	0.1	3.27	0.0018	0.52
Q=CIA	Urban	64	0.067	0.545	0.191	47.0	0.031	33.04	0.4	0.1	4.41	0.0018	0.59
Q=CIA	Urban	65	0.049	0.384	0.195	95.0	0.011	27.25	0.4	0.1	4.22	0.0018	0.58
Q=CIA	Urban	66	0.111	0.456	0.292	44.5	0.027	31.53	0.4	0.1	4.01	0.0018	0.57
	Urban	67	0.189	0.749	0.209	55.1	0.014	41.97	0.4	0.1	3.66	0.0018	0.54
	Urban	68	0.197	0.639	0.258	85.0	0.015	38.76	0.4	0.1	3.46	0.0018	0.53
	Urban	69	0.176	0.826	0.617	24.5	0.013	44.22	0.4	0.1	3.38	0.0018	0.53
		70	0.118	0.703	0.069	5.0	0.018	77.51	0.4	0.1	3.00	0.0018	0.50
Q=CIA	Urban	71	0.109	0.562	0.123	54.7	0.034	30.08	0.4	0.1	3.00	0.0018	0.50
	Urban	72	0.203	0.637	0.263	81.4	0.042	25.92	0.4	0.1	3.00	0.0018	0.50
	Urban	73	0.203	0.764	0.395	37.6	0.020	42.41	0.4	0.1	3.33	0.0018	0.52
Q=CIA	Urban	74	0.115	0.565	0.044	65.4	0.013	36.58	0.4	0.1	3.00	0.0018	0.50
Q=CIA	Urban	75	0.090	0.281	0.185	85.0	0.019	13.96	0.4	0.1	3.58	0.0018	0.54
Q=CIA	Urban	76	0.086	0.479	0.290	59.8	0.020	33.54	0.4	0.1	3.28	0.0018	0.52
Q=CIA	Urban	77	0.116	0.231	0.079	74.1	0.033	17.18	0.4	0.1	3.00	0.0018	0.50
	Urban	78	0.144	0.699	0.160	59.4	0.019	40.52	0.4	0.1	3.34	0.0018	0.52
	Urban	79	0.209	0.959	0.462	48.8	0.005	48.13	0.4	0.1	4.50	0.0018	0.60
	Urban	80	0.075	0.473	0.180	29.0	0.032	31.04	0.4	0.1	4.34	0.0018	0.59
Q=CIA	Urban	81	0.118	0.288	0.202	84.0	0.026	17.86	0.4	0.1	3.13	0.0018	0.51
	Urban	82	0.203	0.629	0.290	76.9	0.017	38.44	0.4	0.1	3.91	0.0018	0.56
	Urban	83	0.161	0.530	0.323	85.0	0.021	29.65	0.4	0.1	3.86	0.0018	0.56
Q=CIA	Urban	84	0.069	0.473	0.101	90.0	0.007	33.88	0.4	0.1	4.45	0.0018	0.60
Q=CIA	Urban	85	0.116	0.562	0.289	65.6	0.030	30.49	0.4	0.1	3.38	0.0018	0.53
	Urban	86	0.187	0.577	0.241	55.2	0.026	34.02	0.4	0.1	3.75	0.0018	0.55
Q=CIA	Urban	87	0.133	0.630	0.071	65.0	0.008	38.49	0.4	0.1	3.96	0.0018	0.56
Q=CIA		88	0.038	0.340	0.139	15.0	0.010	68.15	0.4	0.1	4.04	0.0018	0.57
Q=CIA		89	0.052	0.733	0.053	15.4	0.008	121.76	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	90	0.068	0.267	0.408	59.2	0.025	23.49	0.4	0.1	3.86	0.0018	0.56
Q=CIA	Urban	91	0.121	0.504	0.343	65.0	0.016	34.78	0.4	0.1	3.13	0.0018	0.51
Q=CIA	Urban	92	0.063	0.259	0.137	39.2	0.020	27.61	0.4	0.1	4.20	0.0018	0.58
Q=CIA	Urban	93	0.104	0.642	0.128	29.6	0.017	38.84	0.4	0.1	3.30	0.0018	0.52
Q=CIA	Urban	94	0.073	0.120	0.112	82.5	0.022	14.24	0.4	0.1	4.17	0.0018	0.58
	Urban	95	0.202	0.771	0.343	75.3	0.024	39.74	0.4	0.1	3.63	0.0018	0.54
Q=CIA	Urban	96	0.086	0.341	0.181	46.0	0.029	26.93	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	97	0.107	0.851	0.525	58.6	0.012	44.95	0.4	0.1	3.42	0.0018	0.53
	Urban	98	0.175	0.238	0.258	85.0	0.021	18.20	0.4	0.1	4.50	0.0018	0.60
		99	0.105	0.440	0.329	5.0	0.023	41.93	0.4	0.1	4.09	0.0018	0.57
Q=CIA	Urban	100	0.093	0.546	0.300	48.8	0.004	36.02	0.4	0.1	4.50	0.0018	0.60
Q=CIA	Urban	654	0.118	0.923	0.219	48.8	0.011	47.09	0.4	0.1	3.69	0.0018	0.55
	Urban	661	0.162	0.986	0.393	48.8	0.011	48.93	0.4	0.1	3.54	0.0018	0.54
	Urban	662	0.194	0.901	0.452	48.8	0.023	42.98	0.4	0.1	3.96	0.0018	0.56
Q=CIA	Urban	678	0.059	0.430	0.318	48.8	0.022	25.33	0.4	0.1	3.82	0.0018	0.55
	Urban	680	0.176	0.661	0.213	48.8	0.011	39.39	0.4	0.1	3.54	0.0018	0.54

DFA 0053

Existing Land Use Conditions CUHP Input

* Use Rational Formula in Urban areas if 90 ac or less, in Undeveloped areas (<20% imp) if 50 acres or less

Check for Q=CIA *	Subarea ID	Area (sq.mi)	Length (mi)	Centroid (mi)	Impervious (%)	Slope (ft/ft)	Tc (min)	Storage Pervious	Storage Impervious	Infiltration Initial	Decay Rate	Infiltration Final
Q=CIA	1	0.042	0.261	0.217	35.00	0.012	48.53	0.4	0.1	4.50	0.0018	0.600
	2	0.083	0.359	0.169	5.00	0.016		0.4	0.1	4.50	0.0018	0.600
	3	0.116	0.388	0.130	5.00	0.020		0.4	0.1	4.50	0.0018	0.600
	4	0.125	0.655	0.326	5.00	0.006		0.4	0.1	4.50	0.0018	0.600
	5	0.188	0.954	0.381	5.06	0.013		0.4	0.1	4.50	0.0018	0.600
Q=CIA	6	0.049	0.657	0.397	5.92	0.018	85.10	0.4	0.1	4.50	0.0018	0.600
	7	0.104	0.754	0.356	5.00	0.019		0.4	0.1	4.46	0.0018	0.597
	8	0.181	0.765	0.385	5.00	0.015		0.4	0.1	3.84	0.0018	0.556
Q=CIA	9	0.046	0.426	0.216	12.88	0.010	81.60	0.4	0.1	4.50	0.0018	0.600
	10	0.114	0.753	0.138	22.03	0.014		0.4	0.1	4.50	0.0018	0.600
	11	0.139	0.860	0.440	5.00	0.008		0.4	0.1	4.50	0.0018	0.600
	12	0.195	0.562	0.362	5.00	0.009		0.4	0.1	3.86	0.0018	0.557
	13	0.111	0.686	0.377	5.00	0.006		0.4	0.1	3.84	0.0018	0.556
	14	0.107	0.413	0.237	8.75	0.008		0.4	0.1	4.29	0.0018	0.586
Q=CIA	15	0.053	0.430	0.224	5.00	0.008	91.10	0.4	0.1	4.13	0.0018	0.575
	16	0.095	0.462	0.151	7.91	0.007		0.4	0.1	4.69	0.0014	0.759
	17	0.095	0.528	0.355	24.59	0.013		0.4	0.1	4.54	0.0017	0.628
Q=CIA	18	0.045	0.311	0.143	10.47	0.012	65.17	0.4	0.1	4.78	0.0012	0.824
	19	0.113	0.595	0.238	11.13	0.010		0.4	0.1	4.63	0.0015	0.704
Q=CIA	20	0.019	0.201	0.069	5.00	0.021	41.09	0.4	0.1	4.50	0.0018	0.600
	21	0.121	0.384	0.120	6.42	0.011		0.4	0.1	4.50	0.0018	0.600
	22	0.100	0.474	0.189	5.00	0.006		0.4	0.1	4.26	0.0018	0.584
	23	0.089	0.407	0.143	5.00	0.004		0.4	0.1	4.47	0.0018	0.598
	24	0.122	0.492	0.247	12.51	0.006		0.4	0.1	4.76	0.0012	0.804
Q=CIA	25	0.063	0.281	0.263	38.41	0.003	18.23	0.4	0.1	4.95	0.0008	0.956
Q=CIA	26	0.061	0.459	0.287	33.20	0.006	23.46	0.4	0.1	4.87	0.0010	0.892
Q=CIA	27	0.034	0.233	0.078	6.39	0.007	67.67	0.4	0.1	4.63	0.0015	0.700
Q=CIA	28	0.069	0.207	0.260	7.60	0.002	101.82	0.4	0.1	4.50	0.0018	0.600
	29	0.084	0.207	0.107	6.95	0.022		0.4	0.1	4.50	0.0018	0.600
Q=CIA	30	0.062	0.160	0.129	7.75	0.038	29.52	0.4	0.1	4.74	0.0013	0.792
Q=CIA	31	0.069	0.227	0.091	6.25	0.007	66.14	0.4	0.1	4.50	0.0018	0.600
	32	0.083	0.310	0.083	5.00	0.004		0.4	0.1	4.59	0.0016	0.672
	33	0.102	0.351	0.107	5.00	0.005		0.4	0.1	4.59	0.0016	0.672
	34	0.090	0.359	0.115	5.00	0.011		0.4	0.1	4.50	0.0018	0.600
	35	0.127	0.780	0.579	5.00	0.004		0.4	0.1	4.42	0.0018	0.602
	36	0.098	0.416	0.510	10.28	0.005		0.4	0.1	4.31	0.0018	0.587
Q=CIA	37	0.052	0.257	0.262	17.19	0.006	70.99	0.4	0.1	3.96	0.0018	0.564
	38	0.206	0.649	0.436	7.06	0.006		0.4	0.1	4.47	0.0018	0.598
	39	0.154	0.425	0.210	5.00	0.008		0.4	0.1	4.51	0.0018	0.604
	40	0.090	0.198	0.276	15.63	0.006		0.4	0.1	4.55	0.0017	0.636
Q=CIA	41	0.035	0.059	0.196	8.59	0.006	39.79	0.4	0.1	4.50	0.0018	0.600
	42	0.173	0.648	0.299	5.00	0.005		0.4	0.1	4.50	0.0018	0.600
	43	0.181	0.637	0.329	13.03	0.009		0.4	0.1	4.50	0.0018	0.600
	44	0.204	0.822	0.435	25.00	0.007		0.4	0.1	4.50	0.0018	0.600
Q=CIA	45	0.053	0.438	0.241	30.00	0.006	22.86	0.4	0.1	4.50	0.0018	0.600
	46	0.190	1.080	0.522	24.96	0.007		0.4	0.1	4.36	0.0017	0.631
Q=CIA	47	0.048	0.287	0.363	6.35	0.011	59.76	0.4	0.1	3.75	0.0018	0.550
	48	0.157	0.666	0.319	18.17	0.007		0.4	0.1	4.14	0.0018	0.576
	49	0.156	0.805	0.427	17.43	0.007		0.4	0.1	4.50	0.0018	0.600

DFA 0053

Existing Land Use Conditions CUHP Input

* Use Rational Formula in Urban areas if 90 ac or less, in Undeveloped areas (<20% imp) if 50 acres or less

Check for Q=CIA *	Subarea ID	Area (sq.mi)	Length (mi)	Centroid (mi)	Impervious (%)	Slope (ft/ft)	Tc (min)	Storage Pervious	Storage Impervious	Infiltration Initial	Decay Rate	Infiltration Final
	50	0.180	1.017	0.398	29.03	0.006		0.4	0.1	4.54	0.0017	0.639
Q=CIA	51	0.076	0.346	0.478	6.41	0.007	84.95	0.4	0.1	4.62	0.0015	0.696
	52	0.111	0.630	0.222	6.36	0.004		0.4	0.1	4.50	0.0018	0.600
	53	0.125	0.430	0.266	13.07	0.006		0.4	0.1	4.50	0.0018	0.600
Q=CIA	54	0.064	0.399	0.166	6.21	0.009	83.56	0.4	0.1	4.50	0.0018	0.600
Q=CIA	55	0.012	0.128	0.027	8.81	0.012	40.88	0.4	0.1	4.50	0.0018	0.600
Q=CIA	56	0.069	0.445	0.343	5.48	0.009	86.80	0.4	0.1	4.50	0.0018	0.600
	57	0.128	0.346	0.405	7.55	0.010		0.4	0.1	4.54	0.0017	0.628
	58	0.115	0.885	0.653	19.31	0.004		0.4	0.1	4.67	0.0014	0.732
Q=CIA	59	0.061	0.360	0.136	14.04	0.013	45.25	0.4	0.1	4.74	0.0013	0.792
	60	0.091	0.289	0.366	13.77	0.010		0.4	0.1	4.50	0.0018	0.601
Q=CIA	61	0.072	0.609	0.175	23.67	0.003	27.85	0.4	0.1	4.51	0.0018	0.604
	62	0.121	0.223	0.195	6.00	0.019		0.4	0.1	4.57	0.0017	0.652
Q=CIA	63	0.077	0.880	0.350	26.97	0.005	35.82	0.4	0.1	4.69	0.0014	0.748
	64	0.087	0.711	0.084	5.00	0.001		0.4	0.1	3.32	0.0017	0.543
	65	0.149	0.526	0.333	7.97	0.014		0.4	0.1	4.30	0.0013	0.766
Q=CIA	66	0.075	0.489	0.122	5.00	0.003	143.98	0.4	0.1	3.00	0.0018	0.500
	67	0.161	0.630	0.212	35.21	0.008		0.4	0.1	4.07	0.0018	0.571
Q=CIA	68	0.076	0.485	0.245	5.00	0.005	123.74	0.4	0.1	4.29	0.0018	0.586
	69	0.115	0.513	0.386	9.02	0.006		0.4	0.1	4.44	0.0018	0.596
Q=CIA	70	0.114	0.513	0.047	34.67	0.009	25.04	0.4	0.1	4.35	0.0018	0.590
Q=CIA	71	0.109	0.649	0.194	21.04	0.005	29.04	0.4	0.1	4.37	0.0018	0.591
Q=CIA	72	0.098	0.435	0.301	44.58	0.008	22.77	0.4	0.1	4.11	0.0018	0.574
Q=CIA	73	0.021	0.226	0.178	30.82	0.003	16.64	0.4	0.1	4.50	0.0018	0.600
Q=CIA	74	0.092	0.387	0.037	57.68	0.005	21.36	0.4	0.1	4.50	0.0018	0.600
	75	0.150	0.713	0.072	23.14	0.003		0.4	0.1	4.50	0.0018	0.600
Q=CIA	76	0.129	0.697	0.511	22.00	0.005	30.44	0.4	0.1	4.50	0.0018	0.600
Q=CIA	77	0.086	0.388	0.130	23.89	0.009	21.39	0.4	0.1	4.50	0.0018	0.600
Q=CIA	78	0.078	0.334	0.111	53.16	0.006	19.81	0.4	0.1	4.47	0.0018	0.598
	79	0.164	0.558	0.061	64.50	0.005		0.4	0.1	4.50	0.0018	0.600
Q=CIA	80	0.067	0.470	0.088	13.21	0.010	86.47	0.4	0.1	4.50	0.0018	0.600
	81	0.203	1.022	0.656	7.17	0.004		0.4	0.1	4.10	0.0018	0.573
Q=CIA	82	0.063	0.268	0.132	5.00	0.017	50.70	0.4	0.1	4.50	0.0018	0.600
Q=CIA	83	0.064	0.242	0.270	13.95	0.003	88.51	0.4	0.1	4.50	0.0018	0.600
Q=CIA	84	0.039	0.363	0.193	46.22	0.004	20.65	0.4	0.1	4.50	0.0018	0.600
	85	0.161	0.603	0.315	24.75	0.003		0.4	0.1	4.50	0.0018	0.600
Q=CIA	86	0.040	0.345	0.160	5.00	0.007	85.25	0.4	0.1	4.46	0.0018	0.597
	87	0.140	0.740	0.286	15.28	0.007		0.4	0.1	4.41	0.0018	0.594
Q=CIA	88	0.048	0.280	0.210	21.95	0.014	54.00	0.4	0.1	4.50	0.0018	0.600
	89	0.183	0.615	0.303	58.28	0.006		0.4	0.1	4.50	0.0018	0.600
Q=CIA	90	0.068	0.337	0.155	5.00	0.006	89.65	0.4	0.1	4.50	0.0018	0.600

9.173

DFA 0053

* Use Rational Formula in Urban areas if 90 ac or less, in Undeveloped areas (<20% imp) if 50 acres or less

Future Land Use Conditions CUHP Input

Check for Q=CIA *	Subarea ID	Area (sq.mi)	Length (mi)	Centroid (mi)	Impervious (%)	Slope (ft/ft)	Tc (min)	Storage Pervious	Storage Impervious	Infiltration Initial	Decay Rate	Infiltration Final
Q=CIA	1	0.042	0.261	0.217	60.53	0.012	17.65	0.4	0.1	4.50	0.0018	0.600
	2	0.083	0.359	0.169	5.00	0.016		0.4	0.1	4.50	0.0018	0.600
	3	0.116	0.388	0.130	5.00	0.020		0.4	0.1	4.50	0.0018	0.600
Q=CIA	4	0.125	0.655	0.326	30.00	0.006	29.22	0.4	0.1	4.50	0.0018	0.600
	5	0.188	0.954	0.381	31.75	0.013		0.4	0.1	4.50	0.0018	0.600
Q=CIA	6	0.049	0.657	0.397	51.60	0.018	29.26	0.4	0.1	4.50	0.0018	0.600
Q=CIA	7	0.104	0.754	0.356	36.79	0.019	32.13	0.4	0.1	4.46	0.0018	0.597
	8	0.181	0.765	0.385	28.95	0.015		0.4	0.1	3.84	0.0018	0.556
Q=CIA	9	0.046	0.426	0.216	25.06	0.010	22.48	0.4	0.1	4.50	0.0018	0.600
Q=CIA	10	0.114	0.753	0.138	28.33	0.014	32.08	0.4	0.1	4.50	0.0018	0.600
Q=CIA	11	0.139	0.860	0.440	61.15	0.008	35.23	0.4	0.1	4.50	0.0018	0.600
	12	0.195	0.562	0.362	26.93	0.009		0.4	0.1	3.86	0.0018	0.557
Q=CIA	13	0.111	0.686	0.377	30.00	0.006	30.13	0.4	0.1	3.84	0.0018	0.556
Q=CIA	14	0.107	0.413	0.237	37.17	0.008	22.11	0.4	0.1	4.29	0.0018	0.586
Q=CIA	15	0.053	0.430	0.224	54.04	0.008	22.62	0.4	0.1	4.13	0.0018	0.575
Q=CIA	16	0.095	0.462	0.151	50.81	0.007	23.55	0.4	0.1	4.69	0.0014	0.759
Q=CIA	17	0.095	0.528	0.355	35.34	0.013	25.48	0.4	0.1	4.54	0.0017	0.628
Q=CIA	18	0.045	0.311	0.143	30.00	0.012	19.12	0.4	0.1	4.78	0.0012	0.824
Q=CIA	19	0.113	0.595	0.238	30.00	0.010	27.46	0.4	0.1	4.63	0.0015	0.704
Q=CIA	20	0.019	0.201	0.069	30.00	0.021	15.90	0.4	0.1	4.50	0.0018	0.600
Q=CIA	21	0.121	0.384	0.120	30.00	0.011	21.27	0.4	0.1	4.50	0.0018	0.600
Q=CIA	22	0.100	0.474	0.189	90.00	0.006	23.90	0.4	0.1	4.26	0.0018	0.584
Q=CIA	23	0.089	0.407	0.143	90.00	0.004	21.95	0.4	0.1	4.47	0.0018	0.598
Q=CIA	24	0.122	0.492	0.247	90.00	0.006	24.42	0.4	0.1	4.76	0.0012	0.804
Q=CIA	25	0.063	0.281	0.263	90.00	0.003	18.23	0.4	0.1	4.95	0.0008	0.956
Q=CIA	26	0.061	0.459	0.287	90.00	0.006	23.46	0.4	0.1	4.87	0.0010	0.892
Q=CIA	27	0.034	0.233	0.078	90.00	0.007	16.83	0.4	0.1	4.63	0.0015	0.700
Q=CIA	28	0.069	0.207	0.260	90.00	0.002	16.07	0.4	0.1	4.50	0.0018	0.600
Q=CIA	29	0.084	0.207	0.107	90.00	0.022	15.09	0.4	0.1	4.50	0.0018	0.600
Q=CIA	30	0.062	0.160	0.129	11.86	0.038	14.70	0.4	0.1	4.74	0.0013	0.792
Q=CIA	31	0.069	0.227	0.091	29.94	0.007	16.66	0.4	0.1	4.50	0.0018	0.600
Q=CIA	32	0.083	0.310	0.083	5.00	0.004	19.09	0.4	0.1	4.59	0.0016	0.672
Q=CIA	33	0.102	0.351	0.107	74.51	0.005	20.30	0.4	0.1	4.59	0.0016	0.672
Q=CIA	34	0.090	0.359	0.115	73.82	0.011	20.54	0.4	0.1	4.50	0.0018	0.600
Q=CIA	35	0.127	0.780	0.579	70.15	0.004	32.89	0.4	0.1	4.42	0.0018	0.602
Q=CIA	36	0.098	0.416	0.510	90.00	0.005	22.21	0.4	0.1	4.31	0.0018	0.587
Q=CIA	37	0.052	0.257	0.262	90.00	0.006	17.55	0.4	0.1	3.96	0.0018	0.564
	38	0.206	0.649	0.436	90.00	0.006		0.4	0.1	4.47	0.0018	0.598
	39	0.154	0.425	0.210	90.00	0.008		0.4	0.1	4.51	0.0018	0.604
Q=CIA	40	0.090	0.198	0.276	33.49	0.006	15.81	0.4	0.1	4.55	0.0017	0.636
Q=CIA	41	0.035	0.059	0.196	57.30	0.006	11.73	0.4	0.1	4.50	0.0018	0.600
	42	0.173	0.648	0.299	78.25	0.005		0.4	0.1	4.50	0.0018	0.600
	43	0.181	0.637	0.329	41.78	0.009		0.4	0.1	4.50	0.0018	0.600
	44	0.204	0.822	0.435	25.00	0.007		0.4	0.1	4.50	0.0018	0.600
Q=CIA	45	0.053	0.438	0.241	50.40	0.006	22.86	0.4	0.1	4.50	0.0018	0.600
	46	0.190	1.080	0.522	32.00	0.007		0.4	0.1	4.36	0.0017	0.631
Q=CIA	47	0.048	0.287	0.363	30.90	0.011	18.43	0.4	0.1	3.75	0.0018	0.550
	48	0.157	0.666	0.319	30.29	0.007		0.4	0.1	4.14	0.0018	0.576

DFA 0053

* Use Rational Formula in Urban areas if 90 ac or less, in Undeveloped areas (<20% imp) if 50 acres or less

Future Land Use Conditions CUHP Input

Check for Q=CIA *	Subarea ID	Area (sq.mi)	Length (mi)	Centroid (mi)	Impervious (%)	Slope (ft/ft)	Tc (min)	Storage Pervious	Storage Impervious	Infiltration Initial	Decay Rate	Infiltration Final
	49	0.156	0.805	0.427	90.00	0.007		0.4	0.1	4.50	0.0018	0.600
	50	0.180	1.017	0.398	31.90	0.006		0.4	0.1	4.54	0.0017	0.639
Q=CIA	51	0.076	0.346	0.478	30.23	0.007	20.14	0.4	0.1	4.62	0.0015	0.696
Q=CIA	52	0.111	0.630	0.222	30.32	0.004	28.48	0.4	0.1	4.50	0.0018	0.600
	53	0.125	0.430	0.266	19.18	0.006		0.4	0.1	4.50	0.0018	0.600
Q=CIA	54	0.064	0.399	0.166	76.60	0.009	21.70	0.4	0.1	4.50	0.0018	0.600
Q=CIA	55	0.012	0.128	0.027	85.00	0.012	13.75	0.4	0.1	4.50	0.0018	0.600
Q=CIA	56	0.069	0.445	0.343	56.19	0.009	23.04	0.4	0.1	4.50	0.0018	0.600
Q=CIA	57	0.128	0.346	0.405	81.50	0.010	20.14	0.4	0.1	4.54	0.0017	0.628
Q=CIA	58	0.115	0.885	0.653	83.98	0.004	35.97	0.4	0.1	4.67	0.0014	0.732
Q=CIA	59	0.061	0.360	0.136	65.00	0.013	20.57	0.4	0.1	4.74	0.0013	0.792
Q=CIA	60	0.091	0.289	0.366	66.41	0.010	18.49	0.4	0.1	4.50	0.0018	0.601
Q=CIA	61	0.072	0.609	0.175	37.76	0.003	27.85	0.4	0.1	4.51	0.0018	0.604
	62	0.121	0.223	0.195	15.51	0.019		0.4	0.1	4.57	0.0017	0.652
Q=CIA	63	0.077	0.880	0.350	49.59	0.005	35.82	0.4	0.1	4.69	0.0014	0.748
Q=CIA	64	0.087	0.711	0.084	62.38	0.001	30.85	0.4	0.1	3.32	0.0017	0.543
	65	0.149	0.526	0.333	23.35	0.014		0.4	0.1	4.30	0.0013	0.766
Q=CIA	66	0.075	0.489	0.122	54.74	0.003	24.34	0.4	0.1	3.00	0.0018	0.500
	67	0.161	0.630	0.212	73.64	0.008		0.4	0.1	4.07	0.0018	0.571
Q=CIA	68	0.076	0.485	0.245	5.00	0.005	120.61	0.4	0.1	4.29	0.0018	0.586
Q=CIA	69	0.115	0.513	0.386	36.92	0.006	25.06	0.4	0.1	4.44	0.0018	0.596
Q=CIA	70	0.114	0.513	0.047	42.83	0.009	25.04	0.4	0.1	4.35	0.0018	0.590
Q=CIA	71	0.109	0.649	0.194	21.05	0.005	29.04	0.4	0.1	4.37	0.0018	0.591
	72	0.098	0.435	0.301	44.61	0.008		0.4	0.1	4.11	0.0018	0.574
Q=CIA	73	0.021	0.226	0.178	30.82	0.003	16.64	0.4	0.1	4.50	0.0018	0.600
Q=CIA	74	0.092	0.387	0.037	82.01	0.005	21.36	0.4	0.1	4.50	0.0018	0.600
	75	0.150	0.713	0.072	75.98	0.003		0.4	0.1	4.50	0.0018	0.600
Q=CIA	76	0.129	0.697	0.511	68.40	0.005	30.44	0.4	0.1	4.50	0.0018	0.600
Q=CIA	77	0.086	0.388	0.130	31.41	0.009	21.39	0.4	0.1	4.50	0.0018	0.600
Q=CIA	78	0.078	0.334	0.111	61.44	0.006	19.81	0.4	0.1	4.47	0.0018	0.598
	79	0.164	0.558	0.061	68.07	0.005		0.4	0.1	4.50	0.0018	0.600
Q=CIA	80	0.067	0.470	0.088	22.20	0.010	23.79	0.4	0.1	4.50	0.0018	0.600
	81	0.203	1.022	0.656	24.06	0.004		0.4	0.1	4.10	0.0018	0.573
Q=CIA	82	0.063	0.268	0.132	15.26	0.017	46.38	0.4	0.1	4.50	0.0018	0.600
Q=CIA	83	0.064	0.242	0.270	30.40	0.003	17.11	0.4	0.1	4.50	0.0018	0.600
Q=CIA	84	0.039	0.363	0.193	51.88	0.004	99.02	0.4	0.1	4.50	0.0018	0.600
	85	0.161	0.603	0.315	29.03	0.003		0.4	0.1	4.50	0.0018	0.600
Q=CIA	86	0.040	0.345	0.160	5.00	0.007	83.11	0.4	0.1	4.46	0.0018	0.597
Q=CIA	87	0.140	0.740	0.286	15.49	0.007	31.71	0.4	0.1	4.41	0.0018	0.594
Q=CIA	88	0.048	0.280	0.210	21.94	0.014	18.20	0.4	0.1	4.50	0.0018	0.600
	89	0.183	0.615	0.303	58.30	0.006		0.4	0.1	4.50	0.0018	0.600
Q=CIA	90	0.068	0.337	0.155	5.00	0.006	91.57	0.4	0.1	4.50	0.0018	0.600

Table VI-3

Detailed Detention Cost Estimates

64.2 AC

112th Avenue	218.0	AC.FT.		DP130
Item	*Quantity*	*Unit*	*Unit Cost*	*Total*
Clear and Grub	6.4	ACRE	$12,000.00	$77,040.00
Excavation	12000	CU.YD.	$5.00	$60,000.00
Embankment	12000	CU.YD.	$4.00	$48,000.00
Topsoil	279655	SQ.FT.	$0.20	$55,931.04
Seed and Mulch	279655	SQ.FT.	$0.15	$41,948.28
Low Flow Channel	397	L.F.	$150.00	$59,492.74
Outlet Structure	1	EACH	$30,000.00	$30,000.00
Rip rap 24"	900	SQ.FT.	$50.00	$45,000.00
Construction Subtotal				$417,412.06
Utility Relocation			5%	$20,870.60
Administration, Contingencies, and Engineerin			35%	$153,398.93
Right-of-Way	2796552	SQ.FT.	$1.00	$2,796,552.00
Total Cost				**$3,388,233.60**

62.8 AC

Chambers Road	163.0	AC.FT.		DP136
Item	*Quantity*	*Unit*	*Unit Cost*	*Total*
Clear and Grub	6.3	ACRE	$12,000.00	$75,360.00
Excavation	16000	CU.YD.	$5.00	$80,000.00
Embankment	16000	CU.YD.	$4.00	$64,000.00
Topsoil	273557	SQ.FT.	$0.20	$54,711.36
Seed and Mulch	273557	SQ.FT.	$0.15	$41,033.52
Low Flow Channel	392	L.F.	$150.00	$58,840.49
Outlet Structure	1	EACH	$82,000.00	$82,000.00
Rip rap 24"	900	SQ.FT.	$50.00	$45,000.00
Construction Subtotal				$500,945.37
Utility Relocation			5%	$25,047.27
Administration, Contingencies, and Engineerin			35%	$184,097.42
Right-of-Way	2735568	SQ.FT.	$1.00	$2,735,568.00
Total Cost				**$3,445,658.06**

48.9 AC

88th Avenue	132.0	AC.FT.		DP166
Item	*Quantity*	*Unit*	*Unit Cost*	*Total*
Clear and Grub	4.9	ACRE	$12,000.00	$58,680.00
Excavation	20000	CU.YD.	$5.00	$100,000.00
Embankment	20000	CU.YD.	$4.00	$80,000.00
Topsoil	213008	SQ.FT.	$0.20	$42,601.68
Seed and Mulch	213008	SQ.FT.	$0.15	$31,951.26
Low Flow Channel	346	L.F.	$150.00	$51,921.94
Outlet Structure	1	EACH	$39,000.00	$39,000.00
Rip rap 24"	900	SQ.FT.	$50.00	$45,000.00
Construction Subtotal				$449,154.88
Utility Relocation			5%	$22,457.74
Administration, Contingencies, and Engineerin			35%	$165,064.42
Right-of-Way	2130084	SQ.FT.	$1.00	$2,130,084.00
Total Cost				**$2,766,761.04**

34.3 AC

DFA US-85/116th	142.0	AC.FT.		DP146
Item	*Quantity*	*Unit*	*Unit Cost*	*Total*
Clear and Grub	2.0	ACRE	$12,000.00	$24,000.00
Excavation	30637	CU.YD.	$5.00	$153,185.00
Embankment	30637	CU.YD.	$4.00	$122,548.00
Topsoil	87120	SQ.FT.	$0.20	$17,424.00
Seed and Mulch	87120	SQ.FT.	$0.15	$13,068.00
Low Flow Channel	3400	L.F.	$150.00	$510,000.00
Outlet Structure	1	EACH	$110,000.0	$110,000.00
Rip rap 24"	400	SQ.FT.	$50.00	$20,000.00
Construction Subtotal				$970,225.00
Utility Relocation			5%	$48,511.25
Administration, Contingencies, and Engineerin			35%	$356,557.69
Right-of-Way	1495097	SQ.FT.	$1.00	$1,495,097.00
Total Cost				**$2,870,390.94**

13.7 AC

DFA US-85/E-470	192.0	AC.FT.		DP164
Item	*Quantity*	*Unit*	*Unit Cost*	*Total*
Clear and Grub	1.0	ACRE	$12,000.00	$12,000.00
Excavation	7000	CU.YD.	$5.00	$35,000.00
Embankment	0	CU.YD.	$4.00	$0.00
Topsoil	43560	SQ.FT.	$0.20	$8,712.00
Seed and Mulch	43560	SQ.FT.	$0.15	$6,534.00
Low Flow Channel	600	L.F.	$150.00	$90,000.00
Outlet Structure	1	EACH	$80,000.00	$80,000.00
Rip rap 24"	200	SQ.FT.	$50.00	$10,000.00
Construction Subtotal				$242,246.00
Utility Relocation			5%	$12,112.30
Administration, Contingencies, and Engineerin			35%	$89,025.41
Right-of-Way	597680	SQ.FT.	$1.00	$597,680.00
Total Cost				**$941,063.71**

28.7 AC

DFA I-76/108th	92.0	AC.FT.		DP133
Item	*Quantity*	*Unit*	*Unit Cost*	*Total*
Clear and Grub	0.5	ACRE	$12,000.00	$6,000.00
Excavation	0	CU.YD.	$5.00	$0.00
Embankment	0	CU.YD.	$4.00	$0.00
Topsoil	21780	SQ.FT.	$0.20	$4,356.00
Seed and Mulch	21780	SQ.FT.	$0.15	$3,267.00
Low Flow Channel	830	L.F.	$150.00	$124,500.00
Outlet Structure	1	EACH	$125,000.0	$125,000.00
Rip rap 24"	200	SQ.FT.	$50.00	$10,000.00
Construction Subtotal				$273,123.00
Utility Relocation			5%	$13,656.15
Administration, Contingencies, and Engineerin			35%	$100,372.70
Right-of-Way	1250700	SQ.FT.	$1.00	$1,250,700.00
Total Cost				**$1,637,851.85**

10.0 AC

DFA I-76/112th	60.0	AC.FT.		DP132
Item	*Quantity*	*Unit*	*Unit Cost*	*Total*
Clear and Grub	0.5	ACRE	$12,000.00	$6,000.00
Excavation	0	CU.YD.	$6.00	$0.00
Topsoil	21780	SQ.FT.	$0.20	$4,356.00
Seed and Mulch	21780	SQ.FT.	$0.15	$3,267.00
Low Flow Channel	880	L.F.	$150.00	$132,000.00
Outlet Structure	1	EACH	$133,000.0	$133,000.00
Rip rap 24"	200	SQ.FT.	$50.00	$10,000.00
Construction Subtotal				$288,623.00
Utility Relocation			5%	$14,431.15
Administration, Contingencies, and Engineerin			35%	$106,068.95
Right-of-Way	433555	SQ.FT.	$1.00	$433,555.00
Total Cost				**$842,678.10**

2.2 AC

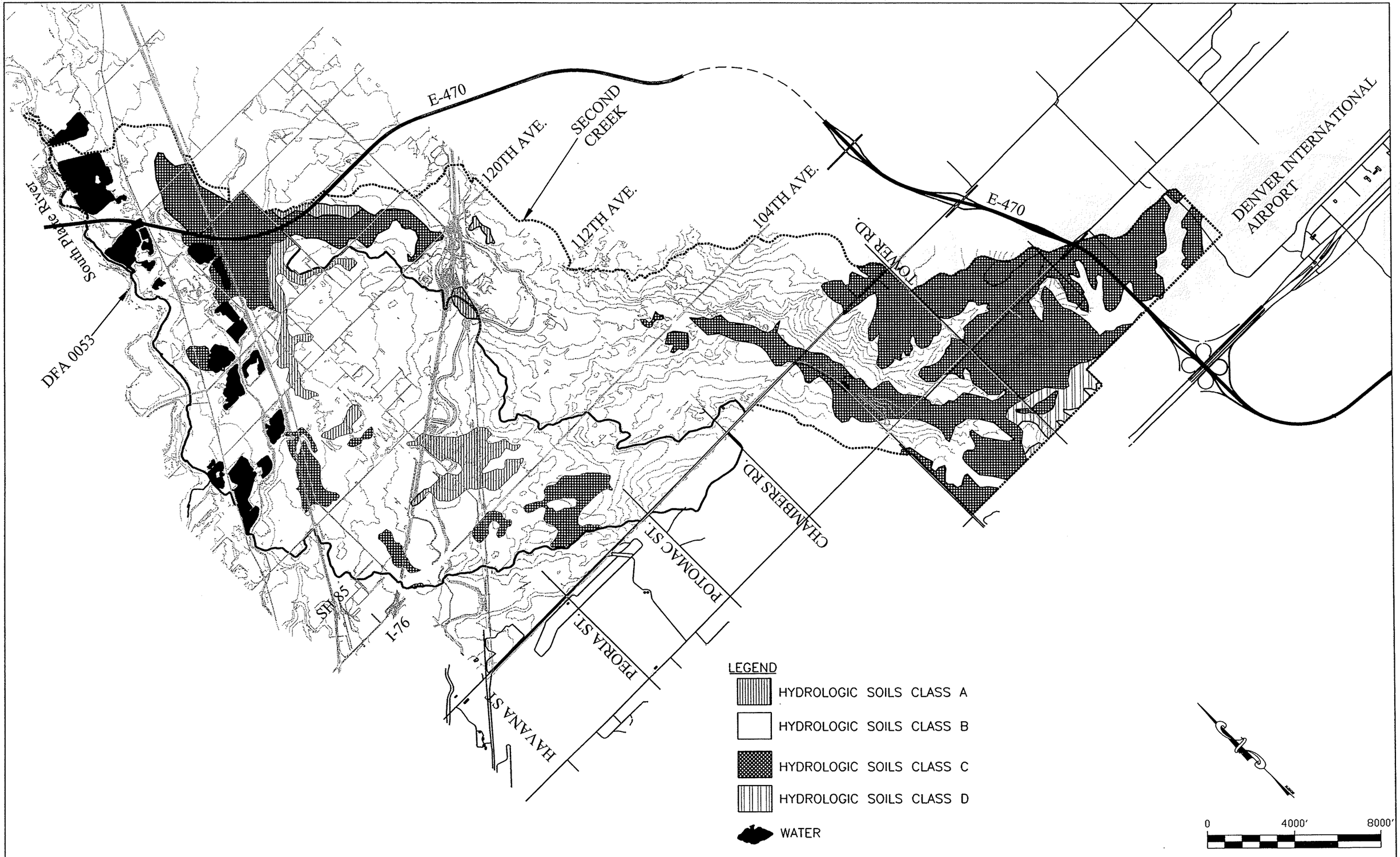
DFA I-76/120th	3.1	AC.FT.		DP130
Item	*Quantity*	*Unit*	*Unit Cost*	*Total*
Clear and Grub	0.1	ACRE	$12,000.00	$1,200.00
Excavation	0	CU.YD.	$6.00	$0.00
Topsoil	4356	SQ.FT.	$0.20	$871.20
Seed and Mulch	4356	SQ.FT.	$0.15	$653.40
Low Flow Channel	100	L.F.	$150.00	$15,000.00
Outlet Structure	0	EACH	$30,000.00	$0.00
Rip rap 24"	100	SQ.FT.	$50.00	$5,000.00
Construction Subtotal				$22,724.60
Utility Relocation			5%	$1,136.23
Administration, Contingencies, and Engineerin			35%	$8,351.29
Right-of-Way	96263	SQ.FT.	$1.00	$96,263.00
Total Cost				**$128,475.12**

9.5 AC

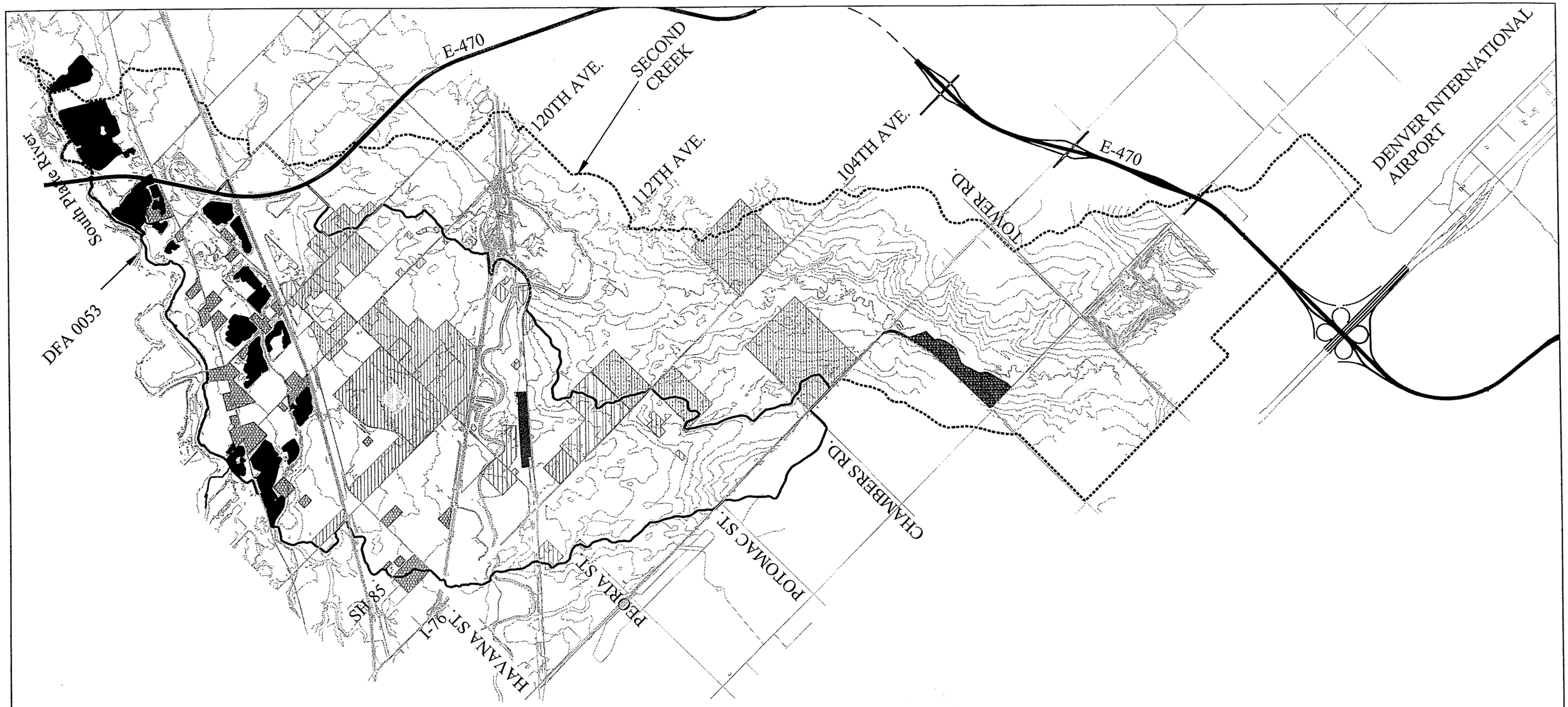
DFA Hwy2/108th	21.5	AC.FT.		DP119
Item	*Quantity*	*Unit*	*Unit Cost*	*Total*
Clear and Grub	1.0	ACRE	$12,000.00	$12,000.00
Embankment	500	CU.YD.	$6.00	$3,000.00
Topsoil	43560	SQ.FT.	$0.20	$8,712.00
Seed and Mulch	43560	SQ.FT.	$0.15	$6,534.00
Low Flow Channel	850	L.F.	$150.00	$127,500.00
Outlet Structure	1	EACH	$4,000.00	$4,000.00
Rip rap 24"	200	SQ.FT.	$50.00	$10,000.00
Construction Subtotal				$171,746.00
Utility Relocation			5%	$8,587.30
Administration, Contingencies, and Engineerin			35%	$63,116.66
Right-of-Way	415246	SQ.FT.	$1.00	$415,246.00
Total Cost				**$658,695.96**

Table VI-3 (con't)
Detailed Detention Cost Estimates

	10.8 AC			
DFA Hwy2/102nd	20.7	AC.FT.		DP114
Item	*Quantity*	*Unit*	*Unit Cost*	*Total*
Clear and Grub	1.0	ACRE	$12,000.00	$12,000.00
Excavation	0	CU.YD.	$6.00	$0.00
Topsoil	43560	SQ.FT.	$0.20	$8,712.00
Seed and Mulch	43560	SQ.FT.	$0.15	$6,534.00
Low Flow Channel	650	L.F.	$150.00	$97,500.00
Outlet Structure	0	EACH	$30,000.00	$0.00
Rip rap 24"	100	SQ.FT.	$50.00	$5,000.00
Construction Subtotal				$129,746.00
Utility Relocation			5%	$6,487.30
Administration, Contingencies, and Engineerin			35%	$47,681.66
Right-of-Way	471753	SQ.FT.	$1.00	$471,753.00
Total Cost				**$655,667.96**



LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001	Kiowa Engineering Corporation 7175 W. Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303)-692-0369	*CITY OF BRIGHTON* *COMMERCE CITY* *ADAMS COUNTY* *URBAN DRAINAGE & FLOOD CONTROL DISTRICT*	SECOND CREEK D/S OF DIA & DFA 0053 OUTFALL SYSTEMS PLANNING STUDY UPDATE	*SOILS MAP*	FIGURE B-1



EXISTING LAND USE

52%	AVG. 2000 SQ.FT. 6 SINGLE FAMILY DWELLING UNITS ON 1 ACRE
50%	SCHOOL
35%	AVG. 2000 SQ.FT. SINGLE FAMILY DWELLING UNITS ON 1/3 ACRE
30%	AVG. 3000 SQ.FT. SINGLE FAMILY DWELLING UNIT ON 1/2 ACRE
25%	AVG. 3000 SQ.FT. SINGLE FAMILY DWELLING UNIT ON 1 ACRE
20%	AVG. 2000 SQ.FT. SINGLE FAMILY DWELLING UNIT ON 1 ACRE
5%	AGRICULTURE/OPEN SPACE
100%	WATER
90%	HEAVY INDUSTRIAL
80%	LIGHT INDUSTRIAL

0 4000′ 8000′

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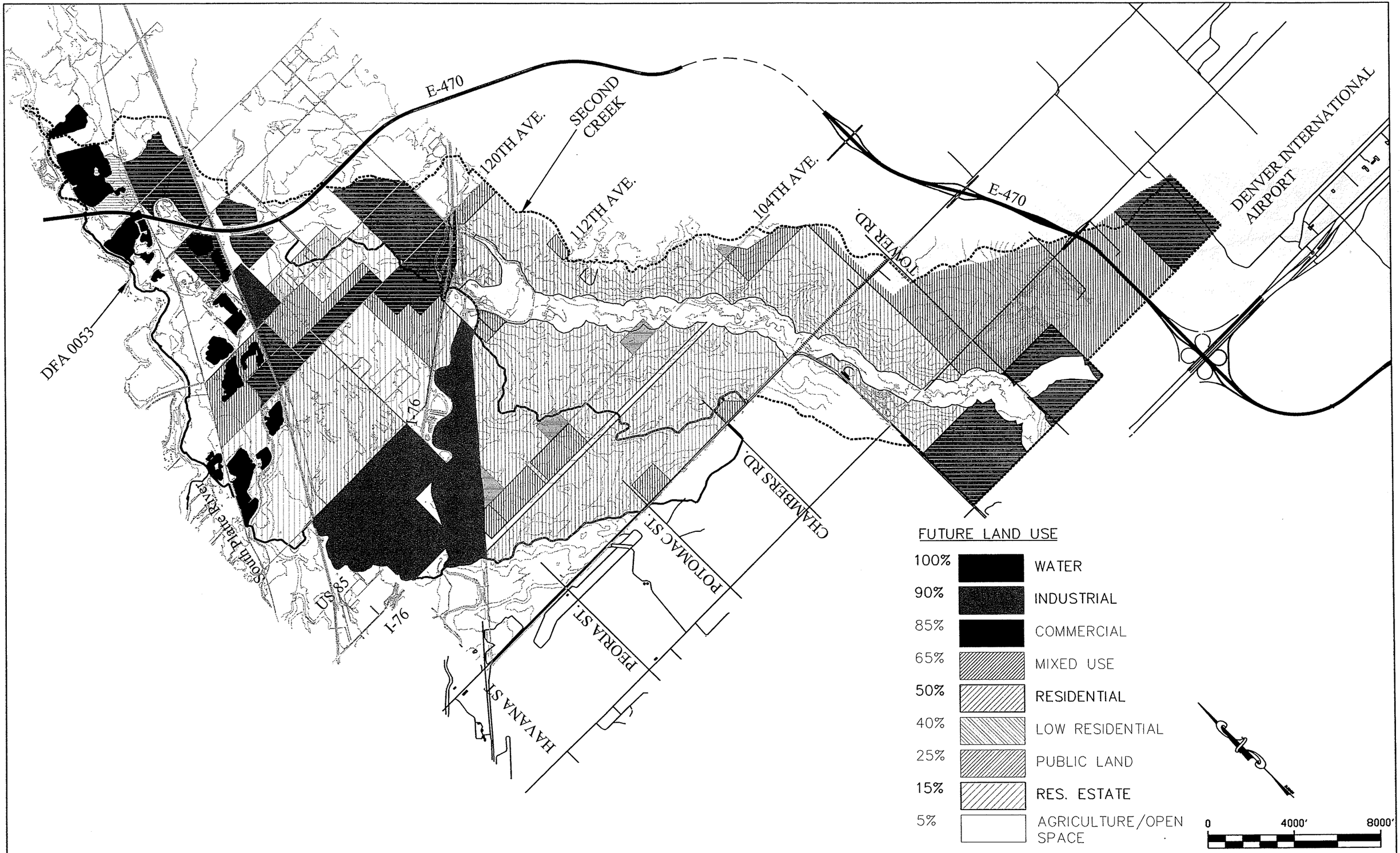
CITY OF BRIGHTON
COMMERCE CITY
ADAMS COUNTY
URBAN DRAINAGE & FLOOD CONTROL DISTRICT

SECOND CREEK D/S OF DIA & DFA 0053
OUTFALL SYSTEMS PLANNING STUDY UPDATE

EXISTING IMPERVIOUSNESS

FIGURE B–2



U.S.G.S MAPPING – 1994

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CITY OF BRIGHTON
COMMERCE CITY
ADAMS COUNTY
URBAN DRAINAGE & FLOOD CONTROL DISTRICT

SECOND CREEK D/S OF DIA & DFA 0053
OUTFALL SYSTEMS PLANNING STUDY

FUTURE IMPERVIOUSNESS

FIGURE B-3

E-470

SECOND CREEK

120TH AVE.

112TH AVE.

104TH AVE.

TOWER RD.

E-470

DENVER INTERNATIONAL AIRPORT

DFA 0053

South Platte River

I-76

CHAMBERS RD.

POTOMAC ST.

PEORIA ST.

HAVANA ST.

SH 85

I-76

935 SECOND CREEK

937 UNNAMED TRIBUTARY

942 WEST FORK TRIBUTARY

LEGEND

- SUBWATERSHED ID NUMBER
- WATERSHED BOUNDARY
- SUBWATERSHED BOUNDARY
- ROAD

0 4000′ 8000′

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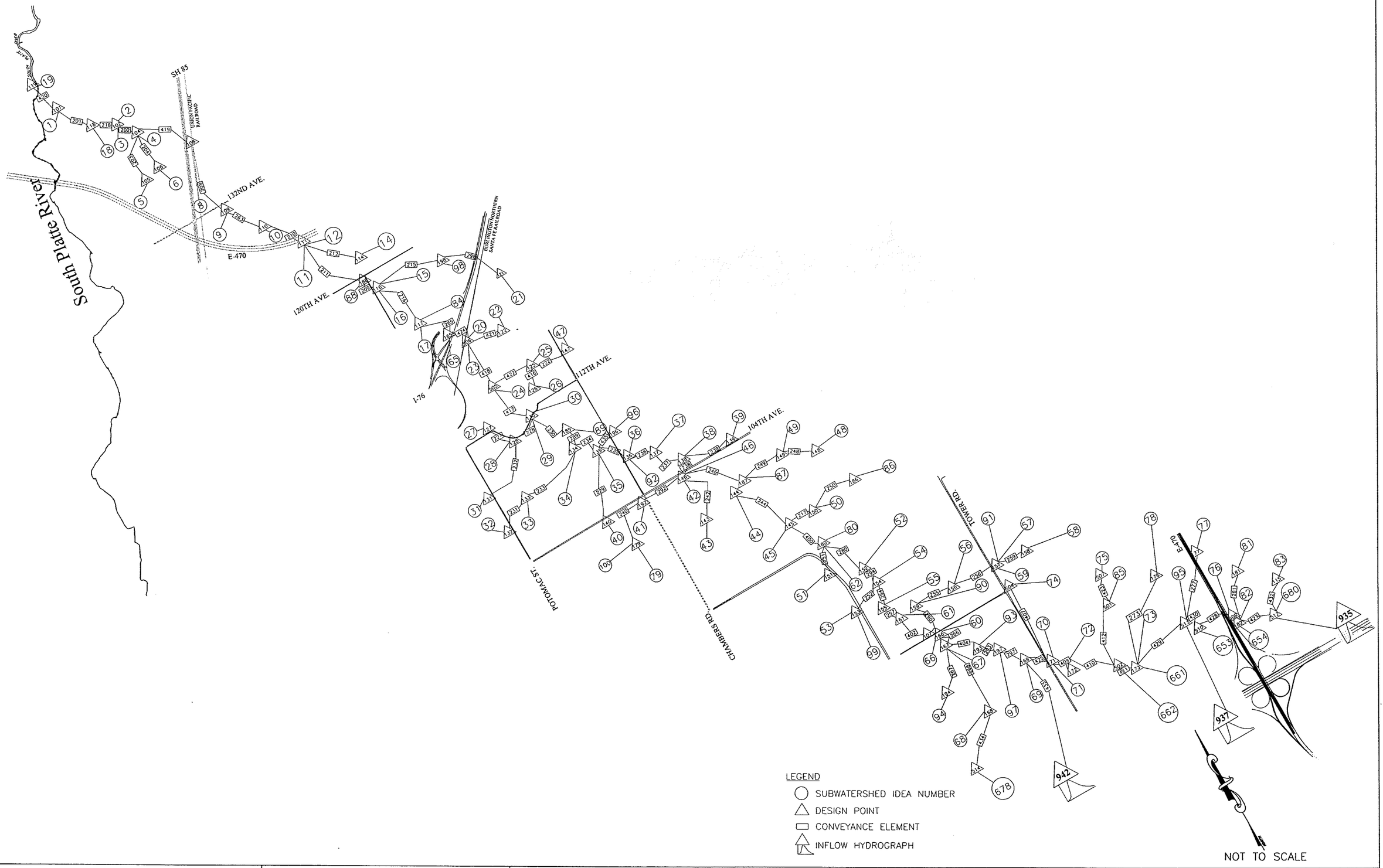

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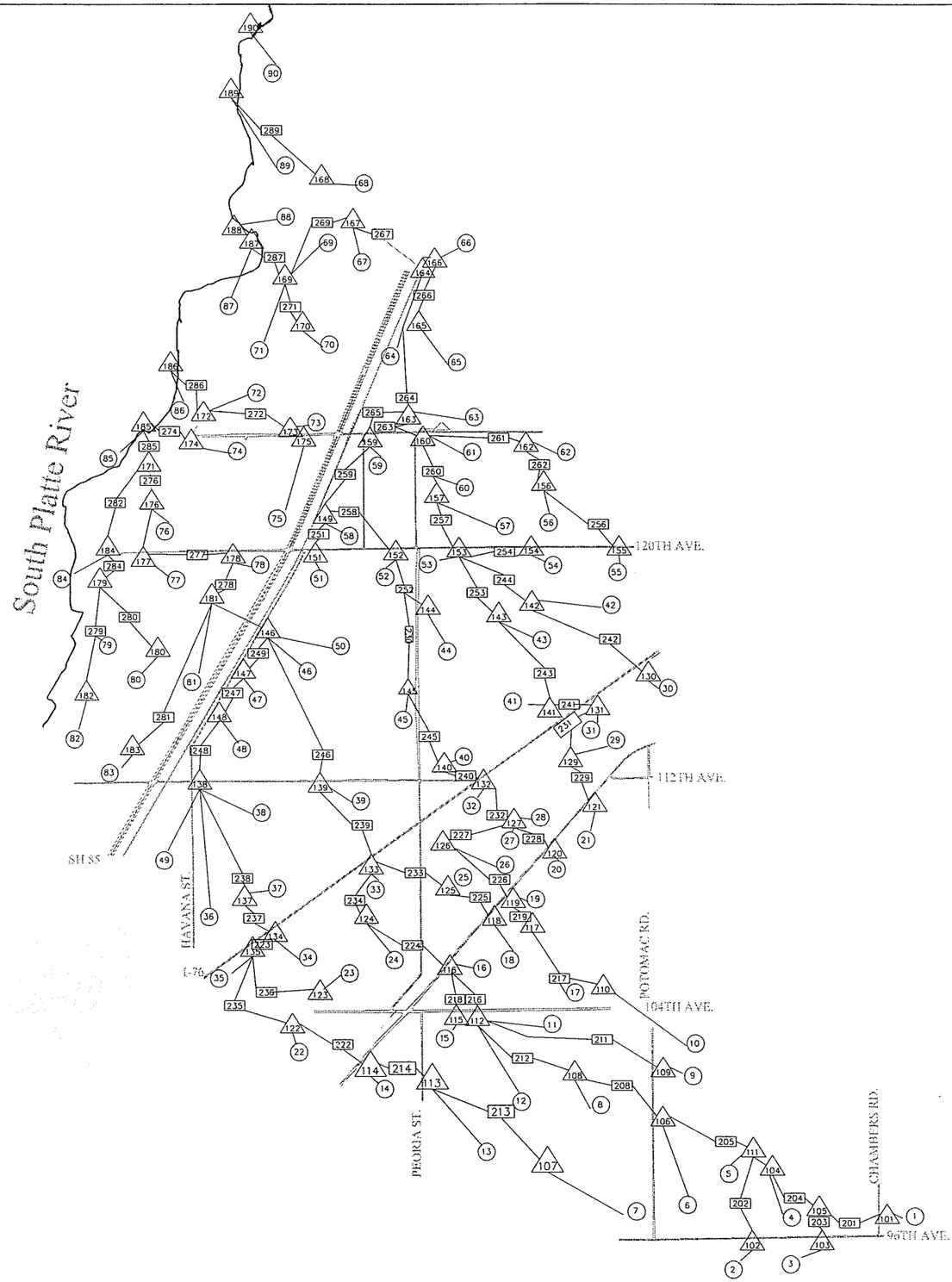

LEGEND

- SUBWATERSHED IDEA NUMBER
- DESIGN POINT
- CONVEYANCE ELEMENT

NOT TO SCALE

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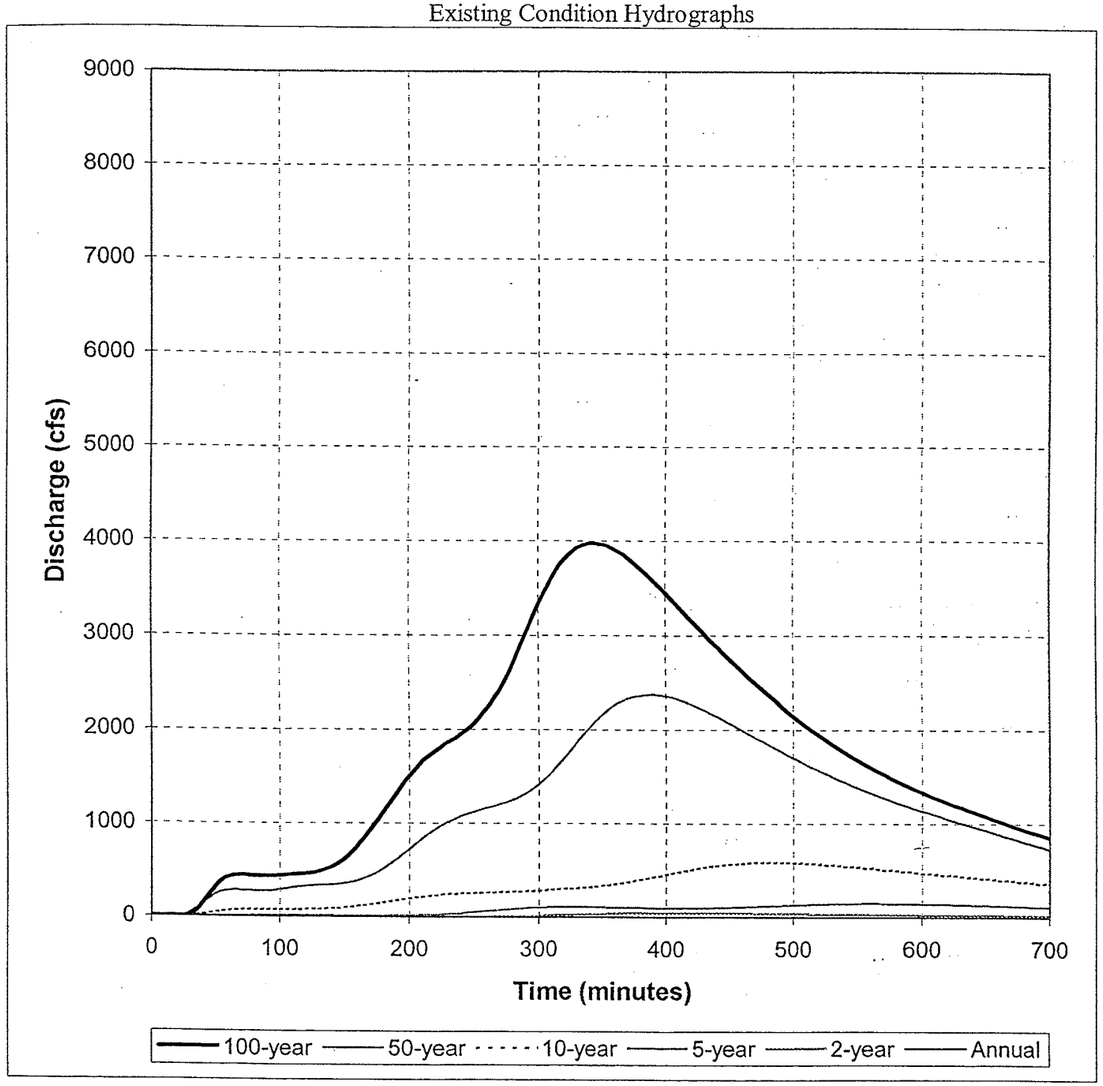
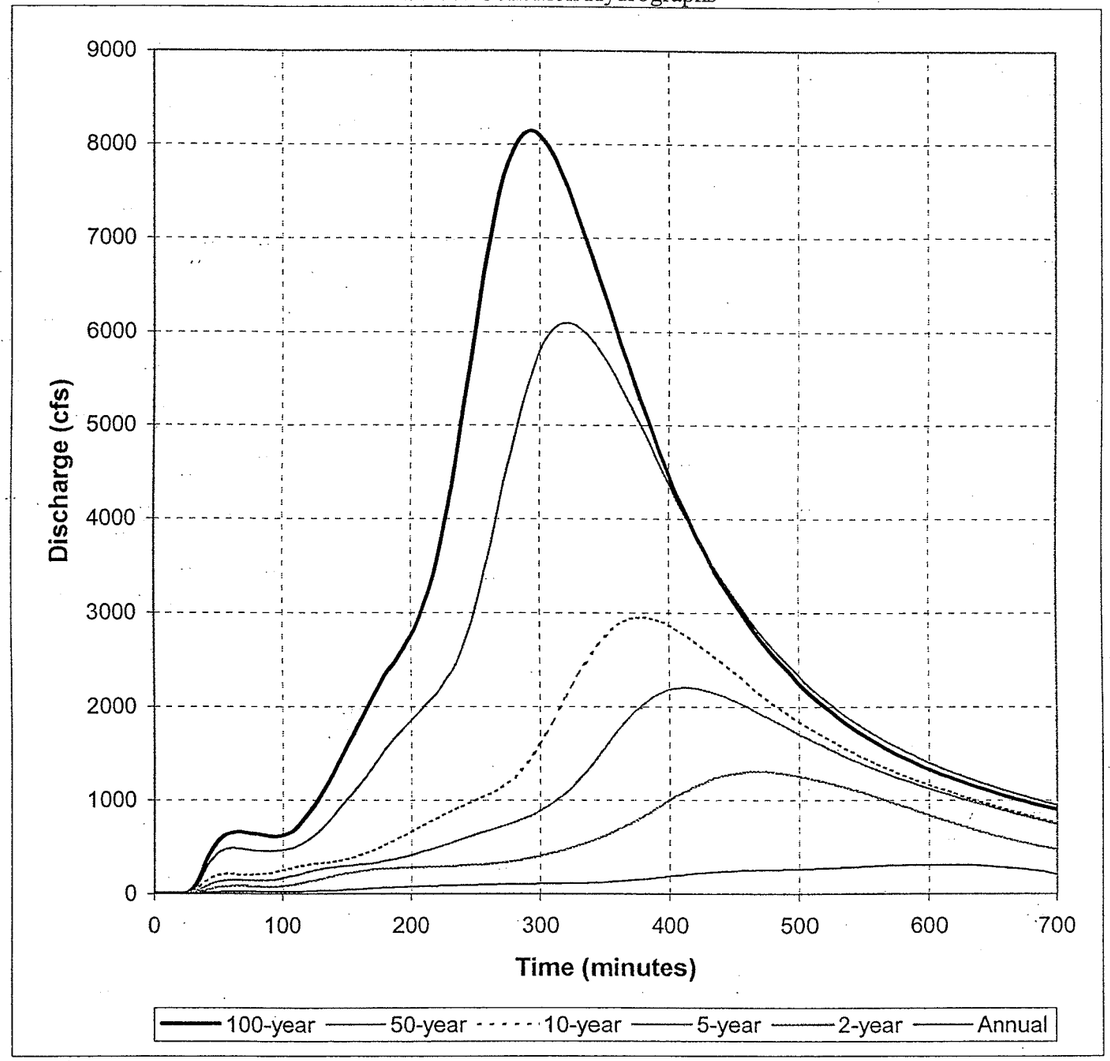
Second Creek Outfall to South Platte River

Existing Condition Hydrographs

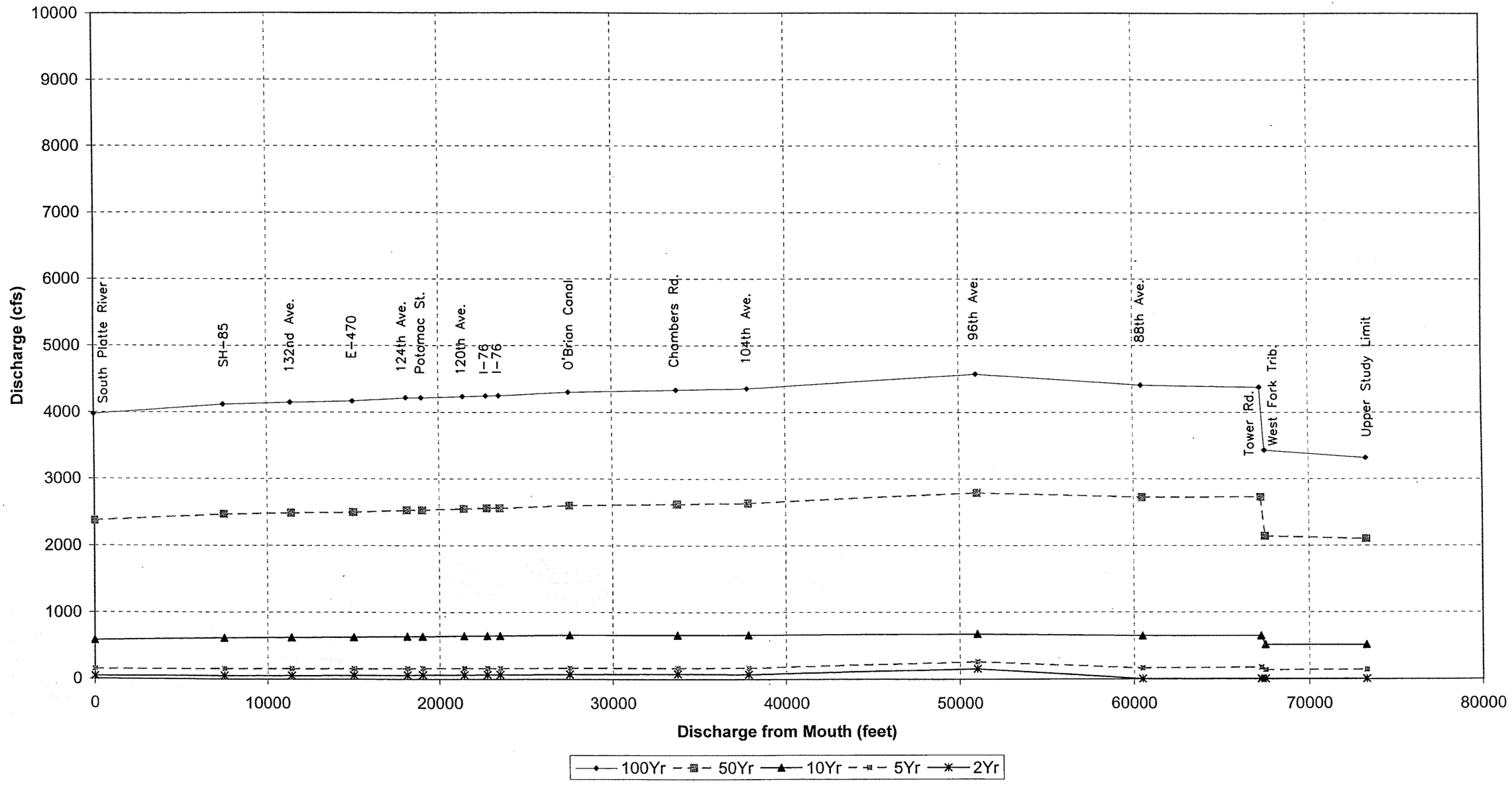


Future Condition Hydrographs



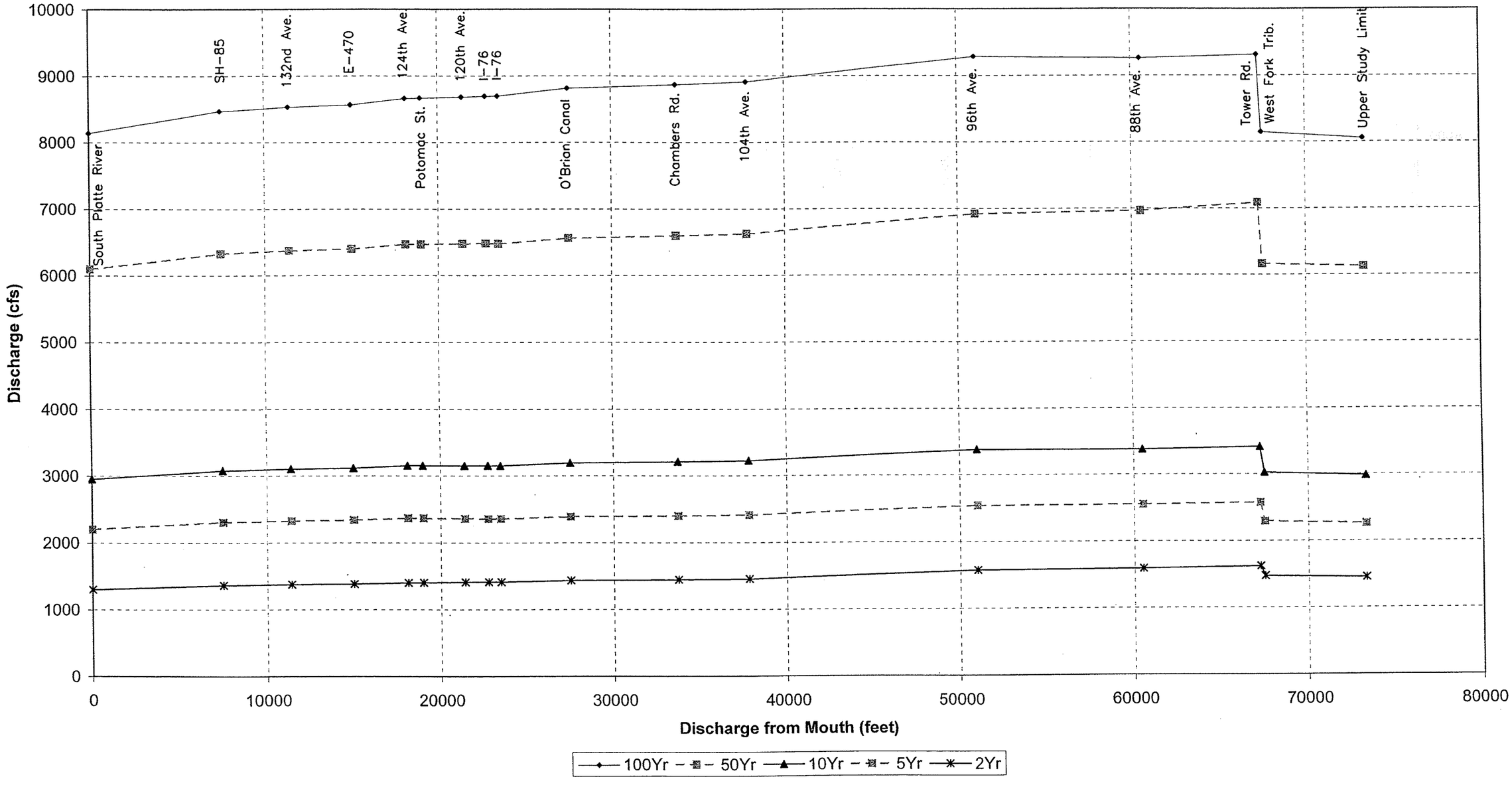
	Kiowa Engineering Corporation 7175 West Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303)-692-0369	CITY OF BRIGHTON COMMERCE CITY ADAMS COUNTY URBAN DRAINAGE & FLOOD CONTROL DISTRICT	SECOND CREEK D/S OF DIA AND DFA 0053 OUTFALL SYSTEMS PLANNING STUDY UPDATE	COMPARISON OF EXISTING AND FUTURE HYDROGRAPHS	FIGURE B-7

Second Creek Existing Discharge Profiles



	Kiowa Engineering Corporation 7175 W. Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303)-692-0369	*CITY OF BRIGHTON* *COMMERCE CITY* *ADAMS COUNTY* *URBAN DRAINAGE & FLOOD CONTROL DISTRICT*	SECOND CREEK D/S OF DIA & DFA 0053 OUTFALL SYSTEMS PLANNING STUDY UPDATE	*EXISTING* *DISCHARGE PROFILES*	FIGURE B-8

Second Creek Future Discharge Profiles



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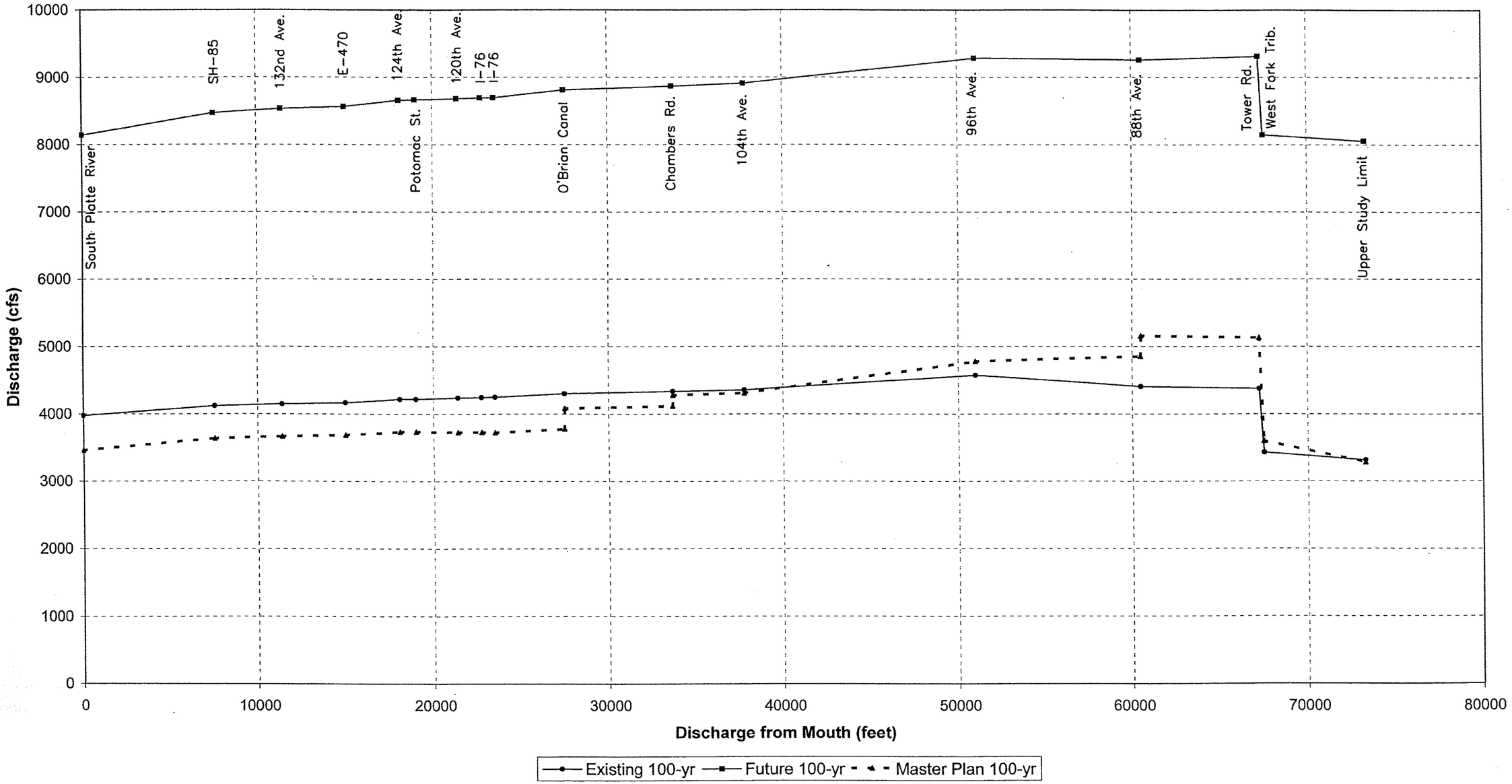
Second Creek Discharge Profiles



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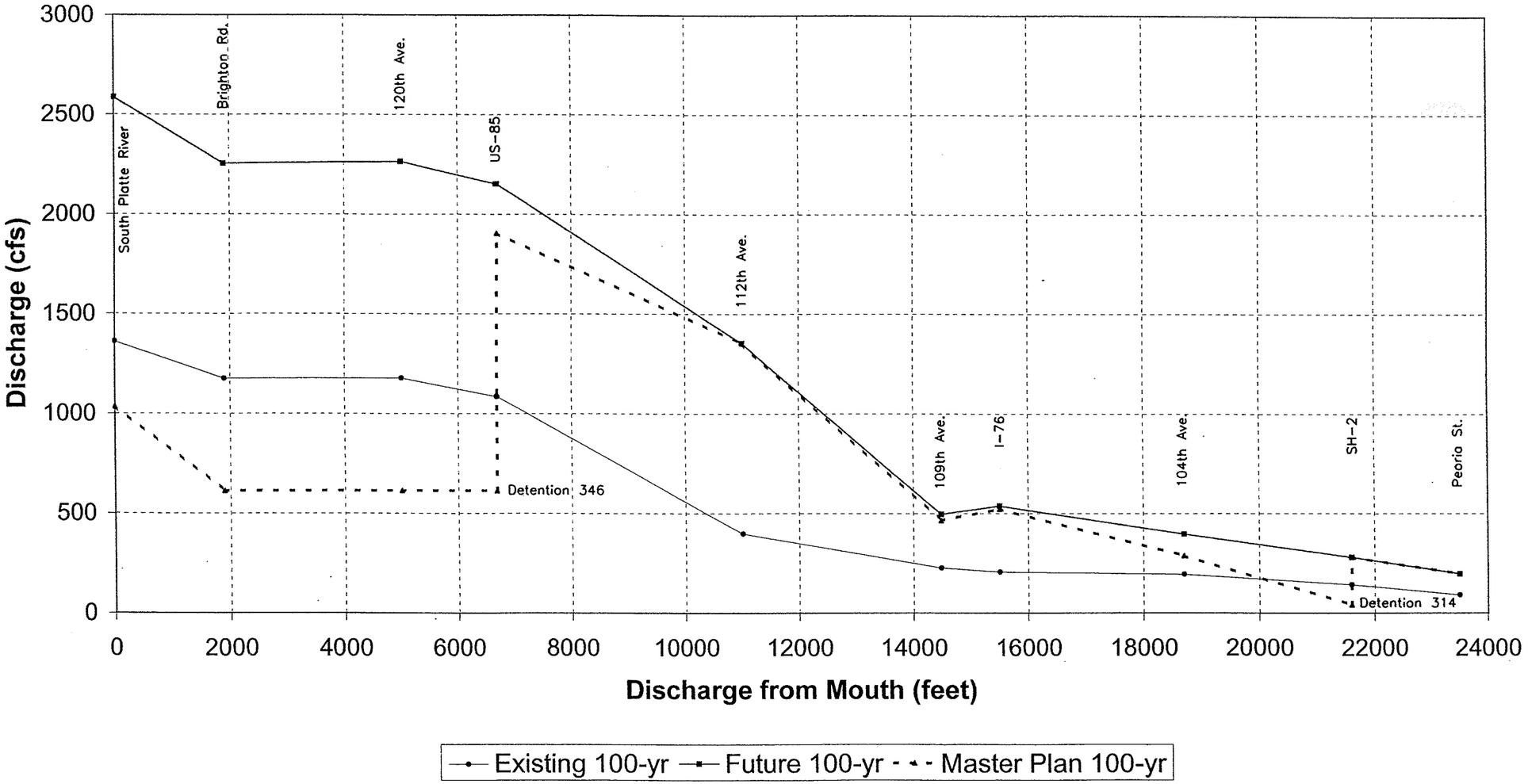
DFA 0053 Henderson Creek Discharge Profiles



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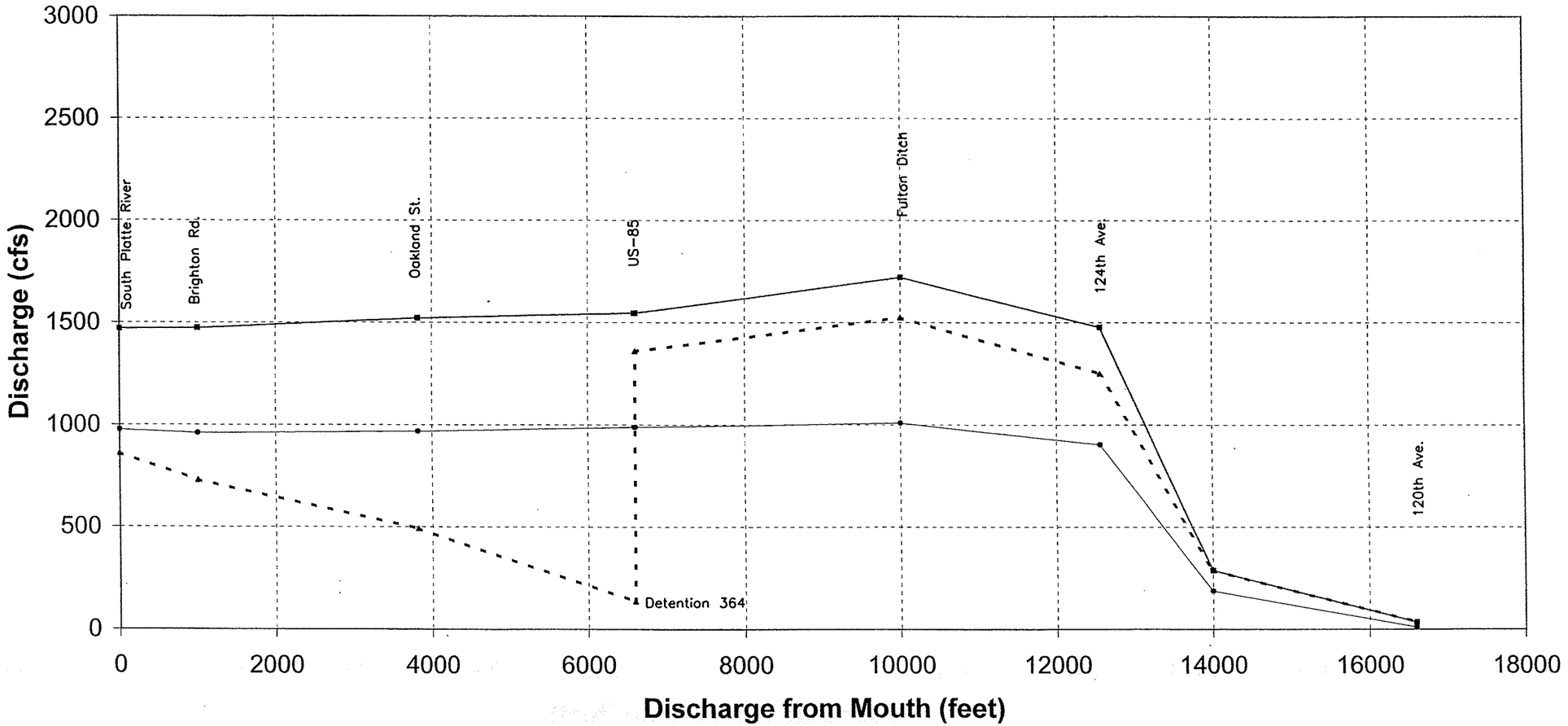
DFA 0053 Fox Run Discharge Profiles



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APPENDIX C

COMPUTER MODELS
INPUT AND OUTPUT FILES

Second Creek SWMM Output for Existing Conditions

100-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	
101	3981	(DIRECT FLOW)	5	45	
102	3981	(DIRECT FLOW)	5	40	
104	3984	(DIRECT FLOW)	5	40	
105	70	(DIRECT FLOW)	1	0	
106	68	(DIRECT FLOW)	1	5	
107	4599	(DIRECT FLOW)	2	25	
108	4121	(DIRECT FLOW)	5	15	
109	4147	(DIRECT FLOW)	5	5	
110	4162	(DIRECT FLOW)	5	0	
111	4167	(DIRECT FLOW)	4	55	
114	114	(DIRECT FLOW)	0	50	
115	134	(DIRECT FLOW)	0	55	
116	4218	(DIRECT FLOW)	4	40	
117	4237	(DIRECT FLOW)	4	35	
118	3981	(DIRECT FLOW)	5	45	
119	3975	(DIRECT FLOW)	5	50	
121	131	(DIRECT FLOW)	0	50	
122	139	(DIRECT FLOW)	0	40	
125	96	(DIRECT FLOW)	1	10	
126	23	(DIRECT FLOW)	0	55	
127	36	(DIRECT FLOW)	0	55	
128	173	(DIRECT FLOW)	0	55	
130	4302	(DIRECT FLOW)	4	10	
131	16	(DIRECT FLOW)	1	10	
132	85	(DIRECT FLOW)	0	45	
133	197	(DIRECT FLOW)	0	45	
134	4318	(DIRECT FLOW)	3	55	
135	4323	(DIRECT FLOW)	3	50	
136	4337	(DIRECT FLOW)	3	45	
137	4345	(DIRECT FLOW)	3	40	
138	4358	(DIRECT FLOW)	3	35	
139	138	(DIRECT FLOW)	0	45	
140	102	(DIRECT FLOW)	0	45	
143	328	(DIRECT FLOW)	0	40	
144	4352	(DIRECT FLOW)	3	25	
145	4553	(DIRECT FLOW)	3	0	
146	4356	(DIRECT FLOW)	3	35	
147	43	(DIRECT FLOW)	1	5	
148	161	(DIRECT FLOW)	0	50	
149	278	(DIRECT FLOW)	0	55	
150	270	(DIRECT FLOW)	1	0	
151	183	(DIRECT FLOW)	0	50	
152	4599	(DIRECT FLOW)	2	45	
153	255	(DIRECT FLOW)	0	50	
154	4575	(DIRECT FLOW)	2	45	
155	4564	(DIRECT FLOW)	2	40	
156	452	(DIRECT FLOW)	1	10	
157	387	(DIRECT FLOW)	1	5	
158	131	(DIRECT FLOW)	1	0	
159	470	(DIRECT FLOW)	1	20	
161	4556	(DIRECT FLOW)	2	35	
164	75	(DIRECT FLOW)	0	45	
165	4246	(DIRECT FLOW)	4	25	
166	4408	(DIRECT FLOW)	2	25	
167	4405	(DIRECT FLOW)	2	25	
168	184	(DIRECT FLOW)	1	0	
169	4377	(DIRECT FLOW)	2	5	
171	3431	(DIRECT FLOW)	2	15	
172	3410	(DIRECT FLOW)	2	10	
173	3317	(DIRECT FLOW)	2	5	
177	204	(DIRECT FLOW)	0	40	
178	139	(DIRECT FLOW)	0	50	
179	147	(DIRECT FLOW)	1	5	
180	4575	(DIRECT FLOW)	2	50	
181	145	(DIRECT FLOW)	0	45	
182	2873	(DIRECT FLOW)	2	5	
186	179	(DIRECT FLOW)	0	50	
187	4355	(DIRECT FLOW)	3	25	
188	4217	(DIRECT FLOW)	4	45	
189	4327	(DIRECT FLOW)	4	0	
192	174	(DIRECT FLOW)	1	15	
193	4335	(DIRECT FLOW)	2	20	
194	74	(DIRECT FLOW)	0	50	
196	95	(DIRECT FLOW)	0	45	
197	4332	(DIRECT FLOW)	2	15	
198	231	(DIRECT FLOW)	0	50	
501	180	(DIRECT FLOW)	0	55	
502	3414	(DIRECT FLOW)	2	5	
504	162	(DIRECT FLOW)	0	45	
505	4273	(DIRECT FLOW)	4	15	
506	4249	(DIRECT FLOW)	4	25	
507	104	(DIRECT FLOW)	0	45	
509	2909	(DIRECT FLOW)	2	5	
510	2911	(DIRECT FLOW)	2	10	
512	2819	(DIRECT FLOW)	2	0	
513	3219	(DIRECT FLOW)	2	0	
514	39	(DIRECT FLOW)	1	0	
935	2727	(DIRECT FLOW)	2	5	
937	449	(DIRECT FLOW)	1	15	
942	1270	(DIRECT FLOW)	1	20	

50-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	
101	2377	(DIRECT FLOW)	6	30	
102	2378	(DIRECT FLOW)	6	25	
104	2379	(DIRECT FLOW)	6	25	
105	46	(DIRECT FLOW)	0	50	
106	46	(DIRECT FLOW)	0	50	
107	2818	(DIRECT FLOW)	2	40	
108	2467	(DIRECT FLOW)	5	55	
109	2485	(DIRECT FLOW)	5	45	
110	2493	(DIRECT FLOW)	5	40	
111	2497	(DIRECT FLOW)	5	35	
114	76	(DIRECT FLOW)	0	45	
115	90	(DIRECT FLOW)	0	50	
116	2530	(DIRECT FLOW)	5	15	
117	2550	(DIRECT FLOW)	5	5	
118	2577	(DIRECT FLOW)	6	30	
119	2373	(DIRECT FLOW)	6	35	
121	86	(DIRECT FLOW)	0	45	
122	87	(DIRECT FLOW)	0	40	
125	63	(DIRECT FLOW)	1	5	
126	15	(DIRECT FLOW)	0	50	
127	24	(DIRECT FLOW)	0	50	
128	115	(DIRECT FLOW)	0	50	
130	2598	(DIRECT FLOW)	4	35	
131	10	(DIRECT FLOW)	1	5	
132	61	(DIRECT FLOW)	0	40	
133	144	(DIRECT FLOW)	0	40	
134	2608	(DIRECT FLOW)	4	25	
135	2612	(DIRECT FLOW)	4	20	
136	2621	(DIRECT FLOW)	4	10	
137	2627	(DIRECT FLOW)	4	5	
138	2636	(DIRECT FLOW)	4	0	
139	93	(DIRECT FLOW)	0	40	
140	73	(DIRECT FLOW)	0	40	
143	236	(DIRECT FLOW)	0	35	
144	2644	(DIRECT FLOW)	3	45	
145	2769	(DIRECT FLOW)	3	20	
146	2634	(DIRECT FLOW)	4	0	
147	27	(DIRECT FLOW)	0	55	
148	106	(DIRECT FLOW)	0	45	
149	176	(DIRECT FLOW)	0	50	
150	170	(DIRECT FLOW)	0	55	
151	121	(DIRECT FLOW)	0	45	
152	2798	(DIRECT FLOW)	3	0	
153	169	(DIRECT FLOW)	0	45	
154	2790	(DIRECT FLOW)	3	0	
155	2792	(DIRECT FLOW)	2	55	
156	292	(DIRECT FLOW)	1	10	
157	258	(DIRECT FLOW)	0	55	
158	90	(DIRECT FLOW)	0	55	
159	297	(DIRECT FLOW)	1	15	
161	2790	(DIRECT FLOW)	2	50	
164	50	(DIRECT FLOW)	0	40	
165	2558	(DIRECT FLOW)	5	0	
166	2723	(DIRECT FLOW)	2	40	
167	2724	(DIRECT FLOW)	2	40	
168	123	(DIRECT FLOW)	0	50	
169	2725	(DIRECT FLOW)	2	15	
171	2144	(DIRECT FLOW)	2	25	
172	2138	(DIRECT FLOW)	2	25	
173	2102	(DIRECT FLOW)	2	15	
177	140	(DIRECT FLOW)	0	35	
178	95	(DIRECT FLOW)	0	45	
179	95	(DIRECT FLOW)	1	0	
180	2790	(DIRECT FLOW)	3	10	
181	101	(DIRECT FLOW)	0	40	
182	1854	(DIRECT FLOW)	2	10	
186	120	(DIRECT FLOW)	0	45	
187	2645	(DIRECT FLOW)	3	45	
188	2529	(DIRECT FLOW)	5	20	
189	2614	(DIRECT FLOW)	4	25	
192	103	(DIRECT FLOW)	1	10	
193	2696	(DIRECT FLOW)	2	30	
194	49	(DIRECT FLOW)	0	45	
196	63	(DIRECT FLOW)	0	40	
197	2700	(DIRECT FLOW)	2	30	
198	154	(DIRECT FLOW)	0	45	
501	119	(DIRECT FLOW)	0	50	
502	2150	(DIRECT FLOW)	2	15	
504	115	(DIRECT FLOW)	0	40	
505	2574	(DIRECT FLOW)	4	50	
506	2557	(DIRECT FLOW)	4	55	
507	70	(DIRECT FLOW)	0	40	
509	1873	(DIRECT FLOW)	2	5	
510	1868	(DIRECT FLOW)	2	15	
512	1835	(DIRECT FLOW)	2	10	
513	2052	(DIRECT FLOW)	2	10	
514	26	(DIRECT FLOW)	0	55	
935	1787	(DIRECT FLOW)	2	10	
937	303	(DIRECT FLOW)	1	15	
942	838	(DIRECT FLOW)	1	20	

10-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	
101	585	(DIRECT FLOW)	8	0	
102	585	(DIRECT FLOW)	8	0	
104	586	(DIRECT FLOW)	7	55	
105	15	(DIRECT FLOW)	0	45	
106	17	(DIRECT FLOW)	0	50	
107	686	(DIRECT FLOW)	2	55	
108	618	(DIRECT FLOW)	7	10	
109	625	(DIRECT FLOW)	6	55	
110	627	(DIRECT FLOW)	6	45	
111	629	(DIRECT FLOW)	6	35	
114	25	(DIRECT FLOW)	0	45	
115	30	(DIRECT FLOW)	0	45	
116	640	(DIRECT FLOW)	6	10	
117	647	(DIRECT FLOW)	5	55	
118	585	(DIRECT FLOW)	8	0	
119	584	(DIRECT FLOW)	8	10	
121	25	(DIRECT FLOW)	0	40	
122	20	(DIRECT FLOW)	0	40	
125	15	(DIRECT FLOW)	1	10	
126	4	(DIRECT FLOW)	0	50	
127	7	(DIRECT FLOW)	0	45	
128	31	(DIRECT FLOW)	0	45	
130	658	(DIRECT FLOW)	5	15	
131	3	(DIRECT FLOW)	1	0	
132	25	(DIRECT FLOW)	0	40	
133	62	(DIRECT FLOW)	0	40	
134	658	(DIRECT FLOW)	5	0	
135	659	(DIRECT FLOW)	4	55	
136	659	(DIRECT FLOW)	4	45	
137	661	(DIRECT FLOW)	4	40	
138	661	(DIRECT FLOW)	4	35	
139	31	(DIRECT FLOW)	0	40	
140	31	(DIRECT FLOW)	0	40	
143	111	(DIRECT FLOW)	0	35	
144	667	(DIRECT FLOW)	4	15	
145	671	(DIRECT FLOW)	3	55	
146	661	(DIRECT FLOW)	4	30	
147	8	(DIRECT FLOW)	0	50	
148	32	(DIRECT FLOW)	0	45	
149	52	(DIRECT FLOW)	0	45	
150	53	(DIRECT FLOW)	0	50	
151	39	(DIRECT FLOW)	0	45	
152	673	(DIRECT FLOW)	3	25	
153	55	(DIRECT FLOW)	0	45	
154	672	(DIRECT FLOW)	3	30	
155	672	(DIRECT FLOW)	3	20	
156	93	(DIRECT FLOW)	1	15	
157	91	(DIRECT FLOW)	0	55	
158	33	(DIRECT FLOW)	0	50	
159	91	(DIRECT FLOW)	1	30	
161	671	(DIRECT FLOW)	3	15	
164	16	(DIRECT FLOW)	0	40	
165	649	(DIRECT FLOW)	5	45	
166	650	(DIRECT FLOW)	3	5	
167	650	(DIRECT FLOW)	3	0	
168	40	(DIRECT FLOW)	0	50	
169	650	(DIRECT FLOW)	2	35	
171	518	(DIRECT FLOW)	2	45	
172	517	(DIRECT FLOW)	2	40	
173	512	(DIRECT FLOW)	2	30	
177	57	(DIRECT FLOW)	0	35	
178	34	(DIRECT FLOW)	0	45	
179	26	(DIRECT FLOW)	0	55	
180	676	(DIRECT FLOW)	3	40	
181	38	(DIRECT FLOW)	0	40	
182	460	(DIRECT FLOW)	2	5	
186	41	(DIRECT FLOW)	0	45	
187	667	(DIRECT FLOW)	4	15	
188	640	(DIRECT FLOW)	6	15	
189	660	(DIRECT FLOW)	5	0	
192	28	(DIRECT FLOW)	1	10	
193	643	(DIRECT FLOW)	2	55	
194	16	(DIRECT FLOW)	0	40	
196	19	(DIRECT FLOW)	0	40	
197	643	(DIRECT FLOW)	2	50	
198	43	(DIRECT FLOW)	0	45	
501	42	(DIRECT FLOW)	0	50	
502	522	(DIRECT FLOW)	2	30	
504	44	(DIRECT FLOW)	0	40	
505	653	(DIRECT FLOW)	5	30	
506	649	(DIRECT FLOW)	5	45	
507	25	(DIRECT FLOW)	0	40	
509	468	(DIRECT FLOW)	2	5	
510	457	(DIRECT FLOW)	2	20	
512	455	(DIRECT FLOW)	2	0	
513	510	(DIRECT FLOW)	2	10	
514	8	(DIRECT FLOW)	0	45	
935	435	(DIRECT FLOW)	2	0	
937	85	(DIRECT FLOW)	1	20	
942	198	(DIRECT FLOW)	1	25	

5-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	
101	149	(DIRECT FLOW)	9	15	
102	149	(DIRECT FLOW)	9	10	
104	149	(DIRECT FLOW)	9	5	
105	3	(DIRECT FLOW)	0	40	
106	6	(DIRECT FLOW)	0	50	
107	170	(DIRECT FLOW)	3	35	
108	155	(DIRECT FLOW)	8	30	
109	156	(DIRECT FLOW)	8	20	
110	157	(DIRECT FLOW)	8	0	
111	157	(DIRECT FLOW)	7	55	
114	4	(DIRECT FLOW)	0	40	
115	5	(DIRECT FLOW)	0	40	
116	160	(DIRECT FLOW)	7	30	
117	161	(DIRECT FLOW)	7	20	
118	149	(DIRECT FLOW)	9	15	
119	149	(DIRECT FLOW)	9	25	
121	5	(DIRECT FLOW)	0	35	
122	5	(DIRECT FLOW)	0	30	
125	2	(DIRECT FLOW)	0	55	
126	0	(DIRECT FLOW)	0	0	
127	0	(DIRECT FLOW)	0	0	
128	5	(DIRECT FLOW)	0	40	
130	166	(DIRECT FLOW)	2	5	
131	0	(DIRECT FLOW)	0	0	
132	12	(DIRECT FLOW)	0	30	
133	35	(DIRECT FLOW)	0	30	
134	172	(DIRECT FLOW)	1	50	
135	172	(DIRECT FLOW)	1	35	
136	167	(DIRECT FLOW)	5	55	
137	168	(DIRECT FLOW)	5	50	
138	168	(DIRECT FLOW)	5	45	
139	8	(DIRECT FLOW)	0	35	
140	17	(DIRECT FLOW)	0	30	
143	72	(DIRECT FLOW)	0	30	
144	166	(DIRECT FLOW)	5	25	
145	169	(DIRECT FLOW)	4	55	
146	168	(DIRECT FLOW)	5	40	
147	1	(DIRECT FLOW)	0	40	
148	6	(DIRECT FLOW)	0	40	
149	8	(DIRECT FLOW)	0	40	
150	8	(DIRECT FLOW)	0	50	
151	7	(DIRECT FLOW)	0	35	
152	166	(DIRECT FLOW)	4	20	
153	9	(DIRECT FLOW)	0	35	
154	166	(DIRECT FLOW)	4	15	
155	167	(DIRECT FLOW)	4	5	
156	29	(DIRECT FLOW)	1	10	
157	28	(DIRECT FLOW)	0	55	
158	12	(DIRECT FLOW)	0	45	
159	26	(DIRECT FLOW)	1	10	
161	168	(DIRECT FLOW)	3	50	
164	3	(DIRECT FLOW)	0	35	
165	162	(DIRECT FLOW)	7	5	
166	167	(DIRECT FLOW)	3	40	
167	168	(DIRECT FLOW)	3	35	
168	9	(DIRECT FLOW)	0	45	
169	178	(DIRECT FLOW)	2	50	
171	139	(DIRECT FLOW)	2	50	
172	139	(DIRECT FLOW)	2	40	
173	143	(DIRECT FLOW)	2	15	
177	19	(DIRECT FLOW)	0	35	
178	9	(DIRECT FLOW)	0	45	
179	5	(DIRECT FLOW)	0	50	
180	261	(DIRECT FLOW)	0	25	
181	12	(DIRECT FLOW)	0	40	
182	122	(DIRECT FLOW)	2	5	
186	7	(DIRECT FLOW)	0	40	
187	167	(DIRECT FLOW)	5	25	
188	159	(DIRECT FLOW)	7	35	
189	172	(DIRECT FLOW)	1	55	
192	5	(DIRECT FLOW)	1	15	
193	168	(DIRECT FLOW)	3	25	
194	3	(DIRECT FLOW)	0	35	
196	3	(DIRECT FLOW)	0	35	
197	168	(DIRECT FLOW)	3	20	
198	7	(DIRECT FLOW)	0	35	
501	9	(DIRECT FLOW)	0	50	
502	144	(DIRECT FLOW)	2	20	
504	15	(DIRECT FLOW)	0	40	
505	163	(DIRECT FLOW)	6	50	
506	162	(DIRECT FLOW)	7	0	
507	5	(DIRECT FLOW)	0	40	
509	122	(DIRECT FLOW)	2	5	
510	121	(DIRECT FLOW)	2	20	
512	122	(DIRECT FLOW)	2	0	
513	141	(DIRECT FLOW)	2	10	
514	0	(DIRECT FLOW)	0	0	
935	119	(DIRECT FLOW)	2	0	
937	33	(DIRECT FLOW)	1	20	
942	60	(DIRECT FLOW)	1	25	

2-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	
101	45	(DIRECT FLOW)	6	40	
102	45	(DIRECT FLOW)	6	35	
104	46	(DIRECT FLOW)	6	25	
105	0	(DIRECT FLOW)	0	0	
106	0	(DIRECT FLOW)	0	0	
107	6	(DIRECT FLOW)	3	15	
108	52	(DIRECT FLOW)	5	30	
109	53	(DIRECT FLOW)	5	10	
110	56	(DIRECT FLOW)	4	40	
111	57	(DIRECT FLOW)	4	30	
114	2	(DIRECT FLOW)	0	45	
115	2	(DIRECT FLOW)	0	45	
116	61	(DIRECT FLOW)	3	55	
117	63	(DIRECT FLOW)	3	35	
118	45	(DIRECT FLOW)	6	40	
119	45	(DIRECT FLOW)	6	55	
121	2	(DIRECT FLOW)	0	45	
122	2	(DIRECT FLOW)	0	40	
125	0	(DIRECT FLOW)	0	0	
126	0	(DIRECT FLOW)	0	0	
127	0	(DIRECT FLOW)	0	0	
128	2	(DIRECT FLOW)	0	45	
130	73	(DIRECT FLOW)	2	25	
131	0	(DIRECT FLOW)	0	0	
132	7	(DIRECT FLOW)	0	40	
133	21	(DIRECT FLOW)	0	40	
134	77	(DIRECT FLOW)	2	5	
135	79	(DIRECT FLOW)	1	40	
136	80	(DIRECT FLOW)	1	30	
137	81	(DIRECT FLOW)	1	20	
138	77	(DIRECT FLOW)	1	15	
139	4	(DIRECT FLOW)	0	40	
140	10	(DIRECT FLOW)	0	40	
143	43	(DIRECT FLOW)	0	35	
144	56	(DIRECT FLOW)	0	45	
145	89	(DIRECT FLOW)	0	40	
146	71	(DIRECT FLOW)	1	15	
147	0	(DIRECT FLOW)	0	0	
148	2	(DIRECT FLOW)	0	45	
149	3	(DIRECT FLOW)	0	45	
150	3	(DIRECT FLOW)	0	50	
151	3	(DIRECT FLOW)	0	45	
152	6	(DIRECT FLOW)	4	50	
153	4	(DIRECT FLOW)	0	45	
154	6	(DIRECT FLOW)	4	40	
155	6	(DIRECT FLOW)	4	25	
156	4	(DIRECT FLOW)	1	5	
157	4	(DIRECT FLOW)	0	55	
158	2	(DIRECT FLOW)	0	50	
159	2	(DIRECT FLOW)	1	25	
161	6	(DIRECT FLOW)	4	0	
164	0	(DIRECT FLOW)	0	0	
165	67	(DIRECT FLOW)	3	10	
166	5	(DIRECT FLOW)	3	50	
167	5	(DIRECT FLOW)	3	45	
168	3	(DIRECT FLOW)	0	45	
169	8	(DIRECT FLOW)	1	0	
171	7	(DIRECT FLOW)	0	50	
172	5	(DIRECT FLOW)	1	15	
173	5	(DIRECT FLOW)	0	55	
177	4	(DIRECT FLOW)	0	35	
178	3	(DIRECT FLOW)	0	45	
179	0	(DIRECT FLOW)	0	0	
180	157	(DIRECT FLOW)	0	30	
181	3	(DIRECT FLOW)	0	40	
182	5	(DIRECT FLOW)	1	15	
186	3	(DIRECT FLOW)	0	45	
187	59	(DIRECT FLOW)	0	45	
188	60	(DIRECT FLOW)	4	0	
189	76	(DIRECT FLOW)	2	10	
192	1	(DIRECT FLOW)	0	45	
193	5	(DIRECT FLOW)	3	25	
194	0	(DIRECT FLOW)	0	0	
196	1	(DIRECT FLOW)	0	45	
197	5	(DIRECT FLOW)	3	15	
198	3	(DIRECT FLOW)	0	45	
501	2	(DIRECT FLOW)	0	50	
502	6	(DIRECT FLOW)	1	5	
504	3	(DIRECT FLOW)	0	40	
505	70	(DIRECT FLOW)	2	45	
506	67	(DIRECT FLOW)	3	5	
507	2	(DIRECT FLOW)	0	45	
509	5	(DIRECT FLOW)	1	15	
510	3	(DIRECT FLOW)	1	25	
512	4	(DIRECT FLOW)	1	5	
513	5	(DIRECT FLOW)	1	20	
514	0	(DIRECT FLOW)	0	0	
935	2	(DIRECT FLOW)	3	20	
937	1	(DIRECT FLOW)	1	5	
942	2	(DIRECT FLOW)	1	5	

0.4" Average

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	
101	102	(DIRECT FLOW)	11	10	
102	102	(DIRECT FLOW)	11	5	
104	102	(DIRECT FLOW)	10	55	
105	0	(DIRECT FLOW)	0	0	
106	0	(DIRECT FLOW)	0	0	
107	146	(DIRECT FLOW)	4	15	
108	109	(DIRECT FLOW)	10	10	
109	111	(DIRECT FLOW)	9	50	
110	112	(DIRECT FLOW)	9	30	
111	113	(DIRECT FLOW)	9	20	
114	0	(DIRECT FLOW)	0	0	
115	0	(DIRECT FLOW)	0	0	
116	115	(DIRECT FLOW)	8	50	
117	117	(DIRECT FLOW)	8	35	
118	102	(DIRECT FLOW)	11	10	
119	101	(DIRECT FLOW)	11	20	
121	0	(DIRECT FLOW)	0	0	
122	0	(DIRECT FLOW)	0	0	
125	0	(DIRECT FLOW)	0	0	
126	0	(DIRECT FLOW)	0	0	
127	0	(DIRECT FLOW)	0	0	
128	0	(DIRECT FLOW)	0	0	
130	121	(DIRECT FLOW)	7	40	
131	0	(DIRECT FLOW)	0	0	
132	2	(DIRECT FLOW)	0	30	
133	6	(DIRECT FLOW)	0	30	
134	123	(DIRECT FLOW)	7	25	
135	125	(DIRECT FLOW)	7	0	
136	125	(DIRECT FLOW)	6	50	
137	126	(DIRECT FLOW)	6	45	
138	126	(DIRECT FLOW)	6	35	
139	0	(DIRECT FLOW)	0	0	
140	3	(DIRECT FLOW)	0	30	
143	15	(DIRECT FLOW)	0	30	
144	130	(DIRECT FLOW)	6	15	
145	135	(DIRECT FLOW)	5	40	
146	126	(DIRECT FLOW)	6	35	
147	0	(DIRECT FLOW)	0	0	
148	0	(DIRECT FLOW)	0	0	
149	0	(DIRECT FLOW)	0	0	
150	0	(DIRECT FLOW)	0	0	
151	0	(DIRECT FLOW)	0	0	
152	141	(DIRECT FLOW)	5	5	
153	0	(DIRECT FLOW)	0	0	
154	141	(DIRECT FLOW)	4	55	
155	142	(DIRECT FLOW)	4	45	
156	0	(DIRECT FLOW

Second Creek SWMM Output for Existing Conditions

100-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)		TIME (HR /MIN)	
201	3981	2.9	0	5	45	
202	3981	4.3	0	5	40	
203	48	1.1	0	1	25	
204	53	1.1	0	1	30	
208	4121	5.2	0	5	15	
209	4217	5.2	0	4	45	
210	4160	5.3	0	5	0	
211	4166	5.3	0	4	55	
212	71	1.2	0	1	20	
215	159	1.3	0	1	20	
216	4204	5.3	0	4	40	
217	262	1.7	0	1	10	
218	3981	5	0	5	45	
222	35	1.1	0	1	25	
227	30	1.1	0	1	15	
228	161	1.6	0	1	10	
229	43	1.1	0	1	15	
230	4293	7.9	0	4	10	
231	55	1.2	0	1	10	
232	12	0.7	0	2	5	
233	130	1.4	0	1	10	
234	4314	7.7	0	3	55	
235	4321	5.5	0	3	50	
236	4337	7.1	0	3	45	
237	4343	7.1	0	3	40	
238	4356	4.2	0	3	35	
239	93	1.3	0	1	10	
240	122	1.4	0	1	30	
242	172	1.5	0	1	5	
244	4348	7.2	0	3	25	
246	4296	7.2	0	3	35	
248	142	1.4	0	1	5	
249	243	1.6	0	1	10	
250	135	1.4	0	1	10	
251	167	1.5	0	1	0	
252	216	1.6	0	1	5	
254	4553	4.4	0	2	45	
255	430	2	0	1	20	
256	365	1.9	0	1	15	
257	4537	4.7	0	2	40	
259	118	1.4	0	1	15	
263	4147	4.2	0	5	5	
264	44	1.1	0	1	15	
265	4235	4.3	0	4	35	
266	4401	4.3	0	2	25	
267	48	1.1	0	1	15	
268	122	1.4	0	1	30	
273	77	1.2	0	1	25	
277	88	1.3	0	1	5	
280	4563	4.5	0	2	55	
281	82	1.2	0	1	15	
289	4317	4.4	0	4	0	
290	453	2	0	1	30	
292	156	1.5	0	1	35	
293	4333	4.4	0	2	20	
294	4575	4.7	0	2	45	
297	4305	4.3	0	2	20	
298	76	1.3	0	1	20	
400	4538	7.2	0	3	0	
402	4537	7.3	0	2	35	
404	4310	7.2	0	2	25	
407	86	1.3	0	1	10	
409	3409	4	0	2	15	
410	3396	4	0	2	15	
411	3318	4	0	2	10	
412	151	1.4	0	1	15	
416	22	0.9	0	1	20	
417	4266	5.6	0	4	20	
418	4249	5.2	0	4	25	
419	3983	5.2	0	5	40	
420	3975	3.6	0	5	50	
421	93	1.3	0	0	55	
422	92	1.3	0	1	25	
423	82	1.3	0	1	0	
424	4246	5.3	0	4	25	
425	3428	4.9	0	2	15	
427	2806	4.7	0	2	10	
428	2899	4.8	0	2	10	
429	3192	4.9	0	2	10	
430	2908	4.8	0	2	10	
432	85	1.3	0	1	25	
433	1100	2.7	0	1	40	
434	30	1	0	1	25	
435	86	1.3	0	0	55	

50-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)		TIME (HR /MIN)	
201	2377	2.3	0	6	30	
202	2378	3.7	0	6	25	
203	31	1	0	1	20	
204	34	1.1	0	1	25	
208	2467	4.6	0	5	55	
209	2529	4.6	0	5	20	
210	2493	4.7	0	5	40	
211	2497	4.7	0	5	35	
212	42	1.1	0	1	15	
215	89	1.2	0	1	15	
216	2529	4.7	0	5	15	
217	161	1.5	0	1	5	
218	2377	4.4	0	6	30	
222	24	0.9	0	1	10	
227	21	1	0	1	0	
228	102	1.4	0	1	5	
229	31	1	0	1	10	
230	2592	7	0	4	35	
231	36	1.1	0	1	5	
232	7	0.5	0	2	5	
233	85	1.3	0	1	5	
234	2606	7	0	4	25	
235	2611	4.8	0	4	20	
236	2621	6.5	0	4	10	
237	2626	6.4	0	4	5	
238	2635	3.5	0	4	0	
239	57	1.2	0	1	5	
240	73	1.2	0	1	30	
242	117	1.4	0	1	0	
244	2640	6.5	0	3	45	
246	2604	6.5	0	4	0	
248	88	1.3	0	1	0	
249	146	1.4	0	1	5	
250	83	1.3	0	1	5	
251	107	1.4	0	0	55	
252	136	1.4	0	1	0	
254	2786	3.7	0	3	0	
255	274	1.7	0	1	20	
256	235	1.6	0	1	10	
257	2778	3.9	0	2	55	
259	78	1.3	0	1	10	
263	2485	3.5	0	5	45	
264	30	1	0	1	5	
265	2550	3.6	0	5	5	
266	2723	3.6	0	2	40	
267	32	1	0	1	5	
268	74	1.2	0	1	30	
273	48	1.1	0	1	20	
277	57	1.2	0	1	0	
280	2780	3.8	0	3	10	
281	52	1.1	0	1	10	
289	2608	3.7	0	4	25	
290	285	1.8	0	1	25	
292	91	1.3	0	1	35	
293	2696	3.7	0	2	30	
294	2787	3.9	0	3	0	
297	2685	3.6	0	2	30	
298	45	1.1	0	1	15	
400	2766	6.5	0	3	20	
402	2781	6.6	0	2	50	
404	2681	6.5	0	2	40	
407	55	1.2	0	1	5	
409	2137	3.4	0	2	25	
410	2135	3.4	0	2	25	
411	2100	3.4	0	2	20	
412	94	1.3	0	1	10	
416	14	0.7	0	1	15	
417	2573	4.9	0	4	50	
418	2557	4.6	0	4	55	
419	2379	4.6	0	6	25	
420	2373	3	0	6	35	
421	55	1.2	0	0	50	
422	58	1.2	0	1	20	
423	52	1.2	0	0	55	
424	2558	4.6	0	5	0	
425	2141	4.4	0	2	30	
427	1821	4.3	0	2	10	
428	1864	4.3	0	2	15	
429	2030	4.4	0	2	20	
430	1866	4.3	0	2	15	
432	52	1.2	0	1	20	
433	715	2.3	0	1	45	
434	20	0.8	0	1	20	
435	54	1.2	0	0	50	

10-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)		TIME (HR /MIN)	
201	585	1.4	0	8	0	
202	585	2.4	0	8	0	
203	10	0.6	0	1	20	
204	14	0.8	0	1	25	
208	618	3.5	0	7	10	
209	640	3.5	0	6	15	
210	627	3.5	0	6	45	
211	629	3.5	0	6	35	
212	15	0.8	0	1	10	
215	26	1	0	1	10	
216	640	3.5	0	6	10	
217	44	1.1	0	1	10	
218	585	3.4	0	9	0	
222	6	0.4	0	1	20	
227	5	0.5	0	1	5	
228	25	1	0	1	5	
229	12	0.7	0	1	10	
230	656	5.1	0	5	15	
231	15	0.9	0	1	0	
232	2	0.2	0	2	25	
233	33	1.1	0	1	10	
234	658	5.8	0	5	0	
235	658	3.7	0	4	55	
236	659	5	0	4	45	
237	661	4.9	0	4	40	
238	661	2.2	0	4	35	
239	18	0.8	0	1	0	
240	20	0.8	0	1	30	
242	45	1.1	0	1	0	
244	664	5	0	4	15	
246	654	5.1	0	4	35	
248	26	1	0	0	55	
249	36	1.1	0	1	5	
250	27	1	0	1	5	
251	30	1	0	1	0	
252	37	1.1	0	1	0	
254	672	2.3	0	3	30	
255	85	1.3	0	1	30	
256	75	1.3	0	1	20	
257	669	2.4	0	3	20	
259	26	1	0	1	15	
263	625	2.2	0	6	55	
264	7	0.5	0	1	5	
265	647	2.2	0	5	55	
266	650	2.2	0	3	5	
267	9	0.5	0	1	5	
268	26	1	0	1	30	
273	18	0.8	0	1	20	
277	23	0.9	0	0	55	
280	669	2.3	0	3	40	
281	19	0.8	0	1	5	
289	658	2.3	0	5	0	
290	86	1.3	0	1	45	
292	25	1	0	1	35	
293	643	2.3	0	2	55	
294	672	2.4	0	3	30	
297	639	2.2	0	2	55	
298	12	0.7	0	1	10	
400	671	5	0	4	0	
402	670	5.1	0	3	20	
404	641	5	0	3	5	
407	21	0.9	0	1	0	
409	516	2.1	0	2	45	
410	517	2.1	0	2	40	
411	511	2.1	0	2	30	
412	31	1	0	1	15	
416	3	0.3	0	1	25	
417	653	3.6	0	5	30	
418	649	3.5	0	5	45	
419	586	3.5	0	7	55	
420	584	1.5	0	8	10	
421	11	0.6	0	0	50	
422	14	0.7	0	1	25	
423	19	0.8	0	0	55	
424	649	3.5	0	5	45	
425	516	3.3	0	2	50	
427	448	3.3	0	2	10	
428	457	3.3	0	2	20	
429	493	3.4	0	2	30	
430	456	3.3	0	2	25	
432	17	0.8	0	1	20	
433	154	1.5	0	2	5	
434	6	0.4	0	1	30	
435	16	0.7	0	0	50	

5-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)		TIME (HR /MIN)	
201	149	0.8	0	9	15	
202	149	1.4	0	9	10	
203	1	0.2	0	1	30	
204	4	0.4	0	1	20	
208	155	2.3	0	8	30	
209	159	2.3	0	7	35	
210	157	2.4	0	8	0	
211	157	2.4	0	7	55	
212	2	0.3	0	1	20	
215	4	0.3	0	1	20	
216	159	2.4	0	7	30	
217	7	0.5	0	1	10	
218	149	2.2	0	9	15	
222	1	0.1	0	1	0	
227	0	0	0	0	0	
228	4	0.4	0	1	0	
229	6	0.5	0	1	15	
230	166	2.7	0	2	5	
231	7	0.6	0	1	0	
232	0	0	0	0	0	
233	21	0.9	0	1	0	
234	165	4.9	0	6	20	
235	167	2.7	0	6	5	
236	167	2.6	0	5	55	
237	168	2.6	0	5	50	
238	168	1.5	0	5	45	
239	4	0.3	0	1	5	
240	3	0.3	0	1	25	
242	30	1	0	0	55	
244	164	2.6	0	5	25	
246	165	2.7	0	5	40	
248	4	0.4	0	1	0	
249	6	0.4	0	1	10	
250	4	0.3	0	1	10	
251	5	0.4	0	0	55	
252	6	0.5	0	1	0	
254	166	1.5	0	4	15	
255	26	1	0	1	25	
256	24	1	0	1	10	
257	167	1.6	0	4	5	
259	9	0.6	0	1	5	
263	156	1.5	0	8	20	
264	1	0.1	0	1	0	
265	161	1.5	0	7	20	
266	167	1.5	0	3	40	
267	1	0.2	0	1	10	
268	4	0.4	0	1	30	
273	4	0.3	0	1	25	
277	6	0.5	0	0	55	
280	163	1.5	0	4	45	
281	5	0.4	0	1	10	
289	172	1.6	0	1	55	
290	25	1	0	1	40	
292	3	0.3	0	1	25	
293	168	1.5	0	3	25	
294	166	1.6	0	4	20	
297	168	1.5	0	3	20	
298	2	0.2	0	1	20	
400	169	2.6	0	4	55	
402	168	2.7	0	3	50	
404	167	2.7	0	3	35	
407	6	0.4	0	1	0	
409	138	1.5	0	2	50	
410	139	1.5	0	2	40	
411	142	1.5	0	2	25	
412	7	0.5	0	1	15	
416	0	0	0	0	0	
417	163	2.4	0	6	50	
418	162	2.4	0	7	0	
419	149	2.4	0	9	5	
420	149	0.7	0	9	25	
421	2	0.2	0	0	50	
422	1	0.2	0	1	0	
423	3	0.3	0	1	0	
424	162	2.4	0	7	5	
425	139	2.1	0	2	55	
427	120	2.1	0	2	10	
428	121	2.1	0	2	20	
429	137	2.2	0	2	20	
430	121	2.1	0	2	25	
432	2	0.3	0	1	30	
433	41	1.1	0	2	20	
434	0	0	0	0	0	
435	3	0.3	0	0	50	

2-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)		TIME (HR /MIN)	
201	45	0.4	0	6	40	
202	45	0.8	0	6	35	
203	0	0	0	0	0	
204	0	0	0	0	0	
208	52	1.4	0	5	30	
209	60	1.5	0	4	0	
210	56	1.5	0	4	40	
211	57	1.5	0	4	30	
212	0	0.1	0	1	0	
215	1	0.1	0	1	5	
216	60	1.5	0	3	55	
217	2	0.2	0	1	5	
218	45	1.2	0	6	40	
222	0	0	0	0	0	
227	0	0	0	0	0	
228	1	0.2	0	1	5	
229	3	0.3	0	1	20	
230	73	1.8	0	2	25	
231	4	0.4	0	1	5	
232	0	0	0	0	0	
233	11	0.6	0	1	10	
234	71	3.3	0	2	5	
235	77	1.9	0	1	40	
236	80	1.8	0	1	30	
237	74	1.7	0	1	25	
238	70	1.2	0	1	15	
239	2	0.2	0	1	15	
240	0	0	0	0	0	
242	20	0.9	0	1	0	
244	40	1.3	0	1	15	
246	49	1.5	0	1	25	
248	1	0.2	0	1	5	
249	1	0.2	0	1	0	
250	1	0.2	0	1	10	
251	2	0.2	0	1	0	
252	2	0.2	0	1	0	
254	6	0.4	0	4	45	
255	2	0.3	0	1	25	
256	3	0.3	0	1	15	
257	6	0.5	0	4	25	
259	2	0.2	0	1	20	
263	53	1.2	0	5	10	
264	0	0	0	0	0	
265	63	1.2	0	3	35	
266	5	0.4	0	3	50	
267	0	0	0	0	0	
268	1	0.1	0	1	25	
273	0	0.1	0	1	15	
277	1	0.1	0	1	0	
280	6	0.5	0	5	30	
281	1	0.1	0	1	5	
289	76	1.3	0	2	10	
290	2	0.2	0	1	55	
292	0	0.1	0	0	50	
293	5	0.4	0	3	25	
294	6	0.5	0	4	50	
297	5	0.4	0	3	15	
298	0	0.1	0	1	0	
400	80	1.8	0	0	40	
402	6	0.4	0	4	0	
404	5	0.4	0	3	50	
407	1	0.1	0	1	5	
409	5	0.4	0	1	20	
410	4	0.4	0	2	30	
411	4	0.4	0	1	25	
412	1	0.1	0	1	5	
416	0	0	0	0	0	
417	70	1.6	0	2	45	
418	67	1.6	0	3	5	
419	46	1.3	0	6	25	
420	45	0.4	0	6	55	
421	0	0.1	0	0	50	
422	0	0	0	0	0	
423	1	0.1	0	0	55	
424	67	1.6	0	3	10	
425	6	0.4	0	1	0	
427	3	0.3	0	1	20	
428	3	0.3	0	1	25	
429	4	0.3	0	2	15	
430	3	0.3	0	1	50	
432	0	0.1	0	1	10	
433	1	0.2	0	2	50	
434	0	0	0	0	0	
435	1	0.1	0	0	50	

0.4" Average

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)		TIME (HR /MIN)	
201	102	0.7	0	11	10	
202	102	1.2	0	11	5	
203	0	0	0	0	0	
204	0	0	0	0	0	
208	109	2	0	10	10	
209	115	2	0	8	55	
210	112	2.1	0	9	30	
211	113	2.1	0	9	20	
212	0	0	0	0	0	
215	0	0	0	0	0	
216	115	2.1	0	8	50	
217	0	0	0	0	0	
218	102	1.8	0	11	10	
222	0	0	0	0	0	
227	0	0	0	0	0	
228	0	0	0	0	0	
229	0	0.1	0	1	0	
230	121	2.3	0	7	40	
231	0	0.1	0	0	45	
232	0	0	0	0	0	
233	2	0.2	0	1	10	
234	123	4.3	0	7	25	
235	125	2.4	0	7	0	
236	125	2.3	0	6	50	
237	126	2.3	0	6	45	
238	126	1.4	0	6	35	
239	0	0	0	0	0	
240	0	0	0	0	0	
242	5	0.4	0	1	5	
244	128	2.3	0	6	15	
246	126	2.4	0	6	35	
248	0	0	0	0	0	
249	0	0	0	0	0	
250	0	0	0	0	0	
251	0	0	0	0	0	
252	0	0	0	0	0	
254	141	1.5	0	4	55	
255	0	0	0	0	0	
256	0	0	0	0	0	
257	142	1.5	0	4	45	
259	0	0	0	0	0	
263	111	1.4	0	9	50	
264	0	0	0	0	0	
265	117	1.4	0	8	35	
266	146	1.5	0	4	15	
267	0	0	0	0	0	
268	0	0	0	0	0	
273	0	0	0	0	0	
277	0	0	0	0	0	
280	137	1.5	0	5	25	
281	0	0	0	0	0	
289	122	1.4	0	7	30	
290	0	0	0	0	0	
292	0	0	0	0	0	
293	147	1.5	0	4	0	
294	141	1.5	0	5	5	
297	147	1.5	0	3	50	
298	0	0	0	0	0	
400	135	2.4	0	5	40	
402	144	2.5	0	4	30	
404	146	2.5	0	4	10	
407	0	0	0	0	0	
409	123	1.4	0	3	20	
410	123	1.4	0	3	10	
411	127	1.4	0	2	45	
412	0	0	0	0	0	
416	0	0	0	0	0	
417	120	2.1	0	7	55	
418	119	2	0	8	15	
419	102	2	0	10	55	
420	101	0.6	0	11	20	
421	0	0	0	0	0	
422	0	0	0	0	0	
423	0	0	0	0	0	
424	119	2.1	0	8	15	
425	123	2	0	3	25	
427	118	2	0	2	15	
428	117	2	0	2	30	
429	128	2.2	0	2	40	
430	117	2.1	0	2	35	
432	0	0	0	0	0	
433	41	1.1	0	2	20	
434	0	0	0	0	0	
435	0	0	0	0	0	

Second Creek SWMM Output for Future Conditions

100-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	8154	(DIRECT FLOW)	4	55
102	8149	(DIRECT FLOW)	4	55
104	8154	(DIRECT FLOW)	4	50
105	144	(DIRECT FLOW)	0	45
106	69	(DIRECT FLOW)	1	5
107	9439	(DIRECT FLOW)	2	20
108	8469	(DIRECT FLOW)	4	30
109	8531	(DIRECT FLOW)	4	25
110	8556	(DIRECT FLOW)	4	20
111	8563	(DIRECT FLOW)	4	15
114	240	(DIRECT FLOW)	0	45
115	412	(DIRECT FLOW)	0	40
116	8665	(DIRECT FLOW)	4	5
117	8681	(DIRECT FLOW)	3	55
118	8154	(DIRECT FLOW)	4	55
119	8139	(DIRECT FLOW)	5	0
121	223	(DIRECT FLOW)	0	45
122	149	(DIRECT FLOW)	0	45
125	221	(DIRECT FLOW)	1	0
126	65	(DIRECT FLOW)	0	50
127	86	(DIRECT FLOW)	0	45
128	418	(DIRECT FLOW)	0	40
130	8812	(DIRECT FLOW)	3	35
131	77	(DIRECT FLOW)	0	45
132	110	(DIRECT FLOW)	0	45
133	219	(DIRECT FLOW)	0	50
134	8850	(DIRECT FLOW)	3	25
135	8853	(DIRECT FLOW)	3	25
136	8868	(DIRECT FLOW)	3	20
137	8887	(DIRECT FLOW)	3	15
138	8913	(DIRECT FLOW)	3	10
139	201	(DIRECT FLOW)	0	45
140	113	(DIRECT FLOW)	0	45
143	407	(DIRECT FLOW)	0	40
144	8928	(DIRECT FLOW)	3	0
145	9259	(DIRECT FLOW)	2	45
146	8910	(DIRECT FLOW)	3	10
147	117	(DIRECT FLOW)	0	45
148	399	(DIRECT FLOW)	0	40
149	610	(DIRECT FLOW)	0	40
150	568	(DIRECT FLOW)	0	45
151	183	(DIRECT FLOW)	0	50
152	9332	(DIRECT FLOW)	2	35
153	255	(DIRECT FLOW)	0	50
154	9321	(DIRECT FLOW)	2	30
155	9323	(DIRECT FLOW)	2	30
156	1004	(DIRECT FLOW)	0	55
157	933	(DIRECT FLOW)	0	45
158	412	(DIRECT FLOW)	0	40
159	987	(DIRECT FLOW)	1	5
161	9353	(DIRECT FLOW)	2	25
164	89	(DIRECT FLOW)	0	50
165	8694	(DIRECT FLOW)	3	50
166	9260	(DIRECT FLOW)	2	20
167	9247	(DIRECT FLOW)	2	15
168	512	(DIRECT FLOW)	0	40
169	9312	(DIRECT FLOW)	2	5
171	8147	(DIRECT FLOW)	2	5
172	8090	(DIRECT FLOW)	2	5
173	8053	(DIRECT FLOW)	1	55
177	280	(DIRECT FLOW)	0	40
178	347	(DIRECT FLOW)	0	40
179	417	(DIRECT FLOW)	0	50
180	9285	(DIRECT FLOW)	2	40
181	295	(DIRECT FLOW)	0	40
182	7814	(DIRECT FLOW)	1	45
186	434	(DIRECT FLOW)	0	40
187	8954	(DIRECT FLOW)	3	0
188	8659	(DIRECT FLOW)	4	5
189	8863	(DIRECT FLOW)	3	30
192	427	(DIRECT FLOW)	1	5
193	9185	(DIRECT FLOW)	2	15
194	180	(DIRECT FLOW)	0	40
196	133	(DIRECT FLOW)	0	45
197	9193	(DIRECT FLOW)	2	10
198	751	(DIRECT FLOW)	0	35
501	364	(DIRECT FLOW)	0	45
502	8134	(DIRECT FLOW)	2	0
504	182	(DIRECT FLOW)	0	50
505	8742	(DIRECT FLOW)	3	45
506	8696	(DIRECT FLOW)	3	50
507	226	(DIRECT FLOW)	0	40
509	7876	(DIRECT FLOW)	1	45
510	7805	(DIRECT FLOW)	1	50
512	7860	(DIRECT FLOW)	1	40
513	8112	(DIRECT FLOW)	1	50
514	72	(DIRECT FLOW)	0	50
935	7716	(DIRECT FLOW)	1	40
937	571	(DIRECT FLOW)	1	0
942	2983	(DIRECT FLOW)	1	0

50-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	6101	(DIRECT FLOW)	5	20
102	6103	(DIRECT FLOW)	5	20
104	6099	(DIRECT FLOW)	5	20
105	113	(DIRECT FLOW)	0	45
106	50	(DIRECT FLOW)	1	5
107	7105	(DIRECT FLOW)	2	30
108	6327	(DIRECT FLOW)	5	0
109	6376	(DIRECT FLOW)	4	50
110	6392	(DIRECT FLOW)	4	45
111	6401	(DIRECT FLOW)	4	40
114	200	(DIRECT FLOW)	0	45
115	340	(DIRECT FLOW)	0	40
116	6469	(DIRECT FLOW)	4	25
117	6476	(DIRECT FLOW)	4	20
118	6101	(DIRECT FLOW)	5	20
119	6095	(DIRECT FLOW)	5	25
121	178	(DIRECT FLOW)	0	45
122	117	(DIRECT FLOW)	0	45
125	169	(DIRECT FLOW)	1	0
126	51	(DIRECT FLOW)	0	50
127	71	(DIRECT FLOW)	0	40
128	333	(DIRECT FLOW)	0	40
130	6561	(DIRECT FLOW)	3	55
131	61	(DIRECT FLOW)	0	45
132	87	(DIRECT FLOW)	0	45
133	171	(DIRECT FLOW)	0	50
134	6589	(DIRECT FLOW)	3	45
135	6590	(DIRECT FLOW)	3	45
136	6598	(DIRECT FLOW)	3	40
137	6613	(DIRECT FLOW)	3	35
138	6632	(DIRECT FLOW)	3	30
139	160	(DIRECT FLOW)	0	45
140	89	(DIRECT FLOW)	0	45
143	319	(DIRECT FLOW)	0	40
144	6629	(DIRECT FLOW)	3	20
145	6893	(DIRECT FLOW)	3	5
146	6626	(DIRECT FLOW)	3	30
147	93	(DIRECT FLOW)	0	45
148	315	(DIRECT FLOW)	0	40
149	475	(DIRECT FLOW)	0	35
150	439	(DIRECT FLOW)	0	45
151	131	(DIRECT FLOW)	0	50
152	6970	(DIRECT FLOW)	2	50
153	183	(DIRECT FLOW)	0	50
154	6955	(DIRECT FLOW)	2	50
155	6970	(DIRECT FLOW)	2	45
156	795	(DIRECT FLOW)	0	55
157	752	(DIRECT FLOW)	0	45
158	341	(DIRECT FLOW)	0	40
159	769	(DIRECT FLOW)	1	5
161	6998	(DIRECT FLOW)	2	40
164	70	(DIRECT FLOW)	0	45
165	6483	(DIRECT FLOW)	4	15
166	6965	(DIRECT FLOW)	2	30
167	6963	(DIRECT FLOW)	2	30
168	425	(DIRECT FLOW)	0	40
169	7086	(DIRECT FLOW)	2	15
171	6162	(DIRECT FLOW)	2	15
172	6117	(DIRECT FLOW)	2	15
173	6126	(DIRECT FLOW)	2	5
177	232	(DIRECT FLOW)	0	40
178	278	(DIRECT FLOW)	0	40
179	327	(DIRECT FLOW)	0	50
180	6922	(DIRECT FLOW)	2	55
181	246	(DIRECT FLOW)	0	40
182	5956	(DIRECT FLOW)	1	50
186	345	(DIRECT FLOW)	0	40
187	6657	(DIRECT FLOW)	3	20
188	6470	(DIRECT FLOW)	4	30
189	6600	(DIRECT FLOW)	3	50
192	321	(DIRECT FLOW)	1	5
193	6933	(DIRECT FLOW)	2	25
194	148	(DIRECT FLOW)	0	40
196	104	(DIRECT FLOW)	0	45
197	6926	(DIRECT FLOW)	2	20
198	636	(DIRECT FLOW)	0	35
501	297	(DIRECT FLOW)	0	45
502	6176	(DIRECT FLOW)	2	5
504	148	(DIRECT FLOW)	0	50
505	6515	(DIRECT FLOW)	4	5
506	6477	(DIRECT FLOW)	4	15
507	187	(DIRECT FLOW)	0	40
509	6002	(DIRECT FLOW)	1	50
510	5946	(DIRECT FLOW)	1	55
512	6017	(DIRECT FLOW)	1	50
513	6187	(DIRECT FLOW)	2	0
514	57	(DIRECT FLOW)	0	50
935	5924	(DIRECT FLOW)	1	50
937	421	(DIRECT FLOW)	1	5
942	2347	(DIRECT FLOW)	1	5

10-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	2956	(DIRECT FLOW)	6	20
102	2958	(DIRECT FLOW)	6	15
104	2959	(DIRECT FLOW)	6	15
105	56	(DIRECT FLOW)	0	40
106	18	(DIRECT FLOW)	0	50
107	3465	(DIRECT FLOW)	2	50
108	3080	(DIRECT FLOW)	5	50
109	3104	(DIRECT FLOW)	5	40
110	3111	(DIRECT FLOW)	5	30
111	3117	(DIRECT FLOW)	5	25
114	127	(DIRECT FLOW)	0	40
115	221	(DIRECT FLOW)	0	35
116	3155	(DIRECT FLOW)	5	10
117	3152	(DIRECT FLOW)	5	0
118	2956	(DIRECT FLOW)	6	20
119	2951	(DIRECT FLOW)	6	25
121	96	(DIRECT FLOW)	0	40
122	59	(DIRECT FLOW)	0	40
125	88	(DIRECT FLOW)	0	50
126	26	(DIRECT FLOW)	0	45
127	40	(DIRECT FLOW)	0	35
128	172	(DIRECT FLOW)	0	35
130	3194	(DIRECT FLOW)	4	35
131	31	(DIRECT FLOW)	0	40
132	45	(DIRECT FLOW)	0	40
133	88	(DIRECT FLOW)	0	45
134	3208	(DIRECT FLOW)	4	25
135	3206	(DIRECT FLOW)	4	15
136	3211	(DIRECT FLOW)	4	10
137	3219	(DIRECT FLOW)	4	5
138	3229	(DIRECT FLOW)	4	0
139	85	(DIRECT FLOW)	0	40
140	46	(DIRECT FLOW)	0	40
143	163	(DIRECT FLOW)	0	35
144	3224	(DIRECT FLOW)	3	45
145	3371	(DIRECT FLOW)	3	25
146	3226	(DIRECT FLOW)	4	0
147	50	(DIRECT FLOW)	0	40
148	166	(DIRECT FLOW)	0	35
149	242	(DIRECT FLOW)	0	35
150	215	(DIRECT FLOW)	0	40
151	39	(DIRECT FLOW)	0	45
152	3407	(DIRECT FLOW)	3	10
153	55	(DIRECT FLOW)	0	45
154	3400	(DIRECT FLOW)	3	10
155	3404	(DIRECT FLOW)	3	5
156	413	(DIRECT FLOW)	0	50
157	419	(DIRECT FLOW)	0	40
158	198	(DIRECT FLOW)	0	35
159	386	(DIRECT FLOW)	1	0
161	3413	(DIRECT FLOW)	3	0
164	35	(DIRECT FLOW)	0	40
165	3153	(DIRECT FLOW)	4	55
166	3378	(DIRECT FLOW)	2	50
167	3373	(DIRECT FLOW)	2	45
168	274	(DIRECT FLOW)	0	35
169	3414	(DIRECT FLOW)	2	25
171	3026	(DIRECT FLOW)	2	30
172	3004	(DIRECT FLOW)	2	25
173	2981	(DIRECT FLOW)	2	15
177	143	(DIRECT FLOW)	0	35
178	160	(DIRECT FLOW)	0	35
179	165	(DIRECT FLOW)	0	45
180	3381	(DIRECT FLOW)	3	20
181	159	(DIRECT FLOW)	0	35
182	2911	(DIRECT FLOW)	2	0
186	191	(DIRECT FLOW)	0	35
187	3241	(DIRECT FLOW)	3	45
188	3153	(DIRECT FLOW)	5	15
189	3212	(DIRECT FLOW)	4	25
192	143	(DIRECT FLOW)	1	0
193	3346	(DIRECT FLOW)	2	40
194	95	(DIRECT FLOW)	0	35
196	52	(DIRECT FLOW)	0	40
197	3343	(DIRECT FLOW)	2	35
198	402	(DIRECT FLOW)	0	30
501	170	(DIRECT FLOW)	0	40
502	3023	(DIRECT FLOW)	2	20
504	85	(DIRECT FLOW)	0	45
505	3168	(DIRECT FLOW)	4	45
506	3151	(DIRECT FLOW)	4	55
507	122	(DIRECT FLOW)	0	35
509	2937	(DIRECT FLOW)	2	0
510	2908	(DIRECT FLOW)	2	5
512	2884	(DIRECT FLOW)	1	55
513	2993	(DIRECT FLOW)	2	5
514	29	(DIRECT FLOW)	0	45
935	2831	(DIRECT FLOW)	1	55
937	122	(DIRECT FLOW)	1	0
942	1082	(DIRECT FLOW)	1	0

5-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	2205	(DIRECT FLOW)	6	55
102	2207	(DIRECT FLOW)	6	50
104	2208	(DIRECT FLOW)	6	45
105	40	(DIRECT FLOW)	0	40
106	10	(DIRECT FLOW)	0	50
107	2611	(DIRECT FLOW)	3	0
108	2307	(DIRECT FLOW)	6	20
109	2326	(DIRECT FLOW)	6	10
110	2334	(DIRECT FLOW)	6	5
111	2338	(DIRECT FLOW)	6	0
114	105	(DIRECT FLOW)	0	40
115	184	(DIRECT FLOW)	0	35
116	2367	(DIRECT FLOW)	5	40
117	2359	(DIRECT FLOW)	5	30
118	2205	(DIRECT FLOW)	6	55
119	2202	(DIRECT FLOW)	7	0
121	73	(DIRECT FLOW)	0	40
122	46	(DIRECT FLOW)	0	40
125	69	(DIRECT FLOW)	0	50
126	19	(DIRECT FLOW)	0	45
127	32	(DIRECT FLOW)	0	35
128	130	(DIRECT FLOW)	0	35
130	2388	(DIRECT FLOW)	5	0
131	23	(DIRECT FLOW)	0	40
132	34	(DIRECT FLOW)	0	40
133	67	(DIRECT FLOW)	0	45
134	2399	(DIRECT FLOW)	4	45
135	2397	(DIRECT FLOW)	4	40
136	2399	(DIRECT FLOW)	4	35
137	2405	(DIRECT FLOW)	4	30
138	2411	(DIRECT FLOW)	4	20
139	65	(DIRECT FLOW)	0	40
140	34	(DIRECT FLOW)	0	40
143	121	(DIRECT FLOW)	0	35
144	2409	(DIRECT FLOW)	4	10
145	2531	(DIRECT FLOW)	3	45
146	2410	(DIRECT FLOW)	4	20
147	38	(DIRECT FLOW)	0	40
148	125	(DIRECT FLOW)	0	35
149	179	(DIRECT FLOW)	0	30
150	158	(DIRECT FLOW)	0	35
151	15	(DIRECT FLOW)	0	45
152	2560	(DIRECT FLOW)	3	25
153	22	(DIRECT FLOW)	0	45
154	2557	(DIRECT FLOW)	3	25
155	2559	(DIRECT FLOW)	3	20
156	320	(DIRECT FLOW)	0	50
157	330	(DIRECT FLOW)	0	40
158	155	(DIRECT FLOW)	0	35
159	298	(DIRECT FLOW)	1	5
161	2568	(DIRECT FLOW)	3	15
164	26	(DIRECT FLOW)	0	40
165	2357	(DIRECT FLOW)	5	25
166	2547	(DIRECT FLOW)	3	5
167	2544	(DIRECT FLOW)	3	0
168	227	(DIRECT FLOW)	0	35
169	2575	(DIRECT FLOW)	2	40
171	2293	(DIRECT FLOW)	2	40
172	2278	(DIRECT FLOW)	2	35
173	2259	(DIRECT FLOW)	2	25
177	115	(DIRECT FLOW)	0	35
178	124	(DIRECT FLOW)	0	35
179	121	(DIRECT FLOW)	0	45
180	2541	(DIRECT FLOW)	3	35
181	131	(DIRECT FLOW)	0	35
182	2243	(DIRECT FLOW)	2	5
186	145	(DIRECT FLOW)	0	35
187	2423	(DIRECT FLOW)	4	5
188	2365	(DIRECT FLOW)	5	45
189	2401	(DIRECT FLOW)	4	50
192	103	(DIRECT FLOW)	1	0
193	2518	(DIRECT FLOW)	2	55
194	79	(DIRECT FLOW)	0	35
196	38	(DIRECT FLOW)	0	40
197	2521	(DIRECT FLOW)	2	50
198	338	(DIRECT FLOW)	0	30
501	136	(DIRECT FLOW)	0	40
502	2292	(DIRECT FLOW)	2	30
504	68	(DIRECT FLOW)	0	45
505	2368	(DIRECT FLOW)	5	10
506	2356	(DIRECT FLOW)	5	20
507	101	(DIRECT FLOW)	0	35
509	2260	(DIRECT FLOW)	2	5
510	2229	(DIRECT FLOW)	2	15
512	2237	(DIRECT FLOW)	2	0
513	2279	(DIRECT FLOW)	2	15
514	22	(DIRECT FLOW)	0	45
935	2199	(DIRECT FLOW)	2	0
937	80	(DIRECT FLOW)	1	5
942	865	(DIRECT FLOW)	1	5

2-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	1304	(DIRECT FLOW)	7	45
102	1305	(DIRECT FLOW)	7	45
104	1306	(DIRECT FLOW)	7	40
105	23	(DIRECT FLOW)	0	40
106	2	(DIRECT FLOW)	0	45
107	1638	(DIRECT FLOW)	3	15
108	1363	(DIRECT FLOW)	7	10
109	1375	(DIRECT FLOW)	6	55
110	1380	(DIRECT FLOW)	6	45
111	1383	(DIRECT FLOW)	6	40
114	74	(DIRECT FLOW)	0	40
115	131	(DIRECT FLOW)	0	35
116	1402	(DIRECT FLOW)	6	20
117	1411	(DIRECT FLOW)	6	10
118	1304	(DIRECT FLOW)	7	45
119	1302	(DIRECT FLOW)	7	55
121	46	(DIRECT FLOW)	0	40
122	29	(DIRECT FLOW)	0	40
125	42	(DIRECT FLOW)	0	50
126	12	(DIRECT FLOW)	0	45
127	21	(DIRECT FLOW)	0	35
128	78	(DIRECT FLOW)	0	40
130	1435	(DIRECT FLOW)	5	35
131	15	(DIRECT FLOW)	0	40
132	21	(DIRECT FLOW)	0	40
133	41	(DIRECT FLOW)	0	45
134	1445	(DIRECT FLOW)	5	25
135	1444	(DIRECT FLOW)	5	15
136	1445	(DIRECT FLOW)	5	10
137	1450	(DIRECT FLOW)	5	0
138	1456	(DIRECT FLOW)	4	50
139	41	(DIRECT FLOW)	0	40
140	21	(DIRECT FLOW)	0	40
143	74	(DIRECT FLOW)	0	35
144	1459	(DIRECT FLOW)	4	35
145	1557	(DIRECT FLOW)	4	5
146	1455	(DIRECT FLOW)	4	50
147	24	(DIRECT FLOW)	0	40
148	78	(DIRECT FLOW)	0	35
149	110	(DIRECT FLOW)	0	35
150	100	(DIRECT FLOW)	0	35
151	3	(DIRECT FLOW)	0	45
152	1587	(DIRECT FLOW)	3	45
153	4	(DIRECT FLOW)	0	45
154	1584	(DIRECT FLOW)	3	45
155	1587	(DIRECT FLOW)	3	40
156	191	(DIRECT FLOW)	0	55
157	204	(DIRECT FLOW)	0	40
158	98	(DIRECT FLOW)	0	35
159	172	(DIRECT FLOW)	1	5
161	1596	(DIRECT FLOW)	3	30
164	16	(DIRECT FLOW)	0	45
165	1413	(DIRECT FLOW)	6	0
166	1588	(DIRECT FLOW)	3	15
167	1586	(DIRECT FLOW)	3	15
168	160	(DIRECT FLOW)	0	35
169	1620	(DIRECT FLOW)	2	50
171	1474	(DIRECT FLOW)	2	50
172	1464	(DIRECT FLOW)	2	45
173	1451	(DIRECT FLOW)	2	35
177	77	(DIRECT FLOW)	0	35
178	77	(DIRECT FLOW)	0	35
179	76	(DIRECT FLOW)	0	45
180	1571	(DIRECT FLOW)	3	55
181	92	(DIRECT FLOW)	0	35
182	1466	(DIRECT FLOW)	2	5
186	89	(DIRECT FLOW)	0	35
187	1469	(DIRECT FLOW)	4	35
188	1401	(DIRECT FLOW)	6	25
189	1445	(DIRECT FLOW)	5	25
192	61	(DIRECT FLOW)	1	0
193	1574	(DIRECT FLOW)	3	5
194	56	(DIRECT FLOW)	0	35
196	23	(DIRECT FLOW)	0	40
197	1574	(DIRECT FLOW)	3	5
198	239	(DIRECT FLOW)	0	30
501	89	(DIRECT FLOW)	0	45
502	1474	(DIRECT FLOW)	2	35
504	43	(DIRECT FLOW)	0	45
505	1421	(DIRECT FLOW)	5	50
506	1412	(DIRECT FLOW)	6	0
507	72	(DIRECT FLOW)	0	35
509	1479	(DIRECT FLOW)	2	5
510	1453	(DIRECT FLOW)	2	15
512	1467	(DIRECT FLOW)	2	0
513	1476	(DIRECT FLOW)	2	20
514	13	(DIRECT FLOW)	0	45
935	1440	(DIRECT FLOW)	2	0
937	9	(DIRECT FLOW)	1	0
942	586	(DIRECT FLOW)	1	0

0.4" Average

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	310	(DIRECT FLOW)	10	10
102	311	(DIRECT FLOW)	10	5
104	311	(DIRECT FLOW)	10	0
105	9	(DIRECT FLOW)	0	35
106	0	(DIRECT FLOW)	0	0
107	430	(DIRECT FLOW)	4	5
108	334	(DIRECT FLOW)	9	10
109	342	(DIRECT FLOW)	8	40
110	343	(DIRECT FLOW)	8	30
111	345	(DIRECT FLOW)	8	15
114	31	(DIRECT FLOW)	0	35
115	60	(DIRECT FLOW)	0	30
116	360	(DIRECT FLOW)	7	35
117	370	(DIRECT FLOW)	7	10
118	310	(DIRECT FLOW)	10	10
119	310	(DIRECT FLOW)	10	20
121	19	(DIRECT FLOW)	0	35
122	12	(DIRECT FLOW)	0	35
125	14	(DIRECT FLOW)	0	50
126	5	(DIRECT FLOW)	0	40
127	9	(DIRECT FLOW)	0	35
128	31	(DIRECT FLOW)	0	30
130	395	(DIRECT FLOW)	6	10
131	6	(DIRECT FLOW)	0	35
132	8	(DIRECT FLOW)	0	35
133	15	(DIRECT FLOW)	0	40
134	397	(DIRECT FLOW)	6	0
135	400	(DIRECT FLOW)	5	50
136	404	(DIRECT FLOW)	5	35
137	404	(DIRECT FLOW)	5	30
138	405	(DIRECT FLOW)	5	25
139	16	(DIRECT FLOW)	0	35
140	8	(DIRECT FLOW)	0	35
143	31	(DIRECT FLOW)	0	30
144	407	(DIRECT FLOW)	5	10
145	416	(DIRECT FLOW)	4	55
146	405	(DIRECT FLOW)	5	25
147	10	(DIRECT FLOW)	0	35
148	33	(DIRECT FLOW)	0	30
149	44	(DIRECT FLOW)	0	30
150	39	(DIRECT FLOW)	0	35
151	0	(DIRECT FLOW)	0	0
152	421	(DIRECT FLOW)	4	35
153	0	(DIRECT FLOW)	0	0
154	422	(DIRECT FLOW)	4	30
155	423	(DIRECT FLOW)	4	25
156	67	(DIRECT FLOW)	0	55
157	85	(DIRECT FLOW)	0	35
158	41	(DIRECT FLOW)	0	30
159	57	(DIRECT FLOW)	1	10
161	426	(DIRECT FLOW)	4	15
164	6	(DIRECT FLOW)	0	35
165	372	(DIRECT FLOW)	7	0
166	428	(DIRECT FLOW)	4	5
167	428	(DIRECT FLOW)	4	0
168	73	(DIRECT FLOW)	0	30
169	441	(DIRECT FLOW)	3	35
171	406	(DIRECT FLOW)	3	30
172	406	(DIRECT FLOW)	3	25

Second Creek SWMM Output for Future Conditions

100-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	
201	8154	3.8	0	4	55
202	8145	5.3	0	4	55
203	88	1.2	0	1	10
204	54	1.1	0	1	30
208	8464	6.4	0	4	30
209	8659	6.4	0	4	5
210	8548	6.5	0	4	20
211	8553	6.5	0	4	15
212	145	1.3	0	1	10
215	351	1.6	0	0	50
216	8615	6.5	0	4	5
217	522	2.1	0	0	50
218	8151	6.1	0	4	55
222	82	1.3	0	1	5
227	66	1.3	0	0	55
228	363	2	0	0	50
229	51	1.2	0	1	20
230	8795	9.4	0	3	35
231	71	1.3	0	1	5
232	41	1.1	0	1	20
233	157	1.5	0	1	15
234	8829	9	0	3	25
235	8836	6.7	0	3	25
236	8867	8.4	0	3	20
237	8883	8.4	0	3	15
238	8910	5.5	0	3	10
239	137	1.4	0	1	5
240	310	1.8	0	1	10
242	195	1.6	0	1	0
244	8922	8.4	0	3	0
246	8834	8.5	0	3	10
248	304	1.8	0	0	50
249	499	2	0	0	50
250	264	1.7	0	0	50
251	167	1.5	0	1	0
252	216	1.6	0	1	5
254	9294	5.8	0	2	35
255	915	2.5	0	1	5
256	815	2.4	0	0	55
257	9314	6.1	0	2	30
259	308	1.8	0	0	50
263	8527	5.4	0	4	25
264	56	1.2	0	1	15
265	8669	5.6	0	3	55
266	9247	5.7	0	2	20
267	96	1.3	0	0	55
268	234	1.6	0	1	0
273	140	1.4	0	1	0
277	124	1.4	0	1	0
280	9275	5.9	0	2	40
281	139	1.4	0	0	55
289	8851	5.8	0	3	30
290	943	2.5	0	1	10
292	375	1.9	0	1	20
293	9176	5.7	0	2	15
294	9323	6.1	0	2	35
297	9172	5.7	0	2	10
298	126	1.4	0	1	10
400	9216	8.4	0	2	45
402	9340	8.6	0	2	25
404	9131	8.5	0	2	20
407	113	1.4	0	1	15
409	8077	5.5	0	2	5
410	8054	5.5	0	2	5
411	8045	5.5	0	2	0
412	282	1.7	0	1	0
416	56	1.2	0	1	5
417	8734	6.9	0	3	45
418	8689	6.4	0	3	50
419	8145	6.4	0	4	50
420	8139	4.6	0	5	0
421	115	1.3	0	1	0
422	208	1.6	0	1	10
423	162	1.5	0	0	50
424	8690	6.4	0	3	50
425	8125	6.1	0	2	10
427	7724	6.2	0	1	45
428	7777	6.2	0	1	50
429	7954	6.3	0	1	55
430	7797	6.3	0	1	50
432	194	1.6	0	0	55
433	2477	3.5	0	1	20
434	48	1.1	0	1	20
435	120	1.4	0	0	55

50-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	
201	6101	3.4	0	5	20
202	6099	4.8	0	5	20
203	64	1.1	0	1	10
204	37	1.1	0	1	30
208	6327	5.8	0	5	0
209	6470	5.9	0	4	30
210	6389	5.9	0	4	45
211	6392	5.9	0	4	40
212	114	1.3	0	1	5
215	275	1.5	0	0	50
216	6422	5.9	0	4	25
217	398	1.9	0	0	50
218	6098	5.6	0	5	20
222	63	1.2	0	1	5
227	52	1.2	0	0	55
228	281	1.8	0	0	50
229	38	1.1	0	1	20
230	6544	8.7	0	3	55
231	53	1.2	0	1	5
232	32	1.1	0	1	15
233	114	1.4	0	1	15
234	6572	8.4	0	3	50
235	6575	6.2	0	3	45
236	6596	7.8	0	3	40
237	6609	7.8	0	3	35
238	6628	4.9	0	3	30
239	104	1.3	0	1	5
240	233	1.6	0	1	5
242	144	1.5	0	1	0
244	6621	7.8	0	3	20
246	6562	7.9	0	3	30
248	234	1.6	0	0	50
249	377	1.8	0	0	50
250	203	1.6	0	0	50
251	117	1.4	0	1	0
252	148	1.5	0	1	5
254	6945	5.2	0	2	50
255	716	2.3	0	1	5
256	644	2.2	0	0	55
257	6961	5.5	0	2	45
259	244	1.7	0	0	50
263	6372	4.9	0	4	50
264	42	1.1	0	1	15
265	6463	5	0	4	20
266	6954	5.1	0	2	30
267	76	1.2	0	0	55
268	184	1.5	0	1	0
273	106	1.3	0	1	0
277	97	1.3	0	1	0
280	6914	5.3	0	2	55
281	110	1.3	0	0	55
289	6591	5.2	0	3	50
290	729	2.3	0	1	10
292	275	1.7	0	1	20
293	6928	5.2	0	2	25
294	6959	5.5	0	2	50
297	6912	5.1	0	2	20
298	94	1.3	0	1	10
400	6855	7.9	0	3	5
402	6991	8	0	2	40
404	6877	8	0	2	30
407	86	1.3	0	1	15
409	6112	4.9	0	2	15
410	6094	4.9	0	2	15
411	6100	5	0	2	10
412	222	1.6	0	1	0
416	43	1.1	0	1	5
417	6506	6.3	0	4	5
418	6470	5.9	0	4	15
419	6091	5.9	0	5	20
420	6095	4.2	0	5	25
421	87	1.3	0	1	0
422	157	1.5	0	1	10
423	130	1.4	0	0	50
424	6479	5.9	0	4	15
425	6140	5.7	0	2	20
427	5876	5.7	0	1	50
428	5925	5.8	0	1	55
429	6049	5.8	0	2	5
430	5936	5.8	0	2	0
432	153	1.5	0	0	55
433	1889	3.2	0	1	25
434	37	1.1	0	1	20
435	92	1.3	0	0	55

10-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	
201	2956	2.6	0	6	20
202	2958	3.9	0	6	15
203	30	1	0	1	5
204	15	0.8	0	1	20
208	3080	4.8	0	5	50
209	3153	4.9	0	5	15
210	3111	4.9	0	5	30
211	3111	4.9	0	5	25
212	61	1.1	0	1	5
215	141	1.3	0	0	45
216	3125	4.9	0	5	10
217	181	1.5	0	0	45
218	2956	4.6	0	6	20
222	32	1	0	1	0
227	28	1.1	0	0	50
228	132	1.5	0	0	45
229	21	0.9	0	1	15
230	3184	7.3	0	4	35
231	26	1.1	0	1	0
232	17	0.8	0	1	10
233	52	1.2	0	1	20
234	3198	7.3	0	4	25
235	3197	5.1	0	4	15
236	3211	6.7	0	4	10
237	3216	6.7	0	4	5
238	3227	3.8	0	4	0
239	48	1.1	0	1	5
240	103	1.3	0	1	5
242	61	1.2	0	0	55
244	3220	6.7	0	3	45
246	3190	6.8	0	4	0
248	112	1.4	0	0	45
249	164	1.5	0	0	50
250	95	1.3	0	0	50
251	30	1	0	1	0
252	37	1.1	0	1	0
254	3394	4	0	3	10
255	360	1.9	0	1	5
256	330	1.8	0	0	55
257	3397	4.2	0	3	5
259	128	1.4	0	0	45
263	3101	3.8	0	5	40
264	23	0.9	0	1	5
265	3143	3.8	0	5	0
266	3371	3.9	0	2	50
267	43	1.1	0	0	50
268	96	1.3	0	0	55
273	51	1.1	0	0	55
277	51	1.2	0	0	55
280	3378	4.1	0	3	20
281	60	1.2	0	0	50
289	3209	4	0	4	25
290	362	1.9	0	1	10
292	120	1.4	0	1	25
293	3343	4	0	2	40
294	3398	4.2	0	3	10
297	3335	3.9	0	2	40
298	43	1.1	0	1	10
400	3348	6.8	0	3	25
402	3409	6.8	0	3	0
404	3316	6.8	0	2	45
407	45	1.1	0	1	15
409	2996	3.8	0	2	30
410	2988	3.8	0	2	25
411	2974	3.8	0	2	20
412	116	1.4	0	1	0
416	23	0.9	0	0	55
417	3164	5.1	0	4	45
418	3146	4.9	0	4	55
419	2956	4.9	0	6	15
420	2951	3.3	0	6	25
421	39	1.1	0	0	55
422	76	1.2	0	1	5
423	76	1.2	0	0	45
424	3151	4.9	0	4	55
425	3022	4.7	0	2	30
427	2846	4.8	0	2	0
428	2899	4.8	0	2	5
429	2930	4.8	0	2	15
430	2897	4.8	0	2	10
432	82	1.3	0	0	50
433	829	2.4	0	1	20
434	20	0.8	0	1	10
435	42	1.1	0	0	50

5-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	
201	2205	2.3	0	6	55
202	2207	3.6	0	6	50
203	26	1	0	1	0
204	7	0.5	0	1	20
208	2307	4.5	0	6	20
209	2365	4.5	0	5	45
210	2334	4.6	0	6	5
211	2332	4.6	0	6	0
212	49	1.1	0	1	5
215	111	1.2	0	0	50
216	2339	4.6	0	5	40
217	130	1.4	0	0	50
218	2205	4.4	0	6	55
222	27	1	0	0	55
227	23	1	0	0	50
228	97	1.4	0	0	50
229	15	0.7	0	1	15
230	2380	6.9	0	5	0
231	21	1	0	1	0
232	12	0.7	0	1	10
233	39	1.1	0	1	20
234	2389	6.9	0	4	50
235	2388	4.7	0	4	40
236	2399	6.4	0	4	35
237	2402	6.3	0	4	30
238	2409	3.4	0	4	20
239	37	1.1	0	1	5
240	74	1.2	0	1	10
242	44	1.1	0	0	55
244	2404	6.4	0	4	10
246	2382	6.4	0	4	20
248	81	1.3	0	0	45
249	117	1.4	0	0	50
250	70	1.2	0	0	50
251	12	0.7	0	0	55
252	15	0.7	0	1	0
254	2552	3.6	0	3	25
255	279	1.7	0	1	5
256	258	1.7	0	0	55
257	2554	3.8	0	3	20
259	98	1.4	0	0	45
263	2326	3.4	0	6	10
264	16	0.7	0	1	5
265	2351	3.5	0	5	30
266	2540	3.5	0	3	5
267	36	1.1	0	0	50
268	77	1.3	0	0	55
273	40	1.1	0	0	55
277	41	1.1	0	0	55
280	2539	3.7	0	3	35
281	49	1.1	0	0	50
289	2399	3.6	0	4	50
290	277	1.7	0	1	15
292	85	1.3	0	1	25
293	2516	3.6	0	2	55
294	2553	3.8	0	3	25
297	2514	3.6	0	2	50
298	34	1.1	0	1	10
400	2514	6.4	0	3	45
402	2564	6.5	0	3	15
404	2497	6.4	0	3	0
407	36	1.1	0	1	15
409	2274	3.4	0	2	40
410	2262	3.5	0	2	35
411	2255	3.5	0	2	30
412	92	1.3	0	1	0
416	17	0.8	0	0	55
417	2364	4.8	0	5	10
418	2351	4.5	0	5	20
419	2207	4.5	0	6	45
420	2202	2.9	0	7	0
421	31	1	0	0	55
422	57	1.2	0	1	5
423	62	1.2	0	0	45
424	2355	4.6	0	5	25
425	2285	4.4	0	2	45
427	2198	4.5	0	2	5
428	2224	4.5	0	2	15
429	2229	4.5	0	2	25
430	2225	4.5	0	2	15
432	66	1.2	0	0	50
433	637	2.2	0	1	25
434	14	0.7	0	1	15
435	32	1	0	0	50

2-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	
201	1304	1.9	0	7	45
202	1305	3.2	0	7	45
203	14	0.7	0	1	0
204	1	0.2	0	1	25
208	1363	4	0	7	10
209	1401	4.1	0	6	25
210	1380	4.1	0	6	45
211	1381	4.1	0	6	40
212	34	1.1	0	1	10
215	71	1.2	0	0	50
216	1395	4.1	0	6	20
217	77	1.3	0	0	50
218	1304	3.9	0	7	45
222	16	0.8	0	0	55
227	16	0.8	0	0	50
228	57	1.2	0	0	50
229	9	0.5	0	1	20
230	1430	6.1	0	5	35
231	13	0.8	0	1	0
232	7	0.5	0	1	15
233	26	1	0	1	15
234	1439	6.4	0	5	25
235	1438	4.2	0	5	15
236	1445	5.8	0	5	10
237	1448	5.8	0	5	0
238	1455	2.9	0	4	50
239	26	0.9	0	1	0
240	43	1.1	0	1	10
242	29	1	0	0	55
244	1456	5.8	0	4	35
246	1436	5.8	0	4	50
248	48	1.1	0	0	45
249	68	1.2	0	0	50
250	41	1.1	0	0	50
251	2	0.2	0	1	0
252	2	0.2	0	1	0
254	1581	3	0	3	45
255	161	1.5	0	1	10
256	152	1.5	0	0	55
257	1583	3.2	0	3	40
259	58	1.2	0	0	50
263	1375	2.8	0	6	55
264	9	0.5	0	1	10
265	1407	2.9	0	6	10
266	1583	3	0	3	15
267	28	1	0	0	45
268	49	1.1	0	0	55
273	29	1	0	0	50
277	29	1	0	0	55
280	1569	3.1	0	3	55
281	35	1	0	0	50
289	1445	3	0	5	25
290	159	1.5	0	1	20
292	49	1.2	0	1	30
293	1572	3	0	3	5
294	1583	3.2	0	3	45
297	1568	3	0	3	5
298	24	1	0	1	5
400	1546	5.9	0	4	5
402	1593	5.9	0	3	30
404	1552	5.9	0	3	15
407	25	1	0	1	10
409	1461	2.9	0	2	50
410	1449	3	0	2	45
411	1450	3	0	2	35
412	58	1.2	0	1	5
416	10	0.6	0	0	55
417	1419	4.2	0	5	50
418	1409	4.1	0	6	0
419	1306	4.1	0	7	40
420	1302	2.3	0	7	55
421	21	0.9	0	0	55
422	34	1.1	0	1	10
423	42	1.1	0	0	45
424	1411	4.1	0	6	5
425	1469	4	0	2	55
427	1438	4.1	0	2	5
428	1450	4.1	0	2	15
429	1429	4.1	0	2	35
430	1449	4.1	0	2	20
432	44	1.1	0	0	50
433	402	1.9	0	1	25
434	8	0.5	0	1	20
435	21	0.8	0	0	45

0.4" Average

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	
201	310	1.2	0	10	10
202	311	1.8	0	10	5
203	4	0.4	0	1	5
204	0	0	0	0	0
208	334	3.1	0	9	10
209	359	3.2	0	7	45
210	343	3.2	0	8	30
211	345	3.2	0	8	15
212	16	0.8	0	1	0
215	29	1	0	0	45
216	359	3.2	0	7	35
217	29	1	0	0	45
218	310	3	0	10	10
222	5	0.4	0	1	0
227	6	0.5	0	0	50
228	22	1	0	0	45
229	3	0.3	0	1	25
230	395	4	0	6	10
231	4	0.4	0	1	0
232	2	0.3	0	1	20
233	8	0.6	0	1	15
234	397	5.5	0	6	0
235	399	3.4	0	5	50
236	404	4	0	5	35
237	404	3.9	0	5	30
238	405	1.9	0	5	25
239	9	0.5	0	1	0
240	17	0.8	0	1	5
242	10	0.6	0	0	50
244	407	4	0	5	10
246	404	4.1	0	5	25
248	21	0.9	0	0	40
249	28	1	0	0	45
250	18	0.8	0	0	45
251	0	0	0	0	0
252	0	0	0	0	0
254	422	2	0	4	30
255	54	1.2	0	1	15
256	53	1.2	0	0	55
257	423	2.1	0	4	25
259	24	1	0	0	45
263	342	1.8	0	8	40
264	3	0.3	0	1	20
265	370	1.9	0	7	10
266	428	2	0	4	5
267	10	0.6	0	0	45
268	22	0.9	0	0	50
273	9	0.5	0	0	50
277	11	0.6	0	0	50
280	417	2	0	4	45
281	14	0.7	0	0	50
289	397	2	0	6	0
290	52	1.2	0	1	30
292	20	0.9	0	1	20
293	428	2	0	3	55
294	421	2.1	0	4	35
297	429	2	0	3	50
298	8	0.5	0	1	10
400	415	4	0	4	55
402	426	4.2	0	4	15
404	427	4.2	0	4	5
407	8	0.5	0	1	15
409	405	1.9	0	3	30
410	406	2	0	3	25
411	413	2	0	3	15
412	25	0.9	0	0	55
416	3	0.3	0	1	0
417	383	3.2	0	6	35
418	373	3.2	0	6	55
419	311	3.1	0	10	0
420	310	1.1	0	10	20
421	7	0.5	0	0	55
422	12	0.7	0	1	10
423	19	0.8	0	0	40
424	372	3.2	0	7	0
425	402	3.2	0	3	40
427	454	3.3	0	2	30
428	442	3.3	0	2	45
429	413	3.3	0	3	10
430	438	3.3	0	2	50
432	20	0.9	0	0	45
433	105	1.4	0	1	50
434	3	0.3	0	1	25
435	7	0.5	0	0	45

Second Creek SWMM Output for Master Plan Conditions

100-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR	/MIN)
101	3026	(DIRECT FLOW)		7	0
102	3027	(DIRECT FLOW)		7	0
104	3028	(DIRECT FLOW)		6	55
105	144	(DIRECT FLOW)		0	45
106	69	(DIRECT FLOW)		1	5
107	5033	(DIRECT FLOW)		2	20
108	3087	(DIRECT FLOW)		6	30
109	3097	(DIRECT FLOW)		6	20
110	3102	(DIRECT FLOW)		6	15
111	3104	(DIRECT FLOW)		6	10
114	240	(DIRECT FLOW)		0	45
115	412	(DIRECT FLOW)		0	40
116	3117	(DIRECT FLOW)		5	55
117	3088	(DIRECT FLOW)		5	50
118	3026	(DIRECT FLOW)		7	0
119	3024	(DIRECT FLOW)		7	5
121	223	(DIRECT FLOW)		0	45
122	149	(DIRECT FLOW)		0	45
125	221	(DIRECT FLOW)		1	0
126	65	(DIRECT FLOW)		0	50
127	86	(DIRECT FLOW)		0	45
128	418	(DIRECT FLOW)		0	40
130	4083	(DIRECT FLOW)		4	25
131	77	(DIRECT FLOW)		0	45
132	110	(DIRECT FLOW)		0	45
133	219	(DIRECT FLOW)		0	50
134	4107	(DIRECT FLOW)		4	10
135	4107	(DIRECT FLOW)		4	5
136	4280	(DIRECT FLOW)		3	45
137	4294	(DIRECT FLOW)		3	40
138	4314	(DIRECT FLOW)		3	35
139	201	(DIRECT FLOW)		0	45
140	113	(DIRECT FLOW)		0	45
143	407	(DIRECT FLOW)		0	40
144	4348	(DIRECT FLOW)		3	20
145	4719	(DIRECT FLOW)		3	0
146	4310	(DIRECT FLOW)		3	30
147	117	(DIRECT FLOW)		0	45
148	399	(DIRECT FLOW)		0	40
149	610	(DIRECT FLOW)		0	40
150	568	(DIRECT FLOW)		0	45
151	183	(DIRECT FLOW)		0	50
152	4842	(DIRECT FLOW)		2	40
153	255	(DIRECT FLOW)		0	50
154	4846	(DIRECT FLOW)		2	40
155	4849	(DIRECT FLOW)		2	35
156	1004	(DIRECT FLOW)		0	55
157	933	(DIRECT FLOW)		0	45
158	412	(DIRECT FLOW)		0	40
159	987	(DIRECT FLOW)		1	5
161	4888	(DIRECT FLOW)		2	30
164	89	(DIRECT FLOW)		0	50
165	3078	(DIRECT FLOW)		5	45
166	5156	(DIRECT FLOW)		2	5
167	5136	(DIRECT FLOW)		2	0
168	512	(DIRECT FLOW)		0	40
169	5131	(DIRECT FLOW)		1	45
171	3602	(DIRECT FLOW)		1	40
172	3468	(DIRECT FLOW)		1	40
173	3286	(DIRECT FLOW)		1	35
177	280	(DIRECT FLOW)		0	40
178	347	(DIRECT FLOW)		0	40
179	417	(DIRECT FLOW)		0	50
180	4779	(DIRECT FLOW)		2	50
181	295	(DIRECT FLOW)		0	40
182	2592	(DIRECT FLOW)		1	25
186	434	(DIRECT FLOW)		0	40
187	4369	(DIRECT FLOW)		3	20
188	3115	(DIRECT FLOW)		6	0
189	4117	(DIRECT FLOW)		4	15
192	427	(DIRECT FLOW)		1	5
193	5039	(DIRECT FLOW)		1	55
194	180	(DIRECT FLOW)		0	40
196	133	(DIRECT FLOW)		0	45
197	5023	(DIRECT FLOW)		1	55
198	751	(DIRECT FLOW)		0	35
501	364	(DIRECT FLOW)		0	45
502	3481	(DIRECT FLOW)		1	30
504	182	(DIRECT FLOW)		0	50
505	3074	(DIRECT FLOW)		5	35
506	3075	(DIRECT FLOW)		5	40
507	226	(DIRECT FLOW)		0	40
509	2714	(DIRECT FLOW)		1	25
510	2690	(DIRECT FLOW)		1	30
512	2554	(DIRECT FLOW)		1	20
513	3186	(DIRECT FLOW)		1	30
514	72	(DIRECT FLOW)		0	50
935	2311	(DIRECT FLOW)		1	20
937	567	(DIRECT FLOW)		1	0
942	1739	(DIRECT FLOW)		1	30

50-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR	/MIN)
101	2302	(DIRECT FLOW)		7	35
102	2303	(DIRECT FLOW)		7	30
104	2304	(DIRECT FLOW)		7	30
105	113	(DIRECT FLOW)		0	45
106	50	(DIRECT FLOW)		1	5
107	3633	(DIRECT FLOW)		2	35
108	2368	(DIRECT FLOW)		7	0
109	2379	(DIRECT FLOW)		6	50
110	2384	(DIRECT FLOW)		6	40
111	2386	(DIRECT FLOW)		6	35
114	200	(DIRECT FLOW)		0	45
115	340	(DIRECT FLOW)		0	40
116	2403	(DIRECT FLOW)		6	20
117	2401	(DIRECT FLOW)		6	10
118	2302	(DIRECT FLOW)		7	35
119	2300	(DIRECT FLOW)		7	40
121	178	(DIRECT FLOW)		0	45
122	117	(DIRECT FLOW)		0	45
125	169	(DIRECT FLOW)		1	0
126	51	(DIRECT FLOW)		0	50
127	71	(DIRECT FLOW)		0	40
128	333	(DIRECT FLOW)		0	40
130	2892	(DIRECT FLOW)		4	55
131	61	(DIRECT FLOW)		0	45
132	87	(DIRECT FLOW)		0	45
133	171	(DIRECT FLOW)		0	50
134	2914	(DIRECT FLOW)		4	40
135	2913	(DIRECT FLOW)		4	35
136	3049	(DIRECT FLOW)		4	10
137	3059	(DIRECT FLOW)		4	5
138	3074	(DIRECT FLOW)		3	55
139	160	(DIRECT FLOW)		0	45
140	89	(DIRECT FLOW)		0	45
143	319	(DIRECT FLOW)		0	40
144	3085	(DIRECT FLOW)		3	40
145	3380	(DIRECT FLOW)		3	20
146	3073	(DIRECT FLOW)		3	55
147	93	(DIRECT FLOW)		0	45
148	315	(DIRECT FLOW)		0	40
149	475	(DIRECT FLOW)		0	35
150	439	(DIRECT FLOW)		0	45
151	131	(DIRECT FLOW)		0	50
152	3479	(DIRECT FLOW)		3	0
153	183	(DIRECT FLOW)		0	50
154	3467	(DIRECT FLOW)		3	0
155	3477	(DIRECT FLOW)		2	55
156	795	(DIRECT FLOW)		0	55
157	752	(DIRECT FLOW)		0	45
158	341	(DIRECT FLOW)		0	40
159	769	(DIRECT FLOW)		1	5
161	3508	(DIRECT FLOW)		2	45
164	70	(DIRECT FLOW)		0	45
165	2398	(DIRECT FLOW)		6	5
166	3746	(DIRECT FLOW)		2	15
167	3731	(DIRECT FLOW)		2	15
168	425	(DIRECT FLOW)		0	40
169	3731	(DIRECT FLOW)		1	55
171	2589	(DIRECT FLOW)		1	50
172	2506	(DIRECT FLOW)		1	50
173	2386	(DIRECT FLOW)		1	40
177	232	(DIRECT FLOW)		0	40
178	278	(DIRECT FLOW)		0	40
179	327	(DIRECT FLOW)		0	50
180	3423	(DIRECT FLOW)		3	10
181	246	(DIRECT FLOW)		0	40
182	1906	(DIRECT FLOW)		1	30
186	345	(DIRECT FLOW)		0	40
187	3107	(DIRECT FLOW)		3	40
188	2402	(DIRECT FLOW)		6	20
189	2918	(DIRECT FLOW)		4	40
192	321	(DIRECT FLOW)		1	5
193	3653	(DIRECT FLOW)		2	10
194	148	(DIRECT FLOW)		0	40
196	104	(DIRECT FLOW)		0	45
197	3652	(DIRECT FLOW)		2	5
198	636	(DIRECT FLOW)		0	35
501	297	(DIRECT FLOW)		0	45
502	2508	(DIRECT FLOW)		1	40
504	148	(DIRECT FLOW)		0	50
505	2398	(DIRECT FLOW)		5	55
506	2395	(DIRECT FLOW)		6	5
507	187	(DIRECT FLOW)		0	40
509	1988	(DIRECT FLOW)		1	30
510	1969	(DIRECT FLOW)		1	35
512	1845	(DIRECT FLOW)		1	25
513	2330	(DIRECT FLOW)		1	35
514	57	(DIRECT FLOW)		0	50
935	1684	(DIRECT FLOW)		1	25
937	421	(DIRECT FLOW)		1	5
942	1287	(DIRECT FLOW)		1	40

10-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR	/MIN)
101	691	(DIRECT FLOW)		5	0
102	689	(DIRECT FLOW)		4	55
104	686	(DIRECT FLOW)		4	50
105	56	(DIRECT FLOW)		0	40
106	18	(DIRECT FLOW)		0	50
107	1366	(DIRECT FLOW)		3	20
108	703	(DIRECT FLOW)		4	0
109	704	(DIRECT FLOW)		3	40
110	703	(DIRECT FLOW)		3	30
111	704	(DIRECT FLOW)		3	25
114	127	(DIRECT FLOW)		0	40
115	221	(DIRECT FLOW)		0	35
116	699	(DIRECT FLOW)		3	5
117	645	(DIRECT FLOW)		3	5
118	691	(DIRECT FLOW)		5	0
119	691	(DIRECT FLOW)		5	5
121	96	(DIRECT FLOW)		0	40
122	59	(DIRECT FLOW)		0	40
125	88	(DIRECT FLOW)		0	50
126	26	(DIRECT FLOW)		0	45
127	40	(DIRECT FLOW)		0	35
128	172	(DIRECT FLOW)		0	35
130	635	(DIRECT FLOW)		8	35
131	31	(DIRECT FLOW)		0	40
132	45	(DIRECT FLOW)		0	40
133	88	(DIRECT FLOW)		0	45
134	636	(DIRECT FLOW)		8	20
135	635	(DIRECT FLOW)		8	10
136	1128	(DIRECT FLOW)		5	35
137	1133	(DIRECT FLOW)		5	30
138	1139	(DIRECT FLOW)		5	20
139	85	(DIRECT FLOW)		0	40
140	46	(DIRECT FLOW)		0	40
143	163	(DIRECT FLOW)		0	35
144	1134	(DIRECT FLOW)		4	55
145	1252	(DIRECT FLOW)		4	20
146	1136	(DIRECT FLOW)		5	15
147	50	(DIRECT FLOW)		0	40
148	166	(DIRECT FLOW)		0	35
149	242	(DIRECT FLOW)		0	35
150	215	(DIRECT FLOW)		0	40
151	39	(DIRECT FLOW)		0	45
152	1293	(DIRECT FLOW)		3	55
153	55	(DIRECT FLOW)		0	45
154	1289	(DIRECT FLOW)		3	55
155	1292	(DIRECT FLOW)		3	45
156	413	(DIRECT FLOW)		0	50
157	419	(DIRECT FLOW)		0	40
158	198	(DIRECT FLOW)		0	35
159	386	(DIRECT FLOW)		1	0
161	1301	(DIRECT FLOW)		3	40
164	35	(DIRECT FLOW)		0	40
165	635	(DIRECT FLOW)		9	15
166	1615	(DIRECT FLOW)		2	35
167	1608	(DIRECT FLOW)		2	30
168	274	(DIRECT FLOW)		0	35
169	1589	(DIRECT FLOW)		2	10
171	1106	(DIRECT FLOW)		2	0
172	1062	(DIRECT FLOW)		2	0
173	969	(DIRECT FLOW)		1	55
177	143	(DIRECT FLOW)		0	35
178	160	(DIRECT FLOW)		0	35
179	165	(DIRECT FLOW)		0	45
180	1274	(DIRECT FLOW)		4	5
181	159	(DIRECT FLOW)		0	35
182	752	(DIRECT FLOW)		1	30
186	191	(DIRECT FLOW)		0	35
187	1147	(DIRECT FLOW)		4	55
188	700	(DIRECT FLOW)		3	10
189	635	(DIRECT FLOW)		8	20
192	143	(DIRECT FLOW)		1	0
193	1563	(DIRECT FLOW)		2	25
194	95	(DIRECT FLOW)		0	35
196	52	(DIRECT FLOW)		0	40
197	1561	(DIRECT FLOW)		2	20
198	402	(DIRECT FLOW)		0	30
501	170	(DIRECT FLOW)		0	40
502	1040	(DIRECT FLOW)		1	55
504	85	(DIRECT FLOW)		0	45
505	635	(DIRECT FLOW)		9	0
506	635	(DIRECT FLOW)		9	15
507	122	(DIRECT FLOW)		0	35
509	799	(DIRECT FLOW)		1	30
510	782	(DIRECT FLOW)		1	40
512	700	(DIRECT FLOW)		1	25
513	934	(DIRECT FLOW)		1	40
514	29	(DIRECT FLOW)		0	45
935	619	(DIRECT FLOW)		1	25
937	148	(DIRECT FLOW)		1	0
942	542	(DIRECT FLOW)		1	50

5-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR	/MIN)
101	590	(DIRECT FLOW)		5	55
102	588	(DIRECT FLOW)		5	55
104	585	(DIRECT FLOW)		5	50
105	40	(DIRECT FLOW)		0	40
106	10	(DIRECT FLOW)		0	50
107	788	(DIRECT FLOW)		3	55
108	594	(DIRECT FLOW)		5	0
109	596	(DIRECT FLOW)		4	40
110	595	(DIRECT FLOW)		4	30
111	596	(DIRECT FLOW)		4	25
114	105	(DIRECT FLOW)		0	40
115	184	(DIRECT FLOW)		0	35
116	594	(DIRECT FLOW)		3	50
117	558	(DIRECT FLOW)		3	30
118	590	(DIRECT FLOW)		5	55
119	590	(DIRECT FLOW)		6	0
121	73	(DIRECT FLOW)		0	40
122	46	(DIRECT FLOW)		0	40
125	69	(DIRECT FLOW)		0	50
126	19	(DIRECT FLOW)		0	45
127	32	(DIRECT FLOW)		0	35
128	130	(DIRECT FLOW)		0	35
130	537	(DIRECT FLOW)		2	30
131	23	(DIRECT FLOW)		0	40
132	34	(DIRECT FLOW)		0	40
133	67	(DIRECT FLOW)		0	45
134	524	(DIRECT FLOW)		7	20
135	523	(DIRECT FLOW)		7	15
136	705	(DIRECT FLOW)		6	15
137	709	(DIRECT FLOW)		6	5
138	714	(DIRECT FLOW)		5	55
139	65	(DIRECT FLOW)		0	40
140	34	(DIRECT FLOW)		0	40
143	121	(DIRECT FLOW)		0	35
144	693	(DIRECT FLOW)		5	35
145	727	(DIRECT FLOW)		5	10
146	712	(DIRECT FLOW)		5	55
147	38	(DIRECT FLOW)		0	40
148	125	(DIRECT FLOW)		0	35
149	179	(DIRECT FLOW)		0	30
150	158	(DIRECT FLOW)		0	35
151	15	(DIRECT FLOW)		0	45
152	744	(DIRECT FLOW)		4	35
153	22	(DIRECT FLOW)		0	45
154	741	(DIRECT FLOW)		4	35
155	741	(DIRECT FLOW)		4	25
156	320	(DIRECT FLOW)		0	50
157	330	(DIRECT FLOW)		0	40
158	155	(DIRECT FLOW)		0	35
159	298	(DIRECT FLOW)		1	5
161	744	(DIRECT FLOW)		4	20
164	26	(DIRECT FLOW)		0	40
165	549	(DIRECT FLOW)		3	25
166	1052	(DIRECT FLOW)		2	45
167	1046	(DIRECT FLOW)		2	40
168	227	(DIRECT FLOW)		0	35
169	1026	(DIRECT FLOW)		2	15
171	724	(DIRECT FLOW)		2	0
172	688	(DIRECT FLOW)		2	0
173	615	(DIRECT FLOW)		1	55
177	115	(DIRECT FLOW)		0	35
178	124	(DIRECT FLOW)		0	35
179	121	(DIRECT FLOW)		0	45
180	736	(DIRECT FLOW)		4	50
181	131	(DIRECT FLOW)		0	35
182	471	(DIRECT FLOW)		1	35
186	145	(DIRECT FLOW)		0	35
187	797	(DIRECT FLOW)		5	35
188	594	(DIRECT FLOW)		4	0
189	524	(DIRECT FLOW)		7	25
192	103	(DIRECT FLOW)		1	0
193	1010	(DIRECT FLOW)		2	30
194	79	(DIRECT FLOW)		0	35
196	38	(DIRECT FLOW)		0	40
197	1008	(DIRECT FLOW)		2	25
198	338	(DIRECT FLOW)		0	30
501	136	(DIRECT FLOW)		0	40
502	671	(DIRECT FLOW)		1	50
504	68	(DIRECT FLOW)		0	45
505	540	(DIRECT FLOW)		3	15
506	545	(DIRECT FLOW)		3	25
507	101	(DIRECT FLOW)		0	35
509	501	(DIRECT FLOW)		1	30
510	492	(DIRECT FLOW)		1	45
512	432	(DIRECT FLOW)		1	20
513	588	(DIRECT FLOW)		1	45
514	22	(DIRECT FLOW)		0	45
935	372	(DIRECT FLOW)		1	25
937	80	(DIRECT FLOW)		1	5
942	366	(DIRECT FLOW)		1	55

2-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR	/MIN)
101	380	(DIRECT FLOW)		6	45
102	380	(DIRECT FLOW)		6	40
104	380	(DIRECT FLOW)		6	35
105	23	(DIRECT FLOW)		0	40
106	2	(DIRECT FLOW)		0	45
107	241	(DIRECT FLOW)		1	20
108	392	(DIRECT FLOW)		5	45
109	394	(DIRECT FLOW)		5	20
110	393	(DIRECT FLOW)		5	10
111	393	(DIRECT FLOW)		5	0
114	74	(DIRECT FLOW)		0	40
115	131	(DIRECT FLOW)		0	35
116	392	(DIRECT FLOW)		4	25
117	371	(DIRECT FLOW)		4	10
118	380	(DIRECT FLOW)		6	45
119	380	(DIRECT FLOW)		6	55
121	46	(DIRECT FLOW)		0	40
122	29	(DIRECT FLOW)		0	40
125	42	(DIRECT FLOW)		0	50
126	12	(DIRECT FLOW)		0	45
127	21	(DIRECT FLOW)		0	35
128	78	(DIRECT FLOW)		0	40
130	362	(DIRECT FLOW)		2	45
131	15	(DIRECT FLOW)		0	40
132	21	(DIRECT FLOW)		0	40
133	41	(DIRECT FLOW)		0	45
134	345	(DIRECT FLOW)		2	30
135	331	(DIRECT FLOW)		3	30
136	336	(DIRECT FLOW)		1	30
137	330	(DIRECT FLOW)		1	25
138	324	(DIRECT FLOW)		3	5
139	41	(DIRECT FLOW)		0	40
140	21	(DIRECT FLOW)		0	40
143	74	(DIRECT FLOW)		0	35
144	255	(DIRECT FLOW)		3	0
145	259	(DIRECT FLOW)		2	35
146	321	(DIRECT FLOW)		3	5
147	24	(DIRECT FLOW)		0	40
148	78	(DIRECT FLOW)		0	35
149	110	(DIRECT FLOW)		0	35
150	100	(DIRECT FLOW)		0	35
151	3	(DIRECT FLOW)		0	45
152	245	(DIRECT FLOW)		2	5
153	4	(DIRECT FLOW)		0	45
154	236	(DIRECT FLOW)		2	5
155	234	(DIRECT FLOW)		1	55
156	191	(DIRECT FLOW)		0	55
157	204	(DIRECT FLOW)		0	40
158	98	(DIRECT FLOW)		0	35
159	172	(DIRECT FLOW)		1	5
161	236	(DIRECT FLOW)		1	35
164	16	(DIRECT FLOW)		0	45
165	365	(DIRECT FLOW)		4	0
166	479	(DIRECT FLOW)		2	35
167	473	(DIRECT FLOW)		2	35
168	160	(DIRECT FLOW)		0	35
169	434	(DIRECT FLOW)		1	40
171	408	(DIRECT FLOW)		1	25
172	375	(DIRECT FLOW)		1	20
173	303	(DIRECT FLOW)		1	0
177	77	(DIRECT FLOW)		0	35
178	77	(DIRECT FLOW)		0	35
179	76	(DIRECT FLOW)		0	45
180	237	(DIRECT FLOW)		2	25
181	92	(DIRECT FLOW)		0	35
182	171	(DIRECT FLOW)		0	35
186	89	(DIRECT FLOW)		0	35
187	278	(DIRECT FLOW)		3	0
188	392	(DIRECT FLOW)		4	30
189	345	(DIRECT FLOW)		2	35
192	61	(DIRECT FLOW)		1	0
193	431	(DIRECT FLOW)		2	35
194	56	(DIRECT FLOW)		0	35
196	23	(DIRECT FLOW)		0	40
197	429	(DIRECT FLOW)		2	30
198	239	(DIRECT FLOW)		0	30
501	89	(DIRECT FLOW)		0	45
502	384	(DIRECT FLOW)		1	5
504	43	(DIRECT FLOW)		0	45
505	363	(DIRECT FLOW)		3	30
506	363	(DIRECT FLOW)		3	55
507	72	(DIRECT FLOW)		0	35
509	203	(DIRECT FLOW)		0	40
510	190	(DIRECT FLOW)		1	45
512	132	(DIRECT FLOW)		1	40
513	259	(DIRECT FLOW)		0	50
514	13	(DIRECT FLOW)		0	45
935	102	(DIRECT FLOW)		1	40
937	6	(DIRECT FLOW)		1	15
942	144	(DIRECT FLOW)		2	35

0.4" Average

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR	/MIN)
101	103	(DIRECT FLOW)		9	10
102	103	(DIRECT FLOW)		9	5
104	103	(DIRECT FLOW)		8	55
105	9	(DIRECT FLOW)		0	35
106	0	(DIRECT FLOW)		0	0
107	118	(DIRECT FLOW)		2	0
108	104	(DIRECT FLOW)		8	15
109	104	(DIRECT FLOW)		7	55
110	104	(DIRECT FLOW)		7	35
111	104	(DIRECT FLOW)		7	30
114	31	(DIRECT FLOW)		0	35
115	60	(DIRECT FLOW)		0	30
116	107	(DIRECT FLOW)		0	30
117	105	(DIRECT FLOW)		12	0
118	103	(DIRECT FLOW)		9	10
119	103	(DIRECT FLOW)		9	20
121	19	(DIRECT FLOW)		0	35
122	12	(DIRECT FLOW)		0	35
125	14	(DIRECT FLOW)		0	50
126	5	(DIRECT FLOW)		0	40
127	9	(DIRECT FLOW)		0	35
128	31	(DIRECT FLOW)		0	30
130	116	(DIRECT FLOW)		2	20
131	6	(DIRECT FLOW)		0	35
132	8	(DIRECT FLOW)		0	35
133	15	(DIRECT FLOW)		0	40
134	117	(DIRECT FLOW)		2	5
135	115	(DIRECT FLOW)		1	50
136	108	(DIRECT FLOW)		1	40
137	109	(DIRECT FLOW)		1	30
138	108	(DIRECT FLOW)		4	20
139	16	(DIRECT FLOW)		0	35
140	8	(DIRECT FLOW)		0	35
143	31	(DIRECT FLOW)		0	30
144	107	(DIRECT FLOW)		4	0
145	111	(DIRECT FLOW)		3	25
146	108	(DIRECT FLOW)		4	15
147	10	(DIRECT FLOW)		0	35
148	33	(DIRECT FLOW)		0	30
149	44	(DIRECT FLOW)		0	30
150	39	(DIRECT FLOW)		0	35
151	0	(DIRECT FLOW)		0	0
152	113	(DIRECT FLOW)		2	50
153	0	(DIRECT FLOW)		0	0
154	114	(DIRECT FLOW)		2	45
155	114	(DIRECT FLOW)

Second Creek SWMM Output for Master Plan Conditions

100-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	
201	3026	2.6	0	7	0
202	3027	4	0	7	0
203	88	1.2	0	1	10
204	54	1.1	0	1	30
208	3087	4.8	0	6	30
209	3115	4.8	0	6	0
210	3102	4.9	0	6	15
211	3097	4.9	0	6	10
212	145	1.3	0	1	10
215	351	1.6	0	0	50
216	3080	4.9	0	6	0
217	522	2.1	0	0	50
218	3026	4.7	0	7	0
222	52	1.3	0	1	5
227	66	1.3	0	0	55
228	363	2	0	0	50
229	51	1.2	0	1	20
230	4068	7.8	0	4	25
231	71	1.3	0	1	5
232	41	1.1	0	1	20
233	157	1.5	0	1	15
234	4093	7.6	0	4	10
235	4094	5.4	0	4	5
236	4278	7.1	0	3	45
237	4291	7.1	0	3	40
238	4311	4.2	0	3	35
239	137	1.4	0	1	5
240	310	1.8	0	1	10
242	195	1.6	0	1	0
244	4341	7.2	0	3	20
246	4254	7.2	0	3	35
248	304	1.8	0	0	50
249	499	2	0	0	50
250	264	1.7	0	0	50
251	167	1.5	0	1	0
252	216	1.6	0	1	5
254	4829	4.5	0	2	40
255	915	2.5	0	1	5
256	815	2.4	0	0	55
257	4841	4.8	0	2	35
259	308	1.8	0	0	50
263	3097	3.8	0	6	20
264	56	1.2	0	1	15
265	3076	3.8	0	5	50
266	5133	4.6	0	2	5
267	96	1.3	0	0	55
268	234	1.6	0	1	0
273	140	1.4	0	1	0
277	124	1.4	0	1	0
280	4772	4.6	0	2	50
281	139	1.4	0	0	55
289	4105	4.4	0	4	15
290	943	2.5	0	1	10
292	375	1.9	0	1	20
293	5015	4.6	0	1	55
294	4834	4.8	0	2	40
297	4986	4.6	0	1	55
298	126	1.4	0	1	10
330	3076	0.1	194.5	5	25
336	4117	0.1	257.3	4	0
366	4854	0.1	236.5	2	20
400	4687	7.2	0	3	0
402	4878	7.4	0	2	30
404	4981	7.4	0	2	0
407	113	1.4	0	1	15
409	3462	4	0	1	40
410	3432	4	0	1	40
411	3286	4	0	1	35
412	282	1.7	0	1	0
416	56	1.2	0	1	5
417	3067	5.1	0	5	35
418	3068	4.8	0	5	40
419	3027	4.9	0	6	55
420	3024	3.3	0	7	5
421	115	1.3	0	1	0
422	208	1.6	0	1	10
423	162	1.5	0	0	50
424	3074	4.9	0	5	45
425	3590	4.9	0	1	40
427	2438	4.6	0	1	25
428	2649	4.7	0	1	30
429	3095	4.9	0	1	35
430	2677	4.7	0	1	30
432	194	1.6	0	0	55
433	1482	2.9	0	1	50
434	48	1.1	0	1	20
435	120	1.4	0	0	55

50-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	
201	2302	2.3	0	7	35
202	2303	3.7	0	7	30
203	64	1.1	0	1	10
204	37	1.1	0	1	30
208	2368	4.5	0	7	0
209	2402	4.6	0	6	20
210	2384	4.6	0	6	40
211	2383	4.6	0	6	35
212	114	1.3	0	1	5
215	275	1.5	0	0	50
216	2389	4.6	0	6	20
217	398	1.9	0	0	50
218	2302	4.4	0	7	35
222	63	1.2	0	1	5
227	52	1.2	0	0	55
228	281	1.8	0	0	50
229	38	1.1	0	1	20
230	2878	7.2	0	4	55
231	53	1.2	0	1	5
232	32	1.1	0	1	15
233	114	1.4	0	1	15
234	2901	7.2	0	4	40
235	2901	5	0	4	35
236	3048	6.7	0	4	10
237	3055	6.6	0	4	5
238	3071	3.7	0	3	55
239	104	1.3	0	1	5
240	233	1.6	0	1	5
242	144	1.5	0	1	0
244	3079	6.7	0	3	40
246	3023	6.7	0	3	55
248	234	1.6	0	0	50
249	377	1.8	0	0	50
250	203	1.6	0	0	50
251	117	1.4	0	1	0
252	148	1.5	0	1	5
254	3459	4	0	3	0
255	716	2.3	0	1	5
256	644	2.2	0	0	55
257	3469	4.3	0	2	55
259	244	1.7	0	0	50
263	2379	3.4	0	6	50
264	42	1.1	0	1	15
265	2394	3.5	0	6	10
266	3731	4.1	0	2	15
267	76	1.2	0	0	55
268	184	1.5	0	1	0
273	106	1.3	0	1	0
277	97	1.3	0	1	0
280	3417	4.1	0	3	10
281	110	1.3	0	0	55
289	2910	3.9	0	4	40
290	729	2.3	0	1	10
292	275	1.7	0	1	20
293	3643	4.1	0	2	10
294	3468	4.2	0	3	0
297	3630	4.1	0	2	5
298	94	1.3	0	1	10
330	2402	0.1	105.1	5	45
336	2918	0.1	233.4	4	30
366	3504	0.1	214.4	2	35
400	3350	6.8	0	3	20
402	3501	6.9	0	2	45
404	3621	6.9	0	2	15
407	86	1.3	0	1	15
409	2504	3.6	0	1	50
410	2470	3.6	0	1	50
411	2378	3.5	0	1	45
412	222	1.6	0	1	0
416	43	1.1	0	1	5
417	2391	4.8	0	5	55
418	2390	4.5	0	6	5
419	2303	4.6	0	7	30
420	2300	3	0	7	40
421	87	1.3	0	1	0
422	157	1.5	0	1	10
423	130	1.4	0	0	50
424	2395	4.6	0	6	5
425	2580	4.6	0	1	50
427	1789	4.3	0	1	30
428	1939	4.4	0	1	35
429	2257	4.5	0	1	45
430	1954	4.4	0	1	40
432	153	1.5	0	0	55
433	1119	2.7	0	2	0
434	37	1.1	0	1	20
435	92	1.3	0	0	55

10-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	
201	691	1.5	0	5	0
202	686	2.5	0	4	55
203	30	1	0	1	5
204	15	0.8	0	1	20
208	700	3.6	0	4	0
209	698	3.6	0	3	10
210	703	3.6	0	3	30
211	690	3.6	0	3	30
212	61	1.1	0	1	5
215	141	1.3	0	0	45
216	639	3.5	0	3	25
217	181	1.5	0	0	45
218	689	3.5	0	5	0
222	32	1	0	1	0
227	28	1.1	0	0	50
228	132	1.5	0	0	45
229	21	0.9	0	1	15
230	635	5	0	8	40
231	26	1.1	0	1	0
232	17	0.8	0	1	10
233	52	1.2	0	1	20
234	635	5.8	0	8	20
235	635	3.6	0	8	15
236	1128	5.6	0	5	35
237	1131	5.5	0	5	30
238	1137	2.6	0	5	20
239	48	1.1	0	1	5
240	103	1.3	0	1	5
242	61	1.2	0	0	55
244	1129	5.6	0	4	55
246	1113	5.6	0	5	20
248	112	1.4	0	0	45
249	164	1.5	0	0	50
250	95	1.3	0	0	50
251	30	1	0	1	0
252	37	1.1	0	1	0
254	1285	2.8	0	3	55
255	360	1.9	0	1	5
256	330	1.8	0	0	55
257	1288	3	0	3	45
259	128	1.4	0	0	45
263	701	2.3	0	3	40
264	23	0.9	0	1	5
265	634	2.2	0	9	25
266	1607	3	0	2	35
267	43	1.1	0	0	50
268	96	1.3	0	0	55
273	51	1.1	0	0	55
277	51	1.2	0	0	55
280	1271	2.9	0	4	5
281	60	1.2	0	0	50
289	635	2.3	0	8	20
290	362	1.9	0	1	10
292	120	1.4	0	1	25
293	1559	3	0	2	25
294	1288	3	0	3	55
297	1549	3	0	2	20
298	43	1.1	0	1	10
330	635	0.1	5.8	8	45
336	635	0.1	163	8	5
366	1304	0.1	173	3	20
400	1237	5.6	0	4	20
402	1299	5.7	0	3	40
404	1544	5.9	0	2	35
407	45	1.1	0	1	15
409	1059	2.6	0	2	5
410	1028	2.6	0	2	0
411	967	2.6	0	1	55
412	116	1.4	0	1	0
416	23	0.9	0	0	55
417	635	3.6	0	9	0
418	635	3.5	0	9	15
419	680	3.6	0	4	50
420	691	1.6	0	5	5
421	39	1.1	0	0	55
422	76	1.2	0	1	5
423	76	1.2	0	0	45
424	635	3.5	0	9	15
425	1103	3.8	0	2	5
427	670	3.5	0	1	35
428	767	3.6	0	1	40
429	900	3.7	0	1	55
430	777	3.7	0	1	45
432	82	1.3	0	0	50
433	479	2	0	2	20
434	20	0.8	0	1	10
435	42	1.1	0	0	50

5-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	
201	590	1.4	0	5	55
202	585	2.4	0	5	55
203	26	1	0	1	0
204	7	0.5	0	1	20
208	594	3.5	0	5	0
209	594	3.5	0	4	0
210	595	3.5	0	4	30
211	589	3.5	0	4	25
212	49	1.1	0	1	5
215	111	1.2	0	0	50
216	553	3.5	0	4	0
217	130	1.4	0	0	50
218	588	3.4	0	6	0
222	27	1	0	0	55
227	23	1	0	0	50
228	97	1.4	0	0	50
229	15	0.7	0	1	15
230	523	4.6	0	7	35
231	21	1	0	1	0
232	12	0.7	0	1	10
233	39	1.1	0	1	20
234	522	5.6	0	7	25
235	522	3.5	0	7	15
236	705	5.1	0	6	15
237	707	5	0	6	5
238	712	2.3	0	5	55
239	37	1.1	0	1	5
240	74	1.2	0	1	10
242	44	1.1	0	0	55
244	688	5.1	0	5	35
246	689	5.1	0	5	55
248	81	1.3	0	0	45
249	117	1.4	0	0	50
250	70	1.2	0	0	50
251	12	0.7	0	0	55
252	15	0.7	0	1	0
254	738	2.4	0	4	35
255	279	1.7	0	1	5
256	258	1.7	0	0	55
257	737	2.5	0	4	25
259	98	1.4	0	0	45
263	594	2.1	0	4	40
264	16	0.7	0	1	5
265	547	2.1	0	3	40
266	1045	2.6	0	2	45
267	36	1.1	0	0	50
268	77	1.3	0	0	55
273	40	1.1	0	0	55
277	41	1.1	0	0	55
280	733	2.4	0	4	50
281	49	1.1	0	0	50
289	524	2.2	0	7	25
290	277	1.7	0	1	15
292	85	1.3	0	1	25
293	1007	2.6	0	2	30
294	739	2.5	0	4	35
297	1000	2.6	0	2	25
298	34	1.1	0	1	10
330	536	0.1	4.9	2	40
336	523	0.1	45.5	7	0
366	745	0.1	155.6	3	55
400	713	5.1	0	5	10
402	741	5.2	0	4	20
404	994	5.5	0	2	40
407	36	1.1	0	1	15
409	687	2.3	0	2	5
410	665	2.3	0	2	0
411	613	2.2	0	1	55
412	92	1.3	0	1	0
416	17	0.8	0	0	55
417	531	3.4	0	3	20
418	538	3.4	0	3	35
419	579	3.5	0	5	50
420	590	1.5	0	6	0
421	31	1	0	0	55
422	57	1.2	0	1	5
423	62	1.2	0	0	45
424	545	3.4	0	3	30
425	723	3.5	0	2	0
427	404	3.3	0	1	35
428	481	3.4	0	1	45
429	562	3.5	0	2	0
430	487	3.4	0	1	50
432	66	1.2	0	0	50
433	312	1.8	0	2	25
434	14	0.7	0	1	15
435	32	1	0	0	50

2-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	
201	380	1.2	0	6	45
202	380	2	0	6	40
203	14	0.7	0	1	0
204	1	0.2	0	1	25
208	392	3.2	0	5	45
209	392	3.2	0	4	30
210	393	3.3	0	5	10
211	388	3.3	0	5	0
212	34	1.1	0	1	10
215	71	1.2	0	0	50
216	367	3.2	0	4	35
217	77	1.3	0	0	50
218	380	3.1	0	6	45
222	16	0.3	0	0	55
227	16	0.8	0	0	50
228	57	1.2	0	0	50
229	9	0.5	0	1	20
230	344	3.8	0	2	45
231	13	0.8	0	1	0
232	7	0.5	0	1	15
233	26	1	0	1	15
234	331	5.4	0	3	40
235	322	3.3	0	3	35
236	328	3.6	0	1	30
237	323	3.6	0	3	10
238	321	1.8	0	3	5
239	26	0.9	0	1	0
240	43	1.1	0	1	10
242	29	1	0	0	55
244	248	3.2	0	3	0
246	274	3.4	0	3	10
248	48	1.1	0	0	45
249	68	1.2	0	0	50
250	41	1.1	0	0	50
251	2	0.2	0	1	0
252	2	0.2	0	1	0
254	230	1.7	0	2	5
255	161	1.5	0	1	10
256	152	1.5	0	0	55
257	224	1.7	0	1	55
259	58	1.2	0	0	50
263	392	1.9	0	5	20
264	9	0.5	0	1	10
265	364	1.9	0	4	10
266	473	2	0	2	40
267	28	1	0	0	45
268	49	1.1	0	0	55
273	29	1	0	0	50
277	29	1	0	0	55
280	233	1.7	0	2	25
281	35	1	0	0	50
289	345	1.9	0	2	35
290	159	1.5	0	1	20
292	49	1.2	0	1	30
293	429	2	0	2	35
294	235	1.7	0	2	10
297	423	2	0	2	35
298	24	1	0	1	5
330	361	0.1	3.3	2	55
336	324	0.1	3.5	3	25
366	120	0.1	132	12	0
400	234	3.1	0	2	40
402	227	3.1	0	1	40
404	430	4.2	0	2	40
407	25	1	0	1	10
409	373	1.9	0	1	25
410	352	1.9	0	1	25
411	300	1.8	0	1	5
412	58	1.2	0	1	5
416	10	0.6	0	0	55
417	355	3.2	0	3	35
418	358	3.2	0	4	0
419	379	3.3	0	6	40
420	380	1.2	0	6	55
421	21	0.9	0	0	55
422	34	1.1	0	1	10
423	42	1.1	0	0	45
424	363	3.2	0	4	0
425	398	3.2	0	1	35
427	130	2.1	0	1	45
428	183	2.5	0	1	45
429	232	2.9	0	1	15
430	189	2.6	0	1	50
432	44	1.1	0	0	50
433	124	1.4	0	3	20
434	8	0.5	0	1	20
435	21	0.8	0	0	45

0.4" Average

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	
201	103	0.7	0	9	10
202	103	1.2	0	9	5
203	4	0.4	0	1	5
204	0	0	0	0	0
208	104	1.9	0	8	15
209	105	1.9	0	7	5
210	104	2	0	7	35
211	104	2	0	7	30
212	16	0.8	0	1	0
215	29	1	0	0	45
216	104	2	0	12	0
217	29	1	0	0	45
218	103	1.8	0	9	10
222	5	0.4	0	1	0
227	6	0.5	0	0	50
228	22	1	0	0	45
229	3	0.3	0	1	25
230	112	2.2	0	2	25
231	4	0.4	0	1	0
232	2	0.3	0	1	20
233	8	0.6	0	1	15
234	108	4.1	0	2	10
235	107	2.2	0	4	50
236	108	2.1	0	1	40
237	107	2.1	0	4	30
238	108	1.3	0	4	20
239	9	0.5	0	1	0
240	17	0.8	0	1	5
242	10	0.6	0	0	50
244	107	2.1	0	4	0
246	106	2.2	0	12	0
248	21	0.9	0	0	40
249	28	1	0	0	45
250	18	0.8	0	0	45
251	0	0	0	0	0
252	0	0	0	0	0
254	114	1.4	0	2	45
255	54	1.2	0	1	15
256	53	1.2	0	0	55
257	114	1.5	0	2	30
259	24	1	0	0	45
263	104	1.3	0	7	55
264	3	0.3	0	1	20
265	105	1.4	0	12	0
266	247	1.7	0	3	25
267	10	0.6	0	0	45
268	22	0.9	0	0	50
273	9	0.5	0	0	50
277	11	0.6	0	0	50
280	111	1.4	0	3	15
281	14	0.7	0	0	50
289	116	1.4	0	2	10
290	52	1.2	0	1	30
292	20	0.9	0	1	20
293	245	1.7	0	3	15
294	113	1.4	0	2	50
297	246	1.7	0	3	10
298	8	0.5	0	1	10
330	108	0.1	3.3	2	45
336	108	0.1	0.4	1	40
366	107	0.1	58.4	12	0
400	110	2.1	0	3	30
402	115	2.2	0	2	15
404	244	3.2	0	3	20
407	8	0.5	0	1	15
409	150	1.5	0	2	20
410	151	1.5	0	2	15
411	146	1.5	0	2	10
412	25	0.9	0	0	55
416	3	0.3	0	1	0
417	106	1.9	0	3	0
418	106	1.9	0	3	15
419	103	2	0	8	55
420	103	0.6	0	9	20
421	7	0.5	0	0	55
422	12	0.7	0	1	10
423	19	0.8	0	0	40
424	106	2	0	3	15
425	155	2.2	0	2	15
427	109	2	0	1	45
428	127	2.1	0	1	55
429	137	2.2	0	2	5
430	128	2.2	0	2	0
432	20	0.9	0	0	45
433	124	1.4	0	3	20
434	3	0.3	0	1	25
435	7	0.5	0	0	45

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1 LOWER SECOND CREEK  100 -YEAR Existing   REVISED 5/15/02
 1 100 YEAR   0..026.078 .12.209.296.529.296.209.162.131.104.104.104.052.052.031
 1 100 YEAR .031.031.031.031.031.031.031.031.012.012.012.012.012.012.012.012.012
 1 100 YEAR .012.012.012.011.012.011.011.011.011.011.011.011.011.011.011.011.011
 1 100 YEAR .011.011.011.011.011.011.011.011.011.011.011.011.011.011.011.011.011
 1 100 YEAR .011.011.011

 70 1 1 5.    1   1
 .188 .289 .167 100. .00118.49   .4   .1  4.5.0018   .6
 70 1 1 5.    2   2
 .121 .421 .088 5.69 .004 114.   .4   .1  4.5.0018   .6
 71 1 1 5.    3   3
 .059 .406 .151   5. .00885.43   .4   .1  4.5.0018   .6
 70 1 1 5.    4   4
 .121 .327 .197   5. .00875.82   .4   .1 3.83.0018 .556
 70 1 1 5.    5   5
 .097 .308 .207   5. .002118.6   .4   .1 3.95.0018 .563
 70 1 1 5.    6   6
 .106 .727 .204   5. .004188.1   .4   .1   3..0018   .5
 70 1 1 5.    8   8
 .093 .786 .411   5. .003203.2   .4   .1 3.38.0018 .525
 70 1 1 5.    9   9
 .127 .453 .236   5. .008 88.8   .4   .1   3..0018   .5
 71 1 1 5.   10  10
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 70 1 1 5.   11  11
 .164 .587 .443 13.4 .005138.1   .4   .1 3.94.0018 .563
 70 1 1 5.   12  12
 .099 .435 .227   5. .003125.2   .4   .1 3.54.0015 .631
 70 1 1 5.   14  14
 .123 .411 .191   5.  .0179.64   .4   .1 3.48.0017 .567
 70 1 1 5.   15  15
 .184 .546 .158   5. .007111.1   .4   .1  3.5.0018 .534
 71 1 1 5.   16  16
 .073 .516 .122   5. .006117.4   .4   .1 4.36.0018 .591
 70 1 1 5.   17  17
 .105 .504 .175   5.  .0190.54   .4   .1  4.5.0018   .6
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         3  102
         4  104
         5  105
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106   204   3     10.     1.     0.1
107   402   3     10.     1.     0.1
108   419   3     10.     1.     0.1
109   208   3     10.     1.     0.1
110   263   3     10.     1.     0.1
111   210   3     10.     1.     0.1
114   212   3     10.     1.     0.1
115   432   3     10.     1.     0.1
116   209   3     10.     1.     0.1
117   216   3     10.     1.     0.1
118   201   3     10.     1.     0.1
119   999   3     10.     1.     0.1
121   298   3     10.     1.     0.1
122   421   3     10.     1.     0.1
125   422   3     10.     1.     0.1
126   416   3     10.     1.     0.1
127   227   3     10.     1.     0.1
128   228   3     10.     1.     0.1
130   417   3     10.     1.     0.1
131   232   3     10.     1.     0.1
132   231   3     10.     1.     0.1
133   233   3     10.     1.     0.1
134   289   3     10.     1.     0.1
135   234   3     10.     1.     0.1
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137   236   3     10.     1.     0.1
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139   239   3     10.     1.     0.1
140   229   3     10.     1.     0.1
143   242   3     10.     1.     0.1
144   187   3     10.     1.     0.1
145   244   3     10.     1.     0.1
146   238   3     10.     1.     0.1
147   222   3     10.     1.     0.1
148   248   3     10.     1.     0.1
149   249   3     10.     1.     0.1
150   217   3     10.     1.     0.1
151   251   3     10.     1.     0.1
152   280   3     10.     1.     0.1
153   252   3     10.     1.     0.1
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156   255   3     10.     1.     0.1
157   256   3     10.     1.     0.1
158   259   3     10.     1.     0.1
159   290   3     10.     1.     0.1
161   257   3     10.     1.     0.1
164   264   3     10.     1.     0.1
165   265   3     10.     1.     0.1
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173   411   3     10.     1.     0.1
177   277   3     10.     1.     0.1
178   273   3     10.     1.     0.1
179   240   3     10.     1.     0.1
180   400   3     10.     1.     0.1
181   281   3     10.     1.     0.1
182   509   3     10.     1.     0.1
186   250   3     10.     1.     0.1
187   246   3     10.     1.     0.1
188   211   3     10.     1.     0.1
189   230   3     10.     1.     0.1
192   292   3     10.     1.     0.1
193   404   3     10.     1.     0.1
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198   215   3     10.     1.     0.1
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507   423   3     10.     1.     0.1
509   428   3     10.     1.     0.1
510   430   3     10.     1.     0.1
512   427   3     10.     1.     0.1
513   429   3     10.     1.     0.1
514   434   3     10.     1.     0.1
201   101   4    100.     1.   0.0014   50.   50.   0.034   1.
                 235.     1.   0.0014  100.  100.   0.022  20.
202   102   4     10.   875.   0.0046   25.   50.   0.047   3.
                 235.   875.   0.0046   50.   50.   0.035  20.
203   104   4     10.  2142.   0.0084    6.    6.   0.067   1.
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204   104   4     10.  1729.   0.0035    6.    6.   0.048   1.
                 235.  1729.   0.0035   50.   50.   0.031  20.
208   108   4     10.  3038.   0.0046    6.    6.   0.046   3.
                 235.  3038.   0.0046   50.   50.   0.035  20.
209   188   4     10.   911.   0.0044    6.    6.   0.045   3.
                 235.   911.   0.0044   50.   50.   0.034  20.
210   110   4     10.  1500.   0.0027    6.    6.   0.038   3.
                 235.  1500.   0.0027   50.   50.   0.028  20.
211   111   4     10.  3737.   0.0027    6.    6.   0.038   3.
                 235.  3737.   0.0027   50.   50.   0.028  20.
212   111   4     10.  2300.   0.0039    6.    6.    0.05   1.
                 235.  2300.   0.0039   50.   50.   0.033  20.
215   116   4     10.  2900.   0.0076    6.    6.   0.065   1.
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0.01    1.
0.01    1.
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216	116	4	10.	2989.	0.0033	6.	6.	0.041	3.
			235.	2989.	0.0033	50.	50.	0.031	20.
217	145	4	10.	1075.	0.0102	6.	6.	0.073	1.
			100.	1075.	0.0102	50.	50.	0.053	10.
218	118	4	10.	788.	0.0127	6.	6.	0.068	3.
			235.	788.	0.0127	50.	50.	0.051	20.
222	125	4	10.	1747.	0.0137	6.	6.	0.081	1.
			100.	1747.	0.0137	50.	50.	0.059	10.
227	128	4	10.	966.	0.0021	6.	6.	0.040	1.
			100.	966.	0.0021	50.	50.	0.029	10.
228	130	4	10.	1017.	0.002	6.	6.	0.039	1.
			100.	1017.	0.002	50.	50.	0.028	10.
229	135	4	10.	4275.	0.0105	6.	6.	0.073	1.
			100.	4275.	0.0105	50.	50.	0.053	10.
230	130	4	10.	2634.	0.0015	4.	4.	0.028	5.
			100.	2634.	0.0015	50.	50.	0.025	10.
231	133	4	10.	1656.	0.0012	6.	6.	0.032	1.
			100.	1656.	0.0012	50.	50.	0.023	10.
232	128	4	10.	3051.	0.0085	6.	6.	0.068	1.
			100.	3051.	0.0085	50.	50.	0.049	10.
233	134	4	10.	2737.	0.0073	6.	6.	0.064	1.
			100.	2737.	0.0073	50.	50.	0.046	10.
234	134	4	10.	1400.	0.0014	4.	4.	0.099	5.
			235.	1400.	0.0014	50.	50.	0.023	20.
235	135	4	10.	1926.	0.0016	4.	4.	0.030	3.
			235.	1926.	0.0016	50.	50.	0.023	20.
236	136	4	10.	1493.	0.0020	4.	4.	0.031	5.
			235.	1493.	0.0020	50.	50.	0.025	20.
237	137	4	10.	1925.	0.0026	4.	4.	0.034	5.
			235.	1925.	0.0026	50.	50.	0.028	20.
238	138	4	10.	360.	0.0139	6.	6.	0.082	1.
			100.	360.	0.0139	50.	50.	0.059	10.
239	146	4	10.	2360.	0.0229	6.	6.	0.099	1.
			100.	2360.	0.0229	50.	50.	0.071	10.
240	192	4	10.	2576.	0.0140	6.	6.	0.082	1.
			100.	2576.	0.0140	50.	50.	0.059	10.
242	146	4	10.	3290.	0.0085	6.	6.	0.068	1.
			100.	3290.	0.0085	50.	50.	0.049	10.
244	144	4	10.	5970.	0.0023	4.	4.	0.033	5.
			235.	5970.	0.0023	50.	50.	0.027	20.
246	146	4	10.	3548.	0.0014	4.	4.	0.027	5.
			235.	3548.	0.0014	50.	50.	0.022	20.
248	149	4	10.	1314.	0.0167	4.	4.	0.087	1.
			100.	1314.	0.0167	50.	50.	0.063	10.
249	187	4	10.	1896.	0.0295	4.	4.	0.108	1.
			100.	1896.	0.0295	50.	50.	0.078	10.
250	150	4	10.	2221.	0.0153	4.	4.	0.084	1.
			100.	2221.	0.0153	50.	50.	0.061	10.
251	180	4	10.	978.	0.0082	6.	6.	0.067	1.
			100.	978.	0.0082	50.	50.	0.048	10.
252	154	4	10.	1567.	0.0108	6.	6.	0.074	1.
			100.	1567.	0.0108	50.	50.	0.054	10.
254	154	4	10.	1414.	0.0028	4.	4.	0.036	1.
			100.	1414.	0.0028	50.	50.	0.029	10.
255	159	4	10.	1681.	0.0119	4.	4.	0.076	1.
			100.	1681.	0.0119	50.	50.	0.055	10.
256	156	4	10.	1784.	0.0135	4.	4.	0.080	1.
			100.	1784.	0.0135	50.	50.	0.058	10.
257	155	4	10.	1725.	0.0017	6.	6.	0.037	1.
			100.	1725.	0.0017	50.	50.	0.027	10.
259	157	4	10.	1420.	0.0070	4.	4.	0.062	1.
			100.	1420.	0.0070	50.	50.	0.045	10.
263	109	4	10.	2126.	0.0038	6.	6.	0.043	1.
			100.	2126.	0.0038	50.	50.	0.032	10.
264	145	4	10.	2875.	0.0313	4.	4.	0.110	1.
			100.	2875.	0.0313	30.	30.	0.080	10.
265	117	4	10.	1926.	0.0031	6.	6.	0.040	1.
			100.	1926.	0.0031	50.	50.	0.030	10.
266	166	4	10.	727.	0.0028	4.	4.	0.035	1.
			100.	727.	0.0028	50.	50.	0.028	10.
267	167	4	10.	2410.	0.0241	4.	4.	0.099	1.
			100.	2410.	0.0241	50.	50.	0.072	10.
268	167	4	10.	3953.	0.0121	6.	6.	0.077	1.
			100.	3953.	0.0121	50.	50.	0.056	10.
273	173	4	10.	4033.	0.0174	6.	6.	0.089	1.
			100.	4033.	0.0174	50.	50.	0.064	10.
277	513	4	10.	3529.	0.0198	4.	4.	0.092	1.
			100.	3529.	0.0198	50.	50.	0.067	10.
280	180	4	10.	2378.	0.0034	6.	6.	0.048	1.
			100.	2378.	0.0034	50.	50.	0.034	10.
281	182	4	10.	3319.	0.0271	6.	6.	0.105	1.
			100.	3319.	0.0271	50.	50.	0.076	10.
289	189	4	10.	586.	0.0014	4.	4.	0.027	1.
			100.	586.	0.0014	50.	50.	0.022	10.
290	107	4	10.	1348.	0.0074	6.	6.	0.064	1.
			100.	1348.	0.0074	50.	50.	0.046	10.
292	146	4	10.	2192.	0.0064	6.	6.	0.061	1.
			100.	2192.	0.0064	50.	50.	0.044	10.
293	193	4	10.	822.	0.0024	4.	4.	0.034	1.
			100.	822.	0.0024	50.	50.	0.027	10.
294	152	4	10.	680.	0.0015	6.	6.	0.035	1.
			100.	680.	0.0015	50.	50.	0.025	10.
297	197	4	10.	3547.	0.0023	4.	4.	0.033	1.
			100.	3547.	0.0023	50.	50.	0.026	10.
298	198	4	10.	3100.	0.0065	6.	6.	0.061	1.
			100.	3100.	0.0065	50.	50.	0.044	10.
400	145	4	10.	2678.	0.0026	4.	4.	0.035	5.
			235.	2678.	0.0026	50.	50.	0.028	20.
402	161	4	10.	3152.	0.0019	4.	4.	0.031	5.
			235.	3152.	0.0019	50.	50.	0.025	20.
404	167	4	10.	2057.	0.0019	4.	4.	0.031	5.
			235.	2057.	0.0019	50.	50.	0.025	20.
407	171	4	10.	3070.	0.0150	6.	6.	0.084	1.
			100.	3070.	0.0150	50.	50.	0.061	10.
409	171	4	10.	889.	0.0067	6.	6.	0.062	1.
			100.	889.	0.0067	50.	50.	0.045	10.
410	172	4	10.	2242.	0.0062	6.	6.	0.060	1.

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                    100.   2242.  0.0062     50.     50.   0.044     10.
411  502    4       10.    782.  0.0051      6.      6.   0.056      1.
                    100.    782.  0.0051     50.     50.   0.040     10.
412  502    4       10.   2018.  0.0173      6.      6.   0.089      1.
                    100.   2018.  0.0173     50.     50.   0.064     10.
416  125    4       10.    947.  0.0063      6.      6.   0.060      1.
                    100.    947.  0.0063     50.     50.   0.036     10.
417  505    4       10.   2686.  0.0052      6.      6.   0.049      3.
                    235.   2686.  0.0052     50.     50.   0.049     20.
418  506    4       10.   2787.   0.005      6.      6.   0.048      3.
                    235.   2787.   0.005     50.     50.   0.036     20.
419  104    4       10.   6815.  0.0021      6.      6.   0.034      3.
                    235.   6815.  0.0021     50.     50.   0.025     20.
420  119    4      100.   1382.  0.0072     25.     50.   0.054      3.
                    235.   1382.  0.0072     50.     50.   0.041     20.
421  506    4       10.   1561.  0.0154      6.      6.   0.085      1.
                    100.   1561.  0.0154     50.     50.   0.055     20.
422  505    4       10.   1266.  0.0126      6.      6.   0.079      1.
                    100.   1266.  0.0126     50.     50.   0.051     20.
423  501    4       10.   1321.  0.0167      6.      6.   0.087      1.
                    100.   1321.  0.0167     50.     50.   0.063     10.
424  165    4       10.    563.  0.0036      6.      6.   0.042      3.
                    235.    563.  0.0036     50.     50.   0.031     20.
425  169    4       10.   1146.  0.0087      6.      6.   0.059      3.
                    235.   1146.  0.0087     50.     50.   0.044     20.
427  182    4       10.   1645.  0.0043      6.      6.   0.045      3.
                    235.   1645.  0.0043     50.     50.   0.034     20.
428  510    4       10.   1996.  0.0040      6.      6.   0.044      3.
                    235.   1996.  0.0040     50.     50.   0.033     20.
429  173    4       10.   2749.  0.0033      6.      6.   0.041      3.
                    235.   2749.  0.0033     50.     50.   0.030     20.
430  513    4       10.    932.  0.0032      6.      6.   0.040      3.
                    235.    932.  0.0032     50.     50.   0.030     20.
432  512    4       10.   3305.  0.0106      6.      6.   0.074      1.
                    100.   3305.  0.0106     50.     50.   0.053     10.
433  169    4       10.   4284.  0.0070      6.      6.   0.063      1.
                    100.   4284.  0.0070     50.     50.   0.045     10.
434  168    4       10.   2548.  0.0196      6.      6.   0.093      1.
                    100.   2548.  0.0196     50.     50.   0.067     10.
435  135    4       10.    758.  0.0185      6.      6.   0.091      1.
                    100.    758.  0.0185     50.     50.   0.066     10.
-1  942  433  8 3    10.      1.     0.1                    0.01     10.
     0.        0.    0.50     59.1      1.08    1129.6     1.33    1272.4
   1.58    1165.7    2.33    628.0      3.75     160.4     6.00      16.3
-1  937  513  8 3    10.      1.     0.1                    0.01     10.
     0.        0.    0.58     35.3      0.83     240.8     1.08     412.9
   1.25     450.0    1.50    408.8      2.58     115.4     6.00       1.0
-1  935  512  8 3    10.      1.     0.1                    0.01     10.
     0.        0.    0.58     75.0      1.33    2042.8     1.75    2632.6
   2.08    2738.5    2.58   2588.7      4.50     969.3     6.00     319.7

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ENDPROGRAM

LOWER SECOND CREEK, 100YR EXISTING CONDITIONS
KIOWA ENGINEERING CORPORATION REVISED 5/13/02

*** PEAK FLOWS, STAGES AND STORAGES OF GUTTERS AND DETENTION DAMS ***

CONVEYANCE ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR/MIN)
115	134.	(DIRECT FLOW)		0 55.
935	2727.	(DIRECT FLOW)		2 5.
432	85.	1.3		1 25.
512	2819.	(DIRECT FLOW)		2 0.
181	145.	(DIRECT FLOW)		0 45.
427	2806.	4.7		2 10.
281	82.	1.2		1 15.
182	2873.	(DIRECT FLOW)		2 5.
509	2909.	(DIRECT FLOW)		2 5.
428	2899.	4.8		2 10.
510	2911.	(DIRECT FLOW)		2 10.
177	204.	(DIRECT FLOW)		0 40.
937	449.	(DIRECT FLOW)		1 15.
430	2908.	4.8		2 10.
277	88.	1.3		1 5.
507	104.	(DIRECT FLOW)		0 45.
513	3219.	(DIRECT FLOW)		2 0.
178	139.	(DIRECT FLOW)		0 50.
423	82.	1.3		1 0.
429	3192.	4.9		2 10.
273	77.	1.2		1 25.
501	180.	(DIRECT FLOW)		0 55.
173	3317.	(DIRECT FLOW)		2 5.
412	151.	1.4		1 15.
411	3318.	4.0		2 10.
502	3414.	(DIRECT FLOW)		2 5.
410	3396.	4.0		2 15.
172	3410.	(DIRECT FLOW)		2 10.
504	162.	(DIRECT FLOW)		0 45.
409	3409.	4.0		2 15.
407	86.	1.3		1 10.
942	1270.	(DIRECT FLOW)		1 20.
171	3431.	(DIRECT FLOW)		2 15.
433	1100.	2.7		1 40.
425	3428.	4.9		2 15.
169	4377.	(DIRECT FLOW)		2 5.
158	131.	(DIRECT FLOW)		1 0.
297	4305.	4.3		2 20.
259	118.	1.4		1 15.
197	4332.	(DIRECT FLOW)		2 15.
514	39.	(DIRECT FLOW)		1 0.
157	387.	(DIRECT FLOW)		1 5.
293	4333.	4.4		2 20.
434	30.	1.0		1 25.
256	365.	1.9		1 15.
193	4335.	(DIRECT FLOW)		2 20.
168	184.	(DIRECT FLOW)		1 0.
194	74.	(DIRECT FLOW)		0 50.
156	452.	(DIRECT FLOW)		1 10.
404	4310.	7.2		2 25.
268	122.	1.4		1 30.
267	48.	1.1		1 15.
255	430.	2.0		1 20.
167	4405.	(DIRECT FLOW)		2 25.
159	470.	(DIRECT FLOW)		1 20.
266	4401.	4.3		2 25.
290	453.	2.0		1 30.
166	4408.	(DIRECT FLOW)		2 25.
107	4599.	(DIRECT FLOW)		2 25.
402	4537.	7.3		2 35.
161	4556.	(DIRECT FLOW)		2 35.
257	4537.	4.7		2 40.
155	4564.	(DIRECT FLOW)		2 40.
153	255.	(DIRECT FLOW)		0 50.
254	4553.	4.4		2 45.
252	216.	1.6		1 5.
154	4575.	(DIRECT FLOW)		2 45.
294	4575.	4.7		2 45.
152	4599.	(DIRECT FLOW)		2 45.
151	183.	(DIRECT FLOW)		0 50.
186	179.	(DIRECT FLOW)		0 50.
280	4563.	4.5		2 55.
251	167.	1.5		1 0.
250	135.	1.4		1 10.
180	4575.	(DIRECT FLOW)		2 50.
164	75.	(DIRECT FLOW)		0 45.
150	270.	(DIRECT FLOW)		1 0.
148	161.	(DIRECT FLOW)		0 50.
400	4538.	7.2		3 0.
264	44.	1.1		1 15.
217	262.	1.7		1 10.
248	142.	1.4		1 5.
145	4553.	(DIRECT FLOW)		3 0.
179	147.	(DIRECT FLOW)		1 5.
149	278.	(DIRECT FLOW)		0 55.
244	4348.	7.2		3 25.
240	122.	1.4		1 30.
249	243.	1.6		1 10.
144	4352.	(DIRECT FLOW)		3 25.
192	174.	(DIRECT FLOW)		1 15.
187	4355.	(DIRECT FLOW)		3 25.
143	328.	(DIRECT FLOW)		0 40.
139	138.	(DIRECT FLOW)		0 45.
292	156.	1.5		1 35.
246	4296.	7.2		3 35.
242	172.	1.5		1 5.
239	93.	1.3		1 10.
146	4356.	(DIRECT FLOW)		3 35.

238	4356.	4.2	3	35.
138	4358.	(DIRECT FLOW)	3	35.
237	4343.	7.1	3	40.
137	4345.	(DIRECT FLOW)	3	40.
236	4337.	7.1	3	45.
196	95.	(DIRECT FLOW)	0	45.
136	4337.	(DIRECT FLOW)	3	45.
140	102.	(DIRECT FLOW)	0	45.
132	85.	(DIRECT FLOW)	0	45.
435	86.	1.3	0	55.
235	4321.	5.5	3	50.
229	43.	1.1	1	15.
231	55.	1.2	1	10.
135	4323.	(DIRECT FLOW)	3	50.
133	197.	(DIRECT FLOW)	0	45.
234	4314.	7.7	3	55.
233	130.	1.4	1	10.
134	4318.	(DIRECT FLOW)	3	55.
131	16.	(DIRECT FLOW)	1	10.
127	36.	(DIRECT FLOW)	0	55.
289	4317.	4.4	4	0.
232	12.	0.7	2	5.
227	30.	1.1	1	15.
126	23.	(DIRECT FLOW)	0	55.
147	43.	(DIRECT FLOW)	1	5.
189	4327.	(DIRECT FLOW)	4	0.
128	173.	(DIRECT FLOW)	0	55.
416	22.	0.9	1	20.
222	35.	1.1	1	25.
230	4293.	7.9	4	10.
228	161.	1.6	1	10.
125	96.	(DIRECT FLOW)	1	10.
130	4302.	(DIRECT FLOW)	4	10.
422	92.	1.3	1	25.
417	4266.	5.6	4	20.
122	139.	(DIRECT FLOW)	0	40.
505	4273.	(DIRECT FLOW)	4	15.
421	93.	1.3	0	55.
418	4249.	5.2	4	25.
506	4249.	(DIRECT FLOW)	4	25.
424	4246.	5.3	4	25.
165	4246.	(DIRECT FLOW)	4	25.
121	131.	(DIRECT FLOW)	0	50.
265	4235.	4.3	4	35.
298	76.	1.3	1	20.
117	4237.	(DIRECT FLOW)	4	35.
198	231.	(DIRECT FLOW)	0	50.
216	4204.	5.3	4	40.
215	159.	1.3	1	20.
116	4218.	(DIRECT FLOW)	4	40.
209	4217.	5.2	4	45.
114	114.	(DIRECT FLOW)	0	50.
188	4217.	(DIRECT FLOW)	4	45.
212	71.	1.2	1	20.
211	4166.	5.3	4	55.
111	4167.	(DIRECT FLOW)	4	55.
210	4160.	5.3	5	0.
110	4162.	(DIRECT FLOW)	5	0.
263	4147.	4.2	5	5.
109	4147.	(DIRECT FLOW)	5	5.
208	4121.	5.2	5	15.
108	4121.	(DIRECT FLOW)	5	15.
106	68.	(DIRECT FLOW)	1	5.
105	70.	(DIRECT FLOW)	1	0.
419	3983.	5.2	5	40.
204	53.	1.1	1	30.
203	48.	1.1	1	25.
104	3984.	(DIRECT FLOW)	5	40.
202	3981.	4.3	5	40.
102	3981.	(DIRECT FLOW)	5	40.
218	3981.	5.0	5	45.
118	3981.	(DIRECT FLOW)	5	45.
201	3981.	2.9	5	45.
101	3981.	(DIRECT FLOW)	5	45.
420	3975.	3.6	5	50.
119	3975.	(DIRECT FLOW)	5	50.
999	3975.	(DIRECT FLOW)	5	50.

CORRECT CNAME NOT FOUND 0

PROGRAM ENDED NORMALLY

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1 LOWER SECOND CREEK  100 -YEAR Future   REVISED 5/15/02
 1 100 YEAR   0..026.078 .12.209.296.529.296.209.162.131.104.104.104.052.052.031
 1 100 YEAR .031.031.031.031.031.031.031.031.012.012.012.012.012.012.012.012.012
 1 100 YEAR .012.012.012.011.012.011.011.011.011.011.011.011.011.011.011.011.011
 1 100 YEAR .011.011.011.011.011.011.011.011.011.011.011.011.011.011.011.011.011
 1 100 YEAR .011.011.011

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 .188 .289 .167 100. .00128.49   .4   .1  4.5.0018   .6
 70 1 1 5.    2   2
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 .059 .406 .15183.05 .008 31.9   .4   .1  4.5.0018   .6
 71 1 1 5.    4   4
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 70 1 1 5.    8   8
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 71 1 1 5.    9   9
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 70 1 1 5.   11  11
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 70 1 1 5.   12  12
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 71 1 1 5.   14  14
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 70 1 1 5.   15  15
 .184 .546 .158  85. .00736.03   .4   .1  3.5.0018 .534
 71 1 1 5.   16  16
 .073 .516 .122  85. .00635.14   .4   .1 4.36.0018 .591
 71 1 1 5.   17  17
 .105 .504 .175  85.  .0134.79   .4   .1  4.5.0018   .6
 71 1 1 5.   18  18
 .128  .16 .409  40. .00924.71   .4   .1  4.5.0018   .6
 71 1 1 5.   19  19
 .075 .148 .063   5. .00554.63   .4   .1  4.5.0018   .6
 71 1 1 5.   20  20
  .05 .296  .0841.63  .0128.67   .4   .1  4.5.0018   .6
 71 1 1 5.   21  21
 .134 .323 .177 55.9 .00929.47   .4   .1 4.51.0018 .607
 71 1 1 5.   22  22
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 71 1 1 5.   23  23
 .081 .528 .20752.92 .00535.49   .4   .1  4.5.0018   .6
 70 1 1 5.   24  24
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 71 1 1 5.   46  46
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LOWER SECOND CREEK, 100YR FUTURE CONDITIONS
KIOWA ENGINEERING CORPORATION REVISED 5/13/02
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         2  102
         3  102
         4  104
         5  105
         6  106
         8  108
         9  109
        10  110
        11  111
        12  111
        14  114
        15  116
        16  116
        17  117
        18  118
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       100  179
       653  510
       654  509
       661  173
       662  502
       678  514
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680  512

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102  218    3      10.      1.      0.1          0.01      1.
104  202    3      10.      1.      0.1          0.01      1.
105  203    3      10.      1.      0.1          0.01      1.
106  204    3      10.      1.      0.1          0.01      1.
107  402    3      10.      1.      0.1          0.01      1.
108  419    3      10.      1.      0.1          0.01      1.
109  208    3      10.      1.      0.1          0.01      1.
110  263    3      10.      1.      0.1          0.01      1.
111  210    3      10.      1.      0.1          0.01      1.
114  212    3      10.      1.      0.1          0.01      1.
115  432    3      10.      1.      0.1          0.01      1.
116  209    3      10.      1.      0.1          0.01      1.
117  216    3      10.      1.      0.1          0.01      1.
118  201    3      10.      1.      0.1          0.01      1.
119  999    3      10.      1.      0.1          0.01      1.
121  298    3      10.      1.      0.1          0.01      1.
122  421    3      10.      1.      0.1          0.01      1.
125  422    3      10.      1.      0.1          0.01      1.
126  416    3      10.      1.      0.1          0.01      1.
127  227    3      10.      1.      0.1          0.01      1.
128  228    3      10.      1.      0.1          0.01      1.
130  417    3      10.      1.      0.1          0.01      1.
131  232    3      10.      1.      0.1          0.01      1.
132  231    3      10.      1.      0.1          0.01      1.
133  233    3      10.      1.      0.1          0.01      1.
134  289    3      10.      1.      0.1          0.01      1.
135  234    3      10.      1.      0.1          0.01      1.
136  235    3      10.      1.      0.1          0.01      1.
137  236    3      10.      1.      0.1          0.01      1.
138  237    3      10.      1.      0.1          0.01      1.
139  239    3      10.      1.      0.1          0.01      1.
140  229    3      10.      1.      0.1          0.01      1.
143  242    3      10.      1.      0.1          0.01      1.
144  187    3      10.      1.      0.1          0.01      1.
145  244    3      10.      1.      0.1          0.01      1.
146  238    3      10.      1.      0.1          0.01      1.
147  222    3      10.      1.      0.1          0.01      1.
148  248    3      10.      1.      0.1          0.01      1.
149  249    3      10.      1.      0.1          0.01      1.
150  217    3      10.      1.      0.1          0.01      1.
151  251    3      10.      1.      0.1          0.01      1.
152  280    3      10.      1.      0.1          0.01      1.
153  252    3      10.      1.      0.1          0.01      1.
154  294    3      10.      1.      0.1          0.01      1.
155  254    3      10.      1.      0.1          0.01      1.
156  255    3      10.      1.      0.1          0.01      1.
157  256    3      10.      1.      0.1          0.01      1.
158  259    3      10.      1.      0.1          0.01      1.
159  290    3      10.      1.      0.1          0.01      1.
161  257    3      10.      1.      0.1          0.01      1.
164  264    3      10.      1.      0.1          0.01      1.
165  265    3      10.      1.      0.1          0.01      1.
166  107    3      10.      1.      0.1          0.01      1.
167  266    3      10.      1.      0.1          0.01      1.
168  268    3      10.      1.      0.1          0.01      1.
169  297    3      10.      1.      0.1          0.01      1.
171  425    3      10.      1.      0.1          0.01      1.
172  409    3      10.      1.      0.1          0.01      1.
173  411    3      10.      1.      0.1          0.01      1.
177  277    3      10.      1.      0.1          0.01      1.
178  273    3      10.      1.      0.1          0.01      1.
179  240    3      10.      1.      0.1          0.01      1.
180  400    3      10.      1.      0.1          0.01      1.
181  281    3      10.      1.      0.1          0.01      1.
182  509    3      10.      1.      0.1          0.01      1.
186  250    3      10.      1.      0.1          0.01      1.
187  246    3      10.      1.      0.1          0.01      1.
188  211    3      10.      1.      0.1          0.01      1.
189  230    3      10.      1.      0.1          0.01      1.
192  292    3      10.      1.      0.1          0.01      1.
193  404    3      10.      1.      0.1          0.01      1.
194  267    3      10.      1.      0.1          0.01      1.
196  435    3      10.      1.      0.1          0.01      1.
197  293    3      10.      1.      0.1          0.01      1.
198  215    3      10.      1.      0.1          0.01      1.
501  412    3      10.      1.      0.1          0.01      1.
502  410    3      10.      1.      0.1          0.01      1.
504  407    3      10.      1.      0.1          0.01      1.
505  418    3      10.      1.      0.1          0.01      1.
506  424    3      10.      1.      0.1          0.01      1.
507  423    3      10.      1.      0.1          0.01      1.
509  428    3      10.      1.      0.1          0.01      1.
510  430    3      10.      1.      0.1          0.01      1.
512  427    3      10.      1.      0.1          0.01      1.
513  429    3      10.      1.      0.1          0.01      1.
514  434    3      10.      1.      0.1          0.01      1.
201  101    4     100.      1.   0.0014   50.   50.  0.034   1.
                  235.      1.   0.0014  100.  100.  0.022  20.
202  102    4      10.    875.   0.0046   25.   50.  0.047   3.
                  235.    875.   0.0046   50.   50.  0.035  20.
203  104    4      10.   2142.   0.0084    6.    6.  0.067   1.
                  235.   2142.   0.0084   50.   50.  0.044  20.
204  104    4      10.   1729.   0.0035    6.    6.  0.048   1.
                  235.   1729.   0.0035   50.   50.  0.031  20.
208  108    4      10.   3038.   0.0046    6.    6.  0.046   3.
                  235.   3038.   0.0046   50.   50.  0.035  20.
209  188    4      10.    911.   0.0044    6.    6.  0.045   3.
                  235.    911.   0.0044   50.   50.  0.034  20.
210  110    4      10.   1500.   0.0027    6.    6.  0.038   3.
                  235.   1500.   0.0027   50.   50.  0.028  20.
211  111    4      10.   3737.   0.0027    6.    6.  0.038   3.
                  235.   3737.   0.0027   50.   50.  0.028  20.
212  111    4      10.   2300.   0.0039    6.    6.  0.05    1.
                  235.   2300.   0.0039   50.   50.  0.033  20.
215  116    4      10.   2900.   0.0076    6.    6.  0.065   1.
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			235.	2900.	0.0076	50.	50.	0.042	20.				100.	1414.	0.0028	50.	50.	0.029	10.
216	116	4	10.	2989.	0.0033	6.	6.	0.041	3.	255	159	4	10.	1681.	0.0119	4.	4.	0.076	1.
			235.	2989.	0.0033	50.	50.	0.031	20.				100.	1681.	0.0119	50.	50.	0.055	10.
217	145	4	10.	1075.	0.0102	6.	6.	0.073	1.	256	156	4	10.	1784.	0.0135	4.	4.	0.080	1.
			100.	1075.	0.0102	50.	50.	0.053	10.				100.	1784.	0.0135	50.	50.	0.058	10.
218	118	4	10.	788.	0.0127	6.	6.	0.068	3.	257	155	4	10.	1725.	0.0017	6.	6.	0.037	1.
			235.	788.	0.0127	50.	50.	0.051	20.				100.	1725.	0.0017	50.	50.	0.027	10.
222	125	4	10.	1747.	0.0137	6.	6.	0.081	1.	259	157	4	10.	1420.	0.0070	4.	4.	0.062	1.
			100.	1747.	0.0137	50.	50.	0.059	10.				100.	1420.	0.0070	50.	50.	0.045	10.
227	128	4	10.	966.	0.0021	6.	6.	0.040	1.	263	109	4	10.	2126.	0.0038	6.	6.	0.043	1.
			100.	966.	0.0021	50.	50.	0.029	10.				100.	2126.	0.0038	50.	50.	0.032	10.
228	130	4	10.	1017.	0.002	6.	6.	0.039	1.	264	145	4	10.	2875.	0.0313	4.	4.	0.110	1.
			100.	1017.	0.002	50.	50.	0.028	10.				100.	2875.	0.0313	30.	30.	0.080	10.
229	135	4	10.	4275.	0.0105	6.	6.	0.073	1.	265	117	4	10.	1926.	0.0031	6.	6.	0.040	1.
			100.	4275.	0.0105	50.	50.	0.053	10.				100.	1926.	0.0031	50.	50.	0.030	10.
230	130	4	10.	2634.	0.0015	4.	4.	0.028	5.	266	166	4	10.	727.	0.0028	4.	4.	0.035	1.
			100.	2634.	0.0015	50.	50.	0.025	10.				100.	727.	0.0028	50.	50.	0.028	10.
231	133	4	10.	1656.	0.0012	6.	6.	0.032	1.	267	167	4	10.	2410.	0.0241	4.	4.	0.099	1.
			100.	1656.	0.0012	50.	50.	0.023	10.				100.	2410.	0.0241	50.	50.	0.072	10.
232	128	4	10.	3051.	0.0085	6.	6.	0.068	1.	268	167	4	10.	3953.	0.0121	6.	6.	0.077	1.
			100.	3051.	0.0085	50.	50.	0.049	10.				100.	3953.	0.0121	50.	50.	0.056	10.
233	134	4	10.	2737.	0.0073	6.	6.	0.064	1.	273	173	4	10.	4033.	0.0174	6.	6.	0.089	1.
			100.	2737.	0.0073	50.	50.	0.046	10.				100.	4033.	0.0174	50.	50.	0.064	10.
234	134	4	10.	1400.	0.0014	4.	4.	0.099	5.	277	513	4	10.	3529.	0.0198	4.	4.	0.092	1.
			235.	1400.	0.0014	50.	50.	0.023	20.				100.	3529.	0.0198	50.	50.	0.067	10.
235	135	4	10.	1926.	0.0016	4.	4.	0.030	3.	280	180	4	10.	2378.	0.0034	6.	6.	0.048	1.
			235.	1926.	0.0016	50.	50.	0.023	20.				100.	2378.	0.0034	50.	50.	0.034	10.
236	136	4	10.	1493.	0.0020	4.	4.	0.031	5.	281	182	4	10.	3319.	0.0271	6.	6.	0.105	1.
			235.	1493.	0.0020	50.	50.	0.025	20.				100.	3319.	0.0271	50.	50.	0.076	10.
237	137	4	10.	1925.	0.0026	4.	4.	0.034	5.	289	189	4	10.	586.	0.0014	4.	4.	0.027	1.
			235.	1925.	0.0026	50.	50.	0.028	20.				100.	586.	0.0014	50.	50.	0.022	10.
238	138	4	10.	360.	0.0139	6.	6.	0.082	1.	290	107	4	10.	1348.	0.0074	6.	6.	0.064	1.
			100.	360.	0.0139	50.	50.	0.059	10.				100.	1348.	0.0074	50.	50.	0.046	10.
239	146	4	10.	2360.	0.0229	6.	6.	0.099	1.	292	146	4	10.	2192.	0.0064	6.	6.	0.061	1.
			100.	2360.	0.0229	50.	50.	0.071	10.				100.	2192.	0.0064	50.	50.	0.044	10.
240	192	4	10.	2576.	0.0140	6.	6.	0.082	1.	293	193	4	10.	822.	0.0024	4.	4.	0.034	1.
			100.	2576.	0.0140	50.	50.	0.059	10.				100.	822.	0.0024	50.	50.	0.027	10.
242	146	4	10.	3290.	0.0085	6.	6.	0.068	1.	294	152	4	10.	680.	0.0015	6.	6.	0.035	1.
			100.	3290.	0.0085	50.	50.	0.049	10.				100.	680.	0.0015	50.	50.	0.025	10.
244	144	4	10.	5970.	0.0023	4.	4.	0.033	5.	297	197	4	10.	3547.	0.0023	4.	4.	0.033	1.
			235.	5970.	0.0023	50.	50.	0.027	20.				100.	3547.	0.0023	50.	50.	0.026	10.
246	146	4	10.	3548.	0.0014	4.	4.	0.027	5.	298	198	4	10.	3100.	0.0065	6.	6.	0.061	1.
			235.	3548.	0.0014	50.	50.	0.022	20.				100.	3100.	0.0065	50.	50.	0.044	10.
248	149	4	10.	1314.	0.0167	4.	4.	0.087	1.	400	145	4	10.	2678.	0.0026	4.	4.	0.035	5.
			100.	1314.	0.0167	50.	50.	0.063	10.				235.	2678.	0.0026	50.	50.	0.028	20.
249	187	4	10.	1896.	0.0295	4.	4.	0.108	1.	402	161	4	10.	3152.	0.0019	4.	4.	0.031	5.
			100.	1896.	0.0295	50.	50.	0.078	10.				235.	3152.	0.0019	50.	50.	0.025	20.
250	150	4	10.	2221.	0.0153	4.	4.	0.084	1.	404	167	4	10.	2057.	0.0019	4.	4.	0.031	5.
			100.	2221.	0.0153	50.	50.	0.061	10.				235.	2057.	0.0019	50.	50.	0.025	20.
251	180	4	10.	978.	0.0082	6.	6.	0.067	1.	407	171	4	10.	3070.	0.0150	6.	6.	0.084	1.
			100.	978.	0.0082	50.	50.	0.048	10.				100.	3070.	0.0150	50.	50.	0.061	10.
252	154	4	10.	1567.	0.0108	6.	6.	0.074	1.	409	171	4	10.	889.	0.0067	6.	6.	0.062	1.
			100.	1567.	0.0108	50.	50.	0.054	10.				100.	889.	0.0067	50.	50.	0.045	10.
254	154	4	10.	1414.	0.0028	4.	4.	0.036	1.	410	172	4	10.	2242.	0.0062	6.	6.	0.060	1.

146	4310.	(DIRECT FLOW)	3	30.
238	4311.	4.2	3	35.
138	4314.	(DIRECT FLOW)	3	35.
237	4291.	7.1	3	40.
137	4294.	(DIRECT FLOW)	3	40.
236	4278.	7.1	3	45.
136	4280.	(DIRECT FLOW)	3	45.
196	133.	(DIRECT FLOW)	0	45.
336	4117.	0.1 257.3	4	0.
140	113.	(DIRECT FLOW)	0	45.
132	110.	(DIRECT FLOW)	0	45.
435	120.	1.4	0	55.
235	4094.	5.4	4	5.
229	51.	1.2	1	20.
231	71.	1.3	1	5.
135	4107.	(DIRECT FLOW)	4	5.
133	219.	(DIRECT FLOW)	0	50.
234	4093.	7.6	4	10.
233	157.	1.5	1	15.
134	4107.	(DIRECT FLOW)	4	10.
131	77.	(DIRECT FLOW)	0	45.
127	86.	(DIRECT FLOW)	0	45.
289	4105.	4.4	4	15.
232	41.	1.1	1	20.
227	66.	1.3	0	55.
189	4117.	(DIRECT FLOW)	4	15.
128	418.	(DIRECT FLOW)	0	40.
126	65.	(DIRECT FLOW)	0	50.
147	117.	(DIRECT FLOW)	0	45.
230	4068.	7.8	4	25.
228	363.	2.0	0	50.
416	56.	1.2	1	5.
222	82.	1.3	1	5.
130	4083.	(DIRECT FLOW)	4	25.
125	221.	(DIRECT FLOW)	1	0.
330	3076.	0.1 194.5	5	25.
422	208.	1.6	1	10.
417	3067.	5.1	5	35.
122	149.	(DIRECT FLOW)	0	45.
505	3074.	(DIRECT FLOW)	5	35.
421	115.	1.3	1	0.
418	3068.	4.8	5	40.
506	3075.	(DIRECT FLOW)	5	40.
424	3074.	4.9	5	45.
165	3078.	(DIRECT FLOW)	5	45.
121	223.	(DIRECT FLOW)	0	45.
265	3076.	3.8	5	50.
298	126.	1.4	1	10.
117	3088.	(DIRECT FLOW)	5	50.
198	751.	(DIRECT FLOW)	0	35.
216	3080.	4.9	6	0.
215	351.	1.6	0	50.
116	3117.	(DIRECT FLOW)	5	55.
209	3115.	4.8	6	0.
114	240.	(DIRECT FLOW)	0	45.
188	3115.	(DIRECT FLOW)	6	0.
212	145.	1.3	1	10.
211	3097.	4.9	6	10.
111	3104.	(DIRECT FLOW)	6	10.
210	3102.	4.9	6	15.
110	3102.	(DIRECT FLOW)	6	15.
263	3097.	3.8	6	20.
109	3097.	(DIRECT FLOW)	6	20.
208	3087.	4.8	6	30.
108	3087.	(DIRECT FLOW)	6	30.
106	69.	(DIRECT FLOW)	1	5.
105	144.	(DIRECT FLOW)	0	45.
419	3027.	4.9	6	55.
204	54.	1.1	1	30.
203	88.	1.2	1	10.
104	3028.	(DIRECT FLOW)	6	55.
202	3027.	4.0	7	0.
102	3027.	(DIRECT FLOW)	7	0.
218	3026.	4.7	7	0.
118	3026.	(DIRECT FLOW)	7	0.
201	3026.	2.6	7	0.
101	3026.	(DIRECT FLOW)	7	0.
420	3024.	3.3	7	5.
119	3024.	(DIRECT FLOW)	7	5.
999	3024.	(DIRECT FLOW)	7	5.

CORRECT CNAME NOT FOUND 0

PROGRAM ENDED NORMALLY

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                    100.   2242.  0.0062     50.     50.   0.044     10.
411  502    4       10.    782.  0.0051      6.      6.   0.056      1.
                    100.    782.  0.0051     50.     50.   0.040     10.
412  502    4       10.   2018.  0.0173      6.      6.   0.089      1.
                    100.   2018.  0.0173     50.     50.   0.064     10.
416  125    4       10.    947.  0.0063      6.      6.   0.060      1.
                    100.    947.  0.0063     50.     50.   0.036     10.
417  505    4       10.   2686.  0.0052      6.      6.   0.049      3.
                    235.   2686.  0.0052     50.     50.   0.049     20.
418  506    4       10.   2787.   0.005      6.      6.   0.048      3.
                    235.   2787.   0.005     50.     50.   0.036     20.
419  104    4       10.   6815.  0.0021      6.      6.   0.034      3.
                    235.   6815.  0.0021     50.     50.   0.025     20.
420  119    4      100.   1382.  0.0072     25.     50.   0.054      3.
                    235.   1382.  0.0072     50.     50.   0.041     20.
421  506    4       10.   1561.  0.0154      6.      6.   0.085      1.
                    100.   1561.  0.0154     50.     50.   0.055     20.
422  505    4       10.   1266.  0.0126      6.      6.   0.079      1.
                    100.   1266.  0.0126     50.     50.   0.051     20.
423  501    4       10.   1321.  0.0167      6.      6.   0.087      1.
                    100.   1321.  0.0167     50.     50.   0.063     10.
424  165    4       10.    563.  0.0036      6.      6.   0.042      3.
                    235.    563.  0.0036     50.     50.   0.031     20.
425  169    4       10.   1146.  0.0087      6.      6.   0.059      3.
                    235.   1146.  0.0087     50.     50.   0.044     20.
427  182    4       10.   1645.  0.0043      6.      6.   0.045      3.
                    235.   1645.  0.0043     50.     50.   0.034     20.
428  510    4       10.   1996.  0.0040      6.      6.   0.044      3.
                    235.   1996.  0.0040     50.     50.   0.033     20.
429  173    4       10.   2749.  0.0033      6.      6.   0.041      3.
                    235.   2749.  0.0033     50.     50.   0.030     20.
430  513    4       10.    932.  0.0032      6.      6.   0.040      3.
                    235.    932.  0.0032     50.     50.   0.030     20.
432  512    4       10.   3305.  0.0106      6.      6.   0.074      1.
                    100.   3305.  0.0106     50.     50.   0.053     10.
433  169    4       10.   4284.  0.0070      6.      6.   0.063      1.
                    100.   4284.  0.0070     50.     50.   0.045     10.
434  168    4       10.   2548.  0.0196      6.      6.   0.093      1.
                    100.   2548.  0.0196     50.     50.   0.067     10.
435  135    4       10.    758.  0.0185      6.      6.   0.091      1.
                    100.    758.  0.0185     50.     50.   0.066     10.
-1  942  433  8 3    10.      1.     0.1                   0.01     10.
     0.        0.     0.50     293.0      0.83    2405.4     1.00    2972.7
   1.17    2806.5     2.00     748.4      3.33     141.8     6.00      89.2
-1  937  513  8 3    10.      1.     0.1                   0.01     10.
     0.        0.     0.67     261.3      0.83     505.0     1.00     563.5
   1.33     458.4     1.83     224.5      2.58      71.1     6.00       0.2
-1  935  512  8 3    10.      1.     0.1                   0.01     10.
     0.        0.     0.67     334.5      1.50    7219.1     1.67    7699.9
   1.92    7094.3     3.00    2281.4      4.00     830.9     6.00     378.5

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ENDPROGRAM
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LOWER SECOND CREEK, 100YR FUTURE CONDITIONS
KIOWA ENGINEERING CORPORATION REVISED 5/13/02

*** PEAK FLOWS, STAGES AND STORAGES OF GUTTERS AND DETENTION DAMS ***

CONVEYANCE ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR/MIN)
115	412.	(DIRECT FLOW)	0	40.
935	7716.	(DIRECT FLOW)	1	40.
432	194.	1.6	0	55.
512	7860.	(DIRECT FLOW)	1	40.
181	295.	(DIRECT FLOW)	0	40.
427	7724.	6.2	1	45.
281	139.	1.4	0	55.
182	7814.	(DIRECT FLOW)	1	45.
509	7876.	(DIRECT FLOW)	1	45.
428	7777.	6.2	1	50.
510	7805.	(DIRECT FLOW)	1	50.
177	280.	(DIRECT FLOW)	0	40.
937	571.	(DIRECT FLOW)	1	0.
430	7797.	6.3	1	50.
277	124.	1.4	1	0.
507	226.	(DIRECT FLOW)	0	40.
513	8112.	(DIRECT FLOW)	1	50.
178	347.	(DIRECT FLOW)	0	40.
423	162.	1.5	0	50.
429	7954.	6.3	1	55.
273	140.	1.4	1	0.
501	364.	(DIRECT FLOW)	0	45.
173	8053.	(DIRECT FLOW)	1	55.
412	282.	1.7	1	0.
411	8045.	5.5	2	0.
502	8134.	(DIRECT FLOW)	2	0.
410	8054.	5.5	2	5.
172	8090.	(DIRECT FLOW)	2	5.
504	182.	(DIRECT FLOW)	0	50.
409	8077.	5.5	2	5.
407	113.	1.4	1	15.
942	2983.	(DIRECT FLOW)	1	0.
171	8147.	(DIRECT FLOW)	2	5.
433	2477.	3.5	1	20.
425	8125.	6.1	2	10.
169	9312.	(DIRECT FLOW)	2	5.
158	412.	(DIRECT FLOW)	0	40.
297	9172.	5.7	2	10.
259	308.	1.8	0	50.
197	9193.	(DIRECT FLOW)	2	10.
514	72.	(DIRECT FLOW)	0	50.
157	933.	(DIRECT FLOW)	0	45.
293	9176.	5.7	2	15.
434	48.	1.1	1	20.
256	815.	2.4	0	55.
193	9185.	(DIRECT FLOW)	2	15.
168	512.	(DIRECT FLOW)	0	40.
194	180.	(DIRECT FLOW)	0	40.
156	1004.	(DIRECT FLOW)	0	55.
404	9131.	8.5	2	20.
268	234.	1.6	1	0.
267	96.	1.3	0	55.
255	915.	2.5	1	5.
167	9247.	(DIRECT FLOW)	2	15.
159	987.	(DIRECT FLOW)	1	5.
266	9247.	5.7	2	20.
290	943.	2.5	1	10.
166	9260.	(DIRECT FLOW)	2	20.
107	9439.	(DIRECT FLOW)	2	20.
402	9340.	8.6	2	25.
161	9353.	(DIRECT FLOW)	2	25.
257	9314.	6.1	2	30.
155	9323.	(DIRECT FLOW)	2	30.
153	255.	(DIRECT FLOW)	0	50.
254	9294.	5.8	2	35.
252	216.	1.6	1	5.
154	9321.	(DIRECT FLOW)	2	30.
294	9323.	6.1	2	35.
152	9332.	(DIRECT FLOW)	2	35.
151	183.	(DIRECT FLOW)	0	50.
186	434.	(DIRECT FLOW)	0	40.
280	9275.	5.9	2	40.
251	167.	1.5	1	0.
250	264.	1.7	0	50.
180	9285.	(DIRECT FLOW)	2	40.
164	89.	(DIRECT FLOW)	0	50.
150	568.	(DIRECT FLOW)	0	45.
148	399.	(DIRECT FLOW)	0	40.
400	9216.	8.4	2	45.
264	56.	1.2	1	15.
217	522.	2.1	0	50.
248	304.	1.8	0	50.
145	9259.	(DIRECT FLOW)	2	45.
179	417.	(DIRECT FLOW)	0	50.
149	610.	(DIRECT FLOW)	0	40.
244	8922.	8.4	3	0.
240	310.	1.8	1	10.
249	499.	2.0	0	50.
144	8928.	(DIRECT FLOW)	3	0.
192	427.	(DIRECT FLOW)	1	5.
187	8954.	(DIRECT FLOW)	3	0.
143	407.	(DIRECT FLOW)	0	40.
139	201.	(DIRECT FLOW)	0	45.
292	375.	1.9	1	20.
246	8834.	8.5	3	10.
242	195.	1.6	1	0.
239	137.	1.4	1	5.
146	8910.	(DIRECT FLOW)	3	10.

238	8910.	5.5	3	10.
138	8913.	(DIRECT FLOW)	3	10.
237	8883.	8.4	3	15.
137	8887.	(DIRECT FLOW)	3	15.
236	8867.	8.4	3	20.
196	133.	(DIRECT FLOW)	0	45.
136	8868.	(DIRECT FLOW)	3	20.
140	113.	(DIRECT FLOW)	0	45.
132	110.	(DIRECT FLOW)	0	45.
435	120.	1.4	0	55.
235	8836.	6.7	3	25.
229	51.	1.2	1	20.
231	71.	1.3	1	5.
135	8853.	(DIRECT FLOW)	3	25.
133	219.	(DIRECT FLOW)	0	50.
234	8829.	9.0	3	25.
233	157.	1.5	1	15.
134	8850.	(DIRECT FLOW)	3	25.
131	77.	(DIRECT FLOW)	0	45.
127	86.	(DIRECT FLOW)	0	45.
289	8851.	5.8	3	30.
232	41.	1.1	1	20.
227	66.	1.3	0	55.
126	65.	(DIRECT FLOW)	0	50.
147	117.	(DIRECT FLOW)	0	45.
189	8863.	(DIRECT FLOW)	3	30.
128	418.	(DIRECT FLOW)	0	40.
416	56.	1.2	1	5.
222	82.	1.3	1	5.
230	8795.	9.4	3	35.
228	363.	2.0	0	50.
125	221.	(DIRECT FLOW)	1	0.
130	8812.	(DIRECT FLOW)	3	35.
422	208.	1.6	1	10.
417	8734.	6.9	3	45.
122	149.	(DIRECT FLOW)	0	45.
505	8742.	(DIRECT FLOW)	3	45.
421	115.	1.3	1	0.
418	8689.	6.4	3	50.
506	8696.	(DIRECT FLOW)	3	50.
424	8690.	6.4	3	50.
165	8694.	(DIRECT FLOW)	3	50.
121	223.	(DIRECT FLOW)	0	45.
265	8669.	5.6	3	55.
298	126.	1.4	1	10.
117	8681.	(DIRECT FLOW)	3	55.
198	751.	(DIRECT FLOW)	0	35.
216	8615.	6.5	4	5.
215	351.	1.6	0	50.
116	8665.	(DIRECT FLOW)	4	5.
209	8659.	6.4	4	5.
114	240.	(DIRECT FLOW)	0	45.
188	8659.	(DIRECT FLOW)	4	5.
212	145.	1.3	1	10.
211	8553.	6.5	4	15.
111	8563.	(DIRECT FLOW)	4	15.
210	8548.	6.5	4	20.
110	8556.	(DIRECT FLOW)	4	20.
263	8527.	5.4	4	25.
109	8531.	(DIRECT FLOW)	4	25.
208	8464.	6.4	4	30.
108	8469.	(DIRECT FLOW)	4	30.
106	69.	(DIRECT FLOW)	1	5.
105	144.	(DIRECT FLOW)	0	45.
419	8145.	6.4	4	50.
204	54.	1.1	1	30.
203	88.	1.2	1	10.
104	8154.	(DIRECT FLOW)	4	50.
202	8145.	5.3	4	55.
102	8149.	(DIRECT FLOW)	4	55.
218	8151.	6.1	4	55.
118	8154.	(DIRECT FLOW)	4	55.
201	8154.	3.8	4	55.
101	8154.	(DIRECT FLOW)	4	55.
420	8139.	4.6	5	0.
119	8139.	(DIRECT FLOW)	5	0.
999	8139.	(DIRECT FLOW)	5	0.

CORRECT CNAME NOT FOUND 0

PROGRAM ENDED NORMALLY

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  366  107 12 2      .1      .1   0.1        0.       0.     0.       0.
    0.        0.     0.23       24.      1.20       54.      3.4      72.
 10.7       87.     29.4       99.      69.7      110.    136.2     120.
183.0     1625.    228.9     4372.     351.0    12138.    506.4   22192.
  336  235 12 2      .1      .1   0.1        0.       0.     0.       0.
    0.        0.     0.49      136.      2.10      272.      5.2     385.
 18.7      472.     57.3      545.     121.6      609.    170.0     639.
218.4     2167.    345.1     8515.     491.9    17541.    679.4   28598.
  330  417 10 2      .1      .1   0.1        0.       0.     0.       0.
    0.        0.     6.70      735.      46.5     1644.     87.0    2206.
128.2     2652.    187.0     3032.     245.4     3370.    408.7    3677.
624.0     3960.    882.9     4225.
  101  420    3     10.      1.     0.1                    0.01      1.
  102  218    3     10.      1.     0.1                    0.01      1.
  104  202    3     10.      1.     0.1                    0.01      1.
  105  203    3     10.      1.     0.1                    0.01      1.
  106  204    3     10.      1.     0.1                    0.01      1.
  107  402    3     10.      1.     0.1                    0.01      1.
  108  419    3     10.      1.     0.1                    0.01      1.
  109  208    3     10.      1.     0.1                    0.01      1.
  110  263    3     10.      1.     0.1                    0.01      1.
  111  210    3     10.      1.     0.1                    0.01      1.
  114  212    3     10.      1.     0.1                    0.01      1.
  115  432    3     10.      1.     0.1                    0.01      1.
  116  209    3     10.      1.     0.1                    0.01      1.
  117  216    3     10.      1.     0.1                    0.01      1.
  118  201    3     10.      1.     0.1                    0.01      1.
  119  999    3     10.      1.     0.1                    0.01      1.
  121  298    3     10.      1.     0.1                    0.01      1.
  122  421    3     10.      1.     0.1                    0.01      1.
  125  422    3     10.      1.     0.1                    0.01      1.
  126  416    3     10.      1.     0.1                    0.01      1.
  127  227    3     10.      1.     0.1                    0.01      1.
  128  228    3     10.      1.     0.1                    0.01      1.
  130  330    3     10.      1.     0.1                    0.01      1.
  131  232    3     10.      1.     0.1                    0.01      1.
  132  231    3     10.      1.     0.1                    0.01      1.
  133  233    3     10.      1.     0.1                    0.01      1.
  134  289    3     10.      1.     0.1                    0.01      1.
  135  234    3     10.      1.     0.1                    0.01      1.
  136  336    3     10.      1.     0.1                    0.01      1.
  137  236    3     10.      1.     0.1                    0.01      1.
  138  237    3     10.      1.     0.1                    0.01      1.
  139  239    3     10.      1.     0.1                    0.01      1.
  140  229    3     10.      1.     0.1                    0.01      1.
  143  242    3     10.      1.     0.1                    0.01      1.
  144  187    3     10.      1.     0.1                    0.01      1.
  145  244    3     10.      1.     0.1                    0.01      1.
  146  238    3     10.      1.     0.1                    0.01      1.
  147  222    3     10.      1.     0.1                    0.01      1.
  148  248    3     10.      1.     0.1                    0.01      1.
  149  249    3     10.      1.     0.1                    0.01      1.
  150  217    3     10.      1.     0.1                    0.01      1.
  151  251    3     10.      1.     0.1                    0.01      1.
  152  280    3     10.      1.     0.1                    0.01      1.
  153  252    3     10.      1.     0.1                    0.01      1.
  154  294    3     10.      1.     0.1                    0.01      1.
  155  254    3     10.      1.     0.1                    0.01      1.
  156  255    3     10.      1.     0.1                    0.01      1.
  157  256    3     10.      1.     0.1                    0.01      1.
  158  259    3     10.      1.     0.1                    0.01      1.
  159  290    3     10.      1.     0.1                    0.01      1.
  161  257    3     10.      1.     0.1                    0.01      1.
  164  264    3     10.      1.     0.1                    0.01      1.
  165  265    3     10.      1.     0.1                    0.01      1.
  166  366    3     10.      1.     0.1                    0.01      1.
  167  266    3     10.      1.     0.1                    0.01      1.
  168  268    3     10.      1.     0.1                    0.01      1.
  169  297    3     10.      1.     0.1                    0.01      1.
  171  425    3     10.      1.     0.1                    0.01      1.
  172  409    3     10.      1.     0.1                    0.01      1.
  173  411    3     10.      1.     0.1                    0.01      1.
  177  277    3     10.      1.     0.1                    0.01      1.
  178  273    3     10.      1.     0.1                    0.01      1.
  179  240    3     10.      1.     0.1                    0.01      1.
  180  400    3     10.      1.     0.1                    0.01      1.
  181  281    3     10.      1.     0.1                    0.01      1.
  182  509    3     10.      1.     0.1                    0.01      1.
  186  250    3     10.      1.     0.1                    0.01      1.
  187  246    3     10.      1.     0.1                    0.01      1.
  188  211    3     10.      1.     0.1                    0.01      1.
  189  230    3     10.      1.     0.1                    0.01      1.
  192  292    3     10.      1.     0.1                    0.01      1.
  193  404    3     10.      1.     0.1                    0.01      1.
  194  267    3     10.      1.     0.1                    0.01      1.
  196  435    3     10.      1.     0.1                    0.01      1.
  197  293    3     10.      1.     0.1                    0.01      1.
  198  215    3     10.      1.     0.1                    0.01      1.
  501  412    3     10.      1.     0.1                    0.01      1.
  502  410    3     10.      1.     0.1                    0.01      1.
  504  407    3     10.      1.     0.1                    0.01      1.
  505  418    3     10.      1.     0.1                    0.01      1.
  506  424    3     10.      1.     0.1                    0.01      1.
  507  423    3     10.      1.     0.1                    0.01      1.
  509  428    3     10.      1.     0.1                    0.01      1.
  510  430    3     10.      1.     0.1                    0.01      1.
  512  427    3     10.      1.     0.1                    0.01      1.
  513  429    3     10.      1.     0.1                    0.01      1.
  514  434    3     10.      1.     0.1                    0.01      1.
  201  101    4    100.      1.  0.0014     50.      50.   0.034      1.
                   235.      1.  0.0014    100.     100.   0.022     20.
  202  102    4     10.    875.  0.0046     25.      50.   0.047      3.
                   235.    875.  0.0046     50.      50.   0.035     20.
  203  104    4     10.   2142.  0.0084      6.       6.   0.067      1.
                   235.   2142.  0.0084     50.      50.   0.044     20.
  204  104    4     10.   1729.  0.0035      6.       6.   0.048      1.
```

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                    100.   3100.  0.0065     50.     50.   0.044     10.
    400  145    4    10.   2678.  0.0026      4.      4.   0.035      5.
                    235.   2678.  0.0026     50.     50.   0.028     20.
    402  161    4    10.   3152.  0.0019      4.      4.   0.031      5.
                    235.   3152.  0.0019     50.     50.   0.025     20.
    404  167    4    10.   2057.  0.0019      4.      4.   0.031      5.
                    235.   2057.  0.0019     50.     50.   0.025     20.
    407  171    4    10.   3070.  0.0150      6.      6.   0.084      1.
                    100.   3070.  0.0150     50.     50.   0.061     10.
    409  171    4    10.    889.  0.0067      6.      6.   0.062      1.
                    100.    889.  0.0067     50.     50.   0.045     10.
    410  172    4    10.   2242.  0.0062      6.      6.   0.060      1.
                    100.   2242.  0.0062     50.     50.   0.044     10.
    411  502    4    10.    782.  0.0051      6.      6.   0.056      1.
                    100.    782.  0.0051     50.     50.   0.040     10.
    412  502    4    10.   2018.  0.0173      6.      6.   0.089      1.
                    100.   2018.  0.0173     50.     50.   0.064     10.
    416  125    4    10.    947.  0.0063      6.      6.   0.060      1.
                    100.    947.  0.0063     50.     50.   0.036     10.
    417  505    4    10.   2686.  0.0052      6.      6.   0.049      3.
                    235.   2686.  0.0052     50.     50.   0.049     20.
    418  506    4    10.   2787.   0.005      6.      6.   0.048      3.
                    235.   2787.   0.005     50.     50.   0.036     20.
    419  104    4    10.   6815.  0.0021      6.      6.   0.034      3.
                    235.   6815.  0.0021     50.     50.   0.025     20.
    420  119    4   100.   1382.  0.0072     25.     50.   0.054      3.
                    235.   1382.  0.0072     50.     50.   0.041     20.
    421  506    4    10.   1561.  0.0154      6.      6.   0.085      1.
                    100.   1561.  0.0154     50.     50.   0.055     20.
    422  505    4    10.   1266.  0.0126      6.      6.   0.079      1.
                    100.   1266.  0.0126     50.     50.   0.051     20.
    423  501    4    10.   1321.  0.0167      6.      6.   0.087      1.
                    100.   1321.  0.0167     50.     50.   0.063     10.
    424  165    4    10.    563.  0.0036      6.      6.   0.042      3.
                    235.    563.  0.0036     50.     50.   0.031     20.
    425  169    4    10.   1146.  0.0087      6.      6.   0.059      3.
                    235.   1146.  0.0087     50.     50.   0.044     20.
    427  182    4    10.   1645.  0.0043      6.      6.   0.045      3.
                    235.   1645.  0.0043     50.     50.   0.034     20.
    428  510    4    10.   1996.  0.0040      6.      6.   0.044      3.
                    235.   1996.  0.0040     50.     50.   0.033     20.
    429  173    4    10.   2749.  0.0033      6.      6.   0.041      3.
                    235.   2749.  0.0033     50.     50.   0.030     20.
    430  513    4    10.    932.  0.0032      6.      6.   0.040      3.
                    235.    932.  0.0032     50.     50.   0.030     20.
    432  512    4    10.   3305.  0.0106      6.      6.   0.074      1.
                    100.   3305.  0.0106     50.     50.   0.053     10.
    433  169    4    10.   4284.  0.0070      6.      6.   0.063      1.
                    100.   4284.  0.0070     50.     50.   0.045     10.
    434  168    4    10.   2548.  0.0196      6.      6.   0.093      1.
                    100.   2548.  0.0196     50.     50.   0.067     10.
    435  135    4    10.    758.  0.0185      6.      6.   0.091      1.
                    100.    758.  0.0185     50.     50.   0.066     10.
-1  942  433  8 3    10.      1.     0.1                   0.01     10.
```

```
      0.        0.      0.67     185.0      1.08     978.0      1.25    1436.0
     1.50    1731.0      2.00    1329.0      3.33     378.0      6.00      97.0
  -1  937  513  8 3     10.      1.     0.1                    0.01     10.
      0.        0.      0.50      20.7      0.83     505.0      1.00     563.5
     1.17     534.0      1.83     224.5      2.58      71.1      6.00       0.2
  -1  935  512  8 3     10.      1.     0.1                    0.01     10.
      0.        0.      0.58      98.7      1.00    1619.0      1.33    2293.0
     1.67    1915.0      2.33     931.0      3.67     559.0      6.00     559.0

   0
   0
   0
ENDPROGRAM
```

CURRENT DATE: 02-23-2004
CURRENT TIME: 09:41:47

FILE DATE: 2/23/04 E
FILE NAME: brigh102

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

CULVERT	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
NO.	INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	95.00	94.00	100.00	4 RCB	14.00	7.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: brigh102 DATE: 2/23/04

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
95.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
97.25	482.4	482.4	0.0	0.0	0.0	0.0	0.0	0.00	1
98.56	964.8	964.8	0.0	0.0	0.0	0.0	0.0	0.00	1
99.64	1447.2	1447.2	0.0	0.0	0.0	0.0	0.0	0.00	1
100.60	1929.6	1929.6	0.0	0.0	0.0	0.0	0.0	0.00	1
101.50	2412.0	2412.0	0.0	0.0	0.0	0.0	0.0	0.00	1
102.40	2894.4	2894.4	0.0	0.0	0.0	0.0	0.0	0.00	1
103.32	3376.8	3376.8	0.0	0.0	0.0	0.0	0.0	0.00	1
104.13	3859.2	3778.5	0.0	0.0	0.0	0.0	0.0	70.08	4
104.42	4341.6	3918.1	0.0	0.0	0.0	0.0	0.0	417.04	4
104.65	4824.0	4023.7	0.0	0.0	0.0	0.0	0.0	787.82	3
104.00	3713.7	3713.7	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: brigh102 DATE: 2/23/04

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
95.00	0.000	0.00	0.00	0.00
97.25	0.000	482.40	0.00	0.00
98.56	0.000	964.80	0.00	0.00
99.64	0.000	1447.20	0.00	0.00
100.60	0.000	1929.60	0.00	0.00
101.50	0.000	2412.00	0.00	0.00
102.40	0.000	2894.40	0.00	0.00
103.32	0.000	3376.80	0.00	0.00
104.13	-0.007	3859.20	10.61	0.27
104.42	-0.003	4341.60	6.47	0.15
104.65	-0.005	4824.00	12.52	0.26

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 02-23-2004
CURRENT TIME: 09:41:47
FILE DATE: 2/23/04 E
FILE NAME: brigh102

PERFORMANCE CURVE FOR CULVERT 1 - 4(14.00 (ft) BY 7.00 (ft)) RCB

DIS- HEAD- INLET OUTLET

CURRENT DATE: 03-04-2004
CURRENT TIME: 12:15:21

FILE DATE: 3/4/04 E
FILE NAME: RR108

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

CULVERT	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
NO.	INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	5013.40	5012.40	50.01	3 RCB	16.00	8.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: RR108 DATE: 3/4/04 E

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
5018.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5020.15	363.5	363.5	0.0	0.0	0.0	0.0	0.0	0.00	1
5020.87	727.0	727.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5021.58	1090.5	1090.5	0.0	0.0	0.0	0.0	0.0	0.00	1
5022.25	1454.0	1454.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5022.92	1817.5	1817.5	0.0	0.0	0.0	0.0	0.0	0.00	1
5023.25	2000.0	2000.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5024.25	2544.5	2544.5	0.0	0.0	0.0	0.0	0.0	0.00	1
5024.94	2908.0	2908.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5025.65	3271.5	3271.5	0.0	0.0	0.0	0.0	0.0	0.00	1
5026.39	3635.0	3635.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5028.00	4251.8	4251.8	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: RR108 DATE: 3/4/04 E

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
5018.50	0.000	0.00	0.00	0.00
5020.15	0.000	363.50	0.00	0.00
5020.87	0.000	727.00	0.00	0.00
5021.58	0.000	1090.50	0.00	0.00
5022.25	0.000	1454.00	0.00	0.00
5022.92	0.000	1817.50	0.00	0.00
5023.25	0.000	2000.00	0.00	0.00
5024.25	0.000	2544.50	0.00	0.00
5024.94	0.000	2908.00	0.00	0.00
5025.65	0.000	3271.50	0.00	0.00
5026.39	0.000	3635.00	0.00	0.00

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 03-04-2004
CURRENT TIME: 12:15:21
FILE DATE: 3/4/04 E
FILE NAME: RR108

PERFORMANCE CURVE FOR CULVERT 1 - 3(16.00 (ft) BY 8.00 (ft)) RCB

DIS- HEAD- INLET OUTLET

CURRENT DATE: 03-04-2004
CURRENT TIME: 10:35:34

FILE DATE: 3/4/04 E
FILE NAME: US85108

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V	SITE DATA: INLET ELEV. (ft)	SITE DATA: OUTLET ELEV. (ft)	SITE DATA: CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS / SHAPE / MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
NO.								
1	5012.50	5011.50	150.00	3 RCB	16.00	8.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: US85108 DATE: 3/4/04 E

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
5012.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5014.30	363.5	363.5	0.0	0.0	0.0	0.0	0.0	0.00	1
5015.36	727.0	727.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5016.25	1090.5	1090.5	0.0	0.0	0.0	0.0	0.0	0.00	1
5017.08	1454.0	1454.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5017.86	1817.5	1817.5	0.0	0.0	0.0	0.0	0.0	0.00	1
5018.61	2181.0	2181.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5018.71	2229.0	2229.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5020.04	2908.0	2908.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5020.75	3271.5	3271.5	0.0	0.0	0.0	0.0	0.0	0.00	1
5021.46	3635.0	3635.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5023.00	4389.3	4389.3	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: US85108 DATE: 3/4/04 E

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
5012.50	0.000	0.00	0.00	0.00
5014.30	0.000	363.50	0.00	0.00
5015.36	0.000	727.00	0.00	0.00
5016.25	0.000	1090.50	0.00	0.00
5017.08	0.000	1454.00	0.00	0.00
5017.86	0.000	1817.50	0.00	0.00
5018.61	0.000	2181.00	0.00	0.00
5018.71	0.000	2229.00	0.00	0.00
5020.04	0.000	2908.00	0.00	0.00
5020.75	0.000	3271.50	0.00	0.00
5021.46	0.000	3635.00	0.00	0.00

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 03-04-2004
CURRENT TIME: 10:35:34

FILE DATE: 3/4/04 E
FILE NAME: US85108

PERFORMANCE CURVE FOR CULVERT 1 - 3(16.00 (ft) BY 8.00 (ft)) RCB

DIS- HEAD- INLET OUTLET

CURRENT DATE: 03-04-2004
CURRENT TIME: 10:42:31

FILE DATE: 3/4/04 E
FILE NAME: 136th108

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V	SITE DATA: INLET ELEV. (ft)	SITE DATA: OUTLET ELEV. (ft)	SITE DATA: CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS / SHAPE / MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
NO.								
1	5014.00	5013.25	100.00	3 RCB	16.00	8.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 136th108 DATE: 3/4/04 E

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
5014.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5016.08	363.5	363.5	0.0	0.0	0.0	0.0	0.0	0.00	1
5017.29	727.0	727.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5018.29	1090.5	1090.5	0.0	0.0	0.0	0.0	0.0	0.00	1
5019.17	1454.0	1454.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5019.66	1672.0	1672.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5020.74	2181.0	2181.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5021.48	2544.5	2544.5	0.0	0.0	0.0	0.0	0.0	0.00	1
5022.21	2908.0	2908.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5022.96	3271.5	3271.5	0.0	0.0	0.0	0.0	0.0	0.00	1
5023.73	3635.0	3635.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5024.00	3756.4	3756.4	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 136th108 DATE: 3/4/04 E

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
5014.00	0.000	0.00	0.00	0.00
5016.08	0.000	363.50	0.00	0.00
5017.29	0.000	727.00	0.00	0.00
5018.29	0.000	1090.50	0.00	0.00
5019.17	0.000	1454.00	0.00	0.00
5019.66	0.000	1672.00	0.00	0.00
5020.74	0.000	2181.00	0.00	0.00
5021.48	0.000	2544.50	0.00	0.00
5022.21	0.000	2908.00	0.00	0.00
5022.96	0.000	3271.50	0.00	0.00
5023.73	0.000	3635.00	0.00	0.00

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 03-04-2004
CURRENT TIME: 10:42:31

FILE DATE: 3/4/04 E
FILE NAME: 136th108

PERFORMANCE CURVE FOR CULVERT 1 - 3(16.00 (ft) BY 8.00 (ft)) RCB

DIS- HEAD- INLET OUTLET

CURRENT DATE: 02-23-2004 FILE DATE: 2/23/04 E
CURRENT TIME: 10:51:12 FILE NAME: 132_109

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

SITE DATA — CULVERT SHAPE, MATERIAL, INLET

NO.	INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	5027.00	5026.50	50.00	2 RCB	8.00	4.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 132_109 DATE: 2/23/04

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
5027.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5031.31	366.6	366.6	0.0	0.0	0.0	0.0	0.0	0.00	1
5032.55	500.0	500.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5035.16	1099.8	717.4	0.0	0.0	0.0	0.0	0.0	380.73	5
5035.76	1466.4	758.0	0.0	0.0	0.0	0.0	0.0	707.22	3
5036.27	1833.0	791.5	0.0	0.0	0.0	0.0	0.0	1040.63	3
5036.74	2199.6	820.1	0.0	0.0	0.0	0.0	0.0	1378.73	3
5037.18	2566.2	846.2	0.0	0.0	0.0	0.0	0.0	1719.48	3
5037.58	2932.8	869.9	0.0	0.0	0.0	0.0	0.0	2062.21	3
5037.97	3299.4	891.8	0.0	0.0	0.0	0.0	0.0	2407.04	3
5038.34	3666.0	912.2	0.0	0.0	0.0	0.0	0.0	2752.61	3
5034.00	629.6	629.6	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 132_109 DATE: 2/23/04

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
5027.00	0.000	0.00	0.00	0.00
5031.31	0.000	366.60	0.00	0.00
5032.55	0.000	500.00	0.00	0.00
5035.16	-0.003	1099.80	1.68	0.15
5035.76	-0.001	1466.40	1.13	0.08
5036.27	-0.001	1833.00	0.88	0.05
5036.74	-0.001	2199.60	0.74	0.03
5037.18	0.000	2566.20	0.56	0.02
5037.58	-0.001	2932.80	0.72	0.02
5037.97	0.000	3299.40	0.59	0.02
5038.34	-0.001	3666.00	1.19	0.03

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 02-23-2004 FILE DATE: 2/23/04 E
CURRENT TIME: 10:51:12 FILE NAME: 132_109

PERFORMANCE CURVE FOR CULVERT 1 - 2(8.00 (ft) BY 4.00 (ft)) RCB

DIS- HEAD- INLET OUTLET

CURRENT DATE: 02-23-2004 FILE DATE: 2/23/04 E
CURRENT TIME: 11:10:28 FILE NAME: 124th188

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

SITE DATA — CULVERT SHAPE, MATERIAL, INLET

NO.	INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	5054.00	5053.50	100.00	5 RCB	13.00	7.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: 124th188 DATE: 2/23/04

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
5054.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5055.96	450.0	450.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5057.11	900.0	900.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5058.04	1350.0	1350.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5058.87	1800.0	1800.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5059.63	2250.0	2250.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5060.36	2700.0	2700.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5061.08	3150.0	3150.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5061.80	3600.0	3600.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5062.02	3731.0	3728.0	0.0	0.0	0.0	0.0	0.0	0.54	4
5062.89	4500.0	4244.2	0.0	0.0	0.0	0.0	0.0	255.78	3
5062.00	3718.9	3718.9	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 124th188 DATE: 2/23/04

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
5054.00	0.000	0.00	0.00	0.00
5055.96	0.000	450.00	0.00	0.00
5057.11	0.000	900.00	0.00	0.00
5058.04	0.000	1350.00	0.00	0.00
5058.87	0.000	1800.00	0.00	0.00
5059.63	0.000	2250.00	0.00	0.00
5060.36	0.000	2700.00	0.00	0.00
5061.08	0.000	3150.00	0.00	0.00
5061.80	0.000	3600.00	0.00	0.00
5062.02	-0.003	3731.00	2.43	0.07
5062.89	0.000	4500.00	0.05	0.00

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 02-23-2004 FILE DATE: 2/23/04 E
CURRENT TIME: 11:10:28 FILE NAME: 124th188

PERFORMANCE CURVE FOR CULVERT 1 - 5(13.00 (ft) BY 7.00 (ft)) RCB

DIS- HEAD- INLET OUTLET

CURRENT DATE: 02-23-2004 FILE DATE: 2/23/04 E
CURRENT TIME: 11:41:43 FILE NAME: 88th

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

CULVERT NO.	SITE DATA: INLET ELEV. (ft)	SITE DATA: OUTLET ELEV. (ft)	SITE DATA: CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS	SHAPE	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	5081.00	5080.00	100.00	3	RCB	20.00	10.00	.012	CONVENTIONAL
2									
3									
4									
5									
6									

SUMMARY OF CULVERT FLOWS (cfs) FILE: 88th DATE: 2/23/04

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
5081.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5083.50	600.0	600.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5084.95	1200.0	1200.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5086.16	1800.0	1800.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5087.21	2400.0	2400.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5088.19	3000.0	3000.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5089.10	3600.0	3600.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5089.98	4200.0	4200.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5090.85	4800.0	4800.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5091.37	5156.0	5156.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5092.61	6000.0	6000.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5192.00	28913.3	0.0	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: 88th DATE: 2/23/04

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
5081.00	0.000	0.00	0.00	0.00
5083.50	0.000	600.00	0.00	0.00
5084.95	0.000	1200.00	0.00	0.00
5086.16	0.000	1800.00	0.00	0.00
5087.21	0.000	2400.00	0.00	0.00
5088.19	0.000	3000.00	0.00	0.00
5089.10	0.000	3600.00	0.00	0.00
5089.98	0.000	4200.00	0.00	0.00
5090.85	0.000	4800.00	0.00	0.00
5091.37	0.000	5156.00	0.00	0.00
5092.61	0.000	6000.00	0.00	0.00

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 02-23-2004 FILE DATE: 2/23/04 E
CURRENT TIME: 11:41:43 FILE NAME: 88th

PERFORMANCE CURVE FOR CULVERT 1 - 3(20.00 (ft) BY 10.00 (ft)) RCB

DIS- HEAD- INLET OUTLET

CURRENT DATE: 02-23-2004 FILE DATE: 2/23/04 E
CURRENT TIME: 11:49:59 FILE NAME: Tower

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

CULVERT NO.	SITE DATA: INLET ELEV. (ft)	SITE DATA: OUTLET ELEV. (ft)	SITE DATA: CULVERT LENGTH (ft)	CULVERT SHAPE, MATERIAL, INLET: BARRELS	SHAPE	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	5205.00	5204.00	75.01	4	RCB	12.00	7.00	.012	CONVENTIONAL
2									
3									
4									
5									
6									

SUMMARY OF CULVERT FLOWS (cfs) FILE: Tower DATE: 2/23/04

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
5205.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5206.83	360.2	360.2	0.0	0.0	0.0	0.0	0.0	0.00	1
5207.90	720.4	720.4	0.0	0.0	0.0	0.0	0.0	0.00	1
5208.81	1080.6	1080.6	0.0	0.0	0.0	0.0	0.0	0.00	1
5209.63	1440.8	1440.8	0.0	0.0	0.0	0.0	0.0	0.00	1
5209.76	1500.0	1500.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5211.08	2161.2	2161.2	0.0	0.0	0.0	0.0	0.0	0.00	1
5211.74	2521.4	2521.4	0.0	0.0	0.0	0.0	0.0	0.00	1
5212.39	2881.6	2881.6	0.0	0.0	0.0	0.0	0.0	0.00	1
5213.04	3241.8	3241.8	0.0	0.0	0.0	0.0	0.0	0.00	1
5213.69	3602.0	3602.0	0.0	0.0	0.0	0.0	0.0	0.00	1
5214.00	3765.8	3765.8	0.0	0.0	0.0	0.0	0.0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: Tower DATE: 2/23/04

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
5205.00	0.000	0.00	0.00	0.00
5206.83	0.000	360.20	0.00	0.00
5207.90	0.000	720.40	0.00	0.00
5208.81	0.000	1080.60	0.00	0.00
5209.63	0.000	1440.80	0.00	0.00
5209.76	0.000	1500.00	0.00	0.00
5211.08	0.000	2161.20	0.00	0.00
5211.74	0.000	2521.40	0.00	0.00
5212.39	0.000	2881.60	0.00	0.00
5213.04	0.000	3241.80	0.00	0.00
5213.69	0.000	3602.00	0.00	0.00

<1> TOLERANCE (ft) = 0.010 <2> TOLERANCE (%) = 1.000

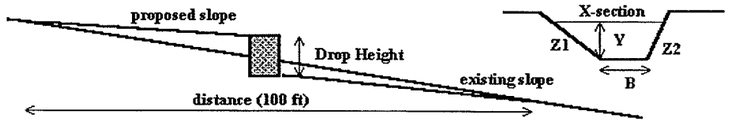
CURRENT DATE: 02-23-2004 FILE DATE: 2/23/04 E
CURRENT TIME: 11:49:59 FILE NAME: Tower

PERFORMANCE CURVE FOR CULVERT 1 - 4(12.00 (ft) BY 7.00 (ft)) RCB

DIS- HEAD- INLET OUTLET

Design of Trapezoidal Grass-Lined Channel

Project: Second Creek
Channel ID: 5-year wetland bottom channel: Outlet to Brighton Rd



Existing Channel Condition (Input)			
Design Discharge	Q_D=	500.0	cfs
Design Discharge Return Period	$Year_D$=	5	years
Existing Ground Slope Along Channel Centerline	So =	0.0041	ft/ft
100-Year Discharge	**Q_{100}=**	**500.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.080	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	45.6 ft	45.6 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.31 ft**	**4.00 ft**
100-Year Flow Velocity	**V_{100}=**	**3.9 fps**	**2.0 fps**
100-Year Top Width	T=	64.1 ft	77.6 ft
100-Year Flow Area	A=	126.6 sq ft	246.3 sq ft
100-Year Froude Number	**Fr =**	**0.24**	**0.04**
100-Year Wetted Perimeter	P=	64.6 ft	78.6 ft
100-Year Hydarulic Radius	R=	2.0 ft	3.1 ft
Design Discharge Flow Depth	Y_D=	**2.31 ft**	**4.00** ft
Design Discharge Flow Velocity	V_D=	**3.9 fps**	**2.0** fps
Design Discharge Top Width	T=	64.1 ft	77.6 ft
Design Discharge Flow Area	A=	126.6 sq ft	246.3 sq ft
Design Discharge Froude Number	**Fr =**	**0.24**	**0.04**
Design Discharge Wetted Perimeter	P=	64.6 ft	78.6 ft
Design Discharge Hydarulic Radius	R=	2.0 ft	3.1 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0026 ft/ft	0.0026 ft/ft
Drop Height per 100 ft	D =	0.2 ft/100 ft	0.2 ft/100 ft

ds
ie 4991

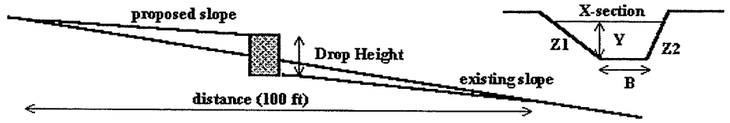
← 724' →

us
ie 4994

3/724 = 0.41%

Design of Trapezoidal Grass-Lined Channel

Project: Second Creek
Channel ID: 5-year wetland bottom channel: Brighton Rd to US-85



Existing Channel Condition (Input)			
Design Discharge	Q_D=	500.0	cfs
Design Discharge Return Period	$Year_D$=	5	years
Existing Ground Slope Along Channel Centerline	So =	0.0025	ft/ft
100-Year Discharge	**Q_{100}=**	**500.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.080	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	46.5 ft	46.5 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.31 ft**	**4.00 ft**
100-Year Flow Velocity	**V_{100}=**	**3.9 fps**	**2.0 fps**
100-Year Top Width	T=	65.0 ft	78.5 ft
100-Year Flow Area	A=	128.7 sq ft	249.9 sq ft
100-Year Froude Number	**Fr =**	**0.24**	**0.04**
100-Year Wetted Perimeter	P=	65.5 ft	79.5 ft
100-Year Hydarulic Radius	R=	2.0 ft	3.1 ft
Design Discharge Flow Depth	Y_D=	**2.31 ft**	**4.00** ft
Design Discharge Flow Velocity	V_D=	**3.9 fps**	**2.0** fps
Design Discharge Top Width	T=	65.0 ft	78.5 ft
Design Discharge Flow Area	A=	128.7 sq ft	249.9 sq ft
Design Discharge Froude Number	**Fr =**	**0.24**	**0.04**
Design Discharge Wetted Perimeter	P=	65.5 ft	79.5 ft
Design Discharge Hydarulic Radius	R=	2.0 ft	3.1 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0025 ft/ft	0.0025 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

ds
ie 4995

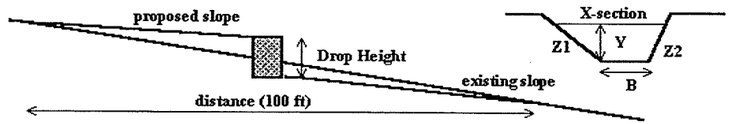
← 67667' →

us
5012

17/67667 = 0.25%

Design of Trapezoidal Grass-Lined Channel

Project: Second Creek
Channel ID: 5-year wetland bottom channel: US-85 to 136th Avenue



Existing Channel Condition (Input)			
Design Discharge	Q_D=	500.0	cfs
Design Discharge Return Period	$Year_D$=	5	years
Existing Ground Slope Along Channel Centerline	So =	0.0053	ft/ft
100-Year Discharge	**Q_{100}=**	**500.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Siope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.080	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	45.6 ft	45.6 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.31 ft**	**4.00 ft**
100-Year Flow Velocity	**V_{100}=**	**3.9 fps**	**2.0 fps**
100-Year Top Width	T=	64.1 ft	77.6 ft
100-Year Flow Area	A=	126.6 sq ft	246.3 sq ft
100-Year Froude Number	**Fr =**	**0.24**	**0.04**
100-Year Wetted Perimeter	P=	64.6 ft	78.6 ft
100-Year Hydarulic Radius	R=	2.0 ft	3.1 ft
Design Discharge Flow Depth	Y_D=	**2.31 ft**	**4.00** ft
Design Discharge Flow Velocity	V_D=	**3.9 fps**	**2.0** fps
Design Discharge Top Width	T=	64.1 ft	77.6 ft
Design Discharge Flow Area	A=	126.6 sq ft	246.3 sq ft
Design Discharge Froude Number	**Fr =**	**0.24**	**0.04**
Design Discharge Wetted Perimeter	P=	64.6 ft	78.6 ft
Design Discharge Hydarulic Radius	R=	2.0 ft	3.1 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0026 ft/ft	0.0026 ft/ft
Drop Height per 100 ft	D =	0.3 ft/100 ft	0.3 ft/100 ft

ds
ie 5012.5

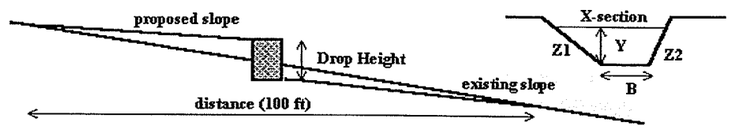
← 190' →

@ 0.53%

us
5013.5

Design of Trapezoidal Grass-Lined Channel

Project: Second Creek
Channel ID: 5-year wetland bottom channel: 136th Avenue to UPRR



Existing Channel Condition (Input)			
Design Discharge	Q_D=	500.0	cfs
Design Discharge Return Period	$Year_D$=	5	years
Existing Ground Slope Along Channel Centerline	So =	0.0034	ft/ft
100-Year Discharge	**Q_{100}=**	**500.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.080	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	45.6 ft	45.6 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.31 ft**	**4.00 ft**
100-Year Flow Velocity	**V_{100}=**	**3.9 fps**	**2.0 fps**
100-Year Top Width	T=	64.1 ft	77.6 ft
100-Year Flow Area	A=	126.6 sq ft	246.3 sq ft
100-Year Froude Number	**Fr =**	**0.24**	**0.04**
100-Year Wetted Perimeter	P=	64.6 ft	78.6 ft
100-Year Hydarulic Radius	R=	2.0 ft	3.1 ft
Design Discharge Flow Depth	Y_D=	**2.31 ft**	**4.00** ft
Design Discharge Flow Velocity	V_D=	**3.9 fps**	**2.0** fps
Design Discharge Top Width	T=	64.1 ft	77.6 ft
Design Discharge Flow Area	A=	126.6 sq ft	246.3 sq ft
Design Discharge Froude Number	**Fr =**	**0.24**	**0.04**
Design Discharge Wetted Perimeter	P=	64.6 ft	78.6 ft
Design Discharge Hydarulic Radius	R=	2.0 ft	3.1 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0026 ft/ft	0.0026 ft/ft
Drop Height per 100 ft	D =	0.1 ft/100 ft	0.1 ft/100 ft

ds
ie 5014

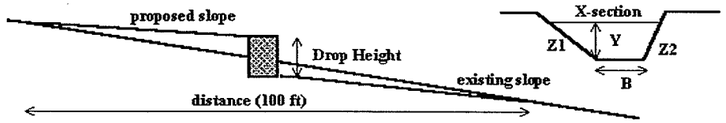
← 1162' →

@ 0.34%

us
5018

Design of Trapezoidal Grass-Lined Channel

Project: Second Creek
Channel ID: 5-year wetland bottom channel: UPRR to 132nd Avenue



Existing Channel Condition (Input)			
Design Discharge	Q_D=	500.0	cfs
Design Discharge Return Period	$Year_D$=	5	years
Existing Ground Slope Along Channel Centerline	So =	0.0033	ft/ft
100-Year Discharge	**Q_{100}=**	**500.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.080	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	45.6 ft	45.6 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.31 ft**	**4.00 ft**
100-Year Flow Velocity	**V_{100}=**	**3.9 fps**	**2.0 fps**
100-Year Top Width	T=	64.1 ft	77.6 ft
100-Year Flow Area	A=	126.6 sq ft	246.3 sq ft
100-Year Froude Number	**Fr =**	**0.24**	**0.04**
100-Year Wetted Perimeter	P=	64.6 ft	78.6 ft
100-Year Hydarulic Radius	R=	2.0 ft	3.1 ft
Design Discharge Flow Depth	Y_D=	**2.31 ft**	**4.00** ft
Design Discharge Flow Velocity	V_D=	**3.9 fps**	**2.0** fps
Design Discharge Top Width	T=	64.1 ft	77.6 ft
Design Discharge Flow Area	A=	126.6 sq ft	246.3 sq ft
Design Discharge Froude Number	**Fr =**	**0.24**	**0.04**
Design Discharge Wetted Perimeter	P=	64.6 ft	78.6 ft
Design Discharge Hydarulic Radius	R=	2.0 ft	3.1 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0026 ft/ft	0.0026 ft/ft
Drop Height per 100 ft	D =	0.1 ft/100 ft	0.1 ft/100 ft

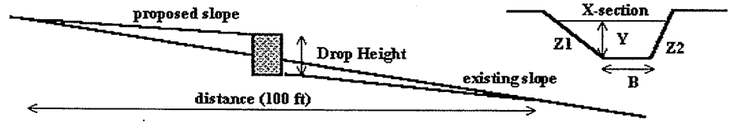
ds — 05

ie 5018.5 ⟵ 1534' ⟶ ie 5023.5

@ 0.33%

Design of Trapezoidal Grass-Lined Channel

Project: Second Creek
Channel ID: 5-year wetland bottom channel: 132nd Avenue to Tucson Street



Existing Channel Condition (Input)			
Design Discharge	Q_D=	500.0	cfs
Design Discharge Return Period	$Year_D$=	5	years
Existing Ground Slope Along Channel Centerline	So =	0.0051	ft/ft
100-Year Discharge	**Q_{100}=**	**500.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.080	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	45.6 ft	45.6 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.31 ft**	**4.00 ft**
100-Year Flow Velocity	**V_{100}=**	**3.9 fps**	**2.0 fps**
100-Year Top Width	T=	64.1 ft	77.6 ft
100-Year Flow Area	A=	126.6 sq ft	246.3 sq ft
100-Year Froude Number	**Fr =**	**0.24**	**0.04**
100-Year Wetted Perimeter	P=	64.6 ft	78.6 ft
100-Year Hydarulic Radius	R=	2.0 ft	3.1 ft
Design Discharge Flow Depth	Y_D=	**2.31 ft**	**4.00** ft
Design Discharge Flow Velocity	V_D=	**3.9 fps**	**2.0** fps
Design Discharge Top Width	T=	64.1 ft	77.6 ft
Design Discharge Flow Area	A=	126.6 sq ft	246.3 sq ft
Design Discharge Froude Number	**Fr =**	**0.24**	**0.04**
Design Discharge Wetted Perimeter	P=	64.6 ft	78.6 ft
Design Discharge Hydarulic Radius	R=	2.0 ft	3.1 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0026 ft/ft	0.0026 ft/ft
Drop Height per 100 ft	D =	0.3 ft/100 ft	0.3 ft/100 ft

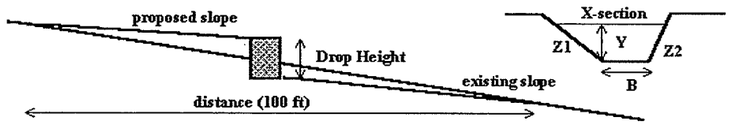
ds — 05

ie 5025 ⟵ 2041' ⟶ ie 5035.5

@ 0.51%

Design of Trapezoidal Grass-Lined Channel

Project: Second Creek
Channel ID: 5-year wetland bottom channel: Tucson Street to 124th Avenue



Existing Channel Condition (Input)			
Design Discharge	Q_D=	500.0	cfs
Design Discharge Return Period	$Year_D$=	5	years
Existing Ground Slope Along Channel Centerline	So =	0.0032	ft/ft
100-Year Discharge	**Q_{100}=**	**500.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.080	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	45.6 ft	45.6 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.31 ft**	**4.00 ft**
100-Year Flow Velocity	**V_{100}=**	**3.9 fps**	**2.0 fps**
100-Year Top Width	T=	64.1 ft	77.6 ft
100-Year Flow Area	A=	126.6 sq ft	246.3 sq ft
100-Year Froude Number	**Fr =**	**0.24**	**0.04**
100-Year Wetted Perimeter	P=	64.6 ft	78.6 ft
100-Year Hydarulic Radius	R=	2.0 ft	3.1 ft
Design Discharge Flow Depth	Y_D=	**2.31 ft**	**4.00** ft
Design Discharge Flow Velocity	V_D=	**3.9 fps**	**2.0** fps
Design Discharge Top Width	T=	64.1 ft	77.6 ft
Design Discharge Flow Area	A=	126.6 sq ft	246.3 sq ft
Design Discharge Froude Number	**Fr =**	**0.24**	**0.04**
Design Discharge Wetted Perimeter	P=	64.6 ft	78.6 ft
Design Discharge Hydarulic Radius	R=	2.0 ft	3.1 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0026 ft/ft	0.0026 ft/ft
Drop Height per 100 ft	D =	0.1 ft/100 ft	0.1 ft/100 ft

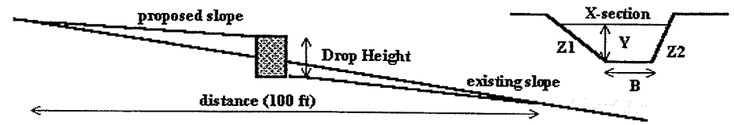
d/s
ie 5036

← 5437' →
@ 0.32%

US
ie 5053.6

Design of Trapezoidal Grass-Lined Channel

Project: Second Creek
Channel ID: 5-year wetland bottom channel: 124th Avenue to Potomac Street



Existing Channel Condition (Input)			
Design Discharge	Q_D=	500.0	cfs
Design Discharge Return Period	$Year_D$=	5	years
Existing Ground Slope Along Channel Centerline	So =	0.0025	ft/ft
100-Year Discharge	**Q_{100}=**	**500.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.080	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	46.5 ft	46.5 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.31 ft**	**4.00 ft**
100-Year Flow Velocity	**V_{100}=**	**3.9 fps**	**2.0 fps**
100-Year Top Width	T=	65.0 ft	78.5 ft
100-Year Flow Area	A=	128.7 sq ft	249.9 sq ft
100-Year Froude Number	**Fr =**	**0.24**	**0.04**
100-Year Wetted Perimeter	P=	65.5 ft	79.5 ft
100-Year Hydarulic Radius	R=	2.0 ft	3.1 ft
Design Discharge Flow Depth	Y_D=	**2.31 ft**	**4.00** ft
Design Discharge Flow Velocity	V_D=	**3.9 fps**	**2.0** fps
Design Discharge Top Width	T=	65.0 ft	78.5 ft
Design Discharge Flow Area	A=	128.7 sq ft	249.9 sq ft
Design Discharge Froude Number	**Fr =**	**0.24**	**0.04**
Design Discharge Wetted Perimeter	P=	65.5 ft	79.5 ft
Design Discharge Hydarulic Radius	R=	2.0 ft	3.1 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0025 ft/ft	0.0025 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

ds
ie 5054

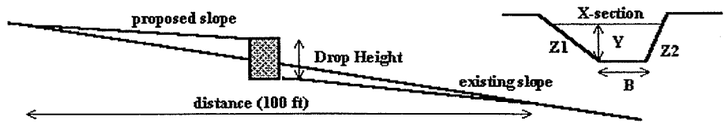
← 1803' →

US
ie 5055.5

it is expected that the future alignment will ~~be~~ shorten the channel length significantly. A length of 600' will produce the desired slope. A shorter length will require a drop structure.

Design of Trapezoidal Grass-Lined Channel

Project: Second Creek
Channel ID: 5-year wetland bottom channel: Potomac Street to 120th Avenue



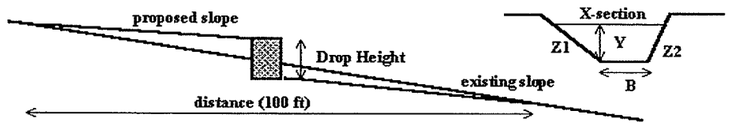
Existing Channel Condition (Input)			
Design Discharge	Q_D=	500.0	cfs
Design Discharge Return Period	$Year_D$=	5	years
Existing Ground Slope Along Channel Centerline	So =	0.0038	ft/ft
100-Year Discharge	**Q_{100}=**	**500.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.080	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel		Mature Channel	
Bottom Width	B=	45.6	ft	45.6	ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.31**	**ft**	**4.00**	**ft**
100-Year Flow Velocity	**V_{100}=**	**3.9**	**fps**	**2.0**	**fps**
100-Year Top Width	T=	64.1	ft	77.6	ft
100-Year Flow Area	A=	126.6	sq ft	246.3	sq ft
100-Year Froude Number	**Fr =**	**0.24**		**0.04**	
100-Year Wetted Perimeter	P=	64.6	ft	78.6	ft
100-Year Hydarulic Radius	R=	2.0	ft	3.1	ft
Design Discharge Flow Depth	Y_D=	**2.31**	**ft**	**4.00**	ft
Design Discharge Flow Velocity	V_D=	**3.9**	**fps**	**2.0**	fps
Design Discharge Top Width	T=	64.1	ft	77.6	ft
Design Discharge Flow Area	A=	126.6	sq ft	246.3	sq ft
Design Discharge Froude Number	**Fr =**	**0.24**		**0.04**	
Design Discharge Wetted Perimeter	P=	64.6	ft	78.6	ft
Design Discharge Hydarulic Radius	R=	2.0	ft	3.1	ft
Drop Height					
Proposed New Channel Slope	Sd=	0.0026	ft/ft	0.0026	ft/ft
Drop Height per 100 ft	D =	0.1	ft/100 ft	0.1	ft/100 ft

d/s
ie. 5056 ← 2916' → @ 0.38%
US
ie 5067

Design of Trapezoidal Grass-Lined Channel

Project: Second Creek
Channel ID: 5-year wetland bottom channel: BNSFRR to Burlington Ditch



Existing Channel Condition (Input)			
Design Discharge	Q_D=	500.0	cfs
Design Discharge Return Period	$Year_D$=	5	years
Existing Ground Slope Along Channel Centerline	So =	0.0029	ft/ft
100-Year Discharge	**Q_{100}=**	**500.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.080	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	45.6 ft	45.6 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.31 ft**	**4.00 ft**
100-Year Flow Velocity	**V_{100}=**	**3.9 fps**	**2.0 fps**
100-Year Top Width	T=	64.1 ft	77.6 ft
100-Year Flow Area	A=	126.6 sq ft	246.3 sq ft
100-Year Froude Number	**Fr =**	**0.24**	**0.04**
100-Year Wetted Perimeter	P=	64.6 ft	78.6 ft
100-Year Hydarulic Radius	R=	2.0 ft	3.1 ft
Design Discharge Flow Depth	Y_D=	**2.31 ft**	**4.00** ft
Design Discharge Flow Velocity	V_D=	**3.9 fps**	**2.0** fps
Design Discharge Top Width	T=	64.1 ft	77.6 ft
Design Discharge Flow Area	A=	126.6 sq ft	246.3 sq ft
Design Discharge Froude Number	**Fr =**	**0.24**	**0.04**
Design Discharge Wetted Perimeter	P=	64.6 ft	78.6 ft
Design Discharge Hydarulic Radius	R=	2.0 ft	3.1 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0026 ft/ft	0.0026 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

d/s
IE 5078

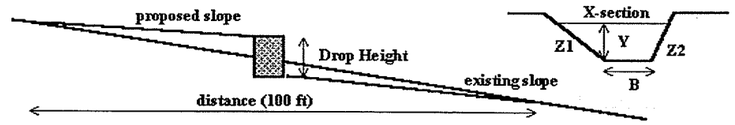
← 1739' →

@ 0.26%

U/S
5083

Design of Trapezoidal Grass-Lined Channel

Project: Second Creek
Channel ID: 5-year wetland bottom channel: Burlington Ditch to O'Brian Canal



Existing Channel Condition (Input)			
Design Discharge	Q_D=	500.0	cfs
Design Discharge Return Period	$Year_D$=	5	years
Existing Ground Slope Along Channel Centerline	So =	0.0074	ft/ft
100-Year Discharge	**Q_{100}=**	**500.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.080	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	45.6 ft	45.6 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.31 ft**	**4.00 ft**
100-Year Flow Velocity	**V_{100}=**	**3.9 fps**	**2.0 fps**
100-Year Top Width	T=	64.1 ft	77.6 ft
100-Year Flow Area	A=	126.6 sq ft	246.3 sq ft
100-Year Froude Number	**Fr =**	**0.24**	**0.04**
100-Year Wetted Perimeter	P=	64.6 ft	78.6 ft
100-Year Hydarulic Radius	R=	2.0 ft	3.1 ft
Design Discharge Flow Depth	Y_D=	**2.31 ft**	**4.00** ft
Design Discharge Flow Velocity	V_D=	**3.9 fps**	**2.0** fps
Design Discharge Top Width	T=	64.1 ft	77.6 ft
Design Discharge Flow Area	A=	126.6 sq ft	246.3 sq ft
Design Discharge Froude Number	**Fr =**	**0.24**	**0.04**
Design Discharge Wetted Perimeter	P=	64.6 ft	78.6 ft
Design Discharge Hydarulic Radius	R=	2.0 ft	3.1 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0026 ft/ft	0.0026 ft/ft
Drop Height per 100 ft	D =	0.5 ft/100 ft	0.5 ft/100 ft

d/s
IE 5087

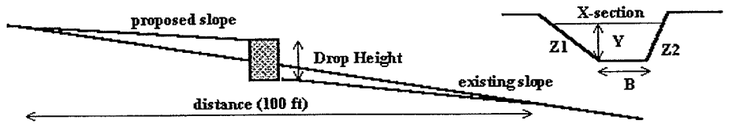
← 1222' →

@ 0.74%

U/S
5096

Design of Trapezoidal Grass-Lined Channel

Project: Reed Run
Channel ID:

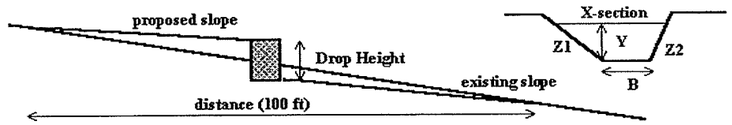


Existing Channel Condition (Input)		
Design Discharge	Q_D=	500.0 cfs
Design Discharge Return Period	$Year_D$=	100 years
Existing Ground Slope Along Channel Centerline	So =	0.0090 ft/ft
100-Year Discharge	**Q_{100}=**	**500.0** cfs
Left Side Slope	Z1 =	4.0 ft/ft
Right Side Slope	Z2 =	4.0 ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040
Check one of the following soil types		
Sandy Soil		check, OR
Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	4.0 ft	4.0 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**3.77 ft**	**4.23 ft**
100-Year Flow Velocity	**V_{100}=**	**7.0 fps**	**5.7 fps**
100-Year Top Width	T=	34.1 ft	37.8 ft
100-Year Flow Area	A=	71.8 sq ft	88.3 sq ft
100-Year Froude Number	**Fr =**	**0.72**	**0.43**
100-Year Wetted Perimeter	P=	35.1 ft	38.8 ft
100-Year Hydarulic Radius	R=	2.0 ft	2.3 ft
Design Discharge Flow Depth	Y_D=	**3.77 ft**	**4.23** ft
Design Discharge Flow Velocity	V_D=	**7.0 fps**	**5.7** fps
Design Discharge Top Width	T=	34.1 ft	37.8 ft
Design Discharge Flow Area	A=	71.8 sq ft	88.3 sq ft
Design Discharge Froude Number	**Fr =**	**0.72**	**0.43**
Design Discharge Wetted Perimeter	P=	35.1 ft	38.8 ft
Design Discharge Hydarulic Radius	R=	2.0 ft	2.3 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0076 ft/ft	0.0077 ft/ft
Drop Height per 100 ft	D =	0.1 ft/100 ft	0.1 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Drew Draw
Channel ID:

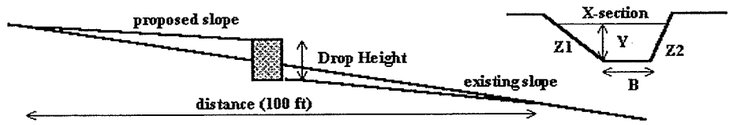


Existing Channel Condition (Input)		
Design Discharge	Q_D=	700.0 cfs
Design Discharge Return Period	$Year_D$=	100 years
Existing Ground Slope Along Channel Centerline	So =	0.0150 ft/ft
100-Year Discharge	**Q_{100}=**	**700.0** cfs
Left Side Slope	Z1 =	4.0 ft/ft
Right Side Slope	Z2 =	4.0 ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040
Check one of the following soil types		
Sandy Soil		check, OR
Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	4.8 ft	4.8 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**4.45 ft**	**5.00 ft**
100-Year Flow Velocity	**V_{100}=**	**7.0 fps**	**5.6 fps**
100-Year Top Width	T=	40.4 ft	44.8 ft
100-Year Flow Area	A=	100.6 sq ft	124.0 sq ft
100-Year Froude Number	**Fr =**	**0.60**	**0.36**
100-Year Wetted Perimeter	P=	41.5 ft	46.0 ft
100-Year Hydarulic Radius	R=	2.4 ft	2.7 ft
Design Discharge Flow Depth	Y_D=	**4.45 ft**	**5.00** ft
Design Discharge Flow Velocity	V_D=	**7.0 fps**	**5.6** fps
Design Discharge Top Width	T=	40.4 ft	44.8 ft
Design Discharge Flow Area	A=	100.6 sq ft	124.0 sq ft
Design Discharge Froude Number	**Fr =**	**0.60**	**0.36**
Design Discharge Wetted Perimeter	P=	41.5 ft	46.0 ft
Design Discharge Hydarulic Radius	R=	2.4 ft	2.7 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0061 ft/ft	0.0061 ft/ft
Drop Height per 100 ft	D =	0.9 ft/100 ft	0.9 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Peachleaf
Channel ID:

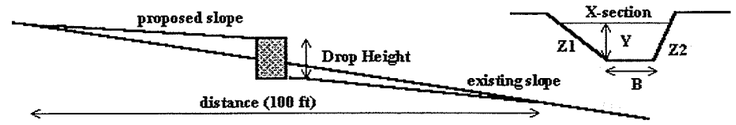


Existing Channel Condition (Input)			
Design Discharge	Q_D=	575.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0150	ft/ft
100-Year Discharge	**Q_{100}=**	**575.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	4.3 ft	4.3 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**4.03 ft**	**4.53 ft**
100-Year Flow Velocity	**V_{100}=**	**7.0 fps**	**5.7 fps**
100-Year Top Width	T=	36.6 ft	40.6 ft
100-Year Flow Area	A=	82.4 sq ft	101.6 sq ft
100-Year Froude Number	**Fr =**	**0.67**	**0.40**
100-Year Wetted Perimeter	P=	37.5 ft	41.7 ft
100-Year Hydarulic Radius	R=	2.2 ft	2.4 ft
Design Discharge Flow Depth	Y_D=	**4.03 ft**	**4.53** ft
Design Discharge Flow Velocity	V_D=	**7.0 fps**	**5.7** fps
Design Discharge Top Width	T=	36.6 ft	40.6 ft
Design Discharge Flow Area	A=	82.4 sq ft	101.6 sq ft
Design Discharge Froude Number	**Fr =**	**0.67**	**0.40**
Design Discharge Wetted Perimeter	P=	37.5 ft	41.7 ft
Design Discharge Hydarulic Radius	R=	2.2 ft	2.4 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0070 ft/ft	0.0070 ft/ft
Drop Height per 100 ft	D =	0.8 ft/100 ft	0.8 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Gramma Gulch
Channel ID:

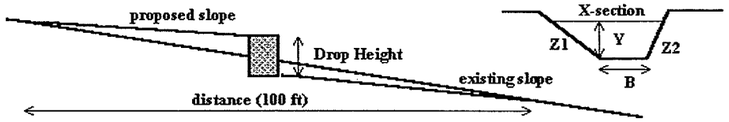


Existing Channel Condition (Input)			
Design Discharge	Q_D=	1000.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0116	ft/ft
100-Year Discharge	**Q_{100}=**	**1,000.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	15.8 ft	15.8 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**4.37 ft**	**5.00 ft**
100-Year Flow Velocity	**V_{100}=**	**6.9 fps**	**5.6 fps**
100-Year Top Width	T=	50.7 ft	55.8 ft
100-Year Flow Area	A=	145.3 sq ft	178.9 sq ft
100-Year Froude Number	**Fr =**	**0.51**	**0.30**
100-Year Wetted Perimeter	P=	51.8 ft	57.0 ft
100-Year Hydarulic Radius	R=	2.8 ft	3.1 ft
Design Discharge Flow Depth	Y_D=	**4.37 ft**	**5.00** ft
Design Discharge Flow Velocity	V_D=	**6.9 fps**	**5.6** fps
Design Discharge Top Width	T=	50.7 ft	55.8 ft
Design Discharge Flow Area	A=	145.3 sq ft	178.9 sq ft
Design Discharge Froude Number	**Fr =**	**0.51**	**0.30**
Design Discharge Wetted Perimeter	P=	51.8 ft	57.0 ft
Design Discharge Hydarulic Radius	R=	2.8 ft	3.1 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0049 ft/ft	0.0049 ft/ft
Drop Height per 100 ft	D =	0.7 ft/100 ft	0.7 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Dragway
Channel ID:

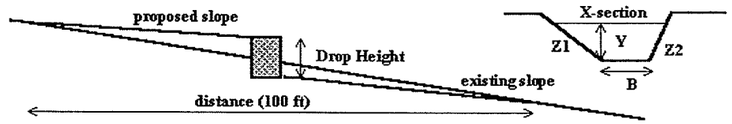


Existing Channel Condition (Input)			
Design Discharge	Q_D=	600.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0150	ft/ft
100-Year Discharge	**Q_{100}=**	**600.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	4.4 ft	4.4 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**4.12 ft**	**4.63 ft**
100-Year Flow Velocity	**V_{100}=**	**7.0 fps**	**5.7 fps**
100-Year Top Width	T=	37.4 ft	41.4 ft
100-Year Flow Area	A=	86.0 sq ft	106.1 sq ft
100-Year Froude Number	**Fr =**	**0.66**	**0.39**
100-Year Wetted Perimeter	P=	38.4 ft	42.6 ft
100-Year Hydarulic Radius	R=	2.2 ft	2.5 ft
Design Discharge Flow Depth	Y_D=	**4.12 ft**	**4.63** ft
Design Discharge Flow Velocity	V_D=	**7.0 fps**	**5.7** fps
Design Discharge Top Width	T=	37.4 ft	41.4 ft
Design Discharge Flow Area	A=	86.0 sq ft	106.1 sq ft
Design Discharge Froude Number	**Fr =**	**0.66**	**0.39**
Design Discharge Wetted Perimeter	P=	38.4 ft	42.6 ft
Design Discharge Hydarulic Radius	R=	2.2 ft	2.5 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0068 ft/ft	0.0068 ft/ft
Drop Height per 100 ft	D =	0.8 ft/100 ft	0.8 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: West Fork
Channel ID:

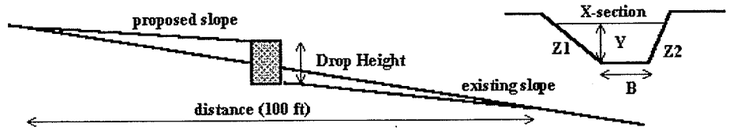


Existing Channel Condition (Input)			
Design Discharge	Q_D=	950.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0060	ft/ft
100-Year Discharge	**Q_{100}=**	**950.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	13.9 ft	13.9 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**4.38 ft**	**5.00 ft**
100-Year Flow Velocity	**V_{100}=**	**6.9 fps**	**5.6 fps**
100-Year Top Width	T=	49.0 ft	53.9 ft
100-Year Flow Area	A=	137.8 sq ft	169.7 sq ft
100-Year Froude Number	**Fr =**	**0.52**	**0.31**
100-Year Wetted Perimeter	P=	50.1 ft	55.2 ft
100-Year Hydarulic Radius	R=	2.8 ft	3.1 ft
Design Discharge Flow Depth	Y_D=	**4.38 ft**	**5.00** ft
Design Discharge Flow Velocity	V_D=	**6.9 fps**	**5.6** fps
Design Discharge Top Width	T=	49.0 ft	53.9 ft
Design Discharge Flow Area	A=	137.8 sq ft	169.7 sq ft
Design Discharge Froude Number	**Fr =**	**0.52**	**0.31**
Design Discharge Wetted Perimeter	P=	50.1 ft	55.2 ft
Design Discharge Hydarulic Radius	R=	2.8 ft	3.1 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0050 ft/ft	0.0050 ft/ft
Drop Height per 100 ft	D =	0.1 ft/100 ft	0.1 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Locust
Channel ID: 169

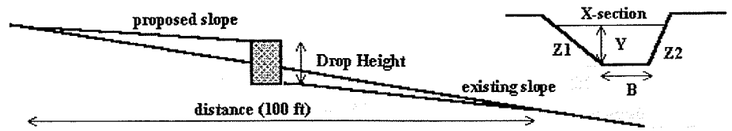


Existing Channel Condition (Input)			
Design Discharge	Q_D=	729.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0031	ft/ft
100-Year Discharge	**Q_{100}=**	**729.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	13.3 ft	13.3 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**4.38 ft**	**5.00 ft**
100-Year Flow Velocity	**V_{100}=**	**5.4 fps**	**4.4 fps**
100-Year Top Width	T=	48.4 ft	53.3 ft
100-Year Flow Area	A=	135.1 sq ft	166.6 sq ft
100-Year Froude Number	**Fr =**	**0.32**	**0.19**
100-Year Wetted Perimeter	P=	49.4 ft	54.6 ft
100-Year Hydarulic Radius	R=	2.7 ft	3.1 ft
Design Discharge Flow Depth	Y_D=	**4.38 ft**	**5.00** ft
Design Discharge Flow Velocity	V_D=	**5.4 fps**	**4.4** fps
Design Discharge Top Width	T=	48.4 ft	53.3 ft
Design Discharge Flow Area	A=	135.1 sq ft	166.6 sq ft
Design Discharge Froude Number	**Fr =**	**0.32**	**0.19**
Design Discharge Wetted Perimeter	P=	49.4 ft	54.6 ft
Design Discharge Hydarulic Radius	R=	2.7 ft	3.1 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0031 ft/ft	0.0031 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Fox Run
Channel ID: 156



Existing Channel Condition (Input)			
Design Discharge	Q_D=	161.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0061	ft/ft
100-Year Discharge	**Q_{100}=**	**161.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	7.8 ft	7.8 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.10 ft**	**2.40 ft**
100-Year Flow Velocity	**V_{100}=**	**4.7 fps**	**3.9 fps**
100-Year Top Width	T=	24.6 ft	27.0 ft
100-Year Flow Area	A=	34.0 sq ft	41.7 sq ft
100-Year Froude Number	**Fr =**	**0.50**	**0.30**
100-Year Wetted Perimeter	P=	25.1 ft	27.6 ft
100-Year Hydarulic Radius	R=	1.4 ft	1.5 ft
Design Discharge Flow Depth	Y_D=	**2.10 ft**	**2.40** ft
Design Discharge Flow Velocity	V_D=	**4.7 fps**	**3.9** fps
Design Discharge Top Width	T=	24.6 ft	27.0 ft
Design Discharge Flow Area	A=	34.0 sq ft	41.7 sq ft
Design Discharge Froude Number	**Fr =**	**0.50**	**0.30**
Design Discharge Wetted Perimeter	P=	25.1 ft	27.6 ft
Design Discharge Hydarulic Radius	R=	1.4 ft	1.5 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0061 ft/ft	0.0062 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

DFA0053 SWMM Output for Existing Conditions

100-year				50-year				10-year				5-year				2-year				0.4" Average			
CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)	CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	44 (DIRECT FLOW)	0	50	101	34 (DIRECT FLOW)	0	50	101	16 (DIRECT FLOW)	0	45	101	12 (DIRECT FLOW)	0	45	101	6 (DIRECT FLOW)	0	45	101	2 (DIRECT FLOW)	0	40
102	105 (DIRECT FLOW)	0	45	102	77 (DIRECT FLOW)	0	45	102	29 (DIRECT FLOW)	0	40	102	17 (DIRECT FLOW)	0	40	102	2 (DIRECT FLOW)	0	40	102	0 (DIRECT FLOW)	0	0
103	171 (DIRECT FLOW)	0	45	103	126 (DIRECT FLOW)	0	45	103	47 (DIRECT FLOW)	0	40	103	27 (DIRECT FLOW)	0	40	103	4 (DIRECT FLOW)	0	40	103	0 (DIRECT FLOW)	0	0
104	211 (DIRECT FLOW)	1	10	104	144 (DIRECT FLOW)	1	10	104	43 (DIRECT FLOW)	1	10	104	22 (DIRECT FLOW)	1	15	104	4 (DIRECT FLOW)	2	15	104	0 (DIRECT FLOW)	1	50
105	175 (DIRECT FLOW)	0	50	105	126 (DIRECT FLOW)	0	50	105	44 (DIRECT FLOW)	0	50	105	24 (DIRECT FLOW)	0	50	105	5 (DIRECT FLOW)	1	0	105	1 (DIRECT FLOW)	1	0
106	349 (DIRECT FLOW)	1	25	106	230 (DIRECT FLOW)	1	25	106	64 (DIRECT FLOW)	1	25	106	31 (DIRECT FLOW)	1	30	106	3 (DIRECT FLOW)	1	10	106	0 (DIRECT FLOW)	3	50
107	81 (DIRECT FLOW)	0	50	107	59 (DIRECT FLOW)	0	50	107	22 (DIRECT FLOW)	0	45	107	12 (DIRECT FLOW)	0	45	107	2 (DIRECT FLOW)	0	45	107	0 (DIRECT FLOW)	0	0
108	402 (DIRECT FLOW)	1	35	108	263 (DIRECT FLOW)	1	35	108	73 (DIRECT FLOW)	1	35	108	34 (DIRECT FLOW)	1	45	108	4 (DIRECT FLOW)	1	5	108	0 (DIRECT FLOW)	6	20
109	28 (DIRECT FLOW)	0	50	109	20 (DIRECT FLOW)	0	50	109	8 (DIRECT FLOW)	0	45	109	5 (DIRECT FLOW)	0	45	109	2 (DIRECT FLOW)	0	45	109	0 (DIRECT FLOW)	0	0
110	172 (DIRECT FLOW)	0	45	110	131 (DIRECT FLOW)	0	45	110	58 (DIRECT FLOW)	0	40	110	40 (DIRECT FLOW)	0	40	110	16 (DIRECT FLOW)	0	40	110	3 (DIRECT FLOW)	0	35
111	276 (DIRECT FLOW)	1	10	111	187 (DIRECT FLOW)	1	10	111	55 (DIRECT FLOW)	1	10	111	28 (DIRECT FLOW)	1	15	111	4 (DIRECT FLOW)	1	5	111	0 (DIRECT FLOW)	1	50
112	480 (DIRECT FLOW)	1	45	112	311 (DIRECT FLOW)	1	45	112	86 (DIRECT FLOW)	1	50	112	43 (DIRECT FLOW)	0	50	112	6 (DIRECT FLOW)	0	50	112	0 (DIRECT FLOW)	10	25
113	92 (DIRECT FLOW)	1	15	113	62 (DIRECT FLOW)	1	15	113	22 (DIRECT FLOW)	0	50	113	13 (DIRECT FLOW)	0	50	113	2 (DIRECT FLOW)	0	50	113	0 (DIRECT FLOW)	0	0
114	143 (DIRECT FLOW)	1	10	114	98 (DIRECT FLOW)	1	0	114	33 (DIRECT FLOW)	0	50	114	20 (DIRECT FLOW)	0	45	114	4 (DIRECT FLOW)	0	40	114	0 (DIRECT FLOW)	0	0
115	30 (DIRECT FLOW)	0	55	115	22 (DIRECT FLOW)	0	55	115	8 (DIRECT FLOW)	0	50	115	5 (DIRECT FLOW)	0	50	115	0 (DIRECT FLOW)	0	0	115	0 (DIRECT FLOW)	0	0
116	511 (DIRECT FLOW)	1	50	116	330 (DIRECT FLOW)	1	55	116	91 (DIRECT FLOW)	2	0	116	42 (DIRECT FLOW)	1	40	116	4 (DIRECT FLOW)	1	5	116	0 (DIRECT FLOW)	13	5
117	189 (DIRECT FLOW)	1	0	117	137 (DIRECT FLOW)	0	55	117	53 (DIRECT FLOW)	0	50	117	34 (DIRECT FLOW)	0	45	117	15 (DIRECT FLOW)	0	45	117	3 (DIRECT FLOW)	0	40
118	26 (DIRECT FLOW)	0	50	118	17 (DIRECT FLOW)	0	50	118	4 (DIRECT FLOW)	0	40	118	2 (DIRECT FLOW)	0	40	118	0 (DIRECT FLOW)	0	0	118	0 (DIRECT FLOW)	0	0
119	274 (DIRECT FLOW)	1	0	119	194 (DIRECT FLOW)	1	0	119	67 (DIRECT FLOW)	0	55	119	40 (DIRECT FLOW)	1	0	119	16 (DIRECT FLOW)	1	0	119	2 (DIRECT FLOW)	1	10
120	17 (DIRECT FLOW)	0	55	120	12 (DIRECT FLOW)	0	45	120	4 (DIRECT FLOW)	0	40	120	3 (DIRECT FLOW)	0	40	120	0 (DIRECT FLOW)	0	0	120	0 (DIRECT FLOW)	0	0
121	170 (DIRECT FLOW)	0	45	121	125 (DIRECT FLOW)	0	45	121	48 (DIRECT FLOW)	0	40	121	28 (DIRECT FLOW)	0	40	121	5 (DIRECT FLOW)	0	40	121	0 (DIRECT FLOW)	0	0
122	195 (DIRECT FLOW)	1	15	122	130 (DIRECT FLOW)	1	15	122	40 (DIRECT FLOW)	1	0	122	21 (DIRECT FLOW)	1	0	122	3 (DIRECT FLOW)	0	55	122	0 (DIRECT FLOW)	0	0
123	89 (DIRECT FLOW)	0	45	123	65 (DIRECT FLOW)	0	45	123	24 (DIRECT FLOW)	0	40	123	13 (DIRECT FLOW)	0	40	123	2 (DIRECT FLOW)	0	40	123	0 (DIRECT FLOW)	0	0
124	511 (DIRECT FLOW)	2	5	124	327 (DIRECT FLOW)	2	10	124	88 (DIRECT FLOW)	2	20	124	40 (DIRECT FLOW)	2	50	124	5 (DIRECT FLOW)	0	45	124	0 (DIRECT FLOW)	16	0
125	115 (DIRECT FLOW)	0	40	125	82 (DIRECT FLOW)	0	40	125	36 (DIRECT FLOW)	0	35	125	29 (DIRECT FLOW)	0	35	125	18 (DIRECT FLOW)	0	35	125	6 (DIRECT FLOW)	0	30
126	245 (DIRECT FLOW)	1	20	126	163 (DIRECT FLOW)	1	20	126	54 (DIRECT FLOW)	1	20	126	31 (DIRECT FLOW)	1	35	126	13 (DIRECT FLOW)	0	40	126	4 (DIRECT FLOW)	0	30
127	271 (DIRECT FLOW)	1	35	127	179 (DIRECT FLOW)	1	40	127	57 (DIRECT FLOW)	1	55	127	31 (DIRECT FLOW)	1	55	127	11 (DIRECT FLOW)	2	5	127	1 (DIRECT FLOW)	1	15
129	252 (DIRECT FLOW)	0	50	129	177 (DIRECT FLOW)	0	50	129	60 (DIRECT FLOW)	0	40	129	33 (DIRECT FLOW)	0	40	129	6 (DIRECT FLOW)	0	40	129	0 (DIRECT FLOW)	0	0
130	74 (DIRECT FLOW)	0	45	130	51 (DIRECT FLOW)	0	45	130	13 (DIRECT FLOW)	0	40	130	4 (DIRECT FLOW)	0	35	130	2 (DIRECT FLOW)	0	40	130	0 (DIRECT FLOW)	0	0
131	216 (DIRECT FLOW)	1	10	131	144 (DIRECT FLOW)	1	10	131	41 (DIRECT FLOW)	1	5	131	20 (DIRECT FLOW)	1	10	131	2 (DIRECT FLOW)	1	20	131	0 (DIRECT FLOW)	0	0
132	274 (DIRECT FLOW)	1	40	132	176 (DIRECT FLOW)	1	40	132	55 (DIRECT FLOW)	2	10	132	30 (DIRECT FLOW)	2	15	132	10 (DIRECT FLOW)	2	30	132	1 (DIRECT FLOW)	2	10
133	533 (DIRECT FLOW)	2	10	133	340 (DIRECT FLOW)	2	15	133	92 (DIRECT FLOW)	2	25	133	42 (DIRECT FLOW)	2	50	133	10 (DIRECT FLOW)	0	55	133	2 (DIRECT FLOW)	1	5
134	207 (DIRECT FLOW)	1	35	134	134 (DIRECT FLOW)	1	40	134	38 (DIRECT FLOW)	0	50	134	21 (DIRECT FLOW)	0	40	134	3 (DIRECT FLOW)	0	40	134	0 (DIRECT FLOW)	0	0
135	193 (DIRECT FLOW)	1	50	135	125 (DIRECT FLOW)	1	50	135	34 (DIRECT FLOW)	2	5	135	16 (DIRECT FLOW)	2	10	135	1 (DIRECT FLOW)	2	20	135	0 (DIRECT FLOW)	0	0
137	227 (DIRECT FLOW)	1	45	137	147 (DIRECT FLOW)	1	45	137	42 (DIRECT FLOW)	1	40	137	21 (DIRECT FLOW)	1	40	137	3 (DIRECT FLOW)	0	45	137	0 (DIRECT FLOW)	0	0
138	399 (DIRECT FLOW)	1	15	138	269 (DIRECT FLOW)	1	10	138	98 (DIRECT FLOW)	0	45	138	59 (DIRECT FLOW)	0	50	138	17 (DIRECT FLOW)	0	45	138	0 (DIRECT FLOW)	0	0
139	532 (DIRECT FLOW)	2	15	139	334 (DIRECT FLOW)	2	30	139	88 (DIRECT FLOW)	2	55	139	40 (DIRECT FLOW)	3	20	139	7 (DIRECT FLOW)	2	5	139	1 (DIRECT FLOW)	1	50
140	288 (DIRECT FLOW)	1	45	140	184 (DIRECT FLOW)	1	45	140	54 (DIRECT FLOW)	2	10	140	29 (DIRECT FLOW)	2	30	140	10 (DIRECT FLOW)	2	50	140	1 (DIRECT FLOW)	2	40
141	199 (DIRECT FLOW)	1	25	141	129 (DIRECT FLOW)	1	30	141	35 (DIRECT FLOW)	1	35	141	17 (DIRECT FLOW)	1	40	141	1 (DIRECT FLOW)	2	25	141	0 (DIRECT FLOW)	0	0
142	153 (DIRECT FLOW)	1	5	142	105 (DIRECT FLOW)	0	55	142	35 (DIRECT FLOW)	0	45	142	19 (DIRECT FLOW)	0	50	142	3 (DIRECT FLOW)	0	50	142	0 (DIRECT FLOW)	0	0
143	219 (DIRECT FLOW)	1	35	143	141 (DIRECT FLOW)	1	40	143	50 (DIRECT FLOW)	0	45	143	31 (DIRECT FLOW)	0	45	143	9 (DIRECT FLOW)	0	45	143	0 (DIRECT FLOW)	0	0
144	365 (DIRECT FLOW)	1	20	144	242 (DIRECT FLOW)	1	10	144	86 (DIRECT FLOW)	0	50	144	55 (DIRECT FLOW)	0	50	144	24 (DIRECT FLOW)	0	45	144	4 (DIRECT FLOW)	0	40
145	98 (DIRECT FLOW)	0	40	145	75 (DIRECT FLOW)	0	40	145	36 (DIRECT FLOW)	0	35	145	25 (DIRECT FLOW)	0	35	145	12 (DIRECT FLOW)	0	35	145	3 (DIRECT FLOW)	0	30
146	1086 (DIRECT FLOW)	1	40	146	714 (DIRECT FLOW)	1	35	146	228 (DIRECT FLOW)	1	30	146	129 (DIRECT FLOW)	1	30	146	42 (DIRECT FLOW)	0	50	146	8 (DIRECT FLOW)	0	45
147	500 (DIRECT FLOW)	1	25	147	340 (DIRECT FLOW)	1	25	147	115 (DIRECT FLOW)	1	25	147	66 (DIRECT FLOW)	1	25	147	17 (DIRECT FLOW)	1	30	147	1 (DIRECT FLOW)	0	55
148	481 (DIRECT FLOW)	1	20	148	327 (DIRECT FLOW)	1	20	148	111 (DIRECT FLOW)	1	15	148	65 (DIRECT FLOW)	1	15	148	19 (DIRECT FLOW)	1	10	148	2 (DIRECT FLOW)	0	40
151	111 (DIRECT FLOW)	1	25	151	73 (DIRECT FLOW)	1	25	151	21 (DIRECT FLOW)	1	25	151	10 (DIRECT FLOW)	1	40	151	1 (DIRECT FLOW)	2	10	151	0 (DIRECT FLOW)	3	55
152	101 (DIRECT FLOW)	1	5	152	71 (DIRECT FLOW)	1	5	152	26 (DIRECT FLOW)	0	45	152	15 (DIRECT FLOW)	0	45	152	3 (DIRECT FLOW)	1	0	152	0 (DIRECT FLOW)	1	0
153	417 (DIRECT FLOW)	1	25	153	274 (DIRECT FLOW)	1	25	153	82 (DIRECT FLOW)	1	20	153	44 (DIRECT FLOW)	1	15	153	10 (DIRECT FLOW)	1	10	153	0 (DIRECT FLOW)	0	0
154	38 (DIRECT FLOW)	0	55	154	28 (DIRECT FLOW)	0	55	154	10 (DIRECT FLOW)	0	45	154	6 (DIRECT FLOW)	0	50	154	0 (DIRECT FLOW)	0	0	154	0 (DIRECT FLOW)	0	0
155	11 (DIRECT FLOW)	2	25	155	8 (DIRECT FLOW)	2	25	155	3 (DIRECT FLOW)	0	40	155	2 (DIRECT FLOW)	0	40	155	0 (DIRECT FLOW)	0	0	155	0 (DIRECT FLOW)	0	0
156	44 (DIRECT FLOW)	1	15	156	32 (DIRECT FLOW)	0	55	156	11 (DIRECT FLOW)	0	50	156	6 (DIRECT FLOW)	0	50	156	0 (DIRECT FLOW)	0	0	156	0 (DIRECT FLOW)	0	0
157	804 (DIRECT FLOW)	1	35	157	525 (DIRECT FLOW)	1	35	157	158 (DIRECT FLOW)	1	30	157	87 (DIRECT FLOW)	1	30	157	26 (DIRECT FLOW)	1	20	157	3 (DIRECT FLOW)	1	30
159	114 (DIRECT FLOW)	0	55	159	81 (DIRECT FLOW)	0	55	159	25 (DIRECT FLOW)	0	50	159	14 (DIRECT FLOW)	0	50	159	8 (DIRECT FLOW)	0	50	159	0 (DIRECT FLOW)	0	0
160	904 (DIRECT FLOW)	1	40	160	588 (DIRECT FLOW)	1	40	160	175 (DIRECT FLOW)	1	45	160	93 (DIRECT FLOW)	1	45	160	25 (DIRECT FLOW)	1	40	160	2 (DIRECT FLOW)	0	35
162	188 (DIRECT FLOW)	0	45	162	136 (DIRECT FLOW)	0	45	162	48 (DIRECT FLOW)	0	40	162	24 (DIRECT FLOW)	0	40	162	4 (DIRECT FLOW)	0	40	162	0 (DIRECT FLOW)	0	0
163	1009 (DIRECT FLOW)	1	40	163	658 (DIRECT FLOW)	1	40	163	197 (DIRECT FLOW)	1	40	163	105 (DIRECT FLOW)	1	40	163	31 (DIRECT FLOW)	1	35	163	4 (DIRECT FLOW)	0	40
164	989 (DIRECT FLOW)	2	5	164	636 (DIRECT FLOW)	2	10	164	183 (DIRECT FLOW)	2	20	164	93 (DIRECT FLOW)	2	30	164	23 (DIRECT FLOW)	2	40	164	1 (DIRECT FLOW)	3	55
165	122 (DIRECT FLOW)	0	55	165	84 (DIRECT FLOW)	0	45	165	22 (DIRECT FLOW)	0	40	165	8 (DIRECT FLOW)	0	40	165	4 (DIRECT FLOW)	0	45	165	0 (DIRECT FLOW)	0	0
166	121 (DIRECT FLOW)	1	15	166	79 (DIRECT FLOW)	1	10	166	20 (DIRECT FLOW)	1	10	166	9 (DIRECT FLOW)	1	5	166	2 (DIRECT FLOW)	1	25	166	0 (DIRECT FLOW)	0	0
167	968 (DIRECT FLOW)	2	20	167	624 (DIRECT FLOW)	2	25	167	177 (DIRECT FLOW)	2	40	167	91 (DIRECT FLOW)	0	40	167	45 (DIRECT FLOW)	0	35	167	11 (DIRECT FLOW)	0	35
168	35 (DIRECT FLOW)	1	0	168	25 (DIRECT FLOW)	1	0	168	9 (DIRECT FLOW)	0	55	168	5 (DIRECT FLOW)	0	55	168	0 (DIRECT FLOW)	0	0	168	0 (DIRECT FLOW)	0	0
169	960 (DIRECT FLOW)	2	35	169	618 (DIRECT FLOW)	2	40	169	173 (DIRECT FLOW)	2	50	169	112 (DIRECT FLOW)	0	50	169	47 (DIRECT FLOW)	0	50	169	8 (DIRECT FLOW)	0	55
170	218 (DIRECT FLOW)	0	40	170	170 (DIRECT FLOW)	0	40	170	85 (DIRECT FLOW)	0	35	170	61 (DIRECT FLOW)	0	40	170	31 (DIRECT FLOW)	0	35	170	8 (DIRECT FLOW)	0	30
171	1300 (DIRECT FLOW)	2	0	171	874 (DIRECT FLOW)	2	0	171	308 (DIRECT FLOW)	2	0	171	184 (DIRECT FLOW)	1	50	171	85 (DIRECT FLOW)	1	15	171	17 (DIRECT FLOW)	1	15
172	215 (DIRECT FLOW)	0	45	172	171 (DIRECT FLOW)	0	40	172	90 (DIRECT FLOW)	0	35	172	69 (DIRECT FLOW)	0	40	172	38 (DIRECT FLOW)	0	40	172	11 (DIRECT FLOW)	0	35
173	36 (DIRECT FLOW)	0	40	173	28 (DIRECT FLOW)	0	40	173	13 (DIRECT FLOW)	0	35	173	9 (DIRECT FLOW)	0	40	173	5 (DIRECT FLOW)	0	35	173	0 (DIRECT FLOW)	0	0
174	225 (DIRECT FLOW)	0	40	174	183 (DIRECT FLOW)	0	40	174	103 (DIRECT FLOW)	0	35	174	78 (DIRECT FLOW)	0	40	174	50 (DIRECT FLOW)	0	35	174	16 (DIRECT FLOW)	0	35
175	236 (DIRECT FLOW)	0	45	175	179 (DIRECT FLOW)	0	45	175	81 (DIRECT FLOW)	0	40	175	56 (DIRECT FLOW)	0	40	175	24 (DIRECT FLOW)	0	40	175	4 (DIRECT FLOW)	0	35
176	1176 (DIRECT FLOW)	2	0	176	777 (DIRECT FLOW)	2	0	176	253 (DIRECT FLOW)	2	0	176	142 (DIRECT FLOW)	2	0	176	47 (DIRECT FLOW)	0	45	176	8 (DIRECT FLOW)	0	55
177	1169 (DIRECT FLOW)	2	0	177	771 (DIRECT FLOW)	2	5	177	248 (DIRECT FLOW)	2	0	177	139 (DIRECT FLOW)	2	5	177	44 (DIRECT FLOW)	1	55	177	7 (DIRECT FLOW)	1	55
178	1178 (DIRECT FLOW)	1	50	178	778 (DIRECT FLOW)	1	50	178	252 (DIRECT FLOW)	1	45	178	143 (DIRECT FLOW)	1	45	178	45 (DIRECT FLOW)	1	45	178	13 (DIRECT FLOW)	0	35
179	632 (DIRECT FLOW)	0	35	179	526 (DIRECT FLOW)	0	35	179	306 (DIRECT FLOW)	0	30	179	230 (DIRECT FLOW)	0	30	179	152 (DIRECT FLOW)	0	30	179	52 (DIRECT FLOW)	0	25
180	41 (DIRECT FLOW)	0	55	180	30 (DIRECT FLOW)	0	50	180	12 (DIRECT FLOW)	0	45	180	7 (DIRECT FLOW)	0	45	180	2 (DIRECT FLOW)	0	45	180	0 (DIRECT FLOW)	0	0
181	1184 (DIRECT FLOW)	1	35	181	783 (DIRECT FLOW)	1	35	181	253 (DIRECT FLOW)	1	30	181	143 (DIRECT FLOW)	1	30	181	45 (DIRECT FLOW)	0	50	181	8 (DIRECT FLOW)	0	45
182	57 (DIRECT FLOW)	0	55	182	41 (DIRECT FLOW)	0	45	182	15 (DIRECT FLOW)	0	40	182	8 (DIRECT FLOW)	0	45	182	0 (DIRECT FLOW)	0	0	182	0 (DIRECT FLOW)	0	0
183	38 (DIRECT FLOW)	0	55	183	28 (DIRECT FLOW)	0	55	183	11 (DIRECT FLOW)	0	45	183	7 (DIRECT FLOW)	0	50	183	2 (DIRECT FLOW)	0	45	183	0 (DIRECT FLOW)	0	0
184	481 (DIRECT FLOW)	0	45	184	374 (DIRECT FLOW)	0	45	184	200 (DIRECT FLOW)	0	40	184	154 (DIRECT FLOW)	0	40	184	91 (DIRECT FLOW)	0	40	184	24 (DIRECT FLOW)	0	40
185	1361 (DIRECT FLOW)	1	55	185	921 (DIRECT FLOW)	1	55	185	337 (DIRECT FLOW)	1	50	185	226 (DIRECT FLOW)	1	5	185	113 (DIRECT FLOW)	1	10	185	24 (DIRECT FLOW)	1	20
186	164 (DIRECT FLOW)	1	0	186	122 (DIRECT FLOW)	1	0	186	54 (DIRECT FLOW)	0	55	186	38 (DIRECT FLOW)	0	55	186	18 (DIRECT FLOW)	1	0	186	4 (DIRECT FLOW)	1	5
187	976 (DIRECT FLOW)	2	35	187	627 (DIRECT FLOW)	2	45	187	186 (DIRECT FLOW)	1	0	187	121 (DIRECT FLOW)	1	0	187	48 (DIRECT FLOW)	1	5	187	7 (DIRECT FLOW)	1	25
188	44 (DIRECT FLOW)	0	50	188	33 (DIRECT FLOW)	0	50	188	14 (DIRECT FLOW)	0	40	188	10 (DIRECT FLOW)	0	45	188	4 (DIRECT FLOW)	0	45	188	0 (DIRECT FLOW)	0	0
189	453 (DIRECT FLOW)	0	40	189	369 (DIRECT FLOW)	0	40	189	209 (DIRECT FLOW)	0	35	189	162 (DIRECT FLOW)	0	40	189	101 (DIRECT FLOW)	0	40	189	33 (DIRECT FLOW)	0	35
190	40 (DIRECT FLOW)	0	55	190	29 (DIRECT FLOW)	0	55	190	10 (DIRECT FLOW)	0	50	190	6 (DIRECT FLOW)	0	50	190	0 (DIRECT FLOW)	0	0	190	0 (DIRECT FLOW)	0	0
191	40 (DIRECT FLOW)	0	55	191	29 (DIRECT FLOW)	0	55	191	10 (DIRECT FLOW)	0	50	191	6 (DIRECT FLOW)	0	50	191	0 (DIRECT FLOW)	0	0	191	0 (DIRECT FLOW)	0	0
195	1361 (DIRECT FLOW)	1	55	195	921 (DIRECT FLOW)	1	55	195	337 (DIRECT FLOW)	1	50	195	226 (DIRECT FLOW)	1	5	195	113 (DIRECT FLOW)	1	10	195	24 (DIRECT FLOW)	1	20
196	164 (DIRECT FLOW)	1	0	196	122 (DIRECT FLOW)	1	0	196	54 (DIRECT FLOW)	0	55	196	38 (DIRECT FLOW)	0	55	196	18 (DIRECT FLOW)	1	0	196	4 (DIRECT FLOW)	1	5
197	976 (DIRECT FLOW)	2	35	197	627 (DIRECT FLOW)	2	45	197	186 (DIRECT FLOW)	1	0	197	121 (DIRECT FLOW)	1	0	197	48 (DIRECT FLOW)	1	5	197	7 (DIRECT FLOW)	1	25
198	44 (DIRECT FLOW)	0	50	198	33 (DIRECT FLOW)	0	50	198	14 (DIRECT FLOW)	0	40	198	10 (DIRECT FLOW)	0	45	198	4 (DIRECT FLOW)	0	45	198	0 (DIRECT FLOW)	0	0
199	453 (DIRECT FLOW)	0	40	199	369 (DIRECT FLOW)	0	40	199	209 (DIRECT FLOW)	0	35	199	162 (DIRECT FLOW)	0	40	199	101 (DIRECT FLOW)	0	40	199	33 (DIRECT FLOW)	0	35

DFA0053 SWMM Output for Future Conditions

100-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	112	(DIRECT FLOW)	0	40
102	105	(DIRECT FLOW)	0	45
103	171	(DIRECT FLOW)	0	45
104	286	(DIRECT FLOW)	1	0
105	221	(DIRECT FLOW)	0	50
106	497	(DIRECT FLOW)	1	10
107	171	(DIRECT FLOW)	0	45
108	598	(DIRECT FLOW)	1	15
109	76	(DIRECT FLOW)	0	40
110	179	(DIRECT FLOW)	0	45
111	345	(DIRECT FLOW)	1	0
112	751	(DIRECT FLOW)	1	15
113	197	(DIRECT FLOW)	0	45
114	280	(DIRECT FLOW)	0	45
115	115	(DIRECT FLOW)	0	45
116	829	(DIRECT FLOW)	1	15
117	215	(DIRECT FLOW)	0	50
118	73	(DIRECT FLOW)	0	40
119	355	(DIRECT FLOW)	0	50
120	31	(DIRECT FLOW)	0	45
121	250	(DIRECT FLOW)	0	40
122	396	(DIRECT FLOW)	0	45
123	270	(DIRECT FLOW)	0	40
124	802	(DIRECT FLOW)	1	30
125	204	(DIRECT FLOW)	0	40
126	319	(DIRECT FLOW)	1	10
127	368	(DIRECT FLOW)	0	40
129	384	(DIRECT FLOW)	0	45
130	75	(DIRECT FLOW)	0	45
131	319	(DIRECT FLOW)	0	55
132	385	(DIRECT FLOW)	0	55
133	885	(DIRECT FLOW)	1	30
134	537	(DIRECT FLOW)	0	50
135	394	(DIRECT FLOW)	0	55
137	497	(DIRECT FLOW)	1	10
138	1354	(DIRECT FLOW)	0	45
139	886	(DIRECT FLOW)	1	45
140	455	(DIRECT FLOW)	1	0
141	279	(DIRECT FLOW)	1	15
142	508	(DIRECT FLOW)	0	40
143	389	(DIRECT FLOW)	0	45
144	569	(DIRECT FLOW)	1	15
145	110	(DIRECT FLOW)	0	45
146	2152	(DIRECT FLOW)	1	10
147	1247	(DIRECT FLOW)	1	0
148	1263	(DIRECT FLOW)	0	50
151	195	(DIRECT FLOW)	0	55
152	196	(DIRECT FLOW)	0	45
153	811	(DIRECT FLOW)	1	0
154	174	(DIRECT FLOW)	0	40
155	36	(DIRECT FLOW)	0	40
156	161	(DIRECT FLOW)	0	45
157	1324	(DIRECT FLOW)	1	15
159	379	(DIRECT FLOW)	0	45
160	1477	(DIRECT FLOW)	1	25
162	288	(DIRECT FLOW)	0	45
163	1721	(DIRECT FLOW)	1	20
164	1546	(DIRECT FLOW)	1	40
165	186	(DIRECT FLOW)	0	45
166	230	(DIRECT FLOW)	0	55
167	1521	(DIRECT FLOW)	1	55
168	36	(DIRECT FLOW)	1	0
169	1473	(DIRECT FLOW)	2	5
170	228	(DIRECT FLOW)	0	45
171	2470	(DIRECT FLOW)	1	30
172	227	(DIRECT FLOW)	0	40
173	35	(DIRECT FLOW)	0	45
174	270	(DIRECT FLOW)	0	40
175	470	(DIRECT FLOW)	0	40
176	2255	(DIRECT FLOW)	1	30
177	2193	(DIRECT FLOW)	1	30
178	2264	(DIRECT FLOW)	1	20
179	667	(DIRECT FLOW)	0	35
180	108	(DIRECT FLOW)	0	40
181	2330	(DIRECT FLOW)	1	10
182	64	(DIRECT FLOW)	0	45
183	125	(DIRECT FLOW)	0	40
184	440	(DIRECT FLOW)	0	45
185	2586	(DIRECT FLOW)	1	35
186	166	(DIRECT FLOW)	1	0
187	1469	(DIRECT FLOW)	2	10
188	75	(DIRECT FLOW)	0	45
189	453	(DIRECT FLOW)	0	40
190	39	(DIRECT FLOW)	0	55
191	39	(DIRECT FLOW)	0	55
195	2586	(DIRECT FLOW)	1	35
196	166	(DIRECT FLOW)	1	0
197	1469	(DIRECT FLOW)	2	10
198	75	(DIRECT FLOW)	0	45
199	453	(DIRECT FLOW)	0	40

50-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	90	(DIRECT FLOW)	0	40
102	77	(DIRECT FLOW)	0	45
103	126	(DIRECT FLOW)	0	45
104	204	(DIRECT FLOW)	0	55
105	162	(DIRECT FLOW)	0	50
106	354	(DIRECT FLOW)	1	0
107	133	(DIRECT FLOW)	0	45
108	419	(DIRECT FLOW)	1	10
109	58	(DIRECT FLOW)	0	40
110	137	(DIRECT FLOW)	0	45
111	243	(DIRECT FLOW)	1	0
112	524	(DIRECT FLOW)	1	5
113	152	(DIRECT FLOW)	0	45
114	213	(DIRECT FLOW)	0	45
115	92	(DIRECT FLOW)	0	40
116	587	(DIRECT FLOW)	1	10
117	161	(DIRECT FLOW)	0	45
118	54	(DIRECT FLOW)	0	40
119	262	(DIRECT FLOW)	0	50
120	24	(DIRECT FLOW)	0	45
121	192	(DIRECT FLOW)	0	40
122	311	(DIRECT FLOW)	0	45
123	227	(DIRECT FLOW)	0	40
124	574	(DIRECT FLOW)	1	30
125	166	(DIRECT FLOW)	0	40
126	227	(DIRECT FLOW)	1	5
127	301	(DIRECT FLOW)	0	40
129	304	(DIRECT FLOW)	0	40
130	53	(DIRECT FLOW)	0	45
131	239	(DIRECT FLOW)	0	55
132	291	(DIRECT FLOW)	0	55
133	640	(DIRECT FLOW)	1	35
134	427	(DIRECT FLOW)	0	50
135	308	(DIRECT FLOW)	0	55
137	377	(DIRECT FLOW)	1	5
138	1141	(DIRECT FLOW)	0	40
139	649	(DIRECT FLOW)	1	50
140	336	(DIRECT FLOW)	1	0
141	201	(DIRECT FLOW)	1	15
142	423	(DIRECT FLOW)	0	40
143	300	(DIRECT FLOW)	0	45
144	403	(DIRECT FLOW)	1	15
145	87	(DIRECT FLOW)	0	40
146	1618	(DIRECT FLOW)	1	10
147	979	(DIRECT FLOW)	1	0
148	1010	(DIRECT FLOW)	0	50
151	141	(DIRECT FLOW)	0	50
152	150	(DIRECT FLOW)	0	45
153	614	(DIRECT FLOW)	0	55
154	144	(DIRECT FLOW)	0	40
155	29	(DIRECT FLOW)	0	40
156	127	(DIRECT FLOW)	0	45
157	953	(DIRECT FLOW)	1	15
159	307	(DIRECT FLOW)	0	45
160	1061	(DIRECT FLOW)	1	25
162	217	(DIRECT FLOW)	0	45
163	1232	(DIRECT FLOW)	1	25
164	1109	(DIRECT FLOW)	1	45
165	136	(DIRECT FLOW)	0	45
166	173	(DIRECT FLOW)	0	50
167	1099	(DIRECT FLOW)	2	0
168	26	(DIRECT FLOW)	1	0
169	1071	(DIRECT FLOW)	2	10
170	177	(DIRECT FLOW)	0	40
171	1821	(DIRECT FLOW)	1	35
172	180	(DIRECT FLOW)	0	40
173	27	(DIRECT FLOW)	0	45
174	225	(DIRECT FLOW)	0	40
175	379	(DIRECT FLOW)	0	40
176	1667	(DIRECT FLOW)	1	30
177	1616	(DIRECT FLOW)	1	30
178	1679	(DIRECT FLOW)	1	20
179	556	(DIRECT FLOW)	0	35
180	82	(DIRECT FLOW)	0	45
181	1746	(DIRECT FLOW)	1	10
182	48	(DIRECT FLOW)	0	45
183	96	(DIRECT FLOW)	0	40
184	343	(DIRECT FLOW)	0	45
185	1906	(DIRECT FLOW)	1	35
186	124	(DIRECT FLOW)	0	55
187	1068	(DIRECT FLOW)	2	15
188	57	(DIRECT FLOW)	0	45
189	369	(DIRECT FLOW)	0	40
190	28	(DIRECT FLOW)	0	55
191	28	(DIRECT FLOW)	0	55
195	1906	(DIRECT FLOW)	1	35
196	124	(DIRECT FLOW)	0	55
197	1068	(DIRECT FLOW)	2	15
198	57	(DIRECT FLOW)	0	45
199	369	(DIRECT FLOW)	0	40

10-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	52	(DIRECT FLOW)	0	35
102	29	(DIRECT FLOW)	0	40
103	47	(DIRECT FLOW)	0	40
104	83	(DIRECT FLOW)	0	40
105	63	(DIRECT FLOW)	0	50
106	157	(DIRECT FLOW)	0	45
107	66	(DIRECT FLOW)	0	40
108	168	(DIRECT FLOW)	1	0
109	27	(DIRECT FLOW)	0	35
110	65	(DIRECT FLOW)	0	40
111	88	(DIRECT FLOW)	0	40
112	249	(DIRECT FLOW)	0	45
113	73	(DIRECT FLOW)	0	40
114	103	(DIRECT FLOW)	0	40
115	51	(DIRECT FLOW)	0	35
116	256	(DIRECT FLOW)	1	5
117	75	(DIRECT FLOW)	0	40
118	22	(DIRECT FLOW)	0	35
119	109	(DIRECT FLOW)	0	45
120	12	(DIRECT FLOW)	0	35
121	93	(DIRECT FLOW)	0	35
122	181	(DIRECT FLOW)	0	40
123	149	(DIRECT FLOW)	0	35
124	262	(DIRECT FLOW)	1	30
125	107	(DIRECT FLOW)	0	35
126	103	(DIRECT FLOW)	0	40
127	192	(DIRECT FLOW)	0	35
129	177	(DIRECT FLOW)	0	35
130	15	(DIRECT FLOW)	0	40
131	111	(DIRECT FLOW)	0	50
132	140	(DIRECT FLOW)	0	45
133	305	(DIRECT FLOW)	1	30
134	237	(DIRECT FLOW)	0	45
135	172	(DIRECT FLOW)	0	45
137	198	(DIRECT FLOW)	1	5
138	741	(DIRECT FLOW)	0	35
139	323	(DIRECT FLOW)	1	55
140	148	(DIRECT FLOW)	0	55
141	91	(DIRECT FLOW)	1	20
142	262	(DIRECT FLOW)	0	35
143	155	(DIRECT FLOW)	0	40
144	167	(DIRECT FLOW)	1	20
145	47	(DIRECT FLOW)	0	35
146	805	(DIRECT FLOW)	1	5
147	531	(DIRECT FLOW)	0	55
148	573	(DIRECT FLOW)	0	45
151	59	(DIRECT FLOW)	0	40
152	72	(DIRECT FLOW)	0	40
153	297	(DIRECT FLOW)	0	50
154	89	(DIRECT FLOW)	0	35
155	19	(DIRECT FLOW)	0	35
156	72	(DIRECT FLOW)	0	40
157	431	(DIRECT FLOW)	1	20
159	185	(DIRECT FLOW)	0	40
160	477	(DIRECT FLOW)	1	30
162	92	(DIRECT FLOW)	0	40
163	567	(DIRECT FLOW)	1	25
164	516	(DIRECT FLOW)	1	55
165	52	(DIRECT FLOW)	0	40
166	86	(DIRECT FLOW)	0	40
167	519	(DIRECT FLOW)	2	5
168	9	(DIRECT FLOW)	0	55
169	498	(DIRECT FLOW)	2	20
170	94	(DIRECT FLOW)	0	40
171	895	(DIRECT FLOW)	1	45
172	96	(DIRECT FLOW)	0	35
173	13	(DIRECT FLOW)	0	35
174	143	(DIRECT FLOW)	0	35
175	239	(DIRECT FLOW)	0	35
176	819	(DIRECT FLOW)	1	35
177	793	(DIRECT FLOW)	1	40
178	820	(DIRECT FLOW)	1	20
179	329	(DIRECT FLOW)	0	30
180	37	(DIRECT FLOW)	0	35
181	859	(DIRECT FLOW)	1	5
182	20	(DIRECT FLOW)	0	40
183	47	(DIRECT FLOW)	0	35
184	185	(DIRECT FLOW)	0	40
185	937	(DIRECT FLOW)	1	45
186	55	(DIRECT FLOW)	0	55
187	496	(DIRECT FLOW)	2	25
188	25	(DIRECT FLOW)	0	35
189	209	(DIRECT FLOW)	0	35
190	10	(DIRECT FLOW)	0	50
191	10	(DIRECT FLOW)	0	50
195	937	(DIRECT FLOW)	1	45
196	55	(DIRECT FLOW)	0	55
197	496	(DIRECT FLOW)	2	25
198	25	(DIRECT FLOW)	0	35
199	209	(DIRECT FLOW)	0	35

5-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	40	(DIRECT FLOW)	0	35
102	17	(DIRECT FLOW)	0	40
103	27	(DIRECT FLOW)	0	40
104	58	(DIRECT FLOW)	0	40
105	39	(DIRECT FLOW)	0	50
106	112	(DIRECT FLOW)	0	45
107	49	(DIRECT FLOW)	0	40
108	114	(DIRECT FLOW)	1	0
109	18	(DIRECT FLOW)	0	40
110	46	(DIRECT FLOW)	0	40
111	60	(DIRECT FLOW)	0	40
112	185	(DIRECT FLOW)	0	45
113	54	(DIRECT FLOW)	0	40
114	75	(DIRECT FLOW)	0	40
115	40	(DIRECT FLOW)	0	40
116	183	(DIRECT FLOW)	1	0
117	53	(DIRECT FLOW)	0	40
118	15	(DIRECT FLOW)	0	35
119	73	(DIRECT FLOW)	0	45
120	8	(DIRECT FLOW)	0	40
121	65	(DIRECT FLOW)	0	35
122	146	(DIRECT FLOW)	0	40
123	124	(DIRECT FLOW)	0	35
124	182	(DIRECT FLOW)	1	35
125	91	(DIRECT FLOW)	0	35
126	84	(DIRECT FLOW)	0	40
127	160	(DIRECT FLOW)	0	35
129	141	(DIRECT FLOW)	0	35
130	7	(DIRECT FLOW)	0	35
131	82	(DIRECT FLOW)	0	50
132	105	(DIRECT FLOW)	0	50
133	218	(DIRECT FLOW)	1	40
134	190	(DIRECT FLOW)	0	45
135	139	(DIRECT FLOW)	0	45
137	156	(DIRECT FLOW)	1	5
138	612	(DIRECT FLOW)	0	35
139	257	(DIRECT FLOW)	0	35
140	108	(DIRECT FLOW)	1	0
141	66	(DIRECT FLOW)	1	20
142	211	(DIRECT FLOW)	0	35
143	116	(DIRECT FLOW)	0	40
144	118	(DIRECT FLOW)	1	20
145	37	(DIRECT FLOW)	0	40
146	621	(DIRECT FLOW)	1	10
147	421	(DIRECT FLOW)	0	55
148	460	(DIRECT FLOW)	0	45
151	38	(DIRECT FLOW)	0	40
152	52	(DIRECT FLOW)	0	40
153	223	(DIRECT FLOW)	0	55
154	72	(DIRECT FLOW)	0	35
155	16	(DIRECT FLOW)	0	35
156	57	(DIRECT FLOW)	0	40
157	311	(DIRECT FLOW)	1	20
159	151	(DIRECT FLOW)	0	40
160	340	(DIRECT FLOW)	1	35
162	60	(DIRECT FLOW)	0	45
163	408	(DIRECT FLOW)	1	30
164	369	(DIRECT FLOW)	2	0
165	30	(DIRECT FLOW)	0	40
166	66	(DIRECT FLOW)	0	40
167	366	(DIRECT FLOW)	2	10
168	5	(DIRECT FLOW)	0	55
169	349	(DIRECT FLOW)	2	30
170	71	(DIRECT FLOW)	0	40
171	671	(DIRECT FLOW)	1	45
172	71	(DIRECT FLOW)	0	40
173	9	(DIRECT FLOW)	0	40
174	116	(DIRECT FLOW)	0	35
175	195	(DIRECT FLOW)	0	35
176	617	(DIRECT FLOW)	1	40
177	596	(DIRECT FLOW)	1	40
178	622	(DIRECT FLOW)	1	25
179	250	(DIRECT FLOW)	0	30
180	25	(DIRECT FLOW)	0	40
181	657	(DIRECT FLOW)	1	10
182	13	(DIRECT FLOW)	0	40
183	32	(DIRECT FLOW)	0	35
184	143	(DIRECT FLOW)	0	40
185	700	(DIRECT FLOW)	1	50
186	39	(DIRECT FLOW)	0	55
187	348	(DIRECT FLOW)	2	35
188	17	(DIRECT FLOW)	0	40
189	163	(DIRECT FLOW)	0	40
190	5	(DIRECT FLOW)	0	50
191	5	(DIRECT FLOW)	0	50
195	700	(DIRECT FLOW)	1	50
196	39	(DIRECT FLOW)	0	55
197	348	(DIRECT FLOW)	2	35
198	17	(DIRECT FLOW)	0	40
199	163	(DIRECT FLOW)	0	40

2-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	26	(DIRECT FLOW)	0	35
102	2	(DIRECT FLOW)	0	40
103	4	(DIRECT FLOW)	0	40
104	28	(DIRECT FLOW)	0	40
105	14	(DIRECT FLOW)	0	55
106	57	(DIRECT FLOW)	0	45
107	26	(DIRECT FLOW)	0	40
108	53	(DIRECT FLOW)	1	0
109	8	(DIRECT FLOW)	0	35
110	22	(DIRECT FLOW)	0	40
111	28	(DIRECT FLOW)	0	40
112	99	(DIRECT FLOW)	0	45
113	25	(DIRECT FLOW)	0	40
114	37	(DIRECT FLOW)	0	40
115	24	(DIRECT FLOW)	0	40
116	96	(DIRECT FLOW)	1	0
117	28	(DIRECT FLOW)	0	40
118	9	(DIRECT FLOW)	0	35
119	39	(DIRECT FLOW)	0	45
120	4	(DIRECT FLOW)	0	35
121	32	(DIRECT FLOW)	0	35
122	100	(DIRECT FLOW)	0	40
123	89	(DIRECT FLOW)	0	35
124	121	(DIRECT FLOW)	0	40
125	66	(DIRECT FLOW)	0	35
126	59	(DIRECT FLOW)	0	40
127	114	(DIRECT FLOW)	0	35
129	97	(DIRECT FLOW)	0	35
130	4	(DIRECT FLOW)	0	40
131	47	(DIRECT FLOW)	0	50
132	67	(DIRECT FLOW)	0	50
133	146	(DIRECT FLOW)	0	45
134	124	(DIRECT FLOW)	0	45
135	90	(DIRECT FLOW)	0	45
137	99	(DIRECT FLOW)	1	10
138	436	(DIRECT FLOW)	0	35
139	182	(DIRECT FLOW)	0	35
140	64	(DIRECT FLOW)	1	5
141	36	(DIRECT FLOW)	1	25
142	148	(DIRECT FLOW)	0	35
143	64	(DIRECT FLOW)	0	40
144	64	(DIRECT FLOW)	1	30
145	22	(DIRECT FLOW)	0	40
146	381	(DIRECT FLOW)	1	10
147	271	(DIRECT FLOW)	1	0
148	306	(DIRECT FLOW)	0	50
151	21	(DIRECT FLOW)	0	40
152	25	(DIRECT FLOW)	0	40
153	130	(DIRECT FLOW)	0	55
154	50	(DIRECT FLOW)	0	35
155	11	(DIRECT FLOW)	0	35
156	35	(DIRECT FLOW)	0	40
157	170	(DIRECT FLOW)	1	30
159	108	(DIRECT FLOW)	0	40
160	186	(DIRECT FLOW)	1	45
162	29	(DIRECT FLOW)	0	45
163	226	(DIRECT FLOW)	1	30
164	207	(DIRECT FLOW)	2	5
165	18	(DIRECT FLOW)	0	40
166	38	(DIRECT FLOW)	0	40
167	200	(DIRECT FLOW)	2	10
168	0	(DIRECT FLOW)	0	0
169	192	(DIRECT FLOW)	2	45
170	39	(DIRECT FLOW)	0	40
171	394	(DIRECT FLOW)	1	55
172	40	(DIRECT FLOW)	0	35
173	4	(DIRECT FLOW)	0	35
174	83	(DIRECT FLOW)	0	35
175	133	(DIRECT FLOW)	0	35
176	364	(DIRECT FLOW)	1	50
177	352	(DIRECT FLOW)	1	50
178	370	(DIRECT FLOW)	1	30
179	167	(DIRECT FLOW)	0	30
180	11	(DIRECT FLOW)	0	35
181	397	(DIRECT FLOW)	1	10
182	4	(DIRECT FLOW)	0	40
183	16	(DIRECT FLOW)	0	35
184	87	(DIRECT FLOW)	0	40
185	410	(DIRECT FLOW)	2	0
186	19	(DIRECT FLOW)	0	55
187	191	(DIRECT FLOW)	2	50
188	7	(DIRECT FLOW)	0	35
189	101	(DIRECT FLOW)	0	40
190	0	(DIRECT FLOW)	0	0
191	0	(DIRECT FLOW)	0	0
195	410	(DIRECT FLOW)	2	0
196	19	(DIRECT FLOW)	0	55
197	191	(DIRECT FLOW)	2	50
198	7	(DIRECT FLOW)	0	35
199	101	(DIRECT FLOW)	0	40

0.4" Average

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	8	(DIRECT FLOW)	0	30
102	0	(DIRECT FLOW)	0	0
103	0	(DIRECT FLOW)	0	0
104	6	(DIRECT FLOW)	0	35
105	3	(DIRECT FLOW)	0	55
106	14	(DIRECT FLOW)	0	40
107	7	(DIRECT FLOW)	0	35
108	11	(DIRECT FLOW)	1	10
109	1	(DIRECT FLOW)	0	30
110	4	(DIRECT FLOW)	0	35
111	6	(DIRECT FLOW)	0	35
112	27	(DIRECT FLOW)	0	40
113	5	(DIRECT FLOW)	0	35
114	10	(DIRECT FLOW)	0	35
115	8	(DIRECT FLOW)	0	35
116	23	(DIRECT FLOW)	1	5
117	7	(DIRECT FLOW)	0	35
118	2	(DIRECT FLOW)	0	30
119	8	(DIRECT FLOW)	0	45
120	0	(DIRECT FLOW)	0	0
121	7	(DIRECT FLOW)	0	30
122	35	(DIRECT FLOW)	0	35
123	31	(DIRECT FLOW)	0	30
124	42	(DIRECT FLOW)	0	35
125	23	(DIRECT FLOW)	0	30
126	20	(DIRECT FLOW)	0	35
127	40	(DIRECT FLOW)	0	30
129	34	(DIRECT FLOW)	0	30
130	0	(DIRECT FLOW)	0	0
131	11	(DIRECT FLOW)	0	55
132	18	(DIRECT FLOW)	0	50
133	43	(DIRECT FLOW)	0	40
134	37	(DIRECT FLOW)	0	45
135	28	(DIRECT FLOW)	0	40
137	29	(DIRECT FLOW)	1	10
138	156	(DIRECT FLOW)	0	35
139	66	(DIRECT FLOW)	0	30
140	17	(DIRECT FLOW)	1	15
141	8	(DIRECT FLOW)	1	50
142	51	(DIRECT FLOW)	0	35
143	18	(DIRECT FLOW)	0	35
144	15	(DIRECT FLOW)	1	55
145	7	(DIRECT FLOW)	0	35
146	101	(DIRECT FLOW)	1	25
147	74	(DIRECT FLOW)	1	5
148	88	(DIRECT FLOW)	0	50
151	5	(DIRECT FLOW)	0	35
152	5	(DIRECT FLOW)	0	35
153	33	(DIRECT FLOW)	0	50
154	17	(DIRECT FLOW)	0	35
155	4	(DIRECT FLOW)	0	30
156	11	(DIRECT FLOW)	0	35
157	44	(DIRECT FLOW)	1	50
159	36	(DIRECT FLOW)	0	35
160	46	(DIRECT FLOW)	1	55
162	6	(DIRECT FLOW)	1	0
163	58	(DIRECT FLOW)	1	55
164	47	(DIRECT FLOW)	2	0
165	3	(DIRECT FLOW)	0	35
166	11	(DIRECT FLOW)	0	35
167	49	(DIRECT FLOW)	0	30
168	0	(DIRECT FLOW)	0	0
169	43	(DIRECT FLOW)	3	25
170	12	(DIRECT FLOW)	0	35
171	102	(DIRECT FLOW)	2	15
172	12	(DIRECT FLOW)

DFA0053 SWMM Output for Future Conditions

100-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)		TIME (HR /MIN)	
201	65	0.9	0	0	55	
202	65	0.9	0	1	10	
203	159	1.3	0	0	50	
204	156	1.3	0	1	10	
205	283	1.6	0	1	20	
208	452	2	0	1	20	
211	26	0.6	0	1	20	
212	500	2.2	0	1	35	
213	50	1.2	0	1	30	
214	141	1.2	0	1	15	
216	724	2.9	0	1	25	
217	99	1.1	0	1	10	
218	85	1	0	0	55	
219	205	1.5	0	1	0	
222	231	1.5	0	1	10	
223	392	1.9	0	1	0	
224	761	2.5	0	1	35	
225	44	0.8	0	1	0	
226	265	1.6	0	1	15	
227	279	1.8	0	1	25	
228	24	0.6	0	1	5	
229	193	1.4	0	0	50	
230	27	0.8	0	1	25	
231	236	1.7	0	1	0	
232	339	1.8	0	1	25	
233	114	1.3	0	1	0	
234	790	2.5	0	1	40	
235	201	1.9	0	1	35	
236	76	1.2	0	1	10	
237	457	2.8	0	1	10	
238	402	1.9	0	1	35	
239	857	2.6	0	1	45	
240	381	1.9	0	1	20	
241	261	2.2	0	1	15	
242	32	0.7	0	1	20	
243	214	1.5	0	1	35	
244	300	1.7	0	0	55	
245	411	1.9	0	1	25	
246	822	2.5	0	2	5	
247	1189	2.9	0	1	0	
248	1055	2.8	0	0	55	
249	1178	3	0	1	5	
251	548	2.3	0	1	25	
252	118	1.3	0	1	10	
253	304	1.7	0	1	15	
254	105	1.1	0	0	55	
256	14	0.5	0	1	0	
257	712	2.5	0	1	15	
260	1252	3.4	0	1	30	
261	169	1.4	0	1	15	
262	119	1.2	0	0	55	
263	1476	3.1	0	1	25	
264	1439	3.5	0	1	45	
265	263	1.8	0	1	0	
266	125	1.3	0	1	10	
267	1496	3.3	0	1	55	
269	1447	3.3	0	2	5	
271	178	1.4	0	0	55	
272	19	0.6	0	1	20	
274	210	1.4	0	0	50	
276	2233	3.7	0	1	35	
277	2175	3.7	0	1	30	
278	2228	4.3	0	1	20	
279	37	0.8	0	1	30	
280	64	0.9	0	1	5	
281	34	0.7	0	1	20	
282	278	1.7	0	1	10	
284	430	1.9	0	0	45	
285	2466	3.8	0	1	35	
286	145	1.3	0	1	0	
287	1466	3.2	0	2	10	
289	25	0.6	0	2	0	
500	470	(DIRECT FLOW)		0	40	

50-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)		TIME (HR /MIN)	
201	50	0.8	0	0	55	
202	44	0.7	0	1	10	
203	114	1.2	0	0	50	
204	109	1.2	0	1	10	
205	191	1.4	0	1	20	
208	313	1.7	0	1	20	
211	18	0.5	0	1	25	
212	345	1.9	0	1	35	
213	35	1	0	1	30	
214	101	1.1	0	1	10	
216	507	2.5	0	1	25	
217	70	1	0	1	10	
218	65	0.9	0	0	55	
219	150	1.3	0	1	0	
222	166	1.3	0	1	10	
223	304	1.7	0	1	0	
224	535	2.2	0	1	35	
225	31	0.7	0	1	0	
226	185	1.4	0	1	15	
227	196	1.6	0	1	25	
228	18	0.5	0	1	5	
229	144	1.2	0	0	50	
230	19	0.7	0	1	25	
231	177	1.5	0	1	0	
232	244	1.6	0	1	25	
233	87	1.1	0	1	0	
234	565	2.2	0	1	40	
235	146	1.6	0	1	40	
236	59	1.1	0	1	10	
237	348	2.5	0	1	10	
238	302	1.7	0	1	40	
239	619	2.3	0	1	50	
240	274	1.7	0	1	10	
241	189	1.9	0	1	15	
242	19	0.6	0	1	20	
243	154	1.3	0	1	40	
244	235	1.5	0	0	55	
245	291	1.6	0	1	25	
246	606	2.2	0	2	10	
247	936	2.7	0	1	0	
248	844	2.6	0	0	55	
249	916	2.7	0	1	5	
251	387	2	0	1	25	
252	84	1.2	0	1	10	
253	216	1.5	0	1	10	
254	82	1	0	0	55	
256	11	0.5	0	1	0	
257	523	2.2	0	1	15	
260	903	3	0	1	30	
261	117	1.2	0	1	15	
262	92	1.1	0	0	55	
263	1055	2.7	0	1	30	
264	1034	3.1	0	1	50	
265	207	1.7	0	1	0	
266	85	1.2	0	1	5	
267	1073	2.9	0	2	0	
269	1049	2.9	0	2	15	
271	136	1.2	0	0	55	
272	14	0.5	0	1	20	
274	168	1.3	0	0	50	
276	1646	3.3	0	1	35	
277	1602	3.3	0	1	30	
278	1652	3.8	0	1	20	
279	25	0.6	0	1	30	
280	46	0.8	0	1	5	
281	23	0.6	0	1	20	
282	207	1.5	0	1	10	
284	335	1.8	0	0	45	
285	1812	3.4	0	1	40	
286	109	1.1	0	1	0	
287	1066	2.9	0	2	15	
289	17	0.5	0	2	0	
500	379	(DIRECT FLOW)		0	40	

10-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)		TIME (HR /MIN)	
201	25	0.6	0	0	50	
202	12	0.4	0	1	10	
203	38	0.7	0	0	45	
204	37	0.7	0	1	10	
205	66	0.9	0	1	25	
208	120	1.2	0	1	20	
211	7	0.4	0	1	25	
212	135	1.3	0	1	40	
213	15	0.7	0	1	40	
214	41	0.8	0	1	10	
216	212	1.8	0	1	25	
217	27	0.7	0	1	10	
218	33	0.7	0	0	50	
219	63	0.9	0	0	55	
222	68	0.9	0	1	5	
223	165	1.3	0	0	50	
224	230	1.5	0	1	40	
225	10	0.4	0	1	0	
226	70	1	0	1	15	
227	84	1.1	0	1	30	
228	7	0.4	0	1	0	
229	62	0.9	0	0	45	
230	9	0.5	0	1	30	
231	84	1.1	0	1	0	
232	121	1.2	0	0	50	
233	45	0.9	0	0	50	
234	256	1.6	0	1	45	
235	71	1.2	0	1	50	
236	32	0.9	0	1	10	
237	180	1.9	0	1	5	
238	162	1.4	0	1	50	
239	295	1.7	0	1	55	
240	124	1.2	0	1	5	
241	84	1.4	0	1	20	
242	4	0.3	0	1	25	
243	71	0.9	0	1	50	
244	127	1.2	0	0	50	
245	129	1.2	0	1	35	
246	298	1.7	0	2	10	
247	512	2.1	0	0	55	
248	496	2.1	0	0	50	
249	490	2.1	0	1	5	
251	162	1.4	0	1	35	
252	34	0.8	0	1	10	
253	93	1.1	0	1	5	
254	45	0.8	0	0	50	
256	6	0.4	0	0	55	
257	240	1.6	0	1	15	
260	409	2.2	0	1	35	
261	44	0.8	0	1	15	
262	46	0.8	0	0	50	
263	476	2	0	1	30	
264	480	2.3	0	2	0	
265	111	1.3	0	0	55	
266	27	0.7	0	1	5	
267	500	2.1	0	2	10	
269	489	2.2	0	2	25	
271	64	0.9	0	0	50	
272	5	0.3	0	1	20	
274	100	1	0	0	45	
276	812	2.5	0	1	45	
277	787	2.5	0	1	40	
278	803	2.9	0	1	25	
279	8	0.4	0	1	35	
280	17	0.5	0	1	5	
281	9	0.4	0	1	20	
282	99	1.1	0	1	10	
284	181	1.4	0	0	40	
285	894	2.6	0	1	45	
286	50	0.8	0	0	55	
287	496	2.1	0	2	25	
289	5	0.3	0	2	15	
500	239	(DIRECT FLOW)		0	35	

5-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)		TIME (HR /MIN)	
201	19	0.6	0	0	50	
202	6	0.3	0	1	10	
203	20	0.6	0	0	50	
204	22	0.6	0	1	15	
205	39	0.7	0	1	25	
208	79	1	0	1	20	
211	4	0.3	0	1	25	
212	87	1.1	0	1	45	
213	10	0.6	0	1	40	
214	28	0.7	0	1	10	
216	145	1.5	0	1	20	
217	18	0.6	0	1	10	
218	25	0.6	0	0	50	
219	43	0.8	0	0	55	
222	47	0.8	0	1	5	
223	132	1.2	0	0	50	
224	157	1.3	0	1	40	
225	7	0.4	0	1	0	
226	46	0.8	0	1	20	
227	58	1	0	1	30	
228	5	0.3	0	1	5	
229	42	0.7	0	0	50	
230	6	0.5	0	1	30	
231	63	1	0	1	0	
232	97	1.1	0	0	50	
233	37	0.8	0	0	50	
234	180	1.4	0	1	45	
235	51	1.1	0	1	50	
236	26	0.8	0	1	10	
237	142	1.7	0	1	5	
238	124	1.2	0	1	50	
239	211	1.5	0	1	50	
240	93	1.1	0	1	5	
241	61	1.2	0	1	20	
242	2	0.2	0	1	25	
243	51	0.8	0	1	55	
244	101	1.1	0	0	50	
245	92	1	0	1	35	
246	214	1.5	0	2	10	
247	407	1.9	0	1	0	
248	409	1.9	0	0	50	
249	387	1.9	0	1	5	
251	113	1.3	0	1	40	
252	23	0.7	0	1	15	
253	66	0.9	0	1	5	
254	36	0.7	0	0	50	
256	5	0.3	0	0	55	
257	177	1.5	0	1	15	
260	295	1.9	0	1	40	
261	29	0.7	0	1	20	
262	35	0.7	0	0	55	
263	339	1.7	0	1	40	
264	346	2	0	2	5	
265	89	1.2	0	1	0	
266	15	0.6	0	1	10	
267	356	1.9	0	2	15	
269	345	1.9	0	2	35	
271	47	0.8	0	0	50	
272	4	0.3	0	1	20	
274	81	1	0	0	45	
276	610	2.2	0	1	50	
277	592	2.2	0	1	40	
278	610	2.6	0	1	25	
279	5	0.3	0	1	40	
280	10	0.4	0	1	5	
281	6	0.4	0	1	20	
282	75	1	0	1	10	
284	140	1.2	0	0	40	
285	669	2.3	0	1	50	
286	36	0.7	0	0	55	
287	348	1.8	0	2	35	
289	3	0.3	0	2	25	
500	195	(DIRECT FLOW)		0	35	

2-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)		TIME (HR /MIN)	
201	11	0.5	0	0	55	
202	1	0.1	0	1	0	
203	2	0.3	0	0	50	
204	8	0.4	0	1	25	
205	14	0.5	0	1	25	
208	36	0.7	0	1	20	
211	2	0.2	0	1	25	
212	38	0.8	0	1	50	
213	5	0.5	0	1	45	
214	12	0.5	0	1	20	
216	71	1.1	0	1	15	
217	8	0.4	0	1	15	
218	14	0.5	0	0	55	
219	21	0.6	0	0	55	
222	22	0.6	0	1	10	
223	84	1	0	0	50	
224	77	1	0	1	40	
225	4	0.3	0	1	5	
226	22	0.6	0	1	20	
227	32	0.8	0	1	25	
228	2	0.2	0	1	10	
229	19	0.5	0	0	50	
230	3	0.4	0	1	45	
231	37	0.8	0	0	55	
232	65	0.9	0	0	50	
233	25	0.7	0	0	55	
234	93	1.1	0	1	50	
235	28	0.8	0	2	0	
236	17	0.7	0	1	15	
237	89	1.4	0	1	10	
238	76	1	0	1	55	
239	117	1.2	0	1	50	
240	57	0.9	0	1	10	
241	33	1	0	1	25	
242	1	0.2	0	1	10	
243	28	0.6	0	2	5	
244	65	0.9	0	0	55	
245	54	0.8	0	1	40	
246	123	1.2	0	2	10	
247	266	1.6	0	1	0	
248	281	1.7	0	0	50	
249	246	1.6	0	1	10	
251	61	1	0	1	50	
252	10	0.5	0	1	20	
253	35	0.7	0	2	5	
254	23	0.6	0	0	55	
256	3	0.3	0	1	0	
257	101	1.2	0	1	20	
260	163	1.5	0	1	50	
261	14	0.5	0	1	25	
262	21	0.6	0	0	55	
263	186	1.3	0	1	50	
264	195	1.6	0	2	15	
265	61	1	0	1	0	
266	8	0.5	0	1	10	
267	198	1.5	0	2	25	
269	190	1.5	0	2	45	
271	25	0.6	0	0	55	
272	2	0.2	0	1	20	
274	55	0.8	0	0	45	
276	360	1.8	0	2	0	
277	350	1.8	0	1	50	
278	363	2.1	0	1	30	
279	2	0.2	0	1	45	
280	4	0.3	0	1	10	
281	3	0.3	0	1	25	
282	44	0.8	0	1	15	
284	85	1	0	0	40	
285	393	1.9	0	2	0	
286	19	0.6	0	0	55	
287	191	1.4	0	2	50	
289	0	0	0	0	0	
500	133	(DIRECT FLOW)		0	35	

0.4" Average

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)		TIME (HR /MIN)	
201	3	0.3	0	0	55	
202	0	0	0	0	0	
203	0	0	0	0	0	
204	2	0.2	0	1	40	
205	3	0.3	0	1	45	
208	8	0.4	0	1	30	
211	0	0	0	0	40	
212	7	0.4	0	2	5	
213	1	0.3	0	2	0	
214	2	0.3	0	1	35	
216	16	0.6	0	1	20	
217	2	0.2	0	1	30	
218	4	0.3	0	0	55	
219	5	0.3	0	1	0	
222	5	0.3	0	1	15	
223	25	0.6	0	0	50	
224	18	0.6	0	2	0	
225	1	0.2	0	0	50	
226	5	0.3	0	1	30	
227	8	0.4	0	1	35	
228	0	0	0	0	0	
229	3	0.3	0	0	50	
230	1	0.2	0	1	40	
231	9	0.5	0	1	5	
232	18	0.5	0	0	50	
233	7	0.4	0	0	55	
234	24	0.6	0	1	55	
235	7	0.5	0	2	5	
236	5	0.4	0	1	35	
237	25	0.9	0	1	15	
238	21	0.6	0	2	5	
239	32	0.7	0	2	0	
240	15	0.5	0	1	20	
241	8	0.5	0	1	50	
242	0	0	0	0	0	
243	6	0.3	0	2	40	
244	18	0.6	0	0	55	
245	13	0.5	0	2	5	
246	32	0.7	0	2	10	
247	74	1	0	1	5	
248	83	1	0	0	50	
249	67	1	0	1	20	
251	14	0.5	0	2	10	
252	2	0.3	0	1	30	
253	8	0.4	0	1	15	
254	7	0.4	0	0	55	
256	1	0.2	0	0	50	
257	25	0.7	0	1	35	
260	41	0.9	0	2	5	
261	3	0.3	0	2	5	
262	6	0.4	0	1	0	
263	45	0.8	0	2	5	
264	46	0.9	0	2	30	
265	18	0.6	0	1	5	
266	2	0.2	0	1	25	
267	45	0.8	0	2	55	
269	43	0.8	0	3	25	
271	6	0.4	0	0	55	
272	0	0	0	0	0	
274	16	0.5	0	0	45	
276	92	1.1	0	2	20	
277	92	1.1	0	2	15	
278	96	1.2	0	1	55	
279	0	0	0	0	0	
280	0	0.1	0	0	45	
281	0	0.1	0	1	10	
282	12	0.5	0	1	30	
284	23	0.6	0	0	40	
285	101	1.1	0	2	25	
286	4	0.3	0	1	0	
287	43	0.8	0	3	35	
289	0	0	0	0	0	
500	50	(DIRECT FLOW)		0	30	

DFA0053 SWMM Output for Master Plan Conditions

100-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	112	(DIRECT FLOW)	0	40
102	105	(DIRECT FLOW)	0	45
103	171	(DIRECT FLOW)	0	45
104	286	(DIRECT FLOW)	1	0
105	221	(DIRECT FLOW)	0	50
106	497	(DIRECT FLOW)	1	10
107	171	(DIRECT FLOW)	0	45
108	598	(DIRECT FLOW)	1	15
109	76	(DIRECT FLOW)	0	40
110	179	(DIRECT FLOW)	0	45
111	345	(DIRECT FLOW)	1	0
112	751	(DIRECT FLOW)	1	15
113	197	(DIRECT FLOW)	0	45
114	280	(DIRECT FLOW)	0	45
115	115	(DIRECT FLOW)	0	45
116	829	(DIRECT FLOW)	1	15
117	215	(DIRECT FLOW)	0	50
118	73	(DIRECT FLOW)	0	40
119	355	(DIRECT FLOW)	0	50
120	31	(DIRECT FLOW)	0	45
121	250	(DIRECT FLOW)	0	40
122	287	(DIRECT FLOW)	0	40
123	270	(DIRECT FLOW)	0	40
124	802	(DIRECT FLOW)	1	30
125	204	(DIRECT FLOW)	0	40
126	167	(DIRECT FLOW)	0	40
127	362	(DIRECT FLOW)	0	40
129	384	(DIRECT FLOW)	0	45
130	75	(DIRECT FLOW)	0	45
131	319	(DIRECT FLOW)	0	55
132	363	(DIRECT FLOW)	0	50
133	885	(DIRECT FLOW)	1	30
134	522	(DIRECT FLOW)	0	50
135	365	(DIRECT FLOW)	0	50
137	465	(DIRECT FLOW)	1	5
138	1353	(DIRECT FLOW)	0	45
139	500	(DIRECT FLOW)	0	40
140	191	(DIRECT FLOW)	0	40
141	279	(DIRECT FLOW)	1	15
142	503	(DIRECT FLOW)	0	40
143	389	(DIRECT FLOW)	0	45
144	310	(DIRECT FLOW)	0	55
145	110	(DIRECT FLOW)	0	45
146	1504	(DIRECT FLOW)	1	5
147	1246	(DIRECT FLOW)	1	0
148	1263	(DIRECT FLOW)	0	50
151	195	(DIRECT FLOW)	0	55
152	196	(DIRECT FLOW)	0	45
153	799	(DIRECT FLOW)	1	0
154	174	(DIRECT FLOW)	0	40
155	36	(DIRECT FLOW)	0	40
156	161	(DIRECT FLOW)	0	45
157	1065	(DIRECT FLOW)	1	10
159	379	(DIRECT FLOW)	0	45
160	1250	(DIRECT FLOW)	1	15
162	288	(DIRECT FLOW)	0	45
163	1524	(DIRECT FLOW)	1	15
164	1359	(DIRECT FLOW)	1	35
165	186	(DIRECT FLOW)	0	45
166	230	(DIRECT FLOW)	0	55
167	492	(DIRECT FLOW)	0	40
168	36	(DIRECT FLOW)	1	0
169	729	(DIRECT FLOW)	0	50
170	228	(DIRECT FLOW)	0	45
171	729	(DIRECT FLOW)	1	5
172	227	(DIRECT FLOW)	0	40
173	35	(DIRECT FLOW)	0	45
174	270	(DIRECT FLOW)	0	40
175	470	(DIRECT FLOW)	0	40
176	612	(DIRECT FLOW)	3	10
177	612	(DIRECT FLOW)	3	10
178	613	(DIRECT FLOW)	3	0
179	660	(DIRECT FLOW)	0	35
180	108	(DIRECT FLOW)	0	40
181	613	(DIRECT FLOW)	2	45
182	64	(DIRECT FLOW)	0	45
183	125	(DIRECT FLOW)	0	40
184	422	(DIRECT FLOW)	0	45
185	1034	(DIRECT FLOW)	1	0
186	166	(DIRECT FLOW)	1	0
187	859	(DIRECT FLOW)	0	55
188	75	(DIRECT FLOW)	0	45
189	453	(DIRECT FLOW)	0	40
190	39	(DIRECT FLOW)	0	55
191	39	(DIRECT FLOW)	0	55
195	1034	(DIRECT FLOW)	1	0
196	166	(DIRECT FLOW)	1	0
197	859	(DIRECT FLOW)	0	55
198	75	(DIRECT FLOW)	0	45
199	453	(DIRECT FLOW)	0	40

50-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	90	(DIRECT FLOW)	0	40
102	77	(DIRECT FLOW)	0	45
103	126	(DIRECT FLOW)	0	45
104	204	(DIRECT FLOW)	0	55
105	162	(DIRECT FLOW)	0	50
106	354	(DIRECT FLOW)	1	0
107	133	(DIRECT FLOW)	0	45
108	419	(DIRECT FLOW)	1	10
109	58	(DIRECT FLOW)	0	40
110	137	(DIRECT FLOW)	0	45
111	243	(DIRECT FLOW)	1	0
112	524	(DIRECT FLOW)	1	5
113	152	(DIRECT FLOW)	0	45
114	213	(DIRECT FLOW)	0	45
115	92	(DIRECT FLOW)	0	40
116	587	(DIRECT FLOW)	1	10
117	161	(DIRECT FLOW)	0	45
118	54	(DIRECT FLOW)	0	40
119	262	(DIRECT FLOW)	0	50
120	24	(DIRECT FLOW)	0	45
121	192	(DIRECT FLOW)	0	40
122	242	(DIRECT FLOW)	0	40
123	227	(DIRECT FLOW)	0	40
124	574	(DIRECT FLOW)	1	30
125	166	(DIRECT FLOW)	0	40
126	140	(DIRECT FLOW)	0	40
127	297	(DIRECT FLOW)	0	40
129	304	(DIRECT FLOW)	0	40
130	53	(DIRECT FLOW)	0	45
131	239	(DIRECT FLOW)	0	55
132	278	(DIRECT FLOW)	0	50
133	640	(DIRECT FLOW)	1	35
134	417	(DIRECT FLOW)	0	50
135	292	(DIRECT FLOW)	0	50
137	361	(DIRECT FLOW)	1	0
138	1141	(DIRECT FLOW)	0	40
139	407	(DIRECT FLOW)	0	40
140	146	(DIRECT FLOW)	0	40
141	201	(DIRECT FLOW)	1	15
142	420	(DIRECT FLOW)	0	40
143	300	(DIRECT FLOW)	0	45
144	230	(DIRECT FLOW)	0	55
145	87	(DIRECT FLOW)	0	40
146	1449	(DIRECT FLOW)	1	5
147	979	(DIRECT FLOW)	1	0
148	1010	(DIRECT FLOW)	0	50
151	141	(DIRECT FLOW)	0	50
152	150	(DIRECT FLOW)	0	45
153	608	(DIRECT FLOW)	0	55
154	144	(DIRECT FLOW)	0	40
155	29	(DIRECT FLOW)	0	40
156	127	(DIRECT FLOW)	0	45
157	777	(DIRECT FLOW)	1	10
159	307	(DIRECT FLOW)	0	45
160	898	(DIRECT FLOW)	1	20
162	217	(DIRECT FLOW)	0	45
163	1098	(DIRECT FLOW)	1	15
164	975	(DIRECT FLOW)	1	35
165	136	(DIRECT FLOW)	0	45
166	173	(DIRECT FLOW)	0	50
167	405	(DIRECT FLOW)	0	40
168	26	(DIRECT FLOW)	1	0
169	556	(DIRECT FLOW)	0	50
170	177	(DIRECT FLOW)	0	40
171	612	(DIRECT FLOW)	2	15
172	180	(DIRECT FLOW)	0	40
173	27	(DIRECT FLOW)	0	45
174	225	(DIRECT FLOW)	0	40
175	379	(DIRECT FLOW)	0	40
176	552	(DIRECT FLOW)	2	15
177	550	(DIRECT FLOW)	3	0
178	551	(DIRECT FLOW)	2	45
179	551	(DIRECT FLOW)	0	35
180	82	(DIRECT FLOW)	0	45
181	552	(DIRECT FLOW)	2	35
182	48	(DIRECT FLOW)	0	45
183	96	(DIRECT FLOW)	0	40
184	331	(DIRECT FLOW)	0	45
185	788	(DIRECT FLOW)	1	0
186	124	(DIRECT FLOW)	0	55
187	644	(DIRECT FLOW)	0	55
188	57	(DIRECT FLOW)	0	45
189	369	(DIRECT FLOW)	0	40
190	28	(DIRECT FLOW)	0	55
191	28	(DIRECT FLOW)	0	55
195	788	(DIRECT FLOW)	1	0
196	124	(DIRECT FLOW)	0	55
197	644	(DIRECT FLOW)	0	55
198	57	(DIRECT FLOW)	0	45
199	369	(DIRECT FLOW)	0	40

10-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	52	(DIRECT FLOW)	0	35
102	29	(DIRECT FLOW)	0	40
103	47	(DIRECT FLOW)	0	40
104	83	(DIRECT FLOW)	0	40
105	63	(DIRECT FLOW)	0	50
106	157	(DIRECT FLOW)	0	45
107	66	(DIRECT FLOW)	0	40
108	168	(DIRECT FLOW)	1	0
109	27	(DIRECT FLOW)	0	35
110	65	(DIRECT FLOW)	0	40
111	88	(DIRECT FLOW)	0	40
112	249	(DIRECT FLOW)	0	45
113	73	(DIRECT FLOW)	0	40
114	103	(DIRECT FLOW)	0	40
115	51	(DIRECT FLOW)	0	35
116	256	(DIRECT FLOW)	1	5
117	75	(DIRECT FLOW)	0	40
118	22	(DIRECT FLOW)	0	35
119	109	(DIRECT FLOW)	0	45
120	12	(DIRECT FLOW)	0	35
121	93	(DIRECT FLOW)	0	35
122	159	(DIRECT FLOW)	0	35
123	149	(DIRECT FLOW)	0	35
124	262	(DIRECT FLOW)	1	30
125	107	(DIRECT FLOW)	0	35
126	91	(DIRECT FLOW)	0	35
127	191	(DIRECT FLOW)	0	35
129	177	(DIRECT FLOW)	0	35
130	15	(DIRECT FLOW)	0	40
131	111	(DIRECT FLOW)	0	50
132	138	(DIRECT FLOW)	0	45
133	305	(DIRECT FLOW)	1	30
134	234	(DIRECT FLOW)	0	45
135	167	(DIRECT FLOW)	0	45
137	191	(DIRECT FLOW)	1	0
138	741	(DIRECT FLOW)	0	35
139	272	(DIRECT FLOW)	0	35
140	72	(DIRECT FLOW)	0	35
141	91	(DIRECT FLOW)	1	20
142	262	(DIRECT FLOW)	0	35
143	155	(DIRECT FLOW)	0	40
144	98	(DIRECT FLOW)	0	50
145	47	(DIRECT FLOW)	0	35
146	719	(DIRECT FLOW)	1	5
147	531	(DIRECT FLOW)	0	55
148	573	(DIRECT FLOW)	0	45
151	59	(DIRECT FLOW)	0	40
152	72	(DIRECT FLOW)	0	40
153	296	(DIRECT FLOW)	0	50
154	89	(DIRECT FLOW)	0	35
155	19	(DIRECT FLOW)	0	35
156	72	(DIRECT FLOW)	0	40
157	355	(DIRECT FLOW)	1	10
159	185	(DIRECT FLOW)	0	40
160	410	(DIRECT FLOW)	1	25
162	92	(DIRECT FLOW)	0	40
163	508	(DIRECT FLOW)	1	20
164	455	(DIRECT FLOW)	1	45
165	52	(DIRECT FLOW)	0	40
166	86	(DIRECT FLOW)	0	40
167	251	(DIRECT FLOW)	0	35
168	9	(DIRECT FLOW)	0	55
169	266	(DIRECT FLOW)	0	45
170	94	(DIRECT FLOW)	0	40
171	433	(DIRECT FLOW)	2	15
172	96	(DIRECT FLOW)	0	35
173	13	(DIRECT FLOW)	0	35
174	143	(DIRECT FLOW)	0	35
175	239	(DIRECT FLOW)	0	35
176	393	(DIRECT FLOW)	2	15
177	389	(DIRECT FLOW)	2	40
178	391	(DIRECT FLOW)	2	20
179	327	(DIRECT FLOW)	0	30
180	37	(DIRECT FLOW)	0	35
181	393	(DIRECT FLOW)	2	15
182	20	(DIRECT FLOW)	0	40
183	47	(DIRECT FLOW)	0	35
184	181	(DIRECT FLOW)	0	40
185	453	(DIRECT FLOW)	2	15
186	55	(DIRECT FLOW)	0	55
187	284	(DIRECT FLOW)	0	50
188	25	(DIRECT FLOW)	0	35
189	209	(DIRECT FLOW)	0	35
190	10	(DIRECT FLOW)	0	50
191	10	(DIRECT FLOW)	0	50
195	453	(DIRECT FLOW)	2	15
196	55	(DIRECT FLOW)	0	55
197	284	(DIRECT FLOW)	0	50
198	25	(DIRECT FLOW)	0	35
199	209	(DIRECT FLOW)	0	35

5-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	40	(DIRECT FLOW)	0	35
102	17	(DIRECT FLOW)	0	40
103	27	(DIRECT FLOW)	0	40
104	58	(DIRECT FLOW)	0	40
105	39	(DIRECT FLOW)	0	50
106	112	(DIRECT FLOW)	0	45
107	49	(DIRECT FLOW)	0	40
108	114	(DIRECT FLOW)	1	0
109	18	(DIRECT FLOW)	0	40
110	46	(DIRECT FLOW)	0	40
111	60	(DIRECT FLOW)	0	40
112	185	(DIRECT FLOW)	0	45
113	54	(DIRECT FLOW)	0	40
114	75	(DIRECT FLOW)	0	40
115	40	(DIRECT FLOW)	0	40
116	183	(DIRECT FLOW)	1	0
117	53	(DIRECT FLOW)	0	40
118	15	(DIRECT FLOW)	0	35
119	73	(DIRECT FLOW)	0	45
120	8	(DIRECT FLOW)	0	40
121	65	(DIRECT FLOW)	0	35
122	131	(DIRECT FLOW)	0	35
123	124	(DIRECT FLOW)	0	35
124	182	(DIRECT FLOW)	1	35
125	91	(DIRECT FLOW)	0	35
126	77	(DIRECT FLOW)	0	35
127	159	(DIRECT FLOW)	0	35
129	141	(DIRECT FLOW)	0	35
130	7	(DIRECT FLOW)	0	35
131	82	(DIRECT FLOW)	0	50
132	103	(DIRECT FLOW)	0	45
133	218	(DIRECT FLOW)	1	40
134	189	(DIRECT FLOW)	0	45
135	136	(DIRECT FLOW)	0	45
137	152	(DIRECT FLOW)	1	0
138	612	(DIRECT FLOW)	0	35
139	229	(DIRECT FLOW)	0	35
140	50	(DIRECT FLOW)	0	35
141	66	(DIRECT FLOW)	1	20
142	210	(DIRECT FLOW)	0	35
143	116	(DIRECT FLOW)	0	40
144	66	(DIRECT FLOW)	0	50
145	37	(DIRECT FLOW)	0	40
146	555	(DIRECT FLOW)	1	5
147	421	(DIRECT FLOW)	0	55
148	460	(DIRECT FLOW)	0	45
151	38	(DIRECT FLOW)	0	40
152	52	(DIRECT FLOW)	0	40
153	223	(DIRECT FLOW)	0	55
154	72	(DIRECT FLOW)	0	35
155	16	(DIRECT FLOW)	0	35
156	57	(DIRECT FLOW)	0	40
157	259	(DIRECT FLOW)	1	15
159	151	(DIRECT FLOW)	0	40
160	292	(DIRECT FLOW)	1	25
162	60	(DIRECT FLOW)	0	45
163	370	(DIRECT FLOW)	1	20
164	327	(DIRECT FLOW)	1	50
165	30	(DIRECT FLOW)	0	40
166	66	(DIRECT FLOW)	0	40
167	200	(DIRECT FLOW)	0	35
168	5	(DIRECT FLOW)	0	55
169	197	(DIRECT FLOW)	0	45
170	71	(DIRECT FLOW)	0	40
171	354	(DIRECT FLOW)	2	20
172	71	(DIRECT FLOW)	0	40
173	9	(DIRECT FLOW)	0	40
174	116	(DIRECT FLOW)	0	35
175	195	(DIRECT FLOW)	0	35
176	322	(DIRECT FLOW)	2	20
177	319	(DIRECT FLOW)	2	35
178	323	(DIRECT FLOW)	2	10
179	250	(DIRECT FLOW)	0	30
180	25	(DIRECT FLOW)	0	40
181	324	(DIRECT FLOW)	2	10
182	13	(DIRECT FLOW)	0	40
183	32	(DIRECT FLOW)	0	35
184	142	(DIRECT FLOW)	0	40
185	367	(DIRECT FLOW)	2	15
186	39	(DIRECT FLOW)	0	55
187	199	(DIRECT FLOW)	0	55
188	17	(DIRECT FLOW)	0	40
189	163	(DIRECT FLOW)	0	40
190	5	(DIRECT FLOW)	0	50
191	5	(DIRECT FLOW)	0	50
195	367	(DIRECT FLOW)	2	15
196	39	(DIRECT FLOW)	0	55
197	199	(DIRECT FLOW)	0	55
198	17	(DIRECT FLOW)	0	40
199	163	(DIRECT FLOW)	0	40

2-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	26	(DIRECT FLOW)	0	35
102	2	(DIRECT FLOW)	0	40
103	4	(DIRECT FLOW)	0	40
104	28	(DIRECT FLOW)	0	40
105	14	(DIRECT FLOW)	0	55
106	57	(DIRECT FLOW)	0	45
107	26	(DIRECT FLOW)	0	40
108	53	(DIRECT FLOW)	1	0
109	8	(DIRECT FLOW)	0	35
110	22	(DIRECT FLOW)	0	40
111	28	(DIRECT FLOW)	0	40
112	99	(DIRECT FLOW)	0	45
113	25	(DIRECT FLOW)	0	40
114	37	(DIRECT FLOW)	0	40
115	24	(DIRECT FLOW)	0	40
116	96	(DIRECT FLOW)	1	0
117	28	(DIRECT FLOW)	0	40
118	9	(DIRECT FLOW)	0	35
119	39	(DIRECT FLOW)	0	45
120	4	(DIRECT FLOW)	0	35
121	32	(DIRECT FLOW)	0	35
122	94	(DIRECT FLOW)	0	35
123	89	(DIRECT FLOW)	0	35
124	121	(DIRECT FLOW)	0	40
125	66	(DIRECT FLOW)	0	35
126	55	(DIRECT FLOW)	0	35
127	113	(DIRECT FLOW)	0	35
129	97	(DIRECT FLOW)	0	35
130	4	(DIRECT FLOW)	0	40
131	47	(DIRECT FLOW)	0	50
132	66	(DIRECT FLOW)	0	50
133	146	(DIRECT FLOW)	0	45
134	123	(DIRECT FLOW)	0	45
135	89	(DIRECT FLOW)	0	45
137	97	(DIRECT FLOW)	1	5
138	436	(DIRECT FLOW)	0	35
139	166	(DIRECT FLOW)	0	35
140	27	(DIRECT FLOW)	0	35
141	36	(DIRECT FLOW)	1	25
142	148	(DIRECT FLOW)	0	35
143	64	(DIRECT FLOW)	0	40
144	31	(DIRECT FLOW)	0	50
145	22	(DIRECT FLOW)	0	40
146	338	(DIRECT FLOW)	1	10
147	271	(DIRECT FLOW)	1	0
148	306	(DIRECT FLOW)	0	50
151	21	(DIRECT FLOW)	0	40
152	25	(DIRECT FLOW)	0	40
153	130	(DIRECT FLOW)	0	55
154	50	(DIRECT FLOW)	0	35
155	11	(DIRECT FLOW)	0	35
156	35	(DIRECT FLOW)	0	40
157	144	(DIRECT FLOW)	1	15
159	108	(DIRECT FLOW)	0	40
160	157	(DIRECT FLOW)	1	30
162	29	(DIRECT FLOW)	0	45
163	210	(DIRECT FLOW)	1	20
164	185	(DIRECT FLOW)	2	0
165	18	(DIRECT FLOW)	0	40
166	38	(DIRECT FLOW)	0	40
167	135	(DIRECT FLOW)	0	35
168	0	(DIRECT FLOW)	0	0
169	104	(DIRECT FLOW)	0	45
170	39	(DIRECT FLOW)	0	40
171	234	(DIRECT FLOW)	2	25
172	40	(DIRECT FLOW)	0	35
173	4	(DIRECT FLOW)	0	35
174	83	(DIRECT FLOW)	0	35
175	133	(DIRECT FLOW)	0	35
176	214	(DIRECT FLOW)	2	30
177	213	(DIRECT FLOW)	2	35
178	215	(DIRECT FLOW)	2	10
179	167	(DIRECT FLOW)	0	30
180	11	(DIRECT FLOW)	0	35
181	219	(DIRECT FLOW)	2	0
182	4	(DIRECT FLOW)	0	40
183	16	(DIRECT FLOW)	0	35
184	87	(DIRECT FLOW)	0	40
185	240	(DIRECT FLOW)	2	25
186	19	(DIRECT FLOW)	0	55
187	99	(DIRECT FLOW)	0	55
188	7	(DIRECT FLOW)	0	35
189	101	(DIRECT FLOW)	0	40
190	0	(DIRECT FLOW)	0	0
191	0	(DIRECT FLOW)	0	0
195	240	(DIRECT FLOW)	2	25
196	19	(DIRECT FLOW)	0	55
197	99	(DIRECT FLOW)	0	55
198	7	(DIRECT FLOW)	0	35
199	101	(DIRECT FLOW)	0	40

0.4" Average

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR /MIN)
101	8	(DIRECT FLOW)	0	30
102	0	(DIRECT FLOW)	0	0
103	0	(DIRECT FLOW)	0	0
104	6	(DIRECT FLOW)	0	35
105	3	(DIRECT FLOW)	0	55
106	14	(DIRECT FLOW)	0	40
107	7	(DIRECT FLOW)	0	35
108	11	(DIRECT FLOW)	1	10
109	1	(DIRECT FLOW)	0	30
110	4	(DIRECT FLOW)	0	35
111	6	(DIRECT FLOW)	0	35
112	27	(DIRECT FLOW)	0	40
113	5	(DIRECT FLOW)	0	35
114	10	(DIRECT FLOW)	0	35
115	8	(DIRECT FLOW)	0	35
116	23	(DIRECT FLOW)	1	5
117	7	(DIRECT FLOW)	0	35
118	2	(DIRECT FLOW)	0	30
119	8	(DIRECT FLOW)	0	45
120	0	(DIRECT FLOW)	0	0
121	7	(DIRECT FLOW)	0	30
122	33	(DIRECT FLOW)	0	35
123	31	(DIRECT FLOW)	0	30
124	42	(DIRECT FLOW)	0	35
125	23	(DIRECT FLOW)	0	30
126	19	(DIRECT FLOW)	0	35
127	40	(DIRECT FLOW)	0	30
129	34	(DIRECT FLOW)	0	30
130	0	(DIRECT FLOW)	0	0
131	11	(DIRECT FLOW)	0	55
132	18	(DIRECT FLOW)	0	50
133	43	(DIRECT FLOW)	0	40
134	37	(DIRECT FLOW)	0	45
135	28	(DIRECT FLOW)	0	40
137	28	(DIRECT FLOW)	1	10
138	156	(DIRECT FLOW)	0	35
139	63	(DIRECT FLOW)	0	30
140	7	(DIRECT FLOW)	0	30
141	8	(DIRECT FLOW)	1	50
142	51	(DIRECT FLOW)	0	35
143	18	(DIRECT FLOW)	0	35
144	6	(DIRECT FLOW)	0	50
145	7	(DIRECT FLOW)	0	35
146	89	(DIRECT FLOW)	1	20
147	74	(DIRECT FLOW)	1	5
148	88	(DIRECT FLOW)	0	50
151	5	(DIRECT FLOW)	0	35
152	5	(DIRECT FLOW)	0	35
153	33	(DIRECT FLOW)	0	50
154	17	(DIRECT FLOW)	0	35
155	4	(DIRECT FLOW)	0	30
156	11	(DIRECT FLOW)	0	35
157	43	(DIRECT FLOW)	0	30
159	36	(DIRECT FLOW)	0	35
160	39	(DIRECT FLOW)	1	50
162	6	(DIRECT FLOW)	1	0
163	55	(DIRECT FLOW)	1	15
164	45	(DIRECT FLOW)	2	0
165	3	(DIRECT FLOW)	0	35
166	11	(DIRECT FLOW)	0	35
167	48	(DIRECT FLOW)	0	30
168	0	(DIRECT FLOW)	0	0
169	25	(DIRECT FLOW)	0	45
170	12	(DIRECT FLOW)	0	35
171	74	(DIRECT FLOW)	2	45
172	12	(DIRECT FLOW)	0	30
173	0	(D

DFA0053 SWMM Output for Master Plan Conditions

100-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)		TIME (HR /MIN)	
201	65	0.9	0	0	55
202	65	0.9	0	1	10
203	159	1.3	0	0	50
204	156	1.3	0	1	10
205	283	1.6	0	1	20
208	452	2	0	1	20
211	26	0.6	0	1	20
212	500	2.2	0	1	35
213	50	1.2	0	1	30
214	141	1.2	0	1	15
216	724	2.9	0	1	25
217	99	1.1	0	1	10
218	85	1	0	0	55
219	205	1.5	0	1	0
222	41	0.8	0	3	10
223	358	1.8	0	0	55
224	761	2.5	0	1	35
225	44	0.8	0	1	0
226	56	0.9	0	2	55
227	91	1.2	0	1	5
228	24	0.6	0	1	5
229	193	1.4	0	0	50
230	27	0.8	0	1	25
231	236	1.7	0	1	0
232	260	1.6	0	0	55
233	114	1.3	0	1	0
234	790	2.5	0	1	40
235	83	1.3	0	1	20
236	76	1.2	0	1	10
237	420	2.7	0	1	5
238	351	1.8	0	1	30
239	383	1.9	0	3	15
240	19	0.6	0	9	45
241	261	2.2	0	1	15
242	13	0.5	0	2	40
243	214	1.5	0	1	35
244	291	1.7	0	0	55
245	104	1.1	0	1	0
246	369	1.8	0	3	45
247	1188	2.9	0	1	0
248	1054	2.8	0	0	55
249	1177	3	0	1	5
251	277	1.8	0	1	10
252	118	1.3	0	1	10
253	304	1.7	0	1	15
254	105	1.1	0	0	55
256	14	0.5	0	1	0
257	698	2.5	0	1	15
260	993	3.1	0	1	20
261	169	1.4	0	1	15
262	119	1.2	0	0	55
263	1248	2.9	0	1	20
264	1227	3.3	0	1	40
265	263	1.8	0	1	0
266	125	1.3	0	1	10
267	135	1.3	0	5	5
269	216	1.6	0	0	55
271	178	1.4	0	0	55
272	19	0.6	0	1	20
274	210	1.4	0	0	50
276	612	2.2	0	3	20
277	612	2.2	0	3	10
278	613	2.6	0	3	0
279	37	0.8	0	1	30
280	64	0.9	0	1	5
281	34	0.7	0	1	20
282	240	1.6	0	1	5
284	411	1.9	0	0	45
285	726	2.4	0	1	10
286	145	1.3	0	1	0
287	682	2.4	0	0	55
289	25	0.6	0	2	0
314	42	0.1	20.7	2	40
319	58	0.1	21.5	2	5
330	17	0.1	3.1	1	35
332	19	0.1	44.9	9	30
333	388	0.1	89.9	2	55
346	613	0.1	114.1	2	45
364	136	0.1	191.5	4	40
500	566 (DIRECT FLOW)			0	40

50-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)		TIME (HR /MIN)	
201	50	0.8	0	0	55
202	44	0.7	0	1	10
203	114	1.2	0	0	50
204	109	1.2	0	1	10
205	191	1.4	0	1	20
208	313	1.7	0	1	20
211	18	0.5	0	1	25
212	345	1.9	0	1	35
213	35	1	0	1	30
214	101	1.1	0	1	10
216	507	2.5	0	1	25
217	70	1	0	1	10
218	65	0.9	0	0	55
219	150	1.3	0	1	0
222	36	0.7	0	3	5
223	284	1.6	0	0	55
224	535	2.2	0	1	35
225	31	0.7	0	1	0
226	49	0.8	0	2	50
227	72	1.1	0	1	5
228	18	0.5	0	1	5
229	144	1.2	0	0	50
230	19	0.7	0	1	25
231	177	1.5	0	1	0
232	206	1.5	0	0	55
233	87	1.1	0	1	0
234	565	2.2	0	1	40
235	63	1.2	0	1	20
236	59	1.1	0	1	10
237	326	2.4	0	1	5
238	267	1.7	0	1	30
239	284	1.7	0	3	20
240	17	0.5	0	8	35
241	189	1.9	0	1	15
242	9	0.4	0	2	30
243	154	1.3	0	1	40
244	229	1.5	0	0	55
245	75	1	0	1	0
246	273	1.6	0	3	50
247	936	2.7	0	1	0
248	843	2.6	0	0	55
249	915	2.7	0	1	5
251	200	1.6	0	1	10
252	84	1.2	0	1	10
253	216	1.5	0	1	10
254	82	1	0	0	55
256	11	0.5	0	1	0
257	514	2.2	0	1	15
260	721	2.7	0	1	25
261	117	1.2	0	1	15
262	92	1.1	0	0	55
263	895	2.5	0	1	20
264	885	2.9	0	1	40
265	207	1.7	0	1	0
266	85	1.2	0	1	5
267	119	1.2	0	5	10
269	168	1.4	0	0	55
271	136	1.2	0	0	55
272	14	0.5	0	1	20
274	168	1.3	0	0	50
276	550	2.1	0	3	5
277	550	2.2	0	3	0
278	551	2.5	0	2	45
279	25	0.6	0	1	30
280	46	0.8	0	1	5
281	23	0.6	0	1	20
282	183	1.5	0	1	5
284	322	1.7	0	0	45
285	611	2.2	0	2	20
286	109	1.1	0	1	0
287	515	2.1	0	0	55
289	17	0.5	0	2	0
314	36	0.1	14.8	2	35
319	50	0.1	14.9	2	5
330	13	0.1	1.9	1	30
332	17	0.1	34.6	8	20
333	289	0.1	69.2	3	0
346	552	0.1	79	2	35
364	119	0.1	145.7	4	45
500	451 (DIRECT FLOW)			0	40

10-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)		TIME (HR /MIN)	
201	25	0.6	0	0	50
202	12	0.4	0	1	10
203	38	0.7	0	0	45
204	37	0.7	0	1	10
205	66	0.9	0	1	25
208	120	1.2	0	1	20
211	7	0.4	0	1	25
212	135	1.3	0	1	40
213	15	0.7	0	1	40
214	41	0.8	0	1	10
216	212	1.8	0	1	25
217	27	0.7	0	1	10
218	33	0.7	0	0	50
219	63	0.9	0	0	55
222	22	0.6	0	3	0
223	160	1.3	0	0	50
224	230	1.5	0	1	40
225	10	0.4	0	1	0
226	34	0.7	0	2	30
227	41	0.8	0	2	10
228	7	0.4	0	1	0
229	62	0.9	0	0	45
230	9	0.5	0	1	30
231	84	1.1	0	1	0
232	116	1.2	0	0	50
233	45	0.9	0	0	50
234	256	1.6	0	1	45
235	37	0.9	0	2	5
236	32	0.9	0	1	10
237	172	1.9	0	1	5
238	146	1.3	0	1	40
239	130	1.3	0	3	35
240	12	0.5	0	6	50
241	84	1.4	0	1	20
242	2	0.2	0	2	35
243	71	0.9	0	1	50
244	126	1.2	0	0	50
245	30	0.7	0	0	55
246	125	1.2	0	4	15
247	511	2.1	0	0	55
248	495	2.1	0	0	50
249	490	2.1	0	1	5
251	79	1.1	0	1	10
252	34	0.8	0	1	10
253	93	1.1	0	1	5
254	45	0.8	0	0	50
256	6	0.4	0	0	55
257	238	1.6	0	1	15
260	332	2	0	1	25
261	44	0.8	0	1	15
262	46	0.8	0	0	50
263	408	1.8	0	1	25
264	414	2.1	0	1	50
265	111	1.3	0	0	55
266	27	0.7	0	1	5
267	85	1	0	5	10
269	89	1.1	0	0	50
271	64	0.9	0	0	50
272	5	0.3	0	1	20
274	100	1	0	0	45
276	391	1.9	0	2	35
277	389	1.9	0	2	40
278	390	2.2	0	2	30
279	8	0.4	0	1	35
280	17	0.5	0	1	5
281	9	0.4	0	1	20
282	91	1.1	0	1	5
284	177	1.4	0	0	40
285	432	1.9	0	2	20
286	50	0.8	0	0	55
287	238	1.6	0	0	55
289	5	0.3	0	2	15
314	22	0.1	6.7	2	25
319	37	0.1	5.5	1	50
330	4	0.1	0.5	1	30
332	12	0.1	18.1	6	35
333	132	0.1	36.8	3	10
346	393	0.1	34	2	15
364	85	0.1	74.3	4	45
500	268 (DIRECT FLOW)			0	35

5-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)		TIME (HR /MIN)	
201	19	0.6	0	0	50
202	6	0.3	0	1	10
203	20	0.6	0	0	50
204	22	0.6	0	1	15
205	39	0.7	0	1	25
208	79	1	0	1	20
211	4	0.3	0	1	25
212	87	1.1	0	1	45
213	10	0.6	0	1	40
214	28	0.7	0	1	10
216	145	1.5	0	1	20
217	18	0.6	0	1	10
218	25	0.6	0	0	50
219	43	0.8	0	0	55
222	15	0.5	0	3	0
223	128	1.2	0	0	50
224	157	1.3	0	1	40
225	7	0.4	0	1	0
226	23	0.6	0	2	35
227	32	0.8	0	1	0
228	5	0.3	0	1	5
229	42	0.7	0	0	50
230	6	0.5	0	1	30
231	63	1	0	1	0
232	94	1.1	0	0	50
233	37	0.8	0	0	50
234	180	1.4	0	1	45
235	28	0.9	0	1	50
236	26	0.8	0	1	10
237	137	1.7	0	1	5
238	114	1.2	0	1	40
239	94	1.1	0	3	35
240	10	0.4	0	6	35
241	61	1.2	0	1	20
242	1	0.2	0	2	25
243	51	0.8	0	1	55
244	100	1.1	0	0	50
245	20	0.6	0	1	0
246	91	1	0	4	15
247	407	1.9	0	1	0
248	409	1.9	0	0	50
249	386	1.9	0	1	5
251	52	0.9	0	1	10
252	23	0.7	0	1	15
253	66	0.9	0	1	5
254	36	0.7	0	0	50
256	5	0.3	0	0	55
257	177	1.5	0	1	15
260	240	1.8	0	1	30
261	29	0.7	0	1	20
262	35	0.7	0	0	55
263	291	1.6	0	1	30
264	300	1.9	0	1	55
265	89	1.2	0	1	0
266	15	0.6	0	1	10
267	70	1	0	5	15
269	70	1	0	0	50
271	47	0.8	0	0	50
272	4	0.3	0	1	20
274	81	1	0	0	45
276	321	1.7	0	2	35
277	319	1.7	0	2	35
278	321	2	0	2	25
279	5	0.3	0	1	40
280	10	0.4	0	1	5
281	6	0.4	0	1	20
282	70	1	0	1	5
284	138	1.2	0	0	40
285	354	1.8	0	2	25
286	36	0.7	0	0	55
287	173	1.4	0	0	55
289	3	0.3	0	2	25
314	16	0.1	4.7	2	25
319	26	0.1	3.8	1	50
330	2	0.1	0.2	1	25
332	10	0.1	13.1	6	20
333	96	0.1	26.7	3	10
346	324	0.1	23.5	2	10
364	70	0.1	54.2	4	45
500	213 (DIRECT FLOW)			0	35

2-year

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)		TIME (HR /MIN)	
201	11	0.5	0	0	55
202	1	0.1	0	1	0
203	2	0.3	0	0	50
204	8	0.4	0	1	25
205	14	0.5	0	1	25
208	36	0.7	0	1	20
211	2	0.2	0	1	25
212	38	0.8	0	1	50
213	5	0.5	0	1	45
214	12	0.5	0	1	20
216	71	1.1	0	1	15
217	8	0.4	0	1	15
218	14	0.5	0	0	55
219	21	0.6	0	0	55
222	8	0.4	0	3	15
223	83	1	0	0	50
224	77	1	0	1	40
225	4	0.3	0	1	5
226	12	0.5	0	2	40
227	22	0.7	0	1	0
228	2	0.2	0	1	10
229	19	0.5	0	0	50
230	3	0.4	0	1	45
231	37	0.8	0	0	55
232	64	0.9	0	0	50
233	25	0.7	0	0	55
234	93	1.1	0	1	50
235	18	0.7	0	1	25
236	17	0.7	0	1	15
237	87	1.4	0	1	5
238	71	1	0	1	50
239	54	0.9	0	3	40
240	6	0.4	0	6	30
241	33	1	0	1	25
242	0	0.1	0	2	35
243	28	0.6	0	2	5
244	65	0.9	0	0	55
245	10	0.4	0	1	0
246	52	0.8	0	4	20
247	266	1.6	0	1	0
248	281	1.7	0	0	50
249	246	1.6	0	1	10
251	24	0.7	0	1	15
252	10	0.5	0	1	20
253	35	0.7	0	2	5
254	23	0.6	0	0	55
256	3	0.3	0	1	0
257	100	1.2	0	1	20
260	132	1.4	0	1	35
261	14	0.5	0	1	25
262	21	0.6	0	0	55
263	157	1.3	0	1	35
264	169	1.5	0	2	5
265	61	1	0	1	0
266	8	0.5	0	1	10
267	47	0.8	0	5	20
269	47	0.8	0	6	5
271	25	0.6	0	0	55
272	2	0.2	0	1	20
274	55	0.8	0	0	45
276	213	1.5	0	2	35
277	213	1.5	0	2	35
278	216	1.7	0	2	20
279	2	0.2	0	1	45
280	4	0.3	0	1	10
281	3	0.3	0	1	25
282	42	0.8	0	1	15
284	84	1	0	0	40
285	234	1.5	0	2	30
286	19	0.6	0	0	55
287	91	1.1	0	1	0
289	0	0	0	0	0
314	8	0.1	2.4	2	25
319	14	0.1	2	1	55
330	1	0.1	0.1	1	10
332	6	0.1	7.9	6	10
333	55	0.1	15.3	3	5
346	219	0.1	12.7	2	0
364	48	0.1	32.1	4	50
500	142 (DIRECT FLOW)			0	35

0.4" Average

CONVEYAN ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)		TIME (HR /MIN)	
201	3	0.3	0	0	55
202	0	0	0	0	0
203	0	0	0	0	0
204	2	0.2	0	1	40
205	3	0.3	0	1	45
208	8	0.4	0	1	30
211	0	0	0	0	40
212	7	0.4	0	2	5
213	1	0.3	0	2	0
214	2	0.3	0	1	35
216	16	0.6	0	1	20
217	2	0.2	0	1	30
218	4	0.3	0	0	55
219	5	0.3	0	1	0
222	2	0.2	0	3	30
223	25	0.6	0	0	50
224	18	0.6	0	2	0
225	1	0.2	0	0	50
226	3	0.3	0	2	50
227	6	0.4	0	1	5
228	0	0	0	0	0
229	3	0.3	0	0	50
230	1	0.2	0	1	40
231	9	0.5	0	1	5
232	18	0.5	0	0	50
233	7	0.4	0	0	55
234	24	0.6	0	1	55
235	5	0.4	0	2	0
236	5	0.4	0	1	35
237	25	0.9	0	1	15
238	21	0.6	0	2	5
239	15	0.5	0	3	50
240	2	0.2	0	6	25
241	8	0.5	0	1	50
242	0	0	0	0	0
243	6	0.3	0	2	40
244	18	0.6	0	0	55
245	2	0.2	0	1	15
246	14	0.5	0	4	45
247	74	1	0	1	5
248	83	1	0	0	50
249	67	1	0	1	20
251	4	0.3	0	1	35
252	2	0.3	0	1	30
253	8	0.4	0	1	15
254	7	0.4	0	0	55
256	1	0.2	0	0	50
257	25	0.7	0	1	35
260	34	0.8	0	1	55
261	3	0.3	0	2	5
262	6	0.4	0	1	0
263	39	0.7	0	1	55
264	42	0.9	0	2	20
265	18	0.6	0	1	5
266	2	0.2	0	1	25
267	13	0.5	0	6	30
269	13	0.5	0	7	25
271	6	0.4	0	0	55
272	0	0	0	0	0
274	16	0.5	0	0	45
276	67	0.9	0	2	50
277	68	0.9	0	2	40
278	72	1.1	0	2	15
279	0	0	0	0	0
280	0	0.1	0	0	45
281	0	0.1	0	1	10
282	12	0.5	0	1	30
284	23	0.6	0	0	40
285	73	1	0	2	50
286	4	0.3	0	1	0
287	21	0.6	0	1	5
289	0	0	0	0	0
314	2	0.1	0.6	2	0
319	3	0.1	0.5	1	40
330	0	0	0	0	0
332	2	0.1	2.3	5	50
333	16	0.1	4.3	3	5
346	76	0.1	2.6	1	50
364	13	0.1	9.3	5	45
500	51 (DIRECT FLOW)			0	30

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1 DFA0053 Existing Conditions 2002 REVISION
 1 100-year   0..026.079.121 .21.367.655.367 .21.162.131.105.105.105.052.052.031
 1 100-year .031.031.031.031.031.031

 71 1 1 5.         1
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 70 1 1 5.         2
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 70 1 1 5.         3
 .116 .388  .13    5.  .02         .4    .1  4.5.0018    .6
 70 1 1 5.         4
 .125 .655 .326    5. .006         .4    .1  4.5.0018    .6
 70 1 1 5.         5
 .188 .954 .381 5.06 .013          .4    .1  4.5.0018    .6
 71 1 1 5.         6
 .049 .657 .397 5.92 .018 85.1     .4    .1  4.5.0018    .6
 70 1 1 5.         7
 .104 .754 .356    5. .019         .4    .14.455.0018 .597
 70 1 1 5.         8
 .181 .765 .385    5. .015         .4    .1 3.84.0018 .556
 71 1 1 5.         9
 .046 .426 .21612.88  .01 81.6     .4    .1  4.5.0018    .6
 70 1 1 5.        10
 .114 .753 .13822.03 .014          .4    .1  4.5.0018    .6
 70 1 1 5.        11
 .139  .86  .44    5. .008         .4    .1  4.5.0018    .6
 70 1 1 5.        12
 .195 .562 .362    5. .009         .4    .13.855.0018 .557
 70 1 1 5.        13
 .111 .686 .377    5. .006         .4    .1 3.84.0018 .556
 70 1 1 5.        14
 .107 .413 .237 8.75 .008          .4    .1 4.29.0018 .586
 71 1 1 5.        15
 .053  .43 .224    5. .008 91.1    .4    .14.125.0018 .575
 70 1 1 5.        16
 .095 .462 .151 7.91 .007          .4    .14.685.0014 .759
 70 1 1 5.        17
 .095 .528 .35524.59 .013          .4    .14.535.0017 .628
 71 1 1 5.        18
 .045 .311 .14310.47 .01265.17     .4    .1 4.78.0012 .824
 70 1 1 5.        19
 .113 .595 .23811.13  .01          .4    .1 4.63.0015 .704
 71 1 1 5.        20
 .019 .201 .069    5. .02141.09    .4    .1  4.5.0018    .6
 70 1 1 5.        21
 .121 .384  .12 6.42 .011          .4    .1  4.5.0018    .6
 70 1 1 5.        22
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 70 1 1 5.        23
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 70 1 1 5.        24
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 71 1 1 5.        25
 .063 .281 .26338.41 .00318.23     .4    .14.945.0008 .956
 71 1 1 5.        26
 .061 .459 .287 33.2 .00623.46     .4    .14.865 .001 .892
 71 1 1 5.        27
 .034 .233 .078 6.39 .00767.67     .4    .14.625.0015   .7
 71 1 1 5.        28
 .069 .207  .26  7.6 .002101.8     .4    .1  4.5.0018    .6
 70 1 1 5.        29
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 71 1 1 5.        30
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 70 1 1 5.        36
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 71 1 1 5.        37
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 70 1 1 5.        38
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 70 1 1 5.        39
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 70 1 1 5.        40
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 71 1 1 5.        41
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 70 1 1 5.        43
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 70 1 1 5.        44
 .204 .822 .435  25. .007          .4    .1  4.5.0018    .6
 71 1 1 5.        45
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 70 1 1 5.        46
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 71 1 1 5.        47
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 70 1 1 5.        48
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 70 1 1 5.        49
 .156 .805 .42717.43 .007          .4    .1  4.5.0018    .6
 70 1 1 5.        50
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 71 1 1 5.        51
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71 1 1 5.        55
.012 .128 .027 8.81 .01240.88    .4    .1  4.5.0018    .6
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.069 .445 .343 5.48 .009 86.8    .4    .1  4.5.0018    .6
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70 1 1 5.        58
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71 1 1 5.        59
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70 1 1 5.        60
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71 1 1 5.        63
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.087 .711 .084 5.00 .001         .4    .13.315.0017 .543
70 1 1 5.        65
.149 .526 .333 7.97 .014         .4    .14.295.0013 .766
71 1 1 5.        66
.075 .489 .122    5. .003143.9   .4    .1   3..0018    .5
70 1 1 5.        67
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71 1 1 5.        68
.076 .485 .245    5. .005123.7   .4    .1 4.29.0018 .586
70 1 1 5.        69
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71 1 1 5.        76
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71 1 1 5.        77
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71 1 1 5.        78
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70 1 1 5.        79
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71 1 1 5.        80
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70 1 1 5.        81
.2031.022 .656 7.17 .004         .4    .14.095.0018 .573
71 1 1 5.        82
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71 1 1 5.        83
.064 .242  .2713.95 .00388.51    .4    .1  4.5.0018    .6
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71 1 1 5.        86
 .04 .345  .16 5.00 .00785.25    .4    .14.455.0018 .597
70 1 1 5.        87
 .14  .74 .28615.28 .007         .4    .1 4.41.0018 .594
71 1 1 5.        88
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70 1 1 5.        89
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   3   4
WATERSHED   1
DIRECT FLOW AREA 0053 100-YEAR EXISTING CONDITION
KIOWA ENGINEERING CORPORATION   2002 REVISION
       192       5.0                                                  1
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         2  102
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        89  189
        90  190

       201  105    4     10.   1550.   0.007      2.      2.    .061     0.2
                         22.   1550.   0.007     50.     50.    .063    10.0
       202  111    4     10.   2450.   0.020      2.      2.    .091     0.2
                         22.   2450.   0.020     50.     50.    .094    10.0
       203  105    4     10.    550.   0.007      2.      2.    .064     0.2
                         22.    550.   0.007     50.     50.    .066    10.0
       204  104    4     10.   1890.   0.006      2.      2.    .061     0.2
                         22.   1890.   0.006     50.     50.    .062    10.0
       205  106    4     10.   2550.   0.008      2.      2.    .066     0.2
                         22.   2550.   0.008     50.     50.    .068    10.0
       208  108    4     10.   2190.   0.008      2.      2.    .067     0.2
                         22.   2190.   0.008     50.     50.    .069    10.0
       211  112    4     10.   4540.   0.008      2.      2.    .067     0.2
                         22.   4540.   0.008     50.     50.    .069    10.0
       212  112    4     10.   2970.   0.003      2.      2.    .048     0.2
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			22.	2970.	0.003	50.	50.	.049	10.0
213	113	4	10.	3620.	0.002	2.	2.	.081	0.2
			22.	3620.	0.002	50.	50.	.084	10.0
214	114	4	10.	2180.	0.006	2.	2.	.057	0.2
			22.	2180.	0.006	50.	50.	.059	10.0
216	116	4	10.	1300.	0.006	2.	2.	.092	0.2
			22.	1300.	0.006	50.	50.	.095	10.0
217	117	4	10.	2790.	0.007	2.	2.	.063	0.2
			22.	2790.	0.007	50.	50.	.066	10.0
218	116	4	10.	1140.	0.007	2.	2.	.063	0.2
			22.	1140.	0.007	50.	50.	.065	10.0
219	119	4	10.	760.	0.003	2.	2.	.043	0.2
			22.	760.	0.003	50.	50.	.045	10.0
222	122	4	10.	1800.	0.007	2.	2.	.062	0.2
			22.	1800.	0.007	50.	50.	.064	10.0
223	134	4	10.	530.	0.011	2.	2.	.076	0.2
			22.	530.	0.011	50.	50.	.078	10.0
224	124	4	10.	2550.	0.006	2.	2.	.060	0.2
			22.	2550.	0.006	50.	50.	.062	10.0
225	125	4	10.	1480.	0.004	2.	2.	.051	0.2
			22.	1480.	0.004	50.	50.	.053	10.0
226	126	4	10.	2420.	0.003	2.	2.	.042	0.2
			22.	2420.	0.003	50.	50.	.044	10.0
227	127	4	10.	1890.	0.001	2.	2.	.031	0.2
			22.	1890.	0.001	50.	50.	.032	10.0
228	127	4	10.	1090.	0.017	2.	2.	.087	0.2
			22.	1090.	0.017	50.	50.	.090	10.0
229	129	4	10.	1090.	0.015	2.	2.	.083	0.2
			22.	1090.	0.015	50.	50.	.086	10.0
230	152	4	10.	4100.	0.004	2.	2.	.094	0.2
			22.	4100.	0.004	50.	50.	.097	10.0
231	131	4	10.	2250.	0.010	2.	2.	.090	0.2
			22.	2250.	0.010	50.	50.	.093	10.0
232	132	4	10.	1520.	0.008	2.	2.	.066	0.2
			22.	1520.	0.008	50.	50.	.068	10.0
233	133	4	10.	1850.	0.009	2.	2.	.088	0.2
			22.	1850.	0.009	50.	50.	.091	10.0
234	133	4	10.	1440.	0.007	2.	2.	.063	0.2
			22.	1440.	0.007	50.	50.	.065	10.0
235	135	4	10.	3890.	0.006	2.	2.	.110	0.2
			22.	3890.	0.006	50.	50.	.113	10.0
236	135	4	10.	3650.	0.004	2.	2.	.082	0.2
			22.	3650.	0.004	50.	50.	.084	10.0
237	137	4	10.	1030.	0.002	2.	2.	.076	0.2
			22.	1030.	0.002	50.	50.	.078	10.0
238	138	4	10.	3430.	0.006	2.	2.	.061	0.2
			22.	3430.	0.006	50.	50.	.063	10.0
239	139	4	10.	2240.	0.005	2.	2.	.057	0.2
			22.	2240.	0.005	50.	50.	.059	10.0
240	140	4	10.	1050.	0.004	2.	2.	.050	0.2
			22.	1050.	0.004	50.	50.	.052	10.0
241	141	4	10.	1186.	0.003	2.	2.	.092	0.2
			22.	1186.	0.003	50.	50.	.095	10.0
242	142	4	10.	3420.	0.004	2.	2.	.048	0.2
			22.	3420.	0.004	50.	50.	.050	10.0
243	143	4	10.	3360.	0.008	2.	2.	.065	0.2
			22.	3360.	0.008	50.	50.	.067	10.0
244	153	4	10.	2270.	0.008	2.	2.	.066	0.2
			22.	2270.	0.008	50.	50.	.068	10.0
245	144	4	10.	2210.	0.011	2.	2.	.074	0.2
			22.	2210.	0.011	50.	50.	.077	10.0
246	146	4	10.	4160.	0.008	2.	2.	.065	0.2
			22.	4160.	0.008	50.	50.	.067	10.0
247	147	4	10.	1130.	0.004	2.	2.	.048	0.2
			22.	1130.	0.004	50.	50.	.050	10.0
248	148	4	10.	1750.	0.005	2.	2.	.053	0.2
			22.	1750.	0.005	50.	50.	.055	10.0
249	146	4	10.	1060.	0.003	2.	2.	.045	0.2
			22.	1060.	0.003	50.	50.	.046	10.0
251	157	4	10.	1200.	0.002	2.	2.	.042	0.2
			22.	1200.	0.002	50.	50.	.043	10.0
252	151	4	10.	2050.	0.001	2.	2.	.033	0.2
			22.	2050.	0.001	50.	50.	.034	10.0
253	153	4	10.	1940.	0.006	2.	2.	.060	0.2
			22.	1940.	0.006	50.	50.	.062	10.0
254	153	4	10.	1680.	0.005	2.	2.	.054	0.2
			22.	1680.	0.005	50.	50.	.056	10.0
256	156	4	10.	2350.	0.006	2.	2.	.059	0.2
			22.	2350.	0.006	50.	50.	.061	10.0
257	157	4	10.	1830.	0.003	2.	2.	.047	0.2
			22.	1830.	0.003	50.	50.	.049	10.0
260	160	4	10.	1530.	0.001	2.	2.	.033	0.2
			22.	1530.	0.001	50.	50.	.034	10.0
261	160	4	10.	3210.	0.004	2.	2.	.049	0.2
			22.	3210.	0.004	50.	50.	.051	10.0
262	162	4	10.	1180.	0.002	2.	2.	.037	0.2
			22.	1180.	0.002	50.	50.	.038	10.0
263	163	4	10.	550.	0.015	2.	2.	.083	0.2
			22.	550.	0.015	50.	50.	.086	10.0
264	164	4	10.	3750.	0.001	2.	2.	.031	0.2
			22.	3750.	0.001	50.	50.	.032	10.0
265	163	4	10.	1510.	0.001	2.	2.	.033	0.2
			22.	1510.	0.001	50.	50.	.034	10.0
266	166	4	10.	1630.	0.001	2.	2.	.032	0.2
			22.	1630.	0.001	50.	50.	.033	10.0
267	167	4	10.	2260.	0.005	2.	2.	.057	0.2
			22.	2260.	0.005	50.	50.	.058	10.0
269	169	4	10.	2710.	0.001	2.	2.	.027	0.2
			22.	2710.	0.001	50.	50.	.028	10.0
271	169	4	10.	1130.	0.007	2.	2.	.063	0.2
			22.	1130.	0.007	50.	50.	.065	10.0
272	172	4	10.	2300.	0.008	2.	2.	.066	0.2
			22.	2300.	0.008	50.	50.	.068	10.0
274	185	4	10.	1030.	0.016	2.	2.	.085	0.2
			22.	1030.	0.016	50.	50.	.088	10.0
276	171	4	10.	1190.	0.007	2.	2.	.062	0.2
			22.	1190.	0.007	50.	50.	.064	10.0
277	177	4	10.	1970.	0.008	2.	2.	.066	0.2
			22.	1970.	0.008	50.	50.	.069	10.0
278	178	4	10.	1460.	0.001	2.	2.	.034	0.2
			22.	1460.	0.001	50.	50.	.035	10.0
279	179	4	10.	2940.	0.005	2.	2.	.057	0.2

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                    22.   2940.   0.005     50.     50.    .059    10.0
280  179    4       10.   2090.   0.007      2.      2.    .062     0.2
                    22.   2090.   0.007     50.     50.    .064    10.0
281  181    4       10.   5390.   0.004      2.      2.    .053     0.2
                    22.   5390.   0.004     50.     50.    .055    10.0
282  171    4       10.   2500.   0.003      2.      2.    .047     0.2
                    22.   2500.   0.003     50.     50.    .048    10.0
284  184    4       10.   1530.   0.007      2.      2.    .061     0.2
                    22.   1530.   0.007     50.     50.    .063    10.0
285  185    4       10.    680.   0.009      2.      2.    .069     0.2
                    22.    680.   0.009     50.     50.    .071    10.0
286  186    4       10.   1820.   0.008      2.      2.    .065     0.2
                    22.   1820.   0.008     50.     50.    .067    10.0
287  187    4       10.    940.   0.006      2.      2.    .061     0.2
                    22.    940.   0.006     50.     50.    .063    10.0
289  189    4       10.   2920.   0.008      2.      2.    .067     0.2
                    22.   2920.   0.008     50.     50.    .069    10.0
101  201    3              1.
102  202    3              1.
103  203    3              1.
104  111    3              1.
105  204    3              1.
106  208    3              1.
107  213    3              1.
108  212    3              1.
109  211    3              1.
110  217    3              1.
111  205    3              1.
112  216    3              1.
113  214    3              1.
114  222    3              1.
115  218    3              1.
116  224    3              1.
117  219    3              1.
118  225    3              1.
119  226    3              1.
120  228    3              1.
121  229    3              1.
122  235    3              1.
123  236    3              1.
124  234    3              1.
125  233    3              1.
126  227    3              1.
127  232    3              1.
129  231    3              1.
130  242    3              1.
131  241    3              1.
132  240    3              1.
133  239    3              1.
134  237    3              1.
135  223    3              1.
137  238    3              1.
138  248    3              1.
139  246    3              1.
140  245    3              1.
141  243    3              1.
142  244    3              1.
143  253    3              1.
144  251    3              1.
145  230    3              1.
146  181    3              1.
147  249    3              1.
148  247    3              1.
151  146    3              1.
152  252    3              1.
153  257    3              1.
154  254    3              1.
155  256    3              1.
156  262    3              1.
157  260    3              1.
159  265    3              1.
160  263    3              1.
162  261    3              1.
163  264    3              1.
164  267    3              1.
165  266    3              1.
166  164    3              1.
167  269    3              1.
168  289    3              1.
169  287    3              1.
170  271    3              1.
171  285    3              1.
172  286    3              1.
173  272    3              1.
174  274    3              1.
175  500    3              1.
176  276    3              1.
177  176    3              1.
178  277    3              1.
179  284    3              1.
180  280    3              1.
181  278    3              1.
182  279    3              1.
183  281    3              1.
184  282    3              1.
190  191    3              1.
189  199    3              1.
188  198    3              1.
187  197    3              1.
186  196    3              1.
185  195    3              1.

   0
   5
 101  102  103  104  105
ENDPROGRAM
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DIRECT FLOW AREA 0053 100-YEAR EXISTING CONDITION
KIOWA ENGINEERING CORPORATION 2002 REVISION

*** PEAK FLOWS, STAGES AND STORAGES OF GUTTERS AND DETENTION DAMS ***

CONVEYANCE ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR/MIN)
103	171.	(DIRECT FLOW)		0 45.
101	44.	(DIRECT FLOW)		0 50.
107	81.	(DIRECT FLOW)		0 50.
203	159.	1.3		0 50.
201	34.	0.7		1 20.
213	31.	1.0		2 0.
105	175.	(DIRECT FLOW)		0 50.
110	172.	(DIRECT FLOW)		0 45.
113	92.	(DIRECT FLOW)		1 15.
204	127.	1.2		1 15.
102	105.	(DIRECT FLOW)		0 45.
217	95.	1.1		1 10.
214	78.	1.0		1 45.
104	211.	(DIRECT FLOW)		1 10.
202	65.	0.9		1 10.
117	189.	(DIRECT FLOW)		1 0.
114	143.	(DIRECT FLOW)		1 10.
111	276.	(DIRECT FLOW)		1 10.
219	184.	1.4		1 10.
222	131.	1.2		1 30.
205	223.	1.5		1 30.
121	170.	(DIRECT FLOW)		0 45.
119	274.	(DIRECT FLOW)		1 0.
123	89.	(DIRECT FLOW)		0 45.
122	195.	(DIRECT FLOW)		1 15.
106	349.	(DIRECT FLOW)		1 25.
229	140.	1.2		0 55.
226	220.	1.5		1 25.
236	36.	0.9		1 40.
235	120.	1.5		2 10.
208	317.	1.7		1 40.
129	252.	(DIRECT FLOW)		0 50.
120	17.	(DIRECT FLOW)		0 55.
126	245.	(DIRECT FLOW)		1 20.
135	193.	(DIRECT FLOW)		1 50.
108	402.	(DIRECT FLOW)		1 35.
109	28.	(DIRECT FLOW)		0 50.
231	167.	1.4		1 10.
228	14.	0.5		1 20.
227	213.	1.6		1 40.
223	193.	1.4		1 55.
212	350.	1.9		2 0.
211	16.	0.5		2 40.
131	216.	(DIRECT FLOW)		1 10.
127	271.	(DIRECT FLOW)		1 35.
134	207.	(DIRECT FLOW)		1 35.
115	30.	(DIRECT FLOW)		0 55.
112	480.	(DIRECT FLOW)		1 45.
241	176.	1.9		1 30.
232	260.	1.6		1 50.
237	201.	2.0		1 50.
218	26.	0.6		1 30.
216	470.	2.4		1 55.
141	199.	(DIRECT FLOW)		1 25.
130	74.	(DIRECT FLOW)		0 45.
132	274.	(DIRECT FLOW)		1 40.
137	227.	(DIRECT FLOW)		1 45.
116	511.	(DIRECT FLOW)		1 50.
118	26.	(DIRECT FLOW)		0 50.
243	153.	1.3		1 55.
242	31.	0.7		1 20.
240	268.	1.7		1 50.
238	206.	1.5		2 25.
224	490.	2.1		2 10.
225	20.	0.6		1 25.
155	11.	(DIRECT FLOW)		2 25.
154	38.	(DIRECT FLOW)		0 55.
143	219.	(DIRECT FLOW)		1 35.
142	153.	(DIRECT FLOW)		1 5.
140	288.	(DIRECT FLOW)		1 45.
138	399.	(DIRECT FLOW)		1 15.
124	511.	(DIRECT FLOW)		2 5.
125	115.	(DIRECT FLOW)		0 40.
256	9.	0.4		2 30.
254	31.	0.7		1 30.
253	212.	1.5		1 50.
244	125.	1.2		1 25.
245	275.	1.6		1 55.
145	98.	(DIRECT FLOW)		0 40.
248	380.	1.9		1 30.
234	505.	2.1		2 15.
233	59.	1.0		1 5.
156	44.	(DIRECT FLOW)		1 15.
153	417.	(DIRECT FLOW)		1 25.
144	365.	(DIRECT FLOW)		1 20.
230	23.	0.8		1 25.
148	481.	(DIRECT FLOW)		1 20.
133	533.	(DIRECT FLOW)		2 10.
262	40.	0.8		1 30.
257	398.	2.0		1 45.
251	358.	2.0		1 35.
152	101.	(DIRECT FLOW)		1 5.
247	472.	2.0		1 30.
239	520.	2.2		2 25.
162	188.	(DIRECT FLOW)		0 45.
157	804.	(DIRECT FLOW)		1 35.
252	76.	1.1		1 35.
147	500.	(DIRECT FLOW)		1 25.

139	532.	(DIRECT FLOW)	2	15.
261	102.	1.1	1	20.
260	786.	2.8	1	50.
151	111.	(DIRECT FLOW)	1	25.
249	492.	2.1	1	35.
246	499.	2.1	2	45.
183	38.	(DIRECT FLOW)	0	55.
159	114.	(DIRECT FLOW)	0	55.
160	904.	(DIRECT FLOW)	1	40.
146	1086.	(DIRECT FLOW)	1	40.
281	19.	0.6	2	40.
165	122.	(DIRECT FLOW)	0	55.
265	90.	1.2	1	25.
263	903.	2.5	1	45.
181	1184.	(DIRECT FLOW)	1	35.
266	90.	1.2	1	15.
163	1009.	(DIRECT FLOW)	1	40.
180	41.	(DIRECT FLOW)	0	55.
182	57.	(DIRECT FLOW)	0	55.
278	1170.	3.3	1	50.
166	121.	(DIRECT FLOW)	1	15.
264	896.	2.9	2	10.
280	32.	0.7	1	35.
279	33.	0.7	1	30.
178	1178.	(DIRECT FLOW)	1	50.
164	989.	(DIRECT FLOW)	2	5.
179	632.	(DIRECT FLOW)	0	35.
277	1165.	2.9	2	5.
267	966.	2.8	2	20.
284	400.	1.9	0	45.
177	1169.	(DIRECT FLOW)	2	0.
170	218.	(DIRECT FLOW)	0	40.
167	968.	(DIRECT FLOW)	2	20.
173	36.	(DIRECT FLOW)	0	40.
184	481.	(DIRECT FLOW)	0	45.
176	1176.	(DIRECT FLOW)	2	0.
271	168.	1.4	0	55.
269	936.	2.8	2	35.
272	20.	0.6	1	20.
282	282.	1.7	1	5.
276	1172.	2.9	2	5.
168	35.	(DIRECT FLOW)	1	0.
169	960.	(DIRECT FLOW)	2	35.
172	215.	(DIRECT FLOW)	0	45.
171	1300.	(DIRECT FLOW)	2	0.
174	225.	(DIRECT FLOW)	0	40.
289	24.	0.6	2	0.
287	958.	2.7	2	40.
286	142.	1.2	1	0.
285	1299.	3.0	2	0.
274	179.	1.3	0	50.
175	236.	(DIRECT FLOW)	0	45.
189	453.	(DIRECT FLOW)	0	40.
188	44.	(DIRECT FLOW)	0	50.
187	976.	(DIRECT FLOW)	2	35.
186	164.	(DIRECT FLOW)	1	0.
185	1361.	(DIRECT FLOW)	1	55.
190	40.	(DIRECT FLOW)	0	55.
500	236.	(DIRECT FLOW)	0	45.
199	453.	(DIRECT FLOW)	0	40.
198	44.	(DIRECT FLOW)	0	50.
197	976.	(DIRECT FLOW)	2	35.
196	164.	(DIRECT FLOW)	1	0.
195	1361.	(DIRECT FLOW)	1	55.
191	40.	(DIRECT FLOW)	0	55.

PROGRAM ENDED NORMALLY

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70 1 1 5.        53
.125  .43 .266 19.2 .006        .4   .1  4.5.0018   .6
71 1 1 5.        54
.064 .399 .166 76.6 .009 21.7   .4   .1  4.5.0018   .6
71 1 1 5.        55
.012 .128 .027 85.0 .012 13.8   .4   .1  4.5.0018   .6
71 1 1 5.        56
.069 .445 .343 56.2 .009 23.0   .4   .1  4.5.0018   .6
71 1 1 5.        57
.128 .346 .405 81.5  .01 20.1   .4   .14.535.0017 .628
71 1 1 5.        58
.115 .885 .653 84.0 .004 36.0   .4   .14.665.0014 .732
71 1 1 5.        59
.061  .36 .136 65.0 .013 20.6   .4   .1 4.74.0013 .792
71 1 1 5.        60
.091 .289 .366 66.4  .01 18.5   .4   .14.501.0018.6012
71 1 1 5.        61
.072 .609 .175 37.8 .003 27.9   .4   .14.505.0018 .604
70 1 1 5.        62
.121 .223 .195 15.5 .019        .4   .14.565.0017 .652
71 1 1 5.        63
.077  .88  .35 49.6 .005 35.8   .4   .14.685.0014 .748
71 1 1 5.        64
.087 .711 .084 62.4 .001 30.9   .4   .13.315.0017 .543
70 1 1 5.        65
.149 .526 .333 23.4 .014        .4   .14.295.0013 .766
71 1 1 5.        66
.075 .489 .122 54.7 .003 24.3   .4   .1   3..0018   .5
70 1 1 5.        67
.161  .63 .212 73.6 .008        .4   .14.065.0018 .571
71 1 1 5.        68
.076 .485 .245  5.0 .005 120.   .4   .1 4.29.0018 .586
71 1 1 5.        69
.115 .513 .386 36.9 .006 25.1   .4   .1 4.44.0018 .596
71 1 1 5.        70
.114 .513 .047 42.8 .009 25.0   .4   .1 4.35.0018  .59
71 1 1 5.        71
.109 .649 .194 21.1 .005 29.0   .4   .14.365.0018 .591
70 1 1 5.        72
.098 .435 .301 44.6 .008        .4   .1 4.11.0018 .574
71 1 1 5.        73
.021 .226 .178 29.5 .003 16.6   .4   .1  4.5.0018   .6
71 1 1 5.        74
.092 .387 .037 82.0 .005 21.4   .4   .1  4.5.0018   .6
70 1 1 5.        75
 .15 .713 .072 76.0 .003        .4   .1  4.5.0018   .6
71 1 1 5.        76
.129 .697 .511 68.4 .005 30.4   .4   .1  4.5.0018   .6
71 1 1 5.        77
.086 .388  .13 31.4 .009 21.4   .4   .1  4.5.0018   .6
71 1 1 5.        78
.078 .334 .111 61.4 .006 19.8   .4   .1 4.47.0018 .598
70 1 1 5.        79
.164 .558 .061 68.1 .005        .4   .1  4.5.0018   .6
71 1 1 5.        80
.067  .47 .088 22.2  .01 23.8   .4   .1  4.5.0018   .6
70 1 1 5.        81
.2031.022 .656 24.1 .004        .4   .14.095.0018 .573
71 1 1 5.        82
.063 .268 .132 15.3 .017 46.4   .4   .1  4.5.0018   .6
71 1 1 5.        83
.064 .242  .27 30.4 .003 17.1   .4   .1  4.5.0018   .6
71 1 1 5.        84
.039 .363 .193 51.9 .004 99.0   .4   .1  4.5.0018   .6
70 1 1 5.        85
.161 .603 .315 29.0 .003        .4   .1  4.5.0018   .6
71 1 1 5.        86
 .04 .345  .16  5.0 .007 83.1   .4   .14.455.0018 .597
71 1 1 5.        87
 .14  .74 .286 15.5 .007 31.7   .4   .1 4.41.0018 .594
71 1 1 5.        88
.048  .28  .21 21.9 .014 18.2   .4   .1  4.5.0018   .6
70 1 1 5.        89
.183 .615 .303 58.3 .006        .4   .1  4.5.0018   .6
71 1 1 5.        90
.068 .337 .155  5.0 .006 91.6   .4   .1  4.5.0018   .6
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WATERSHED   1
DIRECT FLOW AREA 0053 100-YEAR FUTURE CONDITION
KIOWA ENGINEERING CORPORATION   2002 REVISION
       192       5.0                                                    1
         1  101
         2  102
         3  103
         4  104
         5  106
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        90  190

201  105    4      10.   1550.   0.007      2.      2.    .061     0.2
                   22.   1550.   0.007     50.     50.    .063    10.0
202  111    4      10.   2450.   0.020      2.      2.    .091     0.2
                   22.   2450.   0.020     50.     50.    .094    10.0
203  105    4      10.    550.   0.007      2.      2.    .064     0.2
                   22.    550.   0.007     50.     50.    .066    10.0
204  104    4      10.   1890.   0.006      2.      2.    .061     0.2
                   22.   1890.   0.006     50.     50.    .062    10.0
205  106    4      10.   2550.   0.008      2.      2.    .066     0.2
                   22.   2550.   0.008     50.     50.    .068    10.0
208  108    4      10.   2190.   0.008      2.      2.    .067     0.2
                   22.   2190.   0.008     50.     50.    .069    10.0
211  112    4      10.   4540.   0.008      2.      2.    .067     0.2
                   22.   4540.   0.008     50.     50.    .069    10.0
212  112    4      10.   2970.   0.003      2.      2.    .048     0.2
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			22.	2970.	0.003	50.	50.	.049	10.0
213	113	4	10.	3620.	0.002	2.	2.	.081	0.2
			22.	3620.	0.002	50.	50.	.084	10.0
214	114	4	10.	2180.	0.006	2.	2.	.057	0.2
			22.	2180.	0.006	50.	50.	.059	10.0
216	116	4	10.	1300.	0.006	2.	2.	.092	0.2
			22.	1300.	0.006	50.	50.	.095	10.0
217	117	4	10.	2790.	0.007	2.	2.	.063	0.2
			22.	2790.	0.007	50.	50.	.066	10.0
218	116	4	10.	1140.	0.007	2.	2.	.063	0.2
			22.	1140.	0.007	50.	50.	.065	10.0
219	119	4	10.	760.	0.003	2.	2.	.043	0.2
			22.	760.	0.003	50.	50.	.045	10.0
222	122	4	10.	1800.	0.007	2.	2.	.062	0.2
			22.	1800.	0.007	50.	50.	.064	10.0
223	134	4	10.	530.	0.011	2.	2.	.076	0.2
			22.	530.	0.011	50.	50.	.078	10.0
224	124	4	10.	2550.	0.006	2.	2.	.060	0.2
			22.	2550.	0.006	50.	50.	.062	10.0
225	125	4	10.	1480.	0.004	2.	2.	.051	0.2
			22.	1480.	0.004	50.	50.	.053	10.0
226	126	4	10.	2420.	0.003	2.	2.	.042	0.2
			22.	2420.	0.003	50.	50.	.044	10.0
227	127	4	10.	1890.	0.001	2.	2.	.031	0.2
			22.	1890.	0.001	50.	50.	.032	10.0
228	127	4	10.	1090.	0.017	2.	2.	.087	0.2
			22.	1090.	0.017	50.	50.	.090	10.0
229	129	4	10.	1090.	0.015	2.	2.	.083	0.2
			22.	1090.	0.015	50.	50.	.086	10.0
230	152	4	10.	4100.	0.004	2.	2.	.094	0.2
			22.	4100.	0.004	50.	50.	.097	10.0
231	131	4	10.	2250.	0.010	2.	2.	.090	0.2
			22.	2250.	0.010	50.	50.	.093	10.0
232	132	4	10.	1520.	0.008	2.	2.	.066	0.2
			22.	1520.	0.008	50.	50.	.068	10.0
233	133	4	10.	1850.	0.009	2.	2.	.088	0.2
			22.	1850.	0.009	50.	50.	.091	10.0
234	133	4	10.	1440.	0.007	2.	2.	.063	0.2
			22.	1440.	0.007	50.	50.	.065	10.0
235	135	4	10.	3890.	0.006	2.	2.	.110	0.2
			22.	3890.	0.006	50.	50.	.113	10.0
236	135	4	10.	3650.	0.004	2.	2.	.082	0.2
			22.	3650.	0.004	50.	50.	.084	10.0
237	137	4	10.	1030.	0.002	2.	2.	.076	0.2
			22.	1030.	0.002	50.	50.	.078	10.0
238	138	4	10.	3430.	0.006	2.	2.	.061	0.2
			22.	3430.	0.006	50.	50.	.063	10.0
239	139	4	10.	2240.	0.005	2.	2.	.057	0.2
			22.	2240.	0.005	50.	50.	.059	10.0
240	140	4	10.	1050.	0.004	2.	2.	.050	0.2
			22.	1050.	0.004	50.	50.	.052	10.0
241	141	4	10.	1186.	0.003	2.	2.	.092	0.2
			22.	1186.	0.003	50.	50.	.095	10.0
242	142	4	10.	3420.	0.004	2.	2.	.048	0.2
			22.	3420.	0.004	50.	50.	.050	10.0
243	143	4	10.	3360.	0.008	2.	2.	.065	0.2
			22.	3360.	0.008	50.	50.	.067	10.0
244	153	4	10.	2270.	0.008	2.	2.	.066	0.2
			22.	2270.	0.008	50.	50.	.068	10.0
245	144	4	10.	2210.	0.011	2.	2.	.074	0.2
			22.	2210.	0.011	50.	50.	.077	10.0
246	146	4	10.	4160.	0.008	2.	2.	.065	0.2
			22.	4160.	0.008	50.	50.	.067	10.0
247	147	4	10.	1130.	0.004	2.	2.	.048	0.2
			22.	1130.	0.004	50.	50.	.050	10.0
248	148	4	10.	1750.	0.005	2.	2.	.053	0.2
			22.	1750.	0.005	50.	50.	.055	10.0
249	146	4	10.	1060.	0.003	2.	2.	.045	0.2
			22.	1060.	0.003	50.	50.	.046	10.0
251	157	4	10.	1200.	0.002	2.	2.	.042	0.2
			22.	1200.	0.002	50.	50.	.043	10.0
252	151	4	10.	2050.	0.001	2.	2.	.033	0.2
			22.	2050.	0.001	50.	50.	.034	10.0
253	153	4	10.	1940.	0.006	2.	2.	.060	0.2
			22.	1940.	0.006	50.	50.	.062	10.0
254	153	4	10.	1680.	0.005	2.	2.	.054	0.2
			22.	1680.	0.005	50.	50.	.056	10.0
256	156	4	10.	2350.	0.006	2.	2.	.059	0.2
			22.	2350.	0.006	50.	50.	.061	10.0
257	157	4	10.	1830.	0.003	2.	2.	.047	0.2
			22.	1830.	0.003	50.	50.	.049	10.0
260	160	4	10.	1530.	0.001	2.	2.	.033	0.2
			22.	1530.	0.001	50.	50.	.034	10.0
261	160	4	10.	3210.	0.004	2.	2.	.049	0.2
			22.	3210.	0.004	50.	50.	.051	10.0
262	162	4	10.	1180.	0.002	2.	2.	.037	0.2
			22.	1180.	0.002	50.	50.	.038	10.0
263	163	4	10.	550.	0.015	2.	2.	.083	0.2
			22.	550.	0.015	50.	50.	.086	10.0
264	164	4	10.	3750.	0.001	2.	2.	.031	0.2
			22.	3750.	0.001	50.	50.	.032	10.0
265	163	4	10.	1510.	0.001	2.	2.	.033	0.2
			22.	1510.	0.001	50.	50.	.034	10.0
266	166	4	10.	1630.	0.001	2.	2.	.032	0.2
			22.	1630.	0.001	50.	50.	.033	10.0
267	167	4	10.	2260.	0.005	2.	2.	.057	0.2
			22.	2260.	0.005	50.	50.	.058	10.0
269	169	4	10.	2710.	0.001	2.	2.	.027	0.2
			22.	2710.	0.001	50.	50.	.028	10.0
271	169	4	10.	1130.	0.007	2.	2.	.063	0.2
			22.	1130.	0.007	50.	50.	.065	10.0
272	172	4	10.	2300.	0.008	2.	2.	.066	0.2
			22.	2300.	0.008	50.	50.	.068	10.0
274	185	4	10.	1030.	0.016	2.	2.	.085	0.2
			22.	1030.	0.016	50.	50.	.088	10.0
276	171	4	10.	1190.	0.007	2.	2.	.062	0.2
			22.	1190.	0.007	50.	50.	.064	10.0
277	177	4	10.	1970.	0.008	2.	2.	.066	0.2
			22.	1970.	0.008	50.	50.	.069	10.0
278	178	4	10.	1460.	0.001	2.	2.	.034	0.2
			22.	1460.	0.001	50.	50.	.035	10.0
279	179	4	10.	2940.	0.005	2.	2.	.057	0.2

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                    22.   2940.   0.005     50.     50.    .059    10.0
280  179    4       10.   2090.   0.007      2.      2.    .062     0.2
                    22.   2090.   0.007     50.     50.    .064    10.0
281  181    4       10.   5390.   0.004      2.      2.    .053     0.2
                    22.   5390.   0.004     50.     50.    .055    10.0
282  171    4       10.   2500.   0.003      2.      2.    .047     0.2
                    22.   2500.   0.003     50.     50.    .048    10.0
284  184    4       10.   1530.   0.007      2.      2.    .061     0.2
                    22.   1530.   0.007     50.     50.    .063    10.0
285  185    4       10.    680.   0.009      2.      2.    .069     0.2
                    22.    680.   0.009     50.     50.    .071    10.0
286  186    4       10.   1820.   0.008      2.      2.    .065     0.2
                    22.   1820.   0.008     50.     50.    .067    10.0
287  187    4       10.    940.   0.006      2.      2.    .061     0.2
                    22.    940.   0.006     50.     50.    .063    10.0
289  189    4       10.   2920.   0.008      2.      2.    .067     0.2
                    22.   2920.   0.008     50.     50.    .069    10.0
101  201    3              1.
102  202    3              1.
103  203    3              1.
104  111    3              1.
105  204    3              1.
106  208    3              1.
107  213    3              1.
108  212    3              1.
109  211    3              1.
110  217    3              1.
111  205    3              1.
112  216    3              1.
113  214    3              1.
114  222    3              1.
115  218    3              1.
116  224    3              1.
117  219    3              1.
118  225    3              1.
119  226    3              1.
120  228    3              1.
121  229    3              1.
122  235    3              1.
123  236    3              1.
124  234    3              1.
125  233    3              1.
126  227    3              1.
127  232    3              1.
129  231    3              1.
130  242    3              1.
131  241    3              1.
132  240    3              1.
133  239    3              1.
134  237    3              1.
135  223    3              1.
137  238    3              1.
138  248    3              1.
139  246    3              1.
140  245    3              1.
141  243    3              1.
142  244    3              1.
143  253    3              1.
144  251    3              1.
145  230    3              1.
146  181    3              1.
147  249    3              1.
148  247    3              1.
151  146    3              1.
152  252    3              1.
153  257    3              1.
154  254    3              1.
155  256    3              1.
156  262    3              1.
157  260    3              1.
159  265    3              1.
160  263    3              1.
162  261    3              1.
163  264    3              1.
164  267    3              1.
165  266    3              1.
166  164    3              1.
167  269    3              1.
168  289    3              1.
169  287    3              1.
170  271    3              1.
171  285    3              1.
172  286    3              1.
173  272    3              1.
174  274    3              1.
175  173    3              1.
176  276    3              1.
177  176    3              1.
178  277    3              1.
179  284    3              1.
180  280    3              1.
181  278    3              1.
182  279    3              1.
183  281    3              1.
184  282    3              1.
190  191    3              1.
189  199    3              1.
188  198    3              1.
187  197    3              1.
186  196    3              1.
185  195    3              1.

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   5
 101  102  103  104  105
ENDPROGRAM
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DIRECT FLOW AREA 0053 100-YEAR FUTURE CONDITION
KIOWA ENGINEERING CORPORATION 2002 REVISION

*** PEAK FLOWS, STAGES AND STORAGES OF GUTTERS AND DETENTION DAMS ***

CONVEYANCE ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR/MIN)
103	171.	(DIRECT FLOW)	0	45.
101	112.	(DIRECT FLOW)	0	40.
107	171.	(DIRECT FLOW)	0	45.
203	159.	1.3	0	50.
201	65.	0.9	0	55.
213	50.	1.2	1	30.
105	221.	(DIRECT FLOW)	0	50.
110	179.	(DIRECT FLOW)	0	45.
113	197.	(DIRECT FLOW)	0	45.
204	156.	1.3	1	10.
102	105.	(DIRECT FLOW)	0	45.
217	99.	1.1	1	10.
214	141.	1.2	1	15.
104	286.	(DIRECT FLOW)	1	0.
202	65.	0.9	1	10.
117	215.	(DIRECT FLOW)	0	50.
114	280.	(DIRECT FLOW)	0	45.
111	345.	(DIRECT FLOW)	1	0.
219	205.	1.5	1	0.
222	231.	1.5	1	10.
205	283.	1.6	1	20.
121	250.	(DIRECT FLOW)	0	40.
119	355.	(DIRECT FLOW)	0	50.
123	270.	(DIRECT FLOW)	0	40.
122	396.	(DIRECT FLOW)	0	45.
106	497.	(DIRECT FLOW)	1	10.
229	193.	1.4	0	50.
226	265.	1.6	1	15.
236	76.	1.2	1	10.
235	201.	1.9	1	35.
208	452.	2.0	1	20.
129	384.	(DIRECT FLOW)	0	45.
120	31.	(DIRECT FLOW)	0	45.
126	319.	(DIRECT FLOW)	1	10.
135	394.	(DIRECT FLOW)	0	55.
108	598.	(DIRECT FLOW)	1	15.
109	76.	(DIRECT FLOW)	0	40.
231	236.	1.7	1	0.
228	24.	0.6	1	5.
227	279.	1.8	1	25.
223	392.	1.9	1	0.
212	500.	2.2	1	35.
211	26.	0.6	1	20.
131	319.	(DIRECT FLOW)	0	55.
127	368.	(DIRECT FLOW)	0	40.
134	537.	(DIRECT FLOW)	0	50.
115	115.	(DIRECT FLOW)	0	45.
112	751.	(DIRECT FLOW)	1	15.
241	261.	2.2	1	15.
232	339.	1.8	1	25.
237	457.	2.8	1	10.
218	85.	1.0	0	55.
216	724.	2.9	1	25.
141	279.	(DIRECT FLOW)	1	15.
130	75.	(DIRECT FLOW)	0	45.
132	385.	(DIRECT FLOW)	0	55.
137	497.	(DIRECT FLOW)	1	10.
116	829.	(DIRECT FLOW)	1	15.
118	73.	(DIRECT FLOW)	0	40.
243	214.	1.5	1	35.
242	32.	0.7	1	20.
240	381.	1.9	1	20.
238	402.	1.9	1	35.
224	761.	2.5	1	35.
225	44.	0.8	1	0.
155	36.	(DIRECT FLOW)	0	40.
154	174.	(DIRECT FLOW)	0	40.
143	389.	(DIRECT FLOW)	0	45.
142	508.	(DIRECT FLOW)	0	40.
140	455.	(DIRECT FLOW)	1	0.
138	1354.	(DIRECT FLOW)	0	45.
124	802.	(DIRECT FLOW)	1	30.
125	204.	(DIRECT FLOW)	0	40.
256	14.	0.5	1	0.
254	105.	1.1	0	55.
253	304.	1.7	1	15.
244	300.	1.7	0	55.
245	411.	1.9	1	25.
145	110.	(DIRECT FLOW)	0	45.
248	1055.	2.8	0	55.
234	790.	2.5	1	40.
233	114.	1.3	1	0.
156	161.	(DIRECT FLOW)	0	45.
153	811.	(DIRECT FLOW)	1	0.
144	569.	(DIRECT FLOW)	1	15.
230	27.	0.8	1	25.
148	1263.	(DIRECT FLOW)	0	50.
133	885.	(DIRECT FLOW)	1	30.
262	119.	1.2	0	55.
257	712.	2.5	1	15.
251	548.	2.3	1	25.
152	196.	(DIRECT FLOW)	0	45.
247	1189.	2.9	1	0.
239	857.	2.6	1	45.
162	288.	(DIRECT FLOW)	0	45.
157	1324.	(DIRECT FLOW)	1	15.
252	118.	1.3	1	10.
147	1247.	(DIRECT FLOW)	1	0.

139	886.	(DIRECT FLOW)	1	45.
261	169.	1.4	1	15.
260	1252.	3.4	1	30.
151	195.	(DIRECT FLOW)	0	55.
249	1178.	3.0	1	5.
246	822.	2.5	2	5.
183	125.	(DIRECT FLOW)	0	40.
159	379.	(DIRECT FLOW)	0	45.
160	1477.	(DIRECT FLOW)	1	25.
146	2152.	(DIRECT FLOW)	1	10.
281	34.	0.7	1	20.
165	186.	(DIRECT FLOW)	0	45.
265	263.	1.8	1	0.
263	1476.	3.1	1	25.
181	2330.	(DIRECT FLOW)	1	10.
266	125.	1.3	1	10.
163	1721.	(DIRECT FLOW)	1	20.
180	108.	(DIRECT FLOW)	0	40.
182	64.	(DIRECT FLOW)	0	45.
278	2228.	4.3	1	20.
166	230.	(DIRECT FLOW)	0	55.
264	1439.	3.5	1	45.
280	64.	0.9	1	5.
279	37.	0.8	1	30.
178	2264.	(DIRECT FLOW)	1	20.
164	1546.	(DIRECT FLOW)	1	40.
179	667.	(DIRECT FLOW)	0	35.
277	2175.	3.7	1	30.
267	1496.	3.3	1	55.
175	470.	(DIRECT FLOW)	0	40.
284	430.	1.9	0	45.
177	2193.	(DIRECT FLOW)	1	30.
170	228.	(DIRECT FLOW)	0	45.
167	1521.	(DIRECT FLOW)	1	55.
173	505.	(DIRECT FLOW)	0	40.
184	440.	(DIRECT FLOW)	0	45.
176	2255.	(DIRECT FLOW)	1	30.
271	178.	1.4	0	55.
269	1447.	3.3	2	5.
272	265.	1.6	0	50.
282	278.	1.7	1	10.
276	2233.	3.7	1	35.
168	36.	(DIRECT FLOW)	1	0.
169	1473.	(DIRECT FLOW)	2	5.
172	453.	(DIRECT FLOW)	0	45.
171	2470.	(DIRECT FLOW)	1	30.
174	270.	(DIRECT FLOW)	0	40.
289	25.	0.6	2	0.
287	1466.	3.2	2	10.
286	348.	1.8	1	0.
285	2466.	3.8	1	35.
274	210.	1.4	0	50.
189	453.	(DIRECT FLOW)	0	40.
188	75.	(DIRECT FLOW)	0	45.
187	1469.	(DIRECT FLOW)	2	10.
186	370.	(DIRECT FLOW)	1	0.
185	2586.	(DIRECT FLOW)	1	35.
190	39.	(DIRECT FLOW)	0	55.
199	453.	(DIRECT FLOW)	0	40.
198	75.	(DIRECT FLOW)	0	45.
197	1469.	(DIRECT FLOW)	2	10.
196	370.	(DIRECT FLOW)	1	0.
195	2586.	(DIRECT FLOW)	1	35.
191	39.	(DIRECT FLOW)	0	55.

PROGRAM ENDED NORMALLY

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WATERSHED   1
DIRECT FLOW AREA 0053 100-YEAR MASTER PLAN CONDITION
KIOWA ENGINEERING CORPORATION   2002 REVISION
      192       5.0                                                  1
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       88  188
       89  189
       90  190

  346  181  7 2      .1      .1   0.1        0.      0.      0.       0.
  0.0        0.     3.50      102.      18.1      288.      44.6      462.
 84.4       566.    139.9      654.     209.9      730.
  364  267 10 2      .1      .1   0.1        0.      0.      0.       0.
  0.0        0.     17.4       24.      36.3       54.      56.4       72.
 77.7       87.     100.0      99.      123.3      110.     147.8      120.
173.6      130.     200.7     138.
  333  239  5 2      .1      .1   0.1        0.      0.      0.       0.
  0.0        0.0    38.0      136.0     88.8      384.0     152.4     616.0
188.7     1000.0
  332  240  8 2      .1      .1   0.1        0.      0.      0.       0.
  0.0        0.0    12.1        9.      27.3       15.      44.9       19.
 64.3        23.     85.2       26.     108.0       28.     135.6       31.
  330  242  4 2      .1      .1   0.1        0.      0.      0.       0.
  0.0        0.0     2.2       15.0      7.4       26.0      13.6      34.0
  319  226  6 2      .1      .1   0.1        0.      0.      0.       0.
  0.0        0.      5.66       38.     19.54       56.     29.73       64.
32.64       355.    39.92     1080.
  314  222  6 2      .1      .1   0.1        0.      0.      0.       0.
  0.0        0.     9.20       30.     31.42       52.     66.81       68.
 86.3        280   127.19    15243.
  201  105    4     10.    1550.   0.007       2.      2.     .061      0.2
                    22.    1550.   0.007      50.     50.     .063     10.0
```

202	111	4	10.	2450.	0.020	2.	2.	.091	0.2
			22.	2450.	0.020	50.	50.	.094	10.0
203	105	4	10.	550.	0.007	2.	2.	.064	0.2
			22.	550.	0.007	50.	50.	.066	10.0
204	104	4	10.	1890.	0.006	2.	2.	.061	0.2
			22.	1890.	0.006	50.	50.	.062	10.0
205	106	4	10.	2550.	0.008	2.	2.	.066	0.2
			22.	2550.	0.008	50.	50.	.068	10.0
208	108	4	10.	2190.	0.008	2.	2.	.067	0.2
			22.	2190.	0.008	50.	50.	.069	10.0
211	112	4	10.	4540.	0.008	2.	2.	.067	0.2
			22.	4540.	0.008	50.	50.	.069	10.0
212	112	4	10.	2970.	0.003	2.	2.	.048	0.2
			22.	2970.	0.003	50.	50.	.049	10.0
213	113	4	10.	3620.	0.002	2.	2.	.081	0.2
			22.	3620.	0.002	50.	50.	.084	10.0
214	114	4	10.	2180.	0.006	2.	2.	.057	0.2
			22.	2180.	0.006	50.	50.	.059	10.0
216	116	4	10.	1300.	0.006	2.	2.	.092	0.2
			22.	1300.	0.006	50.	50.	.095	10.0
217	117	4	10.	2790.	0.007	2.	2.	.063	0.2
			22.	2790.	0.007	50.	50.	.066	10.0
218	116	4	10.	1140.	0.007	2.	2.	.063	0.2
			22.	1140.	0.007	50.	50.	.065	10.0
219	119	4	10.	760.	0.003	2.	2.	.043	0.2
			22.	760.	0.003	50.	50.	.045	10.0
222	122	4	10.	1800.	0.007	2.	2.	.062	0.2
			22.	1800.	0.007	50.	50.	.064	10.0
223	134	4	10.	530.	0.011	2.	2.	.076	0.2
			22.	530.	0.011	50.	50.	.078	10.0
224	124	4	10.	2550.	0.006	2.	2.	.060	0.2
			22.	2550.	0.006	50.	50.	.062	10.0
225	125	4	10.	1480.	0.004	2.	2.	.051	0.2
			22.	1480.	0.004	50.	50.	.053	10.0
226	126	4	10.	2420.	0.003	2.	2.	.042	0.2
			22.	2420.	0.003	50.	50.	.044	10.0
227	127	4	10.	1890.	0.001	2.	2.	.031	0.2
			22.	1890.	0.001	50.	50.	.032	10.0
228	127	4	10.	1090.	0.017	2.	2.	.087	0.2
			22.	1090.	0.017	50.	50.	.090	10.0
229	129	4	10.	1090.	0.015	2.	2.	.083	0.2
			22.	1090.	0.015	50.	50.	.086	10.0
230	152	4	10.	4100.	0.004	2.	2.	.094	0.2
			22.	4100.	0.004	50.	50.	.097	10.0
231	131	4	10.	2250.	0.010	2.	2.	.090	0.2
			22.	2250.	0.010	50.	50.	.093	10.0
232	132	4	10.	1520.	0.008	2.	2.	.066	0.2
			22.	1520.	0.008	50.	50.	.068	10.0
233	133	4	10.	1850.	0.009	2.	2.	.088	0.2
			22.	1850.	0.009	50.	50.	.091	10.0
234	133	4	10.	1440.	0.007	2.	2.	.063	0.2
			22.	1440.	0.007	50.	50.	.065	10.0
235	135	4	10.	3890.	0.006	2.	2.	.110	0.2
			22.	3890.	0.006	50.	50.	.113	10.0
236	135	4	10.	3650.	0.004	2.	2.	.082	0.2
			22.	3650.	0.004	50.	50.	.084	10.0
237	137	4	10.	1030.	0.002	2.	2.	.076	0.2
			22.	1030.	0.002	50.	50.	.078	10.0
238	138	4	10.	3430.	0.006	2.	2.	.061	0.2
			22.	3430.	0.006	50.	50.	.063	10.0
239	139	4	10.	2240.	0.005	2.	2.	.057	0.2
			22.	2240.	0.005	50.	50.	.059	10.0
240	140	4	10.	1050.	0.004	2.	2.	.050	0.2
			22.	1050.	0.004	50.	50.	.052	10.0
241	141	4	10.	1186.	0.003	2.	2.	.092	0.2
			22.	1186.	0.003	50.	50.	.095	10.0
242	142	4	10.	3420.	0.004	2.	2.	.048	0.2
			22.	3420.	0.004	50.	50.	.050	10.0
243	143	4	10.	3360.	0.008	2.	2.	.065	0.2
			22.	3360.	0.008	50.	50.	.067	10.0
244	153	4	10.	2270.	0.008	2.	2.	.066	0.2
			22.	2270.	0.008	50.	50.	.068	10.0
245	144	4	10.	2210.	0.011	2.	2.	.074	0.2
			22.	2210.	0.011	50.	50.	.077	10.0
246	146	4	10.	4160.	0.008	2.	2.	.065	0.2
			22.	4160.	0.008	50.	50.	.067	10.0
247	147	4	10.	1130.	0.004	2.	2.	.048	0.2
			22.	1130.	0.004	50.	50.	.050	10.0
248	148	4	10.	1750.	0.005	2.	2.	.053	0.2
			22.	1750.	0.005	50.	50.	.055	10.0
249	146	4	10.	1060.	0.003	2.	2.	.045	0.2
			22.	1060.	0.003	50.	50.	.046	10.0
251	157	4	10.	1200.	0.002	2.	2.	.042	0.2
			22.	1200.	0.002	50.	50.	.043	10.0
252	151	4	10.	2050.	0.001	2.	2.	.033	0.2
			22.	2050.	0.001	50.	50.	.034	10.0
253	153	4	10.	1940.	0.006	2.	2.	.060	0.2
			22.	1940.	0.006	50.	50.	.062	10.0
254	153	4	10.	1680.	0.005	2.	2.	.054	0.2
			22.	1680.	0.005	50.	50.	.056	10.0
256	156	4	10.	2350.	0.006	2.	2.	.059	0.2
			22.	2350.	0.006	50.	50.	.061	10.0
257	157	4	10.	1830.	0.003	2.	2.	.047	0.2
			22.	1830.	0.003	50.	50.	.049	10.0
260	160	4	10.	1530.	0.001	2.	2.	.033	0.2
			22.	1530.	0.001	50.	50.	.034	10.0
261	160	4	10.	3210.	0.004	2.	2.	.049	0.2
			22.	3210.	0.004	50.	50.	.051	10.0
262	162	4	10.	1180.	0.002	2.	2.	.037	0.2
			22.	1180.	0.002	50.	50.	.038	10.0
263	163	4	10.	550.	0.015	2.	2.	.083	0.2
			22.	550.	0.015	50.	50.	.086	10.0
264	164	4	10.	3750.	0.001	2.	2.	.031	0.2
			22.	3750.	0.001	50.	50.	.032	10.0
265	163	4	10.	1510.	0.001	2.	2.	.033	0.2
			22.	1510.	0.001	50.	50.	.034	10.0
266	166	4	10.	1630.	0.001	2.	2.	.032	0.2
			22.	1630.	0.001	50.	50.	.033	10.0
267	167	4	10.	2260.	0.005	2.	2.	.057	0.2
			22.	2260.	0.005	50.	50.	.058	10.0
269	169	4	10.	2710.	0.001	2.	2.	.027	0.2
			22.	2710.	0.001	50.	50.	.028	10.0
271	169	4	10.	1130.	0.007	2.	2.	.063	0.2
			22.	1130.	0.007	50.	50.	.065	10.0
272	172	4	10.	2300.	0.008	2.	2.	.066	0.2
			22.	2300.	0.008	50.	50.	.068	10.0
274	185	4	10.	1030.	0.016	2.	2.	.085	0.2
			22.	1030.	0.016	50.	50.	.088	10.0
276	171	4	10.	1190.	0.007	2.	2.	.062	0.2
			22.	1190.	0.007	50.	50.	.064	10.0

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277  177   4     10.   1970.   0.008     2.      2.    .066     0.2
                 22.   1970.   0.008    50.     50.    .069    10.0
278  178   4     10.   1460.   0.001     2.      2.    .034     0.2
                 22.   1460.   0.001    50.     50.    .035    10.0
279  500   4     10.   2940.   0.005     2.      2.    .057     0.2
                 22.   2940.   0.005    50.     50.    .059    10.0
280  500   4     10.   2090.   0.007     2.      2.    .062     0.2
                 22.   2090.   0.007    50.     50.    .064    10.0
281  500   4     10.   5390.   0.004     2.      2.    .053     0.2
                 22.   5390.   0.004    50.     50.    .055    10.0
282  171   4     10.   2500.   0.003     2.      2.    .047     0.2
                 22.   2500.   0.003    50.     50.    .048    10.0
284  184   4     10.   1530.   0.007     2.      2.    .061     0.2
                 22.   1530.   0.007    50.     50.    .063    10.0
285  185   4     10.    680.   0.009     2.      2.    .069     0.2
                 22.    680.   0.009    50.     50.    .071    10.0
286  186   4     10.   1820.   0.008     2.      2.    .065     0.2
                 22.   1820.   0.008    50.     50.    .067    10.0
287  187   4     10.    940.   0.006     2.      2.    .061     0.2
                 22.    940.   0.006    50.     50.    .063    10.0
289  189   4     10.   2920.   0.008     2.      2.    .067     0.2
                 22.   2920.   0.008    50.     50.    .069    10.0
101  201   3           1.
102  202   3           1.
103  203   3           1.
104  111   3           1.
105  204   3           1.
106  208   3           1.
107  213   3           1.
108  212   3           1.
109  211   3           1.
110  217   3           1.
111  205   3           1.
112  216   3           1.
113  214   3           1.
114  314   3           1.
115  218   3           1.
116  224   3           1.
117  219   3           1.
118  225   3           1.
119  319   3           1.
120  228   3           1.
121  229   3           1.
122  235   3           1.
123  236   3           1.
124  234   3           1.
125  233   3           1.
126  227   3           1.
127  232   3           1.
129  231   3           1.
130  330   3           1.
131  241   3           1.
132  332   3           1.
133  333   3           1.
134  237   3           1.
135  223   3           1.
137  238   3           1.
138  248   3           1.
139  246   3           1.
140  245   3           1.
141  243   3           1.
142  244   3           1.
143  253   3           1.
144  251   3           1.
145  230   3           1.
146  346   3           1.
147  249   3           1.
148  247   3           1.
151  146   3           1.
152  252   3           1.
153  257   3           1.
154  254   3           1.
155  256   3           1.
156  262   3           1.
157  260   3           1.
159  265   3           1.
160  263   3           1.
162  261   3           1.
163  264   3           1.
164  364   3           1.
165  266   3           1.
166  164   3           1.
167  269   3           1.
168  289   3           1.
169  287   3           1.
170  271   3           1.
171  285   3           1.
172  286   3           1.
173  272   3           1.
174  274   3           1.
175  500   3           1.
176  276   3           1.
177  176   3           1.
178  277   3           1.
179  284   3           1.
180  280   3           1.
181  278   3           1.
182  279   3           1.
183  281   3           1.
184  282   3           1.
190  191   3           1.
189  199   3           1.
188  198   3           1.
187  197   3           1.
186  196   3           1.
185  195   3           1.
  0
  5
101  102  103  104  105
ENDPROGRAM
```

DIRECT FLOW AREA 0053 100-YEAR MASTER PLAN CONDITION
KIOWA ENGINEERING CORPORATION 2002 REVISION

*** PEAK FLOWS, STAGES AND STORAGES OF GUTTERS AND DETENTION DAMS ***

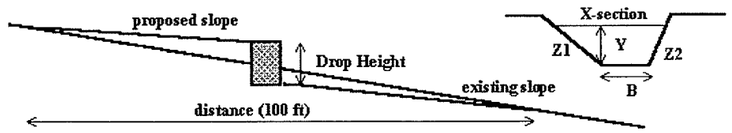
CONVEYANCE ELEMENT	PEAK (CFS)	STAGE (FT)	STORAGE (AC-FT)	TIME (HR/MIN)
103	171.	(DIRECT FLOW)		0 45.
101	112.	(DIRECT FLOW)		0 40.
107	171.	(DIRECT FLOW)		0 45.
203	159.	1.3		0 50.
201	65.	0.9		0 55.
110	179.	(DIRECT FLOW)		0 45.
213	50.	1.2		1 30.
105	221.	(DIRECT FLOW)		0 50.
217	99.	1.1		1 10.
113	197.	(DIRECT FLOW)		0 45.
204	156.	1.3		1 10.
102	105.	(DIRECT FLOW)		0 45.
117	215.	(DIRECT FLOW)		0 50.
214	141.	1.2		1 15.
104	286.	(DIRECT FLOW)		1 0.
202	65.	0.9		1 10.
219	205.	1.5		1 0.
114	280.	(DIRECT FLOW)		0 45.
111	345.	(DIRECT FLOW)		1 0.
119	355.	(DIRECT FLOW)		0 50.
314	42.	0.1	20.7	2 40.
205	283.	1.6		1 20.
319	58.	0.1	21.5	2 5.
222	41.	0.8		3 10.
106	497.	(DIRECT FLOW)		1 10.
121	250.	(DIRECT FLOW)		0 40.
226	56.	0.9		2 55.
123	270.	(DIRECT FLOW)		0 40.
122	287.	(DIRECT FLOW)		0 40.
208	452.	2.0		1 20.
229	193.	1.4		0 50.
120	31.	(DIRECT FLOW)		0 45.
126	167.	(DIRECT FLOW)		0 40.
236	76.	1.2		1 10.
235	83.	1.3		1 20.
108	598.	(DIRECT FLOW)		1 15.
109	76.	(DIRECT FLOW)		0 40.
129	384.	(DIRECT FLOW)		0 45.
228	24.	0.6		1 5.
227	91.	1.2		1 5.
135	365.	(DIRECT FLOW)		0 50.
212	500.	2.2		1 35.
211	26.	0.6		1 20.
231	236.	1.7		1 0.
127	362.	(DIRECT FLOW)		0 40.
223	358.	1.8		0 55.
115	115.	(DIRECT FLOW)		0 45.
112	751.	(DIRECT FLOW)		1 15.
131	319.	(DIRECT FLOW)		0 55.
232	260.	1.6		0 55.
134	522.	(DIRECT FLOW)		0 50.
218	85.	1.0		0 55.
216	724.	2.9		1 25.
241	261.	2.2		1 15.
130	75.	(DIRECT FLOW)		0 45.
132	363.	(DIRECT FLOW)		0 50.
237	420.	2.7		1 5.
116	829.	(DIRECT FLOW)		1 15.
118	73.	(DIRECT FLOW)		0 40.
141	279.	(DIRECT FLOW)		1 15.
330	17.	0.1	3.1	1 35.
332	19.	0.1	44.9	9 30.
137	465.	(DIRECT FLOW)		1 5.
224	761.	2.5		1 35.
225	44.	0.8		1 0.
243	214.	1.5		1 35.
242	13.	0.5		2 40.
240	19.	0.6		9 45.
238	351.	1.8		1 30.
124	802.	(DIRECT FLOW)		1 30.
125	204.	(DIRECT FLOW)		0 40.
155	36.	(DIRECT FLOW)		0 40.
154	174.	(DIRECT FLOW)		0 40.
143	389.	(DIRECT FLOW)		0 45.
142	503.	(DIRECT FLOW)		0 40.
140	191.	(DIRECT FLOW)		0 40.
138	1353.	(DIRECT FLOW)		0 45.
234	790.	2.5		1 40.
233	114.	1.3		1 0.
256	14.	0.5		1 0.
254	105.	1.1		0 55.
253	304.	1.7		1 15.
244	291.	1.7		0 55.
245	104.	1.1		1 0.
145	110.	(DIRECT FLOW)		0 45.
248	1054.	2.8		0 55.
133	885.	(DIRECT FLOW)		1 30.
156	161.	(DIRECT FLOW)		0 45.
153	799.	(DIRECT FLOW)		1 0.
144	310.	(DIRECT FLOW)		0 55.
230	27.	0.8		1 25.
148	1263.	(DIRECT FLOW)		0 50.
333	388.	0.1	89.9	2 55.
262	119.	1.2		0 55.
257	698.	2.5		1 15.
251	277.	1.8		1 10.
152	196.	(DIRECT FLOW)		0 45.
247	1188.	2.9		1 0.

239	383.	1.9	3	15.
162	288.	(DIRECT FLOW)	0	45.
157	1065.	(DIRECT FLOW)	1	10.
252	118.	1.3	1	10.
147	1246.	(DIRECT FLOW)	1	0.
139	500.	(DIRECT FLOW)	0	40.
261	169.	1.4	1	15.
260	993.	3.1	1	20.
151	195.	(DIRECT FLOW)	0	55.
249	1177.	3.0	1	5.
246	369.	1.8	3	45.
159	379.	(DIRECT FLOW)	0	45.
160	1250.	(DIRECT FLOW)	1	15.
146	1904.	(DIRECT FLOW)	1	5.
165	186.	(DIRECT FLOW)	0	45.
265	263.	1.8	1	0.
263	1248.	2.9	1	20.
346	613.	0.1 114.1	2	45.
266	125.	1.3	1	10.
163	1524.	(DIRECT FLOW)	1	15.
181	613.	(DIRECT FLOW)	2	45.
166	230.	(DIRECT FLOW)	0	55.
264	1227.	3.3	1	40.
278	613.	2.6	3	0.
164	1359.	(DIRECT FLOW)	1	35.
178	613.	(DIRECT FLOW)	3	0.
364	136.	0.1 191.5	4	40.
179	660.	(DIRECT FLOW)	0	35.
277	612.	2.2	3	10.
267	135.	1.3	5	5.
284	411.	1.9	0	45.
177	612.	(DIRECT FLOW)	3	10.
170	228.	(DIRECT FLOW)	0	45.
167	492.	(DIRECT FLOW)	0	40.
173	35.	(DIRECT FLOW)	0	45.
184	422.	(DIRECT FLOW)	0	45.
176	612.	(DIRECT FLOW)	3	10.
271	178.	1.4	0	55.
269	216.	1.6	0	55.
272	19.	0.6	1	20.
282	240.	1.6	1	5.
276	612.	2.2	3	20.
168	36.	(DIRECT FLOW)	1	0.
169	729.	(DIRECT FLOW)	0	50.
172	227.	(DIRECT FLOW)	0	40.
171	729.	(DIRECT FLOW)	1	5.
174	270.	(DIRECT FLOW)	0	40.
183	125.	(DIRECT FLOW)	0	40.
180	108.	(DIRECT FLOW)	0	40.
182	64.	(DIRECT FLOW)	0	45.
289	25.	0.6	2	0.
287	682.	2.4	0	55.
286	145.	1.3	1	0.
285	726.	2.4	1	10.
274	210.	1.4	0	50.
175	470.	(DIRECT FLOW)	0	40.
281	34.	0.7	1	20.
280	64.	0.9	1	5.
279	37.	0.8	1	30.
189	453.	(DIRECT FLOW)	0	40.
188	75.	(DIRECT FLOW)	0	45.
187	859.	(DIRECT FLOW)	0	55.
186	166.	(DIRECT FLOW)	1	0.
185	1034.	(DIRECT FLOW)	1	0.
190	39.	(DIRECT FLOW)	0	55.
500	566.	(DIRECT FLOW)	0	40.
199	453.	(DIRECT FLOW)	0	40.
198	75.	(DIRECT FLOW)	0	45.
197	859.	(DIRECT FLOW)	0	55.
196	166.	(DIRECT FLOW)	1	0.
195	1034.	(DIRECT FLOW)	1	0.
191	39.	(DIRECT FLOW)	0	55.

PROGRAM ENDED NORMALLY

Design of Trapezoidal Grass-Lined Channel

Project: Morning Glory
Channel ID: 113

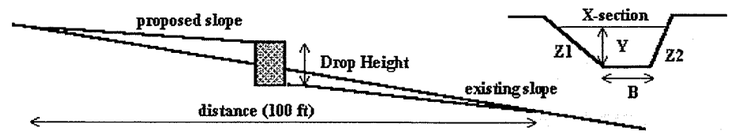


Existing Channel Condition (Input)			
Design Discharge	Q_D=	197.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0045	ft/ft
100-Year Discharge	Q_{100}=	**197.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
Sandy Soil			check, OR
Non-Sandy Soil		X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	10.1 ft	10.1 ft
100-Year Flow Depth (5' maximum)	Y_{100}=	**2.31 ft**	**2.65 ft**
100-Year Flow Velocity	V_{100}=	**4.4 fps**	**3.6 fps**
100-Year Top Width	T=	28.6 ft	31.3 ft
100-Year Flow Area	A=	44.7 sq ft	54.9 sq ft
100-Year Froude Number	**Fr =**	**0.38**	**0.23**
100-Year Wetted Perimeter	P=	29.2 ft	32.0 ft
100-Year Hydarulic Radius	R=	1.5 ft	1.7 ft
Design Discharge Flow Depth	Y_D=	**2.31 ft**	**2.65** ft
Design Discharge Flow Velocity	V_D=	**4.4 fps**	**3.6** fps
Design Discharge Top Width	T=	28.6 ft	31.3 ft
Design Discharge Flow Area	A=	44.7 sq ft	54.9 sq ft
Design Discharge Froude Number	**Fr =**	**0.38**	**0.23**
Design Discharge Wetted Perimeter	P=	29.2 ft	32.0 ft
Design Discharge Hydarulic Radius	R=	1.5 ft	1.7 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0045 ft/ft	0.0045 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Morning Glory
Channel ID: 114

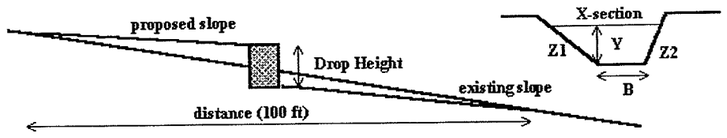


Existing Channel Condition (Input)			
Design Discharge	Q_D=	280.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0043	ft/ft
100-Year Discharge	Q_{100}=	**280.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
Sandy Soil			check, OR
Non-Sandy Soil		X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	10.2 ft	10.2 ft
100-Year Flow Depth (5' maximum)	Y_{100}=	**2.76 ft**	**3.16 ft**
100-Year Flow Velocity	V_{100}=	**4.8 fps**	**3.9 fps**
100-Year Top Width	T=	32.3 ft	35.5 ft
100-Year Flow Area	A=	58.7 sq ft	72.3 sq ft
100-Year Froude Number	**Fr =**	**0.39**	**0.23**
100-Year Wetted Perimeter	P=	33.0 ft	36.3 ft
100-Year Hydarulic Radius	R=	1.8 ft	2.0 ft
Design Discharge Flow Depth	Y_D=	**2.76 ft**	**3.16** ft
Design Discharge Flow Velocity	V_D=	**4.8 fps**	**3.9** fps
Design Discharge Top Width	T=	32.3 ft	35.5 ft
Design Discharge Flow Area	A=	58.7 sq ft	72.3 sq ft
Design Discharge Froude Number	**Fr =**	**0.39**	**0.23**
Design Discharge Wetted Perimeter	P=	33.0 ft	36.3 ft
Design Discharge Hydarulic Radius	R=	1.8 ft	2.0 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0043 ft/ft	0.0043 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Morning Glory
Channel ID: 122



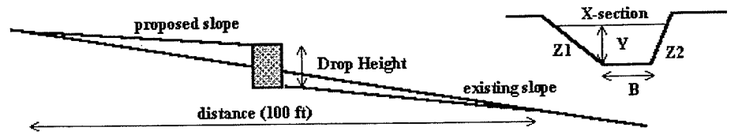
Existing Channel Condition (Input)		
Design Discharge	Q_D=	287.0 cfs
Design Discharge Return Period	$Year_D$=	100 years
Existing Ground Slope Along Channel Centerline	So =	0.0097 ft/ft
100-Year Discharge	**Q_{100}=**	**287.0** cfs
Left Side Slope	Z1 =	4.0 ft/ft
Right Side Slope	Z2 =	4.0 ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040
Check one of the following soil types		
	Sandy Soil	check, OR
	Non-Sandy Soil X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	3.9 ft	3.9 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.84 ft**	**3.20 ft**
100-Year Flow Velocity	**V_{100}=**	**6.6 fps**	**5.4 fps**
100-Year Top Width	T=	26.6 ft	29.5 ft
100-Year Flow Area	A=	43.4 sq ft	53.5 sq ft
Warning 05 100-Year Froude Number	**Fr =**	**0.83**	**0.49**
100-Year Wetted Perimeter	P=	27.3 ft	30.3 ft
100-Year Hydarulic Radius	R=	1.6 ft	1.8 ft
Design Discharge Flow Depth	Y_D=	**2.84 ft**	**3.20** ft
Design Discharge Flow Velocity	V_D=	**6.6 fps**	**5.4** fps
Design Discharge Top Width	T=	26.6 ft	29.5 ft
Design Discharge Flow Area	A=	43.4 sq ft	53.5 sq ft
Warning 05 Design Discharge Froude Number	**Fr =**	**0.83**	**0.49**
Design Discharge Wetted Perimeter	P=	27.3 ft	30.3 ft
Design Discharge Hydarulic Radius	R=	1.6 ft	1.8 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0097 ft/ft	0.0097 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Warning 05: Froude No. exceeds USDCM Criteria Manual Volume II recommendation.

Design of Trapezoidal Grass-Lined Channel

Project: Morning Glory
Channel ID: 135

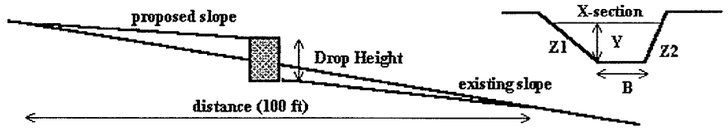


Existing Channel Condition (Input)		
Design Discharge	Q_D=	365.0 cfs
Design Discharge Return Period	$Year_D$=	100 years
Existing Ground Slope Along Channel Centerline	So =	0.0034 ft/ft
100-Year Discharge	**Q_{100}=**	**365.0** cfs
Left Side Slope	Z1 =	4.0 ft/ft
Right Side Slope	Z2 =	4.0 ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040
Check one of the following soil types		
	Sandy Soil	check, OR
	Non-Sandy Soil X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	12.3 ft	12.3 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**3.15 ft**	**3.61 ft**
100-Year Flow Velocity	**V_{100}=**	**4.7 fps**	**3.8 fps**
100-Year Top Width	T=	37.5 ft	41.2 ft
100-Year Flow Area	A=	78.5 sq ft	96.6 sq ft
100-Year Froude Number	**Fr =**	**0.32**	**0.19**
100-Year Wetted Perimeter	P=	38.3 ft	42.1 ft
100-Year Hydarulic Radius	R=	2.0 ft	2.3 ft
Design Discharge Flow Depth	Y_D=	**3.15 ft**	**3.61** ft
Design Discharge Flow Velocity	V_D=	**4.7 fps**	**3.8** fps
Design Discharge Top Width	T=	37.5 ft	41.2 ft
Design Discharge Flow Area	A=	78.5 sq ft	96.6 sq ft
Design Discharge Froude Number	**Fr =**	**0.32**	**0.19**
Design Discharge Wetted Perimeter	P=	38.3 ft	42.1 ft
Design Discharge Hydarulic Radius	R=	2.0 ft	2.3 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0034 ft/ft	0.0034 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Ragweed
Channel ID: 104

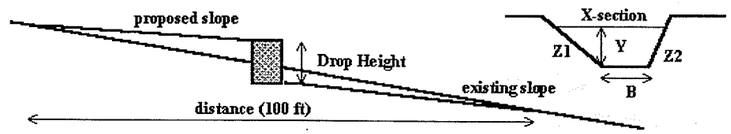


Existing Channel Condition (Input)			
Design Discharge	Q_D=	286.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0070	ft/ft
100-Year Discharge	**Q_{100}=**	**221.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	6.5 ft	6.5 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.48 ft**	**2.81 ft**
100-Year Flow Velocity	**V_{100}=**	**5.4 fps**	**4.4 fps**
100-Year Top Width	T=	26.3 ft	29.0 ft
100-Year Flow Area	A=	40.7 sq ft	49.8 sq ft
100-Year Froude Number	**Fr =**	**0.59**	**0.36**
100-Year Wetted Perimeter	P=	26.9 ft	29.7 ft
100-Year Hydarulic Radius	R=	1.5 ft	1.7 ft
Design Discharge Flow Depth	Y_D=	**2.79 ft**	**2.81** ft
Design Discharge Flow Velocity	V_D=	**5.8 fps**	**5.7** fps
Design Discharge Top Width	T=	28.8 ft	29.0 ft
Design Discharge Flow Area	A=	49.3 sq ft	49.8 sq ft
Design Discharge Froude Number	**Fr =**	**0.61**	**0.59**
Design Discharge Wetted Perimeter	P=	29.5 ft	29.7 ft
Design Discharge Hydarulic Radius	R=	1.7 ft	1.7 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0070 ft/ft	0.0071 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Ragweed
Channel ID: 106



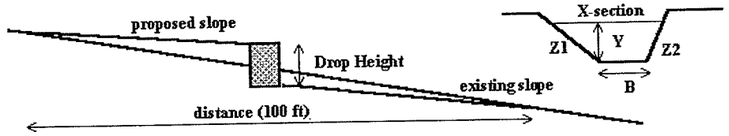
Existing Channel Condition (Input)			
Design Discharge	Q_D=	497.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0093	ft/ft
100-Year Discharge	**Q_{100}=**	**497.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	4.0 ft	4.0 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**3.75 ft**	**4.21 ft**
100-Year Flow Velocity	**V_{100}=**	**7.0 fps**	**5.7 fps**
100-Year Top Width	T=	34.0 ft	37.7 ft
100-Year Flow Area	A=	71.4 sq ft	87.9 sq ft
100-Year Froude Number	**Fr =**	**0.72**	**0.43**
100-Year Wetted Perimeter	P=	34.9 ft	38.7 ft
100-Year Hydarulic Radius	R=	2.0 ft	2.3 ft
Design Discharge Flow Depth	Y_D=	**3.75 ft**	**4.21** ft
Design Discharge Flow Velocity	V_D=	**7.0 fps**	**5.7** fps
Design Discharge Top Width	T=	34.0 ft	37.7 ft
Design Discharge Flow Area	A=	71.4 sq ft	87.9 sq ft
Design Discharge Froude Number	**Fr =**	**0.72**	**0.43**
Design Discharge Wetted Perimeter	P=	34.9 ft	38.7 ft
Design Discharge Hydarulic Radius	R=	2.0 ft	2.3 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0077 ft/ft	0.0077 ft/ft
Drop Height per 100 ft	D =	0.2 ft/100 ft	0.2 ft/100 ft

L = 2810' ⇒ 6' drop height
@ 3' EA ⇒ 2 drops
∴ Place one every 940'

Design of Trapezoidal Grass-Lined Channel

Project: Ragweed
Channel ID: 108

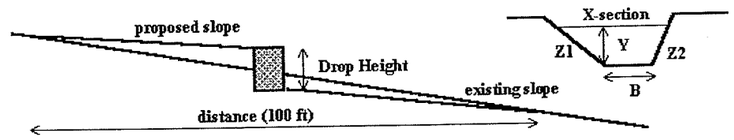


Existing Channel Condition (Input)			
Design Discharge	Q_D=	598.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0062	ft/ft
100-Year Discharge	**Q_{100}=**	**598.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	5.2 ft	5.2 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**4.10 ft**	**4.62 ft**
100-Year Flow Velocity	**V_{100}=**	**6.7 fps**	**5.5 fps**
100-Year Top Width	T=	38.0 ft	42.2 ft
100-Year Flow Area	A=	88.6 sq ft	109.5 sq ft
100-Year Froude Number	**Fr =**	**0.61**	**0.36**
100-Year Wetted Perimeter	P=	39.0 ft	43.3 ft
100-Year Hydarulic Radius	R=	2.3 ft	2.5 ft
Design Discharge Flow Depth	Y_D=	**4.10 ft**	**4.62** ft
Design Discharge Flow Velocity	V_D=	**6.7 fps**	**5.5** fps
Design Discharge Top Width	T=	38.0 ft	42.2 ft
Design Discharge Flow Area	A=	88.6 sq ft	109.5 sq ft
Design Discharge Froude Number	**Fr =**	**0.61**	**0.36**
Design Discharge Wetted Perimeter	P=	39.0 ft	43.3 ft
Design Discharge Hydarulic Radius	R=	2.3 ft	2.5 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0062 ft/ft	0.0062 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Ragweed
Channel ID: 112

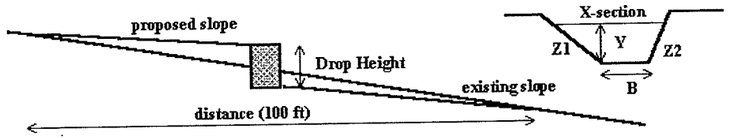


Existing Channel Condition (Input)			
Design Discharge	Q_D=	751.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0038	ft/ft
100-Year Discharge	**Q_{100}=**	**751.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	11.5 ft	11.5 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**4.39 ft**	**5.00 ft**
100-Year Flow Velocity	**V_{100}=**	**5.9 fps**	**4.8 fps**
100-Year Top Width	T=	46.6 ft	51.5 ft
100-Year Flow Area	A=	127.4 sq ft	157.3 sq ft
100-Year Froude Number	**Fr =**	**0.39**	**0.23**
100-Year Wetted Perimeter	P=	47.7 ft	52.7 ft
100-Year Hydarulic Radius	R=	2.7 ft	3.0 ft
Design Discharge Flow Depth	Y_D=	**4.39 ft**	**5.00** ft
Design Discharge Flow Velocity	V_D=	**5.9 fps**	**4.8** fps
Design Discharge Top Width	T=	46.6 ft	51.5 ft
Design Discharge Flow Area	A=	127.4 sq ft	157.3 sq ft
Design Discharge Froude Number	**Fr =**	**0.39**	**0.23**
Design Discharge Wetted Perimeter	P=	47.7 ft	52.7 ft
Design Discharge Hydarulic Radius	R=	2.7 ft	3.0 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0038 ft/ft	0.0038 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Ragweed
Channel ID: 116



Existing Channel Condition (Input)		
Design Discharge	Q_D=	829.0 cfs
Design Discharge Return Period	$Year_D$=	100 years
Existing Ground Slope Along Channel Centerline	So =	0.0067 ft/ft
100-Year Discharge	**Q_{100}=**	**829.0** cfs
Left Side Slope	Z1 =	4.0 ft/ft
Right Side Slope	Z2 =	4.0 ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040
Check one of the following soil types		
Sandy Soil		check, OR
Non-Sandy Soil	X	check

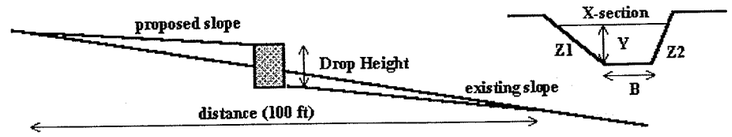
Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	9.5 ft	9.5 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**4.41 ft**	**5.00 ft**
100-Year Flow Velocity	**V_{100}=**	**6.9 fps**	**5.6 fps**
100-Year Top Width	T=	44.8 ft	49.5 ft
100-Year Flow Area	A=	119.6 sq ft	147.4 sq ft
100-Year Froude Number	**Fr =**	**0.56**	**0.33**
100-Year Wetted Perimeter	P=	45.9 ft	50.7 ft
100-Year Hydarulic Radius	R=	2.6 ft	2.9 ft
Design Discharge Flow Depth	Y_D=	**4.41 ft**	**5.00** ft
Design Discharge Flow Velocity	V_D=	**6.9 fps**	**5.6** fps
Design Discharge Top Width	T=	44.8 ft	49.5 ft
Design Discharge Flow Area	A=	119.6 sq ft	147.4 sq ft
Design Discharge Froude Number	**Fr =**	**0.56**	**0.33**
Design Discharge Wetted Perimeter	P=	45.9 ft	50.7 ft
Design Discharge Hydarulic Radius	R=	2.6 ft	2.9 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0055 ft/ft	0.0055 ft/ft
Drop Height per 100 ft	D =	0.1 ft/100 ft	0.1 ft/100 ft

L = 1190' ⇒ 1.2' drop height

∴ Place one midway

Design of Trapezoidal Grass-Lined Channel

Project: Ragweed
Channel ID: 124

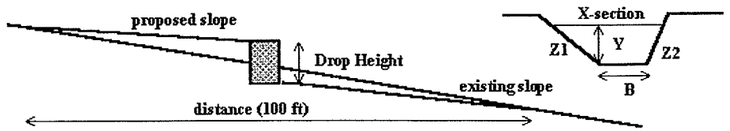


Existing Channel Condition (Input)		
Design Discharge	Q_D=	802.0 cfs
Design Discharge Return Period	$Year_D$=	100 years
Existing Ground Slope Along Channel Centerline	So =	0.0039 ft/ft
100-Year Discharge	**Q_{100}=**	**802.0** cfs
Left Side Slope	Z1 =	4.0 ft/ft
Right Side Slope	Z2 =	4.0 ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040
Check one of the following soil types		
Sandy Soil		check, OR
Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	12.8 ft	12.8 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**4.38 ft**	**5.00 ft**
100-Year Flow Velocity	**V_{100}=**	**6.0 fps**	**4.9 fps**
100-Year Top Width	T=	47.9 ft	52.8 ft
100-Year Flow Area	A=	132.9 sq ft	164.1 sq ft
100-Year Froude Number	**Fr =**	**0.41**	**0.24**
100-Year Wetted Perimeter	P=	48.9 ft	54.0 ft
100-Year Hydarulic Radius	R=	2.7 ft	3.0 ft
Design Discharge Flow Depth	Y_D=	**4.38 ft**	**5.00** ft
Design Discharge Flow Velocity	V_D=	**6.0 fps**	**4.9** fps
Design Discharge Top Width	T=	47.9 ft	52.8 ft
Design Discharge Flow Area	A=	132.9 sq ft	164.1 sq ft
Design Discharge Froude Number	**Fr =**	**0.41**	**0.24**
Design Discharge Wetted Perimeter	P=	48.9 ft	54.0 ft
Design Discharge Hydarulic Radius	R=	2.7 ft	3.0 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0039 ft/ft	0.0039 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Ragweed
Channel ID: 139



Existing Channel Condition (Input)			
Design Discharge	Q_D=	500.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0084	ft/ft
100-Year Discharge	**Q_{100}=**	**500.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

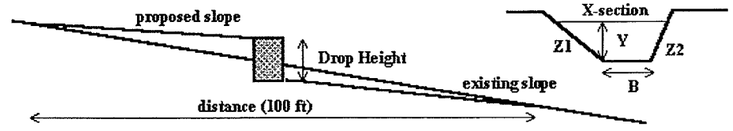
Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	4.0 ft	4.0 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**3.77 ft**	**4.23 ft**
100-Year Flow Velocity	**V_{100}=**	**7.0 fps**	**5.7 fps**
100-Year Top Width	T=	34.1 ft	37.8 ft
100-Year Flow Area	A=	71.8 sq ft	88.3 sq ft
100-Year Froude Number	**Fr =**	**0.72**	**0.43**
100-Year Wetted Perimeter	P=	35.1 ft	38.8 ft
100-Year Hydarulic Radius	R=	2.0 ft	2.3 ft
Design Discharge Flow Depth	Y_D=	**3.77 ft**	**4.23** ft
Design Discharge Flow Velocity	V_D=	**7.0 fps**	**5.7** fps
Design Discharge Top Width	T=	34.1 ft	37.8 ft
Design Discharge Flow Area	A=	71.8 sq ft	88.3 sq ft
Design Discharge Froude Number	**Fr =**	**0.72**	**0.43**
Design Discharge Wetted Perimeter	P=	35.1 ft	38.8 ft
Design Discharge Hydarulic Radius	R=	2.0 ft	2.3 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0076 ft/ft	0.0077 ft/ft
Drop Height per 100 ft	D =	0.1 ft/100 ft	0.1 ft/100 ft

L= 1900' => 1.9' drop height

∴ Place one midway

Design of Trapezoidal Grass-Lined Channel

Project: Ragweed
Channel ID: 146

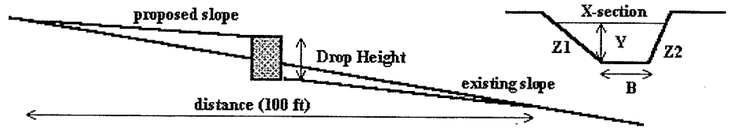


Existing Channel Condition (Input)			
Design Discharge	Q_D=	369.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0068	ft/ft
100-Year Discharge	**Q_{100}=**	**369.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	5.8 ft	5.8 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**3.21 ft**	**3.63 ft**
100-Year Flow Velocity	**V_{100}=**	**6.2 fps**	**5.0 fps**
100-Year Top Width	T=	31.5 ft	34.8 ft
100-Year Flow Area	A=	59.8 sq ft	73.8 sq ft
100-Year Froude Number	**Fr =**	**0.62**	**0.37**
100-Year Wetted Perimeter	P=	32.3 ft	35.7 ft
100-Year Hydarulic Radius	R=	1.9 ft	2.1 ft
Design Discharge Flow Depth	Y_D=	**3.21 ft**	**3.63** ft
Design Discharge Flow Velocity	V_D=	**6.2 fps**	**5.0** fps
Design Discharge Top Width	T=	31.5 ft	34.8 ft
Design Discharge Flow Area	A=	59.8 sq ft	73.8 sq ft
Design Discharge Froude Number	**Fr =**	**0.62**	**0.37**
Design Discharge Wetted Perimeter	P=	32.3 ft	35.7 ft
Design Discharge Hydarulic Radius	R=	1.9 ft	2.1 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0068 ft/ft	0.0069 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Henderson
Channel ID: 138



Existing Channel Condition (Input)		
Design Discharge	Q_D=	1358.0 cfs
Design Discharge Return Period	$Year_D$=	100 years
Existing Ground Slope Along Channel Centerline	So =	0.0060 ft/ft
100-Year Discharge	**Q_{100}=**	**1,358.0** cfs
Left Side Slope	Z1 =	4.0 ft/ft
Right Side Slope	Z2 =	4.0 ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040
Check one of the following soil types		
Sandy Soil		check, OR
Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	29.1 ft	29.1 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**4.32 ft**	**5.00 ft**
100-Year Flow Velocity	**V_{100}=**	**6.8 fps**	**5.5 fps**
100-Year Top Width	T=	63.7 ft	69.1 ft
100-Year Flow Area	A=	200.4 sq ft	245.5 sq ft
100-Year Froude Number	**Fr =**	**0.45**	**0.27**
100-Year Wetted Perimeter	P=	64.7 ft	70.3 ft
100-Year Hydarulic Radius	R=	3.1 ft	3.5 ft
Design Discharge Flow Depth	Y_D=	**4.32 ft**	**5.00** ft
Design Discharge Flow Velocity	V_D=	**6.8 fps**	**5.5** fps
Design Discharge Top Width	T=	63.7 ft	69.1 ft
Design Discharge Flow Area	A=	200.4 sq ft	245.5 sq ft
Design Discharge Froude Number	**Fr =**	**0.45**	**0.27**
Design Discharge Wetted Perimeter	P=	64.7 ft	70.3 ft
Design Discharge Hydarulic Radius	R=	3.1 ft	3.5 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0042 ft/ft	0.0042 ft/ft
Drop Height per 100 ft	D =	0.2 ft/100 ft	0.2 ft/100 ft

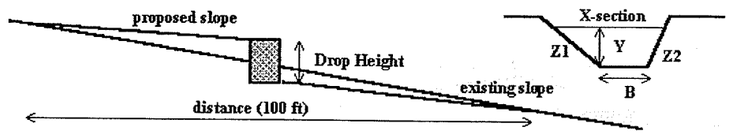
L = 4360' => 9' drop height

@ 3' each => 3 drops

∴ Place one every 1090'

Design of Trapezoidal Grass-Lined Channel

Project: Henderson
Channel ID: 148

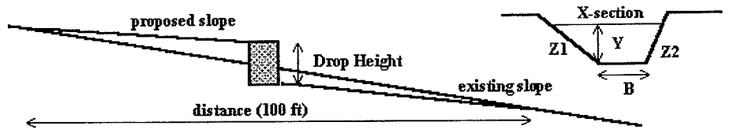


Existing Channel Condition (Input)		
Design Discharge	Q_D=	1263.0 cfs
Design Discharge Return Period	$Year_D$=	100 years
Existing Ground Slope Along Channel Centerline	So =	0.0017 ft/ft
100-Year Discharge	**Q_{100}=**	**1,263.0** cfs
Left Side Slope	Z1 =	4.0 ft/ft
Right Side Slope	Z2 =	4.0 ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040
Check one of the following soil types		
Sandy Soil		check, OR
Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	47.5 ft	47.5 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**4.28 ft**	**5.00 ft**
100-Year Flow Velocity	**V_{100}=**	**4.6 fps**	**3.7 fps**
100-Year Top Width	T=	81.7 ft	87.5 ft
100-Year Flow Area	A=	276.5 sq ft	337.4 sq ft
100-Year Froude Number	**Fr =**	**0.19**	**0.11**
100-Year Wetted Perimeter	P=	82.8 ft	88.7 ft
100-Year Hydarulic Radius	R=	3.3 ft	3.8 ft
Design Discharge Flow Depth	Y_D=	**4.28 ft**	**5.00** ft
Design Discharge Flow Velocity	V_D=	**4.6 fps**	**3.7** fps
Design Discharge Top Width	T=	81.7 ft	87.5 ft
Design Discharge Flow Area	A=	276.5 sq ft	337.4 sq ft
Design Discharge Froude Number	**Fr =**	**0.19**	**0.11**
Design Discharge Wetted Perimeter	P=	82.8 ft	88.7 ft
Design Discharge Hydarulic Radius	R=	3.3 ft	3.8 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0017 ft/ft	0.0017 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Henderson
Channel ID: 171

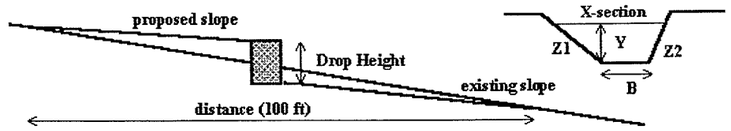


Existing Channel Condition (Input)			
Design Discharge	Q_D=	612.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0060	ft/ft
100-Year Discharge	**Q_{100}=**	**612.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	5.4 ft	5.4 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**4.16 ft**	**4.68 ft**
100-Year Flow Velocity	**V_{100}=**	**6.7 fps**	**5.4 fps**
100-Year Top Width	T=	38.6 ft	42.8 ft
100-Year Flow Area	A=	91.5 sq ft	112.7 sq ft
100-Year Froude Number	**Fr =**	**0.59**	**0.35**
100-Year Wetted Perimeter	P=	39.7 ft	44.0 ft
100-Year Hydarulic Radius	R=	2.3 ft	2.6 ft
Design Discharge Flow Depth	Y_D=	**4.16 ft**	**4.68** ft
Design Discharge Flow Velocity	V_D=	**6.7 fps**	**5.4** fps
Design Discharge Top Width	T=	38.6 ft	42.8 ft
Design Discharge Flow Area	A=	91.5 sq ft	112.7 sq ft
Design Discharge Froude Number	**Fr =**	**0.59**	**0.35**
Design Discharge Wetted Perimeter	P=	39.7 ft	44.0 ft
Design Discharge Hydarulic Radius	R=	2.3 ft	2.6 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0060 ft/ft	0.0061 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Henderson
Channel ID: 176

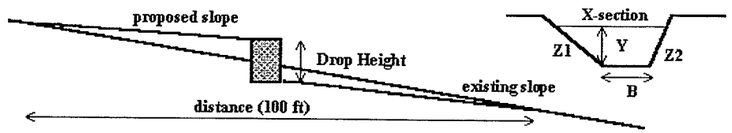


Existing Channel Condition (Input)			
Design Discharge	Q_D=	612.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0046	ft/ft
100-Year Discharge	**Q_{100}=**	**612.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	8.1 ft	8.1 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**4.13 ft**	**4.68 ft**
100-Year Flow Velocity	**V_{100}=**	**6.0 fps**	**4.9 fps**
100-Year Top Width	T=	41.1 ft	45.5 ft
100-Year Flow Area	A=	101.5 sq ft	125.3 sq ft
100-Year Froude Number	**Fr =**	**0.46**	**0.27**
100-Year Wetted Perimeter	P=	42.1 ft	46.7 ft
100-Year Hydarulic Radius	R=	2.4 ft	2.7 ft
Design Discharge Flow Depth	Y_D=	**4.13 ft**	**4.68** ft
Design Discharge Flow Velocity	V_D=	**6.0 fps**	**4.9** fps
Design Discharge Top Width	T=	41.1 ft	45.5 ft
Design Discharge Flow Area	A=	101.5 sq ft	125.3 sq ft
Design Discharge Froude Number	**Fr =**	**0.46**	**0.27**
Design Discharge Wetted Perimeter	P=	42.1 ft	46.7 ft
Design Discharge Hydarulic Radius	R=	2.4 ft	2.7 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0046 ft/ft	0.0046 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Henderson
Channel ID: 185

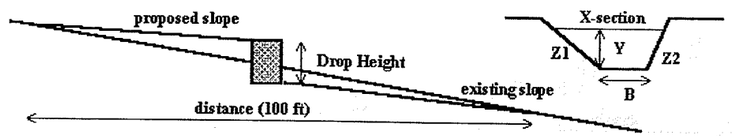


Existing Channel Condition (Input)		
Design Discharge	Q_D=	1034.0 cfs
Design Discharge Return Period	$Year_D$=	100 years
Existing Ground Slope Along Channel Centerline	So =	0.0030 ft/ft
100-Year Discharge	**Q_{100}=**	**1,034.0** cfs
Left Side Slope	Z1 =	4.0 ft/ft
Right Side Slope	Z2 =	4.0 ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040
Check one of the following soil types		
Sandy Soil		check, OR
Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	24.8 ft	24.8 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**4.33 ft**	**5.00 ft**
100-Year Flow Velocity	**V_{100}=**	**5.7 fps**	**4.6 fps**
100-Year Top Width	T=	59.5 ft	64.8 ft
100-Year Flow Area	A=	182.6 sq ft	224.2 sq ft
100-Year Froude Number	**Fr =**	**0.32**	**0.19**
100-Year Wetted Perimeter	P=	60.5 ft	66.1 ft
100-Year Hydarulic Radius	R=	3.0 ft	3.4 ft
Design Discharge Flow Depth	Y_D=	**4.33 ft**	**5.00** ft
Design Discharge Flow Velocity	V_D=	**5.7 fps**	**4.6** fps
Design Discharge Top Width	T=	59.5 ft	64.8 ft
Design Discharge Flow Area	A=	182.6 sq ft	224.2 sq ft
Design Discharge Froude Number	**Fr =**	**0.32**	**0.19**
Design Discharge Wetted Perimeter	P=	60.5 ft	66.1 ft
Design Discharge Hydarulic Radius	R=	3.0 ft	3.4 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0030 ft/ft	0.0030 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Saddle
Channel ID: 184

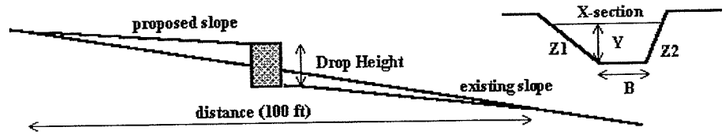


Existing Channel Condition (Input)		
Design Discharge	Q_D=	422.0 cfs
Design Discharge Return Period	$Year_D$=	100 years
Existing Ground Slope Along Channel Centerline	So =	0.0036 ft/ft
100-Year Discharge	**Q_{100}=**	**422.0** cfs
Left Side Slope	Z1 =	4.0 ft/ft
Right Side Slope	Z2 =	4.0 ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040
Check one of the following soil types		
Sandy Soil		check, OR
Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	11.5 ft	11.5 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**3.39 ft**	**3.88 ft**
100-Year Flow Velocity	**V_{100}=**	**5.0 fps**	**4.0 fps**
100-Year Top Width	T=	38.6 ft	42.6 ft
100-Year Flow Area	A=	85.0 sq ft	104.9 sq ft
100-Year Froude Number	**Fr =**	**0.35**	**0.20**
100-Year Wetted Perimeter	P=	39.5 ft	43.5 ft
100-Year Hydarulic Radius	R=	2.2 ft	2.4 ft
Design Discharge Flow Depth	Y_D=	**3.39 ft**	**3.88** ft
Design Discharge Flow Velocity	V_D=	**5.0 fps**	**4.0** fps
Design Discharge Top Width	T=	38.6 ft	42.6 ft
Design Discharge Flow Area	A=	85.0 sq ft	104.9 sq ft
Design Discharge Froude Number	**Fr =**	**0.35**	**0.20**
Design Discharge Wetted Perimeter	P=	39.5 ft	43.5 ft
Design Discharge Hydarulic Radius	R=	2.2 ft	2.4 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0036 ft/ft	0.0036 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Arabian
Channel ID: 172

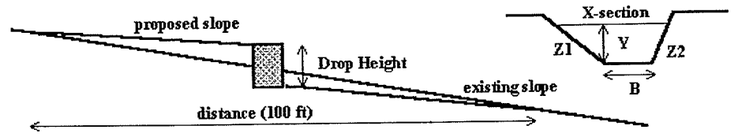


Existing Channel Condition (Input)		
Design Discharge	Q_D=	227.0 cfs
Design Discharge Return Period	$Year_D$=	100 years
Existing Ground Slope Along Channel Centerline	So =	0.0033 ft/ft
100-Year Discharge	**Q_{100}=**	**227.0** cfs
Left Side Slope	Z1 =	4.0 ft/ft
Right Side Slope	Z2 =	4.0 ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040
Check one of the following soil types		
	Sandy Soil	check, OR
	Non-Sandy Soil	X check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	12.8 ft	12.8 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.48 ft**	**2.85 ft**
100-Year Flow Velocity	**V_{100}=**	**4.0 fps**	**3.3 fps**
100-Year Top Width	T=	32.6 ft	35.6 ft
100-Year Flow Area	A=	56.3 sq ft	68.9 sq ft
100-Year Froude Number	**Fr =**	**0.29**	**0.17**
100-Year Wetted Perimeter	P=	33.2 ft	36.3 ft
100-Year Hydraulic Radius	R=	1.7 ft	1.9 ft
Design Discharge Flow Depth	Y_D=	**2.48 ft**	**2.85** ft
Design Discharge Flow Velocity	V_D=	**4.0 fps**	**3.3** fps
Design Discharge Top Width	T=	32.6 ft	35.6 ft
Design Discharge Flow Area	A=	56.3 sq ft	68.9 sq ft
Design Discharge Froude Number	**Fr =**	**0.29**	**0.17**
Design Discharge Wetted Perimeter	P=	33.2 ft	36.3 ft
Design Discharge Hydarulic Radius	R=	1.7 ft	1.9 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0033 ft/ft	0.0033 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Arabian
Channel ID: 186

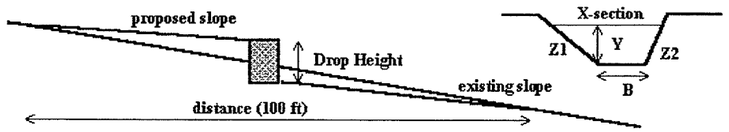


Existing Channel Condition (Input)		
Design Discharge	Q_D=	166.0 cfs
Design Discharge Return Period	$Year_D$=	100 years
Existing Ground Slope Along Channel Centerline	So =	0.0086 ft/ft
100-Year Discharge	**Q_{100}=**	**166.0** cfs
Left Side Slope	Z1 =	4.0 ft/ft
Right Side Slope	Z2 =	4.0 ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040
Check one of the following soil types		
	Sandy Soil	check, OR
	Non-Sandy Soil	X check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	5.6 ft	5.6 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.14 ft**	**2.43 ft**
100-Year Flow Velocity	**V_{100}=**	**5.5 fps**	**4.4 fps**
100-Year Top Width	T=	22.8 ft	25.1 ft
100-Year Flow Area	A=	30.4 sq ft	37.3 sq ft
100-Year Froude Number	**Fr =**	**0.69**	**0.41**
100-Year Wetted Perimeter	P=	23.3 ft	25.7 ft
100-Year Hydraulic Radius	R=	1.3 ft	1.5 ft
Design Discharge Flow Depth	Y_D=	**2.14 ft**	**2.43** ft
Design Discharge Flow Velocity	V_D=	**5.5 fps**	**4.4** fps
Design Discharge Top Width	T=	22.8 ft	25.1 ft
Design Discharge Flow Area	A=	30.4 sq ft	37.3 sq ft
Design Discharge Froude Number	**Fr =**	**0.69**	**0.41**
Design Discharge Wetted Perimeter	P=	23.3 ft	25.7 ft
Design Discharge Hydarulic Radius	R=	1.3 ft	1.5 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0086 ft/ft	0.0086 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Reign
Channel ID: 119

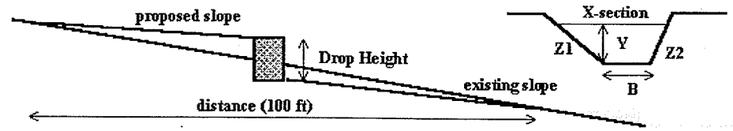


Existing Channel Condition (Input)			
Design Discharge	Q_D=	355.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0063	ft/ft
100-Year Discharge	**Q_{100}=**	**355.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	6.5 ft	6.5 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**3.14 ft**	**3.56 ft**
100-Year Flow Velocity	**V_{100}=**	**5.9 fps**	**4.8 fps**
100-Year Top Width	T=	31.6 ft	35.0 ft
100-Year Flow Area	A=	59.9 sq ft	73.9 sq ft
100-Year Froude Number	**Fr =**	**0.58**	**0.34**
100-Year Wetted Perimeter	P=	32.4 ft	35.9 ft
100-Year Hydarulic Radius	R=	1.8 ft	2.1 ft
Design Discharge Flow Depth	Y_D=	**3.14 ft**	**3.56** ft
Design Discharge Flow Velocity	V_D=	**5.9 fps**	**4.8** fps
Design Discharge Top Width	T=	31.6 ft	35.0 ft
Design Discharge Flow Area	A=	59.9 sq ft	73.9 sq ft
Design Discharge Froude Number	**Fr =**	**0.58**	**0.34**
Design Discharge Wetted Perimeter	P=	32.4 ft	35.9 ft
Design Discharge Hydarulic Radius	R=	1.8 ft	2.1 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0063 ft/ft	0.0064 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Reign
Channel ID: 144

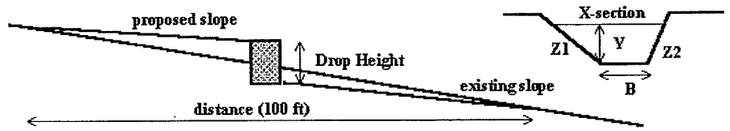


Existing Channel Condition (Input)			
Design Discharge	Q_D=	310.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0055	ft/ft
100-Year Discharge	**Q_{100}=**	**310.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	7.9 ft	7.9 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.93 ft**	**3.33 ft**
100-Year Flow Velocity	**V_{100}=**	**5.4 fps**	**4.4 fps**
100-Year Top Width	T=	31.3 ft	34.5 ft
100-Year Flow Area	A=	57.4 sq ft	70.6 sq ft
100-Year Froude Number	**Fr =**	**0.49**	**0.29**
100-Year Wetted Perimeter	P=	32.0 ft	35.3 ft
100-Year Hydarulic Radius	R=	1.8 ft	2.0 ft
Design Discharge Flow Depth	Y_D=	**2.93 ft**	**3.33** ft
Design Discharge Flow Velocity	V_D=	**5.4 fps**	**4.4** fps
Design Discharge Top Width	T=	31.3 ft	34.5 ft
Design Discharge Flow Area	A=	57.4 sq ft	70.6 sq ft
Design Discharge Froude Number	**Fr =**	**0.49**	**0.29**
Design Discharge Wetted Perimeter	P=	32.0 ft	35.3 ft
Design Discharge Hydarulic Radius	R=	1.8 ft	2.0 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0055 ft/ft	0.0055 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Reign
Channel ID: 157

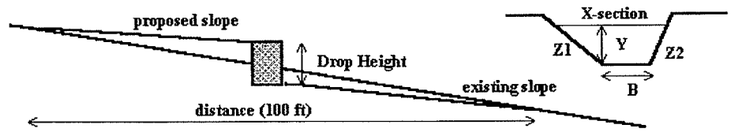


Existing Channel Condition (Input)			
Design Discharge	Q_D=	310.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0034	ft/ft
100-Year Discharge	**Q_{100}=**	**310.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	12.4 ft	12.4 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.90 ft**	**3.33 ft**
100-Year Flow Velocity	**V_{100}=**	**4.5 fps**	**3.6 fps**
100-Year Top Width	T=	35.6 ft	39.0 ft
100-Year Flow Area	A=	69.5 sq ft	85.5 sq ft
100-Year Froude Number	**Fr =**	**0.32**	**0.19**
100-Year Wetted Perimeter	P=	36.3 ft	39.8 ft
100-Year Hydarulic Radius	R=	1.9 ft	2.1 ft
Design Discharge Flow Depth	Y_D=	**2.90 ft**	**3.33** ft
Design Discharge Flow Velocity	V_D=	**4.5 fps**	**3.6** fps
Design Discharge Top Width	T=	35.6 ft	39.0 ft
Design Discharge Flow Area	A=	69.5 sq ft	85.5 sq ft
Design Discharge Froude Number	**Fr =**	**0.32**	**0.19**
Design Discharge Wetted Perimeter	P=	36.3 ft	39.8 ft
Design Discharge Hydarulic Radius	R=	1.9 ft	2.1 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0034 ft/ft	0.0034 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Tumbleweed
Channel ID: 142

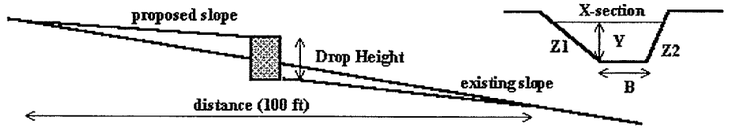


Existing Channel Condition (Input)			
Design Discharge	Q_D=	503.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0061	ft/ft
100-Year Discharge	**Q_{100}=**	**503.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	5.9 ft	5.9 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**3.76 ft**	**4.24 ft**
100-Year Flow Velocity	**V_{100}=**	**6.4 fps**	**5.2 fps**
100-Year Top Width	T=	36.0 ft	39.8 ft
100-Year Flow Area	A=	78.7 sq ft	96.9 sq ft
100-Year Froude Number	**Fr =**	**0.58**	**0.34**
100-Year Wetted Perimeter	P=	36.9 ft	40.9 ft
100-Year Hydarulic Radius	R=	2.1 ft	2.4 ft
Design Discharge Flow Depth	Y_D=	**3.76 ft**	**4.24** ft
Design Discharge Flow Velocity	V_D=	**6.4 fps**	**5.2** fps
Design Discharge Top Width	T=	36.0 ft	39.8 ft
Design Discharge Flow Area	A=	78.7 sq ft	96.9 sq ft
Design Discharge Froude Number	**Fr =**	**0.58**	**0.34**
Design Discharge Wetted Perimeter	P=	36.9 ft	40.9 ft
Design Discharge Hydarulic Radius	R=	2.1 ft	2.4 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0061 ft/ft	0.0061 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Locust
Channel ID: 141



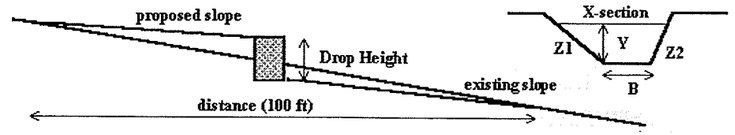
Existing Channel Condition (Input)		
Design Discharge	Q_D=	279.0 cfs
Design Discharge Return Period	$Year_D$=	100 years
Existing Ground Slope Along Channel Centerline	So =	0.0114 ft/ft
100-Year Discharge	**Q_{100}=**	**279.0** cfs
Left Side Slope	Z1 =	4.0 ft/ft
Right Side Slope	Z2 =	4.0 ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040
Check one of the following soil types		
Sandy Soil		check, OR
Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	3.0 ft	3.0 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.81 ft**	**3.16 ft**
100-Year Flow Velocity	**V_{100}=**	**7.0 fps**	**5.7 fps**
100-Year Top Width	T=	25.5 ft	28.3 ft
100-Year Flow Area	A=	39.9 sq ft	49.3 sq ft
Warning 05 100-Year Froude Number	**Fr =**	**0.97**	**0.57**
100-Year Wetted Perimeter	P=	26.1 ft	29.0 ft
100-Year Hydarulic Radius	R=	1.5 ft	1.7 ft
Design Discharge Flow Depth	Y_D=	**2.81 ft**	**3.16** ft
Design Discharge Flow Velocity	V_D=	**7.0 fps**	**5.7** fps
Design Discharge Top Width	T=	25.5 ft	28.3 ft
Design Discharge Flow Area	A=	39.9 sq ft	49.3 sq ft
Warning 05 Design Discharge Froude Number	**Fr =**	**0.97**	**0.57**
Design Discharge Wetted Perimeter	P=	26.1 ft	29.0 ft
Design Discharge Hydarulic Radius	R=	1.5 ft	1.7 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0113 ft/ft	0.0114 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Warning 05: Froude No. exceeds USDCM Criteria Manual Volume II recommendation.

Design of Trapezoidal Grass-Lined Channel

Project: Locust
Channel ID: 143

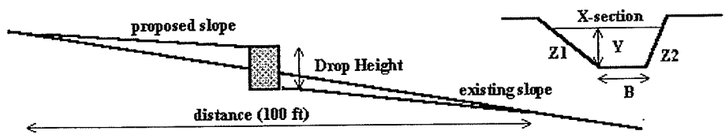


Existing Channel Condition (Input)		
Design Discharge	Q_D=	389.0 cfs
Design Discharge Return Period	$Year_D$=	100 years
Existing Ground Slope Along Channel Centerline	So =	0.0075 ft/ft
100-Year Discharge	**Q_{100}=**	**389.0** cfs
Left Side Slope	Z1 =	4.0 ft/ft
Right Side Slope	Z2 =	4.0 ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040
Check one of the following soil types		
Sandy Soil		check, OR
Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	4.9 ft	4.9 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**3.31 ft**	**3.73 ft**
100-Year Flow Velocity	**V_{100}=**	**6.5 fps**	**5.3 fps**
100-Year Top Width	T=	31.4 ft	34.7 ft
100-Year Flow Area	A=	60.0 sq ft	73.8 sq ft
100-Year Froude Number	**Fr =**	**0.68**	**0.41**
100-Year Wetted Perimeter	P=	32.2 ft	35.6 ft
100-Year Hydarulic Radius	R=	1.9 ft	2.1 ft
Design Discharge Flow Depth	Y_D=	**3.31 ft**	**3.73** ft
Design Discharge Flow Velocity	V_D=	**6.5 fps**	**5.3** fps
Design Discharge Top Width	T=	31.4 ft	34.7 ft
Design Discharge Flow Area	A=	60.0 sq ft	73.8 sq ft
Design Discharge Froude Number	**Fr =**	**0.68**	**0.41**
Design Discharge Wetted Perimeter	P=	32.2 ft	35.6 ft
Design Discharge Hydarulic Radius	R=	1.9 ft	2.1 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0075 ft/ft	0.0076 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Locust
Channel ID: 160

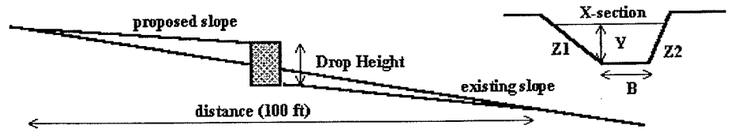


Existing Channel Condition (Input)		
Design Discharge	Q_D=	1250.0 cfs
Design Discharge Return Period	$Year_D$=	100 years
Existing Ground Slope Along Channel Centerline	So =	0.0038 ft/ft
100-Year Discharge	**Q_{100}=**	**1,250.0** cfs
Left Side Slope	Z1 =	4.0 ft/ft
Right Side Slope	Z2 =	4.0 ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040
Check one of the following soil types		
	Sandy Soil	check, OR
	Non-Sandy Soil	X check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	27.5 ft	27.5 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**4.32 ft**	**5.00 ft**
100-Year Flow Velocity	**V_{100}=**	**6.5 fps**	**5.3 fps**
100-Year Top Width	T=	62.1 ft	67.5 ft
100-Year Flow Area	A=	193.5 sq ft	237.6 sq ft
100-Year Froude Number	**Fr =**	**0.42**	**0.24**
100-Year Wetted Perimeter	P=	63.1 ft	68.7 ft
100-Year Hydarulic Radius	R=	3.1 ft	3.5 ft
Design Discharge Flow Depth	Y_D=	**4.32 ft**	**5.00** ft
Design Discharge Flow Velocity	V_D=	**6.5 fps**	**5.3** fps
Design Discharge Top Width	T=	62.1 ft	67.5 ft
Design Discharge Flow Area	A=	193.5 sq ft	237.6 sq ft
Design Discharge Froude Number	**Fr =**	**0.42**	**0.24**
Design Discharge Wetted Perimeter	P=	63.1 ft	68.7 ft
Design Discharge Hydarulic Radius	R=	3.1 ft	3.5 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0038 ft/ft	0.0038 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Locust
Channel ID: 164

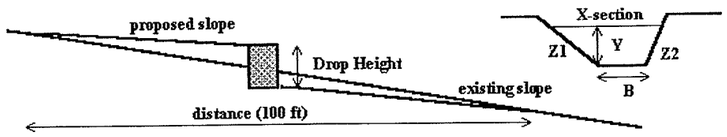


Existing Channel Condition (Input)		
Design Discharge	Q_D=	1359.0 cfs
Design Discharge Return Period	$Year_D$=	100 years
Existing Ground Slope Along Channel Centerline	So =	0.0040 ft/ft
100-Year Discharge	**Q_{100}=**	**1,359.0** cfs
Left Side Slope	Z1 =	4.0 ft/ft
Right Side Slope	Z2 =	4.0 ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040
Check one of the following soil types		
	Sandy Soil	check, OR
	Non-Sandy Soil	X check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	29.9 ft	29.9 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**4.31 ft**	**5.00 ft**
100-Year Flow Velocity	**V_{100}=**	**6.7 fps**	**5.4 fps**
100-Year Top Width	T=	64.4 ft	69.9 ft
100-Year Flow Area	A=	203.3 sq ft	249.6 sq ft
100-Year Froude Number	**Fr =**	**0.44**	**0.26**
100-Year Wetted Perimeter	P=	65.5 ft	71.2 ft
100-Year Hydarulic Radius	R=	3.1 ft	3.5 ft
Design Discharge Flow Depth	Y_D=	**4.31 ft**	**5.00** ft
Design Discharge Flow Velocity	V_D=	**6.7 fps**	**5.4** fps
Design Discharge Top Width	T=	64.4 ft	69.9 ft
Design Discharge Flow Area	A=	203.3 sq ft	249.6 sq ft
Design Discharge Froude Number	**Fr =**	**0.44**	**0.26**
Design Discharge Wetted Perimeter	P=	65.5 ft	71.2 ft
Design Discharge Hydarulic Radius	R=	3.1 ft	3.5 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0040 ft/ft	0.0040 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Fox Run
Channel ID: 162

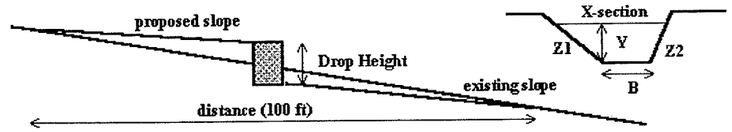


Existing Channel Condition (Input)			
Design Discharge	Q_D=	288.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0041	ft/ft
100-Year Discharge	**Q_{100}=**	**288.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	10.6 ft	10.6 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**2.81 ft**	**3.21 ft**
100-Year Flow Velocity	**V_{100}=**	**4.7 fps**	**3.8 fps**
100-Year Top Width	T=	33.1 ft	36.3 ft
100-Year Flow Area	A=	61.3 sq ft	75.1 sq ft
100-Year Froude Number	**Fr =**	**0.37**	**0.22**
100-Year Wetted Perimeter	P=	33.7 ft	37.0 ft
100-Year Hydarulic Radius	R=	1.8 ft	2.0 ft
Design Discharge Flow Depth	Y_D=	**2.81 ft**	**3.21** ft
Design Discharge Flow Velocity	V_D=	**4.7 fps**	**3.8** fps
Design Discharge Top Width	T=	33.1 ft-	36.3 ft
Design Discharge Flow Area	A=	61.3 sq ft	75.1 sq ft
Design Discharge Froude Number	**Fr =**	**0.37**	**0.22**
Design Discharge Wetted Perimeter	P=	33.7 ft	37.0 ft
Design Discharge Hydarulic Radius	R=	1.8 ft	2.0 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0041 ft/ft	0.0041 ft/ft
Drop Height per 100 ft	D =	0.0 ft/100 ft	0.0 ft/100 ft

Design of Trapezoidal Grass-Lined Channel

Project: Fox Run
Channel ID: 187



Existing Channel Condition (Input)			
Design Discharge	Q_D=	859.0	cfs
Design Discharge Return Period	$Year_D$=	100	years
Existing Ground Slope Along Channel Centerline	So =	0.0076	ft/ft
100-Year Discharge	**Q_{100}=**	**859.0**	cfs
Left Side Slope	Z1 =	4.0	ft/ft
Right Side Slope	Z2 =	4.0	ft/ft
Channel Manning's N (New Condition .030 typ.)	N_{new}=	0.030	
Channel Manning's N (Mature Condition .040 typ.)	N_{mature}=	0.040	
Check one of the following soil types			
	Sandy Soil		check, OR
	Non-Sandy Soil	X	check

Proposed Channel Condition (Calculated)		New Channel	Mature Channel
Bottom Width	B=	10.6 ft	10.6 ft
100-Year Flow Depth (5' maximum)	**Y_{100}=**	**4.40 ft**	**5.00 ft**
100-Year Flow Velocity	**V_{100}=**	**6.9 fps**	**5.6 fps**
100-Year Top Width	T=	45.8 ft	50.6 ft
100-Year Flow Area	A=	124.3 sq ft	153.2 sq ft
100-Year Froude Number	**Fr =**	**0.55**	**0.32**
100-Year Wetted Perimeter	P=	46.9 ft	51.9 ft
100-Year Hydarulic Radius	R=	2.6 ft	3.0 ft
Design Discharge Flow Depth	Y_D=	**4.40 ft**	**5.00** ft
Design Discharge Flow Velocity	V_D=	**6.9 fps**	**5.6** fps
Design Discharge Top Width	T=	45.8 ft	50.6 ft
Design Discharge Flow Area	A=	124.3 sq ft	153.2 sq ft
Design Discharge Froude Number	**Fr =**	**0.55**	**0.32**
Design Discharge Wetted Perimeter	P=	46.9 ft	51.9 ft
Design Discharge Hydarulic Radius	R=	2.6 ft	3.0 ft
Drop Height			
Proposed New Channel Slope	Sd=	0.0053 ft/ft	0.0053 ft/ft
Drop Height per 100 ft	D =	0.2 ft/100 ft	0.2 ft/100 ft

L = 920' => 1.8' drop height

∴ place one midway.

APPENDIX D

SECOND CREEK DETENTION FACILITY 219 SUMMARY

Detention Facility 219 is a key component in the 1990 "*Second Creek Outfall Systems Plan*". Detention Facility 219 collects nearly all of the runoff upstream of DIA (8 square miles) and reduces peak flows from 2700 cfs to 500 cfs by storing 513 ac-ft of runoff, see Figure 1 for facility location.

Since the 1990 report was published, DIA entered an IGA that limits the use on the land within Denver city limits. The IGA requires that the detention facility be located entirely outside of the Denver city limits. This requires moving the embankment approximately 1200 feet to the south. The Sponsors were concerned that changing the facility location could greatly reduce its hydrologic performance from its original designs.

Kiowa Engineering was asked to review the new location and determine if it would be hydrologically equivalent to the original 1990 preliminary design. The new location is less ideal than the original location for three reasons: (1) moving the facility to the south reduces the amount of contributing drainage area that the detention facility can capture, (2) the runway embankment can no longer be utilized as the dam embankment resulting in additional costs in excavation and embankment, and (3) the new location is upstream of two large contributing tributaries which requires a sizeable diversion channel to collect these flows and carry them to the detention area.

The first task in the analysis was to review the contributing upstream drainage area. It was assumed that the two tributaries located west of the embankment would be diverted into the detention area, as shown in Figure 2. Moving the embankment 1200 feet to the south reduces the upstream capture area by 160 acres. The total capture area to the original detention facility was 5100 acres. Losing 160 acres reduces the new facility capture area to 97% of the original upstream drainage area. The 160-acre area will be preserved as open space. In light of this, the new facility's performance should be hydrologically equivalent.

Losing the runway embankment requires a significant amount of fill to build a new 20' embankment. Preliminary analysis indicates that approximately 210,000 cubic yards will be required to build an embankment 20 feet high and 2850 feet long. It was assumed that a roadway or trail alignment would be desired along the top of the embankment. The preliminary design utilizes a 60-foot top width with 4:1 side slopes. Two ridge lines lie within the limits of the 100-year pool. Excavating these areas produces the material required to build the dam embankment. Excavation within the 100-pool limits was determined by blending the contours to meet naturally with the existing topography. Outside of the 100-year pool excavation was determined at 10:1 to tie back to existing. Refer to Figure 3 for proposed grading.

Moving the embankment upstream requires a 3130-foot diversion channel to collect drainage from two significant tributaries west of the pond. The channel design has a constant slope of 0.5% and crosses two ridge lines requiring 18 feet and 11 feet of excavation respectively. To collect the tributary runoff also requires two small embankments to prevent runoff from bypassing the detention area. These embankments are 12 feet and 4 feet respectively.

The design of Detention Facility 219 was carried to the preliminary design level for volumetric consideration and hydrologic equivalence to the 1990 master plan. The following table shows the Elevation-Volume rating with proposed excavation to balance the required cut/fill volumes.

Table 1
Detention Volumetric Rating

Elevation (feet)	Volume (acre-feet)
5320	0
5322	0.38
5324	4.45
5326	18.59
5328	46.57
5330	89.10
5332	151.87
5334	236.73
5336	339.63
5338	460.95
5340	602.93

Detention Statistics

100-year detention volume: 513 acre-feet
100-year pool elevation: 5338.7 feet.
100-year pool surface area: 70 acres

Embankment elevation:	5340 feet
Embankment height:	20 feet
Embankment length:	2850 feet
Embankment slopes:	4:1
Embankment top width:	60 feet

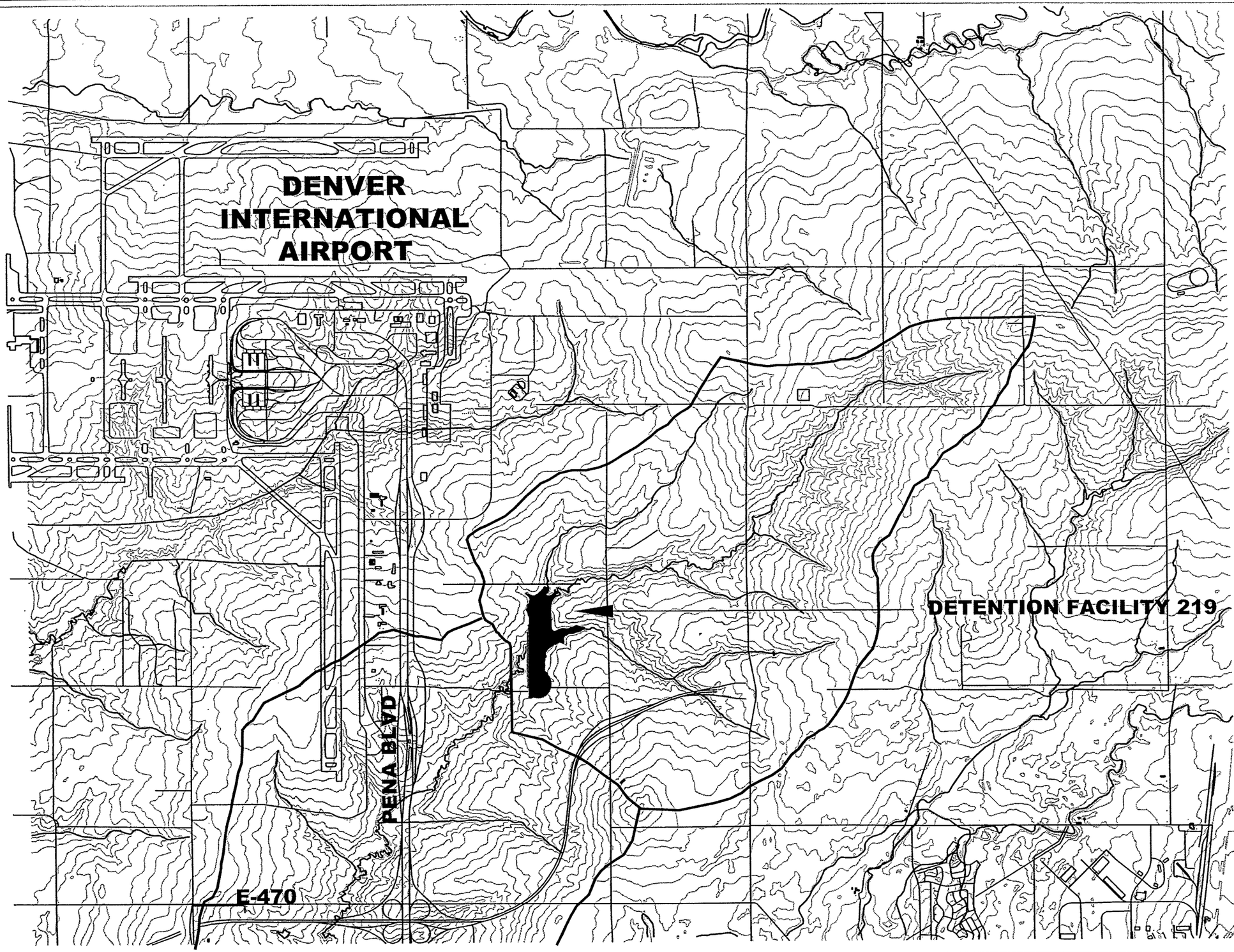
Fill Volume:	210,000 cubic yards
Cut Volume:	225,000 cubic yards

Table 2
Cost Estimate

Item	Quantity	Unit	Unit Cost	Cost
Clearing and Grubbing	38	ACRE	$1,000.00	$38,000
Topsoil, Strip, Stockpile and Spread	20,000	CU.YD.	$5.00	$100,000
Excavation	210,000	CU.YD.	$3.00	$630,000
Embankment	210,000	CU.YD	$3.00	$630,000
Silt Fence	4,000	L.F.	$6.00	$24,000
Seeding, Fertilizer, and Mulch	38	ACRE	$3,000.00	$114,000
72" RCP	200	L.F.	$400.00	$80,000
Headwalls, Wingwalls and Flow Control	1	EACH	$86,000.00	$86,000
Diversion Channel Excavation	90,000	CU.YD.	$3.00	$270,000
Channel Seeding	10	ACRE	$3,000.00	$30,000
Low Flow Channel	3,130	L.F.	$25.00	$78,250
			Subtotal	$2,080,250
typically add 35% for contingencies, administration, utilities, and engineering: +35% =				$728,088
			Total	$2,808,338

After submitting this analysis to the project sponsors, it was suggested that a second cell be added to the detention facility along the western most tributary. This cell would be disconnected from the main Detention Facility 219 and act as a separate detention facility. Adding the second detention area greatly reduces the length of the required diversion channel and produces a more natural plan.

Again, the entire alternate detention area must remain south of the Denver limits and the combined release rates from both facilities must meet the 1990 OSP design goal of 500 cfs. No hydrologic calculations were undertaken to produce the alternate shown in Figures 4 and 5. This is a conceptual alternate to the original plan to meet the same function in a more practical design based on the new facility location. This alternate should be considered in the final design of Detention Facility 219.



	Kiowa Engineering Corporation 7175 West Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303)-692-0369	CITY OF BRIGHTON, COMMERCE CITY, ADAMS COUNTY URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY SECOND CREEK DOWNSTREAM OF DIA AND DFA 0053 WATERSHEDS	DETENTION FACILITY 219 VICINITY MAP	FIGURE 1

12' Embankment

5352

4' Embankment

4:1

60'

5340

4:1

18' Excavation

3130' at 0.5%
12' bottom width
4:1 side slopes

5336

11' Excavation

90,000 C.Y.
Excavation

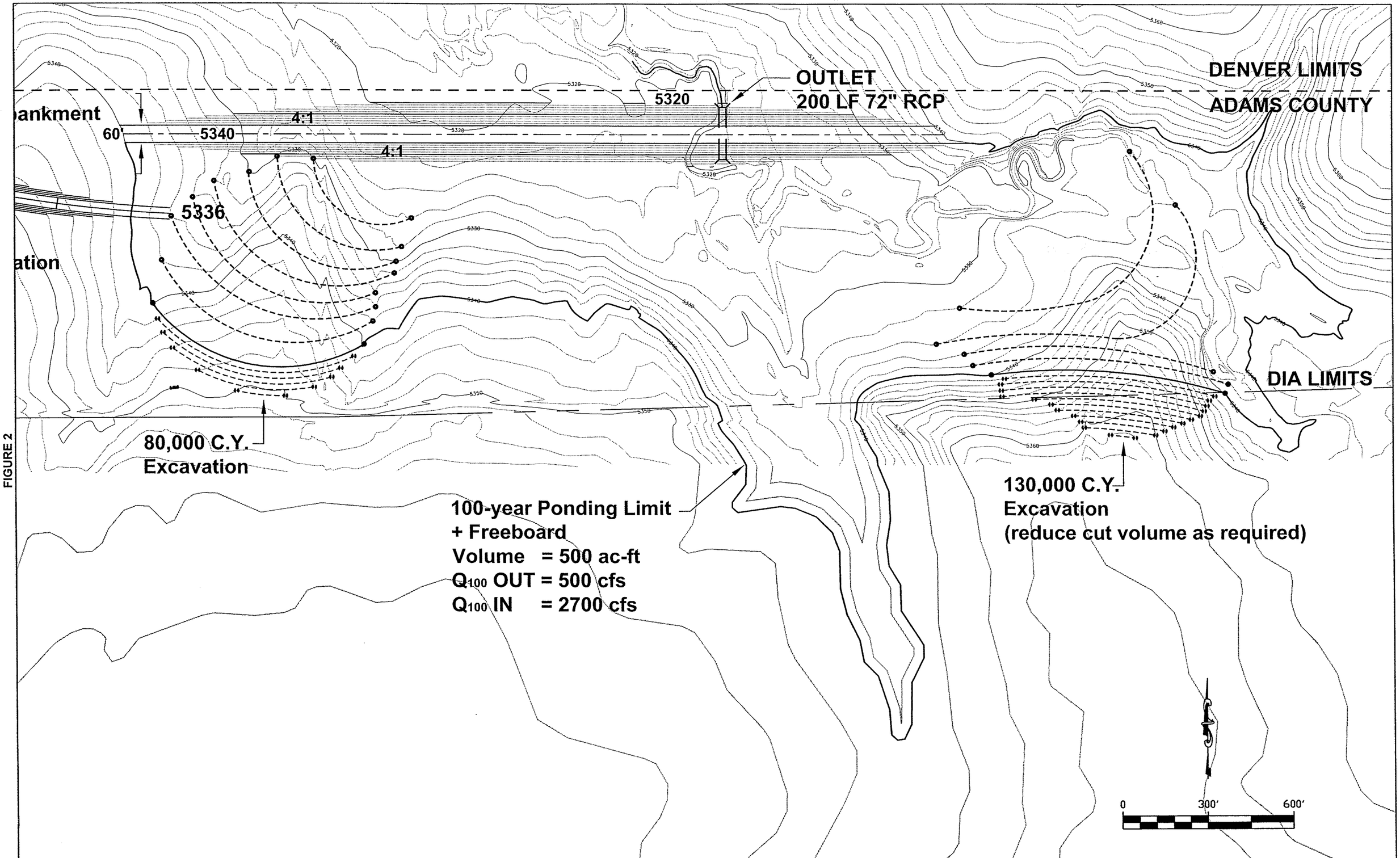
E-470

0 300' 600'

FIGURE 3

	Kiowa Engineering Corporation 7175 West Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303)-692-0369	CITY OF BRIGHTON, COMMERCE CITY, ADAMS COUNTY URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY SECOND CREEK DOWNSTREAM OF DIA AND DFA 0053 WATERSHEDS	DETENTION FACILITY 219 DIVERSION CHANNEL	FIGURE 2

FIGURE 2



	Kiowa Engineering Corporation 7175 West Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303)-692-0369	CITY OF BRIGHTON, COMMERCE CITY, ADAMS COUNTY URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY SECOND CREEK DOWNSTREAM OF DIA AND DFA 0053 WATERSHEDS	DETENTION FACILITY 219 DETENTION LIMITS	FIGURE 3

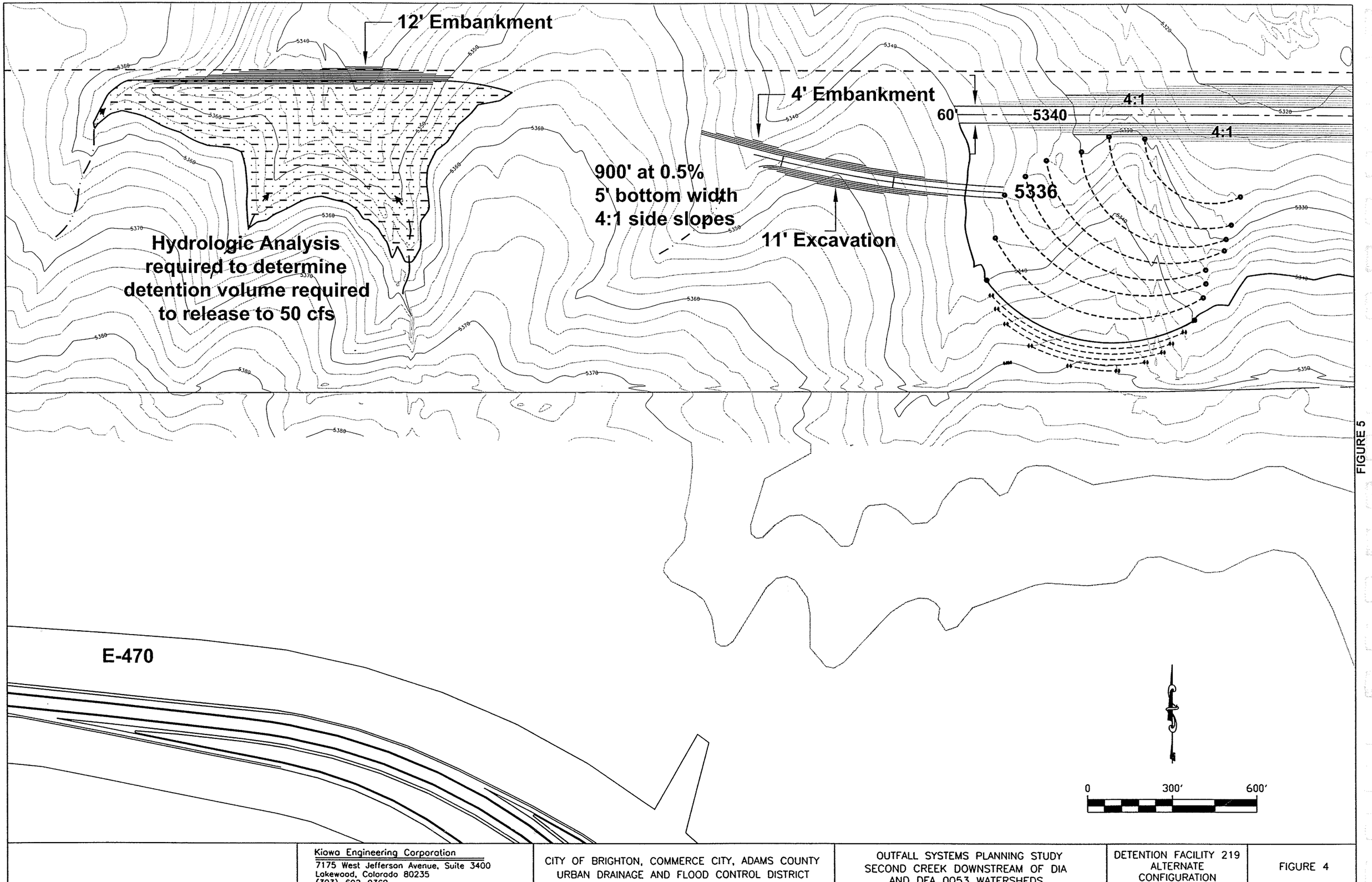


FIGURE 5

	Kiowa Engineering Corporation 7175 West Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303)-692-0369	CITY OF BRIGHTON, COMMERCE CITY, ADAMS COUNTY URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY SECOND CREEK DOWNSTREAM OF DIA AND DFA 0053 WATERSHEDS	DETENTION FACILITY 219 ALTERNATE CONFIGURATION	FIGURE 4

FIGURE 4

ankment

60'

5340

4:1

4:1

5320

OUTLET
200 LF 66" RCP

DENVER LIMITS

ADAMS COUNTY

5336

ation

80,000 C.Y.
Excavation

100-year Ponding Limit
+ Freeboard
Volume = 500 ac-ft
Q_{100} OUT = 450 cfs
Q_{100} IN = 2700 cfs

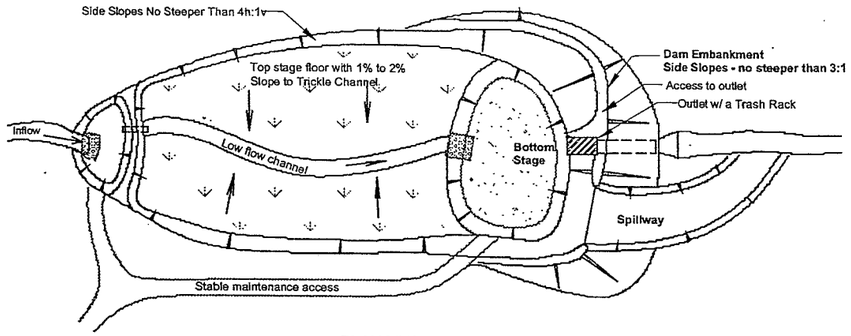
DIA LIMITS

130,000 C.Y.
Excavation
(reduce cut volume as required)

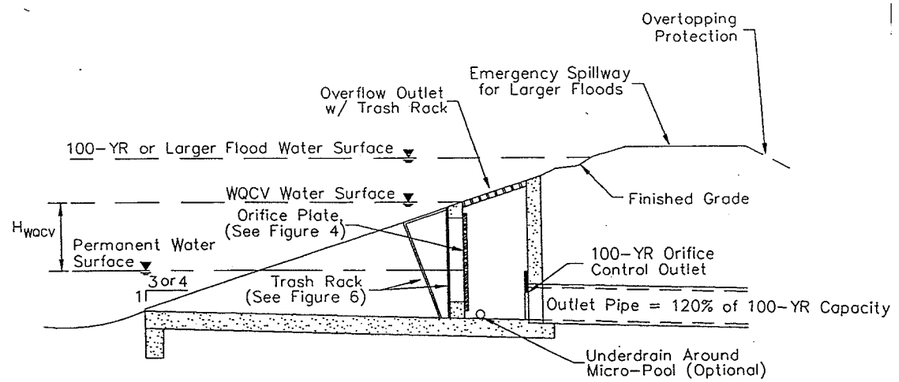
0 300' 600'

	Kiowa Engineering Corporation 7175 West Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303)-692-0369	CITY OF BRIGHTON, COMMERCE CITY, ADAMS COUNTY URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY SECOND CREEK DOWNSTREAM OF DIA AND DFA 0053 WATERSHEDS	DETENTION FACILITY 219 ALTERNATE CONFIGURATION	FIGURE 5

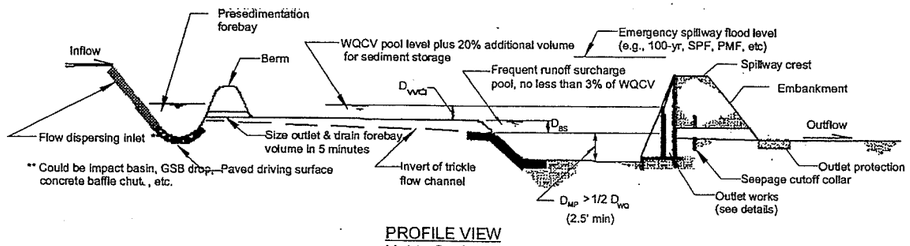
WATER QUALITY BASIN



PLAN VIEW
Not to Scale



Drop Box Outlet Option



PROFILE VIEW
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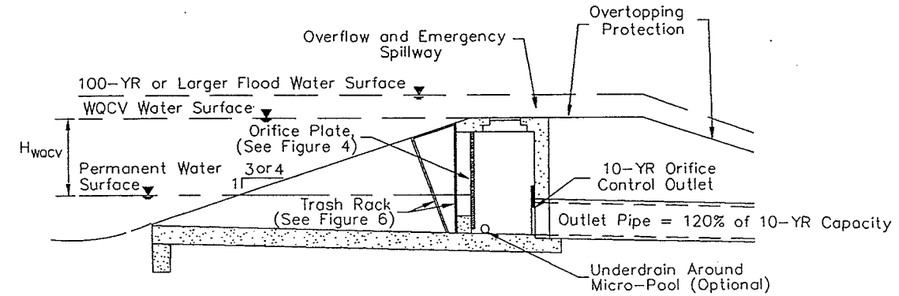
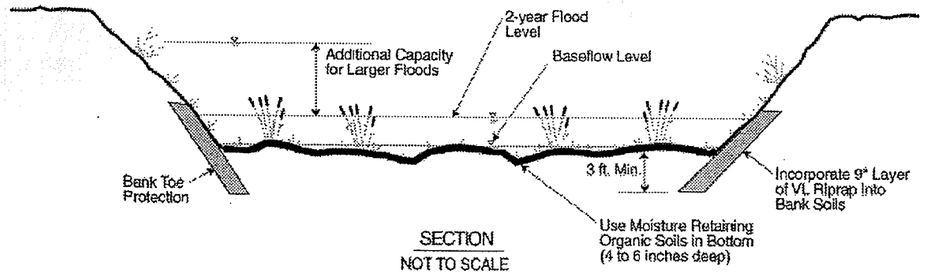
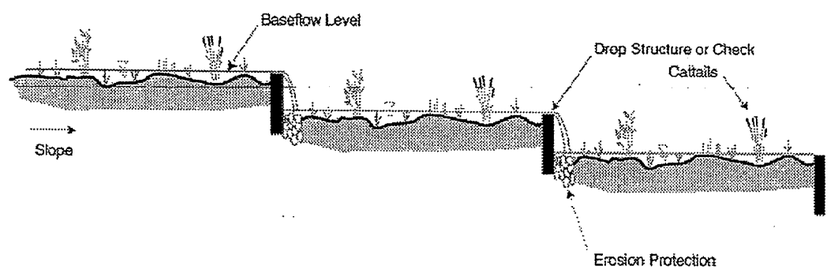


Overtopping Spillway Option

WETLAND CHANNEL



SECTION
NOT TO SCALE



SECTION
NOT TO SCALE

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KIOWA PROJECT NO. 01095

CITY OF BRIGHTON
CITY OF COMMERCE CITY
ADAMS COUNTY
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

SECOND CREEK D/S OF DIA AND DFA 0053
OUTFALL SYSTEMS PLANNING STUDY UPDATE

TYPICAL DETAILS

TypicalDetails.dwg/Aug 13, 2004

APPENDIX E

WETLAND RESOURCES REPORT

WETLAND RESOURCES

for

SECOND CREEK BELOW DENVER INTERNATIONAL AIRPORT and DFA 0053 OUTFALL SYSTEMS PLANNING STUDY UPDATE

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

July, 2002

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I. Introduction

II. Site Description

III. Hydrology

IV. Soils

V. Vegetation

VI. Wetland Locations

1. Second Creek below the O'Brian Canal
2. Second Creek above the O'Brian Canal
   3. Direct Flow Area 00053
   4. Irrigation Canals
5. Open Water

VII. Conclusion

References

INTRODUCTION

The Second Creek below the Denver International Airport and Direct Flow Area 0053 Outfall Systems Planning Study Update area is located in Adams County, Colorado and contains portions of the City of Brighton and Commerce City. This study area is situated between the South Platte River on the west, First Creek on the south, and Third Creek on the north and east. The study area discharges into the South Platte River, and encompasses approximately 20 square miles. The upper portion of Second Creek on and above the Denver International Airport is not included in this study.

This report is a wetland inventory for this basin, and presents a description of the wetland resources associated with the major drainageways. Emphasis was placed on riparian zones and wetlands to determine habitats that may be sensitive to impacts of potential development and to assess their ecological value.

Prior to field reconnaissance survey, soil survey and wetland inventory maps were utilized to indicate potential wetlands. Field assessment was conducted on May 15 and June 24, 2002 during which time I drove and walked the watershed to assess the vegetative, hydrologic, and soil conditions, commensurate with a large area routine level procedure. While in the field, I examined plants, soils, and hydrology in relation to current and historic land uses. Wetlands mapped in this report are potential jurisdictional wetlands, and information presented is suitable for planning purposes. Detailed wetland delineation will need to be done in areas of potential jurisdictional waters prior to construction.

Topographic base mapping was produced by Landmark Mapping Ltd., at 1"=100' with a contour interval of 2'. As access was largely prohibited, aerial photographs of the project area, provided by Colorado Aerial Photo Service were used to characterize the ecosystems. Three types of habitats based on dominant plant species were encountered: emergent wetlands, scrub/shrub complexes, and riparian ecosystems.

SITE DESCRIPTION

The study site drains westerly into the South Platte River. Second Creek is about twenty miles in length, and the Direct Flow basins vary between two to four miles in length. The topography starts with rock outcrops in the upper edges of the basin and grades into the rolling hills of the uplands composed of windblown sediments. Major drainageways dissect these rolling hills and meet up with the broad, flat South Platte River floodplain where ancient alluvial deposits measure a couple of miles wide.

These watersheds have been modified by human activity, with little remaining in a native state. The study area overlays oil and gas fields which are still in production today. Historically, the uplands have been used for ranchland and dryland crops, particularly wheat. In the past, the lower lying areas adjacent to the South Platte River were utilized for irrigated agricultural practices and sod production, but are now are being quarried and converted to open water storage. Much of the study area is being changed to residential, commercial and industrial uses. A large landfill is sited at 88th Avenue and Tower Road.

Many major transportation routes bisect the study area. Principal automotive routes are Interstate 70/US 6, CO 2, US 85, and CO 470. Also impacting the basins are the Burlington, Northern and Santa Fe Railroad and the Union Pacific Railroad. All of these linear features segment the basins by altering, impounding or capturing historic flows.

HYDROLOGY

Prior to human impact, stormwater was conveyed to the South Platte River via a natural channel in Second Creek and its tributaries, and along grasslined swales in the direct flow basins. The hydrology has been altered and augmented by three irrigation ditches the Fulton Ditch, the O'Brien Canal, and the Burlington Canal that flow through the study area. These ditches fed storage ponds or were diverted to fields via irrigation laterals. Pond embankments also appear to have been constructed along drainages to impound stormwater. Most ponds of this type do not appear to function well, as they are so dry that wetland conditions have not developed.

Currently, the stream flows are intercepted by the irrigation ditches, roads and railroads, and thus sever the hydrologic connection to the South Platte River. The intention of this outfall planning study is to restore the connection directly between the drainageways and the river, and to separate stormwater and irrigation water. Developed flows from proposed development will be detained to historic rates.

At the time of field assessment, the antecedent moisture condition was exceedingly low. Precipitation data for the nine previous months was 4.5-inches below average for the time period of August 1, 2001 to May 1, 2002, or about 40% of the average precipitation. The effects of this very low moisture condition were evident in the field reconnaissance.

SOILS

The soils in the Second Creek Basin and DFA 0053 are extremely varied and represent of most of the types present in Adams County. For the purposes of indicating the presence of hydric soils, over thirty different mapped units were categorized into three groups: units very likely to include hydric soils, units having localized hydric inclusions, and units with no mapped hydric soils or inclusions. These categories were applied in the field as wetland indicators.

The first group, units very likely to include hydric soils are generally loamy, alluvial soils that have developed in the floodplains of the South Platte River and intermittently along Second Creek. Hydric inclusions in these units are classified as fluvaquentic haplustolls and halaquepts and meet saturation, flooding, and ponding criteria. Where these alluvial sediments have been quarried, large bodies of open water now are present, providing a supply for water augmentation needs.

The second group, units having localized hydric inclusions, are found interspersed throughout the study area intermingled with the next group. This group is more well-drained than the latter, but hydric inclusions are frequently found in swales, where aquic conditions are a function of topographic position. This group also develops fluvaquentic haplustols, which in these areas, typically meet ponding criteria.

The last group, which is units with no mapped hydric soils or inclusion, is mixed throughout the basins with the previous group. Due to the lack of hydric soil criteria, wetlands were not anticipated to exist in these areas.

A phenomenon to note in the last two soil groups is the existence of wind created blowouts that function intermittently as enclosed basins lacking an outflow. These intermittent basins are dry enough to be farmed. As these soils are well drained, collected water does not usually have the opportunity to develop hydric soil conditions.

VEGETATION

Three different vegetation communities essential to wildlife habitat were located in the study area: emergent, shrub/scrub and riparian.

Emergent wetlands are found in pockets in the study area. Cattails (*Typha latifolia* and *T. angustifolia* OBL) are the dominant persistent emergent wetland plant found. Minor amounts of scouring rush (*Hippichaete laevigata* FACW), three-square (*Schoenoplectus pungeons* OBL), rush (*Juncus balticus* OBL), curley dock (*Rumex crispus* FACW), reed canary grass (*Phalaroides arundinacea* FACW), and spikerush (*Eleocharis palustrus* OBL) are also be present. Intolerant to prolonged desiccation, this plant community tolerates both standing and flowing water, but requires standing water or saturated ground. These plants are found in low gradient stream bottoms and around the edges of ponds. Benefits provided by this wetland type include nutrient and sediment removal, and flood attenuation. This habitat supports insect and other invertebrate populations, which in turn sustain other species, particularly waterfowl.

The shrub/scrub community is dominated by woody vegetation less than six meters in height, and consists mainly of willows (*Salix exigua* OBL). Minor amount so chokecherry (*Padus virginiana* FACU) and golden current (*Ribes aureum* FACW) can also be found. This plant community is found along edges of emergent systems, in pond margins, and in isolated areas with restricted outflow. Along with protecting stream banks from erosion, this plant community provides shelter and a food source for small mammals, songbirds, reptiles and amphibians.

Riparian ecosystems are present along the South Platte River floodplain, the margins of ponds and emergent wetlands, and the irrigation canals. Plains cottonwood (*Populus deltoids* FACW, narrow-leaved cottonwood (*Populus angustifolia* FACW), Russian olive (*Elaeagnus angustifolia* FAC), Siberian elm (*Ulmus pumila* FAC), crack willow (*Salix fragilis* FAC) and peach-leaved willow (*Salix amygdaloides* FACW) are typical species represented in the riparian ecosystem. While most riparian areas do not have all the wetland indicators, they are important habitats for many species as they provide shelter and secondary food sources.

WETLAND LOCATIONS

Second Creek above the O'Brian Canal

From the O'Brien Canal upstream to Tower Road, Second Creek flows in a meandering channel that is variously well vegetated to exposed. Most of the channel alignment is natural, with the exception being in the vicinity of the racetrack. From aerial photographs, it is apparent that the channel bed has migrated laterally in the unconsolidated, non-cohesive sediments. Lateral migration can also be anticipated during future flood events.

Due to the well-drained soils, wetlands are not well developed for this segment of Second Creek. The ordinary high water mark is intermittent along this portion of Second Creek. Intermingled with stretches of exposed channel, are stretches of vegetated channel, which are both wetland and dryland. Wetlands on this stretch of Second Creek are typically small, interspersed pockets of cattail marsh and areas of shrub/scrub wetlands, comprised mostly of coyote willow. Various tree species, such as cottonwoods, elm, and Russian olive, are scattered along the drainageway. In general, wetland development along Second Creek and its tributaries has been impeded by well-drained soils.

The portion of Second Creek between 96th Avenure and 88th Avenue near the racetrack is proposed for restoration. Future plans call for abandoning Buckley Road and 88th Avenue, and adding this area to the Rocky Mountain Arsenal Wildlife Refuge. Additionally, a regional stormwater detention facility is sited in this vicinity. Realization of this plan will enlarge and enhance wildlife habitat at the Refuge.

Second Creek below the O'Brian Canal

Below the O'Brian Canal, Second Creek channel is at times indistinct, as upstream flows have historically been diverted into the irrigation canals. Included in this plan are structures to separate stormwater from irrigation water, which will reestablish natural flowpaths.

The segment of Second Creek below the O'Brian Canal has more well developed wetlands than the upper segment due to more hydric soils, shallower grades and increased hydrology. It can be anticipated that residential development will further amplify wetland hydrology in these areas. Pockets of emergent wetlands are interspersed with patches of willows. Portions also show

evidence of an ordinary high water mark. The Second Creek outfall to the South Platte River is unclear, and appears to be diverted to a storage pond.

Second Creek is a U.S.G.S. "blue line" stream, and as such is a jurisdictional water of the U.S., as are the intermittent emergent wetlands and shrub/scrub complexes.

Direct Flow Basin 0053

Direct flow basin 00053 discharges into the east bank of the South Platte River along a distance of approximately three miles. No "blue line" drainageways appear on the U.S.G.S. Quad Maps in the direct flow basin. Prior to the construction of irrigation canals and transportation corridors, drainage was typically overland flow. For the most part, an ordinary high water mark is rarely present.

The upper portions of the direct flow basin do not have wetland vegetation or soils associated with them. Along the South Platte River floodplain, pockets of possible hydric soils are depicted on the soils maps. As with all the areas within the paleo-floodplain, gravel quarries have made significant impacts, and open water has replaced these soils. Where not quarried, patches of riparian species exist, particularly along the South Platte River.

Irrigation Canals

Three previously mentioned irrigation canals wrap around the study area. Two of these canals partially discharge to Barr Lake. These ditches have a bare, native soil invert and steep sides. They may be intermittently lined with a narrow band of emergent wetland plants, such as reed canary grass, giant reed grass, and cattails, and are also lined with riparian plants, such as cottonwoods, coyote willows, and elm trees. Some areas below the ditches have developed emergent wetlands fed by seepage from the canals.

Irrigation ditches that empty into jurisdictional waters are also considered jurisdictional waters of the U.S. Ponds and wetlands fed by such canals are also jurisdictional. Drainage separation structures anticipated in the vicinity of the canals will need a Department of the Army permit.

Open Water

Large bodies of open water are located along the South Platte River in areas formerly mined for gravel. Most likely fed by diverted river water, some of these ponds are currently being used for water storage for augmentation purposes. As the water is released back to the South Platte River when needed, these ponds should be considered jurisdictional waters of the U.S.

Vegetation surrounding these ponds varies from well-developed wetland and riparian fringes on older ponds to barren edges around newly established ponds. Even though these are manmade ponds, they offer substantial habitat and are well used by wildlife. For instance, an American white pelican was observed in May using a pond on its yearly migration route to its nesting territory in North Dakota.

The other form of open water present in the study area is within the South Platte River channel. Construction activities, such as outfall structures, within the ordinary high water mark of the river will require a permit.

CONCLUSION

As shown on the accompanying "Wetland Inventory Maps", areas marked as wetlands, waters of the U.S., and irrigation ditches will need U.S.A.C.E. permits at the time of construction. Riparian ecosystems impacted in conjunction with permitted activities may also need replacement. These areas will need detailed delineation at the time of construction. The extent of permitting is subject to change and will be need to be determined at the time of construction.

As per the "Preble's Meadow Jumping Mouse Block Clearance for the Denver Metropolitan Area", all of the area in the Second Creek Basin and DFA 0053 below Interstate 76 is cleared for the presence of the mouse. The presence of the mouse is unlikely upstream of Interstate 76, but may need to be determined at the time of construction.

LEGEND

EMERGENT WETLANDS

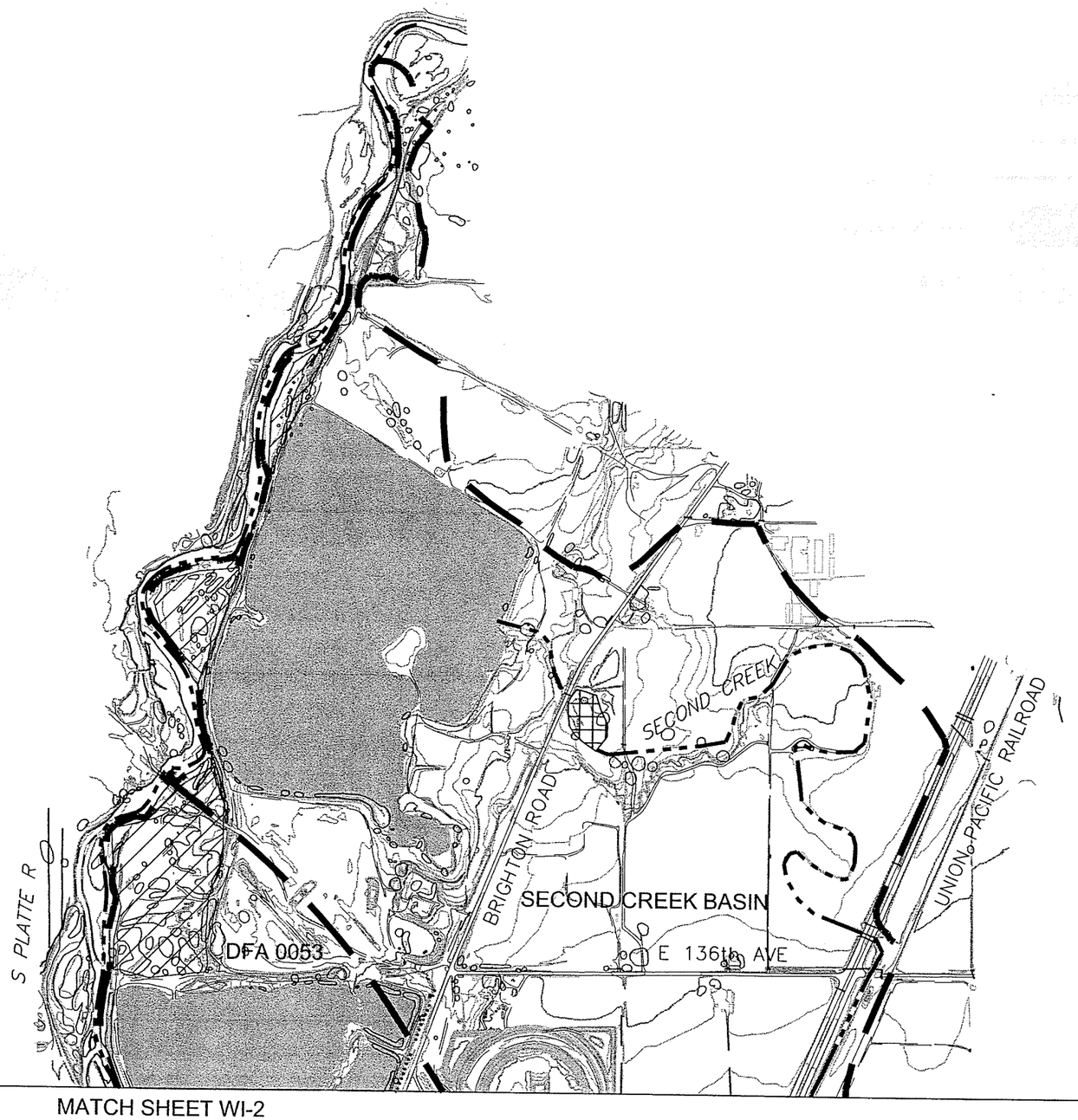
IRRIGATION DITCH

WATERS OF THE U.S.

OPEN WATER

RIPARIAN ECOSYSTEMS

SMALL POCKETS OF EMERGENT AND SHRUB/SCRUB WETLANDS EXIST ALONG SECOND CREEK



0' 500' 1000'

MATCH SHEET WI-2

Kiowa Engineering Corporation
7175 West Jefferson Avenue, Suite 3400
Lakewood, Colorado 80235
(303)-692-0369

CITY OF BRIGHTON, COMMERCE CITY, ADAMS COUNTY
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

OUTFALL SYSTEMS PLANNING STUDY
SECOND CREEK DOWNSTREAM OF DIA AND DFA 0053 WATERSHEDS

WETLANDS INVENTORY

WI-1

MATCH SHEET WI-1

LEGEND

EMERGENT WETLANDS

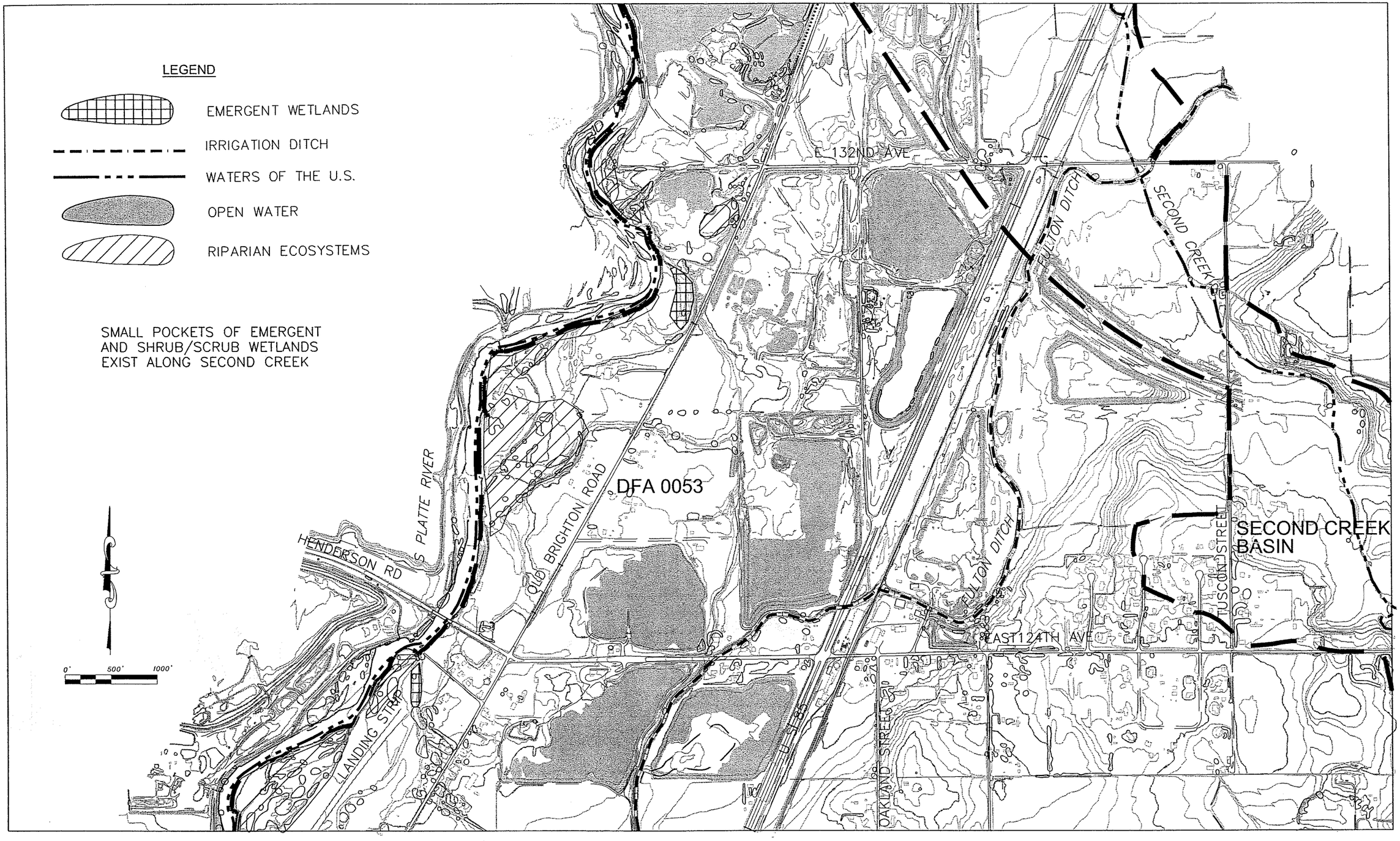
IRRIGATION DITCH

WATERS OF THE U.S.

OPEN WATER

RIPARIAN ECOSYSTEMS

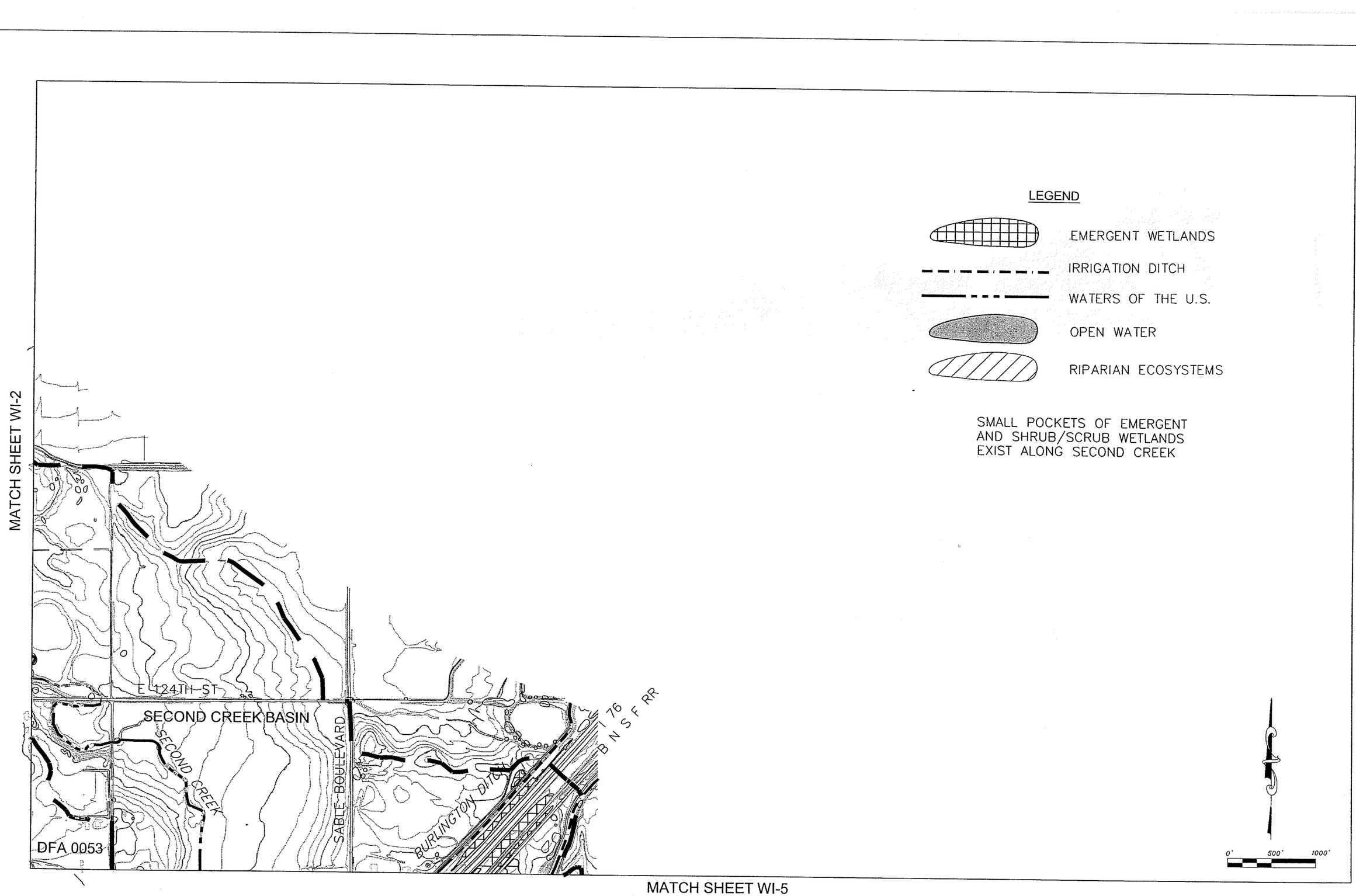
SMALL POCKETS OF EMERGENT AND SHRUB/SCRUB WETLANDS EXIST ALONG SECOND CREEK



MATCH SHEET WI-3

MATCH SHEET WI-4

	Kiowa Engineering Corporation 7175 West Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303)-692-0369	CITY OF BRIGHTON, COMMERCE CITY, ADAMS COUNTY URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY SECOND CREEK DOWNSTREAM OF DIA AND DFA 0053 WATERSHEDS	WETLANDS INVENTORY	WI-2



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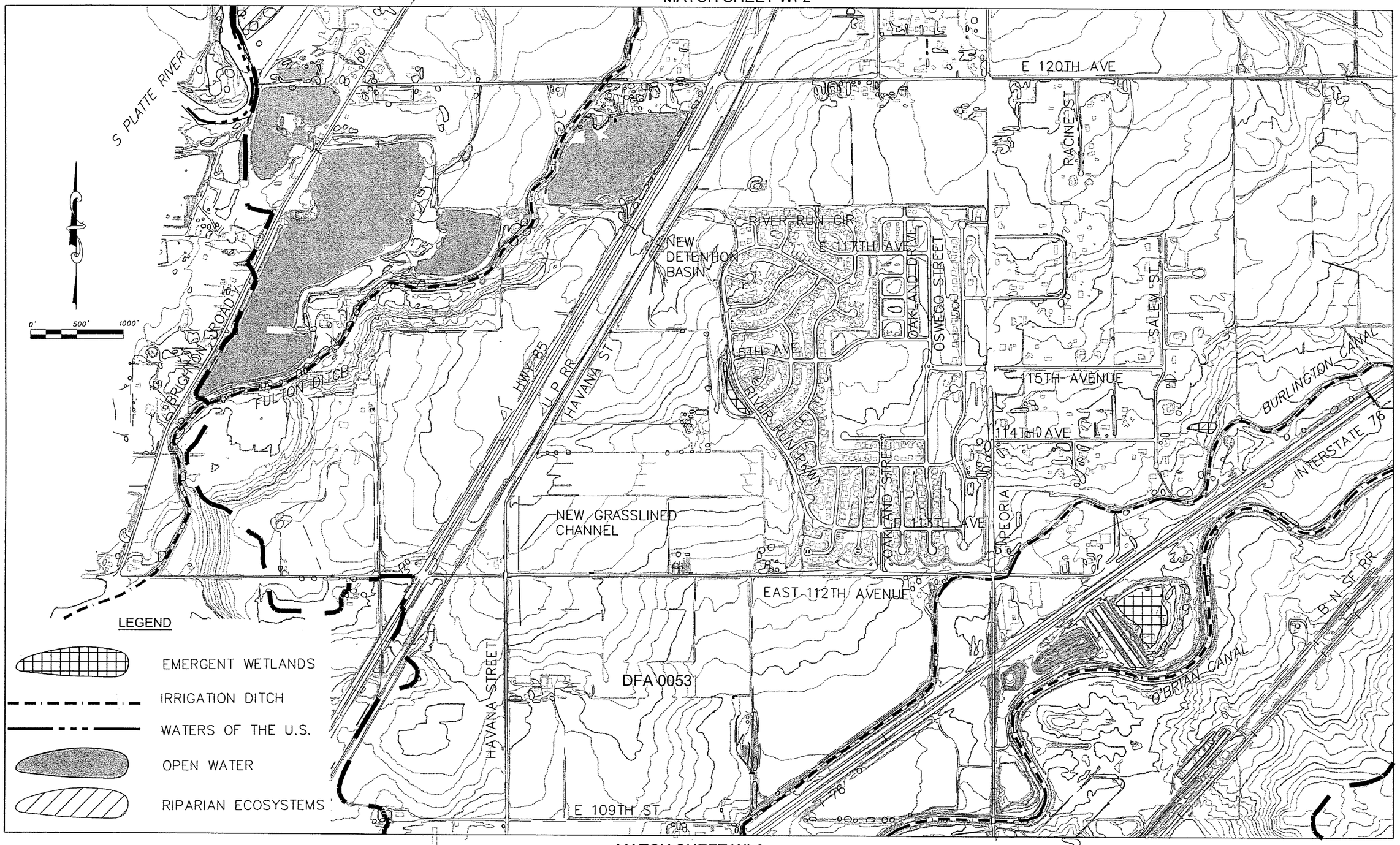
MATCH SHEET WI-2



MATCH SHEET WI-5

MATCH SHEET WI-6

	Kiowa Engineering Corporation 7175 West Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303)-692-0369	CITY OF BRIGHTON, COMMERCE CITY, ADAMS COUNTY URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY SECOND CREEK DOWNSTREAM OF DIA AND DFA 0053 WATERSHEDS	WETLANDS INVENTORY	WI-4

MATCH SHEET WI-3

MATCH SHEET WI-4

EAST 120TH AVE

SECOND CREEK

DFA 0053

I-76

O'BRIAN CANAL

B.N.S.F. RR

SECOND CREEK INDISTINCT IN THIS AREA

EAST 112TH AVENUE

POTOMAC STREET

CHAMBERS ROAD

SECOND CREEK BASIN

THIRD CREEK BASIN

LEGEND

EMERGENT WETLANDS

IRRIGATION DITCH

WATERS OF THE U.S.

OPEN WATER

RIPARIAN ECOSYSTEMS

SMALL POCKETS OF EMERGENT AND SHRUB/SCRUB WETLANDS EXIST ALONG SECOND CREEK

0' 500' 1000'

MATCH SHEET WI-7

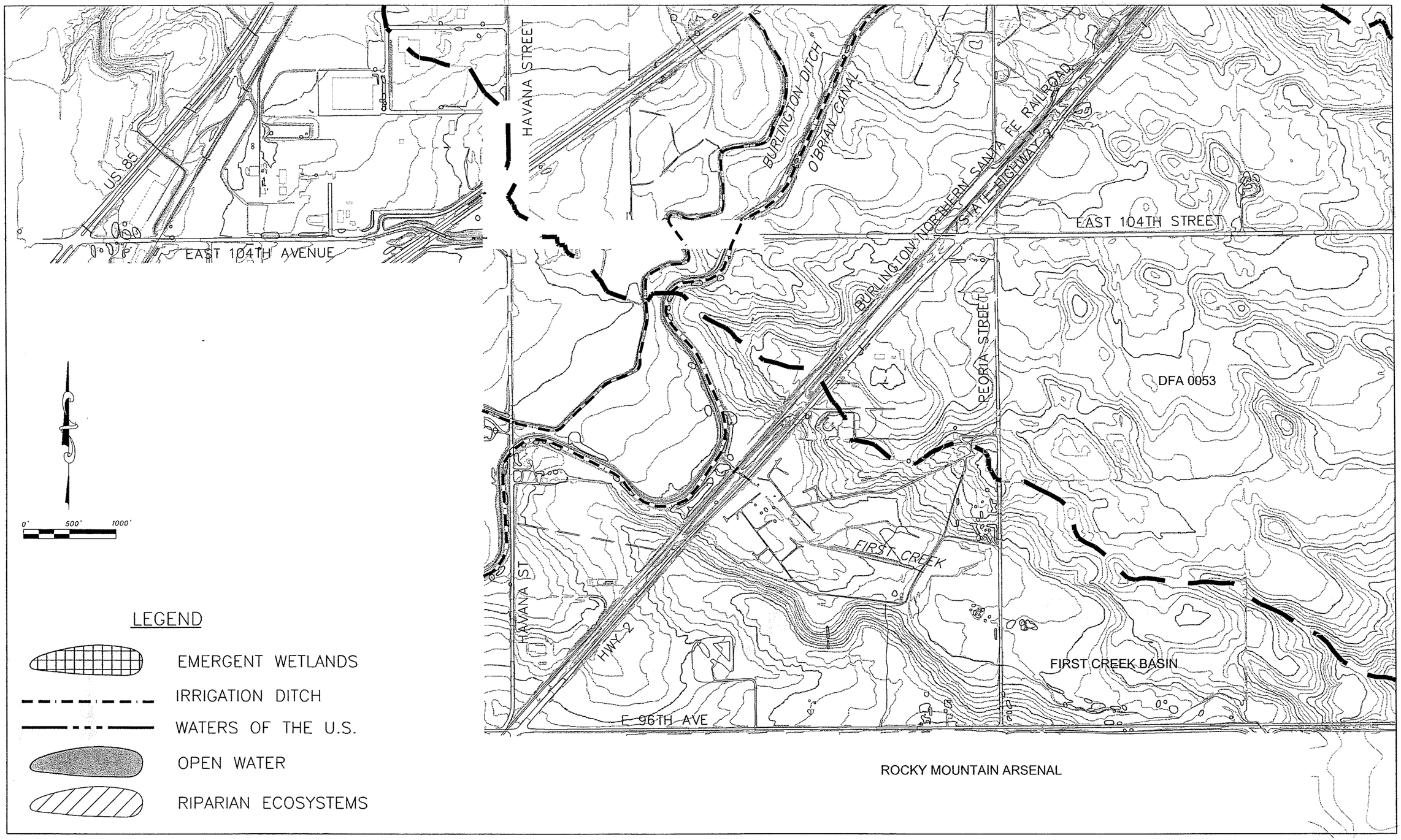
Kiowa Engineering Corporation
7175 West Jefferson Avenue, Suite 3400
Lakewood, Colorado 80235
(303)-692-0369

CITY OF BRIGHTON, COMMERCE CITY, ADAMS COUNTY
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

OUTFALL SYSTEMS PLANNING STUDY
SECOND CREEK DOWNSTREAM OF DIA AND DFA 0053 WATERSHEDS

WETLANDS INVENTORY

MATCH SHEET WI-4



MATCH SHEET WI-7

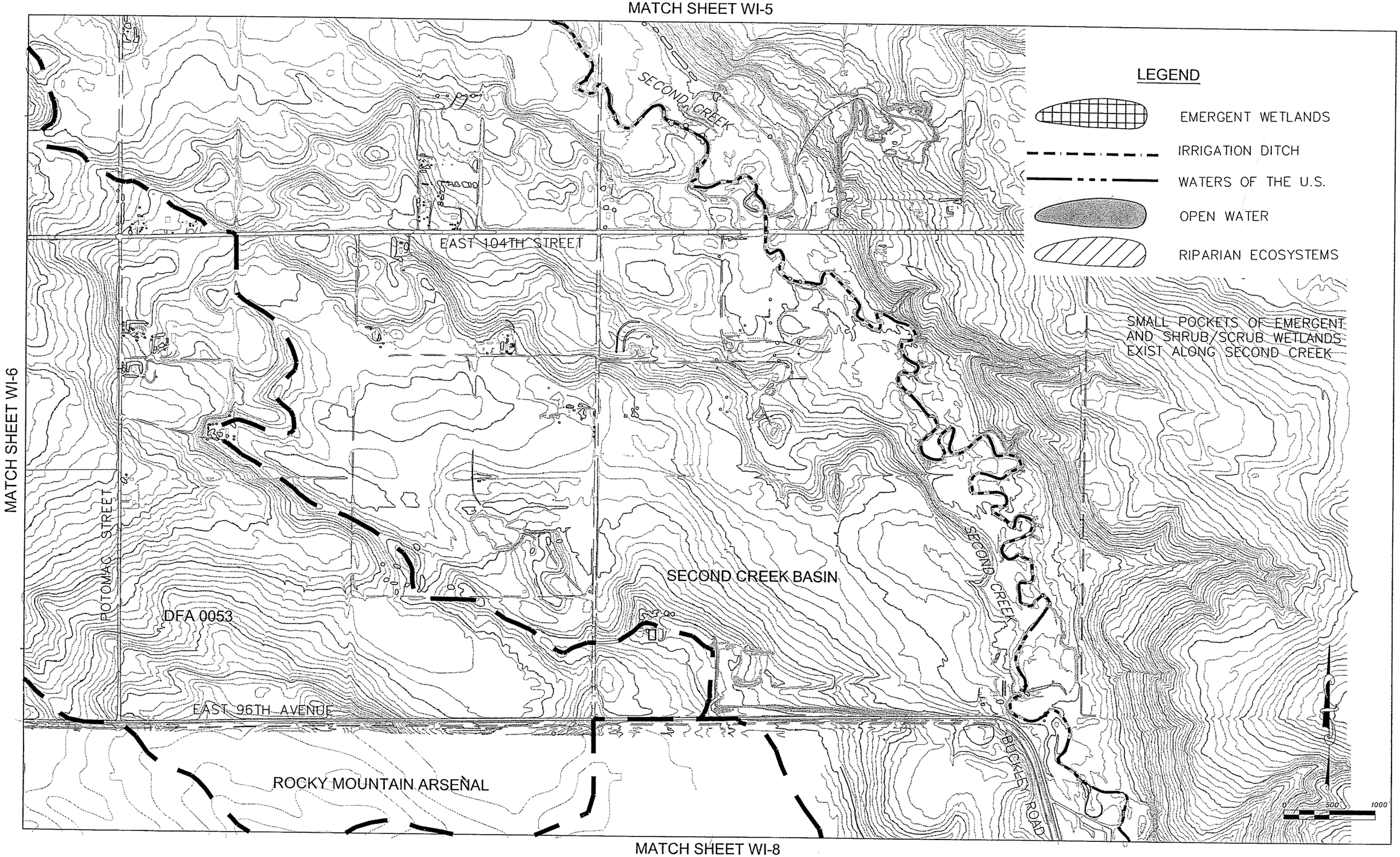
LEGEND

- EMERGENT WETLANDS
- IRRIGATION DITCH
- WATERS OF THE U.S.
- OPEN WATER
- RIPARIAN ECOSYSTEMS

	Kiowa Engineering Corporation 7175 West Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303)-692-0369	CITY OF BRIGHTON, COMMERCE CITY, ADAMS COUNTY URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY SECOND CREEK DOWNSTREAM OF DIA AND DFA 0053 WATERSHEDS	WETLANDS INVENTORY	WI-6

MATCH SHEET WI-5

MATCH SHEET WI-6



LEGEND

- EMERGENT WETLANDS
- IRRIGATION DITCH
- WATERS OF THE U.S.
- OPEN WATER
- RIPARIAN ECOSYSTEMS

SMALL POCKETS OF EMERGENT AND SHRUB/SCRUB WETLANDS EXIST ALONG SECOND CREEK

MATCH SHEET WI-8

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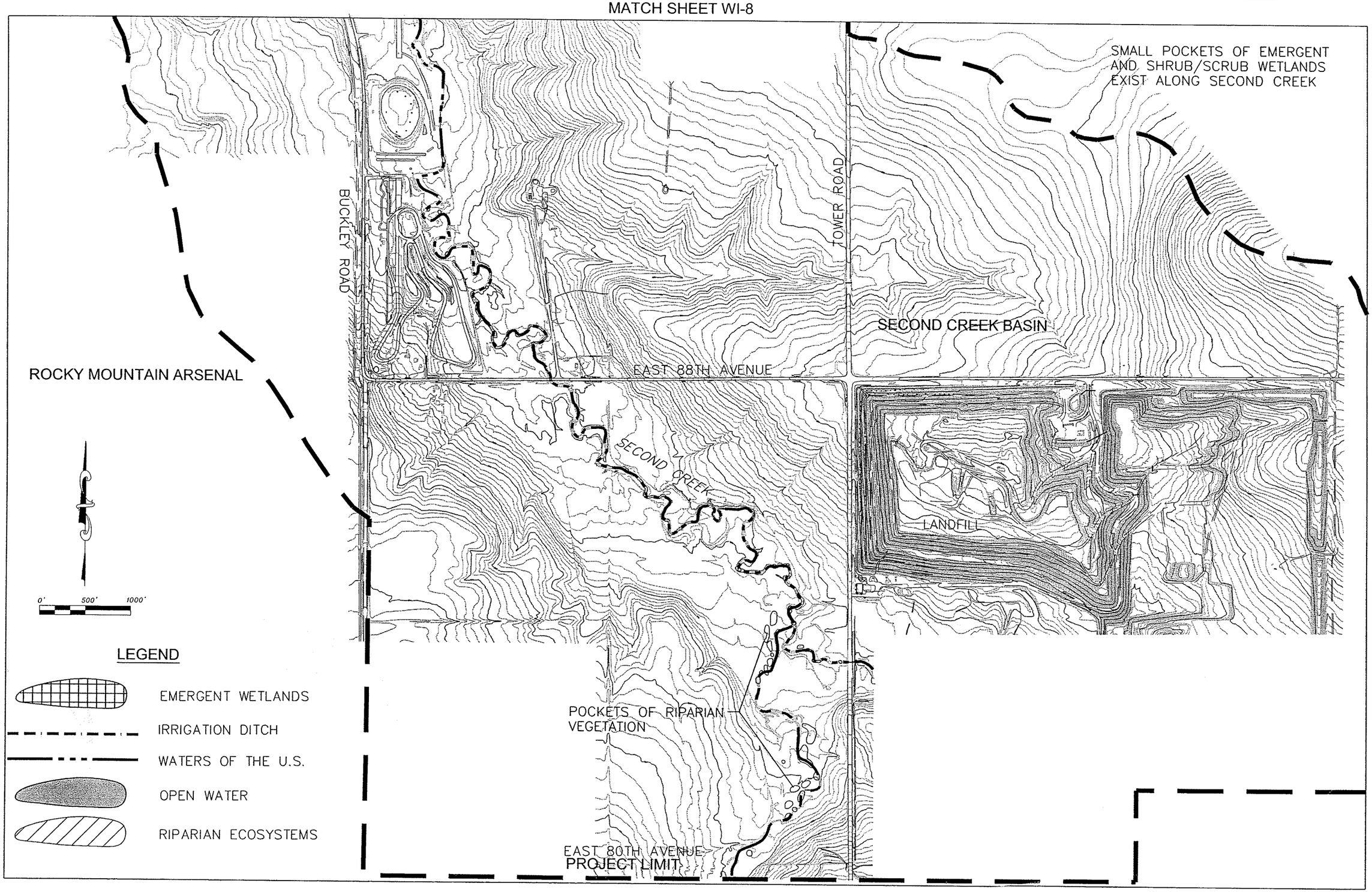
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

OUTFALL SYSTEMS PLANNING STUDY
SECOND CREEK DOWNSTREAM OF DIA
AND DFA 0053 WATERSHEDS

WETLANDS INVENTORY

MATCH SHEET WI-8



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APPENDIX F

Preliminary Design
Plan and Profile Figures

LEGEND

WQCV 4.1 Ac-Ft — WATER QUALITY BASIN

CHECK STRUCTURE

GROUTED SLOPING BOULDER DROP STRUCTURE

5170 — INDEX CONTOUR

INTERMEDIATE CONTOUR

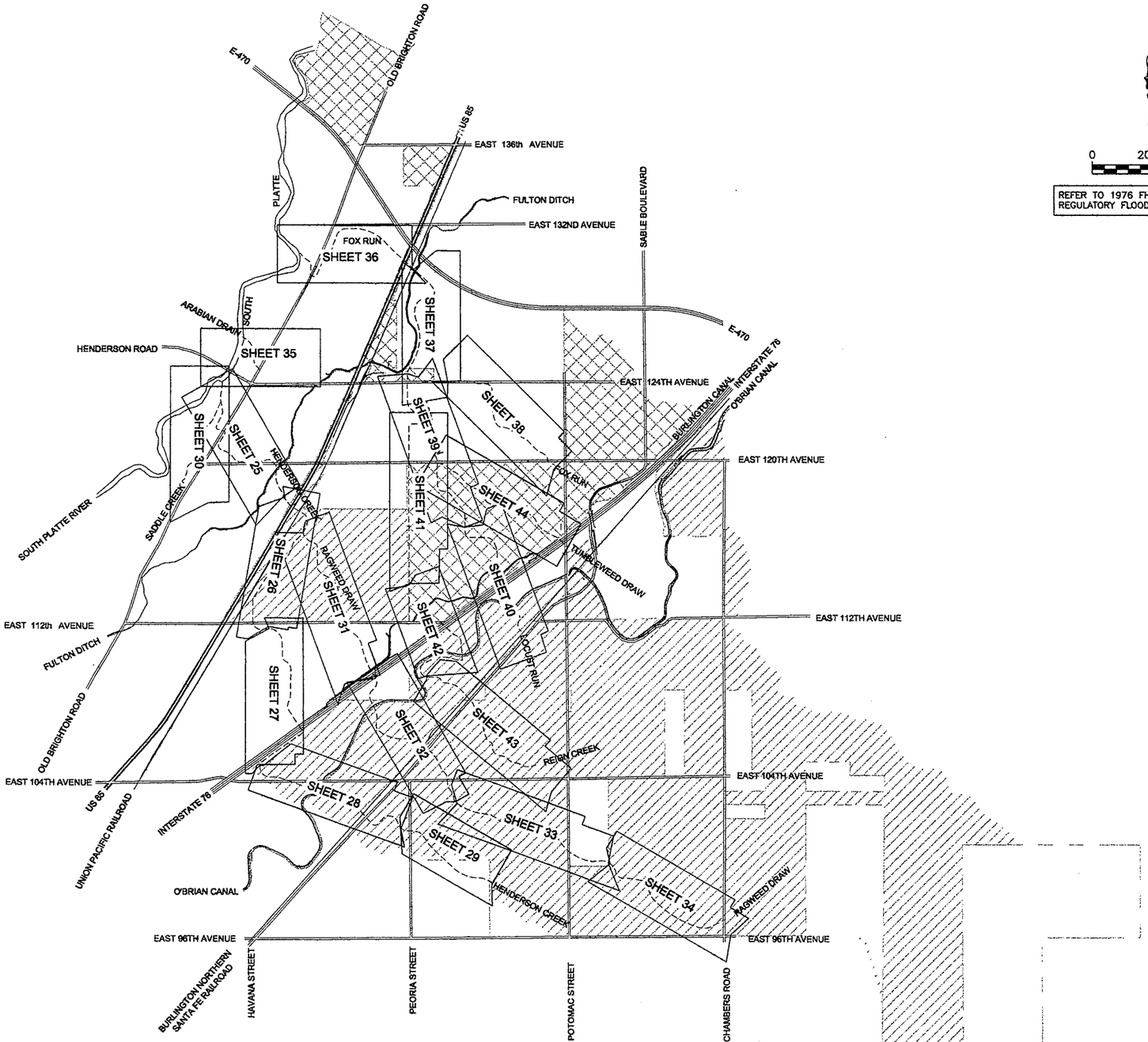
APPROXIMATE FHAD 100-YEAR FLOODPLAIN

CHANNEL CENTERLINE

ADAMS COUNTY / COMMERCE CITY — JURISDICTIONAL BOUNDARY

FLOOD DETENTION FACILITY

ROAD CROSSING STRUCTURE



0 2000' 4000'

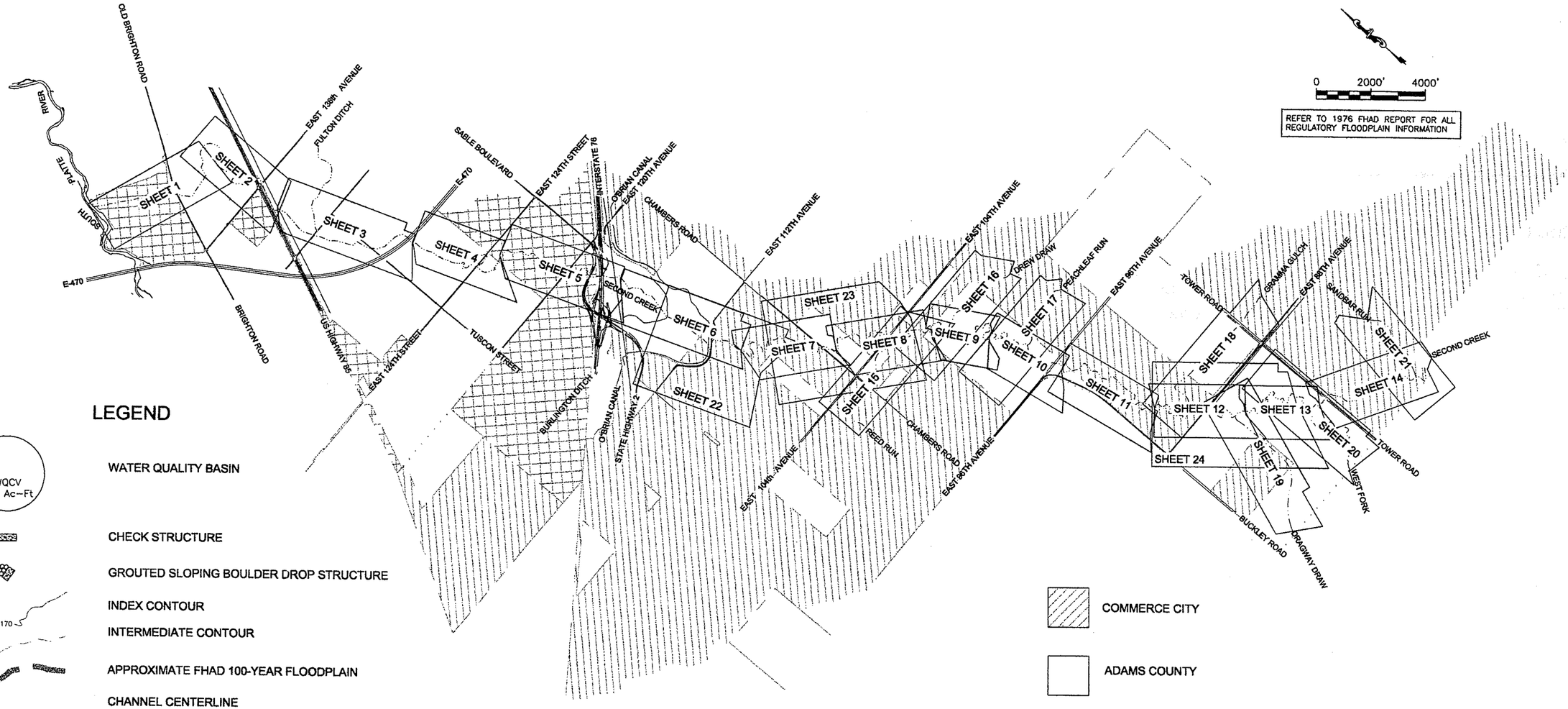
REFER TO 1976 FHAD REPORT FOR ALL REGULATORY FLOODPLAIN INFORMATION

COMMERCE CITY

ADAMS COUNTY

CITY OF BRIGHTON

BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001	Kiowa Engineering Corporation 7175 W. Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303) 692-0369 KIOWA PROJECT NO. 01095	ADAMS COUNTY, CITY OF BRIGHTON CITY OF COMMERCE CITY, AND URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY UPDATE SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS	DFA 0053	SHEET INDEX



LEGEND

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COMMENTARY SHEET 1

Major Drainageway: Second Creek Main Channel **Stations:** 0+00 to 58+00

EXISTING CONDITIONS:

This reach covers 5800 feet and extends from the downstream study limit at the South Platte River outfall to station 58+00, between Brighton Road and US-85. The average channel slope in this reach is 0.26%. The area is mostly undeveloped with some pockets of commercial buildings. There is no visible outfall to the South Platte River. Second Creek outfalls into a large lake prior to reaching the South Platte with no known connection to the river. A buried CMP was found under Brighton Road but is unable to pass any flow.

Problem areas in this reach include: lack of an outfall to the South Platte, inadequate capacity under Brighton Road, and a poorly defined channel.

PROPOSED IMPROVEMENTS:

An outfall to the South Platte can be achieved through an armored spillway excavated near the northwest corner of the lake wall. A 250' width will allow the 100-year peak to pass at a maximum depth less than 2.0 feet.

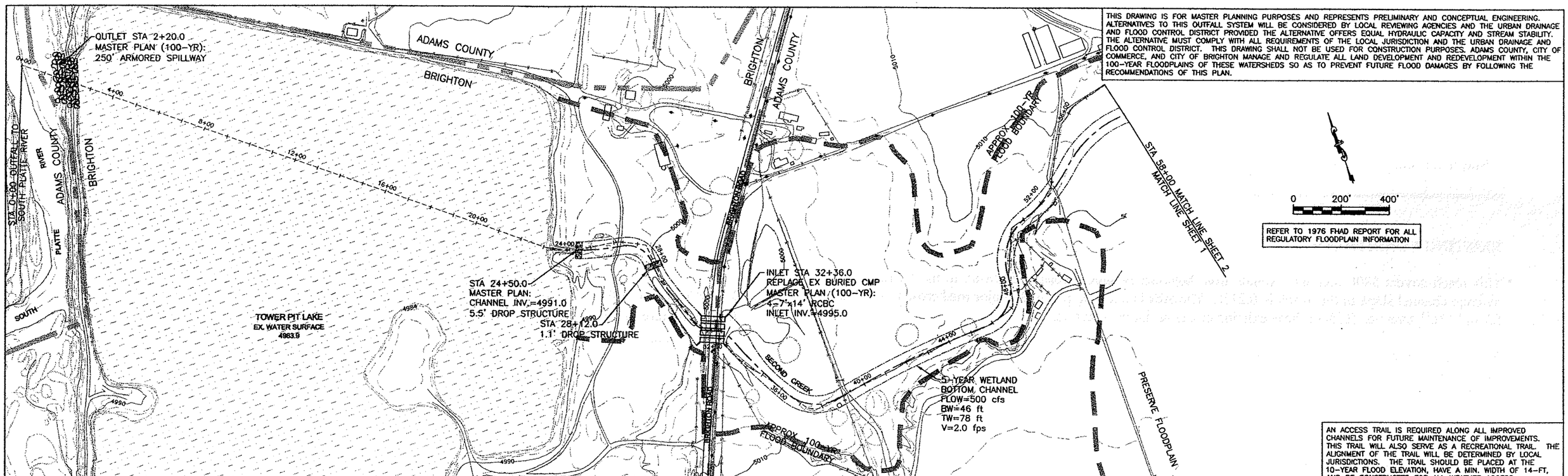
Brighton Road can be upgraded to 100-year capacity via four 7'x14' RCBCs. Lowering the channel 5' at the road crossing allows a larger crossing structure under the road.

Further upstream the master plan includes separation structures at each of the three irrigation canal crossings. These crossings allow the 5-year event to pass under the canals with armored overflows for the larger events. The current channel does not have the capacity to carry the 5-year flows; therefore a 5-year channel has been included in the master plan from the O'Brian Canal to the South Platte River. Flows through this reach are constant. The 5-year channel design requires a 46-foot bottom width, 4:1 side slopes, and a 78-foot top width. To accommodate wetland vegetation, the depth is 4 feet with a design velocity of 2 feet per second. In some locations, drop structures are required to accommodate this design. One drop structure is required in this reach for the wetland bottom design.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 1

Second Creek Main Channel

Improvement	Quantity	Unit	Unit Cost	Total Cost
Armored Spillway	250	LF	$100	$25,000
Drop Structure (5.5')	1	EA	$55,000	$55,000
5-year Wetland Bottom Channel (78')	3288	LF	$140	$460,320
Drop Structure (1.1')	1	EA	$11,000	$11,000
Box Culvert [Quad 7'x14'] Brighton Road	62	LF	$5,100	$316,200
Maintenance Trail	3288	LF	$25	$82,200
Total Estimated Construction Cost				$949,720
Utility Relocation (5% of Construction Cost)				$47,486
Engr. and Contingency (35% of Construction + Utility)				$349,022
Land Value	8.3	Acres	$65,340	$542,520
Total Estimated Cost				**$1,888,748**



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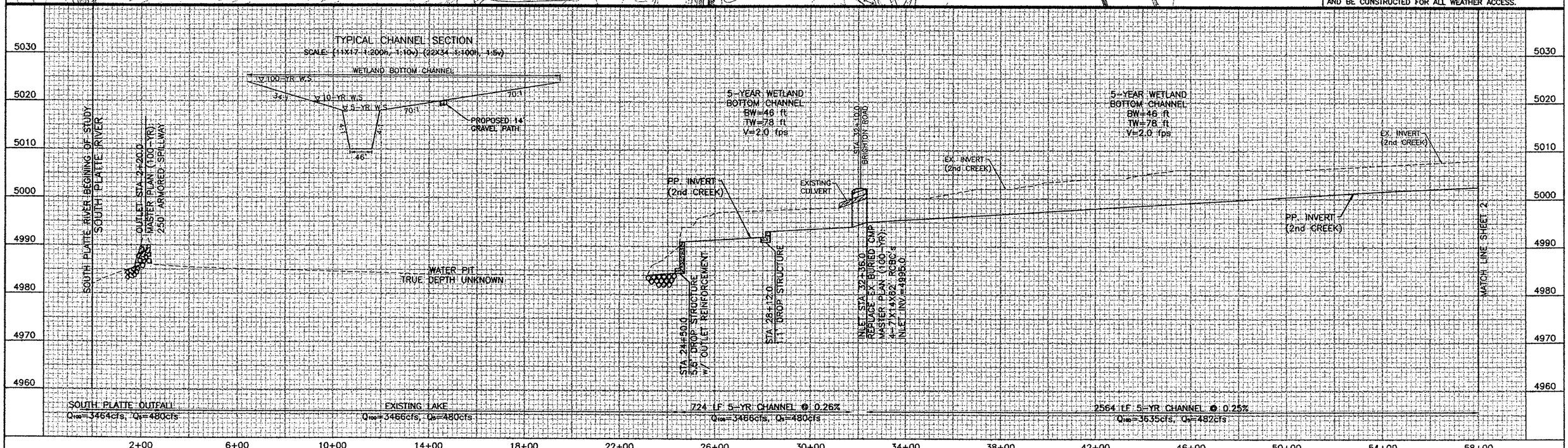
REFER TO 1976 FHAD REPORT FOR ALL REGULATORY FLOODPLAIN INFORMATION

AN ACCESS TRAIL IS REQUIRED ALONG ALL IMPROVED CHANNELS FOR FUTURE MAINTENANCE OF IMPROVEMENTS. THIS TRAIL WILL ALSO SERVE AS A RECREATIONAL TRAIL. THE ALIGNMENT OF THE TRAIL WILL BE DETERMINED BY LOCAL JURISDICTIONS. THE TRAIL SHOULD BE PLACED AT THE 10-YEAR FLOOD ELEVATION, HAVE A MIN. WIDTH OF 14-FT, AND BE CONSTRUCTED FOR ALL WEATHER ACCESS.



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COMMENTARY SHEET 2

Major Drainageway: Second Creek Main Channel **Stations:** 58+00 to 116+00

EXISTING CONDITIONS:

This reach covers 5800 feet and extends from between Brighton Road and US-85 to the UPRR. The average channel slope in this reach is 0.21%. The area is undeveloped with major road crossings at US-85 and 136th Avenue. Both of these existing crossings have 2-year capacity.

Problem areas in this reach include: inadequate capacity under US-85 and 136th Avenue, and a poorly defined meandering channel.

PROPOSED IMPROVEMENTS:

Replacing the existing structures at US-85 and 136th Avenue with triple 8'x16' RCBCs provides 100-year conveyance capacity. The existing structures may be utilized and the required improvements downsized if it is determined that they are suitable with the lower channel invert and are structurally sound. Since this information is not known, the master plan recommends replacing the existing structures.

The ground between US-85 and the UPRR is low and permits Second Creek flows to spill out of the watershed and move on to Third Creek. To prevent this a small 3-foot earth berm is required between the embankments. This holds the Second Creek flows in the watershed and provides adequate head on the US-85 crossing to convey the 100-year event. The topography in this area has historically prohibited sizeable flows from continuing downstream as all flows in excess of the existing 2-year crossings were forced north into Third Creek.

A 5-year wetland bottom channel will be constructed to accommodate the upstream ditch separation of storm water and irrigation water. Two drop structures will be required in the wetland bottom design. The existing channel alignment has extreme meanders and potential for future cutoffs with increased flow rates. The proposed alignment reduces the severity of the meanders while still maintaining the natural sinuosity of the creek. The final channel alignment will be dictated by future development requirements. If the channel length is decreased, drop structures will be required to achieve the design slope of 0.25%.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 2

Second Creek Main Channel

Improvement	Quantity	Unit	Unit Cost	Total Cost
5-year Wetland Bottom Channel (78')	5555	LF	$140	$777,700
Drop Structure (0.5')	1	EA	$5,000	$5,000
Drop Structure (1.0')	1	EA	$10,000	$10,000
Box Culvert [Triple 8'x16'] US-85	135	LF	$5,000	$675,000
Box Culvert [Triple 8'x16'] 136th Avenue	130	LF	$5,000	$650,000
Earth Berm	400	CY	$6	$2,400
Maintenance Trail	5555	LF	$25	$138,875
Total Estimated Construction Cost				$2,258,975
Utility Relocation (5% of Construction Cost)				$112,949
Engr. and Contingency (35% of Construction + Utility)				$830,173
Land Value	14.0	Acres	$65,340	$916,575
Total Estimated Cost				**$4,118,672**

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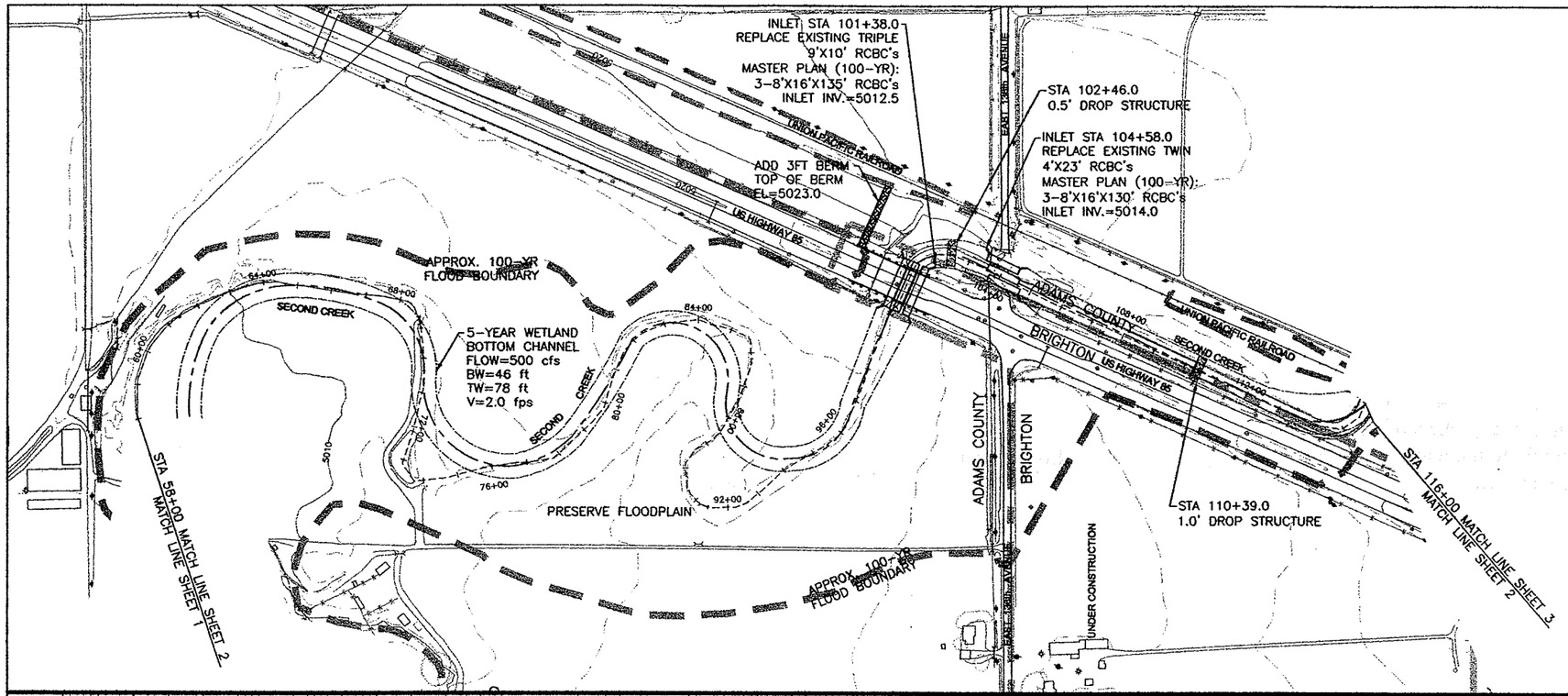

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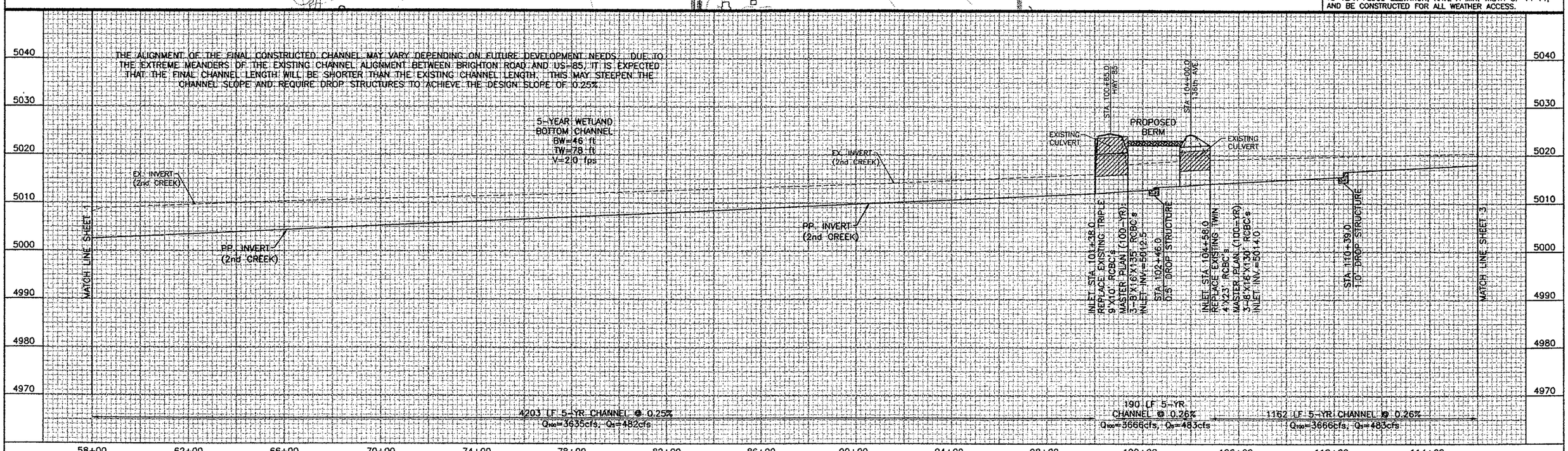
THE ALIGNMENT OF THE FINAL CONSTRUCTED CHANNEL MAY VARY DEPENDING ON FUTURE DEVELOPMENT NEEDS. DUE TO THE EXTREME MEANDERS OF THE EXISTING CHANNEL ALIGNMENT BETWEEN BRIGHTON ROAD AND US-85, IT IS EXPECTED THAT THE FINAL CHANNEL LENGTH WILL BE SHORTER THAN THE EXISTING CHANNEL LENGTH. THIS MAY STEEPEN THE CHANNEL SLOPE AND REQUIRE DROP STRUCTURES TO ACHIEVE THE DESIGN SLOPE OF 0.25%.



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COMMENTARY SHEET 3

Major Drainageway: Second Creek Main Channel **Stations:** 116+00 to 174+00

EXISTING CONDITIONS:

This reach covers 5800 feet and extends from the Union Pacific Railroad to E-470. The average channel slope in this reach is 0.39%. The area is mostly undeveloped with some pockets of development along Tucson Street. The floodplain merges with the Third Creek floodplain to the north. This reach includes several road crossings including, UPRR, 132nd Avenue, Fulton Ditch, Tucson Street, and E-470. With the exception of E-470, these crossings are severely undersized.

Problem areas in this reach include: inadequate capacity under UPRR, 132nd Avenue, Tucson Street, no separation of storm water and irrigation water at Fulton Ditch, and a poorly defined channel.

PROPOSED IMPROVEMENTS:

100-year capacity can be achieved at UPRR by replacing the existing bridge with triple 8'x16' RCBCs. A small 2-foot earth berm will be required to hold Second Creek flows in the watershed and provide head on the box culverts to achieve 100-year capacity. 132nd Avenue and Tucson Street are local roads and do not require full 100-year conveyance capacity. Both of these crossings will require twin 4'x8' RCBCs to provide 10-year conveyance capacity.

Twin 4'x7' RCBCs will be placed under Fulton Ditch to separate the storm water from the irrigation water. This crossing will have 5-year capacity. The top of the box culverts will be utilized as the ditch invert to allow a straight slope, otherwise, a siphon would be required under the ditch. A separation structure will be placed in the ditch to force flows in excess of the 5-year event through the armored overflow.

A 5-year wetland bottom channel will be constructed to accommodate the separation of storm water and irrigation water. Four drop structures will be required in the wetland bottom design to maintain a design velocity of 2.0 feet per second.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 3

Second Creek Main Channel

Improvement	Quantity	Unit	Unit Cost	Total Cost
Box Culvert [Triple 8'x16'] UPRR	105	LF	$5,000	$525,000
Box Culvert [Twin 4'x8'] 132nd Avenue	57	LF	$830	$47,310
Box Culvert [Twin 4'x7'] Fulton Ditch	86	LF	$730	$62,780
Riprap H (24") Armored Overflow (250')	1800	CY	$50	$90,000
Separation Structure	1	EA	$10,000	$10,000
Box Culvert [Twin 4'x8'] Tucson Street	60	LF	$830	$49,800
5-year Wetland Bottom Channel (78')	5105	LF	$140	$714,700
Drop Structure (1.0')	1	EA	$10,000	$10,000
Drop Structure (2.6')	2	EA	$26,000	$52,000
Drop Structure (0.9')	1	EA	$9,000	$9,000
Maintenance Trail	5105	LF	$25	$127,625
Total Estimated Construction Cost				$1,698,215
Utility Relocation (5% of Construction Cost)				$84,911
Engr. and Contingency (35% of Construction + Utility)				$624,094
Land Value	12.9	Acres	$65,340	$842,325
Total Estimated Cost				**$3,249,545**

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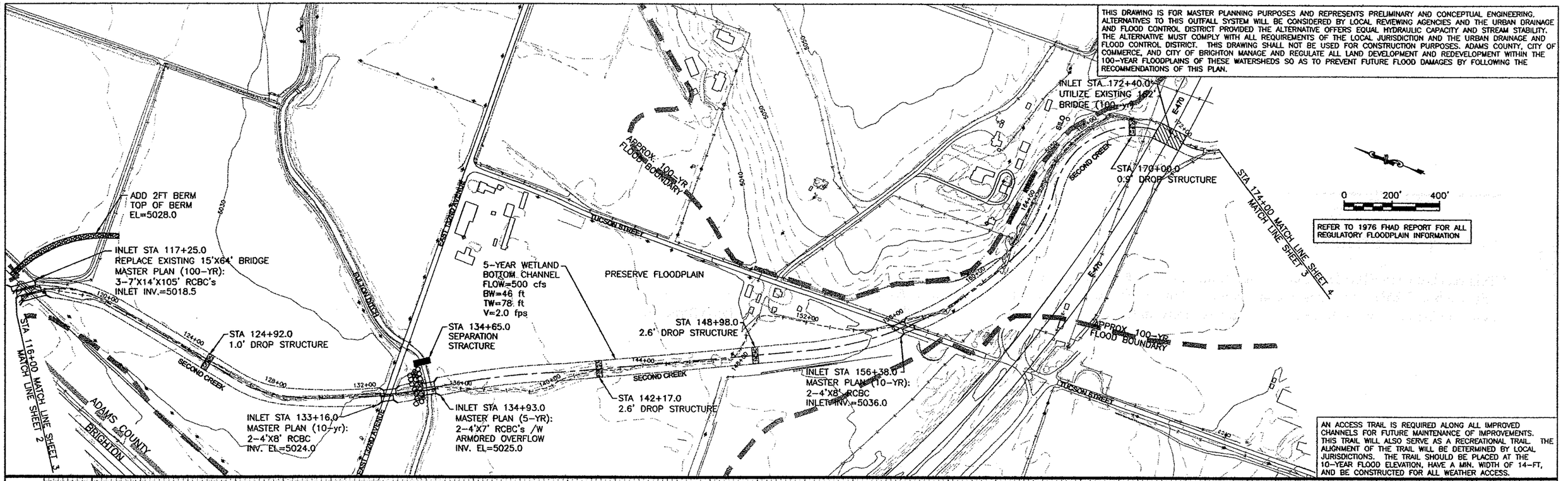

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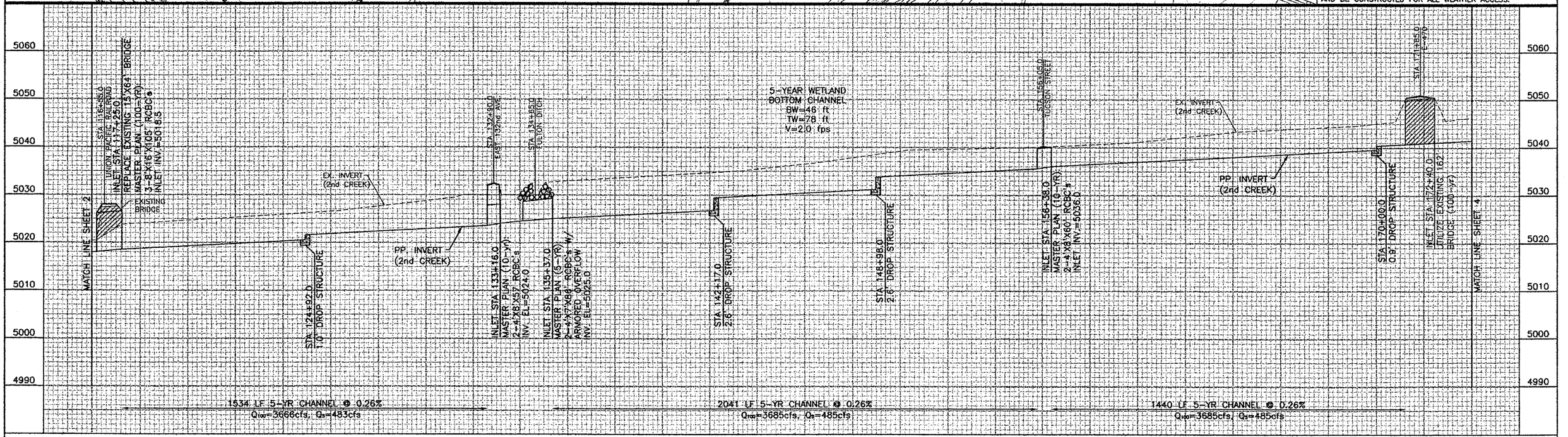

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COMMENTARY SHEET 4

Major Drainageway: Second Creek Main Channel **Stations:** 174+00 to 232+00

EXISTING CONDITIONS:

This reach covers 5800 feet and extends from E-470 to Potomac Street. The average channel slope in this reach is 0.26%. The area is undeveloped. This reach includes road crossings at124th Avenue and Potomac Street. Both of these crossings are severely undersized with less than 2-year capacity.

Problem areas in this reach include: inadequate capacity under 124th Avenue and Potomac Street, and a poorly defined channel.

PROPOSED IMPROVEMENTS:

Adding five 7'x13' RCBCs to 124th Avenue and Potomac Street will achieve 100-year conveyance capacity. The difficulty at these road crossings is the lack of embankment height between the channel invert and top of road. Lowering the channel invert to accommodate the 5-year channel provides some elevation change but still requires several short box culverts to create 100-year capacity. Raising the road by 4 feet at 124th Avenue and 2 feet at Potomac Street allows for 7' box culverts and reduces the number to five at each crossing.

A 5-year wetland bottom channel will be constructed to accommodate the upstream ditch separation of storm water and irrigation water. One drop structure will be required in the wetland bottom design. The existing channel alignment has extreme meanders and creates difficulties in aligning box culverts through 124th Avenue. The proposed alignment reduces the severity of the meanders and creates a better hydraulic alignment for the 124th Avenue crossing.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 4

Second Creek Main Channel

Improvement	Quantity	Unit	Unit Cost	Total Cost
5-year Wetland Bottom Channel (78')	5638	LF	$140	$789,320
Drop Structure (2.5')	1	EA	$25,000	$25,000
Box Culvert [Quintuple 7'x13'] 124th Avenue	85	LF	$5,900	$501,500
Raise 124th Avenue 4 ft	1280	LF	$150	$192,000
Box Culvert [Quintuple 7'x13'] Potomac Street	47	LF	$5,900	$277,300
Raise Potomac Street 2 ft	240	LF	$150	$36,000
Maintenance Trail	5638	LF	$25	$140,950
Total Estimated Construction Cost				$1,962,070
Utility Relocation (5% of Construction Cost)				$98,104
Engr. and Contingency (35% of Construction + Utility)				$721,061
Land Value	14.2	Acres	$65,340	$930,270
Total Estimated Cost				**$3,711,504**

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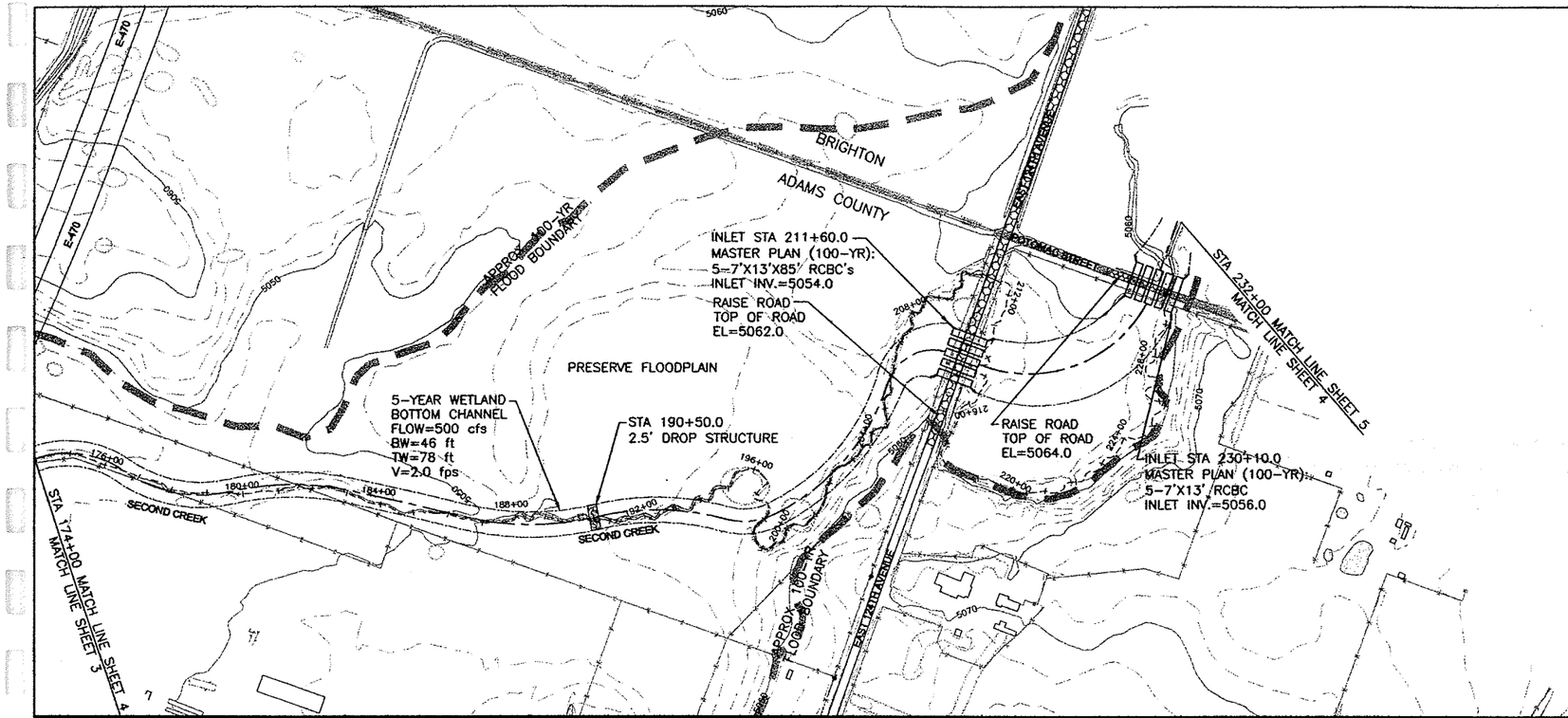

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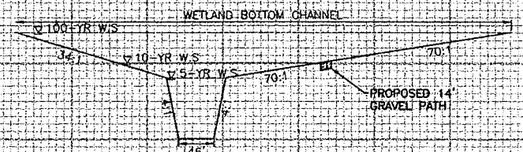
REFER TO 1976 FHAD REPORT FOR ALL REGULATORY FLOODPLAIN INFORMATION

AN ACCESS TRAIL IS REQUIRED ALONG ALL IMPROVED CHANNELS FOR FUTURE MAINTENANCE OF IMPROVEMENTS. THIS TRAIL WILL ALSO SERVE AS A RECREATIONAL TRAIL. THE ALIGNMENT OF THE TRAIL WILL BE DETERMINED BY LOCAL JURISDICTIONS. THE TRAIL SHOULD BE PLACED AT THE 10-YEAR FLOOD ELEVATION, HAVE A MIN. WIDTH OF 14-FT, AND BE CONSTRUCTED FOR ALL WEATHER ACCESS.

TYPICAL CHANNEL SECTION
SCALE: (11X17: 1:200h, 1:10v) (22X34: 1:100h, 1:5v)



THE ALIGNMENT OF THE FINAL CONSTRUCTED CHANNEL MAY VARY DEPENDING ON FUTURE DEVELOPMENT NEEDS. DUE TO THE EXTREME MEANDERS OF THE EXISTING CHANNEL ALIGNMENT BETWEEN 124TH AVENUE AND POTOMAC STREET, IT IS EXPECTED THAT THE FINAL CHANNEL LENGTH WILL BE SHORTER THAN THE EXISTING CHANNEL LENGTH. THE IDEAL LENGTH TO ACHIEVE THE DESIGN SLOPE OF 0.26% IS 600 LF. SHORTER LENGTHS MAY REQUIRE DROP STRUCTURES.

BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001	Kiowa Engineering Corporation 7175 W. Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303) 692-0369 KIOWA PROJECT NO. 01095	DESIGNED BJW/DDR DATE 02/04 DRAWN DDR DATE 02/04 CHECKED BJW DATE 02/04	ADAMS COUNTY, CITY OF BRIGHTON CITY OF COMMERCE CITY, AND URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY UPDATE SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS	2ND CREEK 3500 STA 174+00 to 232+00	SHEET 4

COMMENTARY SHEET 5

Major Drainageway: Second Creek Main Channel **Stations:** 232+00 to 290+00

EXISTING CONDITIONS:

This reach covers 5800 feet and extends from Potomac Street to the Burlington Northern-Santa Fe Railroad. The average channel slope in this reach is 0.29%. The area is undeveloped but contains several major transportation corridors. This reach includes road crossings at 120th Avenue, I-76 on/off ramp, I-76 and BNSFRR. All of these crossings have been recently upgraded to full 100-year conveyance capacity.

Problem areas in this reach include: a poorly defined channel.

PROPOSED IMPROVEMENTS:

A 5-year wetland bottom channel will be fully constructed between Potomac Street and 120th Avenue. One drop structure will be required in this reach to accommodate the wetland design. Between 120th Avenue and BNSFRR the channel is more defined than in most reaches. It is expected that less excavation will be required and more "shaping" to create the 5-year channel. Two drop structures will be required between 120th Avenue and I-76 for the wetland bottom design. No changes other than some channel shaping and constructing the maintenance trail will be required between I-76 and BNSFRR.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 5

Second Creek Main Channel

Improvement	Quantity	Unit	Unit Cost	Total Cost
5-year Wetland Bottom Channel (78')	5903	LF	$140	$826,420
Drop Structure (3.5')	1	EA	$35,000	$35,000
Drop Structure (1.8')	2	EA	$18,000	$36,000
Maintenance Trail	5903	LF	$25	$147,575
Total Estimated Construction Cost				$1,044,995
Utility Relocation (5% of Construction Cost)				$52,250
Engr. and Contingency (35% of Construction + Utility)				$384,036
Land Value	14.9	Acres	$65,340	$973,995
Total Estimated Cost				**$2,455,275**

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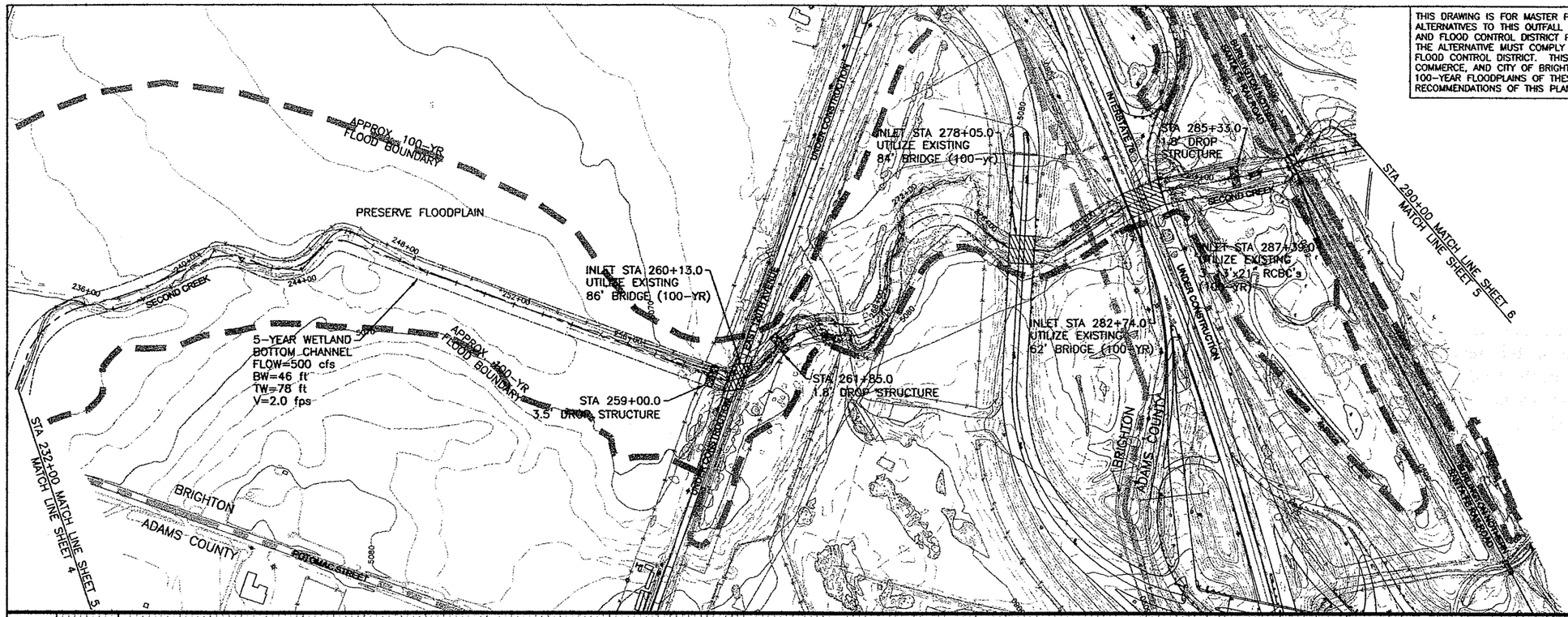

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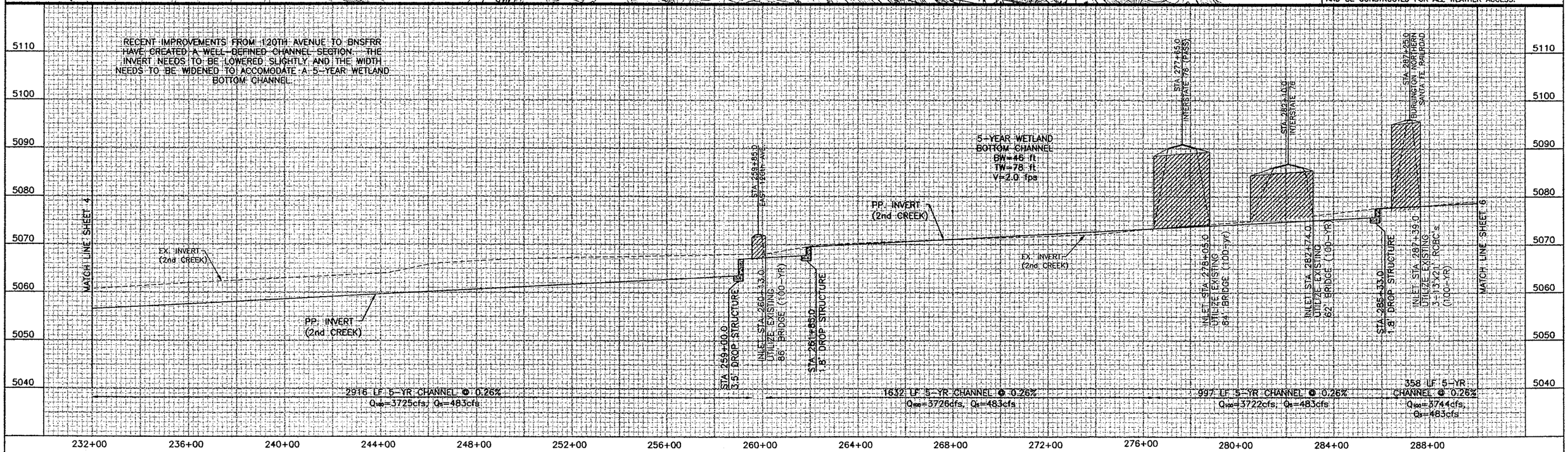

BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001	Kiowa Engineering Corporation 7175 W. Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303) 692-0369 KIOWA PROJECT NO. 01085	DESIGNED BJW/DDR DATE 02/04 DRAWN DDR DATE 02/04 CHECKED BJW DATE 02/04	ADAMS COUNTY, CITY OF BRIGHTON CITY OF COMMERCE CITY, AND URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY UPDATE SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS	2ND CREEK 3500 STA 232+00 to 290+00 SHEET 5

COMMENTARY SHEET 6

Major Drainageway: Second Creek Main Channel **Stations:** 288+00 to 346+44 (348+00)

EXISTING CONDITIONS:

This reach covers 5844 feet and extends from the Burlington Northern-Santa Fe Railroad to upstream of 112th Avenue. The average channel slope in this reach is 0.50%. The area is undeveloped and is anticipated to remain undeveloped as most of the land in this reach lies within the 100-year floodplain. This reach includes two significant irrigation canals, the Burlington Ditch and O'Brian Canal. There are no crossing structures at either canal. Historically all low flows have entered the O'Brian and Burlington and were carried up to Barr Lake. With increasing runoff frequencies and magnitudes, these canals no longer have the capacity to collect all upstream runoff.

Problem areas in this reach include: the need to separate storm water from irrigation water, and a poorly defined channel.

PROPOSED IMPROVEMENTS:

Both of the irrigation canals will have 5-year capacity drainage crossings to separate the storm water from the irrigation water. This is accomplished through twin 4'x8' RCBCs. To avoid siphons, the proposed culverts will be 200' and 750' long to tie into the elevations of the proposed 5-year channel. The top of the box culverts will also be utilized as the ditch bottoms at each crossing. Flows in excess of the 5-year event will spill into the canals. Separation structures will be added to the canals downstream to force excess flows through a controlled, armored overflow back to Second Creek.

The O'Brian Canal requires twin 48" RCPs to provide 200 cfs to the canal. The canal has water rights to 200 cfs from Second Creek. The pipes are gated to allow the canal to refuse the 200 cfs when necessary.

A 5-year wetland bottom channel will be constructed to convey flows passing under the canal crossings. Two drop structures will be required in this reach to accommodate the wetland design.

Regional detention facility #330 is located along the upstream embankment of the 112th Avenue. This road is expected to be enlarged in the future and is shown with a 72-foot road width to reflect the changes. This facility is partially constructed in its interim condition as part of the Shea Homes residential development. This facility stores 195 acre-feet of volume and reduces the 100-year event to 75% of the existing levels.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 6

Second Creek Main Channel

Improvement	Quantity	Unit	Unit Cost	Total Cost
5-year Wetland Bottom Channel (78')	1438	LF	$140	$201,320
Drop Structure (2.4')	1	EA	$2,400	$2,400
Box Culvert [Twin 4'x8'] Burlington Ditch	200	LF	$830	$166,000
Riprap H (24") Armored Overflow (250')	1800	CY	$50	$90,000
Separation Structure	1	EA	$10,000	$10,000
5-year Wetland Bottom Channel (78')	2205	LF	$140	$308,700
Drop Structure (5.3')	1	EA	$53,000	$53,000
Box Culvert [Twin 4'x8'] O'Brian Canal	750	LF	$830	$622,500
Riprap H (24") Armored Overflow (250')	1800	CY	$50	$90,000
Separation Structure	1	EA	$10,000	$10,000
Twin 48" RCP O'Brian 200cfs (gated)	2	EA	$42,000	$84,000
Detention Facility 330 [194.5 ac-ft]	1	EA	$417,412	$417,412
Maintenance Trail	3643	LF	$25	$91,075
Total Estimated Construction Cost				$2,146,407
Utility Relocation (5% of Construction Cost)				$107,320
Engr. and Contingency (35% of Construction + Utility)				$788,805
Land Value	73.4	Acres	$65,340	$4,795,923
Total Estimated Cost				**$7,838,455**

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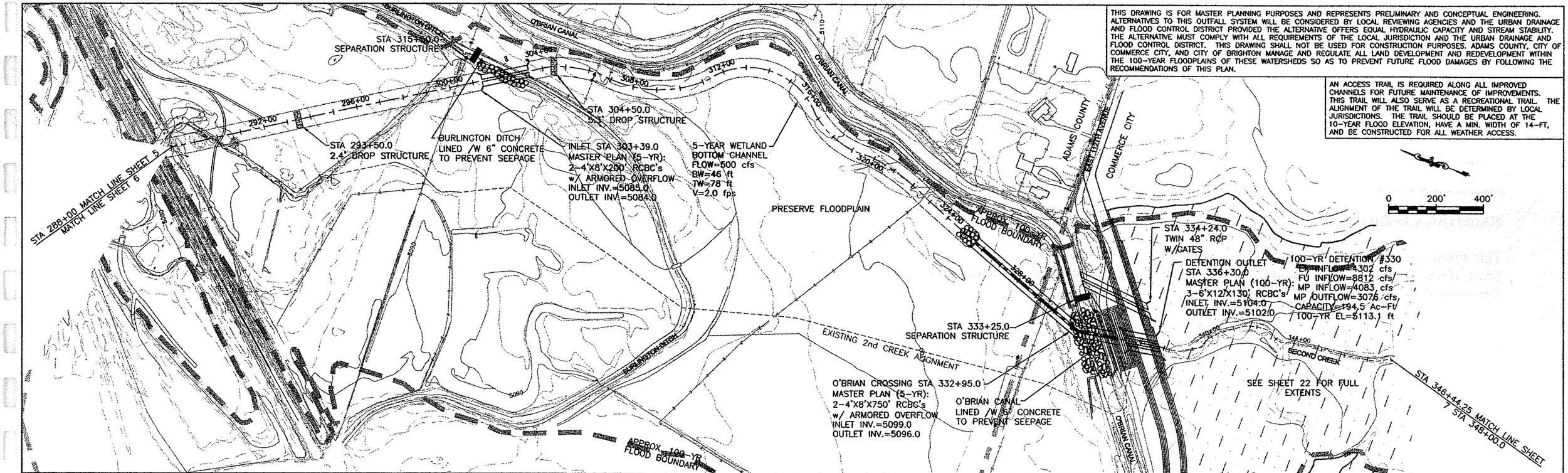

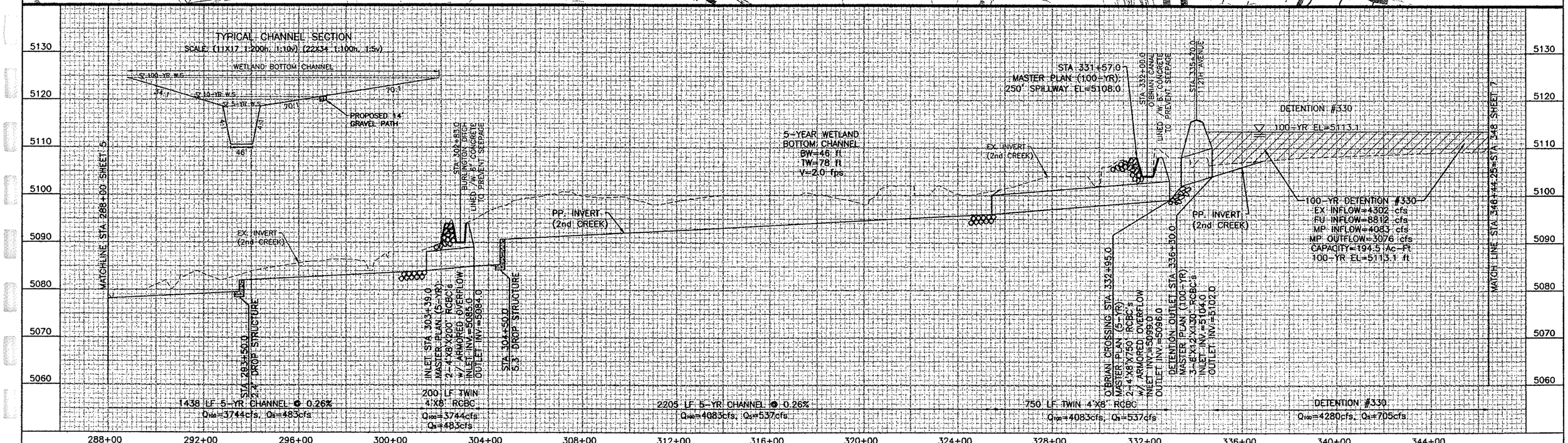

BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001

Kiowa Engineering Corporation
7175 W. Jefferson Avenue, Suite 3400
Lakewood, Colorado 80235
(303) 692-0369
KIOWA PROJECT NO. 01095

DESIGNED	BJW/DDR	DATE 02/04
DRAWN	DDR	DATE 02/04
CHECKED	BJW	DATE 02/04

ADAMS COUNTY, CITY OF BRIGHTON
CITY OF COMMERCE CITY, AND
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

OUTFALL SYSTEMS PLANNING STUDY UPDATE
SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS

2nd CREEK 3500 REV1
STA 288+00 to 346+44.25

SHEET 6

COMMENTARY SHEET 7

Major Drainageway: Second Creek Main Channel **Stations:** 348+00 to 407+00

EXISTING CONDITIONS:

This reach covers 5900 feet from 112th Avenue to Chambers Road with an average slope of 0.19%. Most of the reach lies within the 100-year floodplain. It is expected that residential development will occur outside of the floodplain.

PROPOSED IMPROVEMENTS:

Preserving the natural channel and floodplain will be key components for this reach. The Second Creek trail will fall within the 100-year floodplain.

The second detention facility in the series of multi-frequency facilities is located just upstream of Chambers Road. This facility is designed to control the 10-year flood event. Existing 10-year peak flows are 659 cfs. With no upstream improvements these flows will increase to 3211 cfs (5x). The addition of upstream detention and Detention #336 allows final peaks to be released at existing levels with a downstream outflow of 634 cfs. The 10-year detention design requires 163 acre-feet of storage with a 10-year pool elevation of 5130.9. The 100-year event will spill over the embankment through a controlled spillway. A 500-foot spillway releases the 100-year flows at a depth of 1.7 feet. As the outlet is currently configured it will require approximately 140,000 cubic yards of excavation to maintain the 100-year pool within the existing floodplain limits. Enlarging the spillway width should substantially reduce the required excavation to maintain the 100-year pool inside the 100-year floodplain.

A water quality basin is located at a major drainage area to Second Creek along the west bank. This facility captures and treats runoff from 207 upstream acres.

100-year conveyance capacity is also achieved at Chambers Road via four 8'x16' box culverts. This prevents roadway overtopping up to, and including, the 100-year event.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 7

Second Creek Main Channel

Improvement	Quantity	Unit	Unit Cost	Total Cost
Box Culvert [Quad 8'x16'] Chambers Road	101	LF	$6,660	$672,660
Detention Facility 336 [163 ac-ft]	1	EA	$500,945	$500,945
Water Quality Basin [3.2 ac-ft]	3.2	AF	$32,000	$102,400
Maintenance Trail	5250	LF	$25	$131,250
Total Estimated Construction Cost				$1,407,255
Utility Relocation (5% of Construction Cost)				$70,363
Engr. and Contingency (35% of Construction + Utility)				$517,166
Land Value	76.1	Acres	$65,340	$4,969,602
Total Estimated Cost				**$6,964,386**

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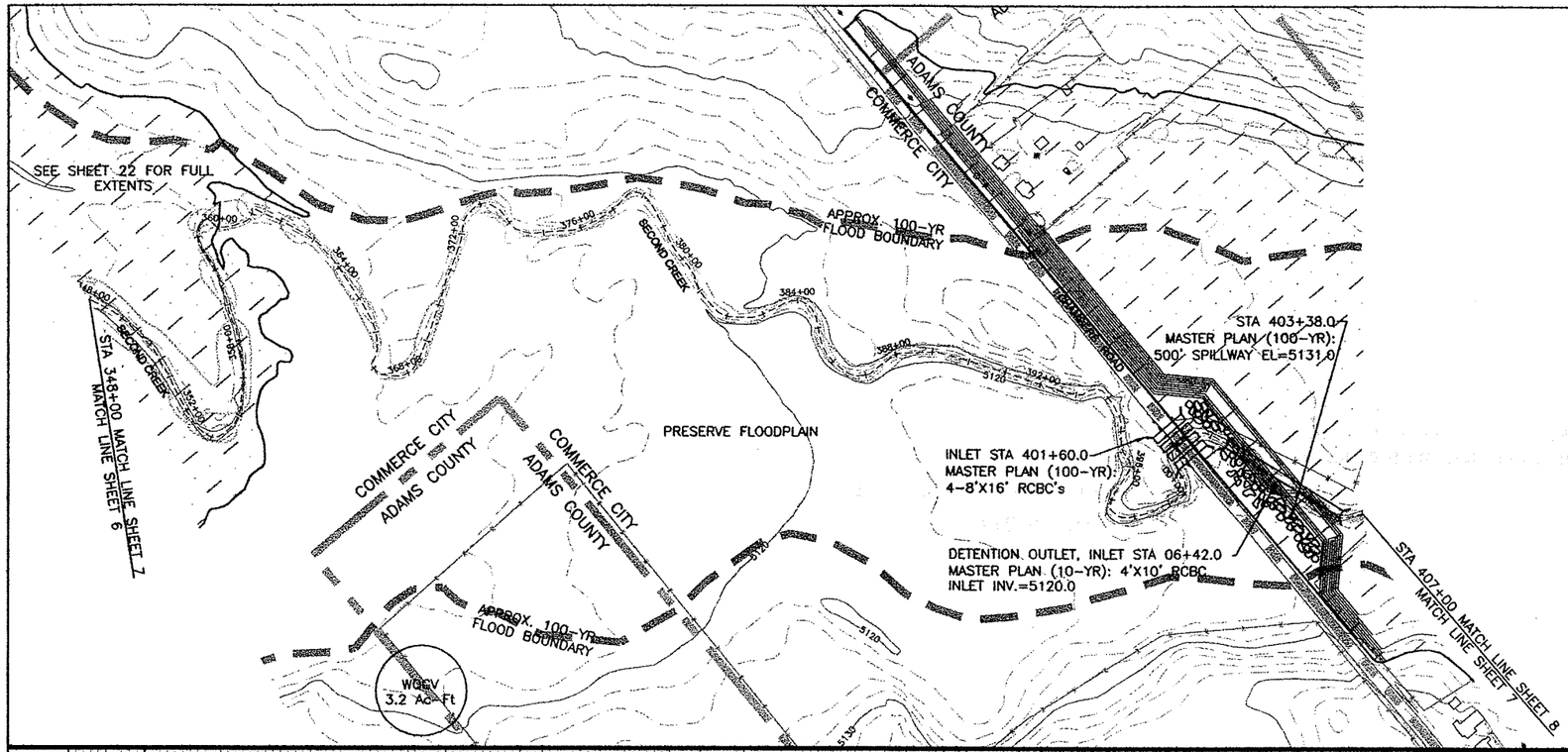

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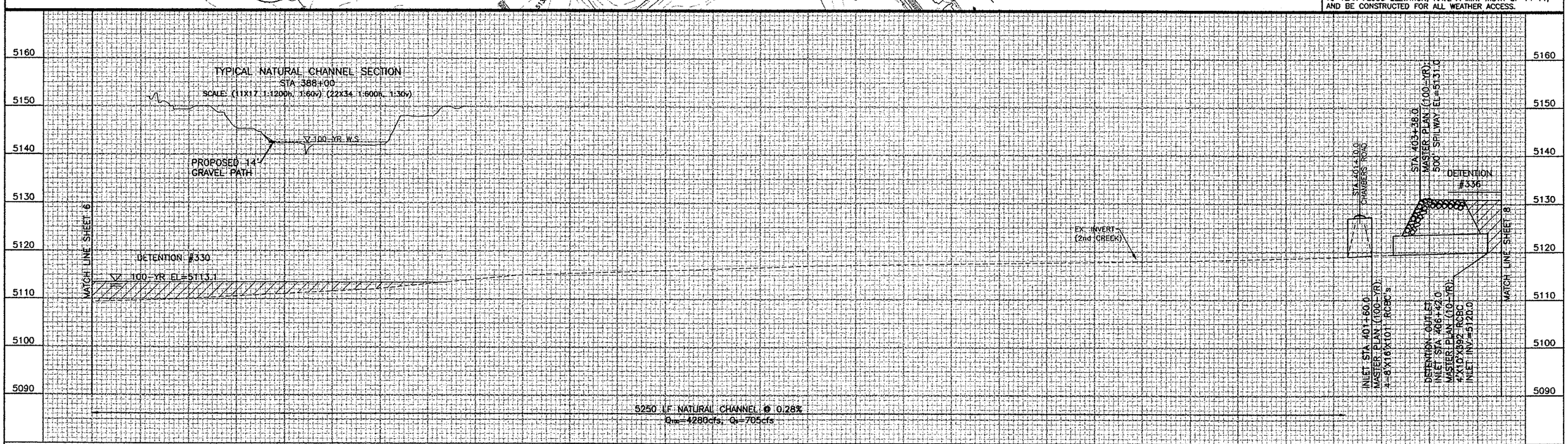

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COMMENTARY SHEET 8

Major Drainageway: Second Creek Main Channel **Stations:** 407+00 to 464+00

EXISTING CONDITIONS:

This reach covers 5700 feet from Chambers Road to 2000' south of 104th Avenue with an average slope of 0.25%. The reach is primarily undeveloped. Fronterra Village has recently been constructed along Chambers Road south of 104th Avenue and north of 96th Avenue. Reed Run enters the main channel near station 441+00.

PROPOSED IMPROVEMENTS:

Preserving the natural channel and floodplain are key components for this reach. The Second Creek trail will fall within the 100-year floodplain.

A water quality basin is located at a major drainage area to Second Creek along the east bank. This facility captures and treats runoff from 121 upstream acres.

100-year conveyance capacity is also achieved at 104th Avenue via four 8'x16' box culverts. This prevents roadway overtopping up to, and including, the 100-year event.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 8

Second Creek Main Channel

Improvement	Quantity	Unit	Unit Cost	Total Cost
Box Culvert [Quad 8'x16'] 104th Avenue	108	LF	$6,660	$719,280
Water Quality Basin [2.5 ac-ft]	2.5	AF	$25,000	$62,500
Maintenance Trail	5592	LF	$25	$139,800
Total Estimated Construction Cost				$921,580
Utility Relocation (5% of Construction Cost)				$46,079
Engr. and Contingency (35% of Construction + Utility)				$338,681
Land Value	14.1	Acres	$65,340	$922,680
Total Estimated Cost				**$2,229,020**

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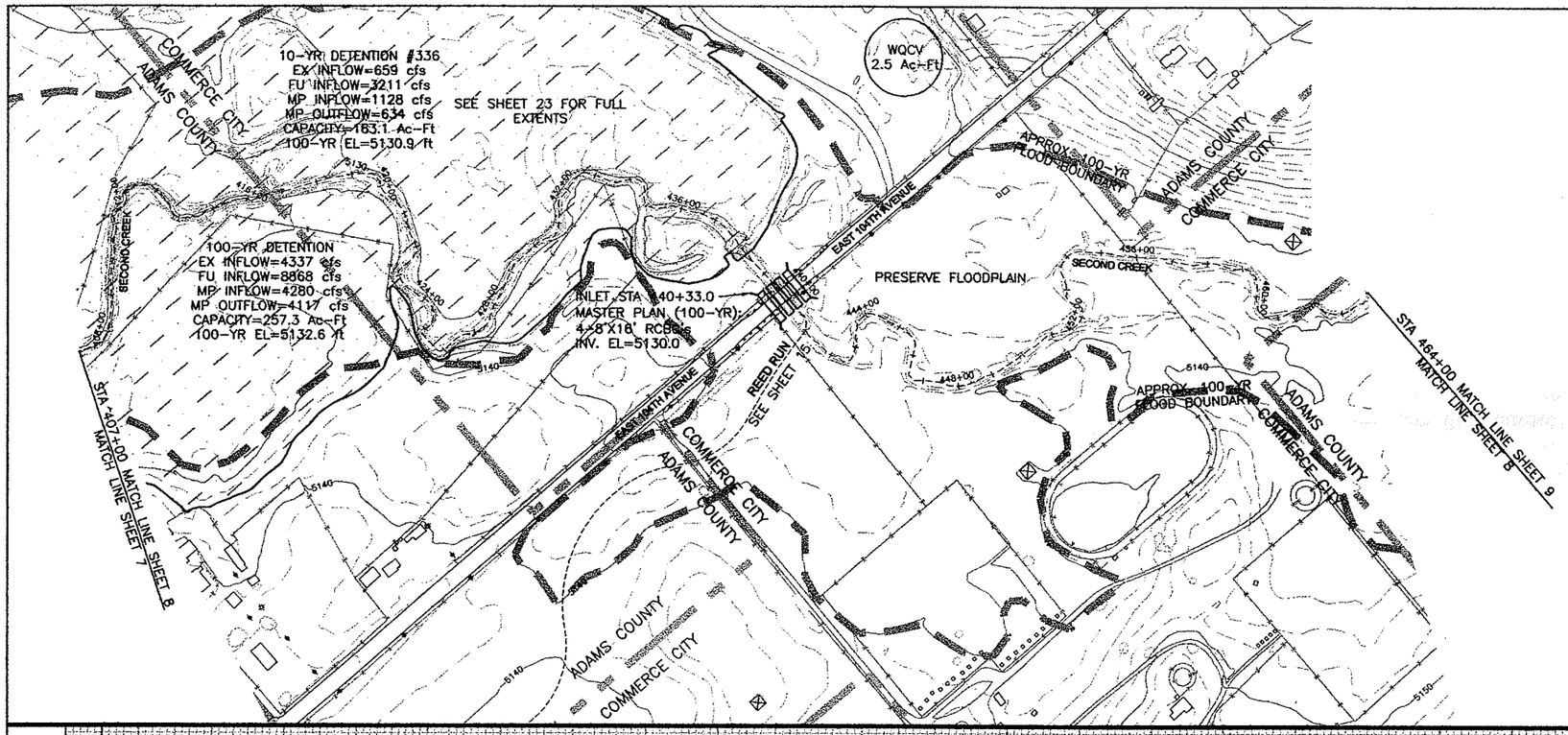

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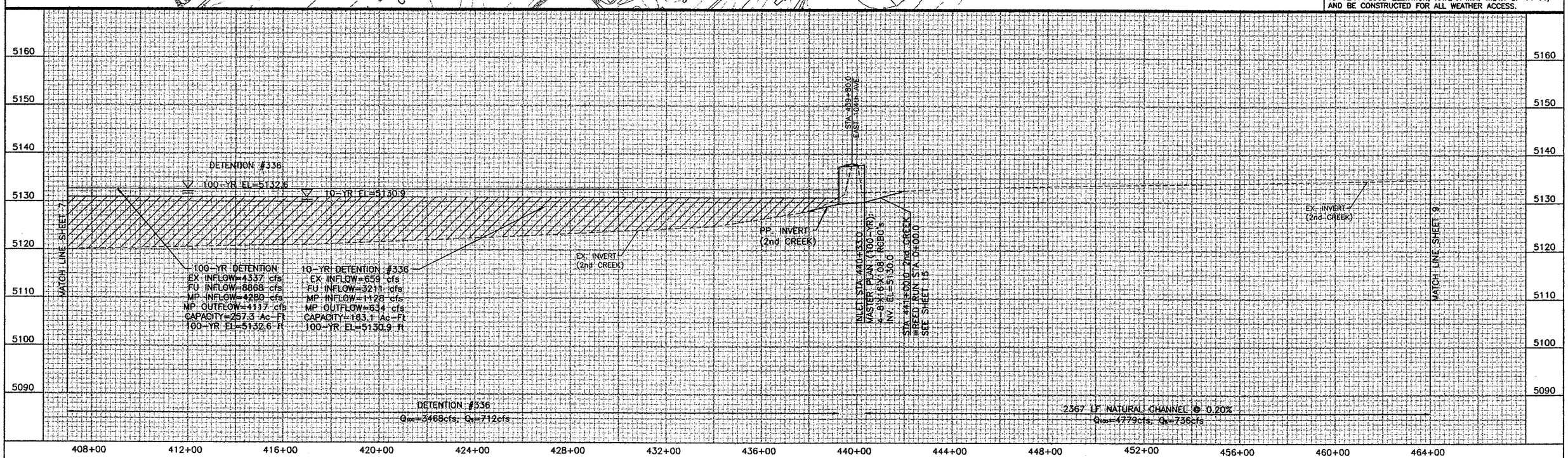

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COMMENTARY SHEET 9

Major Drainageway: Second Creek Main Channel **Stations:** 464+00 to 522+00

EXISTING CONDITIONS:

This reach covers 5800 feet of natural channel with an average slope of 0.15%. Drew Draw enters Second Creek near station 476+50. The existing channel is highly meandering and has no road crossings of the channel.

PROPOSED IMPROVEMENTS:

Except for the addition of a maintenance trail, there are no proposed improvements in this reach. The floodplain will be preserved for its conveyance capacity.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 9

Second Creek Main Channel

Improvement	Quantity	Unit	Unit Cost	Total Cost
Maintenance Trail	5800	LF	$25	$145,000
Total Estimated Construction Cost				$145,000
Utility Relocation (5% of Construction Cost)				$7,250
Engr. and Contingency (35% of Construction + Utility)				$53,288
Land Value	14.6	Acres	$65,340	$957,000
Total Estimated Cost				**$1,162,538**

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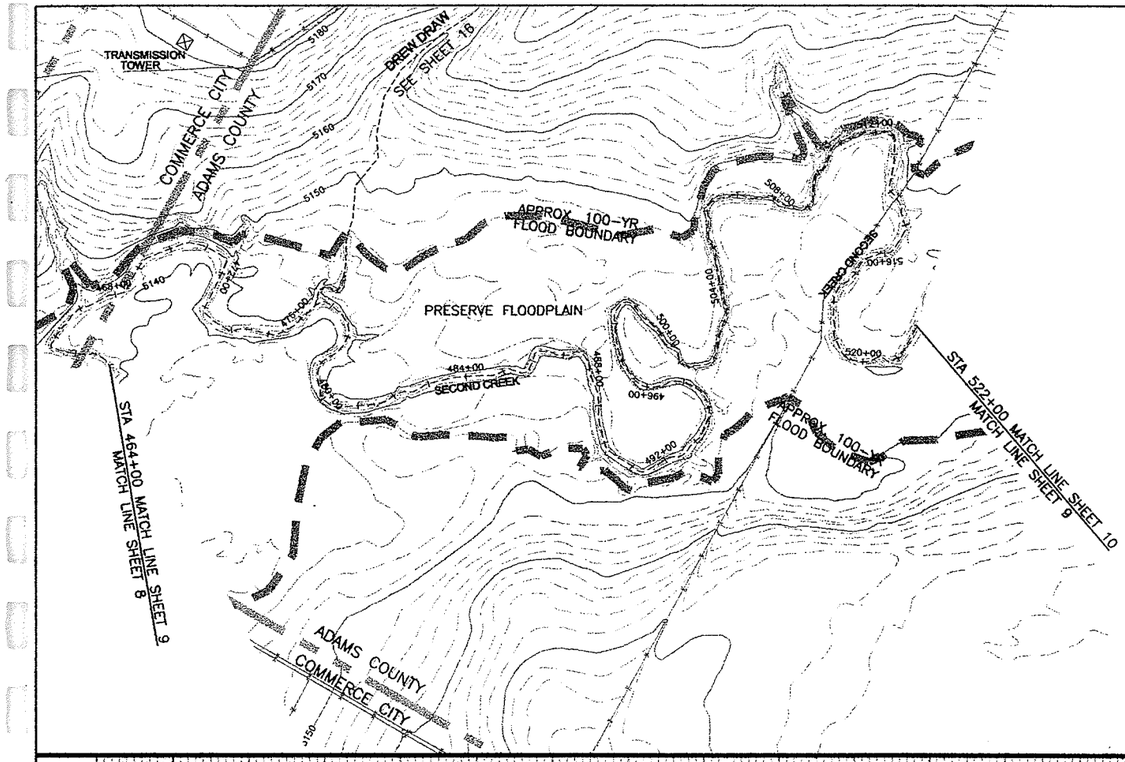

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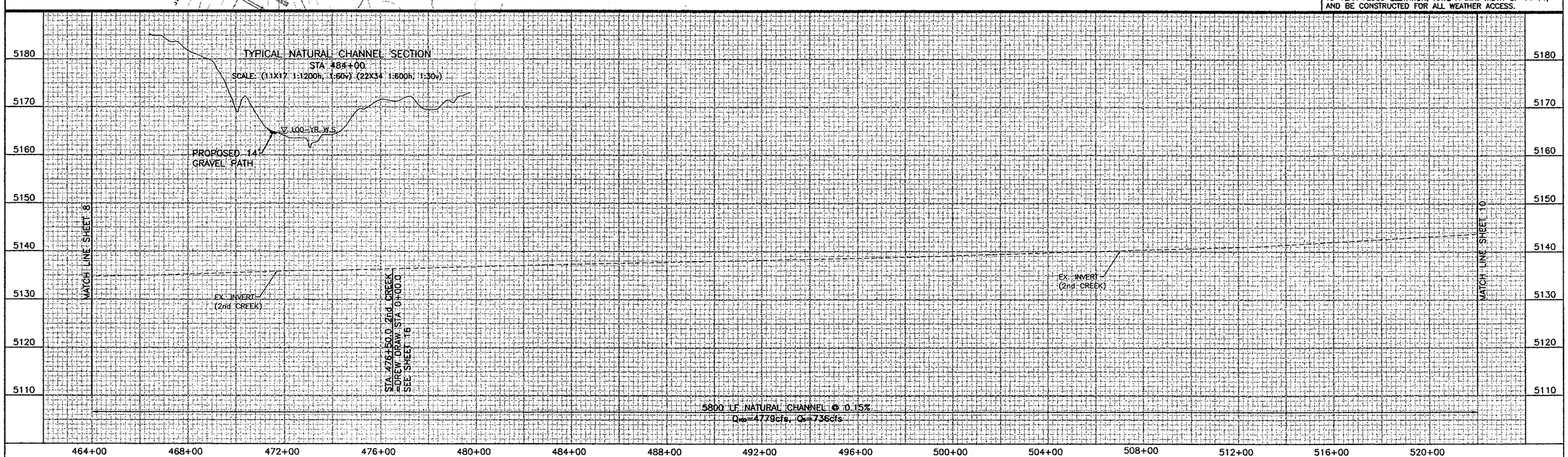

BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001	Kiowa Engineering Corporation 7175 W. Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303) 892-0369 KIOWA PROJECT NO. 01095	DESIGNED BJW/DDR DATE 02/04 DRAWN DDR DATE 02/04 CHECKED BJW DATE 02/04	ADAMS COUNTY, CITY OF BRIGHTON CITY OF COMMERCE CITY, AND URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY UPDATE SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS	2ND CREEK 3500 STA 464+00 to 522+00 SHEET 9

COMMENTARY SHEET 10

Major Drainageway: Second Creek Main Channel **Stations:** 522+00 to 580+00

EXISTING CONDITIONS:

This reach covers 5800 feet of natural channel with an average slope of 0.27%. Peachleaf Run enters Second Creek near station 555+00. There are no road crossings in this reach. Second Creek is highly meandering through this reach.

PROPOSED IMPROVEMENTS:

It is possible that 96th Avenue will be extended to the east in the future; however, currently there are no plans for this crossing. The 100-year peak flow at this location is 4779 cfs and would require a twin 9'x16'box culvert to pass the 100-year flood with no overtopping. If the road is extended, Second Creek will have to be straightened to allow for one crossing location. Although it is not part of the current master plan, it is estimated that the channel would be straightened between stations 566+50 and 581+50, reducing the channel length by 700'. This would require approximately 5500 cubic yards of excavation at a cost of $40,000.

The master plan in this reach requires preservation of the floodplain for 100-year conveyance capacity as well as a maintenance trail located within the floodplain.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 10

Second Creek Main Channel

Improvement	Quantity	Unit	Unit Cost	Total Cost
Maintenance Trail	5800	LF	$25	$145,000
Total Estimated Construction Cost				$145,000
Utility Relocation (5% of Construction Cost)				$7,250
Engr. and Contingency (35% of Construction + Utility)				$53,288
Land Value	14.6	Acres	$65,340	$957,000
Total Estimated Cost				**$1,162,538**

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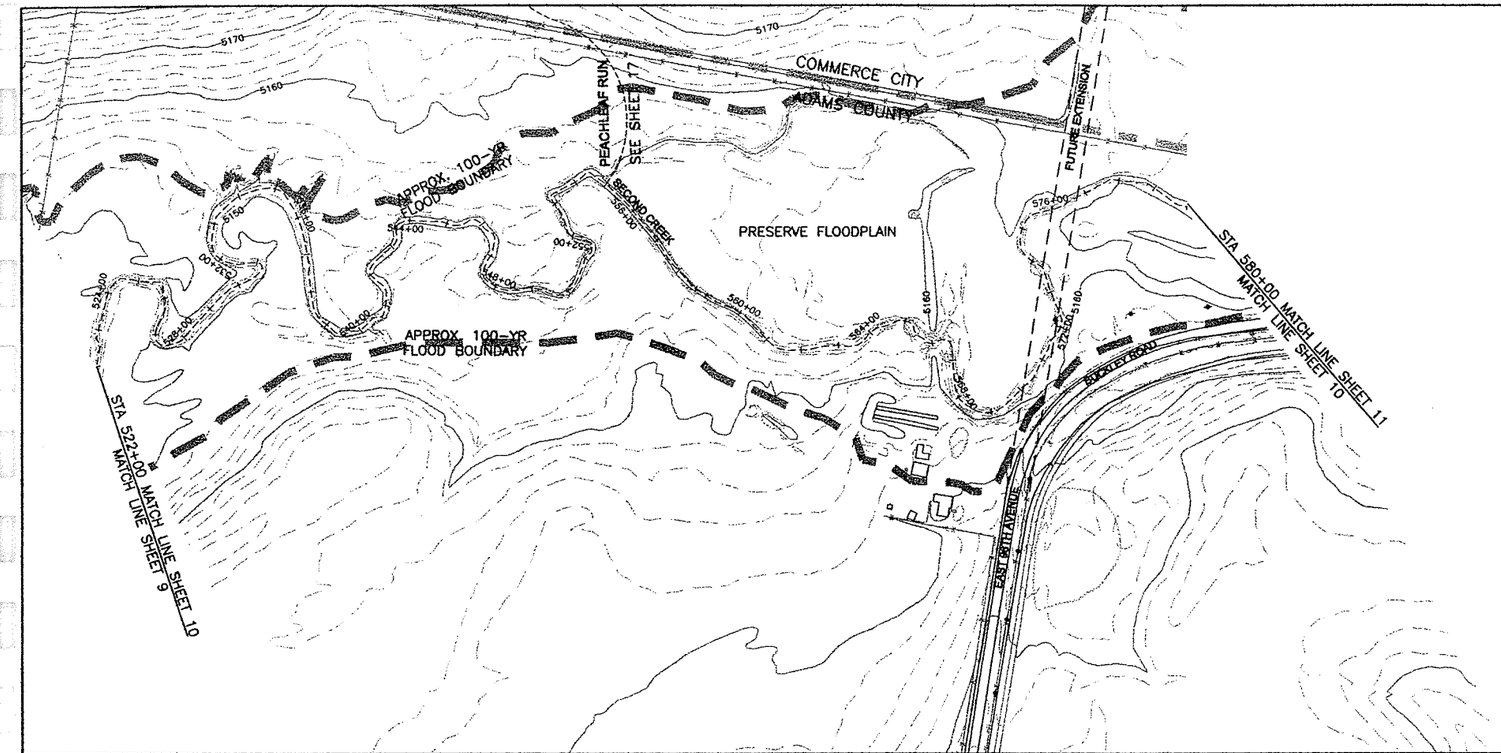

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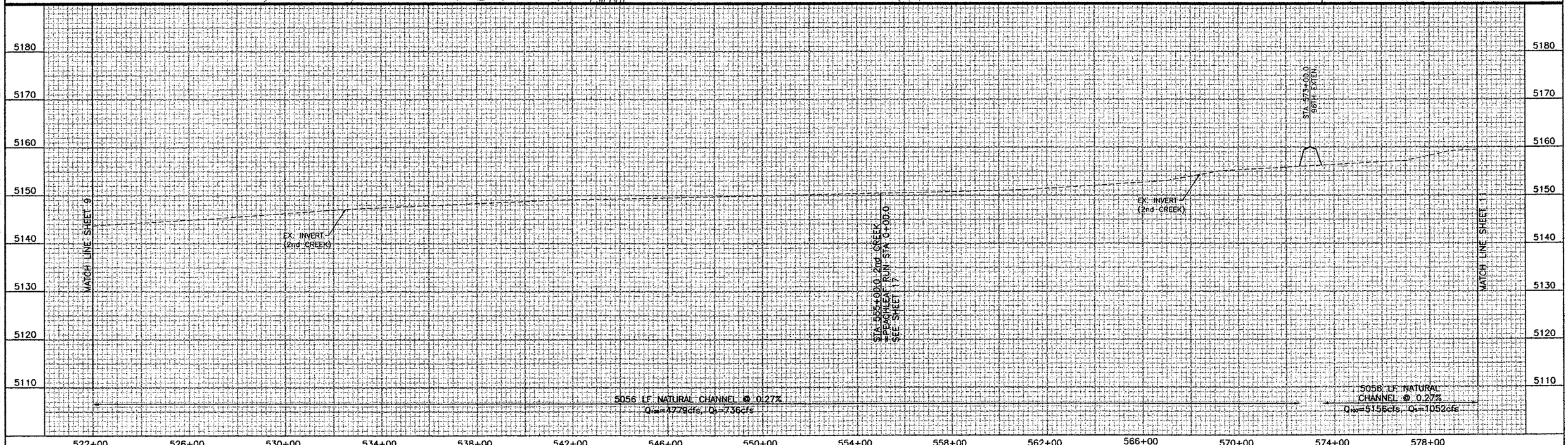

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COMMENTARY SHEET 11

Major Drainageway: Second Creek Main Channel **Stations:** 580+00 to 638+00

EXISTING CONDITIONS:

This reach covers 5800 feet of natural channel with an average slope of 0.27%. The channel parallels Buckley Road and runs adjacent to a race track.

PROPOSED IMPROVEMENTS:

Preserving the 100-year floodplain and adding a trail along the channel are key improvements for this reach.

A water quality basin is located at the outfall of a major east bank drainage area to Second Creek. This facility captures and treats runoff from 129 upstream acres.

It is expected that the race track will be removed in the near future and the area reclaimed for natural habitat. Regrading the west bank of Second Creek is beneficial to enlarge the floodplain through its most narrow section of the study.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 11

Second Creek Main Channel

Improvement	Quantity	Unit	Unit Cost	Total Cost
Water Quality Basin [2.2 ac-ft]	2.2	AF	$22,000	$48,400
Maintenance Trail	5800	LF	$25	$145,000
Total Estimated Construction Cost				$193,400
Utility Relocation (5% of Construction Cost)				$9,670
Engr. and Contingency (35% of Construction + Utility)				$71,075
Land Value	14.6	Acres	$65,340	$957,000
Total Estimated Cost				**$1,231,145**

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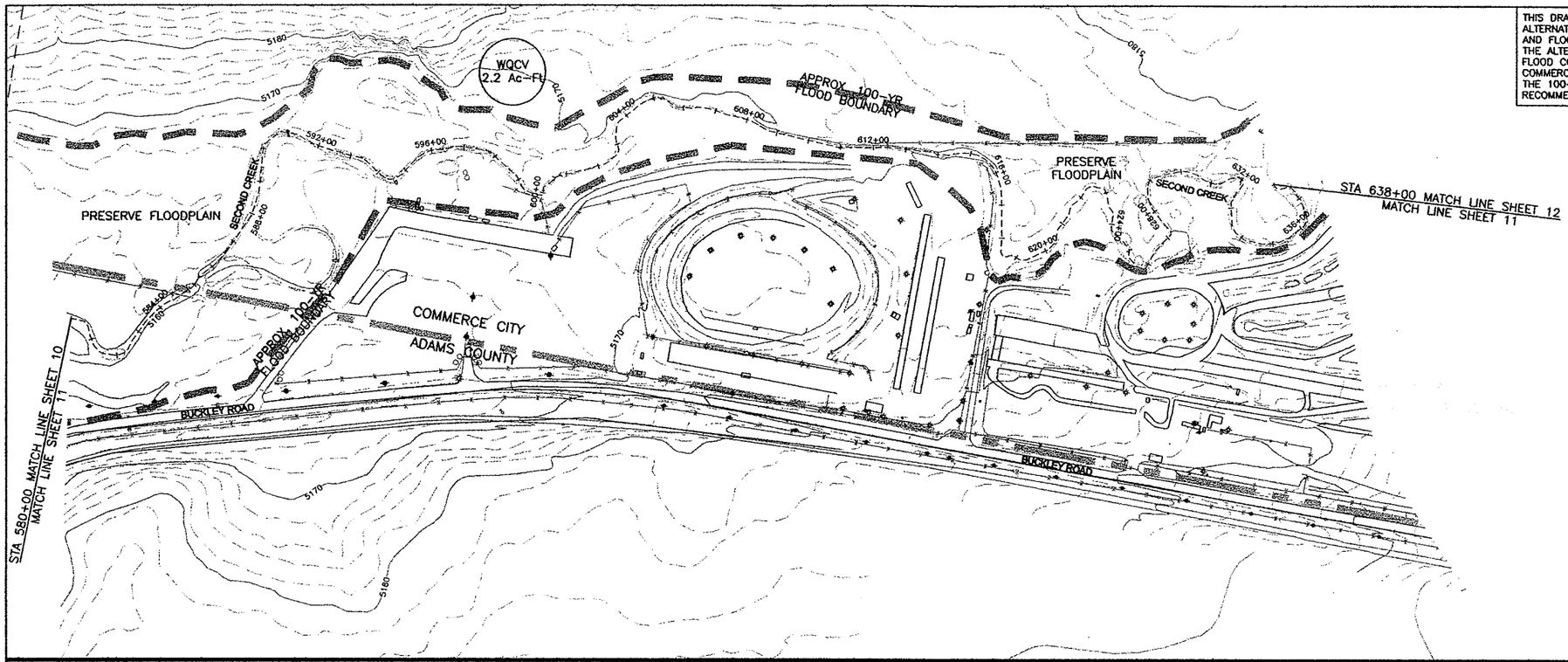

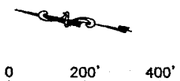

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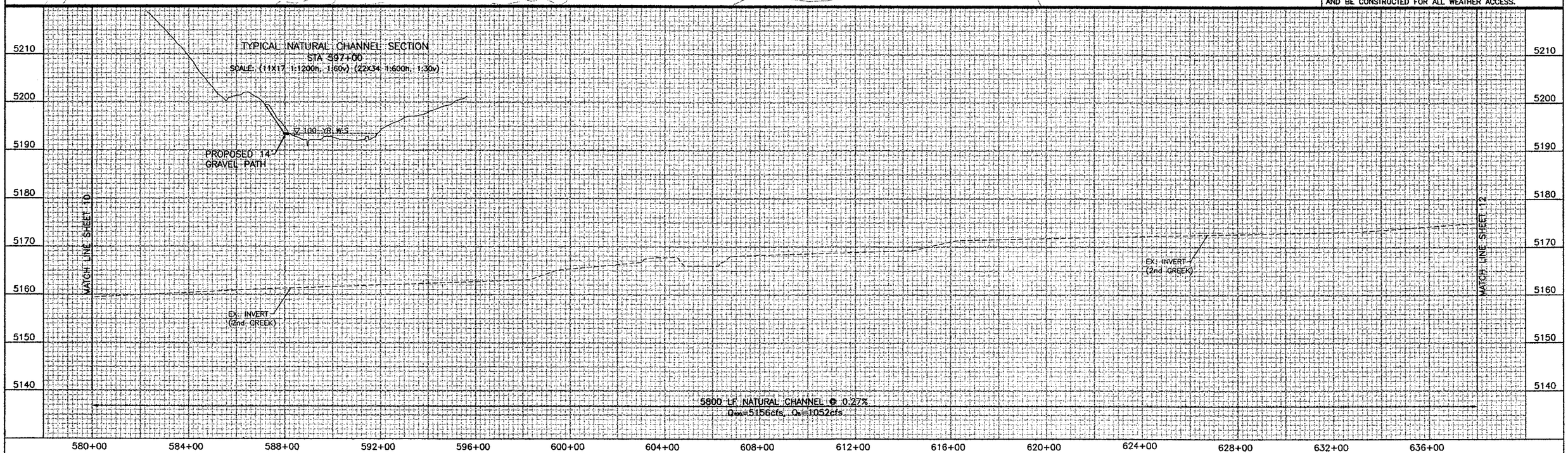

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Kiowa Engineering Corporation
7175 W. Jefferson Avenue, Suite 3400
Lakewood, Colorado 80235
(303) 892-0393
KIOWA PROJECT NO. 01085

DESIGNED	BJW/DDR	DATE 02/04
DRAWN	DDR	DATE 02/04
CHECKED	BJW	DATE 02/04

ADAMS COUNTY, CITY OF BRIGHTON
CITY OF COMMERCE CITY, AND
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

OUTFALL SYSTEMS PLANNING STUDY UPDATE
SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS

2ND CREEK 3500
STA 580+00 to 638+00

SHEET 11

COMMENTARY SHEET 12

Major Drainageway: Second Creek Main Channel **Stations:** 638+00 to 696+00

EXISTING CONDITIONS:

This reach covers 5800 feet north and south of 88th Avenue with an average slope of 0.18%. Two tributaries, Gramma Gulch and Dragway Draw, enter Second Creek along this reach near stations 665+00 and 691+50, respectively. The existing 16' road crossing at 88th Avenue has 2-year conveyance capacity.

Problem areas in this reach include: inadequate capacity under 88th Avenue and the need to preserve the floodplain for flood conveyance.

PROPOSED IMPROVEMENTS:

Preserving the natural channel and floodplain will be key components for this reach. The Second Creek trail will fall within the 100-year floodplain.

The third detention facility in the series of multi-frequency facilities is located just upstream of 88th Avenue. This facility is designed to control the 2-year flood event. Existing 2-year peak flows are 5 cfs. With no upstream improvements, these flows will increase to 1588 cfs (300x). The addition of upstream detention and Detention #366 allows final peaks to be released near existing levels with a downstream outflow of 120 cfs. The 2-year detention design requires 132 acre-feet of storage with a 2-year pool elevation of 5194.0. The 100-year event will spill over the embankment through a controlled spillway. A 500-foot spillway releases the 100-year flows at a depth of 2.1 feet. This detention is shown on Sheet 12 primarily using existing topography. The width of the 100-year pool may be reduced to the existing floodplain limits with approximately 90,000 cubic yards of excavation. Only excavation required to complete the dam embankment was included in the cost estimate for the facility. Alternatively, reducing the spillway elevation, or allowing 88th Avenue to overtop, may be sufficient to maintain the 100-year pool within the 100-year floodplain.

100-year conveyance capacity is also achieved at 88th Avenue via three 10'x20' box culverts. This prevents roadway overtopping up to, and including, the 100-year event. Depending on future land use west of this site, the need for 100-year capacity under 88th Avenue may not be required. If it is decided that a lesser frequency is acceptable, the crossing may be downsized. At the time of this study the local jurisdiction was considering a single 10'x20' RCBC design with road overtopping for flood events greater than the 5-year flood.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 12

Second Creek Main Channel

Improvement	Quantity	Unit	Unit Cost	Total Cost
Box Culvert [Triple 10'x20'] 88th Avenue	156	LF	$7,800	$1,216,800
Detention Facility 366 [132 ac-ft]	1	EA	$449,155	$449,155
Maintenance Trail	5539	LF	$25	$138,475
Total Estimated Construction Cost				$1,804,430
Utility Relocation (5% of Construction Cost)				$90,222
Engr. and Contingency (35% of Construction + Utility)				$663,128
Land Value	62.9	Acres	$65,340	$4,109,061
Total Estimated Cost				**$6,666,841**

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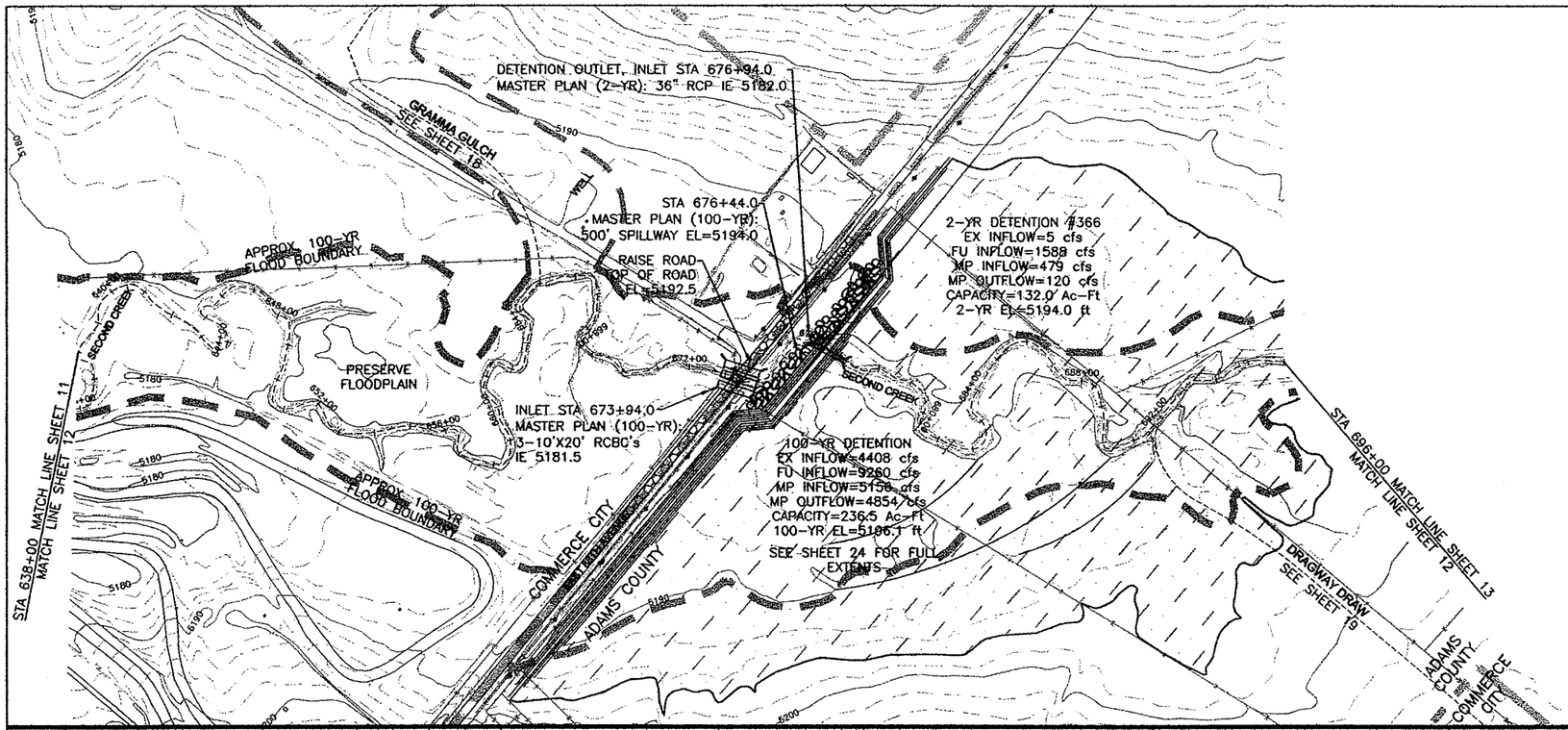

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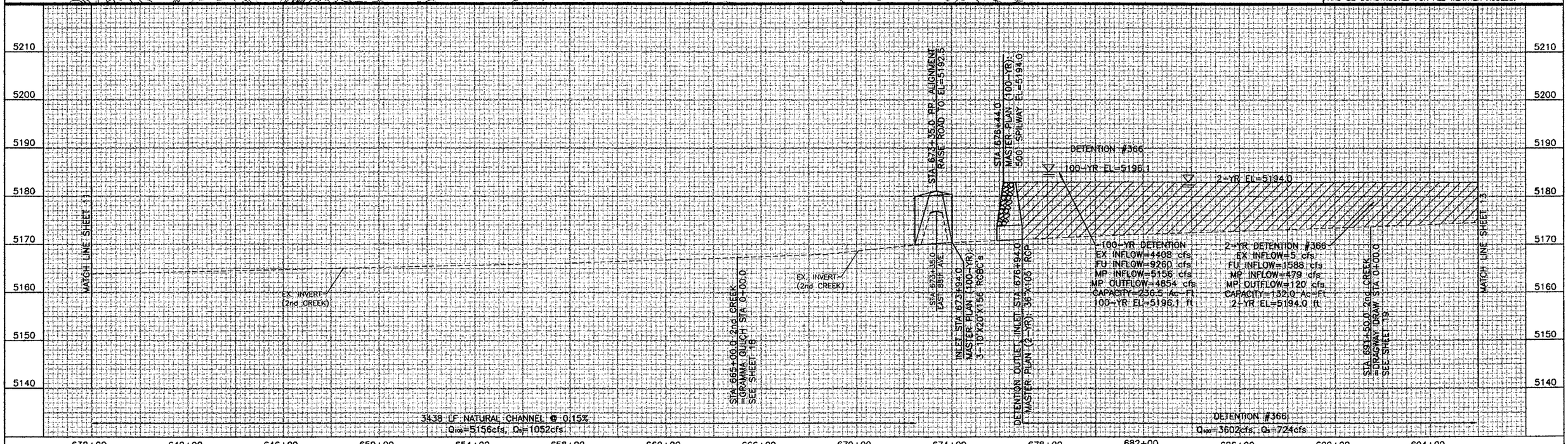

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COMMENTARY SHEET 13

Major Drainageway: Second Creek Main Channel **Stations:** 696+00 to 754+00

EXISTING CONDITIONS:

This reach covers 5800 feet from Detention 366 to near Tower Road. The average channel slope in this reach is 0.32%. West Fork tributary enters Second Creek near station 745+30.

PROPOSED IMPROVEMENTS:

Preserving the floodplain and providing a maintenance trail are key components of the plan in this reach. Second Creek will be preserved as a natural channel through this reach.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 13

Second Creek Main Channel

Improvement	Quantity	Unit	Unit Cost	Total Cost
Maintenance Trail	5800	LF	$25	$145,000
Total Estimated Construction Cost				$145,000
Utility Relocation (5% of Construction Cost)				$7,250
Engr. and Contingency (35% of Construction + Utility)				$53,288
Land Value	14.6	Acres	$65,340	$957,000
Total Estimated Cost				**$1,162,538**

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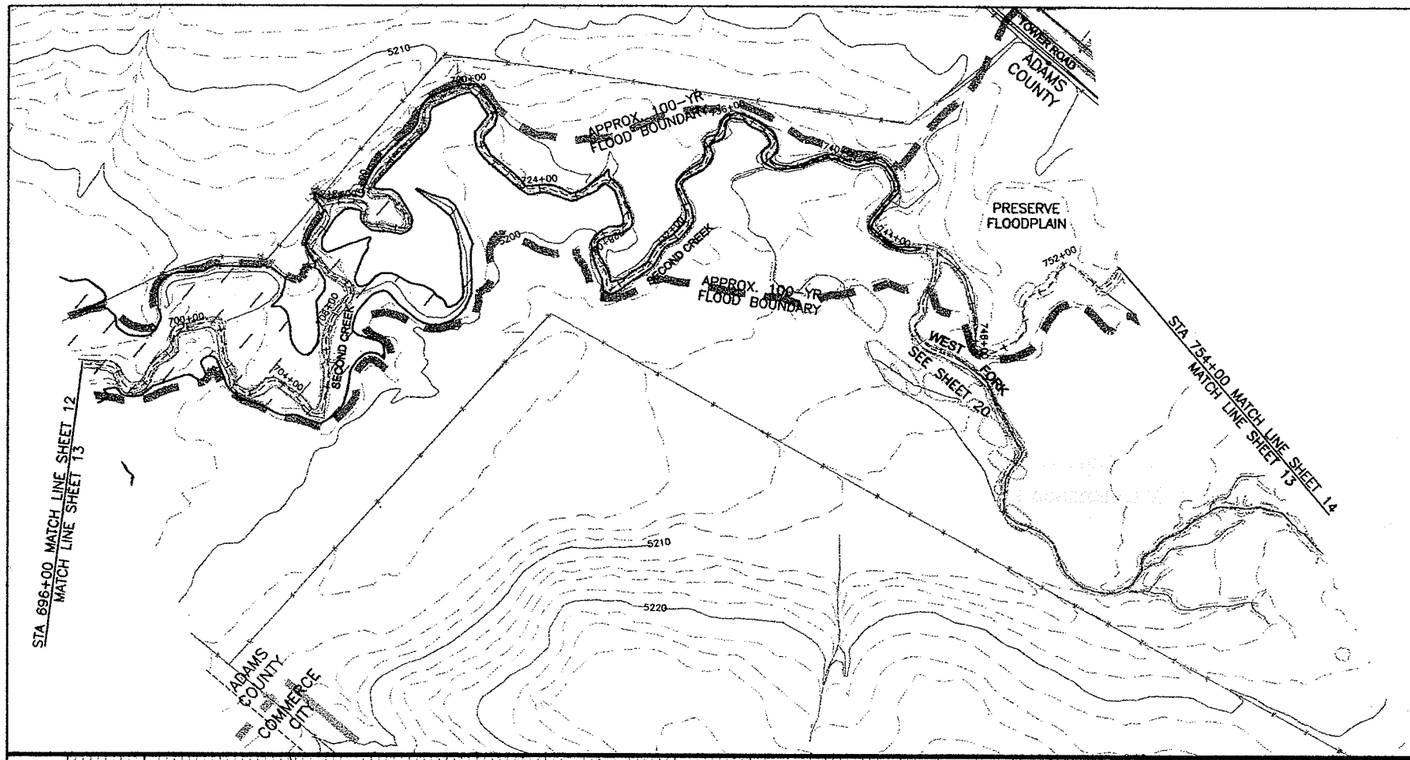

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(303) 692-0369
KIOWA PROJECT NO. 01065

DESIGNED BJW/DDR DATE 02/04
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CHECKED BJW DATE 02/04

ADAMS COUNTY, CITY OF BRIGHTON
CITY OF COMMERCE CITY, AND
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

OUTFALL SYSTEMS PLANNING STUDY UPDATE
SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS

2ND CREEK 3500
STA 696+00 to 754+00

SHEET 13

COMMENTARY SHEET 14

Major Drainageway: Second Creek Main Channel **Stations:** 754+00 to 807+00

EXISTING CONDITIONS:

This reach extends from Tower Road to the upstream study limit at the DIA property. The reach covers 5300 feet of natural channel with an average slope of 0.33%. Sandbar Run enters Second Creek near station 798+00. Tower Road presently has less than 2-year capacity via a 72" CMP.

Problem areas in this reach include: inadequate capacity under Tower Road and the need to preserve the floodplain for flood conveyance.

PROPOSED IMPROVEMENTS:

The Tower Road crossing will be increased to 100-year capacity by replacing the existing structure with four 7'x12' box culverts, or equivalent. This will prevent overtopping of the roadway up to the 100-year flood event.

The floodplain will be preserved for future flood conveyance and a maintenance trail will be added within the floodplain.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 14

Second Creek Main Channel

Improvement	Quantity	Unit	Unit Cost	Total Cost
Box Culvert [Quad 7'x12'] Tower Road	102	LF	$4,370	$445,740
Maintenance Trail	4881	LF	$25	$122,025
Total Estimated Construction Cost				$567,765
Utility Relocation (5% of Construction Cost)				$28,388
Engr. and Contingency (35% of Construction + Utility)				$208,654
Land Value	12.3	Acres	$65,340	$805,365
Total Estimated Cost				**$1,610,172**

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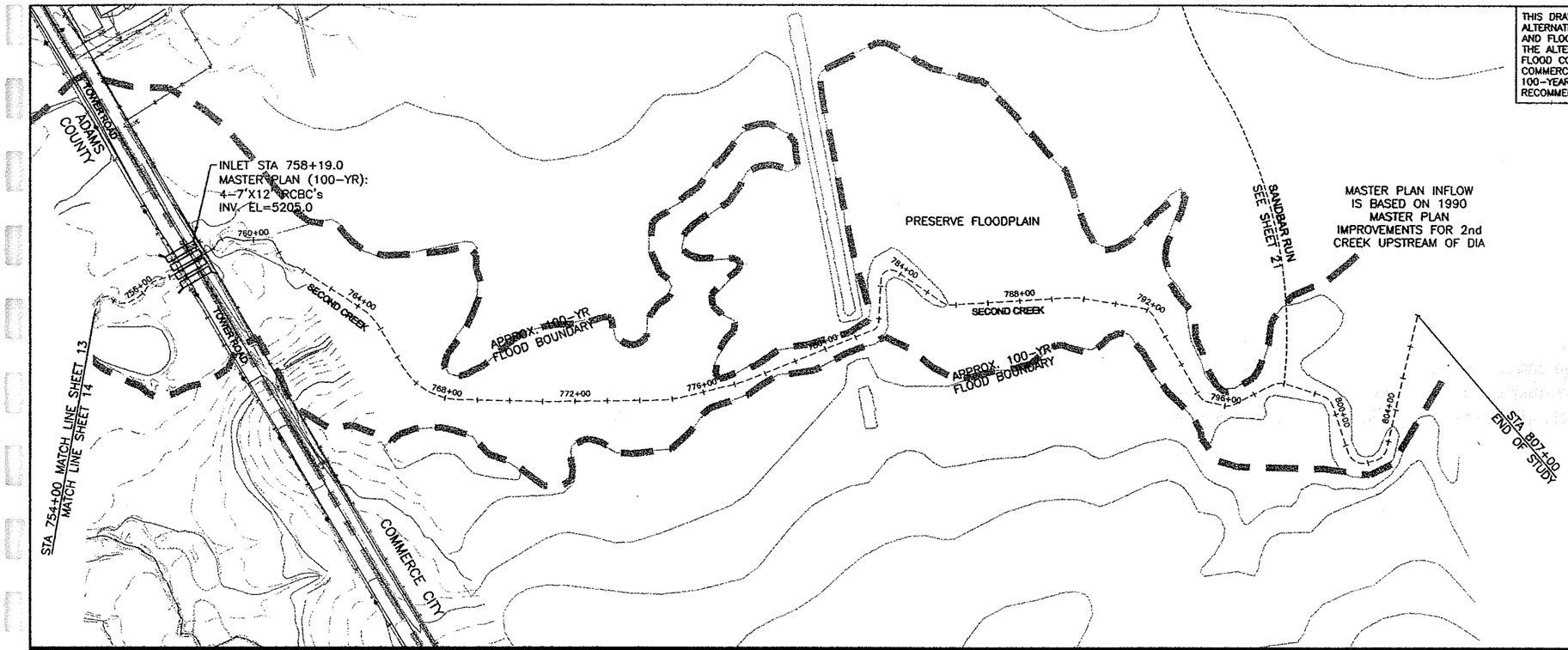

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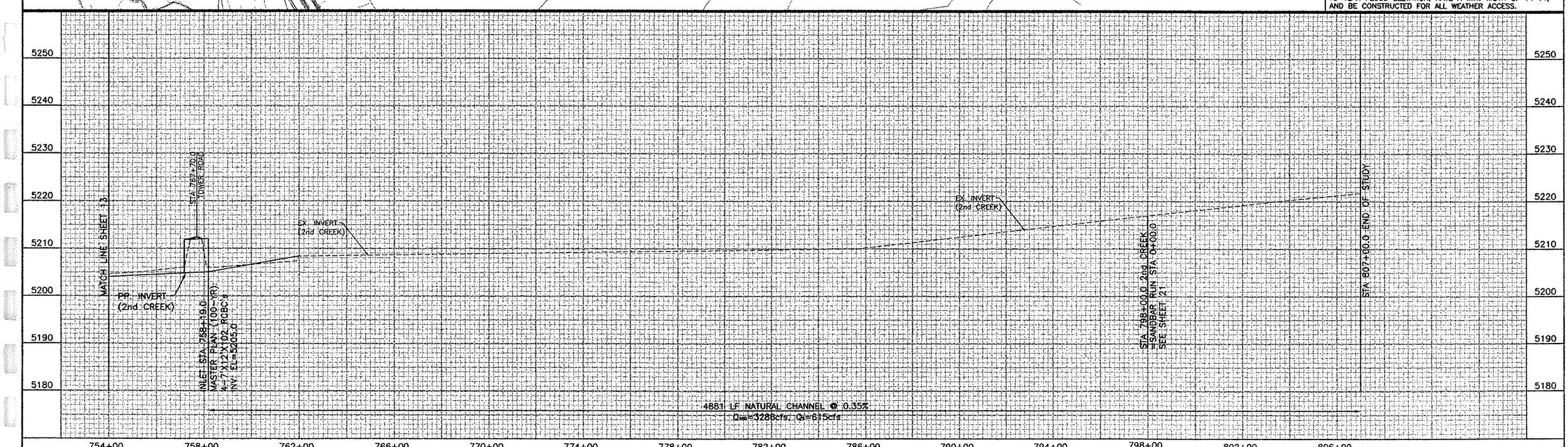

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COMMENTARY SHEET 15

Major Drainageway: Reed Run 3500-03.01 **Stations:** 0+00 to 47+00

EXISTING CONDITIONS:

Reed Run is a 300 acre tributary with 4700 feet of channel. The tributary outfalls to Second Creek near station 441+00, just south of 104th Avenue. The average channel slope in this reach is 1.0%. Most of the channel slope is near 0.50%, but approximately one quarter of the channel is steeply sloped near 2.0%. The area is mostly undeveloped with some pockets of commercial buildings. A new residential development, Fronterra Village, has recently been constructed east of Chambers Road.

Problem areas in this reach include: potential erosion along the steep slopes, a poorly defined channel, and potential water quality degradation from urban development.

PROPOSED IMPROVEMENTS:

The goal for Second Creek and its tributaries upstream of 112th Avenue is to preserve and maintain a natural drainage corridor. The upper quarter of Reed Run is steeply sloped, just over 2.0%. A series of seven check structures will maintain longitudinal slope stability when erosion begins to degrade the channel bottom. The check structures will allow the channel to naturally degrade to a maximum depth of 3 feet at each structure. This plan will allow the channel to evolve naturally to increased upstream flows, but hold the maximum erosion to a controlled level.

Check structures are buried hard points in the channel bottom. They do not impact the channel slope at the time of construction. They are installed prior to erosion, or at the first signs of erosion, to halt degradation to a designed level as it occurs with increased runoff.

Field inspections could not locate the drainage crossing at Chambers Road. Triple 36-inch RCP's are proposed to pass the 10-year event.

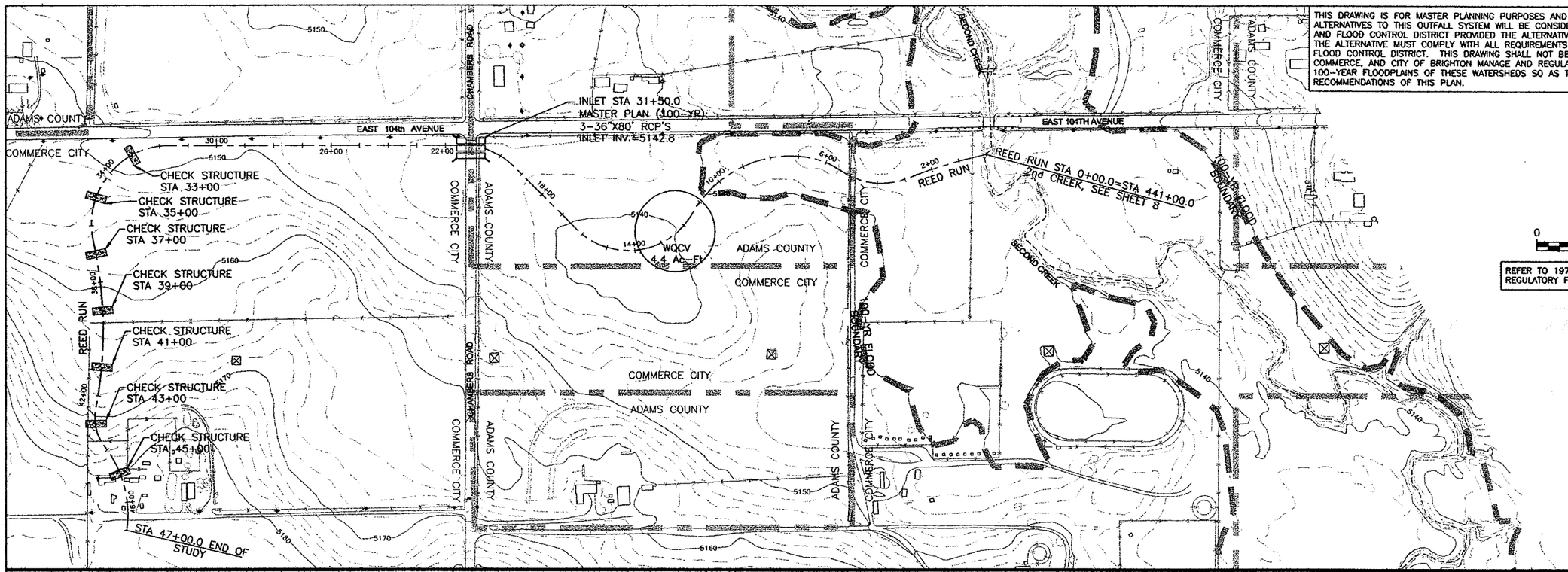
Urban development typically reduces water quality in drainageways, both from urban pollutants and increased sediment transport. A water quality basin will capture these pollutants and settle them from the water prior to releasing to the main channel of Second Creek, and subsequently the South Platte River. This water quality basin treats runoff from 300 upstream acres.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 15

Reed Run

Improvement	Quantity	Unit	Unit Cost	Total Cost
Check structure	7	EA	$10,000	$70,000
RCP [Triple 36"] Chambers Road	240	LF	$60	$14,400
Preserve Floodplain				$0
Water Quality Basin	4.4	AF	$25,000	$110,000
Maintenance Trail	4700	LF	$25	$117,500
Total Estimated Construction Cost				$311,900
Utility Relocation (5% of Construction Cost)				$15,595
Engr. and Contingency (35% of Construction + Utility)				$114,623
Land Value	6.9	Acres	$65,340	$448,332
Total Estimated Cost				**$890,450**

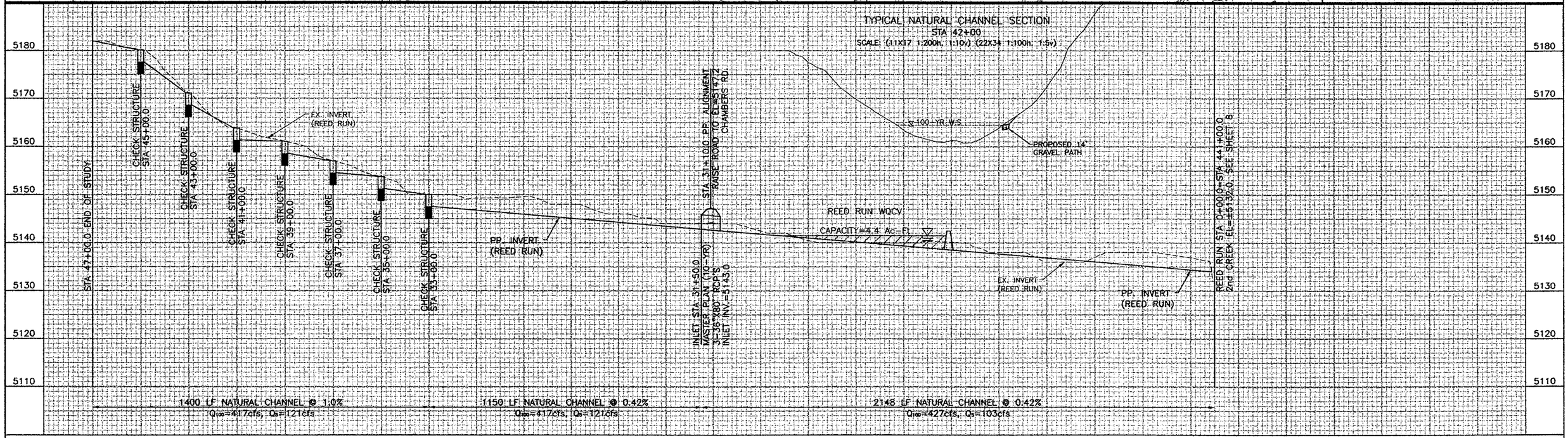
THIS DRAWING IS FOR MASTER PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY LOCAL REVIEWING AGENCIES AND THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT PROVIDED THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY AND STREAM STABILITY. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE LOCAL JURISDICTION AND THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES. ADAMS COUNTY, CITY OF COMMERCE, AND CITY OF BRIGHTON MANAGE AND REGULATE ALL LAND DEVELOPMENT AND REDEVELOPMENT WITHIN THE 100-YEAR FLOODPLAINS OF THESE WATERSHEDS SO AS TO PREVENT FUTURE FLOOD DAMAGES BY FOLLOWING THE RECOMMENDATIONS OF THIS PLAN.



REFER TO 1976 FHAD REPORT FOR ALL REGULATORY FLOODPLAIN INFORMATION

THERE IS NO PREVIOUSLY DEFINED FLOODPLAIN FOR REED RUN

AN ACCESS TRAIL IS REQUIRED ALONG ALL IMPROVED CHANNELS FOR FUTURE MAINTENANCE OF IMPROVEMENTS. THIS TRAIL WILL ALSO SERVE AS A RECREATIONAL TRAIL. THE ALIGNMENT OF THE TRAIL WILL BE DETERMINED BY LOCAL JURISDICTIONS. THE TRAIL SHOULD BE PLACED AT THE 10-YEAR FLOOD ELEVATION, HAVE A MIN. WIDTH OF 14-FT, AND BE CONSTRUCTED FOR ALL WEATHER ACCESS.



BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001	Kiowa Engineering Corporation 7175 W. Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303) 692-0369 KIOWA PROJECT NO. 01095	DESIGNED BJW/DDR DATE 02/04 DRAWN DDR DATE 02/04 CHECKED BJW DATE 02/04	ADAMS COUNTY, CITY OF BRIGHTON CITY OF COMMERCE CITY, AND URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY UPDATE SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS	REED RUN 3500-03.01 STA 0+00 to 47+00 SHEET 15

COMMENTARY SHEET 16

Major Drainageway: Drew Draw 3500-03.02 **Stations:** 0+00 to 33+00

EXISTING CONDITIONS:

The Drew Draw tributary length is 3300 feet and extends from the downstream study limit at Second Creek near station 476+50 east for 3300 feet. The average channel slope in this reach is 2.2%. The tributary is undeveloped.

Problem areas in this reach include: potential erosion along the steep slopes, a poorly defined channel, and potential water quality degradation.

PROPOSED IMPROVEMENTS:

The average channel slope of 2.2% is highly susceptible to future erosion problems with changes in hydrologic conditions. A series of ten check structures will maintain longitudinal slope stability when erosion begins to degrade the channel bottom. The check structures will allow the channel to naturally degrade to a maximum depth of 3 feet. This plan allows the channel to evolve naturally to increased upstream flows, but hold the maximum erosion to a controlled level.

A water quality basin near the outfall to Second Creek will capture any pollutants and sediments, and settle them from the water prior to releasing to the main channel of Second Creek. This basin effectively treats runoff from 245 upstream acres.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 16

Drew Draw

Improvement	Quantity	Unit	Unit Cost	Total Cost
Check structure	10	EA	$10,000	$100,000
Preserve Floodplain				$0
Water Quality Basin	3.7	AF	$25,000	$92,500
Maintenance Trail	3300	LF	$25	$82,500
Total Estimated Construction Cost				$275,000
Utility Relocation (5% of Construction Cost)				$13,750
Engr. and Contingency (35% of Construction + Utility)				$101,063
Land Value	5.0	Acres	$65,340	$328,086
Total Estimated Cost				**$717,899**

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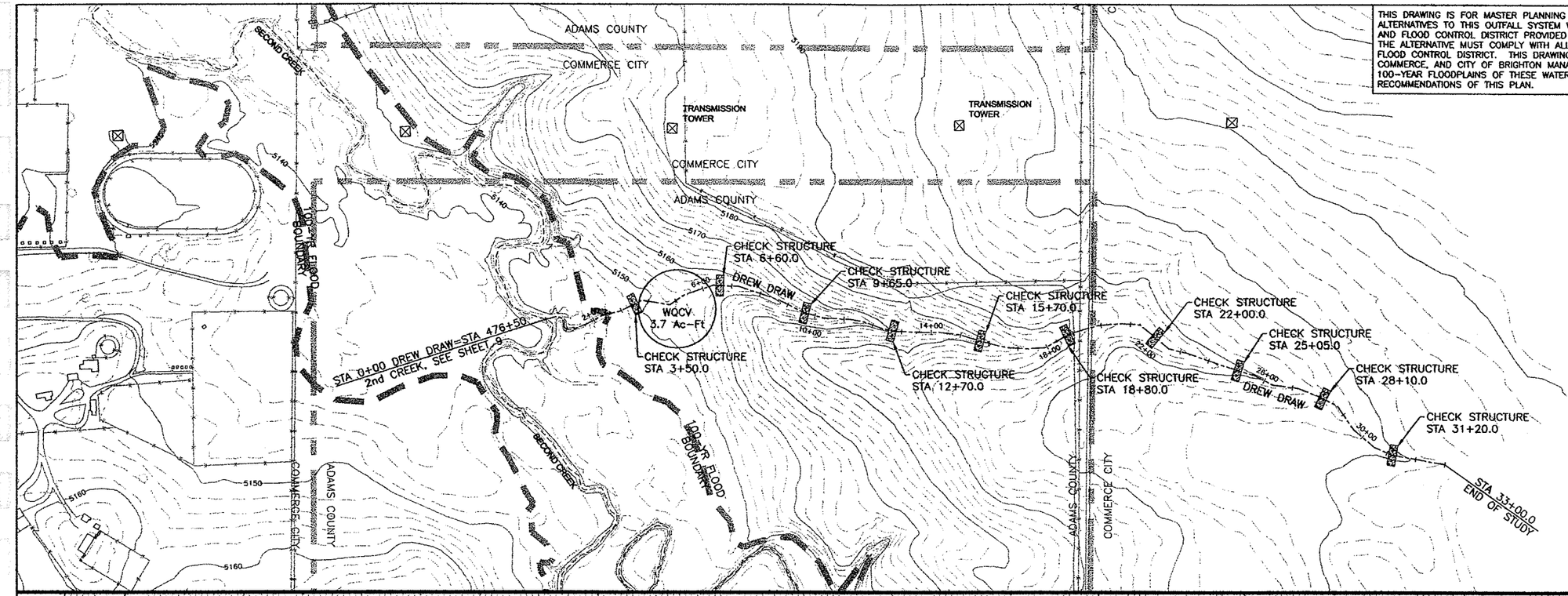
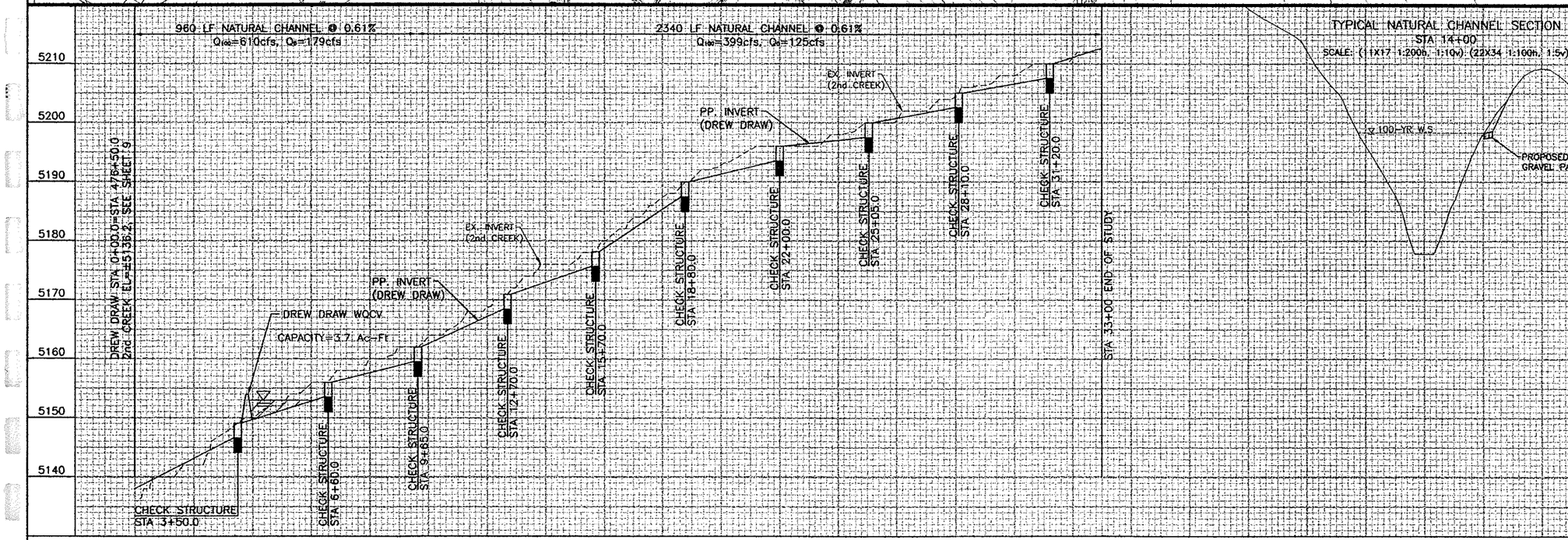


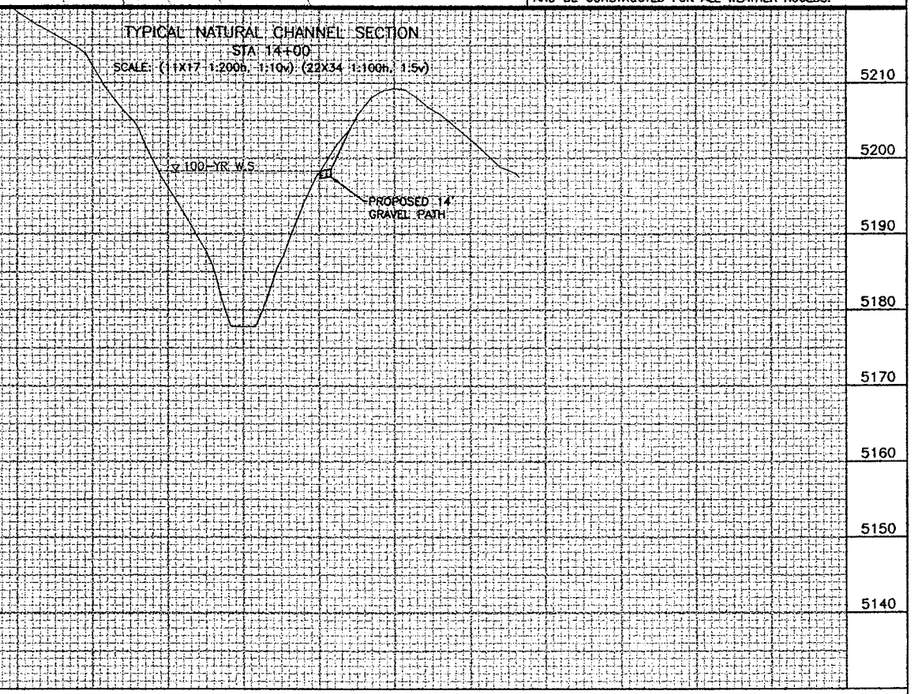
0 200' 400'

REFER TO 1976 FHAD REPORT FOR ALL REGULATORY FLOODPLAIN INFORMATION

THERE IS NO PREVIOUSLY DEFINED FLOODPLAIN FOR DREW DRAW

AN ACCESS TRAIL IS REQUIRED ALONG ALL IMPROVED CHANNELS FOR FUTURE MAINTENANCE OF IMPROVEMENTS. THIS TRAIL WILL ALSO SERVE AS A RECREATIONAL TRAIL. THE ALIGNMENT OF THE TRAIL WILL BE DETERMINED BY LOCAL JURISDICTIONS. THE TRAIL SHOULD BE PLACED AT THE 10-YEAR FLOOD ELEVATION, HAVE A MIN. WIDTH OF 14-FT, AND BE CONSTRUCTED FOR ALL WEATHER ACCESS.





BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001

Kiowa Engineering Corporation
7175 W. Jefferson Avenue, Suite 3400
Lakewood, Colorado 80235
(303) 692-0369
KIOWA PROJECT NO. 01095

DESIGNED BJW/DDR DATE 02/04
DRAWN DDR DATE 02/04
CHECKED BJW DATE 02/04

ADAMS COUNTY, CITY OF BRIGHTON
CITY OF COMMERCE CITY, AND
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

OUTFALL SYSTEMS PLANNING STUDY UPDATE
SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS

DREW DRAW 3500-03.02
STA 00+00 to 33+00

SHEET 16

COMMENTARY SHEET 17

Major Drainageway: Peachleaf Run 3500-03.03 **Stations:** 0+00 to 27+00

EXISTING CONDITIONS:

Peachleaf Run is an east bank tributary with a channel length of 2700 feet. This tributary enters Second Creek near station 555+00. The average channel slope in this reach is 1.9%. The tributary is undeveloped.

Problem areas in this reach include: potential erosion along the steep slopes, a poorly defined channel, and potential water quality degradation.

PROPOSED IMPROVEMENTS:

The average channel slope of 1.9% is susceptible to future erosion problems with changes in hydrologic conditions. A series of seven check structures will maintain longitudinal slope stability when erosion begins to degrade the channel bottom. The check structures will allow the channel to naturally degrade to a maximum depth of 3 feet. This plan allows the channel to evolve naturally to increased upstream flows, but hold the maximum erosion to a controlled level.

Development pressures may warrant the construction of a 100-year grass-lined channel. Although this is not part of the master plan, a 100-year channel section would require a 40' bottom width with 4:1 side sloes and a design slope of 0.7%.

A water quality basin near the outfall to Second Creek will capture any pollutants and sediments, and settle them from the water prior to releasing to the main channel of Second Creek. This basin effectively treats runoff from 210 upstream acres.

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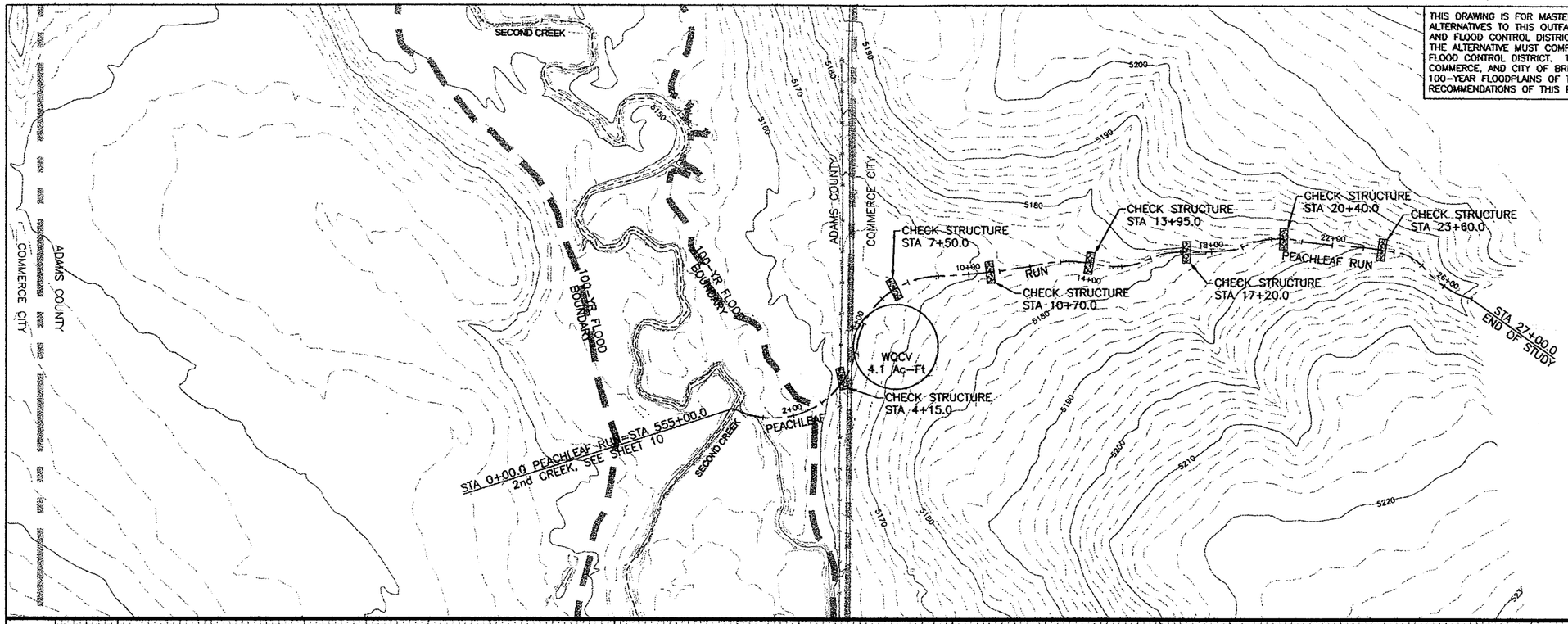
PRELIMINARY DESIGN COST ESTIMATE: SHEET 17

Peachleaf Run

Improvement	Quantity	Unit	Unit Cost	Total Cost
Check structure	7	EA	$10,000	$70,000
Preserve Floodplain				$0
Water Quality Basin	4.1	AF	$25,000	$102,500
Maintenance Trail	2700	LF	$25	$67,500
Total Estimated Construction Cost				$240,000
Utility Relocation (5% of Construction Cost)				$12,000
Engr. and Contingency (35% of Construction + Utility)				$88,200
Land Value	4.5	Acres	$65,340	$291,798
Total Estimated Cost				**$631,998**

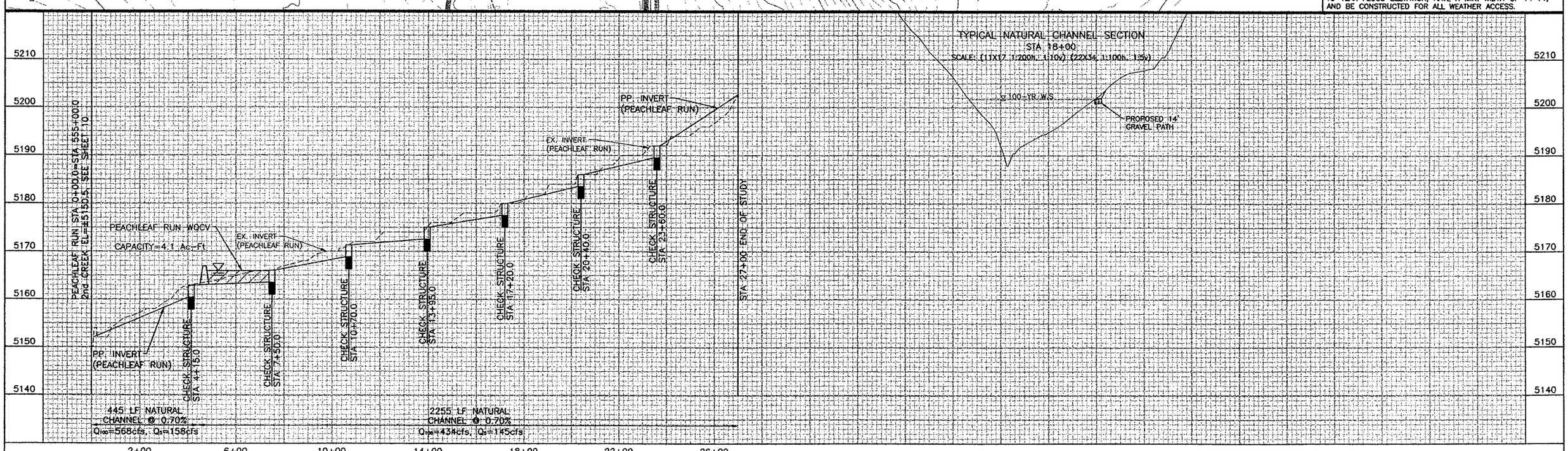
THIS DRAWING IS FOR MASTER PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY LOCAL REVIEWING AGENCIES AND THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT PROVIDED THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY AND STREAM STABILITY. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE LOCAL JURISDICTION AND THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES. ADAMS COUNTY, CITY OF COMMERCE, AND CITY OF BRIGHTON MANAGE AND REGULATE ALL LAND DEVELOPMENT AND REDEVELOPMENT WITHIN THE 100-YEAR FLOODPLAINS OF THESE WATERSHEDS SO AS TO PREVENT FUTURE FLOOD DAMAGES BY FOLLOWING THE RECOMMENDATIONS OF THIS PLAN.



REFER TO 1976 FHAD REPORT FOR ALL REGULATORY FLOODPLAIN INFORMATION

THERE IS NO PREVIOUSLY DEFINED FLOODPLAIN FOR PEACHLEAF RUN

AN ACCESS TRAIL IS REQUIRED ALONG ALL IMPROVED CHANNELS FOR FUTURE MAINTENANCE OF IMPROVEMENTS. THIS TRAIL WILL ALSO SERVE AS A RECREATIONAL TRAIL. THE ALIGNMENT OF THE TRAIL WILL BE DETERMINED BY LOCAL JURISDICTIONS. THE TRAIL SHOULD BE PLACED AT THE 10-YEAR FLOOD ELEVATION, HAVE A MIN. WIDTH OF 14-FT, AND BE CONSTRUCTED FOR ALL WEATHER ACCESS.



TYPICAL NATURAL CHANNEL SECTION
STA 18+00
SCALE: (11X17 1:200h, 1:10v) (22X34, 1:100h, 1:5v)

BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001	Kiowa Engineering Corporation 7175 W. Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303) 692-0369 KIOWA PROJECT NO. 01085	DESIGNED BJW/DDR DATE 02/04 DRAWN DDR DATE 02/04 CHECKED BJW DATE 02/04	ADAMS COUNTY, CITY OF BRIGHTON CITY OF COMMERCE CITY, AND URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY UPDATE SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS	PEACHLEAF RUN 3500-03.03 STA 0+00 to 27+00 SHEET 17

COMMENTARY SHEET 18

Major Drainageway: Gramma Gulch 3500-03.04 **Stations:** 0+00 to 56+00

EXISTING CONDITIONS:

Gramma Gulch is an east bank tributary with a channel length of 5600 feet. This tributary enters Second Creek near station 665+00. The average channel slope in this reach is 1.1%. The tributary is undeveloped.

Problem areas in this reach include: potential erosion along the steep slopes, a poorly defined channel, and potential water quality degradation.

PROPOSED IMPROVEMENTS:

Based on flow magnitudes and channel conditions, a stable slope of 0.49% was calculated for this reach. A series of ten check structures will maintain longitudinal slope stability when erosion begins to degrade the channel bottom. The check structures will allow the channel to naturally degrade to a maximum depth of 3 feet. This plan allows the channel to evolve naturally to increased upstream flows, but hold the maximum erosion to a controlled level.

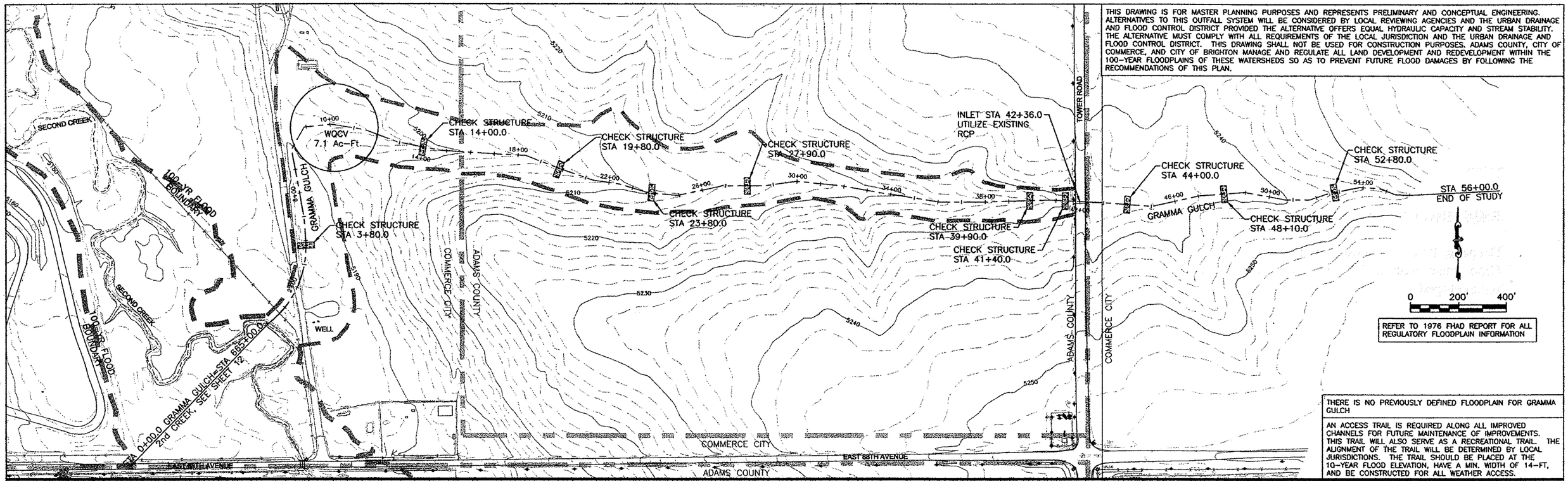
A water quality basin near the outfall to Second Creek will capture any pollutants and sediments, and settle them from the water prior to releasing to the main channel of Second Creek. This basin effectively treats runoff from 565 upstream acres.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 18

Gramma Gulch

Improvement	Quantity	Unit	Unit Cost	Total Cost
Check structure	10	EA	$10,000	$100,000
Preserve Floodplain				$0
Water Quality Basin	7.1	AF	$25,000	$177,500
Maintenance Trail	5600	LF	$25	$140,000
Total Estimated Construction Cost				$417,500
Utility Relocation (5% of Construction Cost)				$20,875
Engr. and Contingency (35% of Construction + Utility)				$153,431
Land Value	8.8	Acres	$65,340	$574,638
Total Estimated Cost				**$1,166,444**

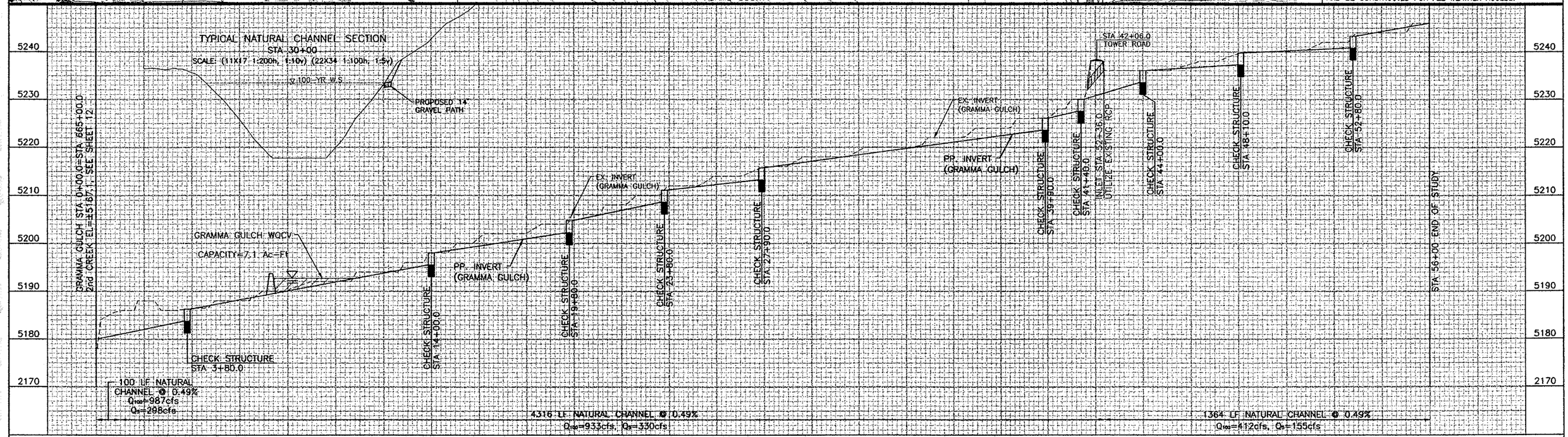
THIS DRAWING IS FOR MASTER PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY LOCAL REVIEWING AGENCIES AND THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT PROVIDED THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY AND STREAM STABILITY. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE LOCAL JURISDICTION AND THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES. ADAMS COUNTY, CITY OF COMMERCE, AND CITY OF BRIGHTON MANAGE AND REGULATE ALL LAND DEVELOPMENT AND REDEVELOPMENT WITHIN THE 100-YEAR FLOODPLAINS OF THESE WATERSHEDS SO AS TO PREVENT FUTURE FLOOD DAMAGES BY FOLLOWING THE RECOMMENDATIONS OF THIS PLAN.



REFER TO 1976 FHAD REPORT FOR ALL REGULATORY FLOODPLAIN INFORMATION

THERE IS NO PREVIOUSLY DEFINED FLOODPLAIN FOR GRAMMA GULCH

AN ACCESS TRAIL IS REQUIRED ALONG ALL IMPROVED CHANNELS FOR FUTURE MAINTENANCE OF IMPROVEMENTS. THIS TRAIL WILL ALSO SERVE AS A RECREATIONAL TRAIL. THE ALIGNMENT OF THE TRAIL WILL BE DETERMINED BY LOCAL JURISDICTIONS. THE TRAIL SHOULD BE PLACED AT THE 10-YEAR FLOOD ELEVATION, HAVE A MIN. WIDTH OF 14-FT, AND BE CONSTRUCTED FOR ALL WEATHER ACCESS.



BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001	Kiowa Engineering Corporation 7175 W. Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303) 892-0389 KIOWA PROJECT NO. 01099	DESIGNED BJW/DDR DATE 02/04 DRAWN DDR DATE 02/04 CHECKED BJW DATE 02/04	ADAMS COUNTY, CITY OF BRIGHTON CITY OF COMMERCE CITY, AND URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY UPDATE SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS	GRAMMA GULCH 3500-03.04 STA 0+00 to 56+00	SHEET 18

COMMENTARY SHEET 19

Major Drainageway: Dragway Draw 3500-03.05 **Stations:** 0+00 to 52+00

EXISTING CONDITIONS:

Dragway Draw is a west bank tributary with a channel length of 5200 feet. This tributary enters Second Creek near station 691+50. The average channel slope in this reach is 1.8%. The tributary is undeveloped.

Problem areas in this reach include: potential erosion along the steep slopes, a poorly defined channel, and potential water quality degradation.

PROPOSED IMPROVEMENTS:

Based on flow magnitudes and channel conditions, a stable slope of 0.68% was calculated for this reach. A series of fourteen check structures will maintain longitudinal slope stability when erosion begins to degrade the channel bottom. The check structures will allow the channel to naturally degrade to a maximum depth of 3 feet. This plan allows the channel to evolve naturally to increased upstream flows, but hold the maximum erosion to a controlled level.

A water quality basin near the outfall to Second Creek will capture any pollutants and sediments, and settle them from the water prior to releasing to the main channel of Second Creek. This basin effectively treats runoff from 345 upstream acres.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 19

Dragway Draw

Improvement	Quantity	Unit	Unit Cost	Total Cost
Check structure	14	EA	$10,000	$140,000
Preserve Floodplain				$0
Water Quality Basin	6.9	AF	$25,000	$172,500
Maintenance Trail	5200	LF	$25	$130,000
Total Estimated Construction Cost				$442,500
Utility Relocation (5% of Construction Cost)				$22,125
Engr. and Contingency (35% of Construction + Utility)				$162,619
Land Value	8.3	Acres	$65,340	$540,282
Total Estimated Cost				**$1,167,526**

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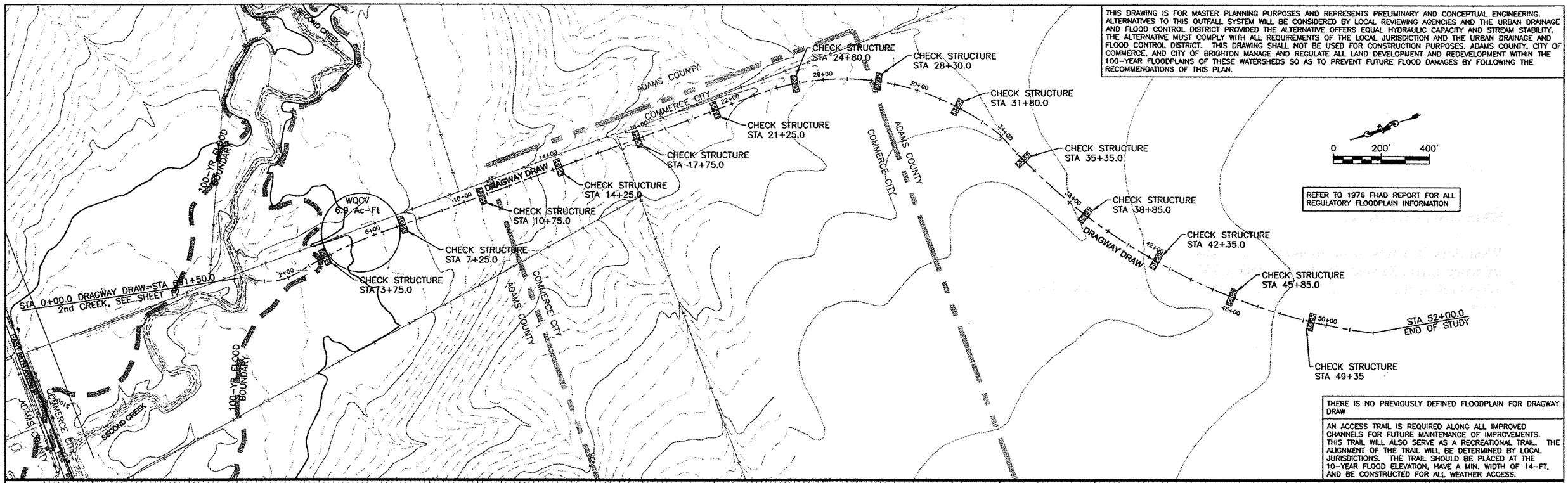
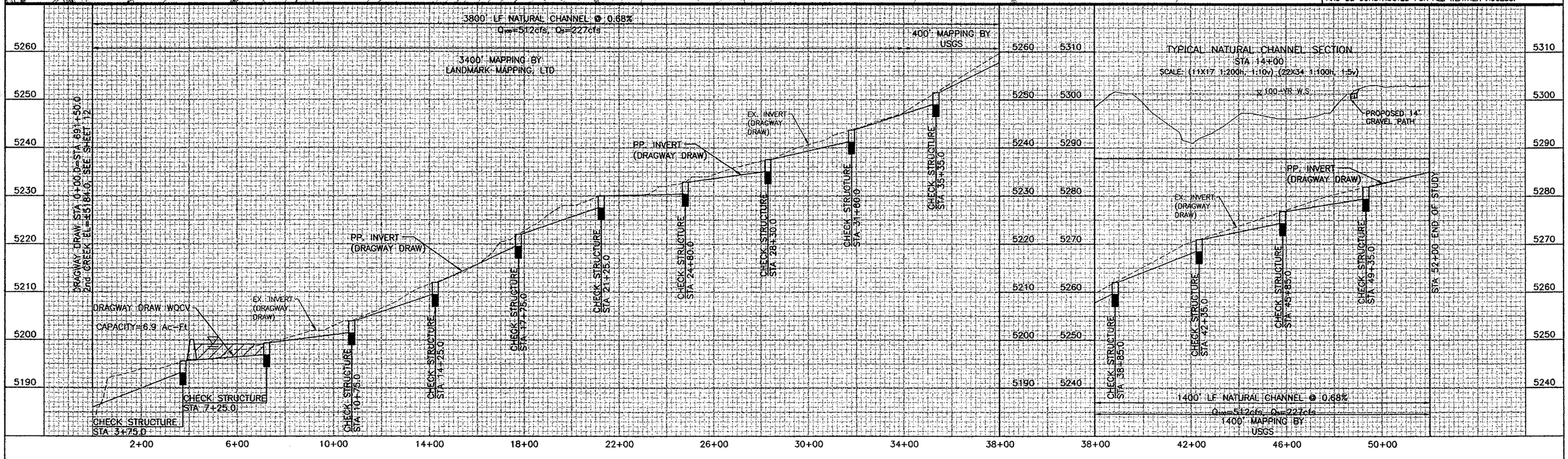


REFER TO 1976 FHAD REPORT FOR ALL REGULATORY FLOODPLAIN INFORMATION

THERE IS NO PREVIOUSLY DEFINED FLOODPLAIN FOR DRAGWAY DRAW

AN ACCESS TRAIL IS REQUIRED ALONG ALL IMPROVED CHANNELS FOR FUTURE MAINTENANCE OF IMPROVEMENTS. THIS TRAIL WILL ALSO SERVE AS A RECREATIONAL TRAIL. THE ALIGNMENT OF THE TRAIL WILL BE DETERMINED BY LOCAL JURISDICTIONS. THE TRAIL SHOULD BE PLACED AT THE 10-YEAR FLOOD ELEVATION, HAVE A MIN. WIDTH OF 14-FT, AND BE CONSTRUCTED FOR ALL WEATHER ACCESS.



BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001	Kiowa Engineering Corporation 7175 W. Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303) 892-0393 KIOWA PROJECT NO. 01085	DESIGNED BJW/DDR DATE 02/04 DRAWN DDR DATE 02/04 CHECKED BJW DATE 02/04	ADAMS COUNTY, CITY OF BRIGHTON CITY OF COMMERCE CITY, AND URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY UPDATE SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS	DRAGWAY DRAW 3500-03.05 STA 0+00 to 52+00	SHEET 19

COMMENTARY SHEET 20

Major Drainageway: West Fork 3501 **Stations:** 0+00 to 44+00

EXISTING CONDITIONS:

West Fork is a west bank tributary with a channel length of 4400 feet within the study limits. This tributary enters Second Creek near station 745+30. The average channel slope in this reach is 0.8%. West Fork is the largest tributary to Second Creek, however, most of the area lies outside of the study limits.

Problem areas in this reach include: potential erosion along the steep slopes, a poorly defined channel, and potential water quality degradation.

PROPOSED IMPROVEMENTS:

Based on flow magnitudes and channel conditions, a stable slope of 0.50% was calculated for this reach. A series of two check structures will maintain longitudinal slope stability when erosion begins to degrade the channel bottom. The check structures will allow the channel to naturally degrade to a maximum depth of 3 feet. This plan allows the channel to evolve naturally to increased upstream flows, but hold the maximum erosion to a controlled level.

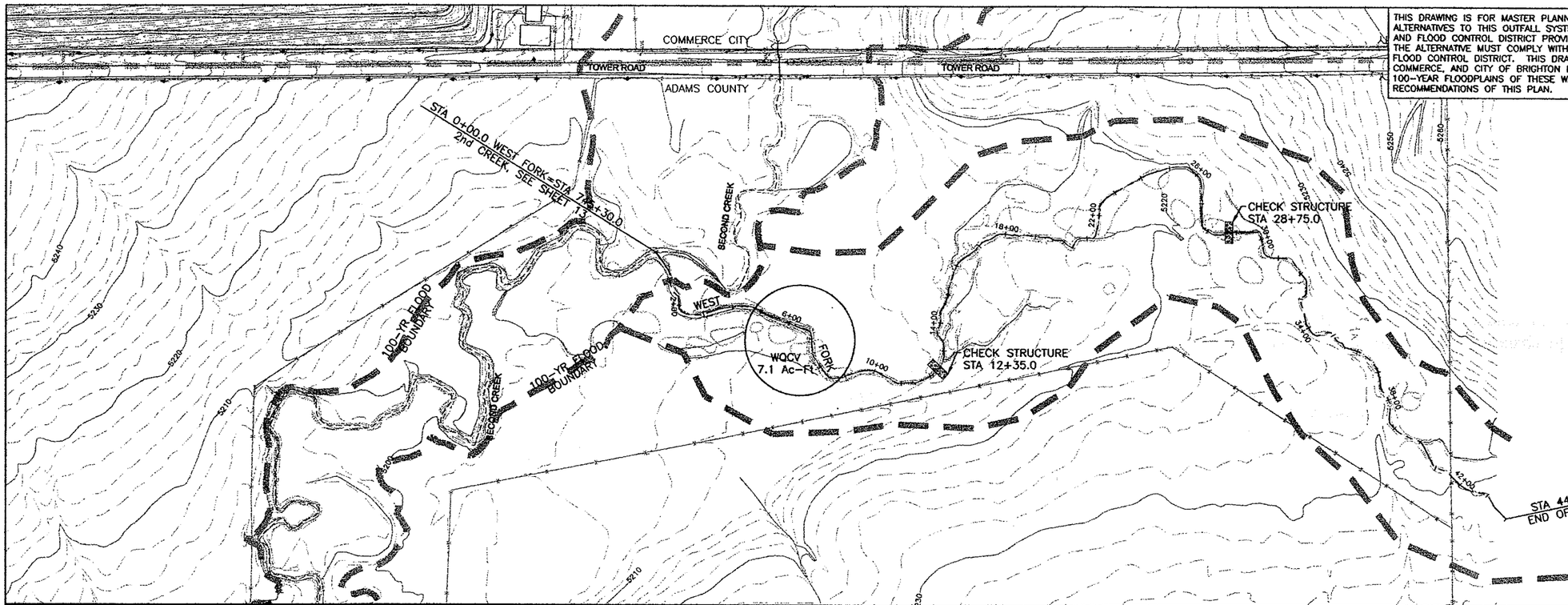
A water quality basin near the outfall to Second Creek will capture any pollutants and sediments, and settle them from the water prior to releasing to the main channel of Second Creek. This basin effectively treats runoff from the maximum area of 640 upstream acres.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 20

West Fork

Improvement	Quantity	Unit	Unit Cost	Total Cost
Check structure	2	EA	$10,000	$20,000
Preserve Floodplain				$0
Water Quality Basin	7.1	AF	$25,000	$177,500
Maintenance Trail	4400	LF	$25	$110,000
Total Estimated Construction Cost				$307,500
Utility Relocation (5% of Construction Cost)				$15,375
Engr. and Contingency (35% of Construction + Utility)				$113,006
Land Value	7.4	Acres	$65,340	$484,638
Total Estimated Cost				**$920,519**

THIS DRAWING IS FOR MASTER PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY LOCAL REVIEWING AGENCIES AND THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT PROVIDED THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY AND STREAM STABILITY. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE LOCAL JURISDICTION AND THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES. ADAMS COUNTY, CITY OF COMMERCE, AND CITY OF BRIGHTON MANAGE AND REGULATE ALL LAND DEVELOPMENT AND REDEVELOPMENT WITHIN THE 100-YEAR FLOODPLAINS OF THESE WATERSHEDS SO AS TO PREVENT FUTURE FLOOD DAMAGES BY FOLLOWING THE RECOMMENDATIONS OF THIS PLAN.



0 200' 400'

REFER TO 1976 FHAD REPORT FOR ALL REGULATORY FLOODPLAIN INFORMATION

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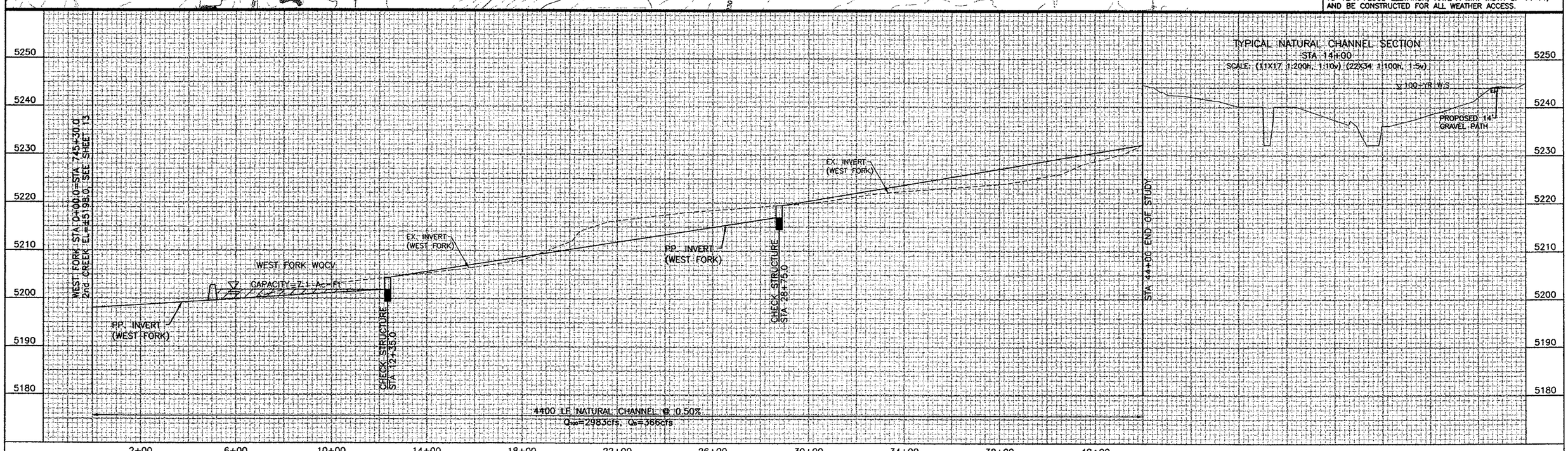

TYPICAL NATURAL CHANNEL SECTION
STA 14+00
SCALE: (11X17 1:200H, 1:10V) (22X34 1:100H, 1:5V)

BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001	Kiowa Engineering Corporation 7175 W. Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303) 692-0388 KIOWA PROJECT NO. 01065	DESIGNED BJW/DDR DATE 02/04 DRAWN DDR DATE 02/04 CHECKED BJW DATE 02/04	ADAMS COUNTY, CITY OF BRIGHTON CITY OF COMMERCE CITY, AND URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY UPDATE SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS	WEST FORK 3501 STA 0+00 to 44+00	SHEET 20

COMMENTARY SHEET 21

Major Drainageway: Sandbar Run 3500-04.01 **Stations:** 0+00 to 30+00

EXISTING CONDITIONS:

Sandbar Run is an east bank tributary with a channel length of 3000 feet. This tributary enters Second Creek near station 798+00. The average channel slope in this reach is 1.1%. The tributary extends upstream into the BFI landfill area.

Problem areas in this reach include: potential erosion along the steep slopes, a poorly defined channel, and potential water quality degradation.

PROPOSED IMPROVEMENTS:

Based on flow magnitudes and channel conditions, a stable slope of 1.0% was calculated for this reach. One check structure will maintain longitudinal slope stability when erosion begins to degrade the channel bottom. The check structures will allow the channel to naturally degrade to a maximum depth of 3 feet. This plan allows the channel to evolve naturally to increased upstream flows, but hold the maximum erosion to a controlled level.

A water quality basin near the outfall to Second Creek will capture any pollutants and sediments, and settle them from the water prior to releasing to the main channel of Second Creek. This basin effectively treats runoff from 240 upstream acres.

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PRELIMINARY DESIGN COST ESTIMATE: SHEET 21

Sandbar Run

Improvement	Quantity	Unit	Unit Cost	Total Cost
Check structure	1	EA	$10,000	$10,000
Preserve Floodplain				$0
Water Quality Basin	5.3	AF	$25,000	$132,500
Maintenance Trail	3000	LF	$25	$75,000
Total Estimated Construction Cost				$217,500
Utility Relocation (5% of Construction Cost)				$10,875
Engr. and Contingency (35% of Construction + Utility)				$79,931
Land Value	5.2	Acres	$65,340	$340,434
Total Estimated Cost				**$648,740**

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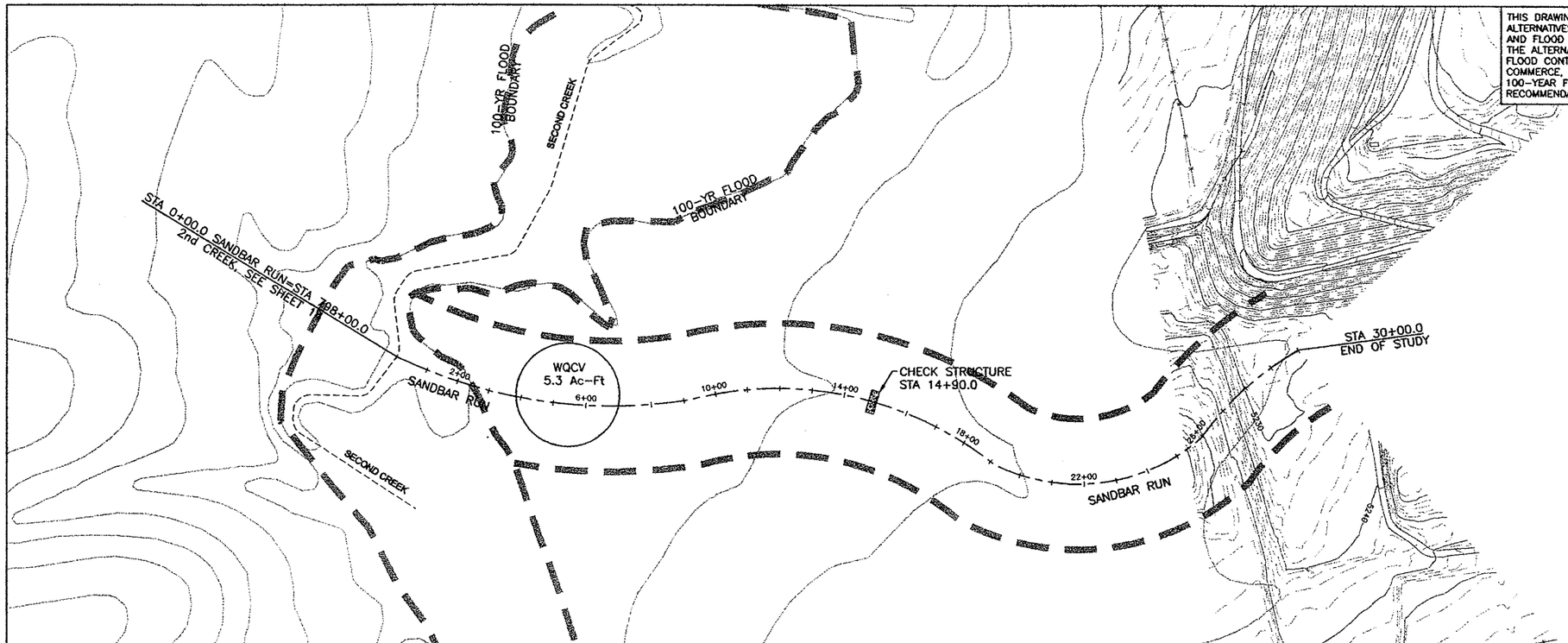
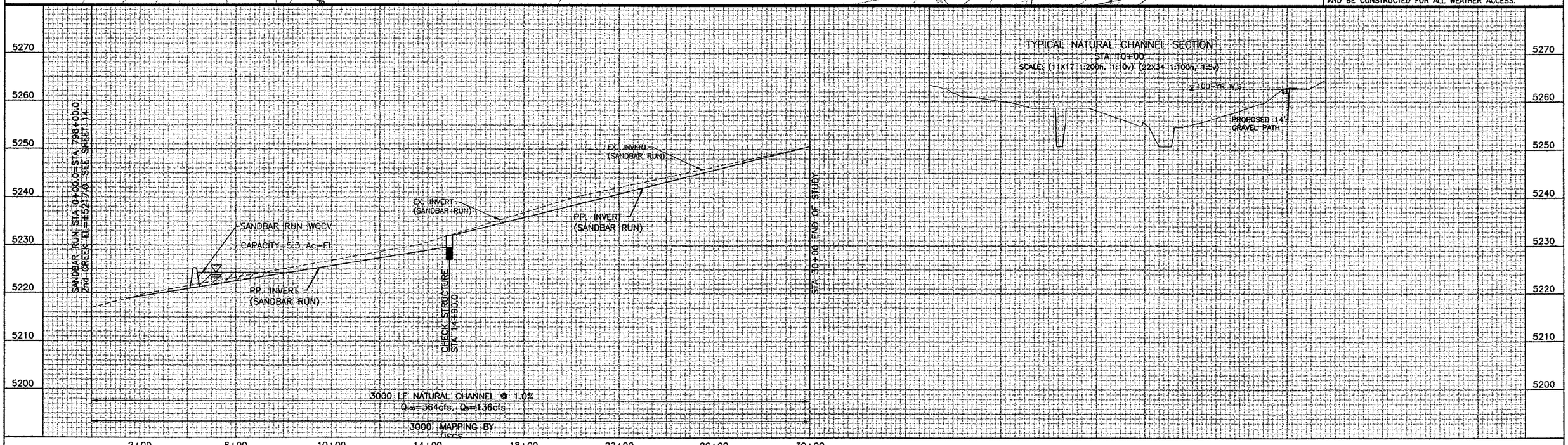


0 200' 400'

REFER TO 1976 FHAD REPORT FOR ALL REGULATORY FLOODPLAIN INFORMATION

AN ACCESS TRAIL IS REQUIRED ALONG ALL IMPROVED CHANNELS FOR FUTURE MAINTENANCE OF IMPROVEMENTS. THIS TRAIL WILL ALSO SERVE AS A RECREATIONAL TRAIL. THE ALIGNMENT OF THE TRAIL WILL BE DETERMINED BY LOCAL JURISDICTIONS. THE TRAIL SHOULD BE PLACED AT THE 10-YEAR FLOOD ELEVATION, HAVE A MIN. WIDTH OF 14-FT, AND BE CONSTRUCTED FOR ALL WEATHER ACCESS.



TYPICAL NATURAL CHANNEL SECTION
STA 10+00
SCALE: (11X17 1:200h, 1:10v) (22X34 1:100h, 1:5v)

BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001	Kiowa Engineering Corporation 7175 W. Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303) 692-0369 KIOWA PROJECT NO. 01065	DESIGNED BJW/DDR DATE 02/04 DRAWN DDR DATE 02/04 CHECKED BJW DATE 02/04	ADAMS COUNTY, CITY OF BRIGHTON CITY OF COMMERCE CITY, AND URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY UPDATE SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS	SANDBAR RUN 3500-04.01 STA 0+00 to 30+00	SHEET 21

COMMENTARY SHEET 22

See Sheet 6 for the description of Detention #330.

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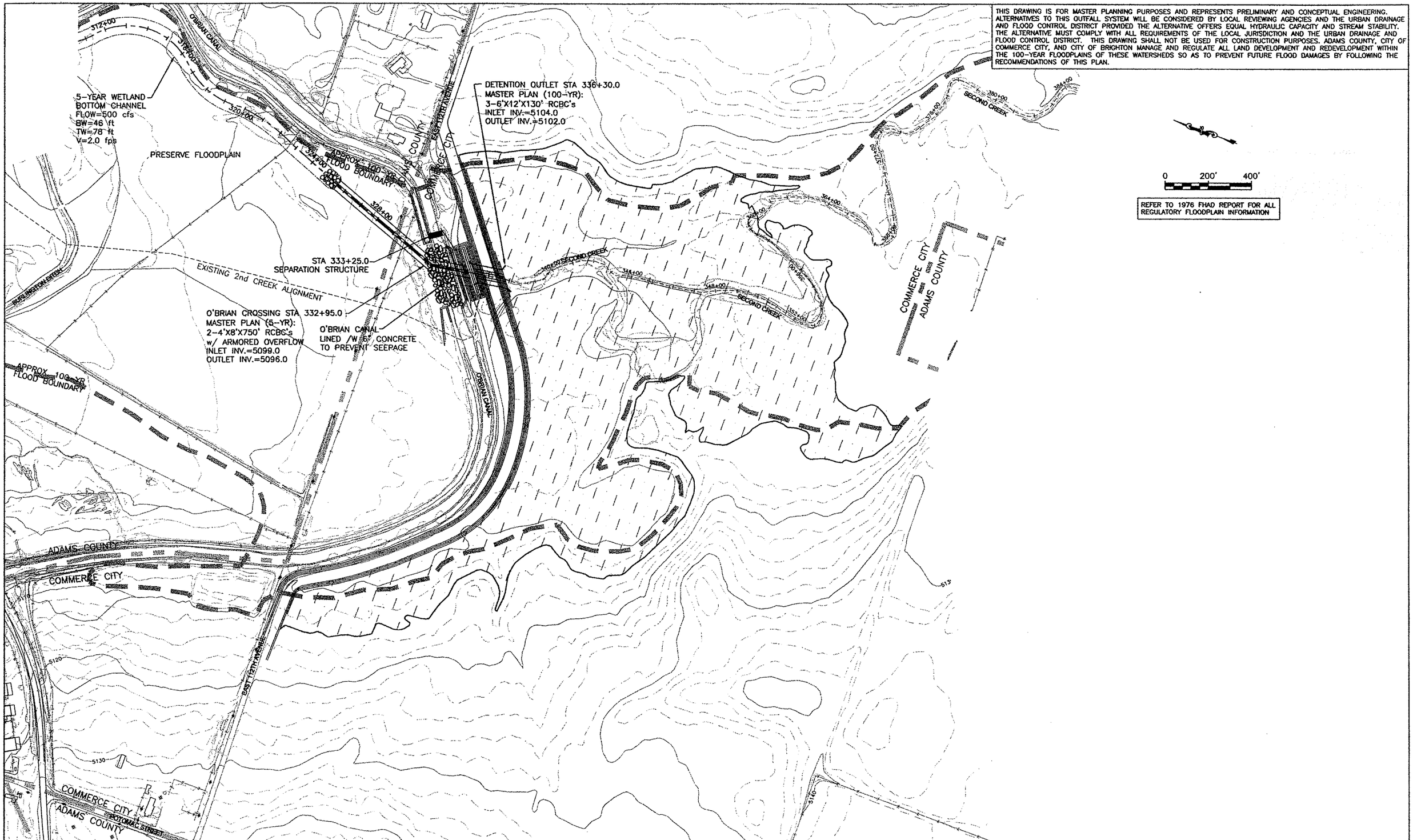

BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001	Kiowa Engineering Corporation 7175 W. Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303) 692-0369 KIOWA PROJECT NO. 01095	DESIGNED BJW/DDR DATE 02/04 DRAWN DDR DATE 02/04 CHECKED BJW DATE 02/04	ADAMS COUNTY, CITY OF BRIGHTON CITY OF COMMERCE CITY, AND URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY UPDATE SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS	2ND CREEK 3500 DETENTION #330	SHEET 22

COMMENTARY SHEET 23

See Sheet 7 for the description of Detention #336.

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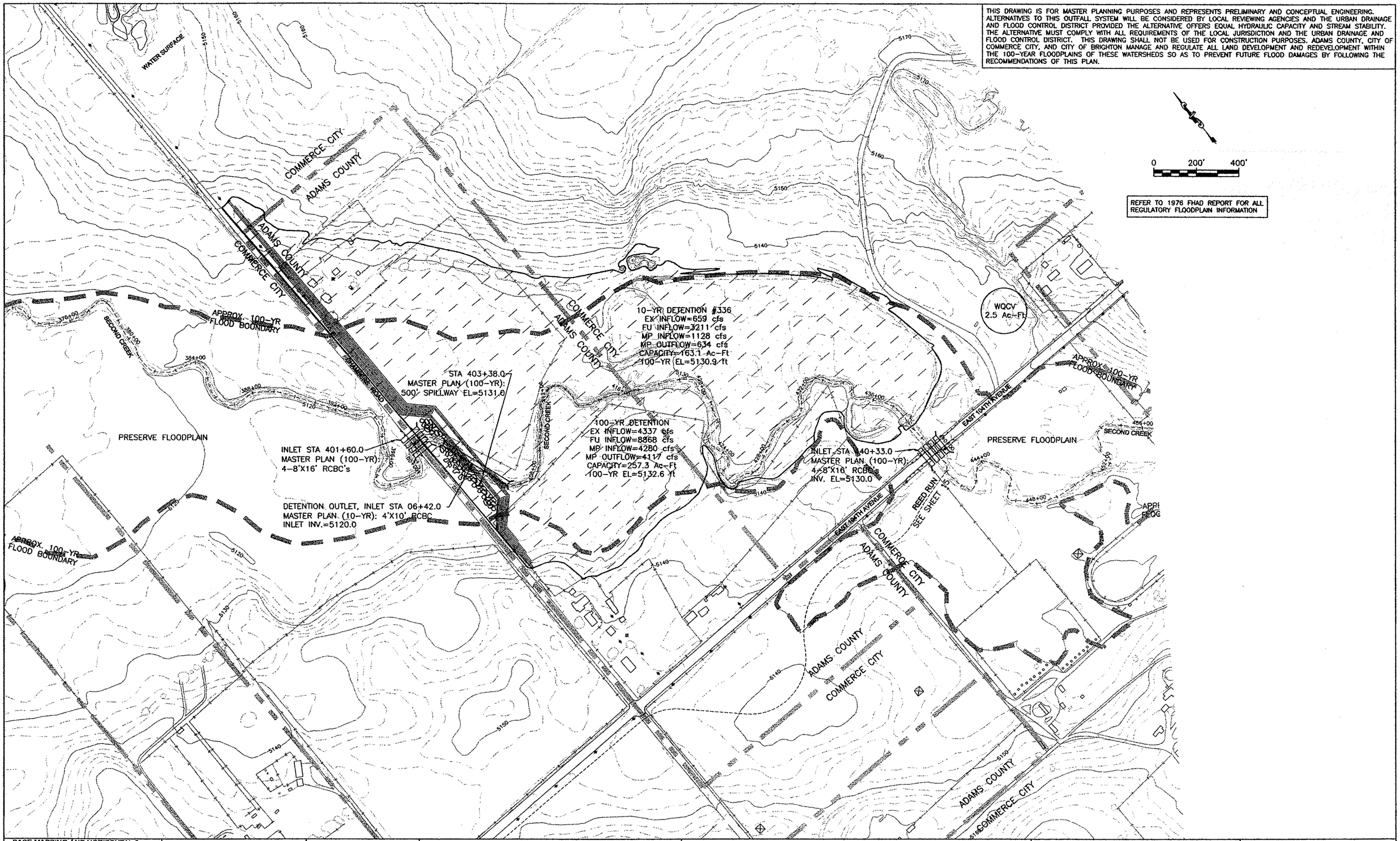

BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001	Kiowa Engineering Corporation 7175 W. Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303) 692-0369 KIOWA PROJECT NO. 01095	DESIGNED BJW/DDR DATE 02/04 DRAWN DDR DATE 02/04 CHECKED BJW DATE 02/04	ADAMS COUNTY, CITY OF BRIGHTON CITY OF COMMERCE CITY, AND URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY UPDATE SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS	2ND CREEK 3500 DETENTION #336	SHEET 23

COMMENTARY SHEET 24

See Sheet 12 for the description of Detention #366.

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0 200' 400'

REFER TO 1976 FHAD REPORT FOR ALL REGULATORY FLOODPLAIN INFORMATION

ADAMS COUNTY
COMMERCE CITY
GRAMMA GULCH
SEE SHEET 18
DETENTION OUTLET, INLET STA 676+94.0
MASTER PLAN (2-YR): 36" RCP IE 5182.0
STA 676+44.0
MASTER PLAN (100-YR):
500' SPILLWAY EL=5194.0
RAISE ROAD
TOP OF ROAD
EL 5192.5
2-YR DETENTION #366
EX INFLOW=5 cfs
FU INFLOW=1588 cfs
MP INFLOW=479 cfs
MP OUTFLOW=120 cfs
CAPACITY=132.0 Ac-Ft
2-YR EL=5194.0 ft
APPROX. 100-YR FLOOD BOUNDARY
PRESERVE FLOODPLAIN
INLET STA 673+94.0
MASTER PLAN (100-YR):
3-10'X20' RCBC's
IE 5181.5
100-YR DETENTION
EX INFLOW=4408 cfs
FU INFLOW=9260 cfs
MP INFLOW=5156 cfs
MP OUTFLOW=4854 cfs
CAPACITY=236.5 Ac-Ft
100-YR EL=5196.1 ft
SECOND CREEK
DRAGWAY DRAW
SEE SHEET 19

BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001	Kiowa Engineering Corporation 7175 W. Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303) 892-0369 KIOWA PROJECT NO. D1095	DESIGNED BJW/DDR DATE 02/04 DRAWN DDR DATE 02/04 CHECKED BJW DATE 02/04	ADAMS COUNTY, CITY OF BRIGHTON CITY OF COMMERCE CITY, AND URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY UPDATE SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS	2ND CREEK 3500 DETENTION #366	SHEET 24

COMMENTARY SHEET 25

Major Drainageway: Henderson Creek 0053-04 **Stations:** 0+00 to 58+00

EXISTING CONDITIONS:

Henderson Creek is one of the two main drainageways in DFA 0053. This reach covers 5800 feet of channel from the outfall to the South Platte River to near US-85 with an average slope of 0.50%. Saddle Creek outfalls to Henderson Creek at station 17+60. The channel passes through Brighton Road, 120th Avenue and Fulton Ditch. 120th Avenue is under construction as part of a new crossing over the South Platte River.

Currently, all upstream flows enter the gravel pit lake at the upper part of the reach. This lake stores a significant volume with little flow continuing downstream. When flows do exceed the lake capacity, they enter Fulton Ditch and are carried out of the watershed. For this reason there is little sign of a channel downstream of Fulton Ditch to the South Platte River.

Problem areas in this reach include: lack of a defined outfall to the South Platte River, a poorly defined channel, and inadequate capacity at Brighton Road, 120th Avenue, and Fulton Ditch.

PROPOSED IMPROVEMENTS:

A proposed gavel mine will be constructed between the South Platte River and Brighton Road. This mine will be administered by Adams County and the Colorado Division of Minerals and Geology. Drainage through this reach will be determined as part of the mining operations.

The existing drainage crossing of Brighton Road is a buried CMP. The size of the pipe could not be measured. 100-year conveyance is provided at Brighton Road with the addition of twin 4'x8' box culverts. Providing a designated flow path is achieved through a 100-year channel. The required channel top width in this reach varies from 44 feet to 50 feet. The 100-year channel between Brighton Road and 120th Avenue has a required top width of 50 feet.

Providing a 100-year crossing for 120th Avenue is achieved through twin 4'x8' box culverts. Upstream of 120th Avenue to Fulton Ditch, the required 100-year channel top width is 44 feet. A 2.6-foot drop structure is required to maintain stable longitudinal slopes through the reach.

A twin 4'x8' box culvert is required to pass 100-year flows under Fulton Ditch. Currently the existing lake captures all upstream flows and rarely releases any flow downstream. Flows that exceed the lake capacity enter Fulton Ditch. Adding a 100-year box culvert releases flows from the lake and bypasses Fulton Ditch. Several feet of storage is required in the lake before flows are transmitted downstream. This lake storage is not included in the models and is not required in sizing the downstream improvements.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 25

Henderson Creek

Improvement	Quantity	Unit	Unit Cost	Total Cost
Box Culvert [Twin 4'x8'] Brighton Road	84	LF	$830	$69,720
100-year Channel (50')	1160	LF	$100	$116,000
Box Culvert [Twin 4'x8'] 120th Avenue	150	LF	$830	$124,500
Drop Structure (2.6')	1	EA	$26,000	$26,000
100-year Channel (44')	1148	LF	$88	$101,024
Box Culvert [Twin 4'x8'] Fulton Ditch	150	LF	$830	$124,500
Maintenance Trail	2308	LF	$25	$57,700
Total Estimated Construction Cost				$619,444
Utility Relocation (5% of Construction Cost)				$30,972
Engr. and Contingency (35% of Construction + Utility)				$227,646
Land Value	5.3	Acres	$65,340	$346,200
Total Estimated Cost				**$1,224,262**

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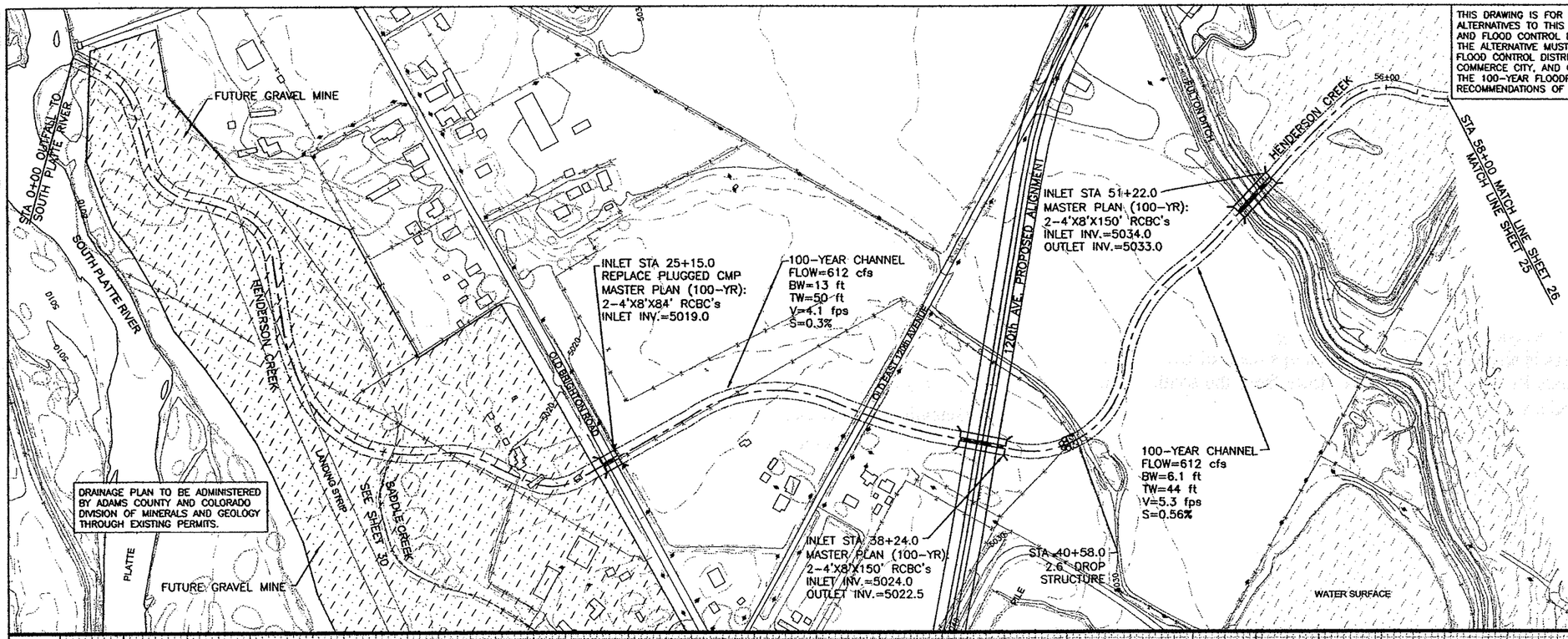
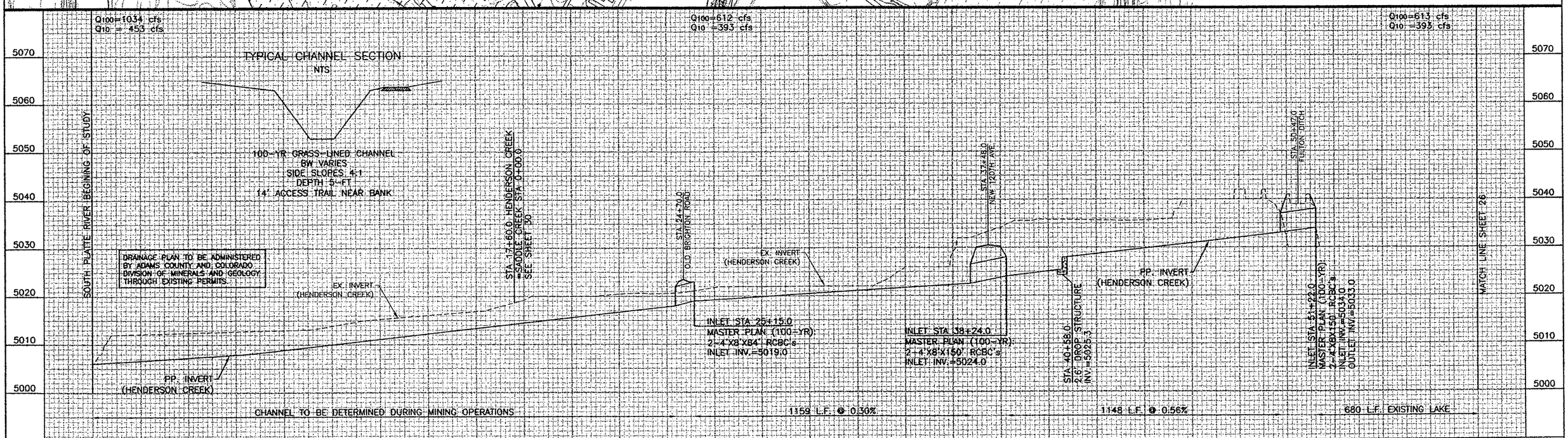


AN ACCESS TRAIL IS REQUIRED ALONG ALL IMPROVED CHANNELS FOR FUTURE MAINTENANCE OF IMPROVEMENTS. THIS TRAIL WILL ALSO SERVE AS A RECREATIONAL TRAIL. THE ALIGNMENT OF THE TRAIL WILL BE DETERMINED BY LOCAL JURISDICTIONS. THE TRAIL SHOULD BE PLACED AT THE 10-YEAR FLOOD ELEVATION, HAVE A MIN. WIDTH OF 14-FT, AND BE CONSTRUCTED FOR ALL WEATHER ACCESS.



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COMMENTARY SHEET 44

Major Drainageway: Tumbleweed Draw 0053-02.03 **Stations:** 0+00 to 54+00

EXISTING CONDITIONS:

Tumbleweed Draw is a small tributary to Locust Run at station 32+00. The channel begins just upstream of 120th Avenue. The channel is poorly defined and undeveloped except for the lower portion that passes through two residential lots. The upper part of this reach includes I-76 with the existing inadvertent detention facility #330.

Problem areas in this reach include: a poorly defined channel and the need to formalize detention at I-76.

PROPOSED IMPROVEMENTS:

A 100-year channel is achieved over the 5100 foot length with top widths varying from 38' to 43'. The upper channel portion requires a 2.2' drop structure to maintain channel stability.

At I-76 there is an existing 30" RCP. This culvert is undersized for 100-year flows. The upstream side of I-76 has an existing low area that stores runoff during large flood events. When this area was included in the hydrologic models it was found to effectively store the 100-year event so that the 30" RCP is capable of passing 100-year flows. The detention will be formalized as Detention #330. This facility reduces the 100-year peak from 75 cfs to 17 cfs with no additional structural improvements. The detention facility is the upstream study limit for Tumbleweed Draw.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 44

Tumbleweed Draw

Improvement	Quantity	Unit	Unit Cost	Total Cost
100-year Channel (43')	3021	LF	$86	$259,806
100-year Channel (38')	2080	LF	$76	$158,080
Drop Structure (2.2')	1	EA	$22,000	$22,000
Detention Facility 330 [3.1 ac-ft]	1	EA	$22,725	$22,725
Water Quality Basin [0.3 acre-feet]	0.3	AF	$25,000	$7,500
Maintenance Trail	5101	LF	$25	$127,525
Total Estimated Construction Cost				$597,636
Utility Relocation (5% of Construction Cost)				$29,882
Engr. and Contingency (35% of Construction + Utility)				$219,631
Land Value	13.9	Acres	$65,340	$908,898
Total Estimated Cost				**$1,756,047**

COMMENTARY SHEET 26

Major Drainageway: Henderson Creek 0053-04 **Stations:** 58+00 to 116+00

EXISTING CONDITIONS:

This reach covers 5800 feet from US-85 to 112th Avenue. The existing crossings at US-85 and 112th Avenue both have less than 2-year capacity. There is an existing retention area upstream of US-85. On the downstream side of US-85 the proposed Dunes Reservoir will capture flows from the south. This facility will be sized to store all inflows with no release.

Problem areas in this reach include: a poorly defined channel, and inadequate capacity at US-85 and 112th Avenue.

PROPOSED IMPROVEMENTS:

Twin 4'x6' box culverts will be placed under US-85, Union Pacific Railroad, and Havana Street for 100-year conveyance capacity. This small size is possible due to Detention #346. This detention facility reduces the 100-year outflow to 508 cfs. Existing flows in the area are 1086 cfs. Over detaining flows at this facility allows the downstream system to be reduced in size and maintains the outfall to the South Platte River at existing levels. An embankment is required 7 feet higher than Havana Street for the detention facility.

A water quality basin is incorporated in the detention facility to capture pollutants and settle them from the water.

Five 4'x7' box culverts are required at 112th Avenue to pass 100-year flows. This design allows for the crossing without raising 112th Avenue.

A 100-year channel with varying top widths from 70 feet to 78 feet provides conveyance through this reach.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 26

Henderson Creek

Improvement	Quantity	Unit	Unit Cost	Total Cost
100-year Channel (44')	230	LF	$88	$20,240
Box Culvert [Twin 4'x6'] US-85+UPRR+Havana Street	570	LF	$625	$356,250
Detention Facility 346 [142 ac-ft]	1	EA	$970,225	$970,225
Water Quality Basin [8.1 acre-feet]	8.1	AF	$25,000	$202,500
100-year Channel (78')	903	LF	$156	$140,868
Box Culvert [Quintuple 4'x7'] 112th Avenue	105	LF	$1,820	$191,100
100-year Channel (70')	575	LF	$140	$80,500
Maintenance Trail	1708	LF	$25	$42,700
Total Estimated Construction Cost				$2,004,383
Utility Relocation (5% of Construction Cost)				$100,219
Engr. and Contingency (35% of Construction + Utility)				$736,611
Land Value	38.2	Acres	$65,340	$2,497,362
Total Estimated Cost				**$5,338,575**

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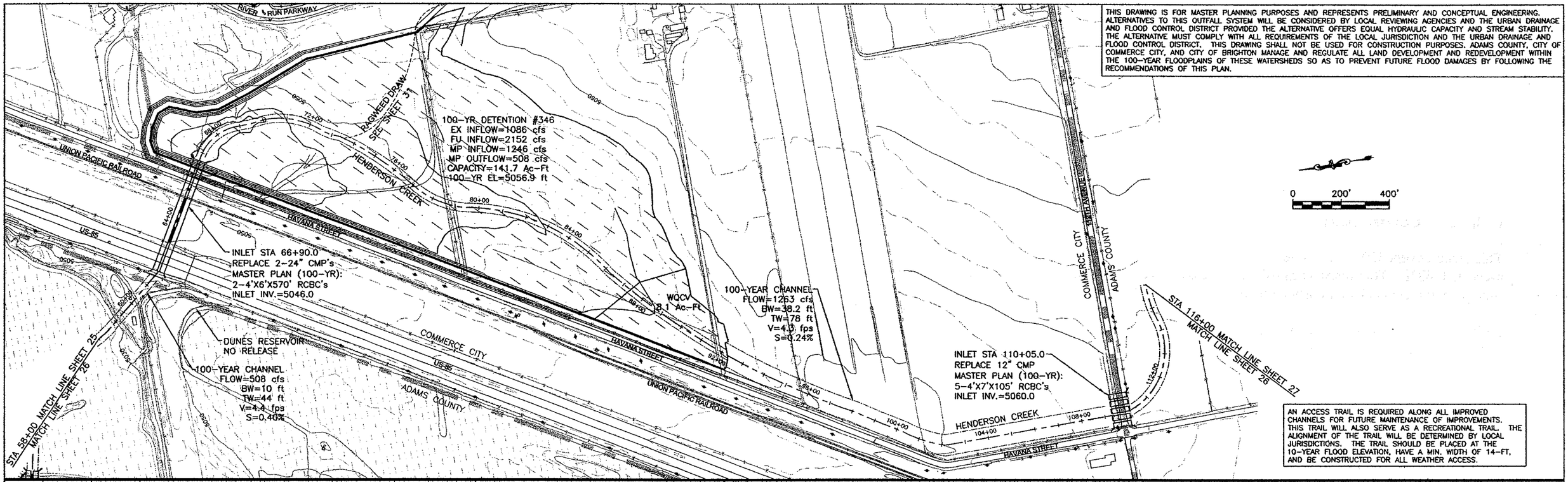

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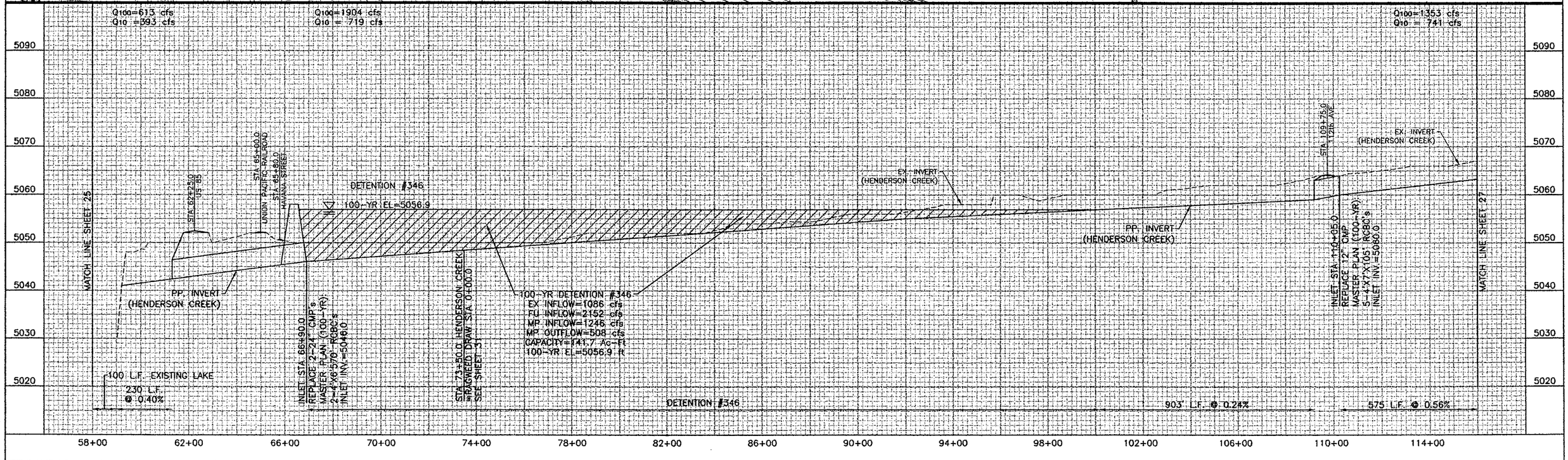

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COMMENTARY SHEET 27

Major Drainageway: Henderson Creek 0053-04 **Stations:** 116+00 to 174+00

EXISTING CONDITIONS:

This reach covers 5800 feet and extends from 112th Avenue past I-76. The average channel slope in this reach is 0.43%. This reach is mostly undeveloped with some pockets of agricultural buildings. The flow path and channel are poorly defined.

Problem areas in this reach include: a poorly defined channel, inadequate capacity at 109th Avenue, and negative channel slope upstream of I-76.

PROPOSED IMPROVEMENTS:

A 100-year channel will connect 109th Avenue to 112th Avenue at a total length of 3366 feet, 2791 feet on Sheet 27. The average channel slope is 0.56% and is stable under master plan 100-year flows.

A 10-year crossing will be added to 109th Avenue via twin 48" CMPs.

A 100-year channel covers 830 feet from 109th Avenue to I-76 with a top width of 37 feet. This reach is steep for the design flows and will require a 1.3' drop structure to reduce the slope to 0.81% for longitudinal stability.

The current I-76 crossing is multi functional. It serves a pathway for local vehicles, mostly agricultural vehicles, as well as a drainage crossing for upstream runoff. The problem upstream of I-76 is the topography, which prevents most of the low flows from reaching the crossing. Excavating a 100-year channel at a slope of 0.14% will provide an uninterrupted connection to upstream flows. The lack of grade in this slope will produce slower moving flows with a peak velocity of 2.9 feet per second and requires a wide channel section with a top width of 60 feet.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 27

Henderson Creek

Improvement	Quantity	Unit	Unit Cost	Total Cost
100-year Channel (45')	2791	LF	$140	$390,740
Box Culvert [Twin 48"] 109th Street - 10-year	97	LF	$160	$15,520
100-year Channel (37')	830	LF	$74	$61,420
Drop Structure (1.3')	1	EA	$13,000	$13,000
100-year Channel (60')	1900	LF	$120	$228,000
Maintenance Trail	5521	LF	$25	$138,025
Total Estimated Construction Cost				$846,705
Utility Relocation (5% of Construction Cost)				$42,335
Engr. and Contingency (35% of Construction + Utility)				$311,164
Land Value	12.7 Acres		$65,340	$828,150
Total Estimated Cost				**$2,028,354**

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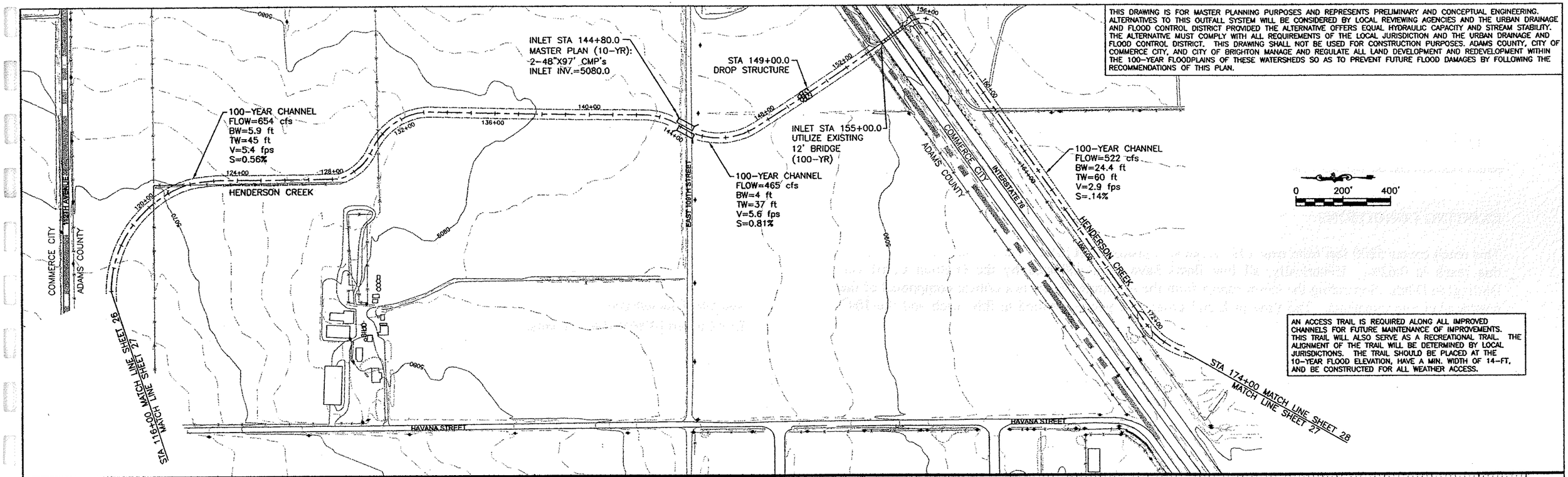

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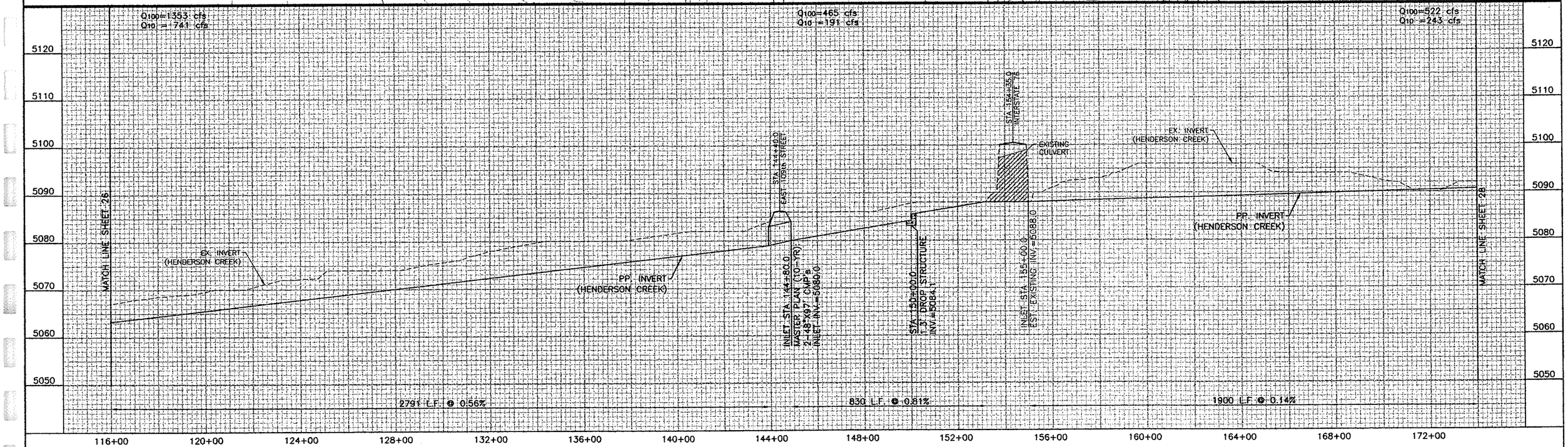

BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001	Kiowa Engineering Corporation 7175 W. Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303) 692-0369 KIOWA PROJECT NO. 01085	DESIGNED BJW/DDR DATE 02/04 DRAWN DDR DATE 02/04 CHECKED BJW DATE 02/04	ADAMS COUNTY, CITY OF BRIGHTON CITY OF COMMERCE CITY, AND URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

OUTFALL SYSTEMS PLANNING STUDY UPDATE SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS	HENDERSON CREEK 0053-04 STA 116+00 to 174+00

COMMENTARY SHEET 28

Major Drainageway: Henderson Creek 0053-04 **Stations:** 174+00 to 232+00

EXISTING CONDITIONS:

This reach covers 5800 feet from near 105th Avenue to upstream of SH-2. The average channel slope in this reach is 0.62%. Historically, all low flows have been collected by the O'Brian Canal and Burlington Ditch. Separating the storm runoff from the irrigation waters is a critical component of the master plan improvements. The flow path and channel is poorly defined in this reach and the 104th Avenue crossing is undersized.

Problem areas in this reach include: a poorly defined channel, lack of irrigation canal crossings, undersized road crossings, and decreased water quality with future urbanization.

Note: in past reports Henderson Creek upstream of I-76 was named "Morning Glory Run". With more detailed mapping and drainage analyses it was found that this is the main Henderson Creek alignment and not a tributary.

PROPOSED IMPROVEMENTS:

A 100-year channel is required to connect 104th to I-76. This channel requires significant excavation to overcome the topography. To minimize excavation and utilize the existing I-76 crossing, the channel is designed at a very flat slope.

104th Avenue requires a 100-year capacity crossing. A 4'x6' box culvert accomplishes this. Due to the alignment of the channel crossing 104th, the box culvert length is longer than if the crossing were perpendicular. A 4'x6' box culvert is also used to provide a 100-year crossing of the O'Brian Canal and Burlington Ditch. All of these crossings are relatively small for 100-year capacity due to the effective detention at SH-2.

A 100-year channel is required to convey flow between the O'Brian Canal and Burlington Northern Santa Fe Railroad. A 6.0 foot drop structure accommodates the steep drop in channel just downstream of the railroad and allows a stable channel slope of 0.73% to be constructed.

The drainage crossing at the BNSFRR and SH-2 is a Twin 24" CMP. Formalizing the upstream detention at Detention #314 effectively reduces flows to provide 100-year capacity through the existing structure with no road overtopping. Flows are reduced from 280 cfs to 42 cfs by this facility. There are three structures shown within the detention pond. The pond limits shown are near existing condition limits. These buildings experience regular flooding and should be removed as part of the master plan.

Urban development typically reduces water quality in drainageways, both from urban pollutants and increased sediment transport. A water quality basin is incorporated in the detention facility to capture these pollutants and settle them from the water prior to releasing downstream.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 28

Henderson Creek

Improvement	Quantity	Unit	Unit Cost	Total Cost
100-year Channel (60')	1184	LF	$120	$142,080
Box Culvert [4'x6'] 104th Avenue	175	LF	$320	$56,000
100-year Channel (40')	542	LF	$80	$43,360
Box Culvert [4'x6'] Burlington Ditch and O'Brian Canal	575	LF	$320	$184,000
100-year Channel (31')	1206	LF	$62	$74,772
Drop Structure (6.0')	1	EA	$60,000	$60,000
Detention Facility 314 [21 ac-ft]	1	EA	$129,746	$129,746
Water Quality Basin [3.0 acre-feet]	3	AF	$25,000	$75,000
100-year Channel (36')	950	LF	$72	$68,400
Maintenance Trail	3882	LF	$25	$97,050
Total Estimated Construction Cost				$930,408
Utility Relocation (5% of Construction Cost)				$46,520
Engr. and Contingency (35% of Construction + Utility)				$341,925
Land Value	19.7 Acres		$65,340	$1,287,972
Total Estimated Cost				**$2,606,825**

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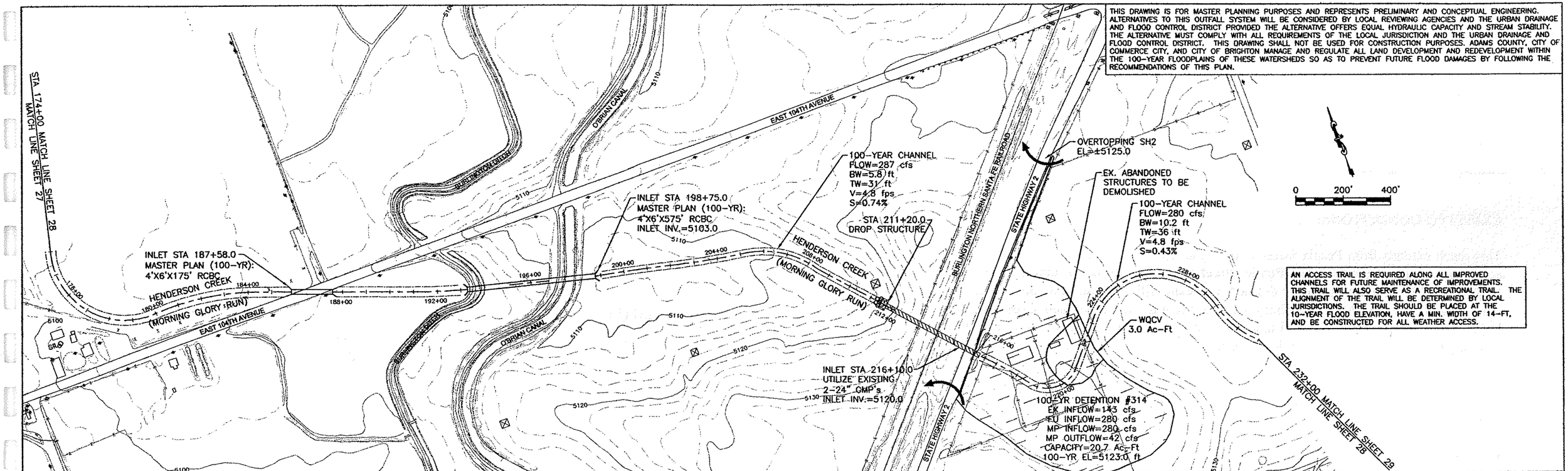

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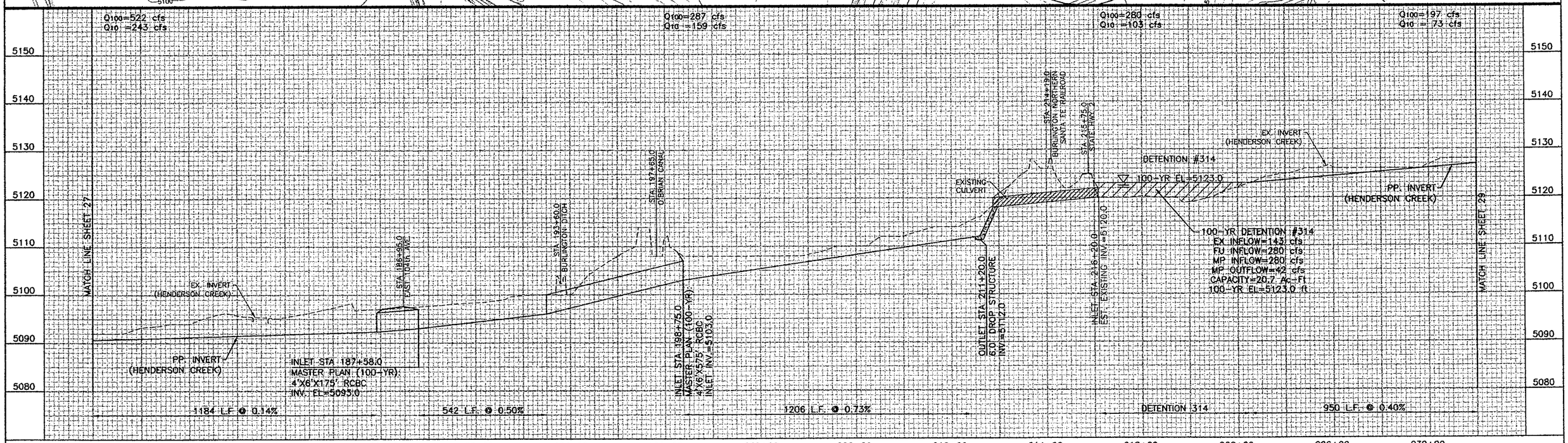

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COMMENTARY SHEET 29

Major Drainageway: Henderson Creek 0053-04 **Stations:** 232+00 to 269+00

EXISTING CONDITIONS:

This reach extends from Peoria Street to the upstream study limits. The reach length is 3700 feet with an average slope of 0.49%. The Peoria Street crossing is severely undersized and the street overtops frequently. The channel is poorly defined upstream with high and low areas that collect runoff. This reach was labeled as Morning Glory Run, a tributary to Henderson Creek, in the previous study. Improved mapping has determined that this channel is continuous with Henderson Creek and the name Morning Glory Run has been kept for consistency.

Problem areas in this reach include: undersized road crossing at Peoria Street and a poorly defined channel.

PROPOSED IMPROVEMENTS:

The Peoria Street crossing will be upgraded to 100-year capacity by adding a 4'x5' box culvert.

Significant excavation is required upstream to remove the high ground and provide a continuous sloping channel. The channel will have 100-year capacity with a 55 foot top width and 0.39% channel slope. An 800 foot channel segment with a 0.89% slope is required to tie the proposed channel back to the existing elevation at the study limit near station 269+00.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 29

Henderson Creek

Improvement	Quantity	Unit	Unit Cost	Total Cost
100-year Channel (36')	272	LF	$72	$19,584
Box Culvert [4'x5'] Peoria Street	80	LF	$260	$20,800
100-year Channel (55')	2550	LF	$110	$280,500
100-year Channel (40')	800	LF	$110	$88,000
Maintenance Trail	2822	LF	$25	$70,550
Total Estimated Construction Cost				$479,434
Utility Relocation (5% of Construction Cost)				$23,972
Engr. and Contingency (35% of Construction + Utility)				$176,192
Land Value	6.5	Acres	$65,340	$423,300
Total Estimated Cost				**$1,102,898**

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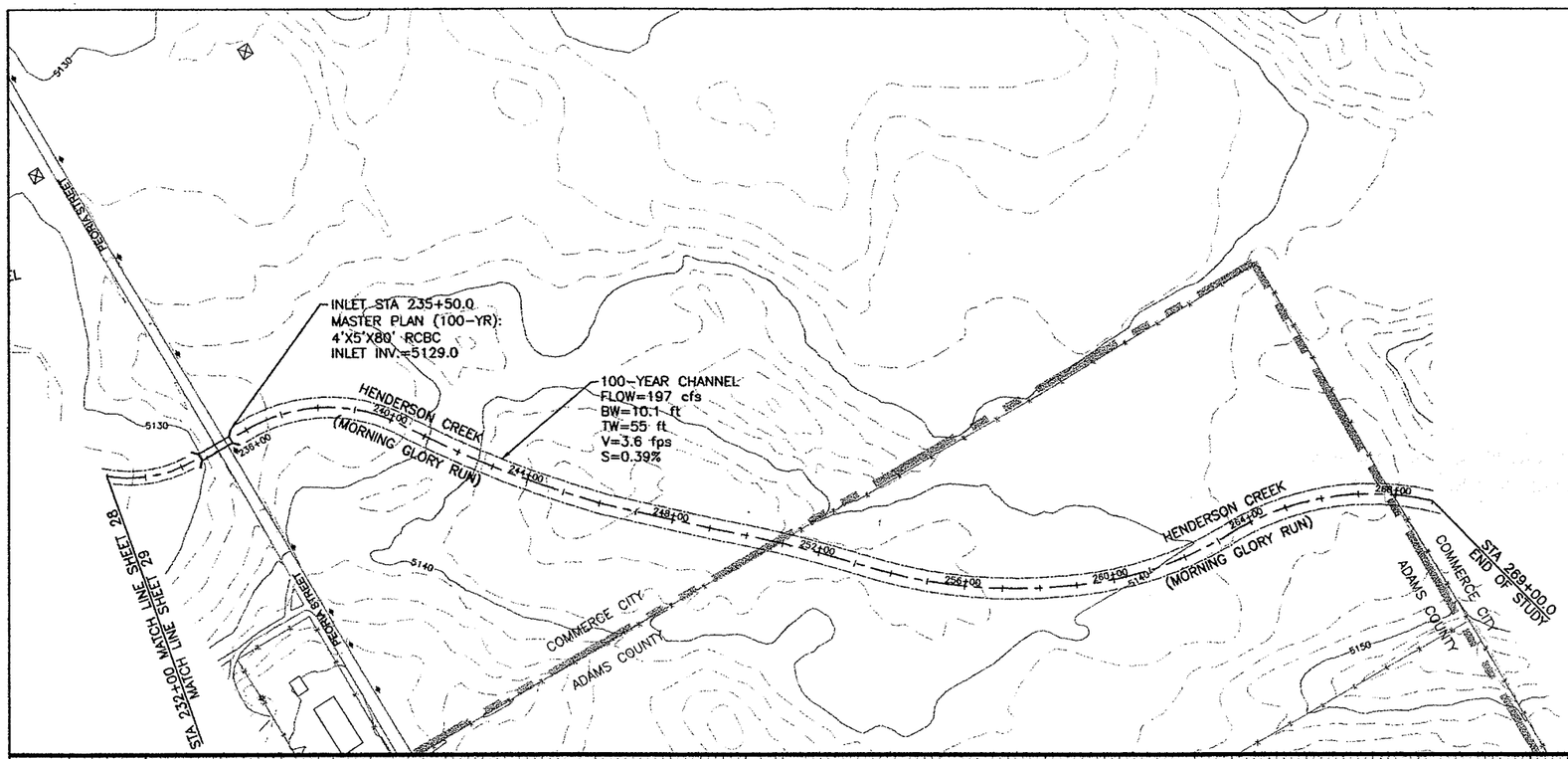

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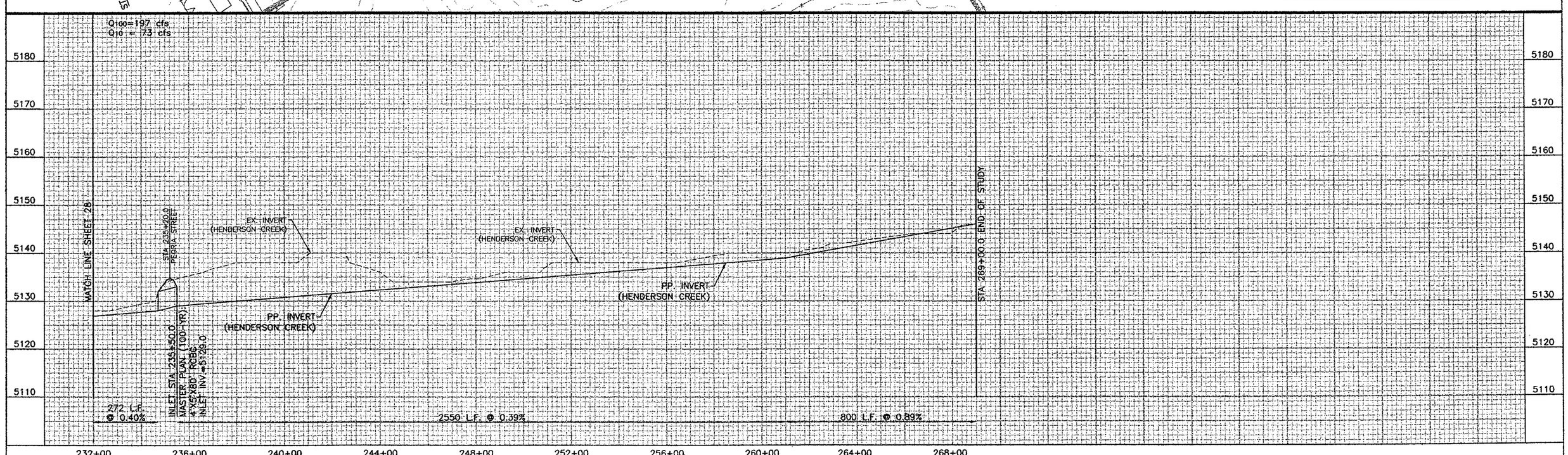

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COMMENTARY SHEET 30

Major Drainageway: Saddle Creek 0053-04.01 **Stations:** 0+00 to 32+00

EXISTING CONDITIONS:

Saddle Creek is a tributary to Henderson Creek with its outfall near station 17+60. The tributary has a channel length of 2580 feet with an average slope of 0.31%. The tributary area begins upstream of the Fulton Ditch in the Dunes Development. Construction of the Dunes Reservoir has eliminated the need for a Fulton Ditch crossing and has moved the design limits to the downstream side of 120th Avenue.

Problem areas in this reach include: a poorly defined channel.

PROPOSED IMPROVEMENTS:

The uppermost drainage area to this tributary will be entirely collected by the Dunes Reservoir. Two gravel pit lakes form the new headwaters of Saddle Creek. The Brinkman-Woodward Pit will be filled in the future. When it is filled a channel will be incorporated to carry flows downstream. A 100-year channel requires a top width of 43 feet and slope of 0.36%.

Downstream of the Brinkman-Woodward Pit a future gravel mine will be administered by Adams County and the Colorado Division of Minerals and Geology. Drainage to Henderson Creek will be incorporated in the mining operations.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 30

Saddle Creek

Improvement	Quantity	Unit	Unit Cost	Total Cost
100-year Channel (43')	630	LF	$86	$54,180
Maintenance Trail	630	LF	$25	$15,750
Total Estimated Construction Cost				$69,930
Utility Relocation (5% of Construction Cost)				$3,497
Engr. and Contingency (35% of Construction + Utility)				$25,699
Land Value	1.4	Acres	$65,340	$94,500
Total Estimated Cost				**$193,626**

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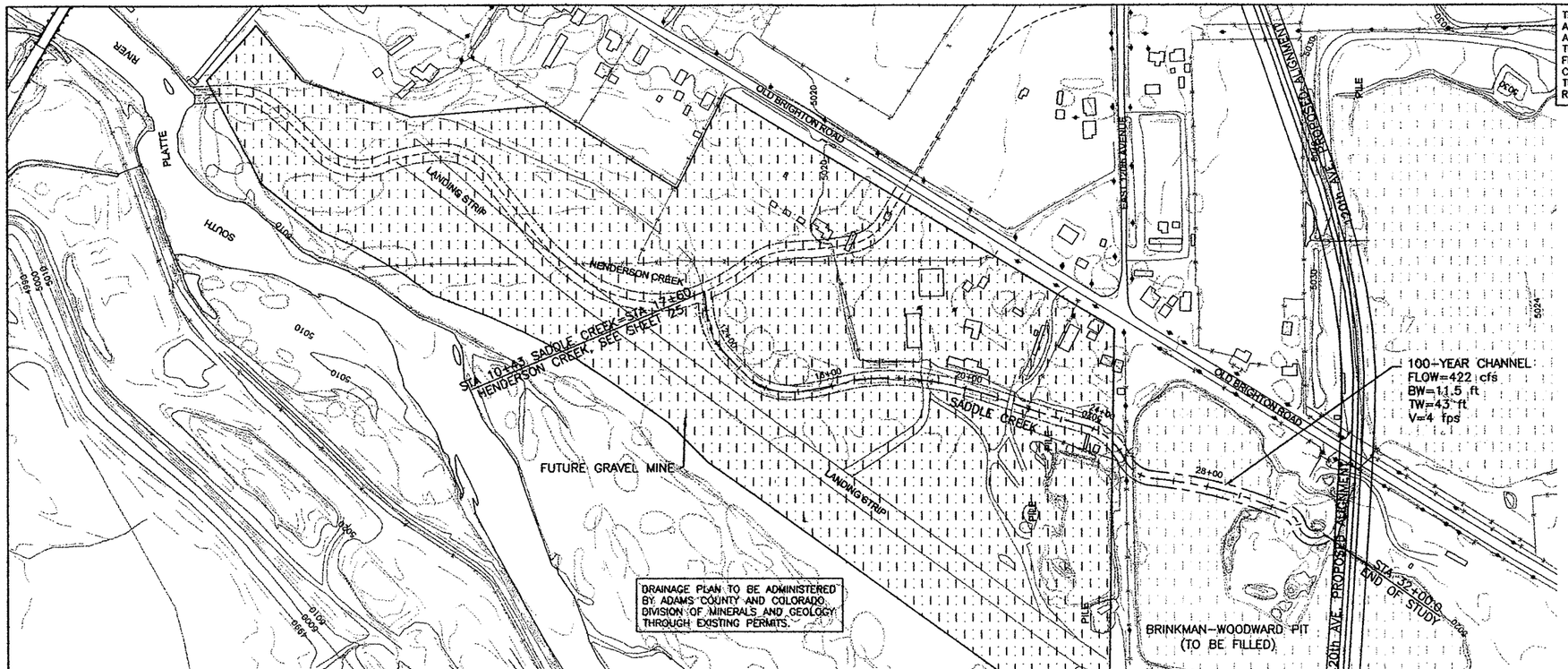

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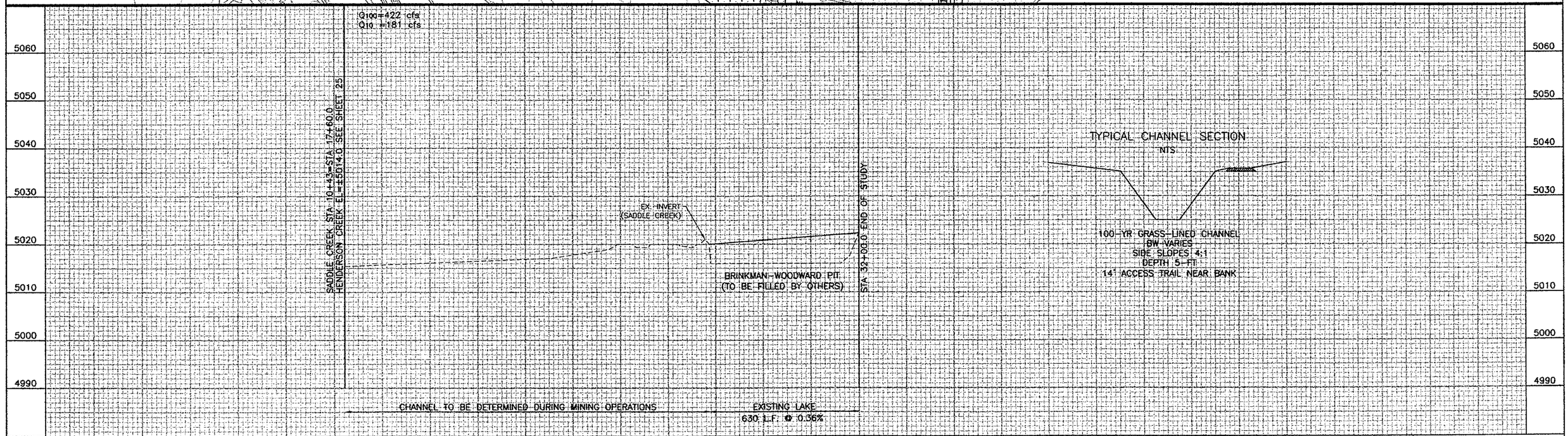

TYPICAL CHANNEL SECTION
NTS

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COMMENTARY SHEET 31

Major Drainageway: Ragweed Draw 0053-04.02 **Stations:** 0+00 to 59+00

EXISTING CONDITIONS:

Ragweed Draw is a large 2.2 square mile tributary to Henderson Creek. It outfalls to Henderson Creek near station 73+50 within the existing retention basin upstream of Havana Street. The current channel alignment has been slightly adjusted to pass around the River Run development. The 112th Avenue crossing is severely undersized with 31 cfs capacity and anticipated 100-year flows of 500 cfs. Upstream of 112th Avenue the channel is non-existent. The I-76 embankment and Burlington Ditch have prevented flows from passing downstream to form a channel.

Problem areas in this reach include: a poorly defined channel, undersized road crossing at 112th Avenue, and lack of crossings at Burlington Ditch and I-76.

PROPOSED IMPROVEMENTS:

This reach begins with Detention Facility 346 at the confluence with Henderson Creek. This facility is discussed on Sheet 26. An 11 acre-foot water quality basin is included on Ragweed Draw within the detention facility.

A 100-year channel carries flows from 112th Avenue to Henderson Creek. This channel requires a 5.5 foot drop structure downstream of 112th Avenue to fit in with existing topography.

112th Avenue will be upgraded to 100-year capacity via a twin 4'x7' box culvert. Excavation of the 100-year channel upstream and downstream allows the box culvert installation without raising the road elevation.

Between I-76 and 112th Avenue the channel is non-existent. A 38-foot top width channel sloped at 0.76% will be excavated to provide 100-year capacity.

Detention Facility #333 located on the upstream side of I-76 and is discussed on Sheet 32. The outlet for the detention facility is a twin 4'x8' box culvert with 100-year capacity. This culvert extends under the Burlington Ditch and also provides the separation of storm runoff and irrigation waters.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 31

Ragweed Draw

Improvement	Quantity	Unit	Unit Cost	Total Cost
Water Quality Basin [11.0 acre-feet]	11.0	AF	$25,000	$275,000
100-year Channel (43')	2760	LF	$86	$237,360
Drop Structure (5.5')	1	EA	$55,000	$55,000
100-year Channel (38')	190	LF	$76	$14,440
Box Culvert [Twin 4'x7'] 112th Avenue	110	LF	$730	$80,300
100-year Channel (38')	1840	LF	$76	$139,840
Box Culvert [Twin 4'x8'] I-76	315	LF	$840	$264,600
Maintenance Trail	4790	LF	$25	$119,750
Total Estimated Construction Cost				$1,186,290
Utility Relocation (5% of Construction Cost)				$59,315
Engr. and Contingency (35% of Construction + Utility)				$435,962
Land Value	11.0	Acres	$65,340	$718,500
Total Estimated Cost				**$2,400,066**

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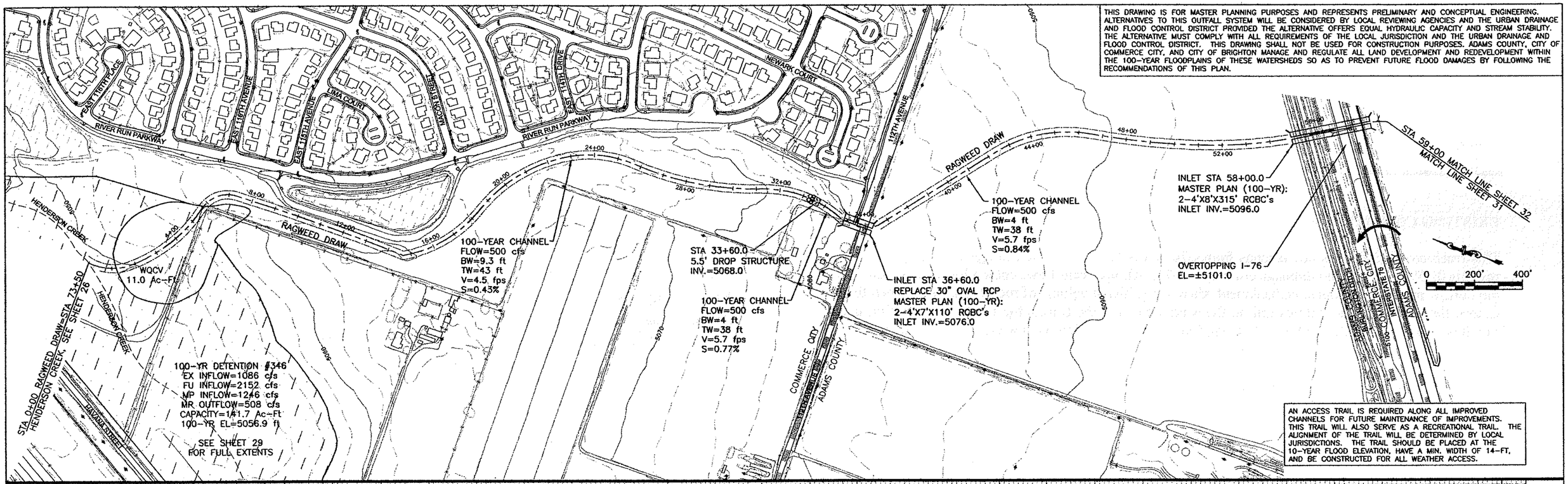

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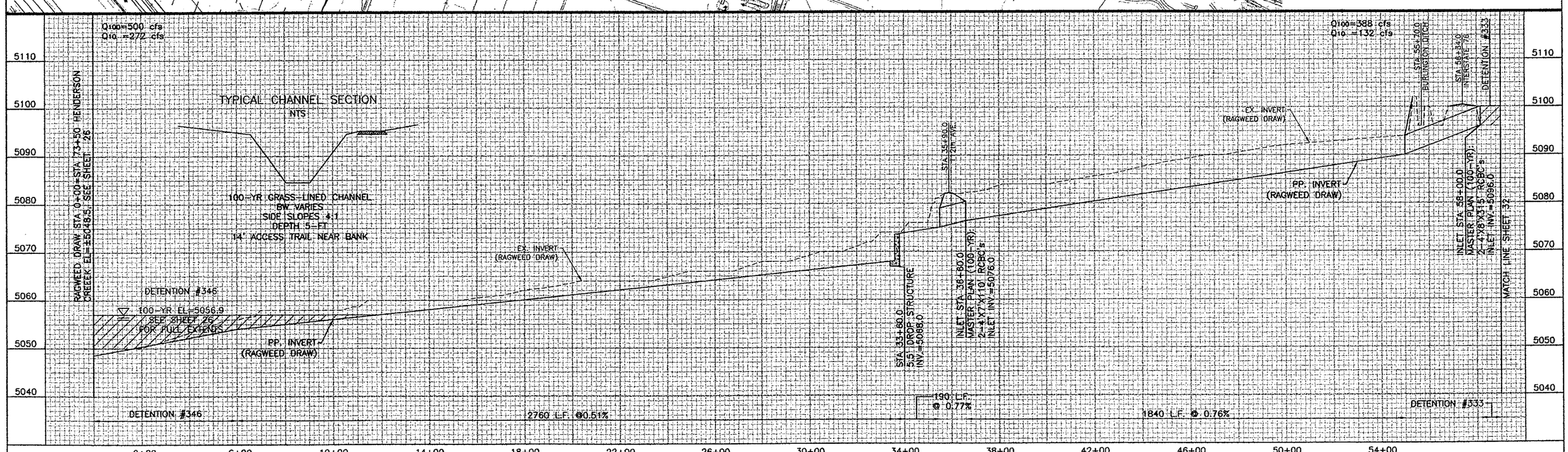

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COMMENTARY SHEET 32

Major Drainageway: Ragweed Draw 0053-04.02 **Stations:** 59+00 to 116+00

EXISTING CONDITIONS:

This reach covers 5700 feet and extends from I-76 to 104th Avenue. The average channel slope in this reach is 0.53%. There is no drainage crossing at I-76. All upstream flows enter a low area, possibly an old borrow pit, at the upstream embankment where a significant volume of runoff is stored. When flows exceed the storage capacity flows spill to the south and enter the Burlington Ditch. Historically, most low flows have been collected by the O'Brian Canal prior to entering the low area at I-76. Peoria Street, SH-2, and 104th Avenue are all overtopped with frequent flood events.

Problem areas in this reach include: a poorly defined channel, undersized roadway crossings, and increased future flows.

PROPOSED IMPROVEMENTS:

Improvements in this reach begin with the formalization of Detention #333. This existing retention site is highly effective at reducing downstream flows. Adding a twin 4'x8' box culvert at I-76 releases downstream flows to historic levels and converts the facility from retention to detention, as a required parameter of the master plan improvements. The box culvert is also extended under the Burlington Ditch to separate storm water from irrigation water. Adding a 10.4 acre-foot water quality basin within the detention facility improves water quality for the region.

Upstream of the detention facility higher flows make it difficult to provide a 100-year crossing structure at the O'Brian Canal. Adding a twin 4'x8' box culvert provides 10-year separation of the storm water and irrigation water. An armored overflow weir and separation structure are required to prevent larger flows from traveling downstream in the O'Brian.

A 100-year channel with a top width of 53 feet is required to carry flows downstream of the BNSFRR.

The crossing at Peoria Street is expanded to 10-year capacity via a Twin 4'x8' box culvert. The excavated channel allows the box culvert construction without raising the road elevation.

At SH-2 an existing 24" CMP is severely undersized to pass flood events. This results in the frequent overtopping of SH-2. Adding three 4'x8' and one 4'x6' box culvert provides 100-year capacity for both SH-2 and the BNSFRR. At 104th Avenue, 100-year capacity is achieved through three 4'x6' and one 4'x8' box culvert.

Upstream of SH-2, a 100-year channel is required with a top width of 50 feet. For longitudinal slope stability, a 1.3' drop structure is required near station 101+70.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 32

Ragweed Draw

Improvement	Quantity	Unit	Unit Cost	Total Cost
Detention Facility 333 [92 ac-ft]	1	EA	$273,123	$273,123
Water Quality Basin [10.4 acre-feet]	10.4	AF	$25,000	$260,000
100-year Channel (53')	130	LF	$106	$13,780
Box Culvert [Twin 4'x8'] O'Brian Canal	144	LF	$840	$120,960
Riprap H (24") Armored Overflow (150')	1100	CY	$50	$55,000
Separation Structure	1	EA	$10,000	$10,000
100-year Channel (53')	1843	LF	$106	$195,358
Box Culvert [Twin 4'x8'] Peoria Street	44	LF	$840	$36,960
100-year Channel (53')	480	LF	$106	$50,880
Box Culvert [Triple 4'x8' + 4'x6'] SH-2 + BNSFRR	240	LF	$1,560	$374,400
100-year Channel (50')	1214	LF	$100	$121,400
Drop Structure (1.3')	1	EA	$13,000	$13,000
Box Culvert [Triple 4'x6' + 4'x8'] 104th Avenue	77	LF	$1,350	$103,950
100-year Channel (52')	750	LF	$104	$78,000
Maintenance Trail	4417	LF	$25	$110,425
Total Estimated Construction Cost				$1,817,236
Utility Relocation (5% of Construction Cost)				$90,862
Engr. and Contingency (35% of Construction + Utility)				$667,834
Land Value	38.8	Acres	$65,340	$2,537,808
Total Estimated Cost				**$5,113,740**

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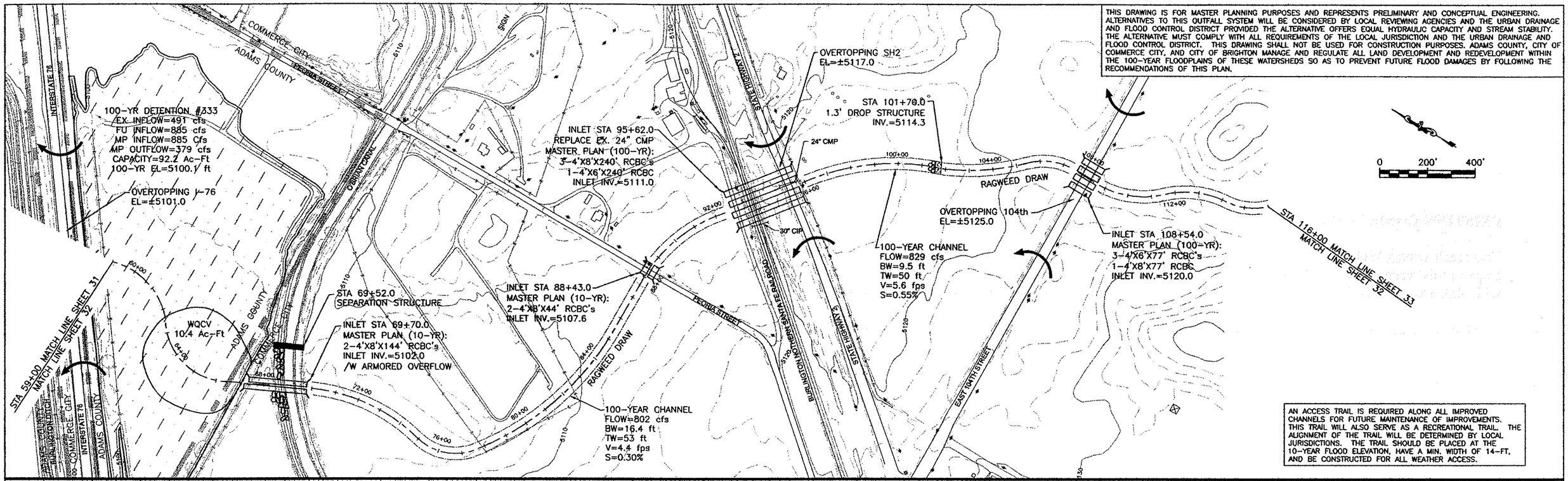

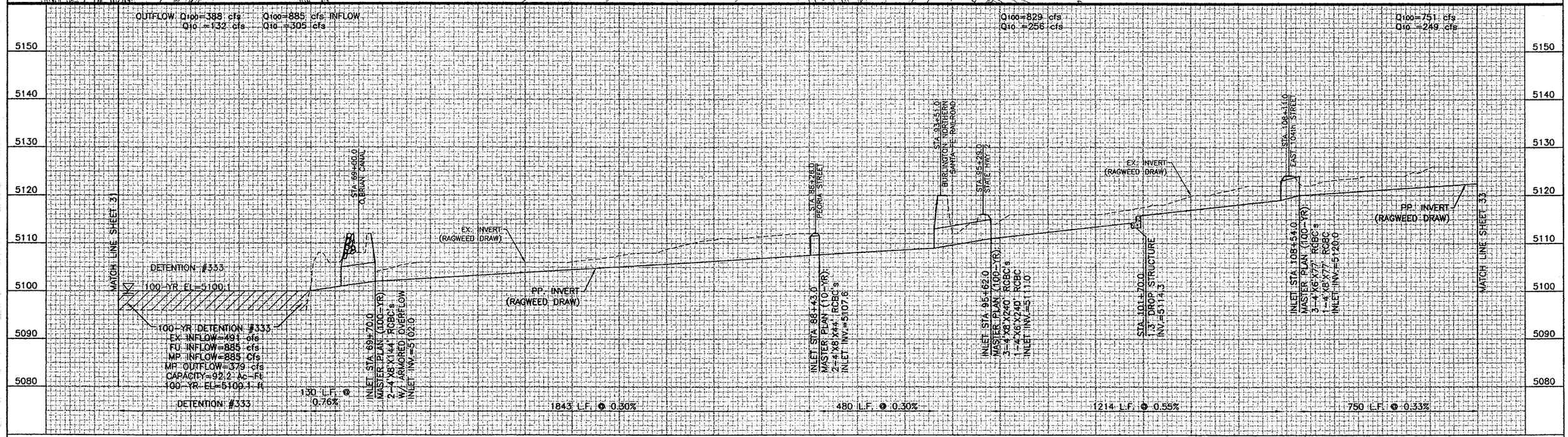

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COMMENTARY SHEET 33

Major Drainageway: Ragweed Draw 0053-04.02 **Stations:** 116+00 to 174+00

EXISTING CONDITIONS:

This reach covers 5800 feet from south of 104th Avenue to east of Potomac Street. The average channel slope in this reach is 0.62%. Most of this reach is undeveloped. The existing channel is poorly defined with high areas preventing continuous downstream flows. The crossing at Potomac Street is undersized.

Problem areas in this reach include: a poorly defined channel and undersized crossing at Potomac Street.

PROPOSED IMPROVEMENTS:

100-year conveyance is achieved through 4335 feet of channel downstream of Potomac Street. The channel top width varies from 42 feet to 52 feet.

100-year conveyance is achieved at Potomac Street via a twin 4'x6' box culvert.

Upstream of Potomac Street are the headwaters of Ragweed Draw. This area is steeper with an existing average slope of 1.0%. A 100-year channel is required with a stable design slope of 0.68%. This requires two drop structures with heights of 3.7 feet each.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 33

Ragweed Draw

Improvement	Quantity	Unit	Unit Cost	Total Cost
100-year Channel (52')	2260	LF	$104	$235,040
100-year Channel (42')	2075	LF	$84	$174,300
Box Culvert [Twin 4'x6'] Potomac Street	55	LF	$625	$34,375
100-year Channel (38')	1410	LF	$76	$107,160
Drop Structure (3.7')	2	EA	$37,000	$74,000
Maintenance Trail	5745	LF	$25	$143,625
Total Estimated Construction Cost				$768,500
Utility Relocation (5% of Construction Cost)				$38,425
Engr. and Contingency (35% of Construction + Utility)				$282,424
Land Value	13.2 Acres		$65,340	$861,750
Total Estimated Cost				**$1,951,099**

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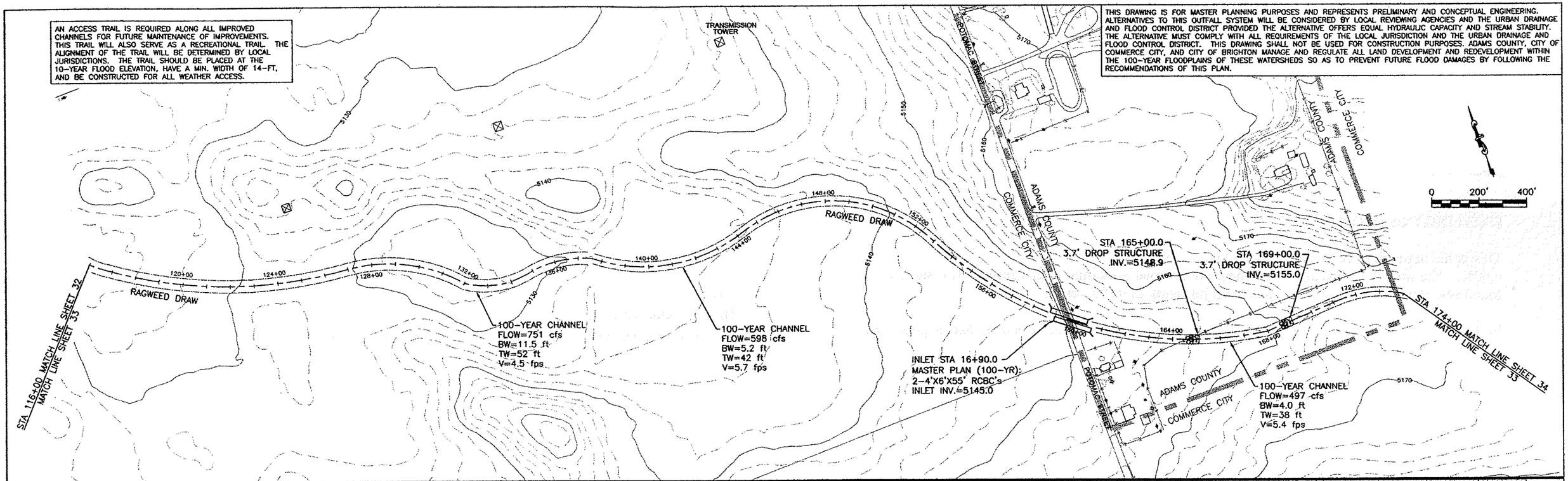

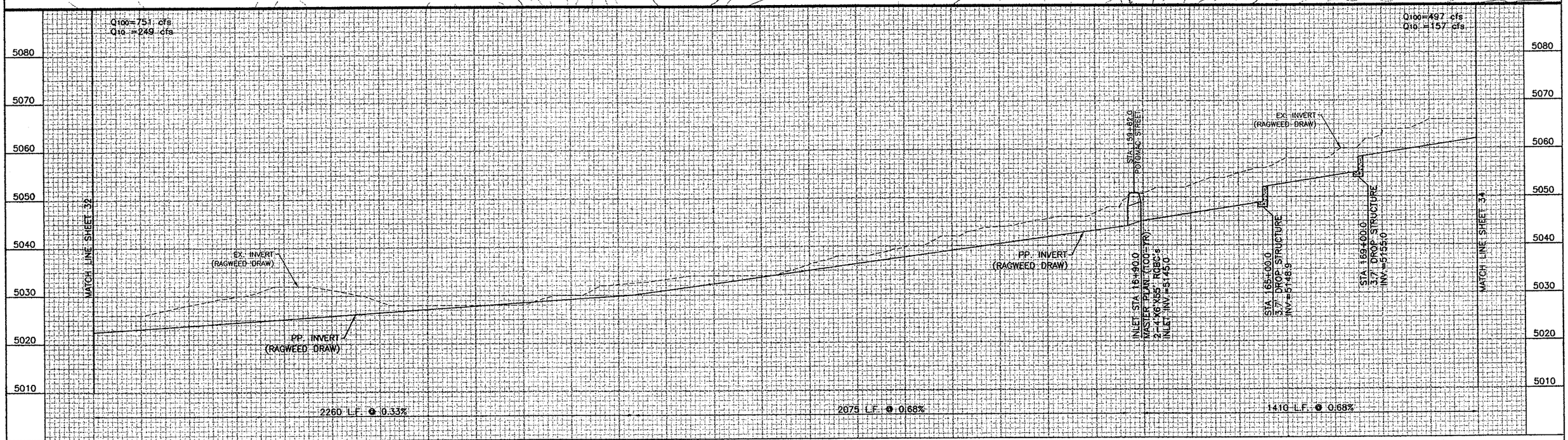

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COMMENTARY SHEET 34

Major Drainageway: Ragweed Draw 0053-04.02 **Stations:** 174+00 to 223+00

EXISTING CONDITIONS:

This is the upper most reach of Ragweed Draw. This reach covers 4900 feet with an average slope of 0.65%. The area is undeveloped and there are no road crossings in this reach. The study limits are found near station 223+00 at Chambers Road just north of 96th Avenue.

Problem areas in this reach include: potential erosion along the steep slopes and a poorly defined channel.

PROPOSED IMPROVEMENTS:

A 100-year channel is achieved in this reach through 4900 feet of channel with top widths varying from 37' to 38'. To minimize excavation, some steeper reaches are required with slopes of 1.13%. In these reaches 2.5' drop structures are required to maintain slope stability.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 34

Ragweed Draw

Improvement	Quantity	Unit	Unit Cost	Total Cost
100-year Channel (38')	1450	LF	$76	$110,200
100-year Channel (28')	750	LF	$56	$42,000
Drop Structure (2.5')	1	EA	$25,000	$25,000
100-year Channel (37')	2050	LF	$74	$151,700
100-year Channel (28')	649	LF	$56	$36,344
Drop Structure (2.5')	1	EA	$25,000	$25,000
Maintenance Trail	4899	LF	$25	$122,475
Total Estimated Construction Cost				$512,719
Utility Relocation (5% of Construction Cost)				$25,636
Engr. and Contingency (35% of Construction + Utility)				$188,424
Land Value	11.2	Acres	$65,340	$734,850
Total Estimated Cost				**$1,461,629**

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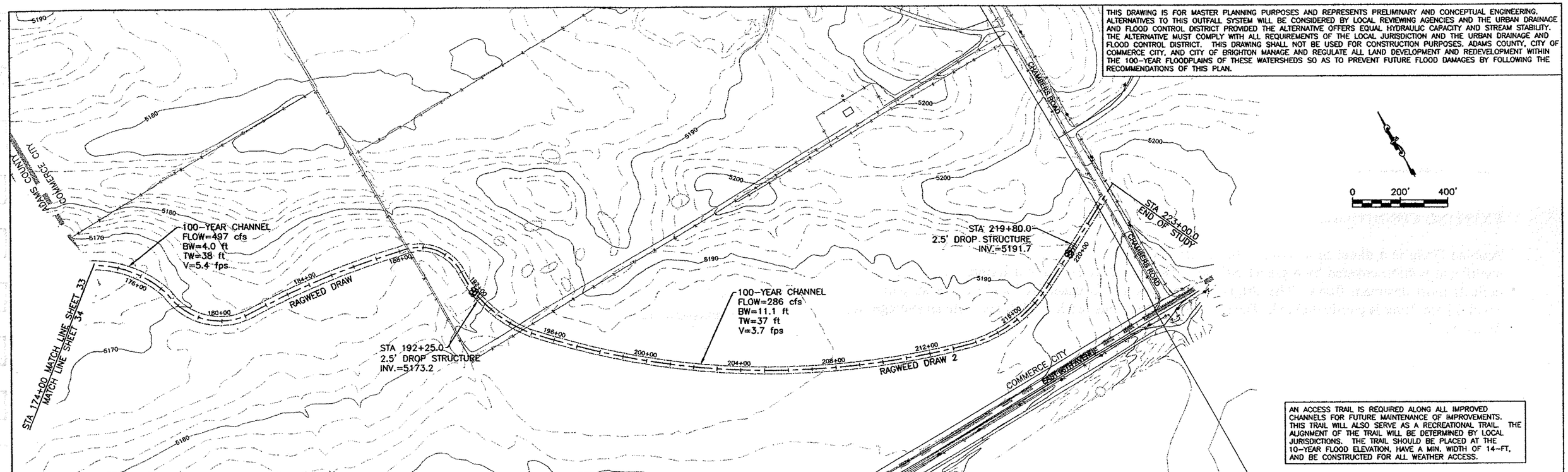

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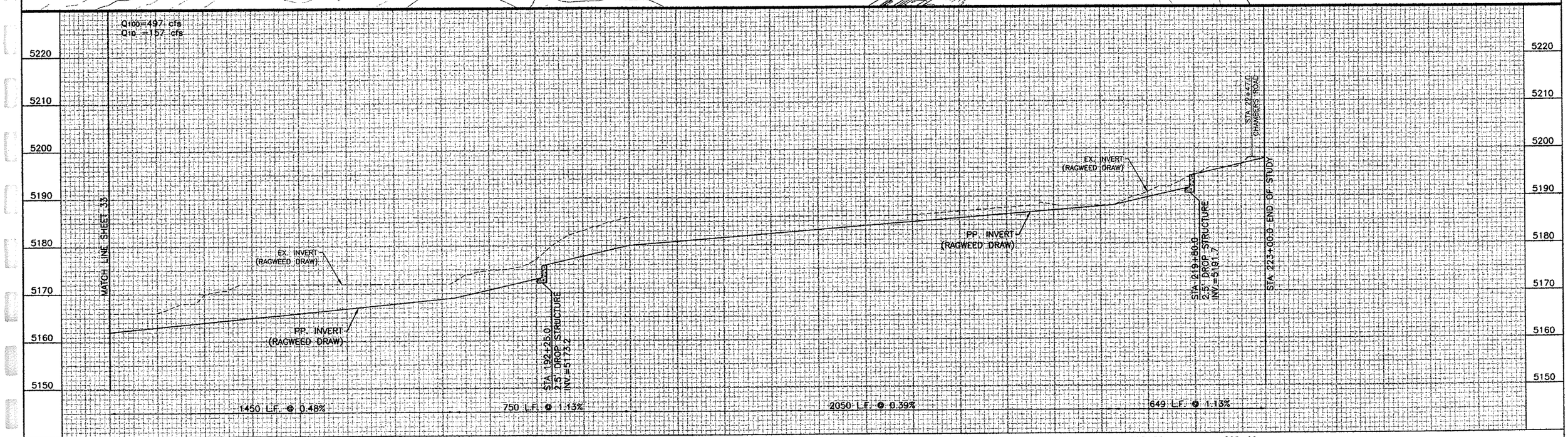

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COMMENTARY SHEET 35

Major Drainageway: Arabian Drain 0053-03 **Stations:** 0+00 to 14+00

EXISTING CONDITIONS:

Arabian Drain is a direct flow basin to the South Platte River. This is a small drainage basin with a significant portion covered by a gravel pit lake. The lake does not have a formal release point and it collects most upstream flows. The Brighton Road crossing is undersized and the outfall path to the South Platte River is poorly defined. The channel length in this reach is 1400 feet with an average slope of 0.79%.

Problem areas in this reach include: a poorly defined channel and undersized road crossing at Brighton Road.

PROPOSED IMPROVEMENTS:

Flows that are released from the gravel pit lake travel to Brighton Road. A new twin 3'x5' box culvert provides a 100-year crossing structure. Downstream of Brighton Road 1280 feet of 26' wide channel carry 100-year flows to the South Platte River. This provides a defined outfall path to the river.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 35

Arabian Drain

Improvement	Quantity	Unit	Unit Cost	Total Cost
100-year Channel (26')	1280	LF	$50	$64,000
Box Culvert [Twin 3'x5'] Brighton Road	44	LF	$390	$17,160
Maintenance Trail	1280	LF	$25	$32,000
Total Estimated Construction Cost				$113,160
Utility Relocation (5% of Construction Cost)				$5,658
Engr. and Contingency (35% of Construction + Utility)				$41,586
Land Value	2.9	Acres	$65,340	$192,000
Total Estimated Cost				**$352,404**

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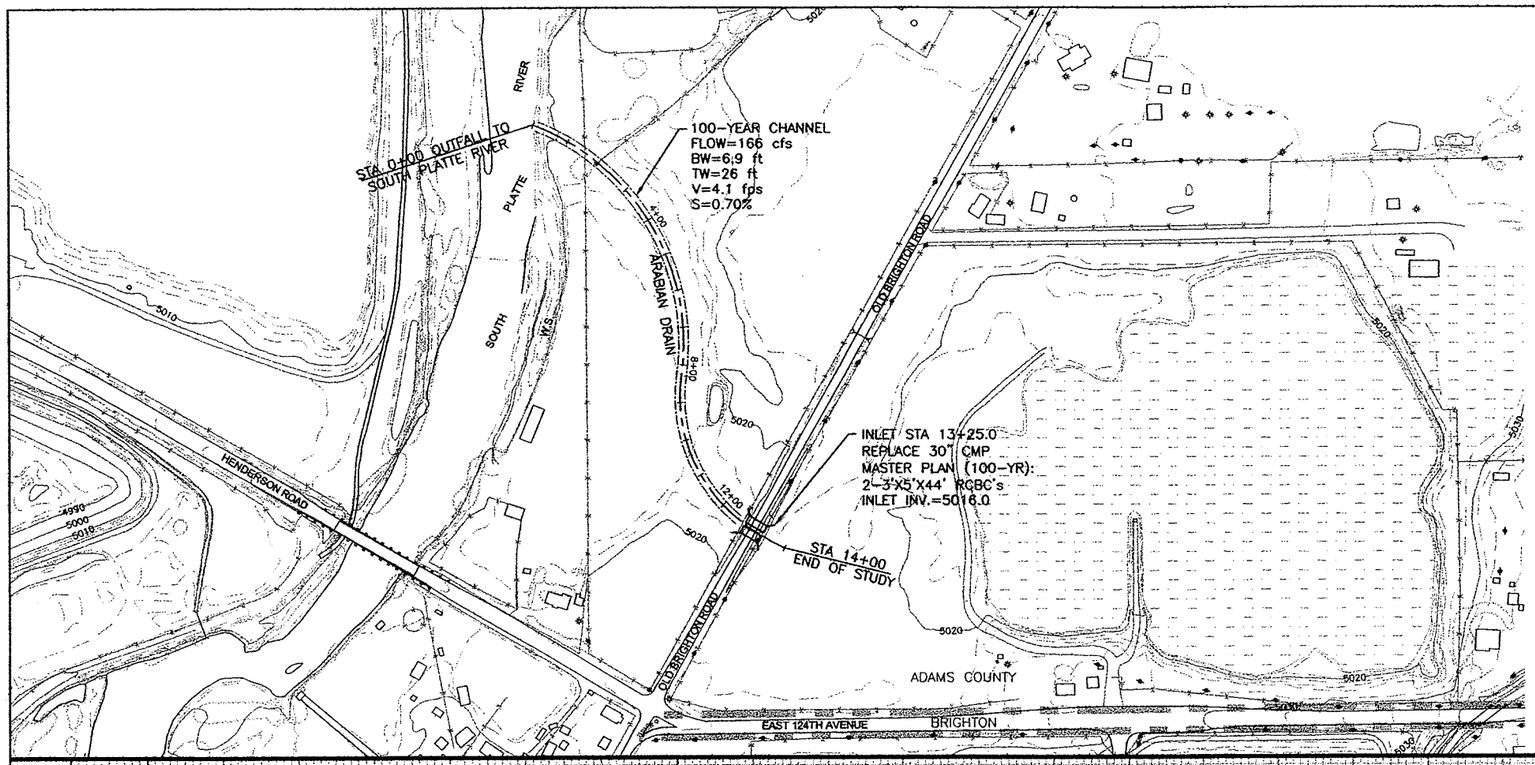

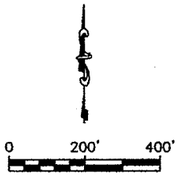

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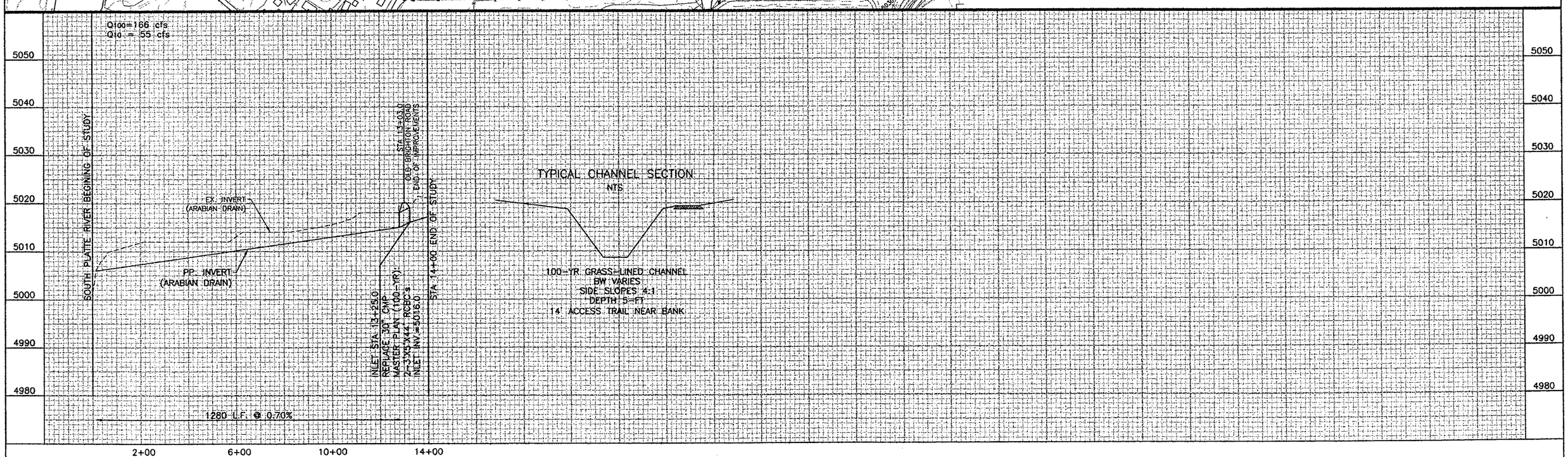

TYPICAL CHANNEL SECTION
NTS

100-YR GRASS-LINED CHANNEL
BW: VARIES
SIDE SLOPES 4:1
DEPTH: 5-FT
14' ACCESS TRAIL NEAR BANK

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COMMENTARY SHEET 36

Major Drainageway: Fox Run 0053-02 **Stations:** 0+00 to 58+00

EXISTING CONDITIONS:

Fox Run is the second large outfall to the South Platte River that constitutes 85% of the total DFA 0053 area. This reach covers the lower 5800 feet from the South Platte River to US-85. Most of this reach travels through gravel mining operations. A large gravel pit lake is located downstream of US-85. Existing mining operations are found between Brighton Road and the lake. Downstream of Brighton Road is a poorly defined outfall to the South Platte River. Historically, US-85 and the lake have prevented regular flows from reaching the river. The drainage crossings at both Brighton Road and US-85 are undersized, and there is no release from the large gravel pit lake.

Problem areas in this reach include: a poorly defined outfall, undersized crossings at Brighton Road and US-85, no release from the large gravel pit lake.

PROPOSED IMPROVEMENTS:

A 100-year channel is required to convey flows from Brighton Road to the South Platte River. A top width of 53 feet provides 100-year capacity and the channel defines the outfall path to the river.

Brighton Road can be increased to 100-year capacity via a twin 4'x7' box culvert.

Upstream of Brighton Road the channel passes through an existing gravel mining operation. Several gravel piles and excavated areas are found in this reach. Upon mining completion, a final slope grade of 0.32% will accommodate a 100-year channel and tie in upstream and downstream culvert crossings.

The west side of the existing gravel pit lake has been built up with a driveway located near station 37+00. A 36" RCP can be installed to allow 100-year flows out of the existing lake and maintain the driveway access.

Another 36" RCP is shown at the upper part of this reach. This pipe is the outlet culvert for Detention Facility #364, shown on Sheet 37. The total culvert length is 1340 feet and requires three manholes for access. Due to the surface elevation and 100-year pool elevation, the manhole covers will need to be locking, watertight covers. This culvert also provides a 100-year crossing under US-85 and Fulton Ditch.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 36

Fox Run

Improvement	Quantity	Unit	Unit Cost	Total Cost
100-year Channel (53')	900	LF	$106	$95,400
Box Culvert [Triple 4'x7'] Brighton Road	92	LF	$1,100	$101,200
100-year Channel (53')	2520	LF	$106	$267,120
36" RCP	320	LF	$60	$19,200
100-year Channel (30')	170	LF	$150	$25,500
36" RCP	540	LF	$60	$32,400
Manhole (Watertight, Locking)	1	EA	$4,000	$4,000
Maintenance Trail	3590	LF	$25	$89,750
Total Estimated Construction Cost				$634,570
Utility Relocation (5% of Construction Cost)				$31,729
Engr. and Contingency (35% of Construction + Utility)				$233,204
Land Value	8.2	Acres	$65,340	$538,500
Total Estimated Cost				**$1,438,003**

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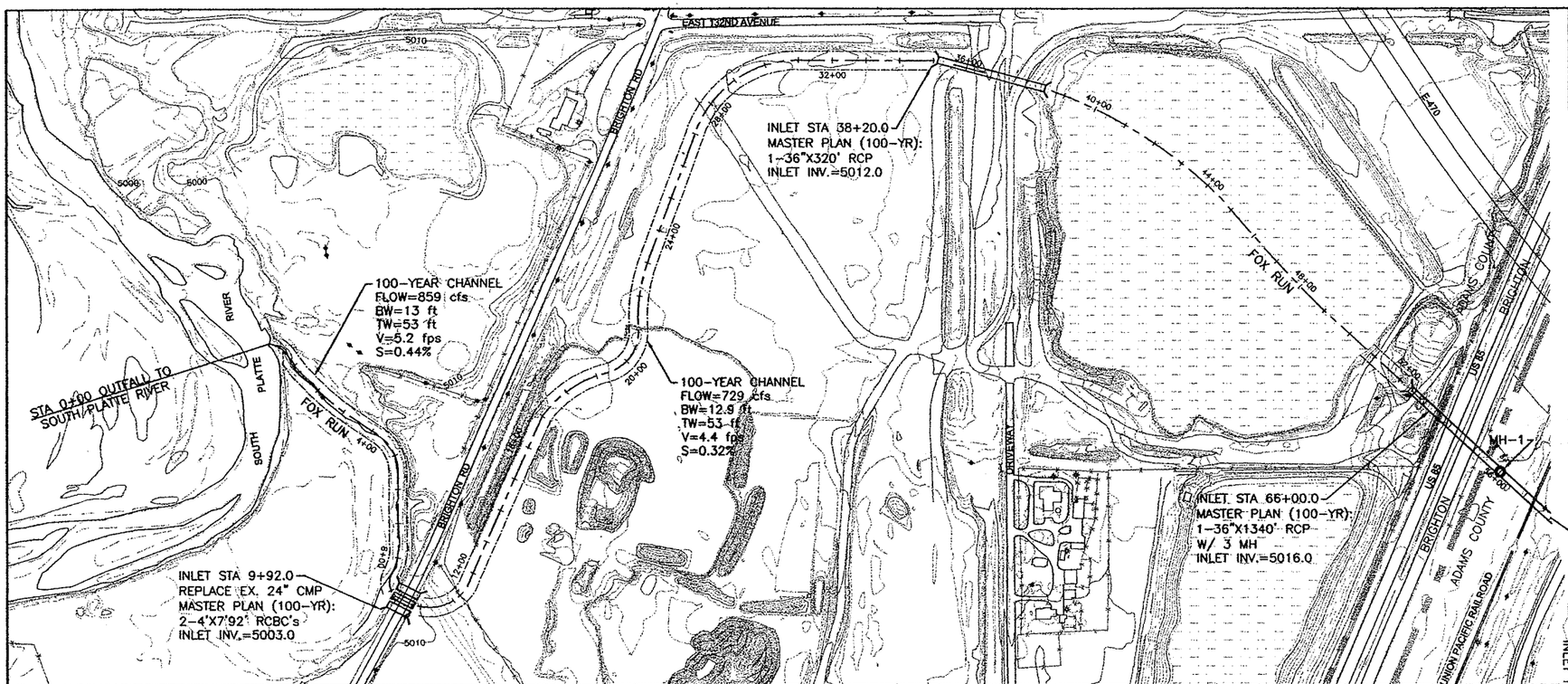

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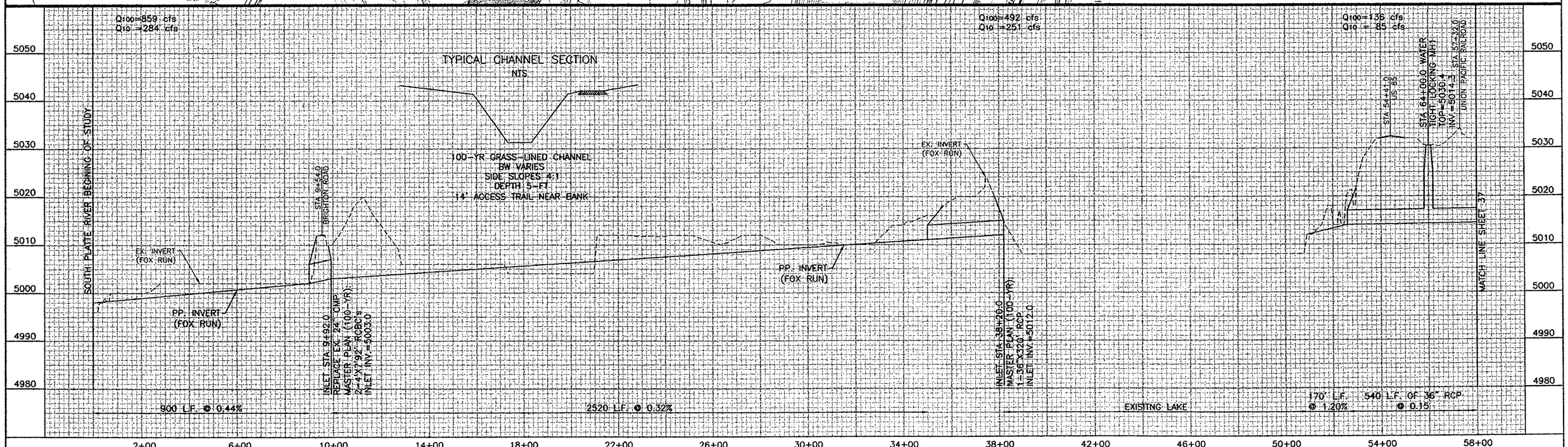

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COMMENTARY SHEET 37

Major Drainageway: Fox Run 0053-02 **Stations:** 58+00 to 116+00

EXISTING CONDITIONS:

This reach covers 5800 feet from US-85 to 124th Avenue. The average channel slope in this reach is 0.41%. The existing flow path enters Fulton Ditch near station 100+00. Locust Run is a large tributary and enters Fox Run near station 102+00. The existing channel is poorly defined through this reach. A large borrow pit used to construct the E-470 embankment is found along E-470.

Problem areas in this reach include: a poorly defined channel, no crossing of the Fulton Ditch, and increased flows from future development.

PROPOSED IMPROVEMENTS:

This reach begins with a continuation of the outlet structure for Detention #364 from Sheet 36. The total length of 36" RCP is 1340 feet and requires 3 manholes for access. Due to manhole cover elevations, the covers should be locking, and watertight to prevent lifting of the covers. The detention outlet also serves as a Fulton Ditch crossing in this reach. Detention #364 is an existing borrow pit used to provide material for the E-470 embankment. No excavation is needed to achieve full 100-year storage. Flows are reduced from 1359 cfs to 136 cfs. Over-detaining volume in this facility allows the outfall to the South Platte River to be maintained at existing magnitudes. A water quality basin serves to remove pollutants and sediments from the storm runoff and has been sized to capture 1 square mile of upstream drainage area.

A 100-year diversion channel is required to convey flows to Detention #364. This channel begins at the confluence of Locust Run with Fox Run and is aligned parallel to the Fulton Ditch alignment to minimize disruption of the adjacent agricultural land. An existing irrigation pond is located between stations 77+00 and 80+00. Access to this pond will need to be provided for use in the agricultural fields east of the diversion ditch.

Upstream of the Locust Run confluence, the required channel size decreases from 69 feet to 35 feet. The alignment of Fox Run is located along the north side of 124th Avenue.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 37

Fox Run

Improvement	Quantity	Unit	Unit Cost	Total Cost
36" RCP	800	LF	$60	$48,000
Manhole (Watertight, Locking)	2	EA	$4,000	$8,000
Detention Facility 364 [192 ac-ft]	1	EA	$242,246	$242,246
Water Quality Basin [11.0 acre-feet]	11	AF	$25,000	$275,000
100-year Channel (69')	2996	LF	$140	$419,440
100-year Channel (35')	1400	EA	$74	$103,600
Maintenance Trail	4396	LF	$25	$109,900
Total Estimated Construction Cost				$1,206,186
Utility Relocation (5% of Construction Cost)				$60,309
Engr. and Contingency (35% of Construction + Utility)				$443,273
Land Value	10.1	Acres	$65,340	$659,400
Total Estimated Cost				**$2,369,169**

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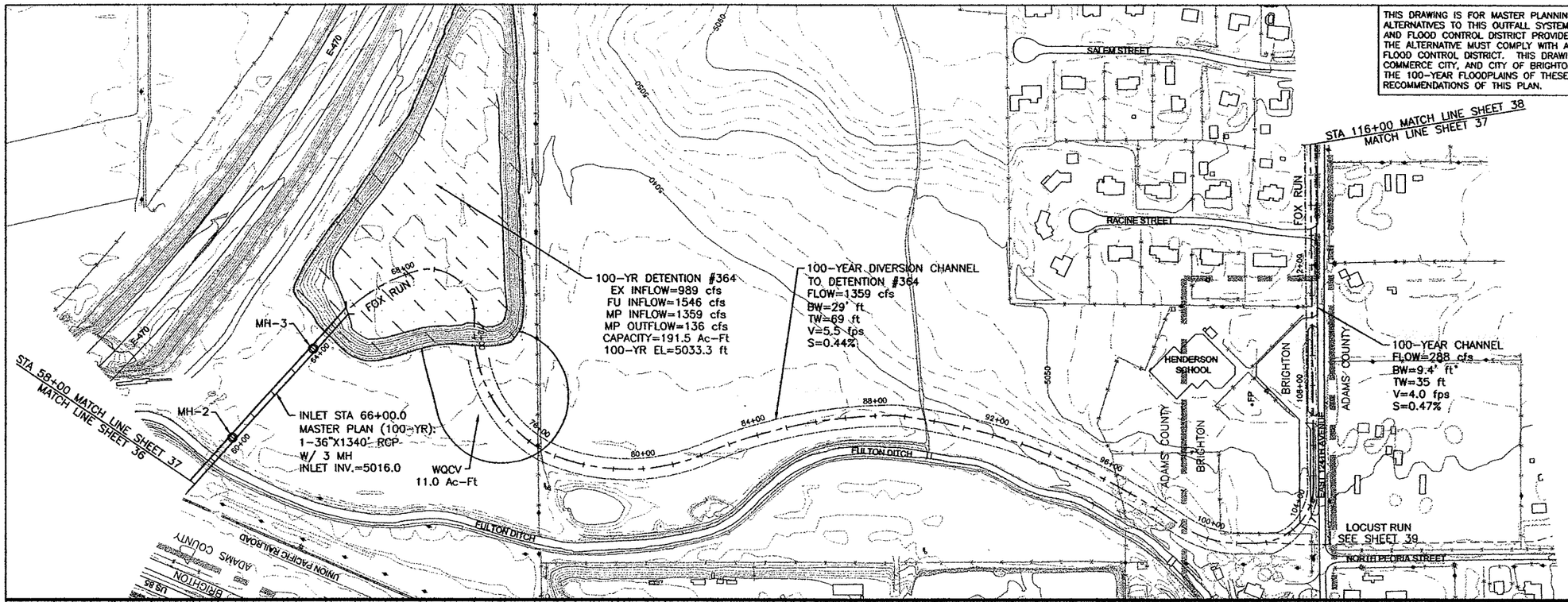

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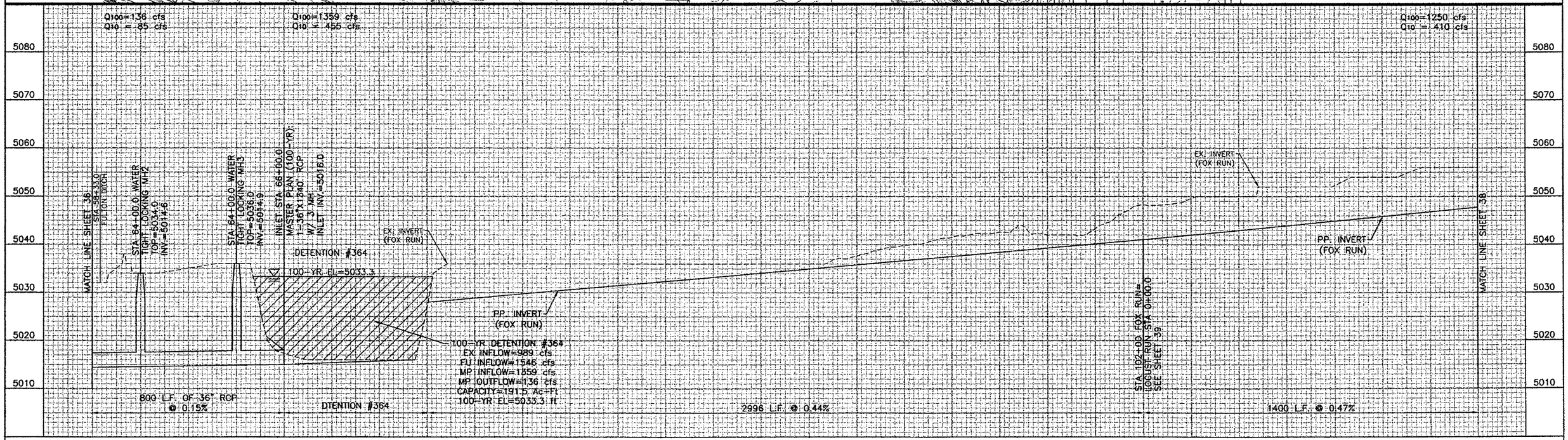

BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001	Kiowa Engineering Corporation 7175 W. Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303) 692-0369 KIOWA PROJECT NO. 01095	DESIGNED BJW/DDR DATE 02/04 DRAWN DDR DATE 02/04 CHECKED BJW DATE 02/04	ADAMS COUNTY, CITY OF BRIGHTON CITY OF COMMERCE CITY, AND URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY UPDATE SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS	FOX RUN 0053-02 STA 58+00 to 116+00 SHEET 37

COMMENTARY SHEET 38

Major Drainageway: Fox Run 0053-02 **Stations:** 116+00 to 166+00

EXISTING CONDITIONS:

This reach covers the upper most portion of Fox Run from 124th Avenue to the upstream study limit. The reach length is 5000 feet with an average slope of 0.36%. The channel is poorly defined and there is no crossing at 124th Avenue.

Problem areas in this reach include: a poorly defined channel and inadequate capacity at 124th Avenue.

PROPOSED IMPROVEMENTS:

A 100-year channel carries flows downstream of 124th Avenue with a top width of 35 feet and channel slope of 0.47%.

At 124th Avenue a 4'x8' box culvert will provide 100-year conveyance capacity.

Upstream of 124th Avenue, Fox Run extends for an additional 4000 feet. 100-year conveyance is achieved through a channel with varying widths from 27' to 38'. The upstream study limit is found at station 166+00 at 120th Avenue.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 38

Fox Run

Improvement	Quantity	Unit	Unit Cost	Total Cost
100-year Channel (35')	920	EA	$70	$64,400
Box Culvert [4'x8'] 124th Avenue	77	LF	$420	$32,340
100-year Channel (38')	1720	LF	$76	$130,720
100-year Channel (27')	2300	LF	$54	$124,200
Maintenance Trail	4940	LF	$25	$123,500
Total Estimated Construction Cost				$475,160
Utility Relocation (5% of Construction Cost)				$23,758
Engr. and Contingency (35% of Construction + Utility)				$174,621
Land Value	11.3	Acres	$65,340	$741,000
Total Estimated Cost				**$1,414,539**

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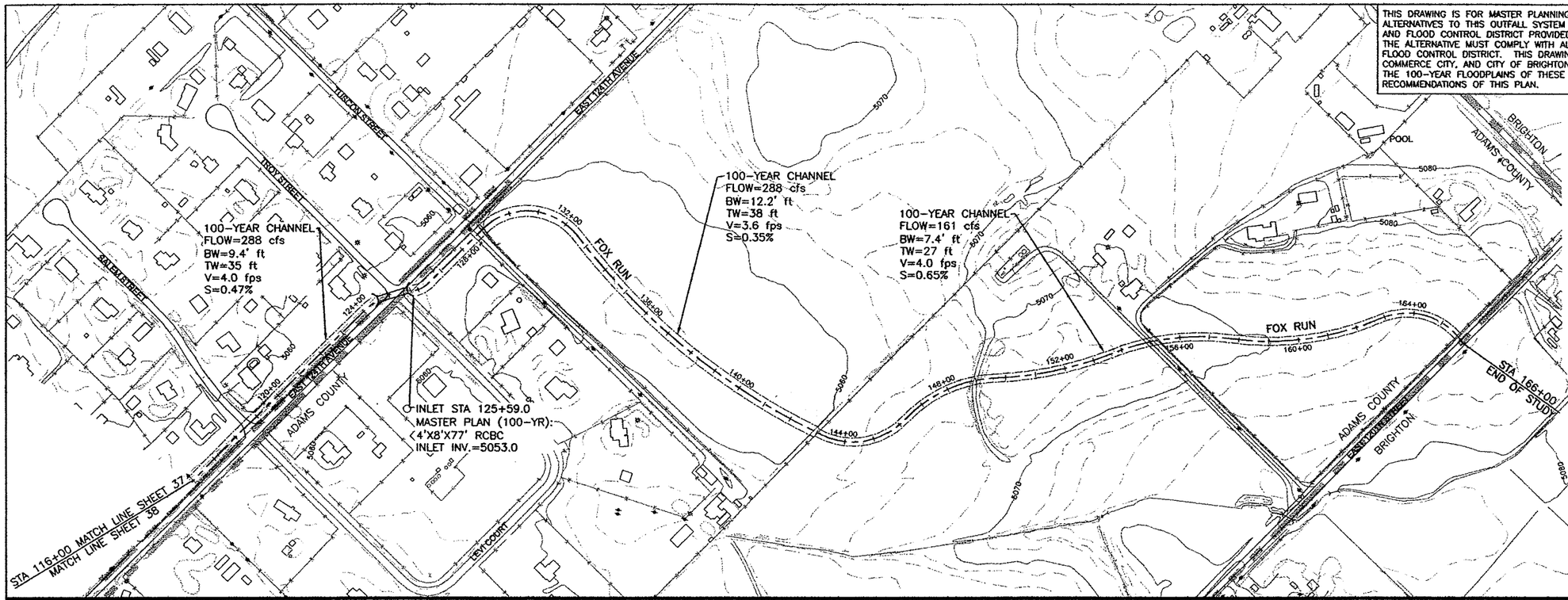

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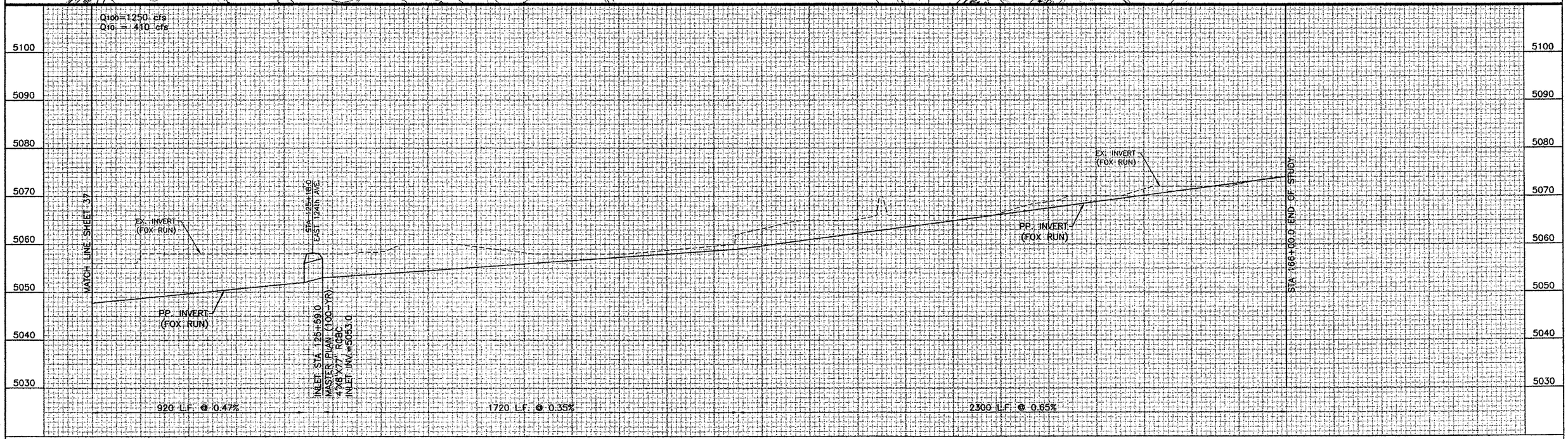

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COMMENTARY SHEET 39

Major Drainageway: Locust Run 0053-02.01 **Stations:** 0+00 to 58+00

EXISTING CONDITIONS:

Locust Run is a large tributary to Fox Run with its confluence near station 102+00. Locust Run has a drainage area of 2.1 square miles including two additional tributaries, Reign Creek and Tumbleweed Draw. This reach of Locust Run covers 5800 feet with an average slope of 0.45%. Due to limited development and the upstream irrigation canals, this area has historically seen little sizeable runoff. The existing drainage path travels along Peoria Street and splits two residential parcels. Reign Creek enters near station 18+00. Tumbleweed Draw enters near station 32+00 just upstream of 120th Avenue. 120th Avenue has an existing 18" CMP for a drainage crossing. The culvert is quickly exceeded by nearly every rainfall event. South of 120th the channel passes through residential lots. Historically, flows have been small and have created flooding problems.

Problem areas in this reach include: a poorly defined channel path, limited area with residential development, and undersized crossings at 124th and 120th Avenues.

PROPOSED IMPROVEMENTS:

Immediately upstream of the Locust Run outfall to Fox Run, the channel passes through 124th Avenue. Four 4'x8' box culverts provide 100-year crossing capacity at this roadway.

A 100-year, 70-foot wide, channel defines the flow path for 100-year flows between 124th and 120th Avenue.

At 120th Avenue the existing 18" CMP is severely undersized. Three 3'x7' box culverts achieve 100-year capacity at this crossing.

Upstream of 120th Avenue a 37-foot, 100-year channel defines the flow path for the future flows.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 39

Locust Run

Improvement	Quantity	Unit	Unit Cost	Total Cost
100-year Channel (70')	170	LF	$140	$23,800
Box Culvert [Quad 4'x8'] 124th Avenue	44	LF	$1,700	$74,800
100-year Channel (70')	2938	LF	$140	$411,320
Box Culvert [Triple 4'x7'] 120th Avenue	44	LF	$1,100	$48,400
100-year Channel (37')	2633	LF	$74	$194,842
Maintenance Trail	5571	LF	$25	$139,275
Total Estimated Construction Cost				$868,637
Utility Relocation (5% of Construction Cost)				$43,432
Engr. and Contingency (35% of Construction + Utility)				$319,224
Land Value	12.8	Acres	$65,340	$835,650
Total Estimated Cost				**$2,066,943**

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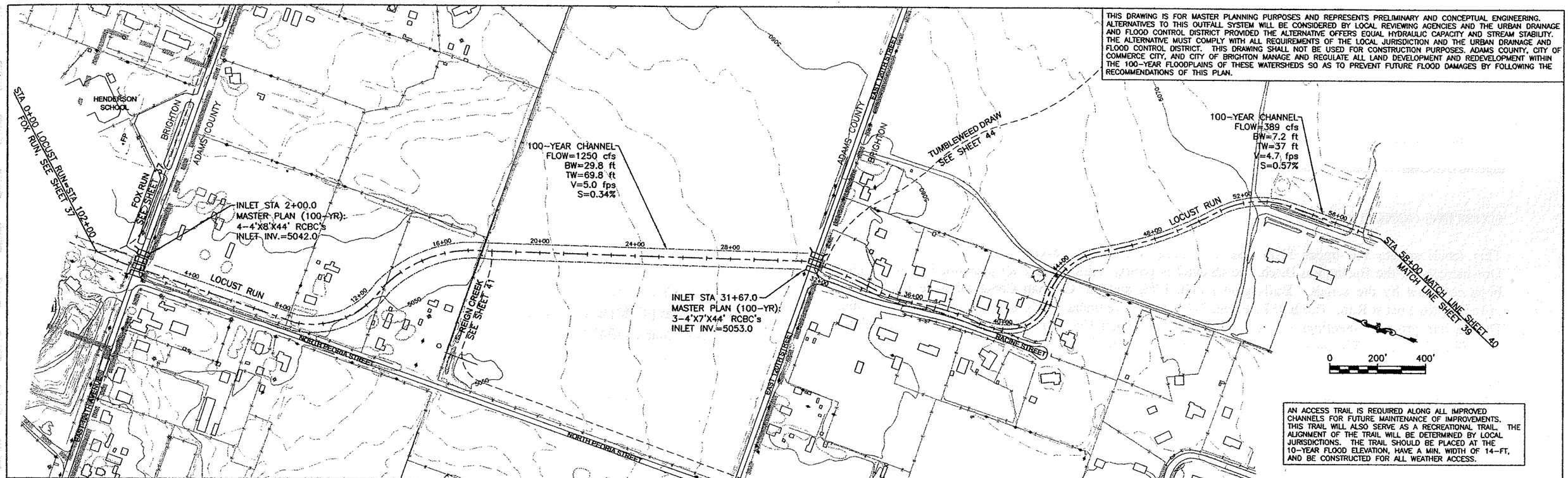

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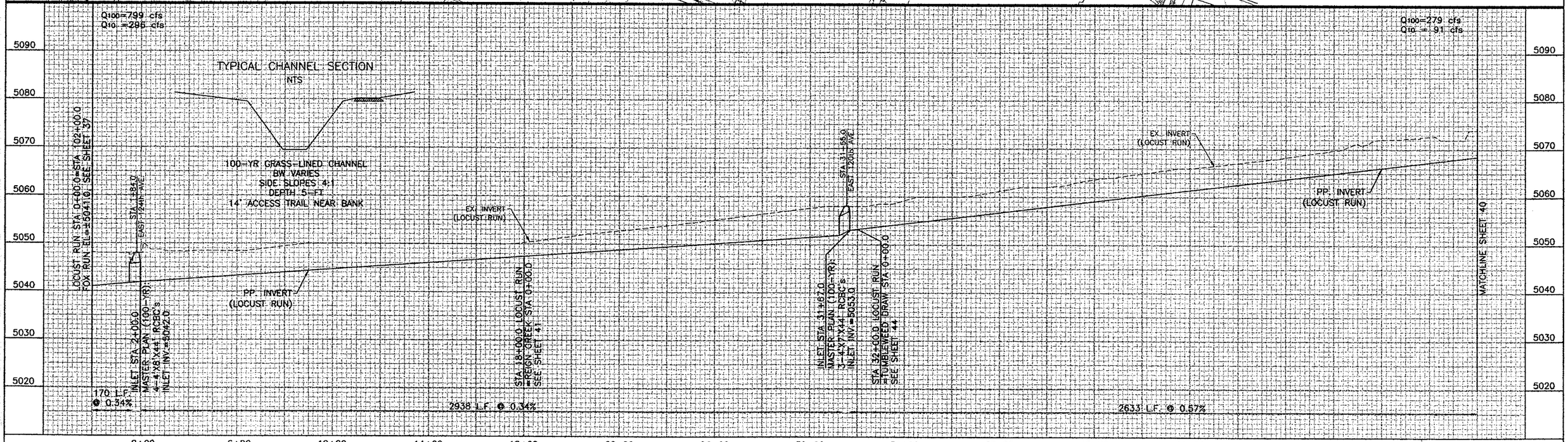

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COMMENTARY SHEET 40

Major Drainageway: Locust Run 0053-02.01 **Stations:** 58+00 to 109+00

EXISTING CONDITIONS:

This reach covers the upper 5100 feet of Locust Run. The average channel slope is 0.98%. Downstream of the Burlington Ditch, the channel is poorly defined since all previous low flows have been collected by the canals. Burlington Ditch, I-76, and the O'Brian Canal all have no drainage crossings for Locust Run. The BNSFRR and SH-2 both have undersized crossings in 42" and 24" CIPs. During our progress meetings we learned that the O'Brian Canal will be relocated to parallel the BNSFRR alignment. This new alignment has been shown on Sheet 40.

Problem areas in this reach include: a poorly defined channel, no crossing structures at Burlington Ditch, I-76, and O'Brian Canal, and undersized crossings at BNSFRR and SH-2.

PROPOSED IMPROVEMENTS:

A 100-year channel is required downstream of the Burlington Ditch. Channel widths vary from 34' to 37' for the channel length of 2429 feet.

100-year capacity can be achieved at the Burlington Ditch via a 4'x8' box culvert.

A 100-year channel is required between the Burlington and I-76 for 123 feet. Due to the steep slope in this reach a 4.9' drop structure is required to maintain a stable slope. The drop also provides the depth necessary to cross under the Burlington Ditch.

100-year capacity can be achieved at I-76 via a 4'x8' box culvert.

A 100-year channel is also required between I-76 and the relocated O'Brian Canal. The steep slope in this reach requires a 0.8' drop structure for channel stability.

Two 3'x5' and one 3'x4' box culvert provide 100-year conveyance capacity at BNSFRR and SH-2

PRELIMINARY DESIGN COST ESTIMATE: SHEET 40

Locust Run

Improvement	Quantity	Unit	Unit Cost	Total Cost
100-year Channel (37')	939	LF	$74	$69,486
100-year Channel (34')	1490	LF	$68	$101,320
Box Culvert [4'x8'] Burlington Ditch	129	LF	$420	$54,180
100-year Channel (34')	123	LF	$68	$8,364
Drop Structure (4.9')	1	EA	$49,000	$49,000
Box Culvert [4'x8'] I-76	200	LF	$420	$84,000
100-year Channel (28')	1820	LF	$56	$101,920
Drop Structure (0.8')	1	EA	$8,000	$8,000
Box Culvert [Twin 3'x5'+3'x4'] SH-2 to O'Brian Canal	360	LF	$550	$198,000
Maintenance Trail	4372	LF	$25	$109,300
Total Estimated Construction Cost				$783,570
Utility Relocation (5% of Construction Cost)				$39,179
Engr. and Contingency (35% of Construction + Utility)				$287,962
Land Value	10.0	Acres	$65,340	$655,800
Total Estimated Cost				**$1,766,510**

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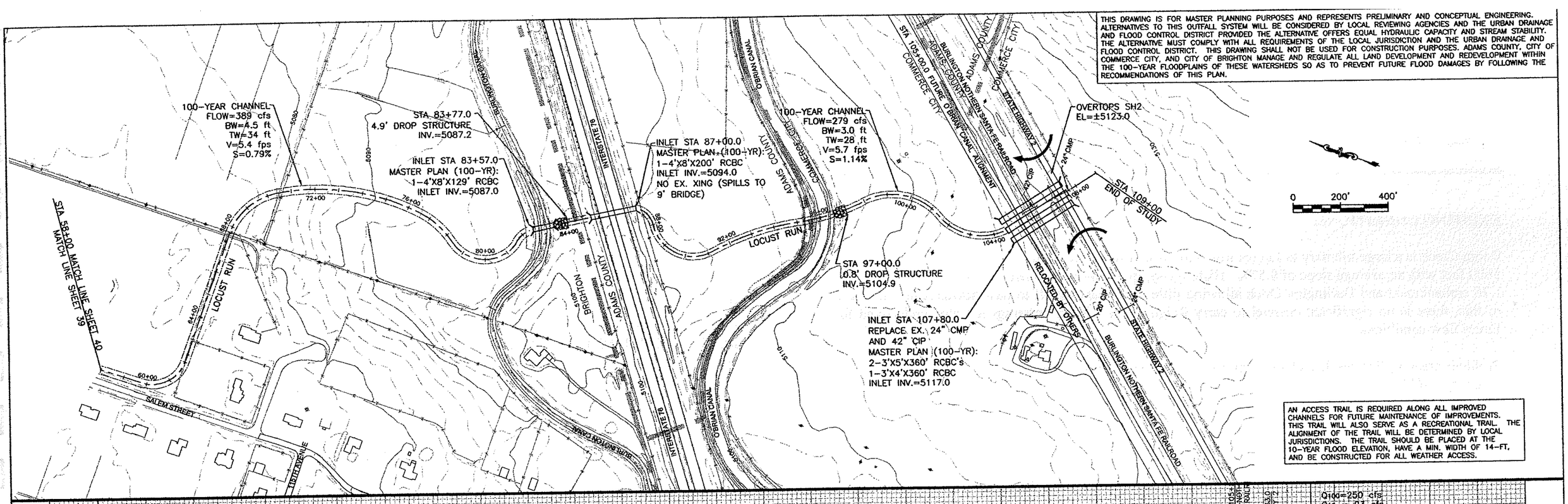

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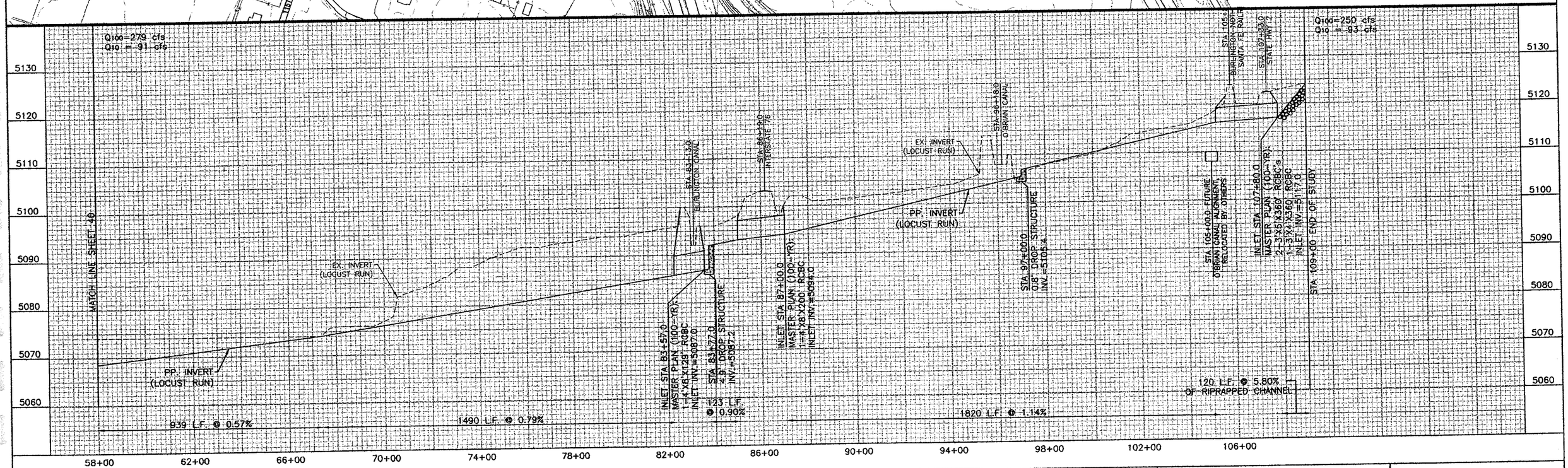

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COMMENTARY SHEET 41

Major Drainageway: Reign Creek 0053-02.02 **Stations:** 0+00 to 58+00

EXISTING CONDITIONS:

Reign Creek is a large tributary to Locust Run with its confluence near station 18+00. This reach covers 5800 feet with an average slope of 0.57%. Historically, most upstream flows have been collected by the I-76 embankment and Burlington Ditch allowing little significant runoff to pass downstream. Because of this, there is no significant channel to carry Reign Creek. Road crossings are also undersized for future flow conditions.

Problem areas in this reach include: a poorly defined channel and undersized road crossings at 120th Avenue, 116th Court, 115th Avenue, and 114th Avenue.

PROPOSED IMPROVEMENTS:

Providing a 100-year channel from 120th Avenue to the outfall at Locust Run requires 1730 feet of a 41-foot wide channel. Based on existing topography, the slope of the proposed channel is flat with a constant slope of 0.29%.

100-year conveyance capacity is required at 120th Avenue. Providing this requires a twin 4'x5' box culvert.

Upstream of 120th Avenue a 100-year channel is achieved with a 44-foot wide channel at a slope of 0.23%. The channel alignment parallels Peoria Street and is an expansion of the existing roadside ditch.

Drainage crossings are required at 116th Court and 115th Avenue. Since these roadways are local streets a 10-year capacity is used. This requires twin 36" RCPs at the three road crossings.

The channel in this area is a 100-year capacity channel with widths varying from 30' to 35'. The channel reach from 115th to 114th is a steeper channel and requires a 1.6' drop structure to maintain channel stability.

From 114th Avenue upstream, an 18" RCP is shown. This pipe is the outlet pipe for Detention #332 at I-76 on Sheet 42.

No maintenance trail is required in this reach since the proposed channel runs adjacent to Peoria Street.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 41

Reign Creek

Improvement	Quantity	Unit	Unit Cost	Total Cost
100-year Channel (41')	1730	LF	$82	$141,860
Box Culvert [Twin 4'x5'] 120th Avenue	44	LF	$520	$22,880
100-year Channel (44')	1660	LF	$88	$146,080
RCP [Twin 36"] 116th Court	44	LF	$120	$5,280
100-year Channel (32')	616	LF	$64	$39,424
RCP [Twin 36"] 116th Court	44	LF	$120	$5,280
100-year Channel (35')	705	LF	$70	$49,350
RCP [Twin 36"] 115th Court	44	LF	$120	$5,280
100-year Channel (30')	713	LF	$60	$42,780
Drop Structure (1.6')	1	EA	$16,000	$16,000
18" RCP	200	LF	$35	$7,000
Maintenance Trail (utilize Peoria Street)	0	LF	$25	$0
Total Estimated Construction Cost				$481,214
Utility Relocation (5% of Construction Cost)				$24,061
Engr. and Contingency (35% of Construction + Utility)				$176,846
Land Value	5.0	Acres	$65,340	$325,440
Total Estimated Cost				**$1,007,561**

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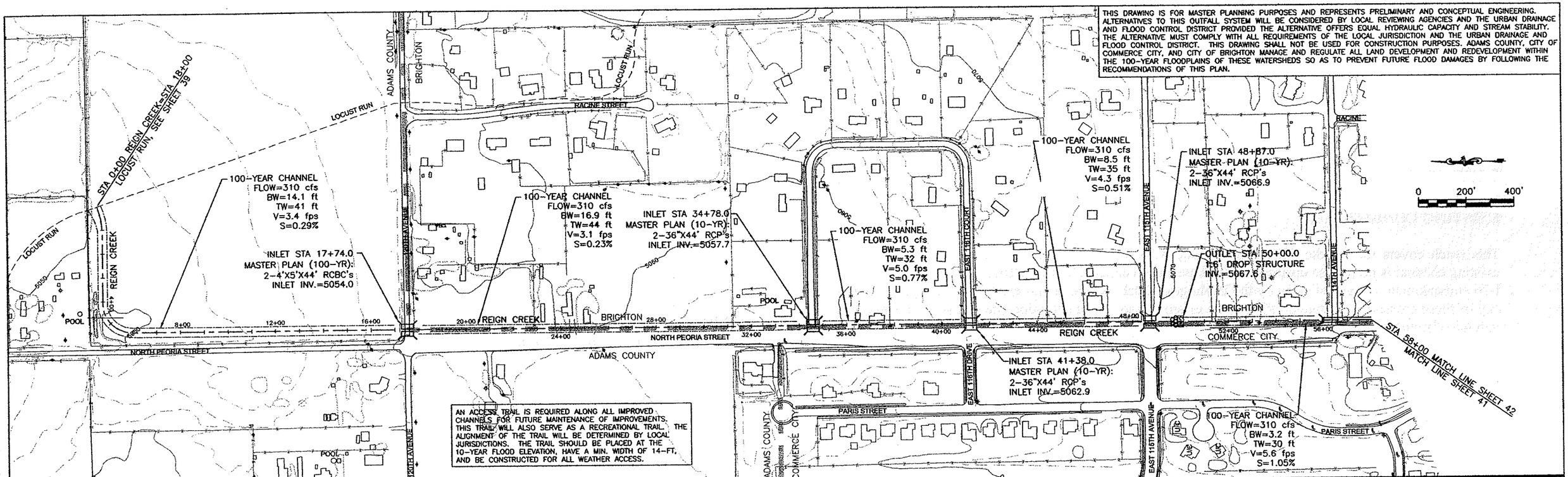

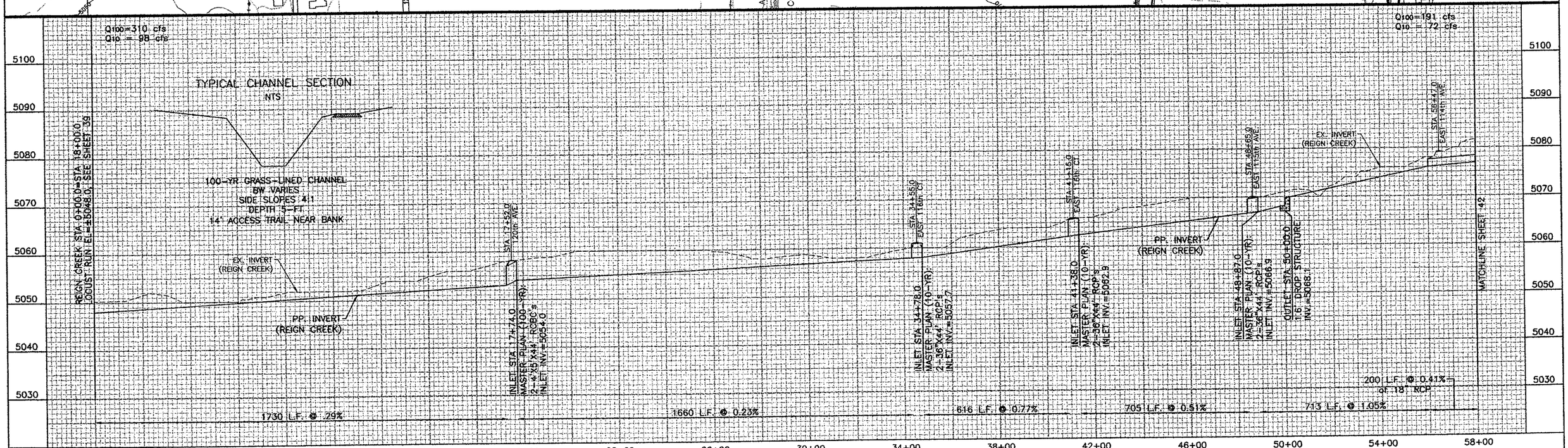

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COMMENTARY SHEET 42

Major Drainageway: Reign Creek 0053-02.02 **Stations:** 58+00 to 116+00

EXISTING CONDITIONS:

This reach covers the middle 5800 feet of Reign Creek. The average channel slope is 0.41%. No existing channel is present as upstream flows have been collected by the O'Brian Canal, detained by the I-76 embankment, or carried away by the Burlington Ditch. There are no existing crossing structures at any of these crossings. Detention #332 is an existing inadvertent detention site that stores a significant volume of runoff.

Problem areas in this reach include: a poorly defined channel and a lack of crossings at I-76, Burlington Ditch, and the O'Brian Canal.

PROPOSED IMPROVEMENTS:

The initial 2680 feet of this reach is an 18" RCP outlet pipe from Detention #332. The pipe length was required to daylight to the proposed downstream channel and to cross I-76, 112th Avenue, Burlington Ditch and 114th Avenue. The length of pipe requires seven manholes for access. These manholes must be locking, and watertight to prevent the covers from lifting.

Detention #332 is an existing low area cut off from the downstream channel by I-76. It is not clear if the low area was created as part of the I-76 construction or some other man-made activity. The volume at this site is capable of fully containing the future 100-year inflow. Since retention is not a design option, an 18" RCP was chosen to drain the stored runoff. This reduces 100-year peaks from 363 cfs to 9 cfs. This greatly aids the design of downstream facilities as the downstream area is not accustomed to receiving flows upstream of the Burlington Ditch.

Water quality enhancement is also achieved at this facility by adding a 6.0 acre-foot water quality basin within Detention #332.

Upstream of the detention facility flows must cross the O'Brian Canal. During our progress meetings it was learned that the O'Brian Canal would be relocated (by others) to run adjacent to the BNSFRR alignment. For this reason the O'Brian Canal does not have a low flow crossing shown at station 95+50, but the crossing is shown at station 131+37 on Sheet 43.

A 100-year channel is required to carry flows upstream of Detention #332. The required top width for the 100-year channel is 43 feet.

PRELIMINARY DESIGN COST ESTIMATE: SHEET 42

Reign Creek

Improvement	Quantity	Unit	Unit Cost	Total Cost
18" RCP	2680	LF	$35	$93,800
Manhole (Watertight, Locking)	7	EA	$4,000	$28,000
Detention Facility 332 [60 ac-ft]	1	EA	$288,623	$288,623
Water Quality Basin [6.0 acre-feet]	6.0	AF	$25,000	$150,000
O'Brian Canal relocated by others	0	LF	$0	$0
100-year Channel (43')	2300	LF	$86	$197,800
Maintenance Trail	2300	LF	$25	$57,500
Total Estimated Construction Cost				$815,723
Utility Relocation (5% of Construction Cost)				$40,786
Engr. and Contingency (35% of Construction + Utility)				$299,778
Land Value	15.3	Acres	$65,340	$998,400
Total Estimated Cost				**$2,154,687**

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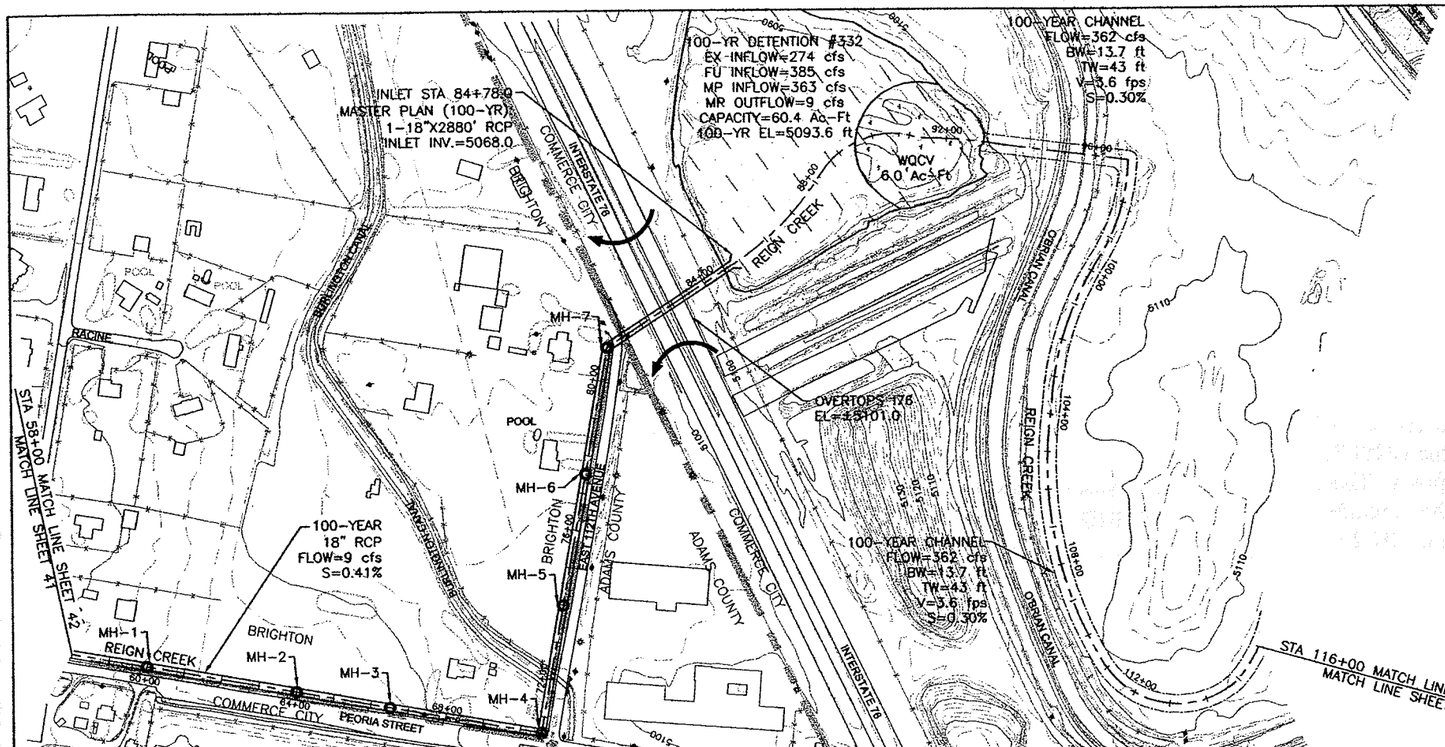
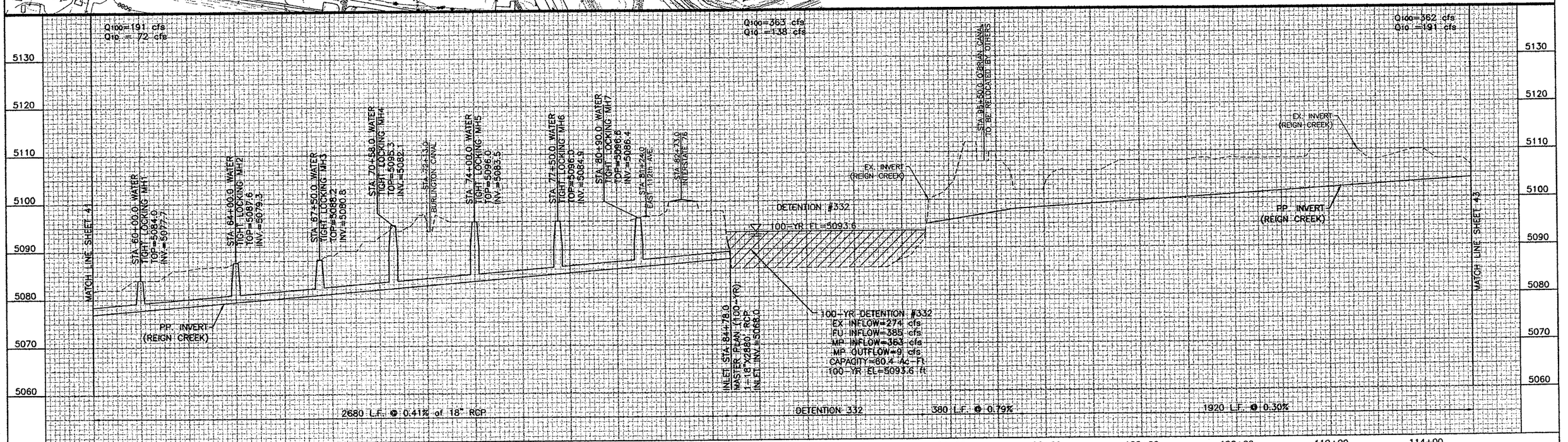


AN ACCESS TRAIL IS REQUIRED ALONG ALL IMPROVED CHANNELS FOR FUTURE MAINTENANCE OF IMPROVEMENTS. THIS TRAIL WILL ALSO SERVE AS A RECREATIONAL TRAIL. THE ALIGNMENT OF THE TRAIL WILL BE DETERMINED BY LOCAL JURISDICTIONS. THE TRAIL SHOULD BE PLACED AT THE 10-YEAR FLOOD ELEVATION, HAVE A MIN. WIDTH OF 14-FT, AND BE CONSTRUCTED FOR ALL WEATHER ACCESS.



BASE MAPPING AND HORIZONTAL & VERTICAL CONTROL PREPARED BY: LANDMARK MAPPING, LTD. BASEMAP 1995, REVISED 1998, 2001	Kiowa Engineering Corporation 7175 W. Jefferson Avenue, Suite 3400 Lakewood, Colorado 80235 (303) 692-0369 KIOWA PROJECT NO. 01095	DESIGNED BJW/DDR DATE 02/04 DRAWN DDR DATE 02/04 CHECKED BJW DATE 02/04	ADAMS COUNTY, CITY OF BRIGHTON CITY OF COMMERCE CITY, AND URBAN DRAINAGE AND FLOOD CONTROL DISTRICT	OUTFALL SYSTEMS PLANNING STUDY UPDATE SECOND CREEK d/s of DIA AND DFA 0053 WATERSHEDS	REIGN CREEK 0053-02.02 STA 58+00 to 116+00	SHEET 42

COMMENTARY SHEET 43

Major Drainageway: Reign Creek 0053-02.02 **Stations:** 116+00 to 169+00

EXISTING CONDITIONS:

This reach covers the upper 5300 feet of Reign Creek from the current O'Brian Canal to the upstream study limits near 104th Avenue. The average slope of this reach is 0.57%. The channel is poorly defined downstream of the BNSFRR. The O'Brian Canal is expected to be relocated to parallel the BNSFRR embankment. The 36" and 30" pipe sizes at BNSFRR and SH-2 are undersized for future flows. There is existing inadvertent detention at SH-2 that is effective at reducing downstream flows when included in the hydrology models. If this detention is not considered, SH-2 will overtop. Upstream of SH-2 the channel slope is steeper, near 0.75%, and the channel is slightly better defined.

Problem areas in this reach include: a poorly defined channel and inadequate capacity at BNSFRR and SH-2.

PROPOSED IMPROVEMENTS:

A 100-year channel is required downstream of the BNSFRR. The channel top width is 43 feet.

The O'Brian Canal is expected to be relocated by others to run adjacent to the BNSFRR. It is assumed that the same invert elevation of the canal will be constructed at the new alignment. This elevation places the new canal directly in the path of the SH-2/BNSFRR 100-year crossing structure. To pass storm runoff past the new O'Brian Canal will require a siphon as shown on Sheet 43. It should be noted that no siphon would be required if the O'Brian Canal alignment is not relocated.

Detention #319 is an existing inadvertent detention area at the upstream embankment of SH-2. This facility will be formalized with little additional construction. The existing 30" CIP releases flows downstream at 58 cfs. The storage volume is 21.5 acre-feet and proposed flows are reduced from 355 cfs. When the detention volume is included, no overtopping of SH-2 occurs. At the peak, some flows will spill to the south to an existing 24" CMP. Adding a small one-foot berm contains all of the 100-year volume within the detention facility. A 2.6 acre-foot water quality basin will effectively reduce the pollutant load from the upstream basin area. The water quality basin will be included in the detention facility.

There is an existing 36" CIP at BNSFRR. The existing pipe invert does not fit with the SH-2 pipe outlet and it is not aligned with the future channel. A new 36" RCP will be added to BNSFRR and continue under the new O'Brian Canal alignment. This pipe will be required as a siphon in order to pass the O'Brian Canal.

The 24" drainage crossing to the south will be replaced with a 3'x4' box culvert to prevent overtopping of SH-2 and provide 100-year conveyance capacity.

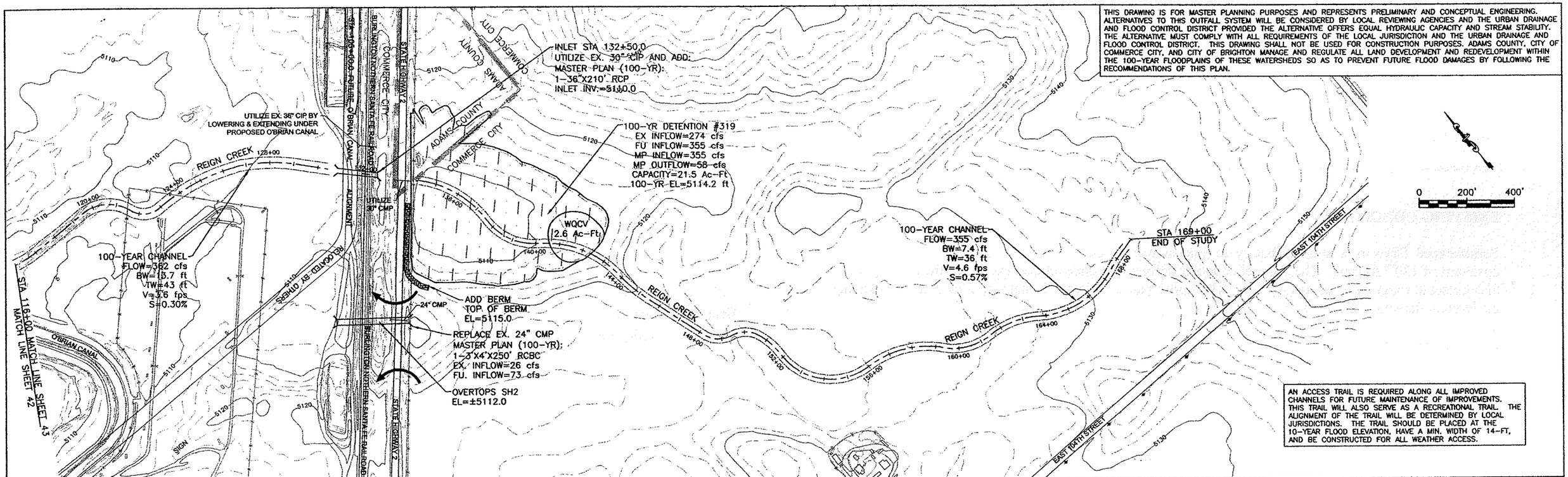
Upstream of the detention facility a 100-yer capacity channel is achieved with a 36-foot top width. The end of the study is located just downstream of 104th Avenue.

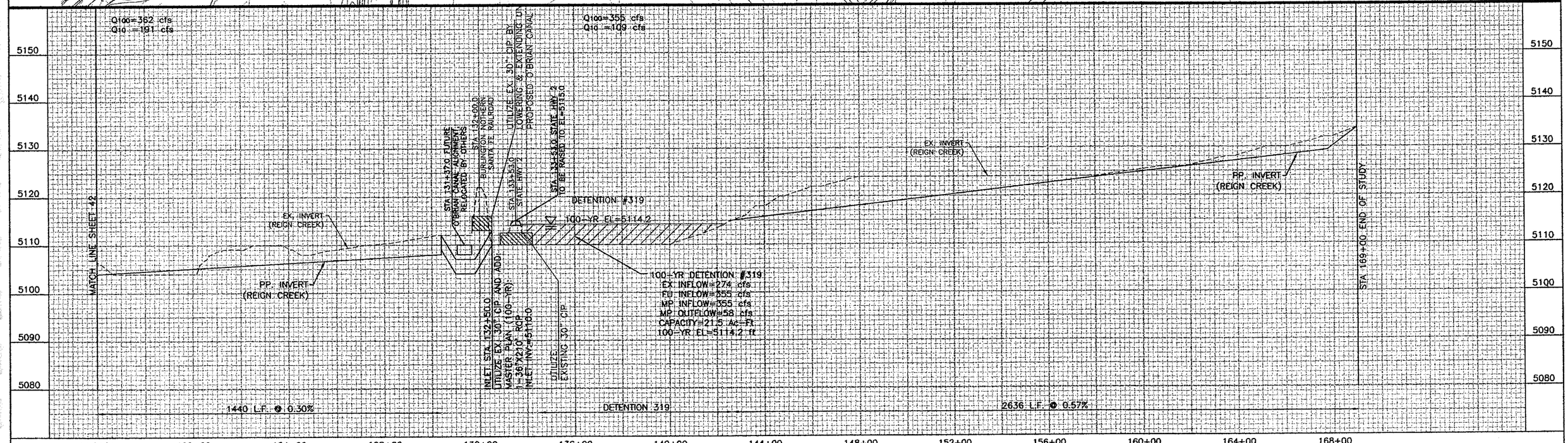
PRELIMINARY DESIGN COST ESTIMATE: SHEET 43

Reign Creek

Improvement	Quantity	Unit	Unit Cost	Total Cost
100-year Channel (43')	1440	LF	$86	$123,840
36" RCP	200	LF	$60	$12,000
Detention Facility 319 [22 ac-ft]	1	EA	$171,746	$171,746
Water Quality Basin [2.6 acre-feet]	2.6	AF	$25,000	$65,000
Box Culvert [3'x4'] SH-2	250	LF	$160	$40,000
100-year Channel (36')	2636	LF	$72	$189,792
Maintenance Trail	4076	LF	$25	$101,900
Total Estimated Construction Cost				$704,278
Utility Relocation (5% of Construction Cost)				$35,214
Engr. and Contingency (35% of Construction + Utility)				$258,822
Land Value	18.9	Acres	$65,340	$1,232,130
Total Estimated Cost				**$2,230,444**

THIS DRAWING IS FOR MASTER PLANNING PURPOSES AND REPRESENTS PRELIMINARY AND CONCEPTUAL ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM WILL BE CONSIDERED BY LOCAL REVIEWING AGENCIES AND THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT PROVIDED THE ALTERNATIVE OFFERS EQUAL HYDRAULIC CAPACITY AND STREAM STABILITY. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF THE LOCAL JURISDICTION AND THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT. THIS DRAWING SHALL NOT BE USED FOR CONSTRUCTION PURPOSES. ADAMS COUNTY, CITY OF COMMERCE CITY, AND CITY OF BRIGHTON MANAGE AND REGULATE ALL LAND DEVELOPMENT AND REDEVELOPMENT WITHIN THE 100-YEAR FLOODPLAINS OF THESE WATERSHEDS SO AS TO PREVENT FUTURE FLOOD DAMAGES BY FOLLOWING THE RECOMMENDATIONS OF THIS PLAN.





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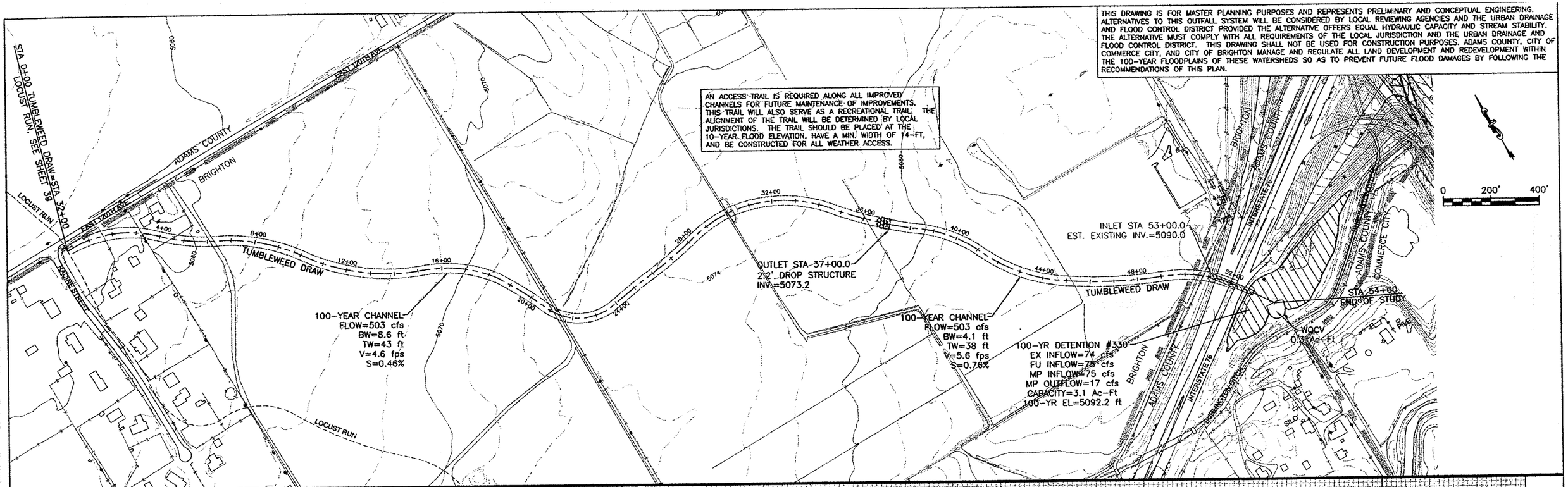

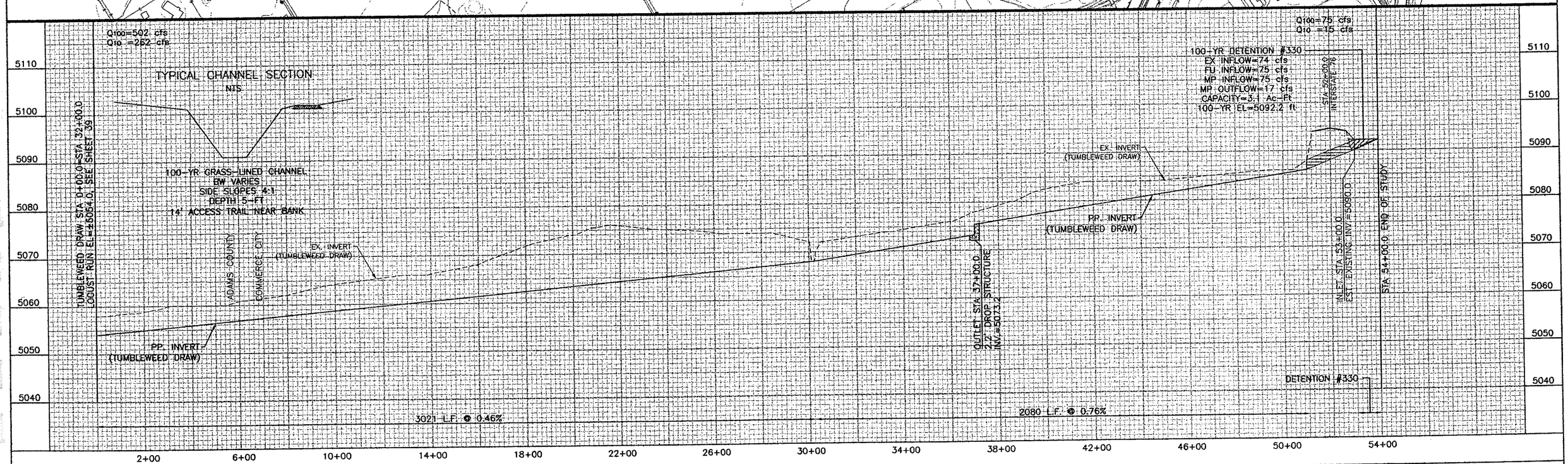

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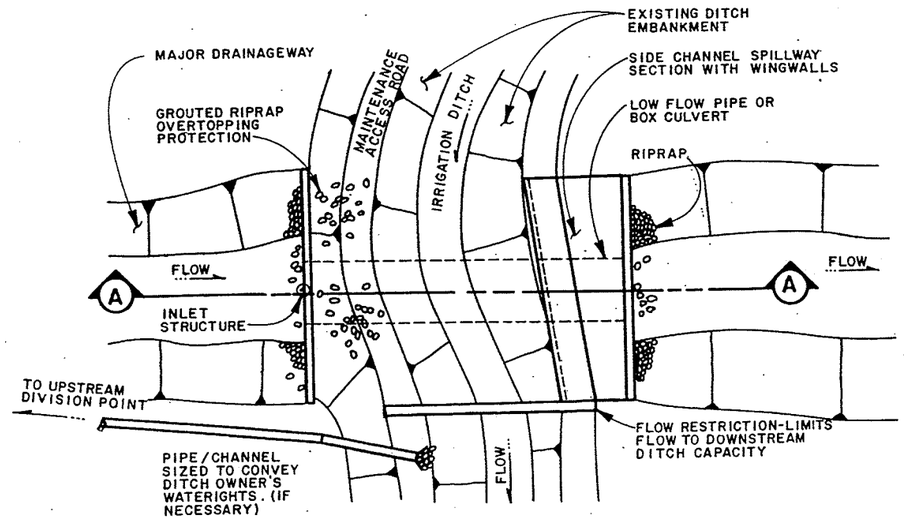
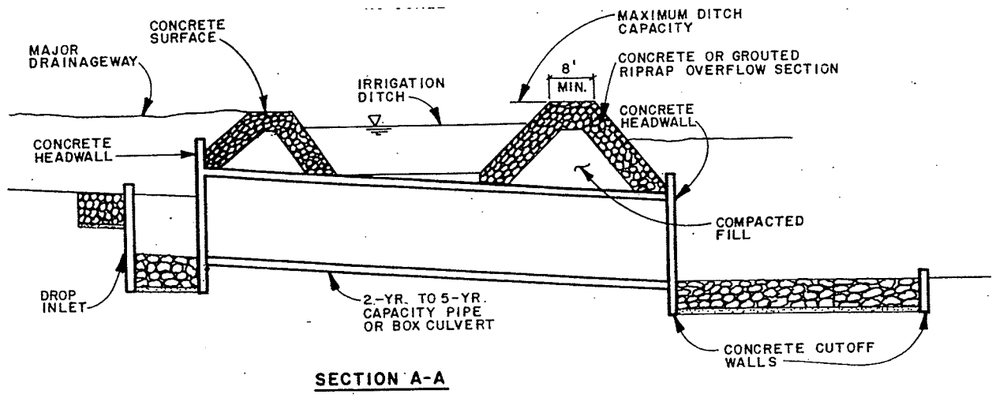
IRRIGATION CANAL CROSSING

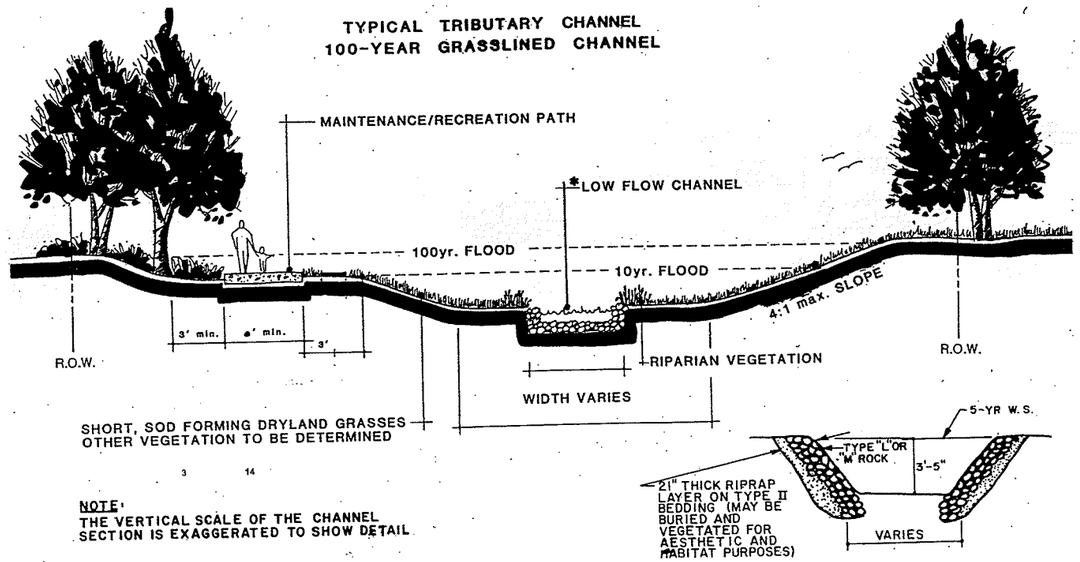


PLAN VIEW



SECTION A-A

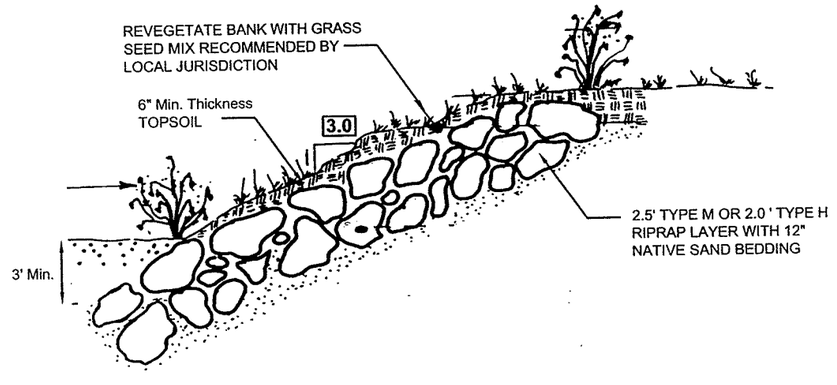
GRASS-LINED CHANNEL



ALTERNATE LOW FLOW CHANNEL
(FOR ERODIBLE SOILS)

LOW FLOW CHANNEL TYPE DEPENDS ON LOCAL SOILS CONDITIONS. REFER TO URBAN STORM DRAINAGE CRITERIA MANUAL.

EMBANKMENT ARMORING



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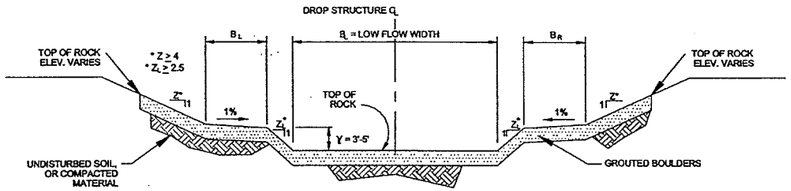
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

SECOND CREEK D/S OF DIA AND DFA 0053
OUTFALL SYSTEMS PLANNING STUDY UPDATE

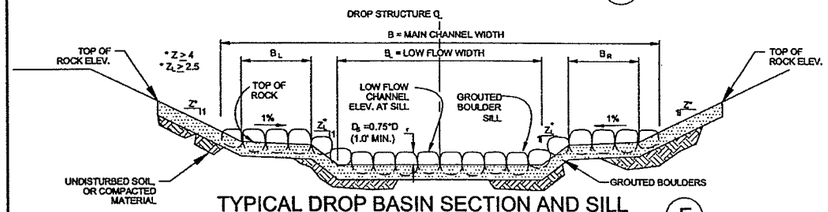
TYPICAL DETAILS

TypicalDetails.dwg/Aug 13, 2004

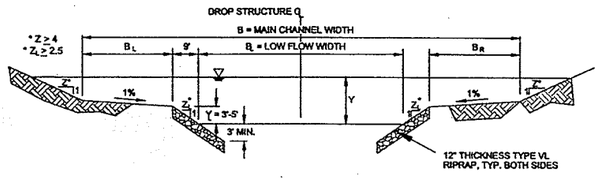
GROUTED SLOPING BOUNDER DROP STRUCTURE



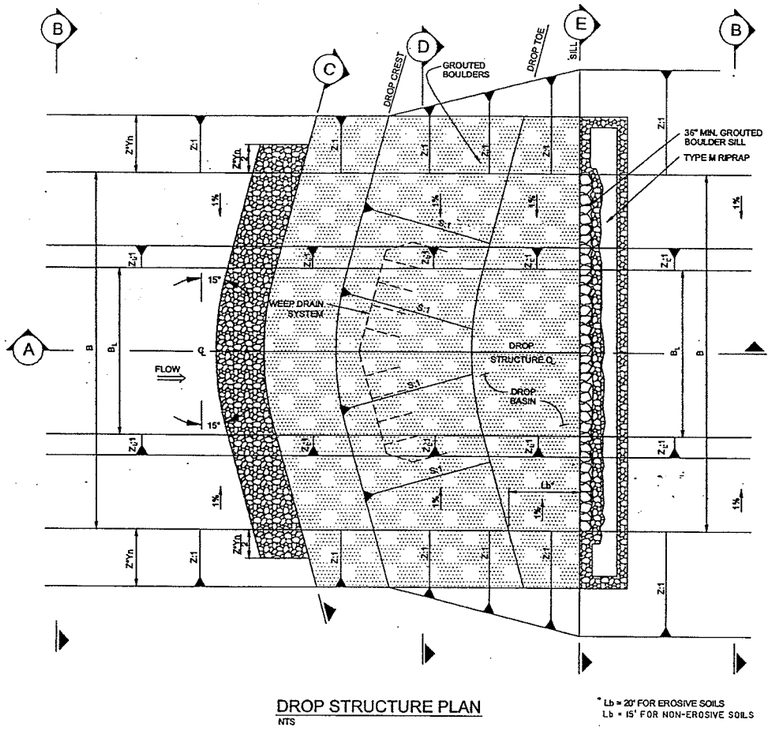
TYPICAL DROP FACE SECTION (D)
NTS



TYPICAL DROP BASIN SECTION AND SILL (E)
NTS

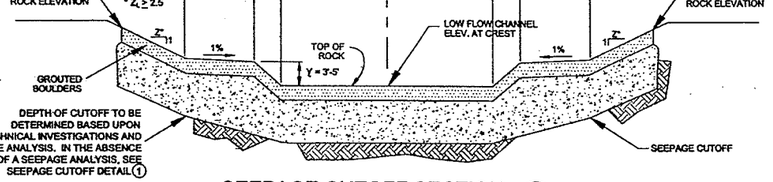


TYPICAL CHANNEL SECTION (UPSTREAM AND DOWNSTREAM OF DROP (B)
NTS

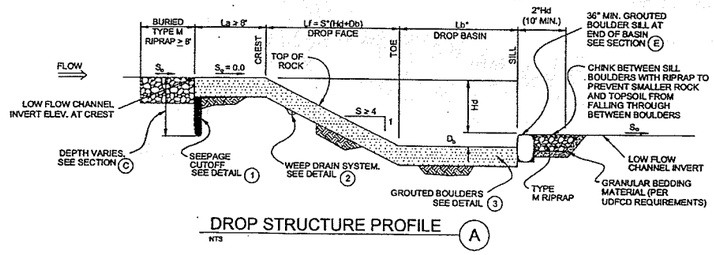


DROP STRUCTURE PLAN
NTS

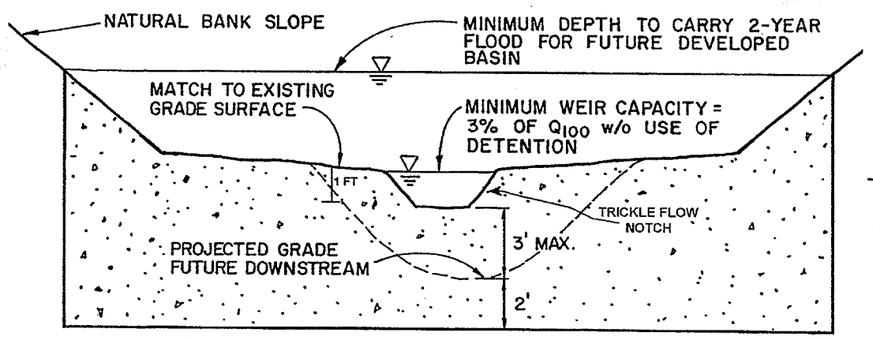
* Lb = 20' FOR EROSIVE SOILS
Lb = 15' FOR NON-EROSIVE SOILS



SEEPAGE CUTOFF SECTION (C)
NTS

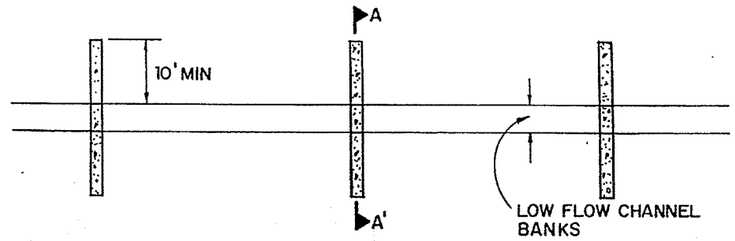


DROP STRUCTURE PROFILE (A)
NTS

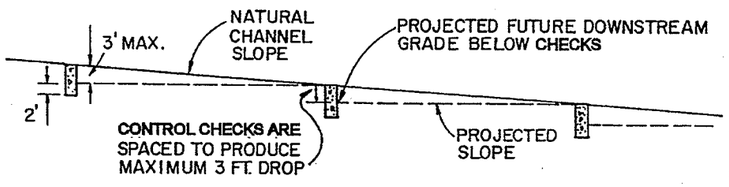


(c) SECTION A-A'

CHECK STRUCTURE



(a) PLAN



(b) PROFILE

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