Newlin Gulch

September 2015

Flood Hazard Area Delineation (FHAD) - DRAFT

Urban Drainage and Flood Control District

Douglas County Colorado

Town of Parker Colorado

MULLER

September 29, 2015

MULLER

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Urban Drainage and Flood Control District
Mr. David Mallory
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2480 W. 26th Avenue, Suite 156 B
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RE: Flood Hazard Area Delineation – Newlin Gulch
Draft Report
Agreement No. 12-09.02A

Dear Mr. Mallory:

Muller Engineering Company is pleased to submit this revised draft Flood Hazard Area Delineation (FHAD) Study for Newlin Gulch. This revision addresses comments provided by UDFCD on the draft June 9th submittal. This report documents the results of the hydrologic and hydraulic update to the watershed, including all items required by the "Digital Flood Hazard Area Delineations Studies Report Checklist".

With this study, we have updated flood hazard mapping of over 4.2 miles of Newlin Gulch through Douglas County and the Town of Parker. The mainstem project limits begin at the Newlin Gulch confluence with Cherry Creek and continue upstream to Hess Road located just below Rueter-Hess Reservoir. This report presents background information on the project reach, study methodology, and a summary of flood hazards identified in the study. The report appendices include detailed flood maps, flood profiles, and floodplain data tables. As part of this study, the 10-, 50-, 100-, and 500-year floods were hydraulically modeled. Additionally, 0.5-foot rise floodways have been modeled in applicable channel reaches.

The information contained in this report is intended to assist UDFCD, Douglas County and the Town of Parker in updating the regulatory flood hazard zones for Newlin Gulch. This report would not have been possible without the excellent input and assistance provided by UDFCD and the project sponsors; their contributions are greatly appreciated.

Sincerely,

Muller Engineering Company, Inc.

Melanie D Chenard

Melanie Chenard, P.E.
Project Engineer

Derek D. Johns

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Project Manager

Table of Contents

1 INTRODUCTION 1-1

1.1 AUTHORIZATION 1-1
1.2 PURPOSE AND SCOPE 1-1
1.3 PLANNING PROCESS 1-1
1.4 MAPPING AND SURVEYS 1-2
1.5 DATA COLLECTION 1-2
1.6 ACKNOWLEDGEMENTS 1-3

2 STUDY AREA DESCRIPTION 2-1

2.1 PROJECT AREA 2-1
2.2 LAND USE 2-1
2.3 REACH DESCRIPTION 2-2
2.4 FLOOD HISTORY 2-5
2.5 ENVIRONMENTAL ASSESSMENT 2-5

3 HYDROLOGIC ANALYSIS 3-1

3.1 OVERVIEW 3-1
3.2 DESIGN RAINFALL 3-1
3.3 SUBWATERSHED CHARACTERISTICS 3-2
3.4 HYDROGRAPH ROUTING 3-2
3.5 PREVIOUS STUDIES 3-3
3.6 MODEL CALIBRATION 3-3
3.7 RESULTS OF ANALYSIS 3-5
3.8 COMPARISON OF EXISTING AND FUTURE DEVELOPMENT CONDITIONS 3-5

4 HYDRAULIC ANALYSIS 4-1

4.1 OVERVIEW 4-1
4.2 EVALUATION OF EXISTING FACILITIES 4-1
4.3 FLOOD HAZARDS 4-4
4.4 PREVIOUS ANALYSES 4-4

5 REFERENCES 5-1

List of Figures

Figure 2-1: Vicinity Map 2-1
Figure 2-2: Watershed Map 2-2
Figure 2-3: Reach Map 2-3

Figure B-1: Hydrology Map B-1
Figure B-2: SWMM Schematic – Upper Watershed B-8
Figure B-3: SWMM Schematic – Lower Watershed B-9
Figure B-4: Existing Development Hydrographs B-10
Figure B-5: Future Development Hydrographs B-11
Figure B-6: Peak Flow Profile – Existing Development B-12
Figure B-7: Peak Flow Profile – Future Development B-13
Figure B-8: FEMA 30%, 0.5' Rule Compliance Analysis B-43

Figure E-1: Existing Hydraulic Structure Photographs ..... E-2 through E-3

List of Tables

Table 1-1: Project Meetings 1-2
Table 1-2: Project Participants 1-3
Table 2-1: Major Crossing Inventory 2-5
Table 3-1: Point Rainfall Depths 3-1
Table 3-2: Depth Reduction Factors 3-2
Table 3-3: Model Calibration 3-4
Table 3-4: Comparison to Previous Studies 3-5
Table 4-1: Existing Crossing Capacity 4-1

Table B-1: Rainfall Distributions B-2
Table B-2: CUHP Input ..... B-3 through B-5
Table B-3: Detention Rating Curves B-6
Table B-4: Peak Flow Rates ..... B-14 through B-15
Table B-5: Runoff Volumes – Existing Development B-16
Table B-6: Runoff Volumes – Future Development B-17
Table B-7: Sample SWMM Input ..... B-18 through B-29
Table B-8: Sample SWMM Output ..... B-30 through B-41

Table C-1: Rueter-Hess Reservoir Routing Alternatives C-6
Table E-1: Manning's n Values E-1

Appendix A: Project Correspondence

Appendix B: Hydrologic Analysis

Appendix C: Rueter-Hess Reservoir Routing Analysis

Appendix D: Rueter-Hess Adequate Assurances Agreement

Appendix E: Hydraulic Analysis

Appendix F: Floodplain and Floodway Data Tables

Appendix G: Flood Map

Appendix H: Flood Profiles

1 INTRODUCTION

1.1 AUTHORIZATION

The Urban Drainage and Flood Control District (UDFCD) contracted with Muller Engineering Company, Inc. to provide a Flood Hazard Area Delineation (FHAD) study for Newlin Gulch. Douglas County and the Town of Parker co-sponsored the project. The work was authorized under UDFCD Agreement No. 12-09.02A, dated July 29, 2013. The study reach in the agreement covered 4.2 miles of the Newlin Gulch mainstem, from the confluence with Cherry Creek to downstream of the Rueter-Hess Reservoir.

1.2 PURPOSE AND SCOPE

The Newlin Gulch watershed was last studied in the Newlin and Baldwin Gulches and Basin 4600-09 Outfall Systems Planning Study (OSP), published in August 1993 by Kiowa Engineering Corporation. The Newlin Gulch floodplain was previously studied in a 1977 Flood Hazard Area Delineation (FHAD) prepared by Howard, Needles, Tammen & Bergendoff along with Happy Canyon Creek, Baldwin, Sulphur, and Tallman Gulches. The FHAD was prepared concurrently with a study for the U.S Department of Housing and Urban Development, Federal Insurance Administration. The HUD-FIA study established the initial regulatory floodplain. Several Letter of Map Revision (LOMR) updates to the floodplain have been incorporated since that time.

UDFCD typically updates master plans every 20-30 years based on requests and support from local governments. In the case of the Newlin Gulch watershed, significant development in the lower portion of the watershed within the Town of Parker has occurred since the 1993 OSP. More development is expected in the near future, in particular along the Parker Homestead reach between Chambers Road and Hess Road. The most dramatic change to the watershed has been the recent construction of the Rueter-Hess Reservoir, a large water storage reservoir. The large normal pool (1.7 square miles) impacts the hydrology of the lower two-thirds of the watershed. This update is therefore well-timed to update flood hazard risks within the watershed. This study will incorporate structures and channel improvements constructed since the 1977 FHAD, and update the regulatory floodplain limits based on lower peak flow rates resulting from Rueter-Hess Reservoir.

The overall scope of work for the FHAD includes the following main tasks:

1. Meet periodically with the project sponsors and other stakeholders to exchange information and to solicit input and direction.
2. Model the steady-state hydraulics of the project reach to define water surface profiles for the 10-, 50-, 100-, and 500-year peak flood events.
3. Generate 0.5-foot floodway encroachments for applicable areas within the study area. The floodway study focused primarily through the Challenger Regional Park reach and in the vicinity of Hess Road.
4. Prepare workmaps, flood profiles, and floodplain and floodway data tables to document the hydraulic analysis results.
5. Prepare agreement tables to document quality control procedures.
6. Compare results of hydraulic analyses with current Letters of Map Revision (LOMR) issued by FEMA and reconcile the differences.
7. Compare the peak flow rates and water surface elevations using Future Development and Existing Development storm runoff scenarios. See Section 3.7 (Comparison of Future and Existing 100-Year Hydrology) for additional information.
8. Prepare a report to document the study methodologies and findings.

1.3 PLANNING PROCESS

Work on the FHAD study began following completion of the Baseline Hydrology portion of the Major Drainageway Plan. The FHAD study was performed in conjunction with the Alternative Analysis in order to identify flood risks and guide the development of alternatives for channel stabilization and hydraulic structures.

Periodic meetings were held to gather input from project sponsors and stakeholders. A summary of project meetings is shown in **Table 1-1**; meeting minutes are included in **Appendix A**.

A public notice was mailed to property owners along Newlin Gulch following preparation of the Draft Alternatives Analysis for the Major Drainageway Plan. The notice directed recipients to the project website for additional information. A copy of the notice and all comments received through the website are also included in **Appendix A**.

Table 1-1: Project Meetings

Meeting	Date	Purpose
Kickoff Meeting	November 19, 2012	Review project scope and project approach, identify information needs
Progress Meeting #2	March 18, 2013	Hydrology status update, review land use assumptions, review SWMM and CUHP model assumptions
Progress Meeting #3	May 15, 2013	Discuss course of action relative to Rueter-Hess Reservoir Routing and Adequate Assurances Agreement with PWSD
Progress Meeting #4	December 17, 2014	Restart project following hiatus while Rueter-Hess Adequate Assurances Agreement was being coordinated and approved
Progress Meeting #5	March 2, 2015	Discussion of issues pertaining to FHAD modeling, discuss approach / goals of Alternatives Analysis
Progress Meeting #6	June 1, 2015	Discussion of Alternatives Analysis review comments

1.4 MAPPING AND SURVEYS

Mapping data sources used for the Newlin Gulch FHAD included the following:

- Color aerial photography was provided by UDFCD. The photography was part of an aerial imagery project by the Town of Parker. Photographs are from early 2012.
- 2-foot interval topography along the main stem of Newlin Gulch was provided by UDFCD. The topography was prepared by Merrick & Company GeoSpatial and was based on LiDAR imaging taken in October of 2012.
- Supplemental ground survey of the Hess Road Bridge, Bradbury Ranch Pond IV, and the Newlin Gulch channel at Challenger Regional Park was provided by UDFCD. Survey was conducted by Accurate EngiSurv, LLC in April 2013.
- 1-foot interval as-built topography based on channel improvements completed in 2013 in the Stonegate Metropolitan District was provided by Muller Engineering Company. The original project survey was conducted by Aztec Consultants in 2009.
- 5-foot interval topography in Douglas County was provided by the County and was used to delineate watershed boundaries and define subwatershed and channel properties south of Lincoln Avenue. The source of the mapping was Merrick & Company's 1996 Digital Elevation Model (DEM) "Mass Points."
- 2-foot interval topography within the northern project area (north of Lincoln Avenue) was obtained from the Denver Democratic National Convention (DNC) LIDAR Survey compiled by Sanborn Geospatial on July 25, 2008.

All mapping is on the Colorado State Plane Central Zone (0502) projection, horizontal datum NAD83, and vertical datum NAVD 1988.

Existing parcel boundaries, zoning, jurisdictional boundaries, and Digital Flood Insurance Rate Map (DFIRM) data were provided by Douglas County in Geographic Information System (GIS) format.

1.5 DATA COLLECTION

Existing floodplain studies were compiled at the beginning of the project. The 1977 FHAD included floodplain mapping based on predicted future peak flow rates on Newlin Gulch from the confluence with Cherry Creek to the Urban Drainage and Flood Control District jurisdictional limit. The current Flood Insurance Study (FIS) for Douglas County is dated September 30, 2005. The most recent FIRM panels depicting the Newlin Gulch flood hazard area are map numbers 08035C0064F, 08035C0066F, 08035C0068F, and 08035C0177F. Several LOMR studies have altered the regulatory floodplain within the study reach. Map revisions were conducted in 2008 for Newlin Gulch from downstream of Lincoln Avenue to upstream of Jordan Road (08-08-0553P), and from upstream of Stonegate Parkway to downstream of Chambers Road (08-08-0334P). A LOMR was conducted in 2010 for channel and bridge improvements at Chambers Road (10-08-0768P), but the Chambers Road bridge was not accounted for in the hydraulic modeling analysis. A final LOMR was conducted in 2011 for channel and bridge improvements beginning upstream of Chambers Road and extending about 3000 feet upstream of Hess Road (11-08-0044P).

Wherever possible, hydraulic cross-sections have been oriented to match the existing LOMR and FHAD studies for the purpose of comparison.

Numerous reports, studies, and design plans were reviewed and utilized in the preparation of this report. A listing of the primary references is as follows; a full listing is included in the References section at the end of this report.

- 1977 Flood Hazard Area Delineation, Happy Canyon Creek, Badger Gulch, Newlin Gulch, Baldwin Gulch, Sulphur Gulch, Tallman Gulch (Howard, Needles, Tammen & Bergendoff)
- 1993 Newlin and Baldwin Gulches and Basin 4600-09 Outfall Systems Planning Study (Kiowa Engineering Corporation)

1.6 ACKNOWLEDGEMENTS

This report could not have been prepared without the participation and support of the following project sponsors and stakeholders. We are grateful for their contributions.

Table 1-2: Project Participants

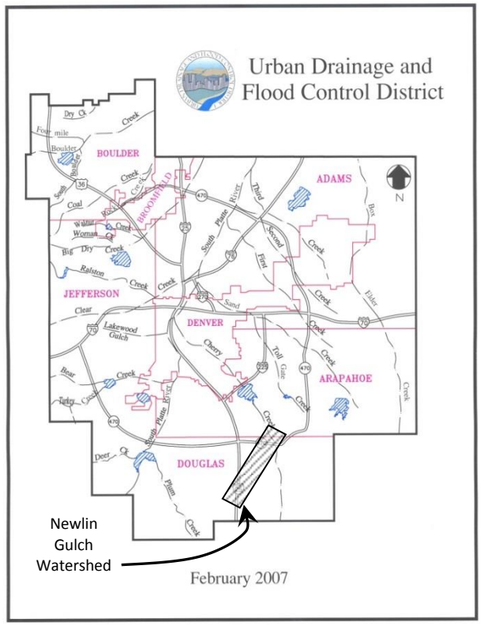
Project Sponsors	Agency
Shea Thomas	Urban Drainage and Flood Control District
Terri Fead	Urban Drainage and Flood Control District
Brad Robenstein	Douglas County
Tom Williams	Town of Parker
Jacob James	Town of Parker
Project Stakeholders	**Agency**
Brad Meyering	City of Castle Pines
Pieter Van Ry	Parker Water and Sanitation District
Jim Swanson	Cherry Creek Basin Water Quality Authority
Ron Lambert	Stonegate Village Metropolitan District
Scott Barnett	Stonegate Village Metropolitan District

2 STUDY AREA DESCRIPTION

2.1 PROJECT AREA

Newlin Gulch originates in the City of Castle Pines, located along I-25 about 3 1/2-miles north of Castle Rock. The creek and its tributaries flow northeast through areas of Castle Pines, unincorporated Douglas County, and the Town of Parker before emptying into Cherry Creek near Challenger Park in the Town of Parker. The Newlin Gulch watershed area is approximately 15 square miles.

Figure 2-1: Vicinity Map



The upper third of the watershed is primarily within the City of Castle Pines. West of I-25, recently annexed areas are slated for residential and commercial development. East of I-25, the watershed includes the majority of the planned Canyons development, also in Castle Pines. The middle third of the watershed starts upstream of the new Rueter-Hess Reservoir and ends at Mainstreet in the Town of Parker. A portion of the Parker Homestead development is located in the watershed just north of Rueter-Hess. The lower third of the watershed, located north of Mainstreet, is nearly fully developed by the Stonegate Village and Challenger Park Estates developments, among others.

Newlin Gulch is UDFCD Project Reuse watershed #4612. The watershed is approximately 8.8 miles in length and has an average width of 1.8 miles for most of its length, tapering to 0.5 miles wide at the north end. The total area is 15.0 square miles or 9,600 acres. Approximately 20% of the watershed area is developed. Another 12% of the watershed is within the projected maximum normal pool of Rueter-Hess Reservoir, which encompasses 1.8 square miles. The highest and lowest points of the watershed are 6680 and 5768 feet above mean sea level, respectively, and the average watershed slope is 1.8%. Underlying soils include hydrologic group A along the mainstem downstream of Hess Road and in some areas within the normal pool of Rueter-Hess, surrounded by areas of group B soils. The majority of the tributary area is underlain by hydrologic group C soils. A map of soil classifications is included as **Figure B-1** in **Appendix B**.

The FHAD study area includes approximately 4.2 miles of mainstem Newlin Gulch downstream of the Rueter-Hess Reservoir, from Hess Road to the Newlin Gulch confluence with Cherry Creek. The scope of this project does not include the channel upstream of Rueter-Hess Reservoir; however, the entire watershed was included in the baseline hydrology.

2.2 LAND USE

Land use within the Newlin Gulch watershed varies from rangeland and open space to high density city center. Existing development conditions were generally based on visual assessment of the aerial photography provided by UDFCD, and future development conditions were based on information provided by project sponsors and stakeholders, including planning documents, zoning, master drainage plans, and direct input. In a few cases, roads were identified separately in land use analysis: the I-25 corridor is reflected as 50% impervious to reflect separation between travel lanes and additional right-of-way, while Hess Road, Chambers Road and Lincoln Avenue are assumed 100% impervious. All other existing or planned roads are assumed to be accounted for in the impervious values of adjacent development. The projected maximum normal pool of Rueter-Hess Reservoir is treated as 100% impervious under both existing and future development conditions.

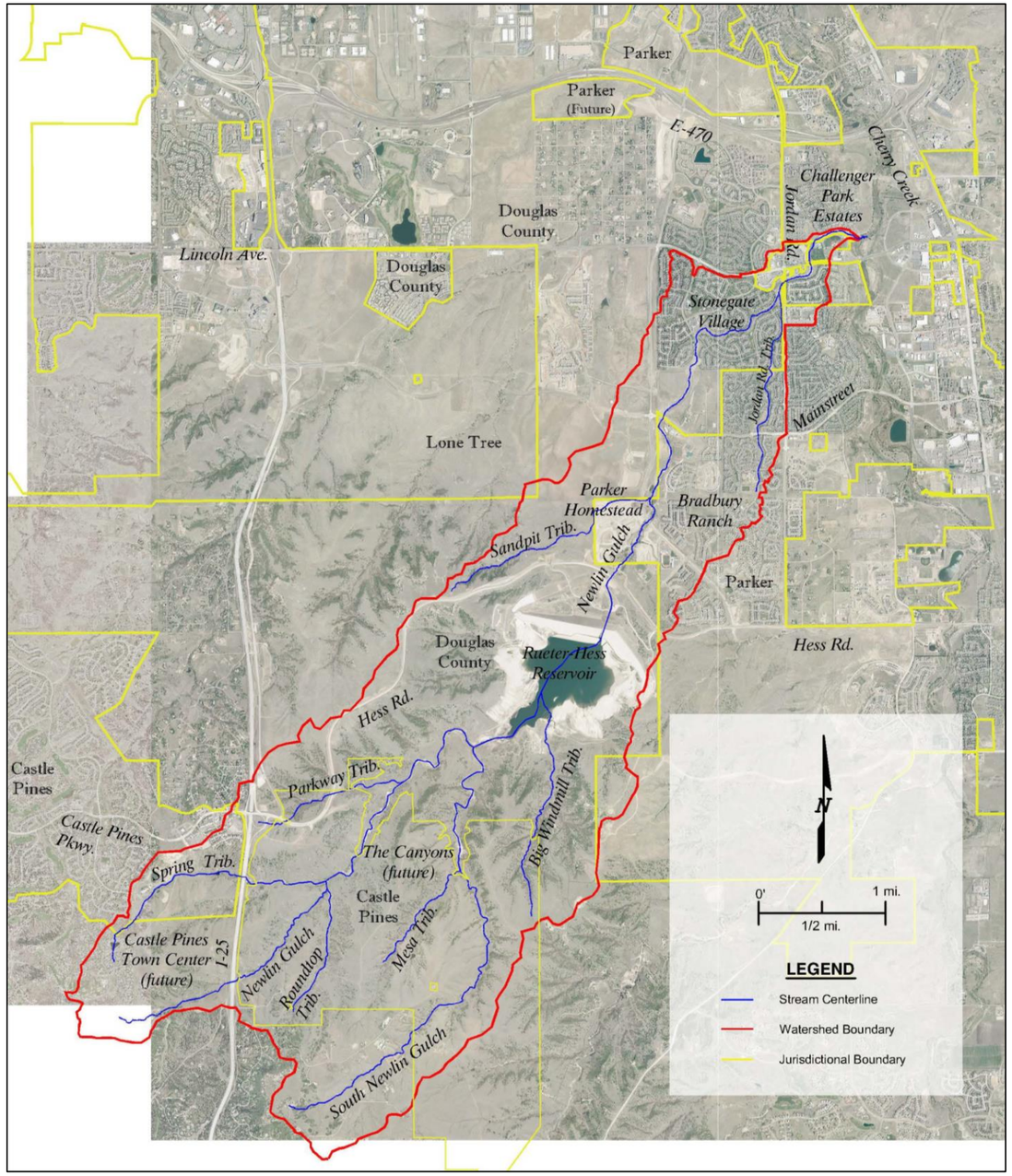
The watershed boundary is shown in **Figure 2-2,** along with jurisdictional boundaries, tributaries, and major developments. The overall existing weighted impervious value for the Newlin Gulch watershed is 22.5%. Future development is projected to increase watershed imperviousness to 34.7%. The interactive hydrology map in Appendix B shows existing and future land use boundaries and impervious values (**Figure B-1**).

Upper Watershed: Castle Pines Town Center to Rueter-Hess Reservoir

The upper watershed extends from approximately two miles south of the I-25 and Castle Pines Parkway Interchange north to the boundary of the Rueter-Hess Reservoir normal pool. The mainstem channel length is slightly less than three miles. A small portion of the watershed west of I-25 includes existing medium-density residential and commercial lots which are part of the City of Castle Pines. The extreme south end of the watershed includes existing large-lot residential from the Sapphire Pointe development. Undeveloped parcels cover the remainder of the upper watershed in the existing condition. Future planned developments include The Canyons, Castle Pine Town Center, and LaGae Ranch. The Canyons is the largest of the three and extends from the edge of Rueter-Hess Reservoir beyond the southern boundary of the watershed. Future land-use and impervious values for the planned developments were based on the most current drainage plans available. The weighted impervious value for the upper watershed is 21% (future development condition).

The upper watershed includes numerous tributary "fingers" to the mainstem: the Spring Tributary, the Roundtop Tributary, the Mesa Tributary, South Newlin Gulch, and the Big Windmill Tributary. The majority of these tributaries (with the exception of the Spring Tributary) are currently undeveloped.

Figure 2-2: Watershed Map



Lower Watershed: Rueter-Hess Reservoir to Cherry Creek Confluence

Rueter-Hess Reservoir is a water supply reservoir owned by Parker Water and Sanitation District (PWSD). It is located on the mainstem of Newlin Gulch in the central portion of the watershed. The construction of the reservoir was completed in 2012 and consists of a 170-foot tall earthen dam that is designed to store 72,000 acre-feet of water. Though the reservoir will not be full for several years, the planned normal pool will have a surface area of approximately 1.8 square miles (1,150 acres), which is approximately 12% of the entire watershed. Downstream of the reservoir, the recent Hess Road extension to I-25 provides a boundary between the reservoir and existing and future residential development. Existing medium to dense residential lots cover a large portion of the lower watershed. These lots are part of a number of subdivisions, including (from north to south): Challenger Park Estates, Stonegate Village, Bradbury Ranch, New Horizon, The Regency, and Newlin Meadows. Additionally, construction is currently underway for the Parker Homestead development just north of Hess Road. The remaining undeveloped areas are centered on the intersection of Chambers and Mainstreet. West of Chambers, commercial and residential development is currently in the planning stages as part of Meridian Village. The weighted impervious value for the lower watershed is 37% (future development condition, excluding the Rueter-Hess normal pool).

The Sandpit Tributary passes through the northern edge of the Parker Homestead development and empties into the mainstem just east of Chambers Road. West of Parker Homestead, construction is currently underway for the new Parker Water and Sanitation District water treatment plant. The upper portion of the Sandpit Tributary remains undeveloped with no plans for future development.

The Jordan Road tributary, which empties into the mainstem just west of Jordan Road, is fully developed with portions of Stonegate Village and Bradbury Ranch.

2.3 REACH DESCRIPTION

Newlin Gulch is an ephemeral, sand-bed channel that is highly susceptible to erosion. Historically, Newlin Gulch was characterized by a wide, flat floodplain with no base flow and no defined low-flow channel. As the watershed has developed, this character has changed: more frequent base flows and reduction of past grazing activities have increased the vegetation density, and channelization of some reaches has narrowed the floodplain, reduced channel meanders, and created a uniform trapezoidal cross section.

Six reaches have been defined within the study area and are shown in **Figure 2-3**. Reach boundaries are based on jurisdictional and planned development boundaries as well as on existing channel characteristics. Major road crossings are listed in **Table 2-1.**

Reach 1 – Challenger Park Estates

The first reach of Newlin Gulch extends from its confluence with Cherry Creek to Recreation Drive within the Town of Parker, along the north edge of Douglas County's Challenger Regional Park. This portion of the drainageway was channelized to allow the development of Challenger Park Estates, which borders the Gulch to the north. The channel section includes a slightly meandering trapezoidal low flow channel and a narrow, uniform 100-year channel. Existing grade control includes two large grouted boulder drop structures and four smaller vertical drops; the constructed channel slope is 0.2%. The upper grouted boulder drop structure, which has a drop height in excess of 12 feet, is positioned just downstream of a 20-inch high pressure gas line. Riparian and wetland areas are present at the confluence with Cherry Creek; vegetation for the remainder of the channel tends to be drier upland species, with some additional pockets of wetland vegetation. The Cherry Creek regional trail crosses the Gulch via a steel pedestrian bridge near the downstream limit. A concrete trail provides maintenance access along the length of the reach. There are no roadway crossings in this reach.

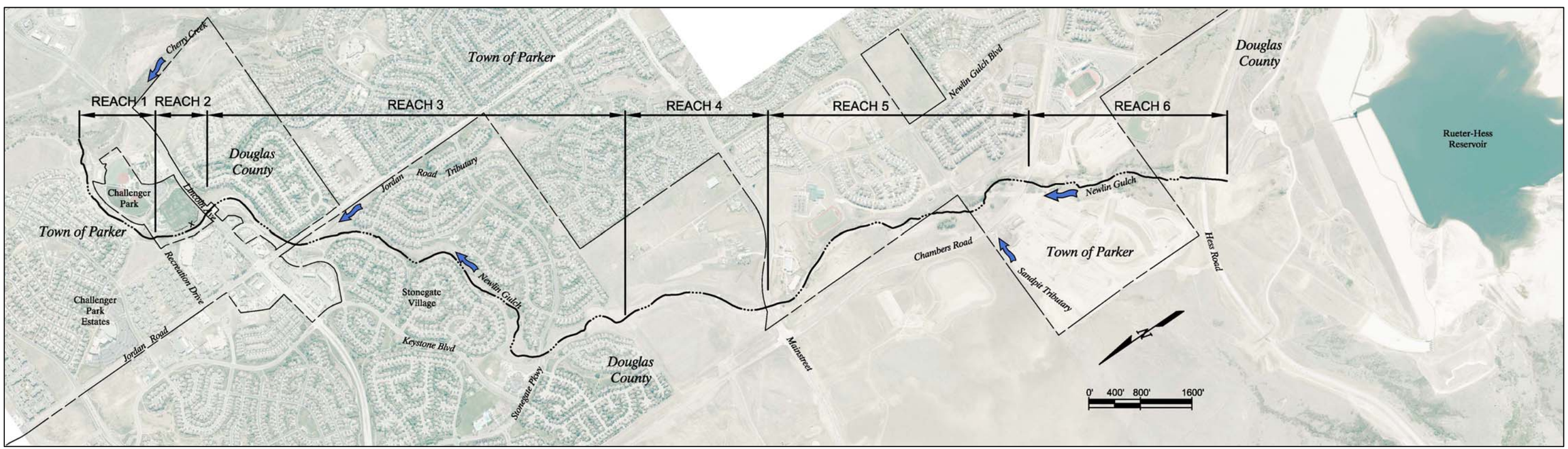
Reach 1

Reach 2 – Challenger Regional Park

Newlin Gulch continues to border Challenger Park in Reach 2, which extends from Recreation Drive to Lincoln Avenue in unincorporated Douglas County. The Recreation Drive crossing is an at-grade crossing where the water is conveyed over rather than under the road (also sometimes referred to as a "Texas crossing"). This presents a safety hazard which necessitates closure of Recreation Drive during even minor storm events, and requires frequent maintenance as buildup of sediment causes ponding on the road. This wide and shallow

Reach 2

Figure 2-3: Reach Map



reach lacks a well-defined low-flow channel, and flows in minor events spread to the east over playing fields and a parking lot. There is no existing grade control; the average channel slope is 0.6%. Vegetation is primarily grasses, with good density near Recreation Drive that decreases approaching Lincoln Avenue. The crossing at Lincoln Avenue is a two-span concrete bridge. A concrete trail provides maintenance access along the length of the reach.

Reach 3 – Stonegate Village

Upstream of Lincoln Avenue, Newlin Gulch passes through Stonegate Village, a master-planned community in unincorporated Douglas County. This is the longest reach included in the study area, at approximately 1.5 miles, and includes two major bridge crossings at Jordan Road and Stonegate Parkway. The open space channel corridor is owned and maintained by Stonegate Village Metropolitan District; development generally was planned around the historic floodplain, so this reach has a more natural feel. Concrete check structures were installed throughout the reach during development of the community in the early 1990s. In recent years, many of the check structures have become exposed due to channel degradation, and the development of deep scour holes has put some of the structures at risk of being undermined. Several channel stabilization projects have been constructed over the last five years to provide additional grade control and convert some of the exposed check structures into permanent drop structures. A total of 12 grouted boulder drop structures have been constructed in this reach. The existing channel slope varies from 0.15% in recently stabilized areas to 0.7% in areas lacking additional grade control.

Reach 3

The Jordan Road Tributary joins Newlin Gulch just upstream of Jordan Road. The tributary originally entered Newlin Gulch near Recreation Drive, but was diverted during development of the area. (A remnant of the lower portion of the tributary runs parallel to Reach 2 on the east side of the Challenger Park playing fields.) Vegetation varies widely through Stonegate Village: near Lincoln Avenue, the channel is very dry and sandy with little vegetation in the base flow channel and upland grasses and shrubs in the overbanks; beyond Jordan Road, there is a marked increase in vegetation with woody riparian habitat (including sandbar willows, cottonwood trees and willow trees) and wetland grasses. Near Stonegate Parkway, the vegetation again transitions to drier upland grasses, though the channel bottom maintains fairly good vegetation density throughout. A concrete trail provides maintenance access along most of the reach, extending from Lincoln Avenue to Pine Grove Elementary School, just north of Stonegate Parkway; an unsurfaced maintenance bench provides access for the remainder of the reach.

Reach 4 – Newlin Crossing

Reach 4 extends from the south end of Stonegate Village to Mainstreet, bisecting the planned Newlin Crossing development. The 1977 FHAD showed a floodplain width of up to 1000 feet in this wide, flat area; though currently undeveloped, the reach has been channelized and several grouted boulder drop structures provide grade control. The constructed slope is 0.56% for the upper portion of the reach, and 0.25% for the lower portion. Vegetation is extremely sparse in the lower part of this reach due to the presence of prairie dogs; density improves toward Mainstreet but remains dominated by upland species. There is no maintenance access in this reach; a regional trail is shown in the development plan.

Reach 4

Reach 5 – Mainstreet to Chambers

Upstream of the Mainstreet crossing, Newlin Gulch roughly parallels Chambers Road within the Town of Parker. This reach is generally characterized by a wide sandy channel bottom, with patches of shrubs and other upland vegetation. Stands of cottonwood and willow trees are found at the upper end of the reach, along with increasing wetland fringes. The average channel slope is 0.92%; with the exception of a drop structure at the Mainstreet bridge and a check structure near the upstream end, there is no grade control in this reach. Old Newlin Gulch Road, which was cut off by the construction of Chambers Road, provides maintenance access for the upper end of the reach. There is no maintenance access for the remainder of the reach.

Reach 5

Reach 6 – Parker Homestead

The final reach included in the study area extends from Chambers Road to Hess Road. Most of this reach lies within the Parker Homestead development in the Town of Parker, though the upper portion crosses again into unincorporated Douglas County. The base flow channel migrates frequently in the wide, flat floodplain. This reach is second only to Reach 3 in vegetation establishment, with numerous trees and frequent stands of shrubs and wetland vegetation. A check structure located near Chambers Road and a large grouted boulder drop structure upstream of Hess Road provide some grade control; a low water trail crossing midway through the reach is planned for construction during the course of this study. The existing average channel slope is 1.3%. A concrete trail provides maintenance access for most of the reach, ending near the Town boundary. Degradation is evident just downstream of Hess Road; this is expected due to the "clear-water" releases from Rueter-Hess Reservoir.

Reach 6

Table 2-1: Major Crossing Inventory

Crossing Location	Street Type	Crossing Type
Recreation Drive	Non-Residential Local	At-Grade Crossing
Lincoln Avenue	Arterial	Double Span Concrete Bridge
Jordan Road	Collector	Double Span Concrete Bridge
Stonegate Parkway	Collector	Single Span Concrete Bridge
Mainstreet	Arterial	Triple Span Concrete Bridge
Chambers Road	Arterial	Single Span Concrete Bridge
Hess Road	Arterial	Single Span Concrete Bridge

2.4 FLOOD HISTORY

The 1993 OSP does not include a record of flooding for the watershed, in part because the majority of development in the lower watershed (downstream of Rueter-Hess Reservoir) occurred after the 1993 OSP study. The floodplain was effectively managed during development to leave sufficient capacity for major storms flows while preventing damage to adjacent structures. The addition of Rueter-Hess Reservoir reduces the peak flows in the developed portions of the watershed, further reducing the flooding impacts.

In Challenger Park, the at-grade crossing of Recreation Drive causes ongoing flooding problems. The crossing is signed with flood warnings including flashing hazard lights. Despite these warnings, vehicles have been documented using the crossing during flood events; there have been numerous instances of vehicles stalling in the moving water.

2.5 ENVIRONMENTAL ASSESSMENT

As detailed in the reach descriptions in Section 2.3, scattered wetland and riparian zones are present along much of Newlin Gulch. The vegetation in some of these areas, however, is much sparser than other drainageways in the area, and does not provide high-quality wildlife habitat. The vegetation is expected to continue to evolve toward more wetland and riparian species as development continues to progress.

No federally threatened or endangered species have been identified within the project area; however, a project site-specific review should be conducted prior to implementing any recommended improvements. In addition, any work along the creek corridor should consider non-protected species in the area and avoid impacts during sensitive periods such as nesting/mating season.

3 HYDROLOGIC ANALYSIS

3.1 OVERVIEW

In watersheds where hydrologic models exist, master planning efforts generally utilize the existing models as a starting point for baseline hydrology, with revisions made as necessary to reflect changes in the watershed and to update the models to current software. For Newlin Gulch, hydrologic models from the 1993 OSP were provided by UDFCD. Electronic AutoCAD or GIS files were not available for the OSP subwatershed delineation. A number of challenges arose while reviewing and attempting to recreate the boundaries based on the Hydrological Basin Map from the 1993 report. Most evident was the impact of Rueter-Hess Reservoir on the watershed: the maximum normal pool of the Reservoir covers about 12% of the total watershed area. As a result, the Big Windmill, Canal, and Parkway Tributaries have been significantly shortened, and the Benchmark Tributary has been completed eliminated by the Reservoir permanent pool. Accordingly, the subwatershed delineations, design points, and routing elements necessary to model the Reservoir are different from the 1993 OSP. In addition, significant development in the lower watershed necessitated numerous changes to subwatershed boundaries, design points, and routing elements. As a result, though the 1993 boundaries were used as a guide, a new subwatershed delineation was performed.

These watersheds were evaluated using UDFCD's Colorado Urban Hydrograph Procedure (CUHP) 2005, version 1.3.3 (release date January 2010). Hydrographs generated in CUHP were then routed through the Environmental Protection Agency's (EPA) Storm Water Management Model (SWMM), version 5.0.020. Due to the numerous changes that would have been needed to reflect the updated delineation, the design team elected to create a new SWMM model as well rather than update the previous model. This facilitated numerous improvements to the model to make it more user-friendly with the current software, including a revised naming scheme for subwatersheds, conveyance elements, and design points; layout of the SWMM model elements in the graphical user interface (GUI) over a background image of the watershed; and updating SWMM node elevations to match the project mapping.

3.2 DESIGN RAINFALL

One-hour point rainfall depths for the 2-, 5-, 10-, 25-, 50-, and 100-year storm events were obtained from UDFCD rainfall maps for the project area and compared with the values used in the 1993 OSP. Current values are slightly lower than those used in 1993 for all but the 50-year storm, as shown in **Table 3-1.** The 500-year point rainfall was calculated based on the point values for the other storms using UD-Rain Version 1.01.

Table 3-1: Point Rainfall Depths

Storm Event	One-Hour Rainfall Depth (in)	
	1993 OSP	Current Study
2-year	1.06	0.95
5-year	1.43	1.41
10-year	1.66	1.66
25-year	N/A	1.97
50-year	2.26	2.28
100-year	2.6	2.57
500-year	N/A	3.21

UDFCD is currently in the process of updating the criteria presented in the USDCM. Updates include changes to the design storm duration and adjustments based on watershed size. The September 2012 draft version of Chapter 4 – Rainfall of the USDCM was used to develop the design rainfall distributions for this study. While the 1993 OSP used a 3-hour design storm for the Newlin Gulch watershed, the updated criteria eliminates 3-hour design storms and extends the use of a 2-hour storm duration to watersheds up to 15 square miles. Because the Newlin Gulch watershed is almost exactly 15 square miles, only a 2-hour storm distribution was used.

Adjustments to the incremental rainfall point values based on watershed area have also changed with the September 2012 draft criteria. Depth Reduction Factors (DRFs) are only applied to watershed areas greater than 15 square miles for the 25-, 50-, 100- and 500-year storm events; therefore no adjustment for these design storms was made. For the smaller 2-, 5-, and 10-year storm events, DRFs are applied when watershed areas exceed 2 square miles. In order to apply a DRF, adjustment values are interpolated from tables provided in the draft criteria based on the applicable contributing area. CHUP and SWMM are then run with the adjusted incremental rainfall values, and design peak flow rates from the DRF-adjusted models are used for design points where the cumulative area exceeds the limits given. Several DRF-adjusted runs may be required as the cumulative watershed area increases down the mainstem. For design points in the upper watershed or off the mainstem, where the cumulative area is below the DRF threshold, the unadjusted models are used to generate design peak flow rates.

In this case, Rueter-Hess Reservoir effectively disconnects the upper watershed from the lower watershed by drastically minimizing the contributions of the upper watershed on the lower watershed peak flow rates. As a result, the project team elected to apply the DRFs separately in the upper and lower watersheds in order to avoid over-correcting for the contributing watershed area below the reservoir. Upstream of Rueter-Hess, the 2 square mile limit is exceeded at the confluence of Newlin Gulch, Spring Tributary, and Roundtop Tributary, with a combined area of 2.8 square miles. The contributing watershed area increases to 3.2 square miles at the edge of the projected normal reservoir pool. DRFs based on a 3 square mile area were interpolated from the 2 square mile and 5 square mile values listed in the draft criteria and applied to design points NG014 (edge of normal pool), NG013, and NG220 (total reservoir inflow). Downstream of Rueter-Hess (excluding the area contributing to the reservoir), the 2 square mile limit is exceeded at the confluence of Newlin Gulch and Sandpit Tributary, with an combined area of 2.2 square miles. The contributing watershed area increases to 4.5 square miles at the confluence of Newlin Gulch and Cherry Creek. For simplicity, the same 3 square mile DRF adjustment was made for the lower watershed, and applied to mainstem design points NG006 (at Stonegate Parkway) through NG000 (at the confluence with Cherry Creek).

Adjustment factors for the 3 square mile DRF are presented in **Table 3-2.** Rainfall distributions for all return periods, adjusted and unadjusted, are listed in **Table B-1, Appendix B**. Tables 4-1, 4-3, and 4-4 of the draft criteria update, which detail the applications of DRFs, are also included in **Appendix B**.

Table 3-2: Depth Reduction Factors

Time (minutes)	3 Square Mile Area DRF 2-, 5-, and 10-Year Design Rainfall
5	1.00
10	1.00
15	0.99
20	0.95
25	0.95
30	0.95
35	0.99
40	0.99
45	1.00
50	1.00
55	1.00
60	1.00
65-120	1.00

3.3 SUBWATERSHED CHARACTERISTICS

Subwatershed characteristics were defined according to the revised delineation and current mapping and land use information. For each subwatershed, the flow path from the highest point in the basin was determined from the project mapping and used to define the length and distance to centroid. The length-weighted slope along the flow path was then calculated according to the method described in the USDCM. Existing and future imperviousness was determined based on the land use assumptions outlined in **Section 2.2**. Hydrologic soil group classifications were determined via the Natural Resources Conservation Service Web Soil Survey. Based on the soil groups present in each subwatershed, weighted values were calculated for initial and final infiltration rates as well as for the Horton's decay coefficient. Depression losses in pervious and impervious areas were set at 0.5 and 0.1, respectively, to match the values used in the 1993 OSP. A unit hydrograph time increment of 1 minute was used, since some of the subwatersheds are less than 90 acres (USDCM Table RO-1).

A total of 98 subwatersheds were defined. Areas ranged from 22 acres to 177 acres, with an average size of 87 acres (excluding the Rueter-Hess basin A-220). At the outset of the study, the maximum desired subwatershed area was 130 acres, however, this requirement was relaxed to allow for more reasonable subwatershed delineations in undeveloped areas. With the exception of Rueter-Hess, four subwatersheds (A-165, A-210, C-110, and C-120) significantly exceed the 130 acre guideline.

Hydrologic soil groups, existing and future impervious values, and subwatershed boundaries are shown on the interactive hydrology map in **Figure B-1, Appendix B**. A summary of all subwatershed values used in CUHP is presented in **Table B-2**, **Appendix B**.

3.4 HYDROGRAPH ROUTING

A new SWMM model was created for routing of the hydrographs generated in CUHP. Channel geometry was approximated from the project mapping, utilizing 2' interval topography north of Rueter-Hess Reservoir, and 5' interval topography in the remainder of the watershed. Trapezoidal elements were used exclusively for conveyance. SWMM determines channel slopes based on the segment length and elevations of upstream and downstream nodes; node elevations were defined based on the project mapping. Manning's n values were calculated using the Jarrett equation (USDCM Equation RO-10), and then were compared to the 1993 OSP values. Design points were placed at the downstream end of each subwatershed, with additional points included to reflect flow rates before and after the confluence with each tributary channel. Two detention storage areas were identified as eligible for inclusion into the baseline hydrology: Rueter-Hess Reservoir and Bradbury Ranch Pond IV. These are further discussed in **Sections 3.4.1** and **3.4.2** below.

SWMM model conveyance elements, subwatershed nodes, design points and storage elements are shown on the interactive hydrology map in **Figure B-1, Appendix B**. SWMM routing schematics are provided as **Figures B-2 and B-3** in **Appendix B**. SWMM input parameters and output results for the 100-year future development condition are included in **Tables B-7 and B-8, Appendix B**.

3.4.1 Rueter-Hess Reservoir Routing

The most significant storage area within the Newlin Gulch watershed is Rueter-Hess Reservoir, located on the Newlin gulch mainstem. The reservoir is owned and operated by Parker Water and Sanitation District (PWSD). Although the reservoir is designed only for water storage, the reservoir surface area is so large relative to the tributary watershed that it provides significant inadvertent flood detention. Outflows from the reservoir are controlled through a gated, multi-chambered tower that connects to two 78-inch diameter outlet conduits. The service spillway is comprised of two of the upper openings in the outlet works tower, each approximately 10-feet wide and 5-feet tall. The maximum normal pool elevation for the reservoir is elevation 6215.1 (NAVD88) which is equal to the crest of the service spillway. According to an evaluation conducted by the reservoir design engineer, the service spillway can convey both the 100-year and 500-year storm events. An auxiliary (or emergency) spillway consisting of a 500-foot long labyrinth weir is located on the west side of the dam embankment. The auxiliary spillway crest is at elevation 6216.7, which is 1.6-feet above the service spillway crest. The auxiliary spillway is designed to convey extreme flood events (greater that the 500-year).

To determine the flood detention impacts of Rueter-Hess, several options for routing floods through the reservoir were evaluated with the SWMM model. These options included flood routing through the service spillway, routing through the auxiliary spillway, and routing without the reservoir. The results of the routing options are summarized in a memorandum completed in May 2013 entitled *Rueter-Hess Reservoir Flood Control Benefits.* This memorandum, along with a summary table comparing downstream flows for the different routing options, are provided in **Appendix C**. The project sponsors, in cooperation with

PWSD, selected the option of routing through the auxiliary spillway for the baseline hydrology. The modeling results for this option show that, in the future development condition, a peak 100-year inflow of over 10,000 cfs routed through the reservoir will be discharged downstream of the Reservoir at less than 1,000 cfs and the reservoir water surface will surcharge or rise by approximately 0.8-feet. No modification to the outlet works or spillways is necessary to achieve this flood detention/attenuation. The project sponsors and PWSD selected the auxiliary spillway routing option because it accounts for the significant inadvertent flood detention provided by the Reservoir, while still allowing for some flexibility to change the service spillway elevation in the future to accommodate additional water storage without altering 100-year flood discharges downstream.

The baseline hydrology model assumes the following for Rueter-Hess: the reservoir normal pool is 100% impervious, the reservoir is full to the auxiliary spillway crest (elev. 6216.7) prior to the storm event, the service spillway is ignored/blocked, and the upstream hydrograph is routed through the auxiliary spillway.

The project sponsors entered into an agreement with PWSD on November 13, 2014, entitled "Agreement Regarding the Intent to Assure the Flood Routing Capability of Rueter-Hess Reservoir in Douglas County, Agreement No. 14-05.05". This agreement officially recognizes the inadvertent flood routing capability of the Reservoir for the 100-year discharge along Newlin Gulch and the intention to assure that this flood routing capability is maintained. A copy of the agreement is included as **Appendix D**.

The reservoir stage-area and stage-discharge curves used for the baseline SWMM model are included in **Table B-3, Appendix B**. These curves were taken directly from the original storage and discharge rating curves shown on Drawing No. A-05 of the reservoir record drawings. A copy of this drawing is also included in **Appendix B**.

3.4.2 Bradbury Ranch Pond IV

Currently, the only regional detention pond recognized in the Newlin Gulch watershed is the Bradbury Ranch Pond IV located along the Jordan Road Tributary just south of Mainstreet. The detention pond was built with Phase 1 of the Bradbury Ranch development in the late 1990's and early 2000's. Pond IV is referred to in many of the Phase III drainage reports for the various filings of the development, but despite extensive searching no design plans were found. A stage-area curve was developed based on Douglas County 5-foot interval topography. A stage-discharge curve was developed based on a detailed ground survey of the two-stage pond outlet works, which consist of a 60-inch open-ended culvert (lower stage), and a 30-foot broad-crested weir (upper stage). The SWMM analysis shows that the upper stage will overtop in storm events exceeding a 50-year recurrence. Overtopping flows will cross Mainstreet at Bradbury Parkway before rejoining the Jordan Road Tributary.

Stage-area and stage-discharge curves for Bradbury Ranch Pond IV are included in **Table B-3, Appendix B.**

3.5 PREVIOUS STUDIES

Newlin Gulch was previously analyzed in a 1977 FHAD and a 1993 OSP. The FHAD established the regulatory FEMA flow rates. Hydrographs were based on a 24-hour design storm with a Type IIA SCS rainfall distribution; peak discharges were calculated with the Soil Conservation Service's computer programs WSP2 and TR20.

The 1993 OSP utilized 2-hour and 3-hour design storms. Hydrographs were generated with the PC version of CUHP and routed through UDSWM2-PC. In 1993, the OSP notes that less than five-percent of the watershed area was impervious. The future land-use assumptions made in the OSP significantly increased the watershed imperviousness, but are still much lower than the current future land use projections. The future land use maps included in the OSP indicate that the upper portion of the watershed was modeled as about 80% open space (2%), with about 15% large lot residential (10%) and a small area of high-density residential (45%). The future land use imperviousness estimated in this area in the current study is significantly higher.

3.6 MODEL CALIBRATION

Standard practice for master planning studies on previously studied watersheds includes calibration of the hydrologic model to reconcile the results within 10% of the previously published data. This practice ensures that changes in baseline hydrology are due to changes within the watershed or updates to criteria rather than differences in software. Calibration is generally done through adjustment of Cp and/or Ct values in the CUHP, which impact the peak flow rates and the time to peak, respectively. This study targeted the 1993 OSP existing condition peak flow rates for reconciliation. A calibration "Historic" model was prepared, using 2% imperviousness across the entire watershed, and 100-year 2-hour and 3-hour rainfall distributions.

The results were found to agree within 10% for the majority of mainstem design points compared. In portions of the upper watershed, the 1993 OSP and current historic model do not calibrate to within 10%. However, these areas are on the upper end of an undeveloped watershed, where little infrastructure has been designed and built based on the previous peak flows. These results were presented to the project sponsors at the progress meeting on March 18, 2013. It was agreed that the current study CUHP and SWMM models reconciled with the 1993 OSP, and that no calibration of the model was necessary. Results of the calibration analysis are shown in Table 3-3.

Table 3-3: Model Calibration

Location	FHAD Cross Section	OSP Design Point	Current Design Point	1977 FHAD * 100-Yr (cfs)	1993 OSP ** Existing (cfs)	1993 OSP ** Future (cfs)	Current Study 100-Yr Historic† (cfs)	% Increase Historic Model vs 1993 OSP***	% Increase Historic Model vs. 1977
Newlin Gulch									
Cherry Creek	28	180	NG000	4790	5357	5513	5674	6%	18%
Lincoln Ave. (U/S)		177	NG001		5198	5396	5637	8%	
Jordan Rd. (U/S)	23	176	NG002	4720	5220	5412	5636	8%	19%
Mainstreet (U/S)	16	166	NG006	4590	5330	5545	5269	-1%	15%
Mainstem and Tributary Inflow to Rueter-Hess		150	NG013		4969	5138	4454	-10%	
I-25 (U/S)		103	NG019		321	311	412	28%	
Tributaries									
Jordan Rd. Tributary at Newlin Confluence		276	SJ000		545	785	560	3%	
South Newlin at Mesa Confluence		128	SN001		1106	1167	1369	24%	
Mesa Tributary at South Newlin Confluence		224	MT000		420	470	490	17%	
Roundtop Tributary at Newlin Confluence		217	RT000		383	393	424	11%	
Spring Tributary at Newlin Confluence		219	ST000		773	840	885	14%	

Notes:
* 1977 FHAD flows based on 24-hour storm and WSP-2 and TR-20 models.
** 1993 OSP flows based on 3-hour storm and CUHP/UDSWM models.
*** Comparisons are based on current study historic model vs. the Existing Conditions 1993 OSP model and the 1977 FHAD model.
†Used 3-hour design storm where total watershed area is greater than 10 square miles. Used 2-hour design storm elsewhere.

3.7 RESULTS OF ANALYSIS

Newlin Gulch was analyzed for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year storm events under existing and future development conditions, using a 2-hour design storm. A comparison to previous studies is presented in **Table 3-4** below. Overall, while peak flow rates have increased somewhat in the upper watershed above Rueter-Hess Reservoir, peak flow rates in the lower watershed have decreased due to the effects of the reservoir. Though the reduction is drastic immediately below of the reservoir, the effect lessens as the mainstem approaches its confluence with Cherry Creek.

Detailed results are included in **Appendix B**. Peak flow rates at each design point are listed in **Table B-4**; runoff volumes and accumulated drainage areas at key locations are listed in **Tables B-5 and B-6**. Hydrographs at key locations for the 2-, 10-, and 100-year events are shown in **Figures B-4 and B-5**. Peak flow profiles for all storm events on the mainstem of Newlin Gulch are shown in **Figures B-6 and B-7**.

Table 3-4: Comparison to Previous Studies

					1993 OSP **		Current Study	
Location	FHAD Cross Section	OSP Design Point	Current Design Point	1977 FHAD * 100-Yr (cfs)	100-Yr Existing (cfs)	100-Yr Future (cfs)	100-Yr Existing (cfs)	100-Yr Future (cfs)
Newlin Gulch								
Cherry Creek	28	180	NG000	4790	5357	5513	2843	3539
Lincoln Ave. (U/S)		177	NG001		5198	5396	2795	3450
Jordan Rd. (U/S)	23	176	NG002	4720	5220	5412	2793	3443
Stonegate Parkway (U/S)			NG004				2212	2660
Mainstreet (U/S)	16	166	NG006	4590	5330	5545	1945	2244
Chambers Rd. (U/S)			NG009				905	1029
Hess Rd.			NG011				890	1015
Rueter-Hess Reservoir Outflow			NG012				880	999
RH Total Inflow (Including Reservoir Subwatershed)			NG220				8822	10362
Mainstem and Tributary Inflow to RH		150	NG013		4969	5138	5871	7649
Mainstem Inflow to RH			NG014				2454	3256
I-25 (U/S)		103	NG019		321	311	426	514
Tributaries								
Jordan Rd. Tributary at Newlin Confluence		276	SJ000		545	785	690	758
South Newlin at Mesa Confluence		128	SN001		1106	1167	1388	1564
Mesa Tributary at South Newlin Confluence		224	MT000		420	470	493	598
Roundtop Tributary at Newlin Confluence		217	RT000		383	393	429	504
Spring Tributary at Newlin Confluence		219	ST000		773	840	1009	1427

Notes:
* 1977 FHAD flows based on 24-hour storm and WSP-2 and TR-20 models.
** 1993 OSP flows based on 3-hour storm and CUHP/UDSWM models.

3.8 COMPARISON OF EXISTING AND FUTURE DEVELOPMENT CONDITIONS

It is FEMA policy that Floodplain Insurance Rate Maps (FIRMs) reflect watershed conditions at the time the study is conducted, not projected future conditions. However, it is UDFCD policy to prepare FHADs based on future development conditions in order to guide the limits of development along major drainageways. FEMA will accept hydrologic studies based on future development if the following criteria are met: 1) the future development 100-year peak flow rate exceeds the existing condition peak flow rate by no more than 30-percent, and 2) the 100-year water surface elevation (WSEL) generated by the future development peak flow rate exceeds the WSEL of the existing condition peak flow rate by no more than 0.5-feet. If these criteria are not met, the floodplain mapping set forth in the FHAD cannot be submitted for acceptance by FEMA, and a separate DFIRM analysis must be conducted based on the existing development conditions.

Comparison of the existing and future development peak flow rates for Newlin Gulch indicate that the future development peak flow rates never exceed the existing development peak flow rates by more than 30-percent. Upstream of Stonegate Parkway, the increases in estimated future development WSELs are consistently less than 0.5-feet. Downstream of Stonegate Parkway, the increases fluctuate between 0.25-feet and 0.9-feet over the existing development WSELs. Because this area was developed prior to the construction of Rueter-Hess and channel improvements were designed based on higher peak flow rates, the floodplain remains contained within the channel. This information was presented to the project sponsors at the progress meeting in March 2015. The project sponsors determined that the results are within FEMA guidelines, such that a separate DFIRM analysis is not required for regulatory purposes.

The comparison figure for the 30-percent and 0.5-foot criteria has been included in **Appendix B**. No separate hydraulic analysis was conducted using the existing conditions flow rates.

The baseline hydrology analysis for the Newlin Gulch Major Drainageway Plan was accepted by UDFCD on March 3, 2015.

4 HYDRAULIC ANALYSIS

4.1 OVERVIEW

Hydraulic modeling and floodplain delineation were performed for 4.2 miles of the Newlin Gulch mainstem using HEC-RAS version 4.1.0. The hydraulic model was run using 1-dimensional, steady state flow through a standard step backwater calculation. Results of the HEC-RAS analysis have been published in tabular form as the Floodplain and Floodway Data Tables in **Appendix F.** Flood maps showing the 100- and 500-year floodplains based on the HEC-RAS output have been included in **Appendix G.** Flood profiles based on the same output have been included in **Appendix H.**

4.2 EVALUATION OF EXISTING FACILITIES

The Newlin Gulch channel is generally well-defined, resulting in few problems related to floodplain capacity. Notable areas with poorly defined or insufficient conveyance are confined to the channel running along Challenger Park from Lincoln Avenue to just downstream of Recreation Drive, resulting in areas of a nearby parking lot and restroom structures being inundated by the floodplain.

Hydraulic cross sections are located so as to represent the topography of the channel, with additional sections at grade control and crossing structures. The maximum spacing between sections is approximately 500 feet, though in most areas the spacing is much less. Where possible, cross sections were laid out to match sections used in previous analyses, including several Letter of Map Revision (LOMR) studies. Cross section alignments were adjusted as necessary to reflect the direction of flood flows in the overbanks while remaining perpendicular to the channel at its centerline. The Newlin Gulch centerline uniformly follows the low-flow path rather than the floodplain path. In most cases, however, the two paths are coincident.

Bank stations were chosen based on field observation, and are generally set to reflect a wide, sandy channel bottom. In some reaches, bank stations were set higher up the banks to reflect changes in vegetation between the flood-prone channel and the overbanks. Manning's n values were estimated based on field observations. Photos on pages 4-2 and 4-3 depict representative channel sections from each reach that characterize the various types of vegetation and their associated 'n' values used in the hydraulic modeling. Values vary from 0.040 to 0.12. A summary table by reach is included in **Appendix E**.

Channel geometry and reach lengths were generated and imported into HEC-RAS using Power InRoads v8i and modified as necessary to reflect longer overbank reach lengths, additional detailed survey data, and structure information. Construction of a channel stabilization project on a portion of Reach 3 (see **Figure 2-3**) postdated the project topography; channel geometry for this segment is based on the design plans (*Newlin Gulch Channel Improvements Downstream of Stonegate Parkway, July 2012*) and as-built information.

Seven major roadway crossings were modeled: six bridges and one at-grade crossing. For several of these, bridge data was taken from LOMR HEC-RAS models; the LOMR case numbers are included in **Table 4-1**. The Recreation Drive cross section is based on a detailed ground survey; bridge data for Chambers Road is based on as-built plans for the bridge. Stonegate Parkway bridge data is based on the design HEC-RAS model for the Newlin Gulch project mentioned above; detailed project survey was the original source.

The HEC-RAS model also includes several pedestrian trail crossings. Data for the steel pedestrian bridge near the confluence with Cherry Creek was based on a combination of HEC-2 data from the Challenger Park Estates LOMR and field measurements. Two low-flow crossings in Stonegate Village were modeled based on design plans and as-built data. Finally, a proposed low-flow crossing midway between Chambers Road and Hess Road was modeled based on design plans; construction is expected to be completed during the course of this study.

The 100-year floodplain was delineated based on the future development, existing infrastructure hydrology described in **Section 3**. The hydraulic model was also run with existing development peak flow rates; the two hydraulic profiles were compared and generally exhibited less than one half foot difference in base flood elevation, so a separate existing development condition floodplain was not delineated.

Since the majority of Newlin Gulch is contained in a well-defined channel, floodways have generally been set coincident to the floodplain with no additional analysis performed. In certain areas of overbank flooding and backwater stagnation (particularly within the Challenger Park reach and along the undeveloped reach between Chambers Road and Hess Road), separate floodways have been computed and delineated based on a 0.5-foot rise for both hydraulic grade line and energy grade line.

Results of the hydraulic analysis indicated no flooding of existing structures or major crossings, with the exception of Recreation Drive. A summary of the crossings and their capacity is shown in **Table 4-1**.

Table 4-1: Existing Crossing Capacity

Crossing Location	Station	Crossing Type	Capacity	Bridge Data Source
Recreation Drive	2171	At-Grade Crossing	Zero	N/A
Lincoln Avenue	3150	Double Span Concrete Bridge	>500-yr	LOMR Case # 08-08-0553P
Jordan Road	4750	Double Span Concrete Bridge	>500-yr	LOMR Case # 08-08-0553P
Stonegate Parkway	10000	Single Span Concrete Bridge	>500-yr	Channel Design Model
Mainstreet	14000	Triple Span Concrete Bridge	>500-yr	LOMR Case # 08-08-0334P
Chambers Road	18950	Single Span Concrete Bridge	>500-yr	As-built plans
Hess Road	21850	Single Span Concrete Bridge	>500-yr	LOMR Case # 11-08-0044P

Reach 1 – Challenger Park Estates
Dense, healthy wetlands with sparse, bunch grass in overbanks
Manning's 'n': 0.04 (overbanks) / 0.08 (channel)

Reach 1 – Challenger Park Estates
Sparsely vegetated with short, grassy overbanks
Manning's 'n': 0.04 (overbanks) / 0.05 (channel)

Reach 2 – Challenger Regional Park
Medium density grasses with turf fields in right overbank
Manning's 'n': 0.04 (left overbank) / 0.03 (right overbank) / 0.04 (channel)

Reach 3 – Stonegate Village
Dry, sandy channel with upland grasses in overbanks
Manning's 'n': 0.04 (overbanks) / 0.04 (channel)

Reach 3 – Stonegate Village
Woody, riparian channel with upland grasses in overbanks
Manning's 'n': 0.04 (overbanks) / 0.08 (channel)

Reach 3 – Stonegate Village
Dense, wetland willows with medium growth cottonwoods and upland grasses in overbanks
Manning's 'n': 0.04 (overbanks) / 0.12 (channel)

Reach 4 - Newlin Crossing
Wide, sparsely vegetated channel with upland grasses
Manning's 'n': 0.04 (overbanks) / 0.04 (channel)

Reach 5 – Mainstreet to Chambers
Wide, sandy channel with patchy shrubs and vegetation
Manning's 'n': 0.05 (overbanks) / 0.04 (channel)

Reach 5 – Mainstreet to Chambers
Dense, medium-growth cottonwoods near channel with dense shrubs and vegetation in overbanks
Manning's 'n': 0.08 (overbanks) / 0.10 (channel)

Reach 6 – Parker Homestead
Rocky channel with medium-growth cottonwoods and upland shrubs in overbanks
Manning's 'n': 0.06 (overbanks) / 0.06 (channel)

Reach 6 – Parker Homestead
Wide, sandy channel with sparse vegetation
Manning's 'n': 0.04 (overbanks) / 0.04 (channel)

4.3 FLOOD HAZARDS

Flood hazards within the study area are concentrated in the Challenger Park area, at the juncture of Reaches 1 and 2 (see **Figure 2-3**). The most significant hazard is at Recreation Drive, which exhibits flooding in even the smallest event due to the lack of grade separation. Flooding depths for the various storm events modeled are tabulated in **Table 4-2**.

Flooding at Recreation Drive during Nuisance Event

Flooding also occurs regularly in the west parking lot, located adjacent to Newlin Gulch at Recreation Drive. With the adjacent channel having less than a 2-year capacity, small, nuisance flows typically spill into the lot. In 25-year and larger storms, flows spill over the high point in Recreation Drive. This results in about 30 cfs of shallow flooding along the adjacent internal drive (herein referred to as Recreation Drive East), which is the sole access for the east parking lot. Street flow capacity calculations for Recreation Drive East are located in **Appendix E;** any flows in excess of the street capacity will spill back into the channel. Backwater flooding also extends into the south parking lot. Finally, the large grouted boulder drop structure downstream of Recreation Drive has only 10-year capacity at the crest, causing larger storm events to end-around the structure on the right bank. While no nearby buildings or residences are inundated by the flooding, erosion in this area could threaten the drop structure or the adjacent buried utilities, including a 20-inch high pressure gas line, a 12-inch effluent force main, and a 6-inch sanitary force main.

Table 4-2: Overtopping Depths at Recreation Drive

Storm Event	Overtopping Depth (ft)
10-Year	3.45
50-Year	4.54
100-Year	4.80
500-Year	5.12

4.4 PREVIOUS ANALYSES

Previous hydraulic analyses along Newlin Gulch include the 1977 FHAD, 1993 OSP, and various LOMRs. The 1977 FHAD noted overtopping at Jordan Road and West Parker Road (now Mainstreet) in the 100-year event; these crossings have since been replaced. Few buildings existed in the watershed, so there were no other flood impacts noted. The 1993 OSP noted overtopping at Lincoln Avenue in addition to Jordan Road and West Parker Road; this crossing has also been replaced.

In general, the floodplain limits and flow depths are reduced in comparison with the current regulatory floodplain. This is a result of the reduction in peak flow rates due to the inclusion of Rueter-Hess Reservoir in the baseline hydrology. A comparison table depicting the differences in the 100-year water surface elevations between the FHAD and regulatory floodplain is located in **Appendix E.**

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Appendix A

PROJECT CORRESPONDENCE

MEETING
MEMORANDUM

MULLER ENGINEERING COMPANY, INC.
CONSULTING ENGINEERS
777 SOUTH WADSWORTH BLVD., SUITE 4-100
LAKEWOOD, COLORADO 80226
(303) 988-4939

Project
Newlin Gulch MDP

Sponsors
UDFCD / Douglas County / Town of Parker

Meeting Location
UDFCD

Attendees
Shea Thomas, UDFCD
Bill DeGroot, UDFCD
Brad Robenstein, Douglas County
Tom Williams, Town of Parker
Jacob James, Town of Parker
Derek Johns, Muller Engineering Company
Jim Wulliman, Muller Engineering Company
Andy Pultorak, Muller Engineering Company

Purpose
Newlin Gulch MDP Kick-off Meeting

Meeting Date
Nov. 19, 2012

Issue Date
Nov. 28, 2012

MEC Project No.
12-050.01

Minutes Prepared By
Andy Pultorak

Routing
ASP / DDJ / JTW

Action Items
All action items are requested to be completed by December 7, 2012 unless otherwise noted.

Muller Action Items:
1. Muller will review the Baldwin Gulch mapping provided by Shea and update the survey request for Baldwin accordingly. Muller will then send the updated request to Shea.
2. Muller will contact Parker Water & Sanitation District (PWSD) to obtain the Reuter-Hess spillway configuration for use in modeling the Reservoir impacts to the downstream watershed.
3. Muller will provide a survey request figure to Shea with survey needs at Challenger Park (Recreation Drive).
4. Muller will coordinate with the sponsors to setup the first progress meeting.
5. Muller will contact Castle Pines to obtain the latest development plans for the upper watershed.
6. Muller will setup the project website and invite the project team to review before posting.

UDFCD Action Items:
1. ~~Shea will provide aerial mapping for Baldwin Gulch to Muller.~~ (Complete)
2. ~~Shea will invite Muller to the project Dropbox folder.~~ (Complete)
3. Shea will provide new 2-foot LiDAR mapping of the Newlin Gulch watershed once processing is complete (should be the week of November 25th).

Douglas County Action Items:
1. Brad (Douglas County) will provide Muller with the LOMR document for the Hess Rd. crossing (LOMR 11-08-0044P).
2. Brad (Douglas County) will provide Muller with drainage reports and as-built plans for the requested developments within the watershed.

Town of Parker Action Items:
1. Jacob will provide Muller with drainage reports and as-built documents for the requested developments within the watershed.
2. ~~Jacob will provide Muller with LOMR documents for the crossings at Lincoln, Jordan, and Chambers~~ (Complete).

Discussion

THE FOLLOWING IS OUR UNDERSTANDING OF THE SUBJECT MATTER COVERED IN THIS CONFERENCE. IF THIS DIFFERS WITH YOUR UNDERSTANDING, PLEASE NOTIFY US IMMEDIATELY.

Agenda

1. REVIEW PROJECT APPROACH AND SPONSOR GOALS

a. Derek introduced the project and stated that the goal was to update the Major Drainageway Plan for the Newlin Gulch watershed based on current and projected land use.

b. Reuter-Hess Reservoir impacts

- Derek stated that the construction of the Reuter-Hess Reservoir significantly attenuates the downstream peak flows for major floods. Although the reservoir was not designed for flood storage, the large surface area provides significant storage for major floods. Derek said that evaluations complete by the design engineer for Reuter-Hess indicate that, with the reservoir at full capacity, the 100-year flood event would cause about 0.6-feet of rise in the reservoir. For the 100-year event, the reservoir will not crest the emergency spillway and the downstream peak flow will be reduced to near zero.
- Derek said that recent infrastructure projects downstream of the dam utilized the reduced peak flow rates in design, resulting in significant cost savings. However, since FEMA does not recognize the reduced flow rate, the map revisions for these projects used the much higher regulatory flow rate. Therefore, these projects showed overtopping where none is likely to occur.
- Tom said that from a land-use perspective he was in favor of keeping the FIS flow rates intact, since the watershed has already been significantly developed. However, from an infrastructure planning perspective, he saw value in having FEMA adopt the reduced flow rates so that smaller, most cost-effective crossing structures could be built.
- Jim noted that FEMA would require an adequate assurances agreement to be entered into by Parker Water and Sanitation District (the reservoir operator) before the flood storage could be acknowledged by FEMA. Bill DeGroot said that at Standley Lake the reservoir operator had initially signed an adequate assurances agreement but later started work on a project which would have modified the reservoir operation and put houses in the floodplain. He also pointed out that designing channel crossings to the current FIS flow rate provided a factor of safety against clogging.
- Muller will evaluate the watershed hydrology with and without the flood storage effects of Reuter-Hess, and present their findings to the team at a future progress meeting. The project team will decide which set of flow rates makes the most sense to publish for this study considering the issues mentioned above.
- Tom stated that Reuter-Hess had held runoff from large storm events in June and July. The State Engineer's Office required release of this water, which started at 20-30 cfs and increased to a few hundred cfs. This caused noticeable stream degradation in Newlin Gulch immediately downstream. The team expected that the frequency and duration of flow releases from reservoir operations could threaten the stability of Newlin Gulch in the future.

Tom has discussed operations with PWSD and would like Reuter-Hess to release at lower flow rates of 20-30 cfs over a longer time period when they have to release runoff. This study will develop recommendations to stabilize the channel and prevent downcutting and erosion.

c. Muller will make sure that the recommendations of the MDP are consistent with the goal of preserving natural and beneficial stream functions. The team would like to preserve the natural character of the Newlin Gulch floodplain.

d. As part of the study, the team would like Muller to prepare alternatives to address flood conveyance at the Recreation Drive "Texas" crossing in Challenger Park. The team noted that, despite flood warning devices, this area continued to pose a hazard to motorists. Tom said that one of the challenges at this location is to design a crossing in a manner that does not cause floodplain issues.

e. The Baldwin Gulch portion of the study will focus on a stability analysis of the spillway for the Soil Conservation Service dam east of Pine Lane. The stability of the Baldwin Gulch channel between the dam and Pine Lane will also be evaluated. Muller will prepare a list of supplemental survey needs for this area (see Action Items).

2. DATA FOR BASELINE HYDROLOGY.

a. Mapping
- Muller presented a large scale figure of the Newlin Gulch watershed superimposed on 5-foot topography provided by Douglas County.
- If necessary, Muller has access to the 2008 DNC LiDAR topo for areas north of Lincoln.
- Shea thought that the new LiDAR topo she had flown this year for Newlin Gulch might cover the entire watershed.
- Muller will use the new LiDAR topo provided by Shea (see Action Items) to delineate the basins and sub-basins, and will supplement with the Douglas County 5-foot topo as necessary.

b. Land Use
- Shea provided Muller with aerial imagery from 2011 for the watershed.
- Jacob will provide Muller with updated 2012 aerial photography.
- Muller obtained zoning maps for Douglas County and Parker.
- Muller has already obtained some drainage reports and as-built documents for the surrounding developments as part of the adjacent Happy Canyon Creek master plan. Muller will request additional drainage reports and as-builts as necessary (see Action Items).
- The development plan in Castle Pines (upstream of Reuter-Hess) has changed significantly since the 1994 OSP. Muller will coordinate with Brad Meyering (Castle Pines Metro District) to obtain the latest development plan in this area.

c. Identify Existing Detention Ponds (regional and publically maintained)
- With the exception of Reuter-Hess, Derek asked the project team if they were aware of any publically maintained detention ponds within the watershed. The team was not aware of any ponds.

d. Reuter-Hess Reservoir
- As part of several design projects within Stonegate Village, Muller had already obtained some documentation regarding the operation of the Reuter-Hess Reservoir. Muller will coordinate with PWSD to obtain additional information needed to complete the baseline hydrology (see Action Items).
- Derek mentioned that in his previous experiences modeling watersheds containing large reservoirs, certain unique challenges arose. Muller plans to model the reservoir full to the normal pool elevation prior to the storm and make the reservoir a sub-basin within the watershed with an imperviousness of 100%. The team agreed with this approach. Derek

stated that some basin characteristics (such as average basin slope) were difficult to estimate for a reservoir. Shea said that she would work with Muller to adjust the Cp factor to create a reasonable time to peak for the reservoir sub-basin.

3. Approach to Baseline Hydrology

Derek summarized the steps for developing the baseline hydrology:

a. Convert CUHP/SWMM file from 1994 OSP

b. Update subwatershed boundaries and characteristics (excluding % imperv.)

c. Calibrate to the existing FEMA flow rates (per 1977 FHAD). The FEMA flow rates are published downstream of Reuter-Hess. Upstream of Reuter-Hess, Muller will compare their peak flow rates to the 1994 OSP, but no calibration is required. Muller will also compare, but not calibrate, their flow rates to those published as part of the recent Cherry Creek FHAD study.

d. Update % imperviousness values for existing and future land use.

e. Add eligible publically maintained detention ponds.

4. SUPPLEMENTAL FIELD SURVEY

a. Newlin Gulch MDP
- The team discussed the need for supplemental ground survey at road crossings. Parker and Douglas County have LOMR studies for all of the major crossings and will send copies of these studies to Muller. The team decided that no supplemental crossing survey is warranted at this time.
- Derek mentioned a private drive between Chambers Rd. and Hess Rd. This is a low-water crossing consisting of 18-inch culvert pipes. The team decided that no survey is necessary at this location.
- Muller will coordinate with Shea to obtain ground survey of the Recreation Drive "Texas" crossing (see Action Items).

b. Baldwin Gulch
- Shea has already obtained 2-foot aerial mapping of the SCS dam on Baldwin Gulch as part of a survey effort for another project. Muller will review this survey and determine if additional ground survey is warranted (see Action Items).

5. IDENTIFY AND CONTACT STAKEHOLDERS (WHO AND WHEN)

The team discussed contacting other stakeholders (below). Muller will contact PWSD and Castle Pines initially as part of the baseline hydrology task. At Shea's recommendation, the team will wait for the completion of the baseline hydrology to involve the other stakeholders in progress meetings.

a. Parker Water & Sanitation District

b. Castle Pines

c. CCBWQA and CDOT

6. PROJECT WEBSITE

a. The project website will be similar to the website Muller created for the Happy Canyon MDP & FHAD.

b. The website will contain sponsor logos but not individual contact information.

c. The website comment form will be setup so that comments are emailed to Muller. Muller will then distribute comments to the project sponsors.

d. Muller will create a draft version of the website for Shea to review before making it live.

Newlin Gulch MDP – Kickoff Meeting – Meeting Minutes
November 19, 2012

7. PROJECT SCHEDULE.

a. Derek presented a draft project schedule to the team.

b. Muller anticipates completing the first draft of the baseline hydrology by early February. Shea thought that this was an appropriate timeframe.

8. OTHER ITEMS AND NEXT MEETING.

a. The next meeting will be held in January. Muller will coordinate with the sponsors to establish an acceptable meeting time.

b. There being no other business, the meeting was adjourned.

END OF MINUTES

MEETING MEMORANDUM

MULLER ENGINEERING COMPANY, INC.

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Project
Newlin Gulch MDP

Sponsors
UDFCD / Douglas County / Town of Parker

Meeting Location
UDFCD

Attendees
Shea Thomas, UDFCD
Bill DeGroot, UDFCD
Brad Robenstein, Douglas County
Tom Williams, Town of Parker
Jacob James, Town of Parker
Derek Johns, Muller Engineering Company
Jim Wulliman, Muller Engineering Company

Purpose
Newlin Gulch MDP – Progress Meeting #2

Meeting Date
March 18, 2013

Issue Date
April 21, 2013

MEC Project No.
12-050.01

Minutes Prepared By
Derek Johns

Routing
ASP / DDJ / JTW

Muller Action Items:

1. Muller will evaluate two other options for routing at Rueter-Hess Reservoir:
   a. Route flows through the auxiliary spillway.
   b. Eliminate Rueter-Hess Reservoir completely and model reservoir subwatershed based on historic conditions and 2% imperviousness.
2. Muller will email the Sandpit Tributary flow rates to the project team.
3. Muller will evaluate flow rates for smaller storm events (2-yr, 5-yr, etc.) on Newlin Gulch by the Parker Homestead development and email these to Parker.
4. Muller will update the project schedule.

UDFCD Action Items:

1. Shea will provide input to Muller regarding depression storage losses for subwatersheds.
2. Shea will provide input to Muller regarding using Jarrett's equation to compute n-values for SWMM channels.
3. Shea will get the project website linked up to the UDFCD website.

Douglas County Action Items:

1. Brad will investigate whether or not there is a regional detention pond on the Spring Tributary upstream of I-25.
2. Brad and Tom will setup a meeting with PWSD to discuss Rueter-Hess Reservoir routing.

Town of Parker Action Items:

1. Jacob will provide Muller with drainage and as-built information for the regional detention pond on the Jordan Road Tributary upstream of Mainstreet.

Discussion

THE FOLLOWING IS OUR UNDERSTANDING OF THE SUBJECT MATTER COVERED IN THIS CONFERENCE. IF THIS DIFFERS WITH YOUR UNDERSTANDING, PLEASE NOTIFY US IMMEDIATELY.

Derek provided an overview of the draft hydrology modeling completed since the last meeting and summarized the initial results. Below is a summary of the information discussed in the meeting.

1. SUBWATERSHEDS

a. Derek reviewed the mapping that was used for the hydrology analysis. The mapping consists of the following:
   - New 2-foot contour mapping for the Newlin Gulch channel corridor downstream of Rueter-Hess Reservoir. This mapping was completed in 2012 and provided by UDFCD.
   - Older 5-foot contour mapping for areas beyond the 2-foot mapping limits and for the watershed upstream of Rueter-Hess Reservoir. This older mapping was completed in 1996 and provided by Douglas County.
   - Aerial photography from Parker dated 2012.

b. Derek explained that the older 5-foot mapping does not always reflect drainage patterns correctly in newly developed areas. Therefore, land development drainage reports/maps were used to help delineate subwatersheds in newly developed areas.

c. Derek explained that the initial plan was to start with the subwatersheds from the 1993 Outfall Systems Plan (OSP) and then check the delineation based on the more current topographic mapping. However, it was discovered that the OSP subwatersheds were no longer application for the following reasons:
   - There have been many new developments since the OSP and these developments have changed drainage patterns within the watershed.
   - The Rueter-Hess Reservoir subwatershed is very large. The reservoir was delineated as a single subwatershed based on the normal pool elevation. The normal pool elevation is significantly higher than the current water level and this results in a subwatershed area of 1.8 square miles or approximately 12% of the entire Newlin Gulch watershed.
   - The OSP subwatersheds were delineated using older mapping.

d. Given these issues, a new subwatershed delineation was completed based on the more current mapping. The 15.0 square mile Newlin Gulch watershed was subdivided into 111 subwatersheds. The average subwatershed size is approximately 90 acres and only a few subwatersheds exceed 130 acres.

2. SOILS MAP

Derek handed out a map of the hydrologic soil types within the watershed. Most of the watershed consists of Type C/D soils. Type A and B soils exist along the Newlin Gulch channel.

3. LAND USE

a. Derek handed out land use maps for existing and future development conditions and explained that these were prepared based on the 2012 aerial photography and information provided in land development drainage reports. Imperviousness values were assigned according to UDFCD guidelines.

b. Douglas County. Land use for areas within unincorporated Douglas County include the following developments:
   1. Stonegate Village (existing) and Meridian Business Park (future).
   2. Happy Canyon Ranches, Sapphire Pointe, and development along Lemon Gulch Road.
      a. Brad (Douglas County) agreed that these were all large lot developments and would stay that way in the future. Brad thought that the development along Lemon Gulch Road was 35-acre lots.
      b. Brad agreed with the percent imperviousness values shown on the maps.

c. Town of Parker. Land use within Parker includes the following existing and future developments:
   1. Challenger Park and Bradbury Ranch (existing).
   2. New Horizon, Regency, Newlin Meadows (mostly developed).
   3. Newlin Crossing (on-hold).
   4. Parker Homestead (just started).
   5. Reuter-Hess WTP (just started).

d. Castle Pines. Land use within Castle Pines includes the following developments:
   1. The Canyons is a very large development being planned immediately upstream of Rueter-Hess Reservoir. Imperviousness values for this development were based on information provided in a Phase 1 drainage report.
   2. Lagae Ranch and Castle Pines Town Center (future).

e. Major Roads. Imperviousness values assumed for major roads were as follows:
   1. For I-25 and Hess Road, 60% imperviousness was assumed including ROW.
   2. For Chambers, Lincoln, Mainstreet, and Jordan Road, the imperviousness was assumed to be 100%.

f. For existing land use conditions, Derek said that the composite percent imperviousness for the entire watershed was 4.9% in the 1993 OSP Study and is 22.5% for the current study.

g. For future land use conditions, Derek said that the composite percent imperviousness for the entire watershed was 12.6% in the 1993 OSP Study and is significantly higher at 34.7% for the current study.

h. The Town of Parker and Douglas County will review the land use maps and provide comments to Muller.

4. CUHP MODEL

a. Derek said that both 2-hr and 3-hr rainfall events were modeled.

b. Derek stated that the depression losses used for the CUHP model approximately match the values used in the 1993 OSP. For pervious areas, a depression loss of 0.5-inches was used. For impervious areas, a depression loss of 0.1-inches was used (OSP ranged from 0.1 to 0.15-inches). These values are within the range listed in the UDFCD criteria manual but slightly higher than the "recommended" values. Shea stated that she will review these and get back to Muller with comments (see UDFCD Action Items).

Newlin Gulch MDP – Progress Meeting #2– Meeting Minutes
March 18, 2013

c. Rueter-Hess Reservoir subwatershed. Derek stated that the subwatershed for Rueter-Hess Reservoir was delineated at its normal pool elevation. An imperviousness of 100% and a subwatershed slope of 0.1% were assumed. This is consistent with how similar reservoirs have been modeled within the District. The draft results of the CUHP modeling indicate a 100-year peak flow of 2958 cfs or 2.6 cfs/acre for the Rueter-Hess subwatershed. Derek noted that this is similar to the results of a study completed on Standley Lake in Westminster, Colorado, which yielded a unit discharge of 3.1 cfs/acre for the lake.

d. Derek said that Muller performed a unit discharge check of the CUHP results. It was found that for undeveloped areas the subwatershed unit discharge typically varied from 1.0 to 1.6 cfs/acre. For residential areas, the unit discharge ranged from 2.0 to 3.8 cfs/acre. For business/commercial areas, the unit discharge ranged from 3.8 to 4.9 cfs/acre. Shea said that the unit discharges for oddly shaped basins (i.e., not meeting the 4:1 shape factor) should be checked. If the unit discharges are outside the normal range, then the Cp value should be adjusted.

5. SWMM MODEL

a. Derek explained that Muller developed a new SWMM model for the Newlin Gulch watershed and did not use the 1993 OSP model. This approach was used for the same reasons mentioned earlier regarding the subwatershed delineation.

b. Natural Channel n-values.
   - Derek explained that initially Muller used typical channel n-values that would be used for hydraulic models and then increased them by 25% per UDFCD guidelines. However, it was found that the n-values computed in this way were typically lower than those in the 1993 OSP.
   - Therefore, Muller modified the n-values and used higher values that were closer to those in the 1993 OSP which were based on the Jarrett equation. Derek asked if the project sponsors had a preference on the approach for estimated n-values. Shea responded that she will look into the best approach for computing channel n-values for the SWMM model (see UDFCD Action Items).

c. Rueter-Hess Reservoir. Derek described the approach that was used to route flows through Rueter-Hess (RH) Reservoir.
   - Storage/discharge data for the reservoir was based on tables shown on construction drawings provided by Parker Water and Sanitation District (PWSD).
   - The reservoir was assumed to be full at its normal pool elevation of 6215.1 at the start of the storm event.
   - Flows were routed through the service spillway which consists of a rectangular opening in the outlet works tower.
   - Subwatersheds adjacent and upstream of the reservoir were not routed but instead directly added to the reservoir inflow hydrograph.
   - Several options for routing through the reservoir were modeled.
     1. Historic conditions prior to the reservoir being built (entire watershed including reservoir at 2% imperviousness).
     2. With the RH reservoir storage in-place and flow routed through the service spillway.
     3. Without the RH reservoir storage attenuation benefits (but reservoir footprint at 100% imperviousness).

d. Regional Detention Ponds. Derek stated that Muller was not aware of any eligible publically maintained detention ponds in the watershed.

- Tom and Bill mentioned that there is a regional pond on the Jordan Road Tributary upstream of Mainstreet. Jacob will send Muller information on this pond (see Parker Action Items).
- Brad said that there may be a regional pond on the Spring Tributary upstream of I-25 and will look into this further (see Douglas County Action Items).
- Tom mentioned that the Canyons development is proposing some regional detention ponds. However, since these are future ponds, they cannot be considered in the Baseline hydrology but would be applicable for the Master Plan conditions hydrology.

e. Draft Hydrology Results. Muller prepared a table that summarizes the draft peak discharges for the 100-year event and compares them to discharges reported in the 1977 FHAD and the 1993 OSP studies. The draft results indicate the following.

1. The 100-year peak discharges for the "Historic Conditions" model are very similar to the discharges reported in the 1993 OSP for existing conditions. Shea said that since these values are within 10-percent of each other, no further calibration adjustments are necessary.
2. The option of accounting for RH reservoir storage and routing through the service spillway results in peak discharges that are lower than both the1977 FHAD and 1993 OSP discharges.
3. The option of modeling without RH reservoir storage attenuation (but reservoir footprint at 100% imperviousness) results in peak discharges that are substantially larger (more than double) the 1977 FHAD and 1993 OSP discharges.
4. The reservoir surcharge (rise in water level) is approximately 0.8-feet in the 100-year event when routed through the service spillway.
5. The 100-year storm event never spills over the reservoir's auxiliary spillway (emergency overflow spillway) because the auxiliary crest is 1.6-feet higher than the service spillway.

f. If the storage attenuation benefits of Rueter-Hess Reservoir are ignored, the peak 100-discharges are much higher than the 1977 FHAD discharges and would result in floodplain impacts to properties downstream of reservoir. Derek presented a floodplain exhibit of Newlin Gulch that was prepared for a separate project located downstream of the reservoir. The exhibit included the delineation of the 500-year event (based on the FHAD discharge of approximately 8000 cfs) and showed that the resulting 500-year floodplain encroaches on several properties. Since the current study 100-year flows without RH reservoir are even higher than 8000 cfs, it was concluded that there would be floodplain impacts to properties downstream if the RH storage benefits were ignored.

6. NEXT STEPS FOR BASELINE HYDROLOGY EVALUATION

a. The group discussed Rueter-Hess Reservoir routing options. To account for RH reservoir storage attenuation benefits, an "adequate assurances" agreement with the reservoir owner, PWSD, would be needed.

- Derek suggested that perhaps routing through the auxiliary spillway should be considered to allow more flexibility in possible future changes to the reservoir. The auxiliary spillway would be more difficult to change and any changes would likely have minimal impacts to the attenuation benefits. The group agreed with evaluating this option.
- Bill also requested that Muller look at the option of taking out RH reservoir completely and modeling the reservoir subwatershed based on historic conditions and 2% imperviousness.
- There was some discussion regarding the reservoir's emergency release rate of 590 cfs. This is the maximum discharge rate that the reservoir can release through the outlet works if there is a need to lower the water level for dam safety issues.

Newlin Gulch MDP – Progress Meeting #2– Meeting Minutes
March 18, 2013

b. Muller will model the two additional routing options for the reservoir discussed above. Once this is complete, Tom and Brad will setup a meeting with PWSD to discuss the draft hydrology results and the associated impacts of Rueter-Hess Reservoir.

c. Shea said that regarding rainfall duration, only the 2-hr storm needs to be evaluated for the watershed given UDFCD's new guidelines. The previous UDFCD guidelines require that the 3-hour storm be used for areas greater than 10 sq. miles. However, the new guidelines that are coming out soon recommend that the 2-hour storm be used for watershed areas up to 15 square miles and that the 3-hour storm be used for areas greater than 15 square miles.

7. PROJECT WEBSITE

Derek mentioned that the project website is complete and was sent to UDFCD. However, it appears that it has not been linked up to the "Master Plan" portion of the website. Shea will look into this (see UDFCD action items).

8. PROJECT SCHEDULE

Derek will review and update the project schedule.

9. OTHER ITEMS

a. The project sponsors were interested in the flow rates for the Sandpit Tributary and requested that Muller email these results to the group (see Muller Action Items).

b. Tom mentioned that a low water trail crossing of Newlin Gulch is being considered near the Parker Homestead development. Tom requested that Muller send draft peak flows at this locations for the smaller storm events such as the 2-yr, 5-yr, and 10-yr (see Muller Action Items).

c. Shea and Brad said that they would like Muller to complete the dam breach and hazard evaluation for the Baldwin Gulch dam. Shea will send Muller a scope for this work.

END OF MINUTES

MEETING
MEMORANDUM

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Project
Newlin Gulch MDP

Sponsors
UDFCD / Douglas County / Town of Parker

Meeting Location
UDFCD

Attendees
Shea Thomas, UDFCD
Bill DeGroot, UDFCD
Fred Koch, Douglas County
Brad Robenstein, Douglas County
Tom Williams, Town of Parker
Jacob James, Town of Parker
Derek Johns, Muller Engineering Company
Jim Wulliman, Muller Engineering Company

Purpose
Newlin Gulch MDP – Progress Meeting #3

Meeting Date
May 15, 2013

Issue Date
June 21, 2013

MEC Project No.
12-050.01

Minutes Prepared By
Derek Johns

Routing
ASP / DDJ / JTW

Muller Action Items:

1. Muller will prepare a memorandum that summarizes the hydrologic evaluation of Rueter-Hess Reservoir and the flood control benefits associated with reservoir.
2. Muller will start preparing portions of the Draft Hydrology Report but will hold-off on finishing/publishing the report until PWSD Board approves the concept of officially recognizing the flood control benefits of Rueter-Hess Reservoir.
3. Muller will prepare a fee for a new FHAD study on Newlin Gulch.

UDFCD Action Items:

1. Shea will send an example "adequate assurances" agreement to Douglas County and Parker.

Douglas County and Town of Parker Action Items:

1. Douglas County and Parker will take the lead on coordinating with PWSD and working out the details for an adequate assurances agreement to officially recognize the flood control benefits of Rueter-Hess Reservoir.
2. Douglas County and Parker will pull out information from the Rueter-Hess memorandum and provide this to PWSD staff for their presentation to their Board.

Discussion

THE FOLLOWING IS OUR UNDERSTANDING OF THE SUBJECT MATTER COVERED IN THIS CONFERENCE. IF THIS DIFFERS WITH YOUR UNDERSTANDING, PLEASE NOTIFY US IMMEDIATELY.

1. MEETING WITH PWSD

Tom (Parker) and Fred (Douglas County) summarized the outcome of the meeting that the Town of Parker and Douglas County had with Parker Water and Sanitation District (PWSD). They met with Ron Redd/PWSD and it went well. PWSD is open to considering an agreement that would allow the flood control benefits of Rueter-Hess Reservoir to be officially recognized. PWSD sees this as an opportunity to show some of the other benefits of the reservoir. Specifics of the routing assumptions were not discussed, but Tom said that we should proceed with the option of routing through the auxiliary spillway. Tom said that in past conversations, Jim Nichol/PWSD has mentioned that PWSD would like to have the flexibility to possibly store more water in the future within the 1.6-foot zone between the service spillway and the auxiliary spillway.

2. RUETER-HESS RESERVOIR INFORMATION

Derek said that the hydrologic modeling of Rueter-Hess Reservoir was based on storage and discharge rating curves provided on as-built drawing. Muller does not have as-built drawings of the spillway dimensions. The group decided that the as-built drawing of the rating curves is sufficient documentation. Fred said that this as-built drawing should be included as part of the "adequate assurances" agreement with PWSD (the document that would be used to officially recognize the flood control benefits of Rueter-Hess Reservoir).

3. ADEQUATE ASSURANCES AGREEMENT

Bill and Shea said that UDFCD has an example "adequate assurances" agreement to start from and will send it to Fred. The agreement with PWSD will include Parker, Douglas County, and UDFCD. Parker and Douglas County will take the lead on this effort.

4. INFORMATION FOR PWSD BOARD MEETING

Tom said that the PWSD Board meets every two weeks. The group asked Muller to prepare a technical memorandum that summarizes the hydrologic evaluation and explains the flood control benefits of Rueter-Hess Reservoir. Parker and Douglas County will pull information from the memorandum and provide this to PWSD staff for their presentation to the Board. Fred said that Wendy Holmes (Douglas County) can help write/format this information which PWSD staff can use for their presentation to the Board and also as a press release.

The technical memorandum should include a summary of the hydrologic evaluation of Rueter-Hess Reservoir and document the flood control benefits. Specific items that were suggested to include in the memo are as follows:

a. Tom and Jacob suggested to state that storm flows would have increased with new development and list the percent increases.
b. Derek suggested showing an exhibit of the current floodplain in Stonegate Village and how it is currently close to residential properties. This exhibit would help to show that any significant increases in storm flows could result in properties being in the floodplain.
c. Tom said to mention flooding issues at Recreation Drive and how being able to recognize flood control benefits of Rueter-Hess Reservoir will allow improvements at this location to be accomplished more cost effectively.
d. Tom said to mention that the lower flows will also allow new bridges (i.e., Jordan Road) to be constructed more cost effectively.

The group requested that the memorandum be prepared as soon as possible (next week). Shea said that UDFCD will cover the cost for preparing the memo and Fred said that Douglas County could pay for any "extra" figures and graphics needed for marketing and/or press releases.

5. FHAD

Tom said that Parker would like to pursue doing a new Flood Hazard Area Delineation (FHAD) study that recognizes the lower peak flows from Rueter-Hess Reservoir. Tom thought that a new FHAD would be beneficial for the following reasons.

a. Recreation Drive flooding issue. A new bridge or culvert crossing is needed at this location that could at least convey small storms (i.e., 5-year event). A few years ago, Parker looked at putting in a new bridge at this location but there were floodplain issues along the adjacent commercial property. Recognizing lower flows from Rueter-Hess would allow for a more cost effective solution at this location.
b. Jordan Road Bridge. Tom said that Parker has a project underway to widen Jordan Road and add a turn lane where it crosses Newlin Gulch. To do this, the existing bridge will need to be widened but the hydraulic evaluations are indicating that there would be a rise in the floodplain which would cause problems at this location. To resolve the floodplain issue, they would have to tear out the existing bridges and build a new bridge with a longer span. Tom said that if flows are truly lower as a result of Rueter-Hess Reservoir, then it makes sense to officially recognize this. The lower flows would allow for a more cost effective solution at this location.
c. Tom added that any other new bridges or channel structures will be more cost effective by recognizing the lower flows in a new FHAD.
d. Fred mentioned some concern with developing a new FHAD using the lower flows because he does not want to constrict the existing floodplain. Tom does want to constrict the floodplain either. Tom said that the entire Newlin Gulch floodplain corridor downstream of Rueter-Hess has been dedicated as open space to Stonegate Village and the Town of Parker, so no new development can occur that would constrict the floodplain.
e. As an idea to provide more floodplain buffer, Jim mentioned the idea of adding the 590 cfs emergency flow release from Rueter-Hess Reservoir to peak storm flows. Tom thought this would be a little too conservative and not necessary.

Newlin Gulch MDP – Progress Meeting #3– Meeting Minutes
May 15, 2013

f. The group decided to proceed with a new FHAD study. Bill and Shea did not originally plan on a new FHAD but said that they can find the funding for this. Shea asked Muller to provide a fee for a new FHAD.

6. DRAFT HYDROLOGY REPORT

Tom felt that we should hold-off on publishing the Draft Hydrology Report until the PWSD Board approves the concept of officially recognizing the flood control benefits of Rueter-Hess Reservoir. Shea said that Muller could start working on portions of the report but agreed with Tom that we should hold-off on finishing it until we get PWSD's response. Shea said to not include all the sections in the draft report that are specified in the checklist. Some sections are not necessary at this phase of the project. Shea said to refer to the Coal Creek/Rock Creek draft hydrology report as a good example of sections that should be included.

END OF MINUTES

MEETING MEMORANDUM

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Project
Newlin Gulch MDP

Sponsors
UDFCD / Douglas County / Town of Parker

Meeting Location
UDFCD

Attendees
Shea Thomas, UDFCD
Brad Robenstein, Douglas County
Jacob James, Town of Parker
Derek Johns, Muller Engineering Company
Andy Pultorak, Muller Engineering Company

Meeting Date
December 17, 2014

Issue Date
January 5, 2015

MEC Project No.
12-050.01

Minutes Prepared By
Andy Pultorak

Routing
ASP / DDJ

Purpose
Newlin Gulch MDP – Progress Meeting #4

Muller Action Items:
1. Muller will run subwatershed hydrology using the latest version of CUHP (v. 1.4.4) to determine if peak flowrates or volumes are impacted.
2. Muller will finish the draft baseline hydrology and submit to UDFCD for review.
3. Muller will update the project website with the revised schedule.
4. Muller will email the project stakeholders (Stonegate Village, Cherry Creek Water Quality Basin Authority) regarding the FHAD study.

UDFCD Action Items:
1. Shea will send the executed adequate assurances agreement to Muller for inclusion in the appendices of the baseline hydrology report.

DISCUSSION:

THE FOLLOWING IS OUR UNDERSTANDING OF THE SUBJECT MATTER COVERED IN THIS MEETING. IF THIS DIFFERS WITH YOUR UNDERSTANDING, PLEASE NOTIFY US IMMEDIATELY.

1. INTRODUCTION

Derek (Muller) summarized the status of the project. The project was on-hold for approximately 1 ½ years waiting for the adequate assurances agreement between Parker Water and Sanitation District (PWSD) and the project Stakeholders to be finalized. Prior to stopping work, Muller had prepared hydrologic models and a memorandum summarizing the flood control benefits of Rueter-Hess Reservoir. The project Sponsors used this information over a year-long process to prepare the adequate assurances agreement with PWDS. The

agreement was signed in October, 2014. This was a major milestone, clearing the way for the masterplan to account for the flood control benefits of the reservoir.

2. DRAFT HYDROLOGY REPORT

Prior to stopping work, Muller had written much of the draft baseline hydrology report. The report and appendices need to be finalized and assembled before they can be submitted for review by the project team. The project team discussed several elements of the report as follows:

a. Adequate Assurances Agreement: The adequate assurances agreement formalizes the flood control benefits of Reuter-Hess Reservoir and the reduced peak flowrates downstream. The agreement is based on flowrates provided by Muller using the hydrologic models prepared for the eventual baseline hydrology submittal. Shea would like to include a copy of the adequate assurances agreement as an appendix in the report (see Action Items). The technical memorandum, prepared by Muller and used in the development of the agreement, should also be included as an appendix in the report. The team requested that none of the hydrologic model results which ignore the flood control benefits of Reuter-Hess be included in the text of the main report (to avoid confusion).
b. Land Use: Derek noted that the hydrologic models were prepared using the best available land use information during the development of the models. This included some conceptual and preliminary drainage reports for future developments, including the Canyons development in Castle Pines. Derek noted that these development plans may or may not have changed since the hydrologic models were prepared. This could potentially impact the imperviousness and infiltration assumptions used in the hydrologic models. Brad Robenstein (Douglas County) said that he was unaware of any major changes with the Canyons development. Shea agreed that the preliminary information used during the initial model development was adequate and did not need to be revisited. Jacob James (Town of Parker) noted that there were no changes to future land use assumptions within the Town boundaries.
c. Interactive PDF: Andy Pultorak (Muller) asked Shea if including static PDFs for land-use, routing, and subwatershed figures in the draft submittal was acceptable to UDFCD, since this would eliminate some repeated work if the figures changed between draft and final submittals. Shea agreed that static PDFs were acceptable for the draft submittal, as long as the interactive PDF was included in the final.

3. FLOOD HAZARD AREA DELINEATION

The scope of the masterplan work includes a Flood Hazard Area Delineation (FHAD) study of the portion of the Newlin Gulch mainstem downstream of the reservoir (upstream limits near Hess Road).

a. Derek noted that the scope of work did not include a schedule for the FHAD study. He anticipated starting work on the FHAD study after submitting the baseline hydrology report. The preliminary FHAD submittal is anticipated 10 weeks after the submittal of the draft baseline hydrology report. Shea was OK with this timeframe. Shea noted that Muller should plan to meet with Terri Fead (UDFCD) before she reviews the first preliminary submittal.
b. Derek mentioned that there are several challenges with the hydraulic modeling, particularly in the Stonegate reach, that might warrant a meeting earlier in the process. This includes channel work that post-dates the available LiDAR mapping. Shea agreed that this meeting could occur when Muller submits the draft cross-section locations map to UDFCD for review.
c. Shea said that the floodplain group is typically notifying all impacted property owners that a FHAD is in progress. Terri and David Mallory (UDFCD) will handle this notification process.

d. A public meeting (included in the current scope) may not be warranted for this project. The project team may decide to distribute a flyer or have individual meetings with impacted property owners instead. Muller was asked not to include a public meeting in the schedule.
e. Derek said that Muller had recently completed several channel improvement projects in Stonegate Village for which LOMRs had not been issued. He noted that Barbara Chongtoua (UDFCD), wanted incorporate these map revisions as part of the PMR issued following the current FHAD study, rather than issue individual LOMRs for these projects. Shea generally agreed with this approach and thought that LOMRs would not be necessary, but wanted to discuss it further with Terri Fead and David Mallory.

4. ALTERNATIVES ANALYSIS

The project team discussed the following items in regards to the Alternatives Analysis:

a. Jacob noted that Recreation Drive has been closed several times in the past two years due to flooding.
b. Derek noted that Tom Williams (Town of Parker) had mentioned a possible flood capacity issue at the Jordan Road over Newlin Gulch bridge. This may be improved by the reduction in flowrates resulting from the Rueter-Hess flood attenuation. Brad and Jacob were unaware of any specific concern at Jordan Road.
c. Jacob pointed out proposed trail crossing locations north and south of Chambers Road. The crossing south of Chambers (in Parker Homestead) was currently undergoing final design by Muller Engineering. The crossing north of Chambers (part of the Douglas County East-West Trail) was undergoing final design by Hartwig and Associates. Jacob noted that he would like to get a general sense for masterplanned drop structure locations in this area as soon as possible to help him locate the crossings and set inverts. Jacob would like to include the proposed crossings in the FHAD study.
d. Jacob noted that the Town has recently seen increased aggradation upstream of Chambers Road. Downstream of Jordan, a 3-foot headcut has formed at an existing check structure. Derek said that one focus of the study will be to estimate how the addition of the reservoir will impact long term sediment transport within the watershed.
e. Shea told Muller not to include a benefit cost analysis in the Alternatives Analysis report. She noted that a benefit cost analysis does not produce a reasonable result if there are no structures (or few structures) in the floodplain.

5. SCHEDULE

Derek presented an updated schedule for review by the project team. Shea agreed with the milestones as shown. Muller will submit the draft baseline hydrology report and start work on the FHAD study. Muller will schedule the next progress meeting for early February. The meeting will include discussion of the draft baseline hydrology report, early results of the alternatives analysis, and early results from the FHAD study. Muller will invite Stakeholders, including Stonegate Village and Cherry Creek Basin Water Quality Authority (CCBWQA). Jacob will contact PWSD by email regarding any future water and sewer crossings of Newlin Gulch. Muller will update the major milestones dates on the project website.

END OF MINUTES

DRAFT BASELINE HYDROLOGY COMMENTS

Draft baseline hydrology was submitted to the project sponsors on January 20, 2015 for review. Comments were received on February 9, 2015 in the form of an annotated PDF copy of the report. Select comments have been reproduced below; responses are italicized. Minor comments/corrections were addressed in the revision but are not listed here.

UDFCD COMMENTS:

Figure B-1 [Several inconsistencies were noted between future impervious values shown on the subwatershed map and values listed in Table B-2, CUHP Input]
All inconsistencies have been corrected; this may have resulted in minor changes to future composite impervious values for some subwatersheds.

TOWN OF PARKER COMMENTS

Figure B-1 [Re: Future Land Use, Newlin Crossing development area north of Mainstreet, shown as mixture of 10%, 45%, 70% impervious]

- Change everything east of Newlin Gulch to 45%
- Change everything west of Newlin Gulch to Chambers to 70%

[Re: Future Land Use, parcel at SW corner of Mainstreet and Jordan, shown as 10% impervious]

- This is slated for commercial development, use 70%

[Re: Future Land Use, area of Parker at southeast edge of Rueter-Hess, at upstream end of Benchmark Tributary, shown as 2% impervious]

- This will likely be 40% impervious

Impervious values have been updated as requested based on recent development plans. Future development CUHP/SWMM models have been re-run; peak flows and all associated tables and figures updated.

[Re: Future Land Use, Meridian development west of Chambers Rd, north and south of Mainstreet]

- Confirm with Brad that land use is slated to be this high 75%

See Douglas County comments below.

DOUGLAS COUNTY COMMENTS

Figure B-1 [Re: Future Land Use, Meridian development west of Chambers Rd, north and south of Mainstreet]
This area does seem too high. I looked at the PDs for Meridian International Business Center and Sierra Ridge. The area currently shown as 75% is more likely to be around 60%.
Future impervious for Meridian has been updated to 60% as requested. The small corner of the watershed that lies within the City of Lone Tree was changed to 70% to match future land use values used for the adjacent areas in the 2012 Happy Canyon Creek MDP.

MEETING MEMORANDUM

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Project
Newlin Gulch MDP and FHAD

Sponsors
UDFCD / Douglas County / Town of Parker

Meeting Location
Town of Parker

Attendees
Shea Thomas, UDFCD
Brad Robenstein, Douglas County
Jacob James, Town of Parker
Jim Swanson, CCBWQA
Scott Barnett, Mulhern MRE (representing SVMD)
Derek Johns, Muller Engineering Company
Melanie Chenard, Muller Engineering Company
Sam Rogers, Muller Engineering Company

Purpose
Newlin Gulch MDP and FHAD – Progress Meeting #5

Meeting Date
March 2, 2015

Issue Date
March 13, 2015

Muller Project No.
12-050.01

Minutes Prepared By
Sam Rogers/Melanie Chenard

The following is our understanding of the subject matter covered in this meeting. If this differs with you understanding, please notify us as soon as possible.

ACTION ITEM SUMMARY:

Muller Action Items:
1. Provide 30% rule graphic to UDFCD. *Complete.*
2. Add Terri Fead to the email distribution list. *Complete.*

UDFCD Action Items:
1. Schedule meeting with Muller and Terri Fead to discuss the FHAD. *Complete.*
2. Inquire about separation distance required to avoid pedestrian railing requirement.

Town of Parker Action Items:
1. Look for additional information on the pedestrian bridge near Cherry Creek. *Complete.*
2. Schedule potholing of gas line downstream of Recreation Drive. *Complete.*

Douglas County Action Items:
1. Obtain feedback from Douglas County roadway staff on necessity of guardrails or pedestrian railings at Recreation Drive low-flow crossing.
2. Obtain feedback from Douglas County park staff on desired design criteria for parking lot.

Stonegate Village Metro District Action Items:
1. Provide Muller with any available information on utility lines near Recreation Drive.

DISCUSSION:

1. GENERAL

Melanie Chenard gave an update on the Baseline Hydrology Report progress. Comments from the project sponsors have been addressed and a final submittal of the report should be ready in the next couple of days.

Project stakeholders representing the Cherry Creek Basin Water Quality Authority (CCBWQA) and Stonegate Village Metro District (SVMD) were introduced to the team, and Derek Johns provided some background on the overall Master Plan project and introduced the next two components, the FHAD study and Alternatives Analysis study.

2. FHAD

Preliminary analysis for the Flood Hazard Area Delineation (FHAD) study has begun. The study area limits for the FHAD begin downstream at the confluence with Cherry Creek at Challenger Park, and end upstream of Hess Road, just below Rueter-Hess Reservoir. Particular issues and discussion items are outlined as follows:

a. 30%, 0.5' Rule: The FHAD will be based on the future development hydrology. Muller compared the peak flow rates and BFEs based on future development to those based on existing development to verify that the FHAD will be eligible for adoption by FEMA as the regulatory floodplain. The results of this evaluation were plotted and presented to the team. Peak flow rates based on future development are less than 30% greater than peak flow rates based on existing development for the entire reach. BFEs based on future development are ***more*** than 0.5' higher than BFEs based on existing development for approximately the lower third of the reach. However, with the overall reduction in peak flow rates due to the baseline hydrology updates, no new structure impacts are anticipated. Shea will review this with UDFCD's floodplain group, but expects this will satisfy FEMA's requirements.

b. Bridge Modeling: Melanie reviewed the planned approach for HEC-RAS modeling of bridges, as follows:
- Lincoln Ave, Jordan Rd, Mainstreet, and Hess Rd: bridge routines from recent LOMRs will be imported into HEC-RAS model
- Stonegate Pkwy: bridge routine from design floodplain model prepared by Muller will be imported into HEC-RAS model
- Chambers Rd: LOMR for this work did not have a bridge routine; bridge data will be entered based on as-built drawings of the bridge previously provided to Muller by Jacob James
- Muller does not have any information on the pedestrian bridge near the confluence of Newlin Gulch with Cherry Creek. Though it was supposedly constructed as a breakaway bridge, it should be modeled with the full height of the railings blocked. Jacob will look for any additional information on this bridge as there is no remaining project budget to get it surveyed.

c. Upstream Limit of Model: Currently, Muller has the upstream limit of the FHAD model set near the crest section of the large grouted boulder drop structure just upstream of Hess Road. Muller inquired if this is sufficient or if it should be extended up to the primary reservoir spillway outlet works or, alternately, up the auxiliary spillway. Shea said that this limit should be fine but that Muller should review this with Terri Fead (UDFCD). Muller will also look at how the floodplain was modeled in the CLOMR for Rueter-Hess.

d. Manning's n-Values: Sam Rogers showed photos representing various roughness values along Newlin Gulch. In general, Muller is proposing to err on the higher, more conservative range of appropriate n-values. Shea noted that values should not be increased based on expectations of future vegetation growth due to anticipated changes in channel conditions or base flows, but should be reflective of expected vegetation regrowth following construction or other disturbance. Proposed channel n-values range from 0.04 to 0.12; overbank n-values are generally 0.04 with select areas up to 0.08. Muller noted that a small reach near the confluence with the Jordan Road Tributary has little vegetation (n=0.04) though the areas immediately upstream and downstream have good willow and wetland growth (n=0.08), and inquired about matching the n-value for the adjacent area. Shea would like to keep the higher n-value here but is not sure if that will be acceptable; Muller will discuss this area with Terri Fead. Jacob noted that the current vegetative growth is artificially low between Lincoln Ave. and Recreation Drive due to clearing that was done following a recent oil spill. He requested that the channel n-value be increased from 0.04 to 0.05 in this reach. The team agreed with the rest of the n-values presented.

e. Meeting with UDFCD Floodplain Group: Shea will set up a meeting in the next couple of weeks with Muller and Terri Fead to discuss the FHAD in more detail. Shea noted that Terri should be included in future progress meetings.

3. ALTERNATIVES ANALYSIS

Muller has begun work on an Alternatives Analysis study for Newlin Gulch within the same limits as the FHAD. Items discussed in the meeting are outlined below:

a. Reach Breakdown: Design reaches for the project were identified and approved by the team as follows (local jurisdiction noted in parenthesis):
- Reach 1: Cherry Creek to downstream side of Recreation Drive (Town of Parker)
- Reach 2: Recreation Drive to Lincoln Avenue (inclusive of both crossings) (Douglas County)
- Reach 3: Upstream of Lincoln Avenue to southern boundary of Stonegate (Douglas County)
- Reach 4: Southern boundary of Stonegate to downstream side of Mainstreet (Douglas County
- Reach 5: Mainstreet to Chambers Road (inclusive of both crossings) (Town of Parker)
- Reach 6: Upstream of Chambers Road to upstream study limit (Town of Parker)

b. Problem Areas: A draft figure illustrating existing channel condition and problem areas was handed out, and photos of existing conditions were reviewed. Highlights include the following, by reach:
- Reach 1: Generally stable channel, some scour at upstream approaches to of existing vertical drop structures.
- Reach 2: Recreation Drive crossing is a ford crossing that requires road closure several times per year. Aggradation in the channel seems to have worsened the condition. The upstream channel is very shallow and flooding of the adjacent parking lot is common.
- Reach 3: There is severe scour at the lower of two check structures between Lincoln Ave. and Jordan Road. Two storm sewer outfalls empty onto the trail near Jordan Road – per Scott, these frequently cause icing problems on the trail. Aggradation beneath the Jordan Road bridge is evident – per Scott, constant trail maintenance is required here. Some channel scour is evident near the Jordan Road Tributary confluence. Between Jordan Road and Stonegate parkway, the channel is stable; three projects have been completed by Muller

Newlin Gulch MDP – Progress Meeting #5– Meeting Minutes
March 2, 2015

in recent years, and a preliminary design has been prepared for future stabilization. Upstream of Stonegate Parkway, some headcutting is evident.
- Reach 4: This reach is currently pretty stable, though there are indications that additional grade control might be needed as upstream development continues.
- Reach 5: Upstream of Mainstreet, the private landowner has livestock corrals adjacent to and in the channel, and appears to be spreading manure and wood chips in the overbank. Besides preventing any vegetative growth, this practice has water quality impacts that should be considered. There is scour at a fairly new check structure downstream of Chambers, near the future crossing of the East-West Regional Trail.
- Reach 6: There is active degradation in this reach downstream of the proposed trail crossing at Parker Homestead, and also just downstream of Hess Road.

c. Channel Slope: Derek summarized the design slopes used for previous projects along the reach, which ranged from 0.13% to 0.40%, and the channel condition for each project area. With this information, he has developed recommended stable channel slopes for the reach, varying from 0.15% to 0.30%. Shea commented that UDFCD generally uses 0.2% for sandy channels and 0.4% for non-sandy channels, but given the observations was ok with the proposed flatter slopes. The rest of the group concurred.

d. Grade Control Options: Derek inquired about comparing lower-height drop structures (1.5-2') to larger (4') drops in the alternative analysis. Per Shea, with the forthcoming revisions to the open channel chapter of the USDCM, she would like to limit drops to a maximum of 3' height in planning documents. She said there is no need to look at different options for grade control, and that aside from Recreation Drive (discussed below), there may not be much in the way of alternatives for this project.

e. Recreation Drive: This will be the primary focus of the alternative analysis. Existing conditions and considerations include the following:
- Per Jacob, the Town of Parker currently closes the road whenever flows exceed 50 cfs.
- The large grouted boulder drop structure downstream has limited bank height at the crest and it appears that high flows spill around the south end of the drop.
- Lowering the drop crest would help provide grade separation at the crossing as well as address the capacity concerns at the drop; however, there is a buried high-pressure gas line just upstream of the drop that may not be deep enough to accommodate a lowered drop.
- The parking lot adjacent to Newlin Gulch upstream of Recreation Drive is less than 1' above the channel invert. Flooding in the lot is common.
- Aggradation in the channel appears to have worsened the general condition at the crossing.
- Any proposed improvements would have to avoid floodplain impacts to the adjacent commercial development.

Upon discussion with the team, it was decided that Muller will look at a low-flow option that maintains the existing downstream drop structure invert and a low-flow option with a lowered channel invert. No 100-year option will be considered. Additional discussion of the crossing included the following points:
- Jacob will have the gas line potholed. Muller will inquire about encasement and relocation costs.
- Brad would like to get 10-year capacity at the crossing if possible
- Any railings required may negatively impact the floodplain upstream of the crossing. Per Shea, UDFCD criteria requires pedestrian railing for any drop greater than 3'. Extending the culvert well beyond the edge of road may be a way to avoid either pedestrian railing or guardrail requirements. Shea will check what separation distance would be required

between the drop and any pedestrian walkways to avoid a need for railings. Brad will solicit feedback from the County roadway staff. Jacob would prefer that we account for guardrail in the hydraulic model (if possible); then they could decide during final design whether to include it.

- Brad will review desired design criteria for the parking lot with the County Parks staff. Several park structures appear to be within the 100-year floodplain; our plan should aim to get the restrooms out of the 100-year floodplain.
- Scott noted that there are multiple SVMD utility lines in the vicinity, including return flow from the WWTP, a sanitary force main, and water lines. These may be a hindrance to design of a low-flow crossing. He will send Muller whatever information he can find.

f. Other Topics: Scott mentioned that SVMD has their effluent discharge line in Cherry Creek under Lincoln Avenue, and that they would like to move it to Newlin Gulch if possible. Effluent flow rates are 2-3 MGD.

4. PROJECT SCHEDULE

Muller is still working according to the schedule presented in December, with target milestone dates of March 31st for the FHAD preliminary submittal and April 14th for the draft Alternative Analysis.

5. PUBLIC MEETING

No public meeting is planned for this project. Instead, UDFCD will prepare and send a mailing after submittal of the draft alternatives. The mailing will be a simple postcard format and will direct people to the project website.

6. NEXT MEETING

Further coordination on the alternatives will be handled via email. The next project meeting will be held following submittal and sponsor review of the draft Alternative Analysis.

END OF MINUTES

MEETING MEMORANDUM

MULLER ENGINEERING COMPANY, INC.

CONSULTING ENGINEERS
777 SOUTH WADSWORTH BLVD., SUITE 4-100
LAKEWOOD, COLORADO 80226
(303) 988-4939

Project
Newlin Gulch MDP and FHAD

Sponsors
UDFCD / Douglas County / Town of Parker

Meeting Location
Town of Parker

Attendees
Shea Thomas, UDFCD
Brad Robenstein, Douglas County
Jacob James, Town of Parker
Jim Swanson, CCBWQA
Derek Johns, Muller Engineering Company
Melanie Chenard, Muller Engineering Company
Sam Rogers, Muller Engineering Company

Purpose
Newlin Gulch MDP and FHAD – Progress Meeting #6

Meeting Date
June 1, 2015

Issue Date
June 4, 2015

Muller Project No.
12-050.01

Minutes Prepared By
Sam Rogers/Melanie Chenard

The following is our understanding of the subject matter covered in this meeting. If this differs with your understanding, please notify us as soon as possible.

ACTION ITEM SUMMARY:

Muller Action Items:
1. Inquire with Scott Barnett about encasement requirements for sanitary lines under Recreation Drive.
2. Send Jacob a rating curve of flow vs. depth at Recreation Drive.

UDFCD Action Items:
1. Inquire about unit cost for weed control.
2. Inquire about unit costs for land acquisition from past master plans.
3. Forward public comment responses to Muller.

Town of Parker/Douglas County Action Items:
1. Send Muller as-built bridge drawings for Jordan Road and Mainstreet over Newlin Gulch.

Newlin Gulch MDP – Progress Meeting #6– Meeting Minutes
June 1, 2015

DISCUSSION:

1. GENERAL

Melanie Chenard gave an update on the FHAD Report and Alternatives Analysis Report progress. Muller has received comments on the Preliminary FHAD Submittal from Terri Fead at UDFCD and comments on the Draft Alternatives Report from the project sponsors. Muller will address these comments as well as any additional discussions that come up in this meeting and submit both the Draft FHAD Report and the Final Alternatives Analysis Report the week of June 8th, 2015.

2. FHAD

a. Preliminary analysis for the Flood Hazard Area Delineation (FHAD) study was completed and submitted to UDFCD for review in early April. Terri Fead replied with comments on the hydraulic model, floodplain workmaps, water surface profiles, floodplain data, and agreements tables on May 12th. Muller will address these comments and include the revised documents in a draft submittal of the FHAD Report on June 9th, 2015.

b. Bridge data for the Jordan Road, Lincoln Avenue, and Mainstreet crossings over Newlin Gulch was obtained from recent LOMR models. It was noted that the deck thicknesses for these bridges were inaccurate in the LOMR models, ranging from only 1' to 2' thick. While the inaccuracies do not seem to impact the hydraulics due to the large size of the bridges, Muller would like to reflect them accurately in the HEC-RAS model and on the FHAD profile drawing. As-built drawings for the Lincoln Avenue bridge are available on the UDFCD server; additional information is needed for Jordan Road and Mainstreet. Jacob and Brad will provide Muller with as-built drawings

c. Melanie reviewed the draft floodway delineations with the project team. At Challenger Park, a right bank floodway is defined from Lincoln to downstream of Recreation Drive. At the upstream end of the study area, floodways are defined upstream of Hess Road and in areas downstream of Hess Road where there are large backwater areas. The team agreed that the floodways look appropriate.

3. ALTERNATIVES ANALYSIS

Muller has submitted a Draft Alternatives Analysis Report and received comments back from the project sponsors. Items discussed in the meeting are outlined below:

a. Recreation Drive: Melanie gave an overview of the three alternatives proposed for the crossing at Recreation Drive. All three alternatives include adding a four-celled box culvert with 10-year capacity near the low point of Recreation Drive, with higher storm events overtopping the crossing. Alternative A matches the existing channel invert and minimizes road reconstruction, such that high flows will continue to spill onto Recreation Drive East and around the right bank of the grouted boulder drop structure. Alternative B also matches the existing channel invert but includes additional road reconstruction to raise the high point in Recreation Drive, eliminating the spill to Recreation Drive East. The right side of the grouted boulder drop would be raised to contain 100-year flows within the drop. Alternative C lowers the invert of the culverts at Recreation Drive, which requires lowering the crest of the grouted boulder drop as well as the 20" high pressure gas line.

- Jacob recommended in a review comment that a sheet pile cutoff wall and some riprap bank protection be added to Alternative A to protect the drop structure and utilities from erosion. Muller agrees with this comment and has updated the Alternative A figure and cost estimate accordingly.
- Alternative B features a small berm to the east of the parking lot bathrooms that would help contain 100-year flows from entering Recreation Drive East. Shea Thomas had provided a review comment about the creation of a levee condition. Melanie clarified that the intent of the berm is to improve the hydraulics, but that the mapped floodplain for this alternative would need to ignore the effects of the berm.
- Shea had a comment for Muller to investigate the hydraulic impacts of skewing the proposed culvert at Recreation Drive. Melanie mentioned that skewing the bridge had little to no effect on the hydraulics, but that it will be investigated in more detail during conceptual design. Jacob requested that, during conceptual design, Muller attempt to lay out the improvements such that the adjacent trail could be replaced in the same alignment (though the grades may change) in order to minimize the impact on the adjacent property.
- Shea had provided a review comment inquiring about the impacts of Alternatives A and B on the SVMD sanitary lines in Recreation Drive. Melanie mentioned that both lines are set fairly deep (about 6-8'), but will check with Scott Barnett of Mulhern MRE as to whether these lines would need to be encased.
- Numerous comments were provided on the Alternative Evaluation Summary Matrix. Muller handed out copies of the updated matrix and asked for any other feedback on the weightings or rankings of the various items as the three alternatives are very closely rated. Shea noted that Muller's recommended plan doesn't necessarily need to match the results of the matrix, and that the sponsors are free to deviate from the recommended plan in their selected plan. Jacob commented that, from the Town's persepective, Alternative B does not provide a much more substantial incentive over Alternative A based on the $400k cost difference, but that ultimately the Town would defer to the County's preference.
- The team had previously discussed whether guardrails or handrails would be required at the crossing. Brad had indicated that the County wouldn't require guardrails due to the low design speed. They would likely want to have pedestrian rails, though these could potentially be excluded if the culvert extends sufficiently beyond the edge of the roadway / sidewalk. Jacob had expressed a preference to include railings in the MDP modeling, and leave the decision for final design. Therefore, Muller has assumed 54" railing that would act as fully blocked over the culvert. If desired by the team, this assumption can be re-considered during conceptual design.
- Muller asked for more feedback about the flooding in the parking lot. Alternatives A and B provide 2-year protection, and Alternative C provides 10-year protection. Brad thought these levels of protection were adequate and that there is no need for Muller to look at raising the parking lot. In order to address the issue of minor flooding at the restrooms that is introduced with Alternatives A and B, the project team agreed that installing a small floodwall around the structure would suffice.

b. Channel Alternatives: Melanie presented Jacob's comments on the use of existing and proposed grade structures in Reach 5, Town of Parker's jurisdiction. In general, Jacob would like to retrofit existing check structures into drop structures and increase proposed drop heights from 2' up to 2.5' or 3' in order to decrease the amount of structures needed.

c. Maintenance:
- Jacob and Brad confirmed that concrete maintenance trails should be included for all areas currently without maintenance access.

- In the operation and maintenance section of the Master Planning cost spreadsheet, Shea recommended that "mowing" be changed to "weed control", with the cost and/or frequency reduced. Shea will inquire with Barbara Chongtoua on a more specific cost for weed control.

d. Land Acquisition: No land acquisition costs were included in the draft Alternative Analysis. Muller assumed that reaches yet to develop would have dedicated open space/drainageway tracts, as per the currently developed reaches. The only acquisition required by the plan is at Recreation Drive. This is within the Town of Parker; per Jacob, land acquisition costs at Recreation Drive should be included. Jacob will look into whether there are existing trail and/or drainageway easements; if so, perhaps only a temporary construction easement would be needed. Shea will investigate land acquisition costs from prior master plans and forward them on to Muller.

e. Public Comments/Responses: Shea will forward Muller her responses to public comments to include in Appendix A of the report.

4. BALDWIN GULCH

Derek explained that the original contract included some analysis of stabilization improvements needed on Baldwin Gulch. Though the scope for the Baldwin piece has evolved, Derek thought there is still a need to look at stabilization improvements between the dam and Pine Drive. The team agreed; Muller will prepare a memo with recommended improvements that UDFCD will attach to the original OSP document, which is still in effect for Baldwin Gulch.

5. PROJECT SCHEDULE

An updated project schedule was handed out. The timeline for the Conceptual Design Report has been shortened to make up for additional time spent on the Alternative Analysis. As was previously stated, target milestone dates are June 9th for the Draft FHAD Report submittal and June 10th for the Final Alternative Analysis Report.

6. OTHER ITEMS AND NEXT MEETING

a. Jacob requested that Muller provide a rating curve of the existing conditions flow vs. depth at Recreation Drive. The Town plans to relocate a flow gage from Jordan Road to the downstream side of Recreation Drive to improve the warning system at the crossing.
b. The next project meeting will be held following submittal and sponsor review of the draft Conceptual Design Report.

END OF MINUTES

Public Notification Postcard
Mailed in early May, 2015

Newlin Gulch Major Drainageway Plan

The Urban Drainage and Flood Control District, in cooperation with the Town of Parker and Douglas County, is in the process of preparing a stormwater master plan for the Newlin Gulch corridor downstream of the Reuter-Hess Reservoir. You are receiving this notification because your property is near Newlin Gulch.

The purpose of the study is to define flood-prone areas, develop alternatives to mitigate flood hazards, update the FEMA floodplain and prepare a conceptual design and cost estimate of selected improvements.

The draft Alternatives Analysis report is available on the project website listed below. Feel free to contact any of the project team members if you have comments or questions.

Project website: **projects.udfcd.org/newlingulch**

Comment from Newlin Gulch Website
Received: Friday, May 08, 2015 8:39 AM

Name: Hills, Darold
Company: Stonegate
Phone: 303-840-0986
E-Mail: budhills@yahoo.com
Comments: How will this all affect the home owners with respect to flood insurance. When we purchased our homes the dam wasn't even a concept.

From: Shea Thomas
Sent: Monday, May 11, 2015 2:36 PM
To: 'budhills@yahoo.com'
Subject: FW: Comment from Newlin Gulch Website

Mr. Hills -

Thank you for accessing the Newlin Gulch Major Drainageway Plan project website. I hope you were able to find sufficient information to understand the goals of the master planning study underway by the Urban Drainage and Flood Control District, Town of Parker and Douglas County.

Due to the inter-governmental agreement signed by the Urban Drainage and Flood Control District, Parker Water and Sanitation District, Town of Parker and Douglas County, the Rueter-Hess Reservoir will help to hold back stormwater during a flood event in addition to the original function of water supply. This means the floodplain downstream of the dam will be reduced and property owners currently paying mandatory flood insurance may see a reduction in cost. Part of this study is to re-map the floodplain and submit the results to FEMA, who will reassess the flood insurance requirements once they accept the new maps. This process typically takes 1-2 years after we complete our study.

Please feel free to contact me directly if you have any further questions.

Shea B. Thomas, PE
Urban Drainage and Flood Control District
Project Manager, Master Planning
2480 W. 26th Ave., Suite 156-B
Denver, CO 80211
(303) 455-6277

Comment from Newlin Gulch Website
Received: Friday, May 08, 2015 5:17 PM

Name: Ken & Marlene Snavely
Company: Stonegate Parkway, Stonemeadow Drive
Phone: 3038058613
E-Mail: ken1316@yahoo.com
Comments: We back up to the greenbelt (10584 Stonemeadow Drive) and were wondering if, at this time, there is any possibility that we will end up in a "flood plain" and thus be required to purchase flood insurance?

Second, could you please tell us if it is the Reuter-Hess Reservoir that is allowing water to flow down the drainageway several days a week and where the water is ending up? We were wondering if it is connected to the Chambers Reservoir since we notice the reservoir's level is rising?

Thank you,
Ken Snavely

From: Shea Thomas
Sent: Monday, May 11, 2015 2:38 PM
To: 'ken1316@yahoo.com'
Subject: FW: Comment from Newlin Gulch Website

Mr. Snavely -

Thank you for accessing the Newlin Gulch Major Drainageway Plan project website. I hope you were able to find sufficient information to understand the goals of the master planning study underway by the Urban Drainage and Flood Control District, Town of Parker and Douglas County.

Due to the inter-governmental agreement signed by the Urban Drainage and Flood Control District, Parker Water and Sanitation District, Town of Parker and Douglas County, the Rueter-Hess Reservoir will help to hold back stormwater during a flood event in addition to the original function of water supply. This means the floodplain downstream of the dam will be reduced so if you are not paying mandatory flood insurance now you won't be required to do so as a result of this study. Please note that all properties are at risk of flooding and are encouraged to purchase flood insurance whether required to do so or not.Part of this study is to re-map the floodplain and submit the results to FEMA, who will reassess the flood insurance requirements once they accept the new maps. This process typically takes 1-2 years after we complete our study.

Water is released from the Rueter-Hess Reservoir and flows along Newlin Gulch to Cherry Creek near the Parker Recreation Center. The water does not go to Chambers Reservoir. Parker Water is currently in the testing and startup phase of the water treatment plant located near the reservoir. They are discharging water from the plant to Newlin Gulch during this phase. Depending on how the testing goes, they could be finished at any time or it could last up to three more weeks.

Please feel free to contact me directly if you have any further questions.

Shea B. Thomas, PE
Urban Drainage and Flood Control District
Project Manager, Master Planning
2480 W. 26th Ave., Suite 156-B
Denver, CO 80211
(303) 455-6277

Comment from Newlin Gulch Website
Received: Thursday, June 04, 2015 7:03 PM

Name: Martina Fagley
Company: Challenger Park Neighborhood
Phone: 3038050336
E-Mail: mfagley@live.com
Comments: I received a postcard about the Newlin Gulch Major Drainageway Plan. I looked on the map and see that my house is out of the blue but my back yard may or maynot be in the blue. My address is 9692 S Coltsfoot Dr. Parker. What does this mean to my house?

From: Shea Thomas
Sent: Wednesday, June 10, 2015 3:54 PM
To: 'mfagley@live.com'
Subject: FW: Comment from Newlin Gulch Website

Ms. Fagley -

Thank you for accessing the Newlin Gulch Major Drainageway Plan project webste. I hope you were able to find sufficient information to understand the goals of the master planning study underway by the Urban Drainage and Flood Control District, Town of Parker and Douglas County.

Due to the inter-governmental agreement signed by the Urban Drainage and Flood Control District, Parker Water and Sanitation District, Town of Parker and Douglas County, the Rueter-Hess Reservoir will help to hold back stormwater during a flood event in addition to the original function of water supply. This means the floodplain downstream of the dam will be reduced.

Your specific property is not affected at all by our study. You are correct in stating the 100-yr floodplain shown in the report clips the corner of your property, but that is also the case with the current FEMA floodplain. FEMA only requires homeowners to purchase flood insurance if their home is in the floodplain, not their property. That does not apply to you. In addition, no improvements we are recommending in our study would adversely impact your property.

I hope this answered your question and alleviates any concern you may have. If you have further questions or comments, please feel free to contact me.

Shea B. Thomas, PE
Urban Drainage and Flood Control District
Project Manager, Master Planning
2480 W. 26th Ave., Suite 156-B
Denver, CO 80211
(303) 455-6277

Comment from Newlin Gulch Website
Received: Tuesday, June 30, 2015 5:01 PM

Name: Gary Amelon
Company:
Phone: 3038402066
E-Mail: amelon41@comcast.net
Comments:
Greetings! I live on the northside of Newlin Gulch in Stonegate just below Pine Grove Elementary. I have been at this location since 1991 and I believe this year has provided the most water I have seen during the past 24 years. The improvement project has done well in moving a substantial amount of water through the gulch without erosion and obstructions. I know we have several low spots where mosquitoes are becoming a problem but I know you are working on a solution.

I was standing on my deck a few days ago watching a couple of your deer grazing. Hawks were flying with a number of nests in the trees. Ducks are now a common site flying low and landing on the water. Good job, and I have only one request. When the new plantings were placed in the gulch, a couple of years ago, signs were put up to stay off the newly seeded areas. Isn't it time for these signs to be removed. The signs are now leaning and are the only obstruction to the natural aesthetics you created.

Thank you from a part-time waterfront property owner.

All the Best

Gary Amelon

PRELIMINARY FHAD SUBMITTAL COMMENTS

The preliminary FHAD analysis was submitted to Urban Drainage and Flood Control District on April 7, 2015 for review. Comments were received on May 12, 2015 in the form of annotated PDF copies of the Floodplain and Floodway Data Tables, the UDFCD Agreement Tables, the Floodplain Workmap, and the Flood Profiles. Changes made based on those comments are outlined below. Minor comments/corrections were addressed in the revision but are not listed here.

FLOODPLAIN AND FLOODWAY DATA TABLE COMMENTS:

1) The order of river stationing in the table has been reversed to progress from downstream to upstream.

2) Minor discrepancies between hydraulic model values and table values have been corrected.

3) A floodway has been delineated to exclude particular areas of ineffective flow in the upstream reach of the study.

4) Negative surcharges have been removed from the floodway model.

5) Regarding Cross Sections 1177 to 1777, the top widths have been adjusted to include shallow flooding in the right overbank. The floodway remains the same and does not include shallow flooding.

UDFCD AGREEMENT TABLE COMMENTS:

1) The order of river stationing in the table has been reversed to progress from downstream to upstream.

2) The Base Flood Elevation check columns for the model vs. profile and model vs. plan location have been completed and added to the table.

3) Regarding Cross Sections 1177 to 1777, the map top widths have been adjusted to include shallow flooding in the right overbank. The floodway remains the same as the model top widths and does not include shallow flooding.

FLOODPLAIN WORKMAP COMMENTS:

1) The effective FEMA 100-year floodplain for Newlin Gulch and Cherry Creek has been added to the map.

2) All bridge, trail, and culvert crossings have been shaded and identified on the map.

FLOOD PROFILE COMMENTS:

1) The bridge deck thickness at Stonegate Parkway has been adjusted to more accurately depict the upstream elevations of the structure. The plotted 500-year WSEL has been verified to match the model results.

DRAFT FHAD SUBMITTAL COMMENTS

The draft FHAD report and analysis were submitted to Urban Drainage and Flood Control District on June 9, 2015 for review. Comments were received on September 1, 2015 in the form of annotated PDF copies of the FHAD Report, the UDFCD Agreement Tables, the Floodplain and Floodway Data Tables, the Floodplain Workmap, and the Flood Profiles. Changes made based on those comments are outlined below. Minor comments/corrections were addressed in the revision but are not listed here.

FHAD REPORT COMMENTS:

1) LOMRs that were used in the FHAD analysis and mentioned in the report have been added to the References section.

2) In Section 3.8, a more detailed explanation was provided to state that the future hydrology, existing infrastructure 100-year floodplain is contained within the portions of channel that show more than a 0.5-foot increase in future over existing development WSELs.

UDFCD AGREEMENT TABLE COMMENTS:

1) The floodway delineation at the crest of the grouted boulder drop structure downstream of Recreation Drive is encroached into the main channel at cross section 1841. The hydraulic model is very sensitive to floodway encroachments, and results in negative surcharges if the encroachments are set outside of the main channel bank stations. In order to remedy this, the bank stations at sections 1841 and 1867 were adjusted to the outer edges of the grouted boulder crest structure to eliminate the negative surcharges in the floodway model, without modifying any encroachments.

2) At cross section 3046, there was an increase in the floodway WSEL over the floodplain WSEL even though no encroachment was set for that section. As a result, the floodway top width was depicted wider than the floodplain top width. The increase in WSEL is affected by the floodway encroachments at the next two cross sections downstream of 3046. To fix the WSEL and top width differences, the right overbank (ROB) encroachments at cross sections 2943 and 2748 were widened by 30 feet each to eliminate the effects on section 3046.

3) At cross section 6789, no ineffective flow area (IEFA) was set for the backwater encountered in the left overbank (LOB). In addition, the floodway was encroaching into the main channel of the section and causing differences in the floodway and floodplain water surfaces for the cross sections upstream. In order to remedy this, a permanent IEFA was set at the limits of backwater in the LOB, and the floodway encroachment was set at the same limit as the IEFA. Changes to the WSELs were updated on the workmap, profiles, Agreement Table, and Floodplain and Floodway Data Table.

4) At cross section 20250, the geometry was incorrect in the HEC-RAS model according to the design contours for the trail crossing. Because of this, the 100-year floodplain top width in the model was shorter than the top width shown on the workmap. To remedy this so the top widths match, the cross section geometry was updated to match the design grading. Changes to the WSELs were updated on the workmap, profiles, Agreement Table, and Floodplain and Floodway Data Table.

FLOODPLAIN AND FLOODWAY DATA TABLE COMMENTS:

1) Issues encountered at cross section 1841 were remedied in the same manner as documented in the UDFCD Agreement Table Comments.

2) Issues encountered at cross section 3046 were remedied in the same manner as documented in the UDFCD Agreement Table Comments.

3) Issues encountered at cross section 6789 were remedied in the same manner as documented in the UDFCD Agreement Table Comments.

4) Issues encountered at cross section 20250 were remedied in the same manner as documented in the UDFCD Agreement Table Comments.

FLOODPLAIN WORKMAP COMMENTS:

1) Limits of Detailed Study were added at the downstream limit of Newlin Gulch and at the confluence with Sandpit Tributary.

2) At the confluence with Cherry Creek, the Newlin Gulch effective floodplain was joined with the Cherry Creek effective floodplain at the intersections where both delineations cross each other.

3) In general, BFE lines and labels were adjusted to improve legibility along the entire channel.

4) In general, BFE lines were adjusted to ensure they crossed the 100-year floodplain at the correct contour elevation and correct location per the hydraulic model and profile.

5) In general, BFE lines were removed from inside bridges unless there was overtopping.

6) In general, cross section labels were adjusted to improve legibility along the entire channel.

7) The draw order of each delineation was adjusted to depict the 100-year floodway on top of the 100-year floodplain, and the 100-year floodplain on top of the 500-year floodplain.

8) Line weights for contours were adjusted to better distinguish between major and minor contours.

9) Contour labels were added and adjusted to improve legibility.

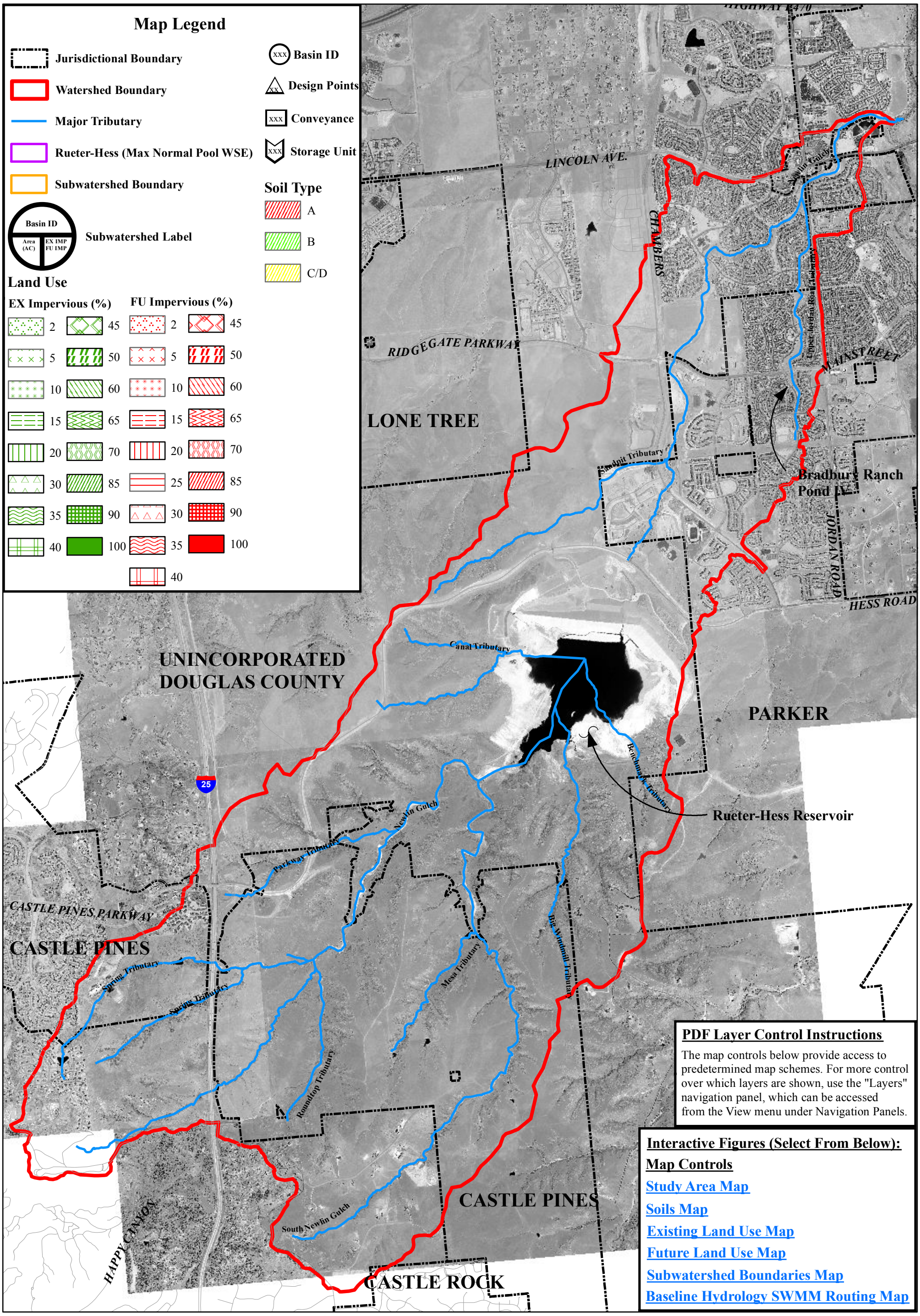
10) In general, floodplain and floodway delineations were re-evaluated and adjusted to ensure that the 100-year floodplain was coincident or within the 500-year floodplain.

FLOOD PROFILE COMMENTS:

1) The elevations have been specified to be on the NAVD 88 datum.

Appendix B

HYDROLOGIC ANALYSIS



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Lakewood, Colorado 80226-4355
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Fax: (303) 988-4969

Newlin Gulch Major Drainageway Plan
Figure B-1: Hydrology Map
March 2015

Urban Drainage and Flood Control District
Town of Parker Colorado
Douglas County Colorado

Table B-1
Rainfall Distributions

2-Hour Design Storm Rainfall Depth (in)

	2-year		5-year		10-year		25-year	50-year	100-year	500-year
Time	no area adjustment	3 mi^2 area adjustment	no area adjustment	3 mi^2 area adjustment	no area adjustment	3 mi^2 area adjustment	no area adjustment	no area adjustment	no area adjustment	no area adjustment
0:05	0.019	0.019	0.028	0.028	0.033	0.033	0.026	0.030	0.026	0.032
0:10	0.038	0.038	0.052	0.052	0.061	0.061	0.069	0.080	0.077	0.096
0:15	0.073	0.079	0.112	0.121	0.124	0.135	0.099	0.114	0.118	0.148
0:20	0.103	0.145	0.147	0.206	0.169	0.237	0.158	0.182	0.206	0.257
0:25	0.162	0.226	0.240	0.336	0.282	0.396	0.296	0.342	0.360	0.449
0:30	0.090	0.127	0.125	0.175	0.135	0.190	0.493	0.570	0.643	0.803
0:35	0.054	0.059	0.074	0.081	0.085	0.092	0.236	0.274	0.360	0.449
0:40	0.043	0.047	0.056	0.061	0.065	0.071	0.158	0.182	0.206	0.257
0:45	0.029	0.028	0.052	0.051	0.064	0.063	0.099	0.114	0.159	0.199
0:50	0.029	0.028	0.052	0.051	0.054	0.053	0.099	0.114	0.129	0.161
0:55	0.029	0.028	0.043	0.042	0.054	0.053	0.063	0.073	0.103	0.128
1:00	0.029	0.028	0.043	0.042	0.054	0.053	0.063	0.073	0.103	0.128
1:05	0.029	0.028	0.043	0.042	0.054	0.053	0.063	0.073	0.103	0.128
1:10	0.019	0.019	0.043	0.042	0.054	0.053	0.047	0.055	0.051	0.064
1:15	0.019	0.019	0.036	0.035	0.054	0.053	0.047	0.055	0.051	0.064
1:20	0.019	0.019	0.032	0.031	0.042	0.041	0.035	0.041	0.031	0.039
1:25	0.019	0.019	0.032	0.031	0.032	0.032	0.035	0.041	0.031	0.039
1:30	0.019	0.019	0.032	0.031	0.032	0.032	0.028	0.032	0.031	0.039
1:35	0.019	0.019	0.032	0.031	0.032	0.032	0.028	0.032	0.031	0.039
1:40	0.019	0.019	0.022	0.021	0.032	0.032	0.028	0.032	0.031	0.039
1:45	0.019	0.019	0.022	0.021	0.032	0.032	0.028	0.032	0.031	0.039
1:50	0.019	0.019	0.022	0.021	0.032	0.032	0.028	0.032	0.031	0.039
1:55	0.010	0.009	0.022	0.021	0.029	0.028	0.028	0.032	0.031	0.039
2:00	0.010	0.009	0.019	0.018	0.022	0.022	0.028	0.032	0.031	0.039

Table B-2
CUHP Input

	Area		Dist to Centroid		Length		Length-Weighted Slope	Weighted % Impervious		Depression Storage		Infiltration		
								Existing	Future	Pervious	Impervious	Initial Rate	Final Rate	Decay Coeff.
Subwatershed ID	acres	sq mi	ft	mi	ft	mi	ft/ft	%	%	watershed in	watershed in	in/hr	in/hr	1/second
Newlin Gulch														
A100	79	0.12334	2568	0.486	4965	0.940	0.0127	46.18	46.40	0.5	0.1	4.36	0.63	0.0016
A104	22	0.03412	1052	0.199	1595	0.302	0.0044	41.04	41.04	0.5	0.1	4.82	0.86	0.0011
A108	76	0.11808	2154	0.408	3574	0.677	0.0099	40.62	41.00	0.5	0.1	4.04	0.61	0.0017
A110	63	0.09787	556	0.105	2748	0.520	0.0109	52.16	52.35	0.5	0.1	4.64	0.71	0.0015
A115	79	0.12317	1631	0.309	2961	0.561	0.0176	40.39	40.39	0.5	0.1	3.35	0.52	0.0018
A120	133	0.20788	1735	0.329	4809	0.911	0.0098	37.06	37.15	0.5	0.1	4.43	0.66	0.0016
A125	61	0.09537	1211	0.229	3559	0.674	0.0088	44.65	44.65	0.5	0.1	3.00	0.50	0.0018
A130	73	0.11470	1082	0.205	3524	0.667	0.0216	37.76	37.76	0.5	0.1	3.90	0.67	0.0015
A135	97	0.15218	1820	0.345	4634	0.878	0.0134	9.53	59.99	0.5	0.1	4.00	0.59	0.0017
A140	77	0.11958	1485	0.281	3696	0.700	0.0177	7.98	37.05	0.5	0.1	4.62	0.71	0.0015
A145	41	0.06477	1101	0.209	2513	0.476	0.0297	16.52	66.80	0.5	0.1	4.01	0.59	0.0017
A150	132	0.20642	2025	0.384	4980	0.943	0.0165	20.92	29.24	0.5	0.1	3.72	0.62	0.0016
A155	51	0.08018	1081	0.205	2357	0.446	0.0349	5.40	61.27	0.5	0.1	4.46	0.60	0.0018
A160	36	0.05703	1056	0.200	2499	0.473	0.0161	10.16	11.95	0.5	0.1	4.20	0.72	0.0014
A165	137	0.21432	2262	0.428	4332	0.821	0.0265	2.83	56.38	0.5	0.1	3.64	0.54	0.0018
A170	91	0.14161	1918	0.363	4845	0.918	0.0285	34.06	40.99	0.5	0.1	3.21	0.53	0.0017
A175	53	0.08328	1864	0.353	3506	0.664	0.0372	42.84	65.77	0.5	0.1	3.23	0.52	0.0018
A180	107	0.16724	3092	0.586	4764	0.902	0.0262	42.28	50.98	0.5	0.1	3.38	0.54	0.0018
A190	67	0.10513	2282	0.432	5385	1.020	0.0236	15.02	28.59	0.5	0.1	3.75	0.58	0.0017
A200	122	0.19109	2356	0.446	4926	0.933	0.0347	18.12	24.09	0.5	0.1	3.32	0.52	0.0018
A205	80	0.12535	2541	0.481	4255	0.806	0.0445	6.87	6.87	0.5	0.1	3.96	0.56	0.0018
A210	177	0.27629	1904	0.361	4598	0.871	0.0326	5.06	5.06	0.5	0.1	3.56	0.54	0.0018
A220	1150	1.79681	5078	0.962	14239	2.697	0.0010	100.00	100.00	0.0	0.0	0.00	0.00	0.0000
A221	23	0.03657	307	0.058	456	0.086	0.0216	2.11	2.24	0.5	0.1	4.01	0.57	0.0018
A222	112	0.17480	836	0.158	2008	0.380	0.0546	2.91	29.20	0.5	0.1	3.20	0.51	0.0018
A223	48	0.07532	371	0.070	844	0.160	0.0567	2.00	2.00	0.5	0.1	3.28	0.52	0.0018
A224	37	0.05826	560	0.106	1743	0.330	0.0566	2.00	2.00	0.5	0.1	3.01	0.50	0.0018
A225	76	0.11903	905	0.171	2459	0.466	0.0474	2.00	2.00	0.5	0.1	3.12	0.51	0.0018
A226	108	0.16815	1387	0.263	2916	0.552	0.0456	2.15	2.15	0.5	0.1	3.18	0.51	0.0018
A227	97	0.15157	647	0.123	1571	0.298	0.0490	2.00	18.86	0.5	0.1	3.01	0.50	0.0018
A228	35	0.05437	504	0.095	1070	0.203	0.0552	2.00	42.18	0.5	0.1	3.00	0.50	0.0018
A230	116	0.18124	910	0.172	3193	0.605	0.0459	2.00	33.62	0.5	0.1	3.09	0.51	0.0018
A240	127	0.19807	1373	0.260	3827	0.725	0.0377	2.00	42.72	0.5	0.1	3.07	0.50	0.0018
A250	68	0.10593	1969	0.373	4102	0.777	0.0278	2.00	25.27	0.5	0.1	3.00	0.50	0.0018
A260	99	0.15492	1730	0.328	3591	0.680	0.0316	2.00	13.14	0.5	0.1	3.00	0.50	0.0018
A270	132	0.20610	904	0.171	2977	0.564	0.0439	8.43	9.14	0.5	0.1	3.02	0.50	0.0018

Table B-2
CUHP Input

	Area		Dist to Centroid		Length		Length-Weighted Slope	Weighted % Impervious		Depression Storage		Infiltration		
								Existing	Future	Pervious	Impervious	Initial Rate	Final Rate	Decay Coeff.
Subwatershed ID	acres	sq mi	ft	mi	ft	mi	ft/ft	%	%	watershed in	watershed in	in/hr	in/hr	1/second
Newlin Gulch														
A275	40	0.06230	922	0.175	2808	0.532	0.0370	6.61	61.80	0.5	0.1	3.00	0.50	0.0018
A280	100	0.15627	1232	0.233	3387	0.641	0.0420	7.18	66.26	0.5	0.1	3.00	0.50	0.0018
A290	111	0.17348	2138	0.405	4124	0.781	0.0452	9.88	28.85	0.5	0.1	3.00	0.50	0.0018
A300	123	0.19254	2369	0.449	4642	0.879	0.0406	2.59	3.41	0.5	0.1	3.00	0.50	0.0018
South Jordan Tributary														
B100	84	0.13156	2228	0.422	4831	0.915	0.0178	43.67	43.84	0.5	0.1	3.74	0.56	0.0018
B110	115	0.17999	2293	0.434	5041	0.955	0.0147	32.69	44.22	0.5	0.1	3.11	0.51	0.0018
B120	91	0.14226	810	0.153	3186	0.603	0.0189	44.57	44.57	0.5	0.1	3.00	0.50	0.0018
B130	69	0.10807	1293	0.245	3339	0.632	0.0214	42.09	47.86	0.5	0.1	3.45	0.53	0.0018
B135	99	0.15400	1248	0.236	3395	0.643	0.0230	42.00	45.76	0.5	0.1	3.03	0.50	0.0018
B140	65	0.10231	848	0.161	3006	0.569	0.0376	34.72	38.23	0.5	0.1	3.07	0.50	0.0018
Sandpit Tributary														
C100	73	0.11409	1627	0.308	3571	0.676	0.0210	5.68	39.49	0.5	0.1	3.53	0.54	0.0018
C110	134	0.21009	1631	0.309	3241	0.614	0.0291	2.09	21.47	0.5	0.1	3.00	0.50	0.0018
C115	82	0.12791	942	0.178	1917	0.363	0.0541	2.00	16.52	0.5	0.1	3.29	0.52	0.0018
C120	147	0.23006	2253	0.427	6042	1.144	0.0366	12.37	12.40	0.5	0.1	3.00	0.50	0.0018
C125	76	0.11915	2169	0.411	4310	0.816	0.0405	5.35	5.35	0.5	0.1	3.64	0.54	0.0018
Canal Tributary														
D100	58	0.09018	485	0.092	1515	0.287	0.0315	2.00	2.00	0.5	0.1	3.00	0.50	0.0018
D105	23	0.03628	707	0.134	1316	0.249	0.0494	2.00	2.00	0.5	0.1	3.00	0.50	0.0018
D110	118	0.18431	1478	0.280	4687	0.888	0.0160	13.20	13.21	0.5	0.1	3.00	0.50	0.0018
D115	34	0.05294	489	0.093	1747	0.331	0.0545	2.00	2.00	0.5	0.1	3.00	0.50	0.0018
D120	88	0.13720	650	0.123	1747	0.331	0.0556	4.86	4.86	0.5	0.1	3.00	0.50	0.0018
D125	44	0.06920	509	0.096	759	0.144	0.0247	2.70	2.74	0.5	0.1	3.00	0.50	0.0018
Big Windmill Tributary														
E100	86	0.13510	917	0.174	2973	0.563	0.0486	2.00	13.28	0.5	0.1	3.00	0.50	0.0018
E105	52	0.08142	275	0.052	1912	0.362	0.0433	2.00	2.00	0.5	0.1	3.00	0.50	0.0018
E110	26	0.04037	528	0.100	879	0.166	0.0628	4.38	4.63	0.5	0.1	3.00	0.50	0.0018
E115	47	0.07349	515	0.098	907	0.172	0.0602	5.02	5.03	0.5	0.1	3.00	0.50	0.0018
E120	122	0.18987	2043	0.387	3851	0.729	0.0411	2.16	22.64	0.5	0.1	3.00	0.50	0.0018
E124	82	0.12759	1970	0.373	3842	0.728	0.0383	4.57	4.57	0.5	0.1	3.00	0.50	0.0018
E128	133	0.20792	1700	0.322	4095	0.775	0.0401	4.90	6.13	0.5	0.1	3.00	0.50	0.0018

Table B-2
CUHP Input

Subwatershed ID	Area		Dist to Centroid		Length		Length-Weighted Slope	Weighted % Impervious		Depression Storage		Infiltration		
								Existing	Future	Pervious	Impervious	Initial Rate	Final Rate	Decay Coeff.
	acres	sq mi	ft	mi	ft	mi	ft/ft	%	%	watershed in	watershed in	in/hr	in/hr	1/second
South Newlin Gulch														
F100	120	0.18764	3124	0.592	6498	1.231	0.0283	2.00	20.92	0.5	0.1	3.00	0.50	0.0018
F102	57	0.08830	627	0.119	1847	0.350	0.0496	2.00	7.02	0.5	0.1	3.01	0.50	0.0018
F104	105	0.16419	1101	0.209	3021	0.572	0.0490	2.00	37.92	0.5	0.1	3.00	0.50	0.0018
F106	97	0.15209	822	0.156	1734	0.328	0.0565	2.00	5.68	0.5	0.1	3.00	0.50	0.0018
F110	106	0.16600	1210	0.229	3346	0.634	0.0293	2.00	26.48	0.5	0.1	3.00	0.50	0.0018
F120	120	0.18673	1883	0.357	3939	0.746	0.0287	2.00	28.64	0.5	0.1	3.00	0.50	0.0018
F125	76	0.11910	1779	0.337	3518	0.666	0.0384	2.00	22.58	0.5	0.1	3.00	0.50	0.0018
F130	93	0.14500	1739	0.329	3729	0.706	0.0240	2.91	10.00	0.5	0.1	3.00	0.50	0.0018
F140	125	0.19559	2298	0.435	4151	0.786	0.0311	4.79	9.47	0.5	0.1	3.00	0.50	0.0018
F145	91	0.14255	1879	0.356	4122	0.781	0.0392	5.95	10.99	0.5	0.1	3.00	0.50	0.0018
F150	97	0.15083	1880	0.356	4552	0.862	0.0403	5.07	10.00	0.5	0.1	3.00	0.50	0.0018
F155	118	0.18503	1212	0.229	2798	0.530	0.0467	5.00	10.00	0.5	0.1	3.00	0.50	0.0018
Mesa Tributary														
G100	63	0.09892	1730	0.328	3584	0.679	0.0413	2.00	19.52	0.5	0.1	3.00	0.50	0.0018
G110	87	0.13587	1335	0.253	3530	0.668	0.0324	2.00	17.11	0.5	0.1	3.00	0.50	0.0018
G115	85	0.13319	2000	0.379	3834	0.726	0.0402	2.04	16.25	0.5	0.1	3.00	0.50	0.0018
G120	82	0.12759	1650	0.313	3485	0.660	0.0318	2.00	27.65	0.5	0.1	3.00	0.50	0.0018
G130	112	0.17453	1716	0.325	4081	0.773	0.0383	4.05	10.76	0.5	0.1	3.00	0.50	0.0018
Parkway Tributary														
H100	32	0.05073	479	0.091	1001	0.190	0.0541	2.00	19.02	0.5	0.1	3.00	0.50	0.0018
H110	90	0.14116	1729	0.327	3867	0.732	0.0364	9.43	52.24	0.5	0.1	3.01	0.50	0.0018
H115	108	0.16810	2025	0.384	3886	0.736	0.0417	8.13	9.28	0.5	0.1	3.00	0.50	0.0018
H120	103	0.16166	2052	0.389	4317	0.818	0.0377	32.08	71.30	0.5	0.1	3.02	0.50	0.0018
H125	109	0.17012	1720	0.326	3764	0.713	0.0412	18.42	26.98	0.5	0.1	3.00	0.50	0.0018
Roundtop Tributary														
I100	77	0.11958	1930	0.365	4134	0.783	0.0332	2.00	32.00	0.5	0.1	3.01	0.50	0.0018
I110	130	0.20300	1783	0.338	4637	0.878	0.0333	2.38	19.69	0.5	0.1	3.00	0.50	0.0018
I115	92	0.14452	1633	0.309	3760	0.712	0.0409	5.33	5.82	0.5	0.1	3.09	0.51	0.0018
I120	70	0.10934	2167	0.410	3979	0.754	0.0436	4.49	7.98	0.5	0.1	3.00	0.50	0.0018
Spring Tributary														
J100	98	0.15269	1484	0.281	3416	0.647	0.0327	2.00	41.01	0.5	0.1	3.56	0.54	0.0018
J110	88	0.13699	986	0.187	2878	0.545	0.0398	11.11	22.12	0.5	0.1	3.32	0.52	0.0018
J120	120	0.18808	1955	0.370	4659	0.882	0.0341	5.39	40.25	0.5	0.1	3.00	0.50	0.0018
J130	121	0.18902	1178	0.223	2519	0.477	0.0386	23.83	57.41	0.5	0.1	3.28	0.52	0.0018
J140	88	0.13737	998	0.189	2976	0.564	0.0357	8.50	31.76	0.5	0.1	3.00	0.50	0.0018
J150	90	0.14075	1606	0.304	3843	0.728	0.0370	14.65	32.56	0.5	0.1	3.00	0.50	0.0018
J155	61	0.09556	1141	0.216	2440	0.462	0.0490	5.82	33.06	0.5	0.1	3.00	0.50	0.0018
J160	91	0.14257	2047	0.388	4398	0.833	0.0403	25.01	25.01	0.5	0.1	3.00	0.50	0.0018

Table B-3
Detention Rating Curves

Rueter-Hess Reservoir (SWMM element NG220)

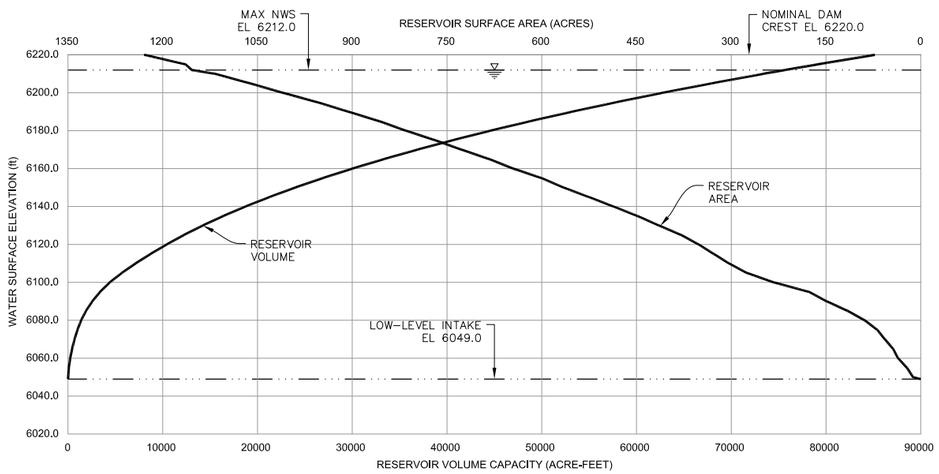
	Storage Curve		Outlet Curve	
Elevation (ft)	Stage (ft)	Area (sq ft)	Stage (ft)	Discharge (cfs)
6216.7	0	50,660,280	0	0
6217.1			0.4	359
6217.6			0.9	1,220
6218.1	1.4	50,965,200	1.4	2,381
6218.6			1.9	3,785
6219.1			2.4	5,403
6219.6			2.9	7,217
6220.1			3.4	9,213
6220.6			3.9	11,380
6221.1			4.4	13,712
6221.6			4.9	16,202
6222.1			5.4	18,846
6222.6			5.9	21,640
6223.1	6.4	53,622,360	6.4	24,579

Reuter-Hess Reservoir storage curve based on a starting WSEL at the Auxiliary Spillway crest (Elev. 6216.7). Outlet curve based on flow through the Auxiliary Spillway only based on the table "Service Spillway and Auxiliary Spillway Rating Curves" taken from record drawings from the Rueter-Hess Dam and Reservoir project (DWG. A-05), dated 10/12.

Bradbury Ranch Pond IV (SWMM element SJ130)

	Storage Curve		Outlet Curve	
Elevation (ft)	Stage (ft)	Area (sq ft)	Stage (ft)	Discharge (cfs)
5918.7	0	0	0.0	0.00
5921.7			3.0	66.85
5922.2			3.5	94.54
5922.7			4.0	115.79
5923.2			4.5	133.70
5923.7			5.0	149.48
5924.2			5.5	163.75
5924.7			6.0	176.87
5925	6.3	82,308		
5925.2			6.5	189.08
5925.7			7.0	200.55
5926.2			7.5	211.40
5926.7			8.0	221.72
5927.2			8.5	231.58
5927.5	8.8	150,181		
5927.7			9.0	247.00
5928.2			9.5	290.23
5928.7			10.0	351.23
5929.2			10.5	426.96
5929.7			11.0	516.27
5930	11.3	218,054	11.3	576.13

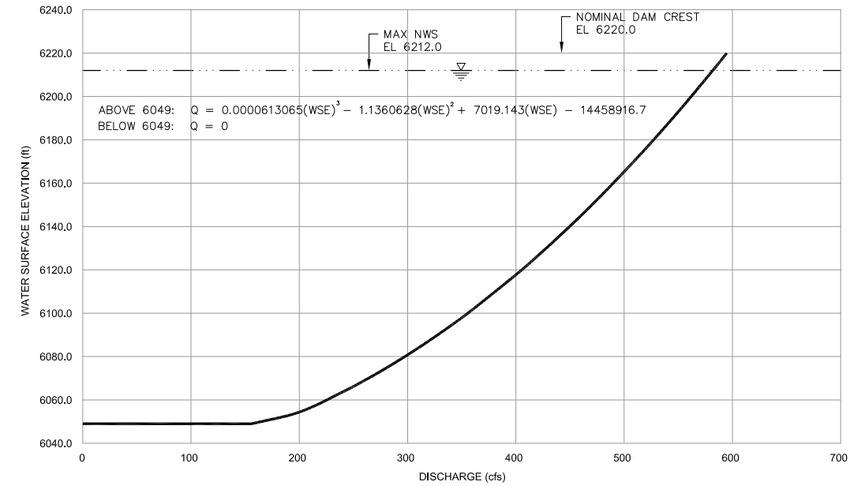
Pond IV storage curve based on 5-ft Douglas County topography. Outlet curve was developed based on supplemental ground survey of outlet structure conducted in April 2013.



RESERVOIR ELEVATION-AREA-VOLUME CURVE

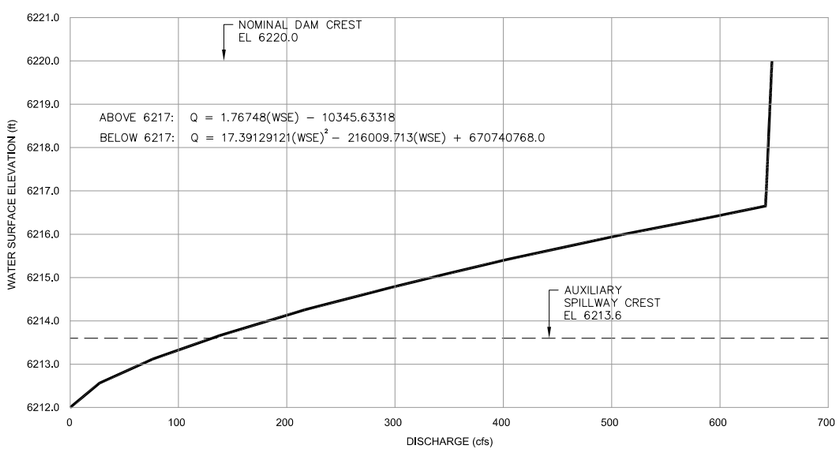
OUTLET WORKS RATING CURVE AND RESERVOIR
STORAGE VOLUME & AREA VALUES

GAGE HEIGHT (FEET)	ELEVATION (FEET)	OUTLET WORKS RATING CURVE (CFS)	RESERVOIR STORAGE VOLUME (ACRE-FEET)	RESERVOIR STORAGE AREA (ACRES)
0	6049	0	0	12
6	6055	203.0	87	22
11	6060	225.1	232	36
16	6065	245.2	432	44
21	6070	263.8	686	57
26	6075	281.2	1,001	69
31	6080	297.6	1,395	89
36	6085	313.1	1,907	116
41	6090	327.8	2,569	149
46	6095	342.0	3,386	177
51	6100	355.6	4,411	233
56	6105	368.6	5,683	276
61	6110	381.3	7,134	304
66	6115	393.5	8,714	328
71	6120	405.3	10,413	352
76	6125	416.9	12,242	380
81	6130	428.1	14,229	415
86	6135	439	16,391	449
91	6140	449.6	18,731	487
96	6145	460.1	21,265	526
101	6150	470.2	23,995	566
106	6155	480.2	26,912	601
111	6160	490.0	30,031	646
116	6165	499.5	33,356	684
121	6170	508.9	36,887	728
126	6175	518.1	40,631	770
131	6180	527.2	44,597	816
136	6185	536.1	48,785	858
141	6190	544.9	53,199	907
146	6195	553.5	57,857	956
151	6200	562.0	62,773	1,011
156	6205	570.3	67,959	1,064
161	6210	578.6	73,415	1,119
163	6212	581.8	75,689	1,155
166	6215	586.7	79,175	1,170
171	6220	594.7	85,176	1,231



OUTLET WORKS RATING CURVE

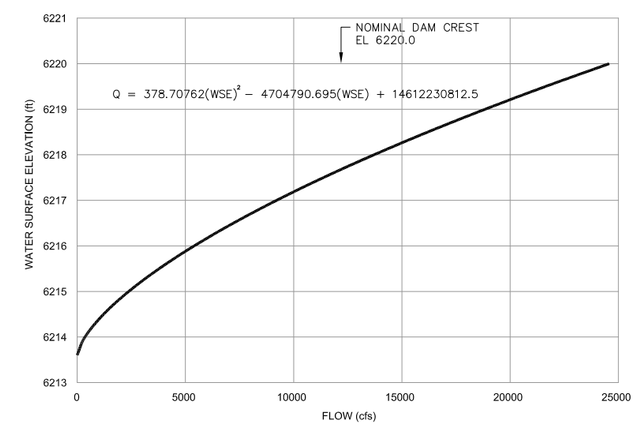
NOTE 1



SERVICE SPILLWAY RATING CURVE

SERVICE SPILLWAY AND
AUXILIARY SPILLWAY RATING CURVES

GAGE HEIGHT (FEET)	ELEVATION (FEET)	SERVICE SPILLWAY (CFS)	AUXILIARY SPILLWAY (CFS)
163	6212.0	0.0	---
163.5	6212.5	22.6	---
164	6213.0	64.0	---
164.6	6213.6	117.6	0
165	6214.0	181.0	359
165.5	6214.5	253.0	1,220
166	6215.0	332.6	2,381
166.5	6215.5	419.1	3,785
167	6216.0	512.0	5,403
167.5	6216.5	610.9	7,217
168	6217.0	642.8	9,213
168.5	6217.5	643.7	11,380
169	6218.0	644.6	13,712
169.5	6218.5	645.4	16,202
170	6219.0	646.3	18,846
170.5	6219.5	647.2	21,640
171	6220.0	648.0	24,579



AUXILIARY SPILLWAY RATING CURVE

NOTES:

1. OUTLET WORKS RATING CURVE ASSUMES THE FOLLOWING: FLOW IS THROUGH THE LOW-LEVEL INTAKE, CONVEYED THROUGH THE UPSTREAM CONDUIT AND LEFT PIPE OF THE DOWNSTREAM CONDUIT TO THE IMPACT BASIN; ALL GATES ALONG THIS REACH ARE FULLY OPEN; THE LOW-LEVEL INTAKE IS HYDRAULICALLY SUBMERGED; AND THE LOW-LEVEL INTAKE TRASHRACK IS FREE OF DEBRIS.
2. RATING CURVES BASED ON THEORETICAL VALUES AND ACTUAL FIELD PERFORMANCE COULD VARY.

C-1834

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NO.	DATE	ISSUE/REVISION	DES	DRN	CHK	APP
0	10/12	RECORD DRAWINGS	JDN	ZMR	ERF	RJH

RJH CONSULTANTS, INC.

PARKER WATER AND SANITATION DISTRICT

RJH PROJECT 05101

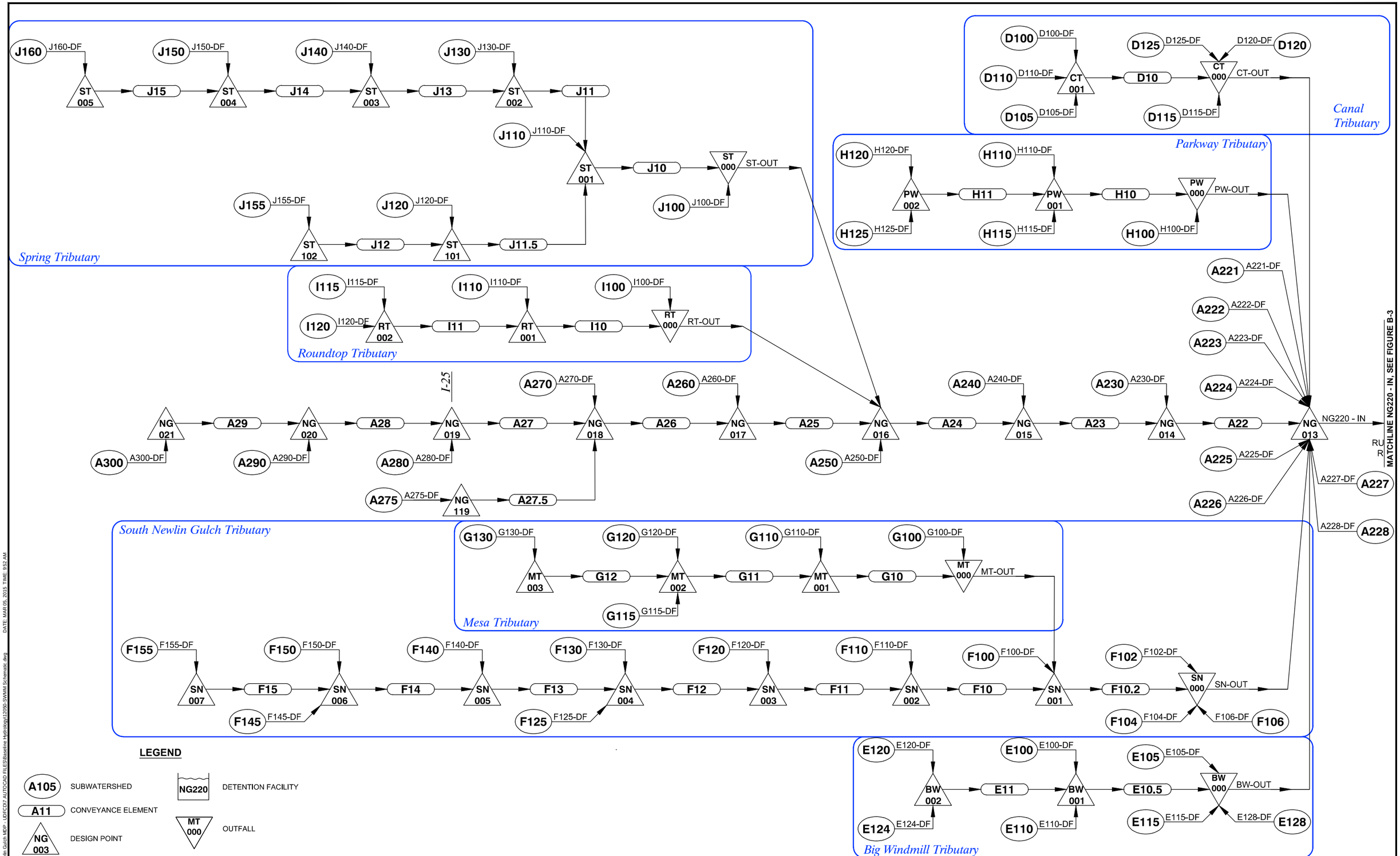
RUETER-HESS
DAM AND RESERVOIR
RECORD DRAWINGS
DOUGLAS COUNTY,
COLORADO

HYDRAULIC INFORMATION

DWG. NO. A-05

SHEET NO. 5 of 167

P:\0711 - RUETER-HESS ENLARGEMENT CONSTRUCTION\CAD\RECORD DRAWINGS\RECORD A PACKAGE\0711 SHEET A-05.DWG 1/21/2013



No.	DATE	REVISIONS	APPR.

MULLER ENGINEERING CO., INC.
CONSULTING ENGINEERS
777 SOUTH WADSWORTH BLVD. 4-100
LAKEWOOD, COLORADO
80226 (303) 988-4939
PROJECT NO. 12-050.01

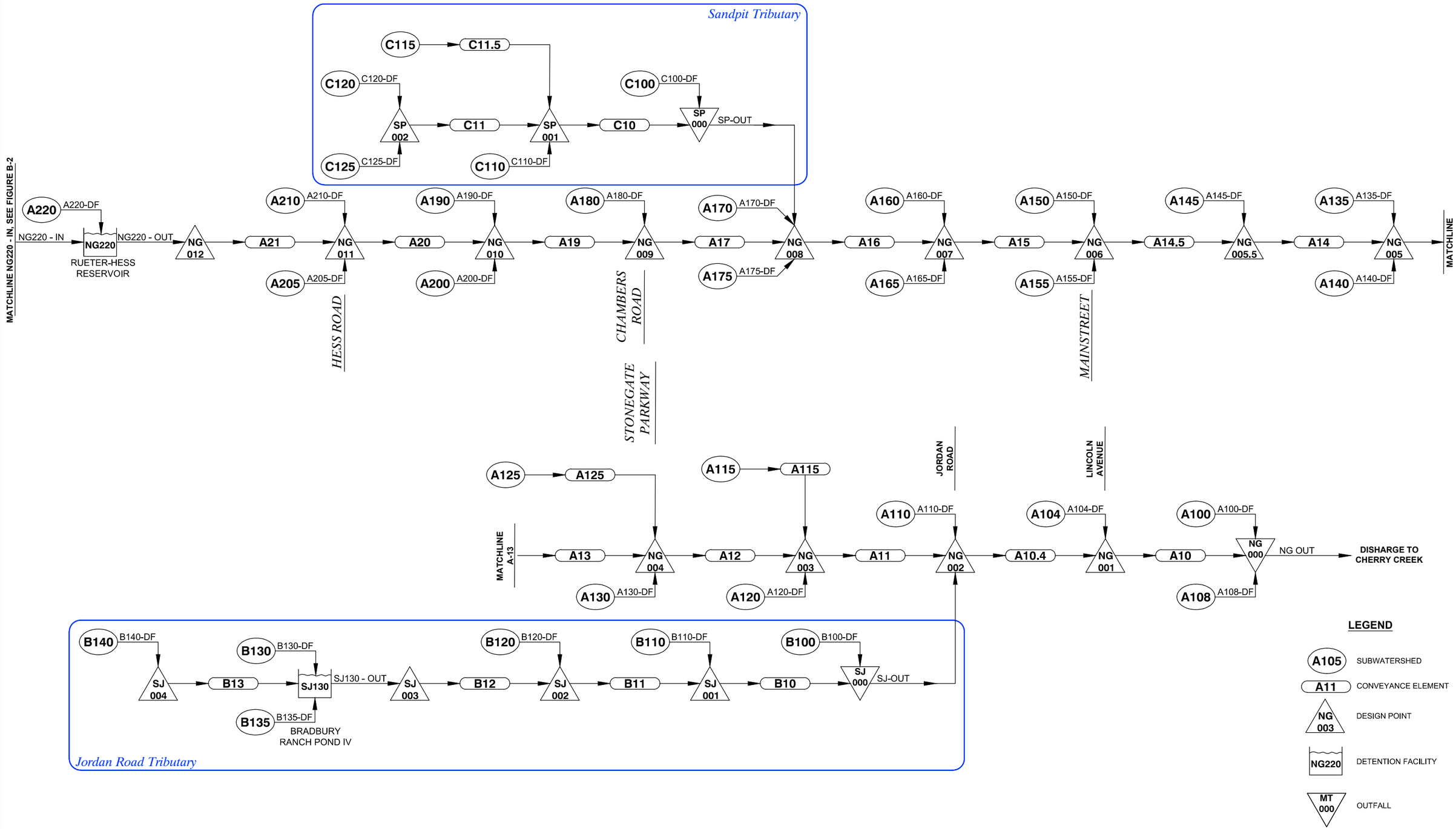
DESIGN ASP
DRAWN RJT
CHECK ASP

NEWLIN GULCH
MAJOR DRAINAGEWAY PLAN

FIGURE B-2
SWMM SCHEMATIC - UPPER WATERSHED

DATE MARCH 2015
FIGURE NO. B-2

NAME: P:\12-050\01 Newlin Gulch MDP - UDFCD\7 AUTOCAD FILES\Baseline Hydrology\12050-SWMM Schematic.dwg DATE: MAR 05, 2015 TIME: 9:52 AM



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80226 (303) 988-4939
PROJECT NO. 12-050.01

DESIGN ASP
DRAWN RJT
CHECK ASP

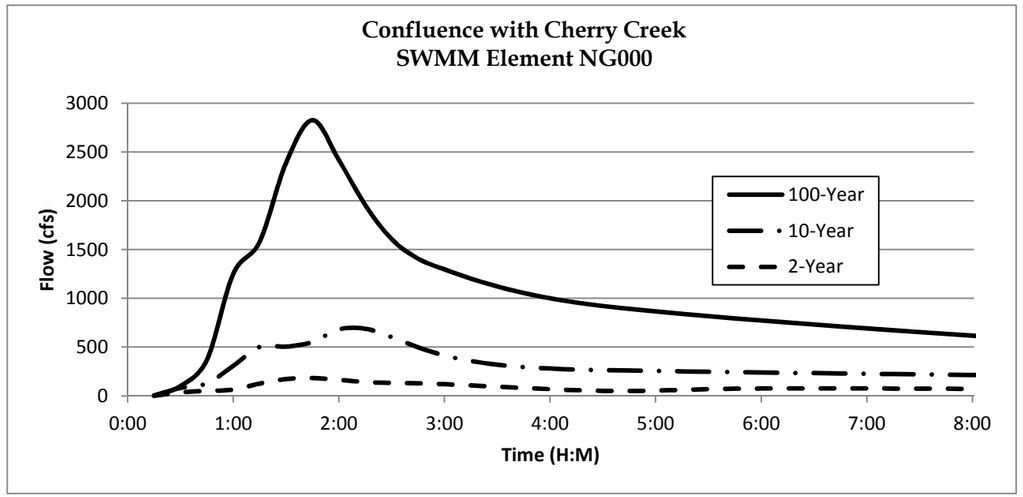
NEWLIN GULCH
MAJOR DRAINAGEWAY PLAN

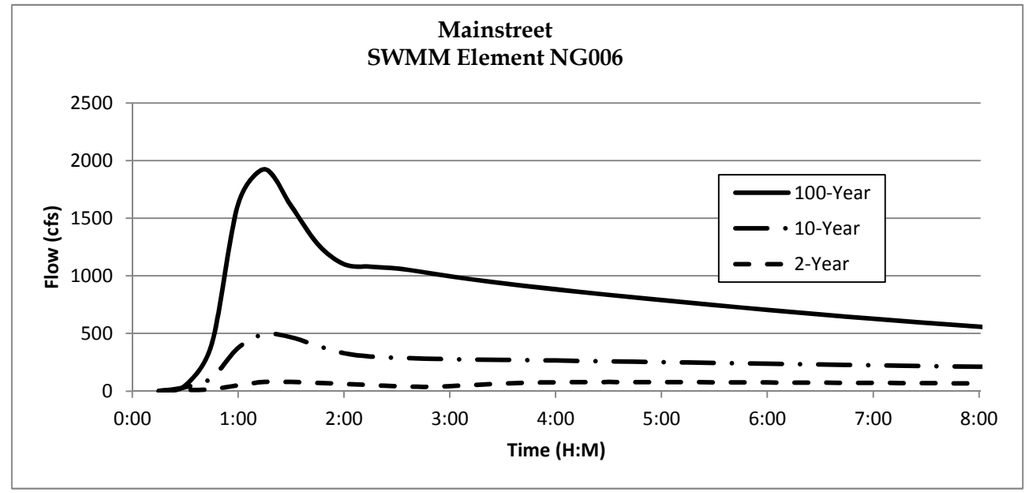
FIGURE B-3
SWMM SCHEMATIC - LOWER WATERSHED

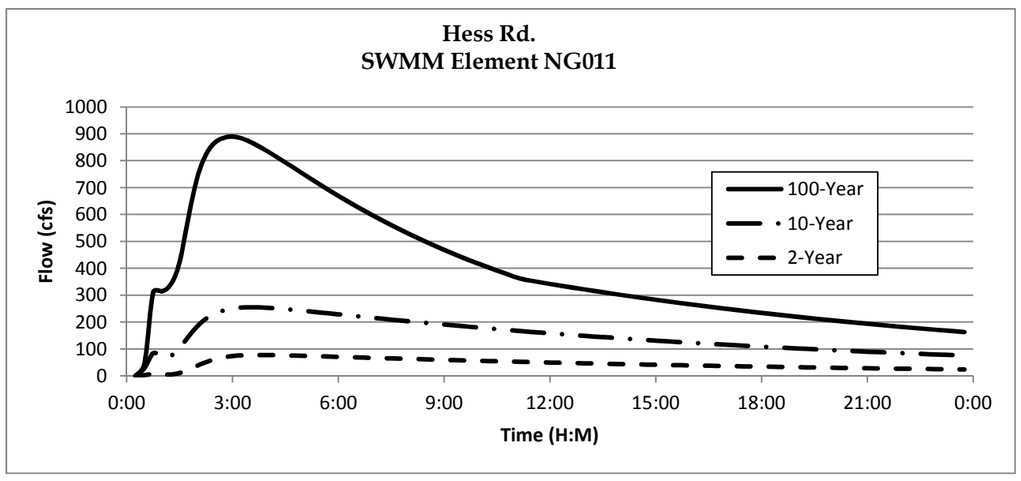
DATE MARCH 2015
FIGURE NO. B-3

NAME: P:\12-050.01 Newlin Gulch MDP - UDFCD\7 AUTOCAD FILES\Baseline Hydrology\12050-SWMM Schematic.dwg DATE: MAR 05, 2015 TIME: 9:57 AM

Figure B-4
Existing Development Hydrographs







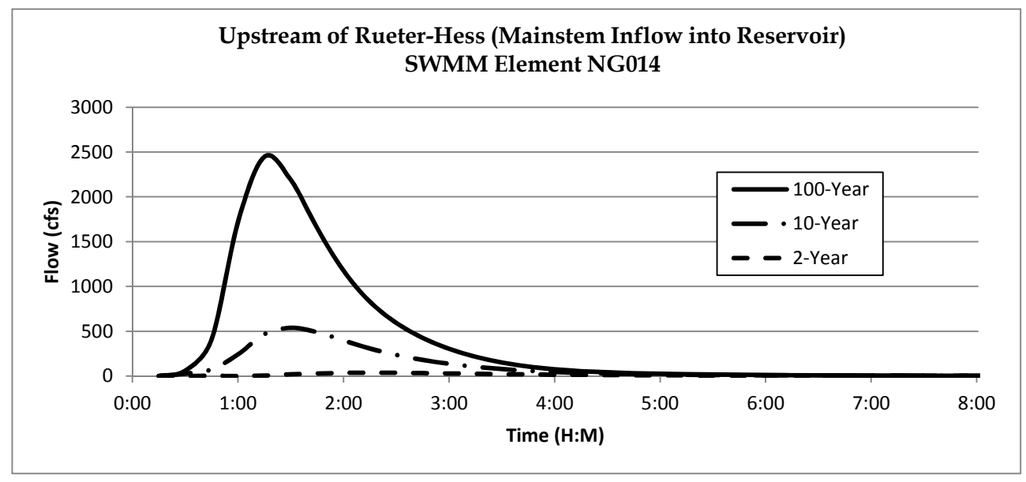
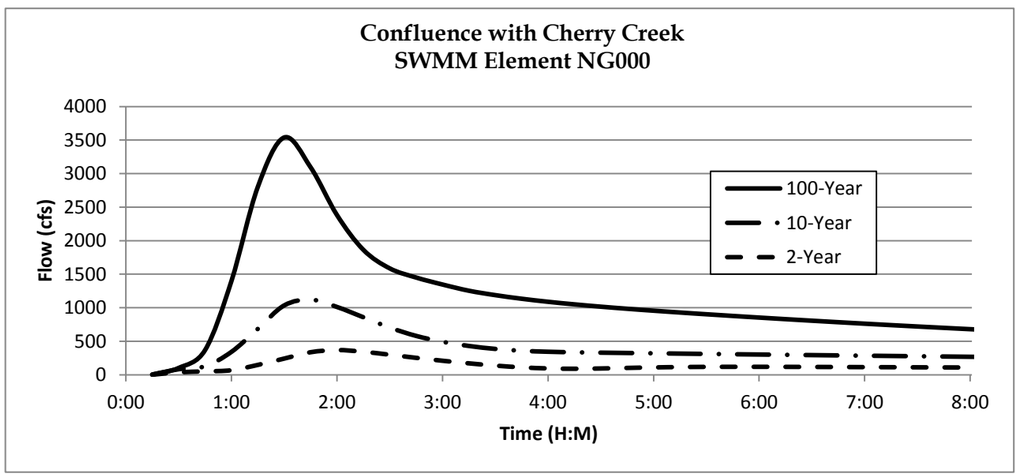
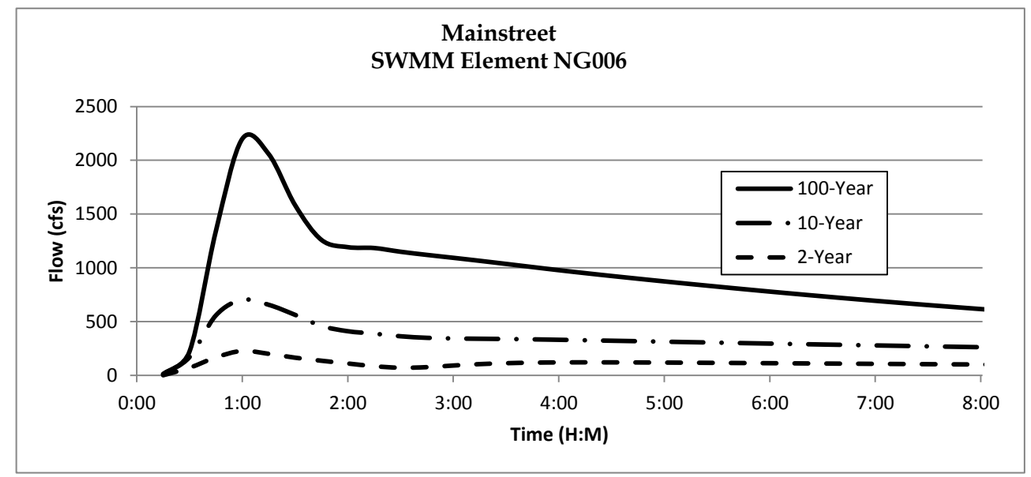
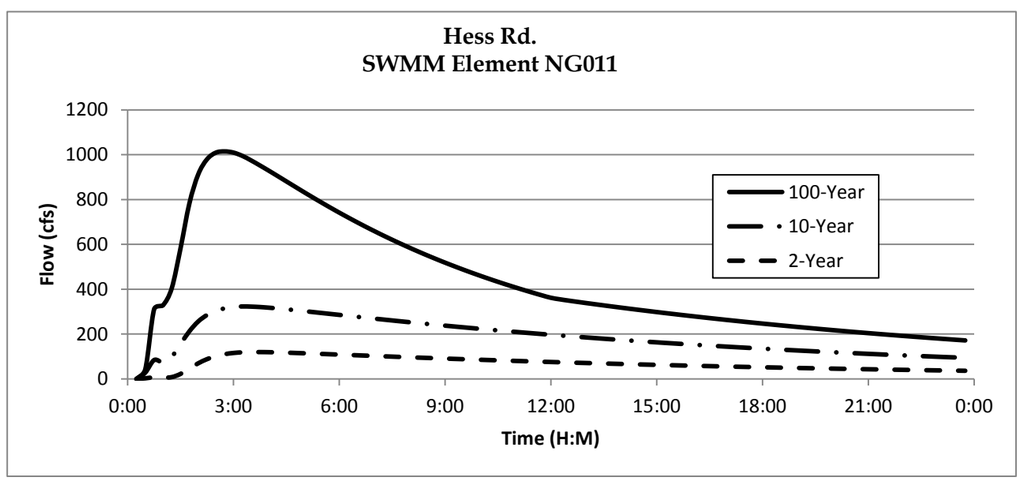


Figure B-5
Future Development Hydrographs







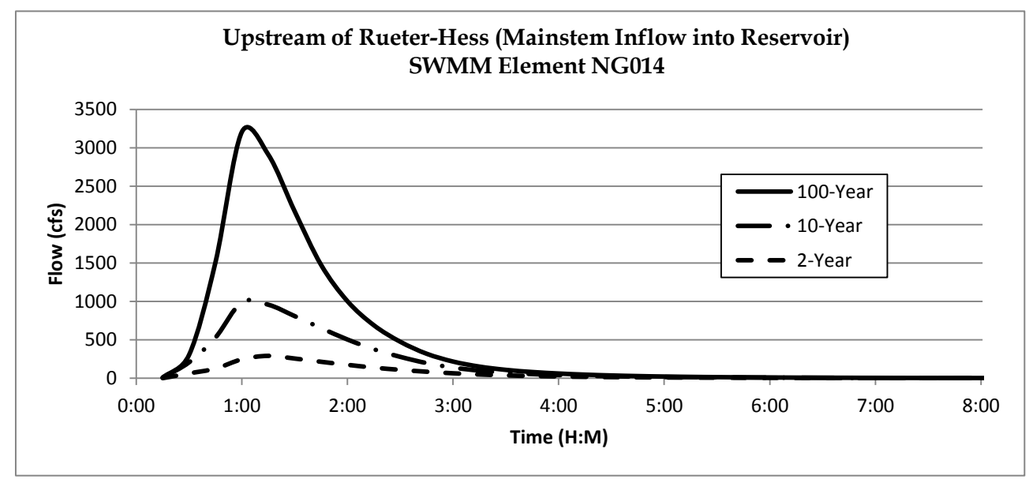


Figure B-6
Peak Flow Profile - Existing Development

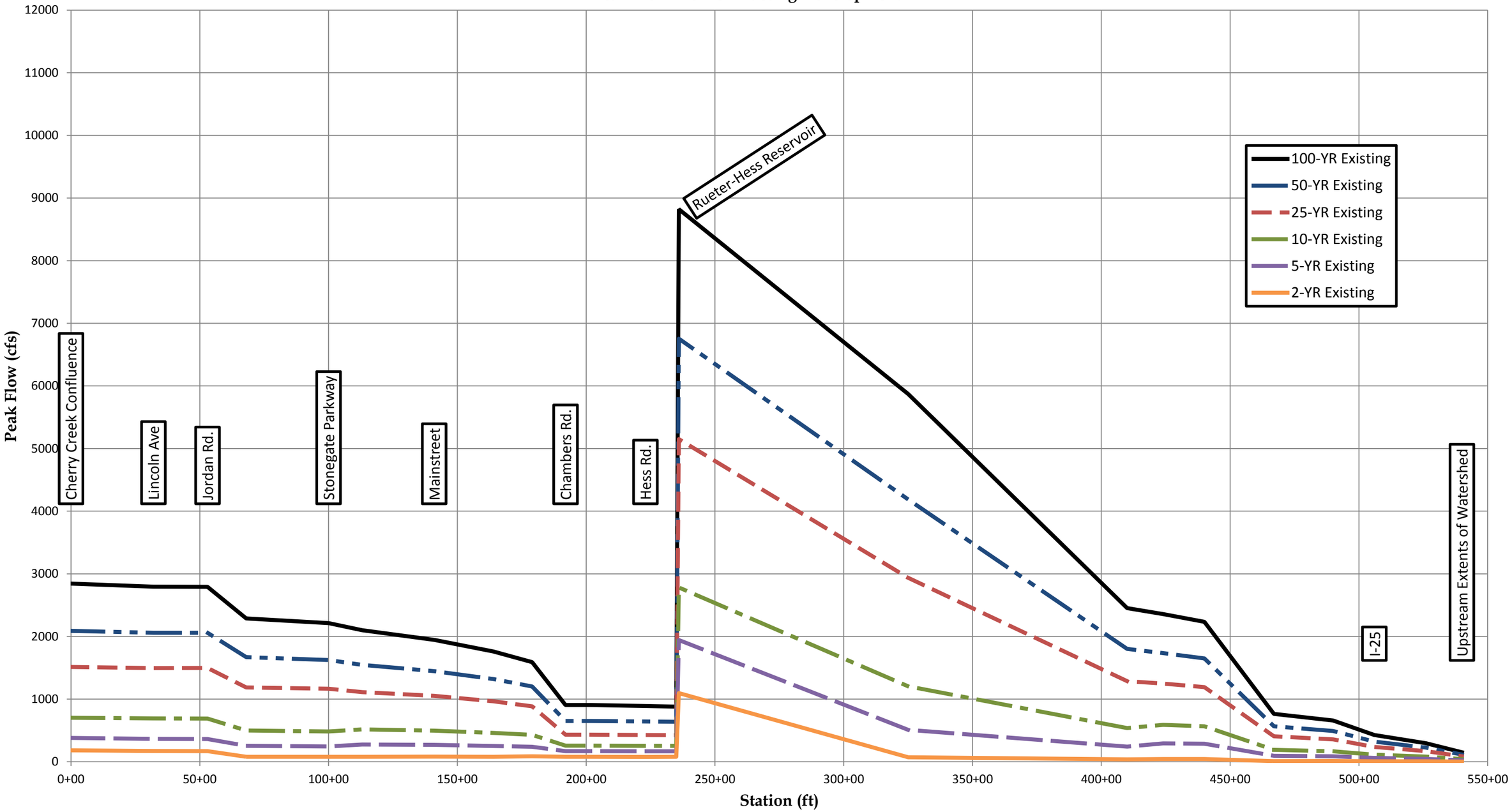


Figure B-7
Peak Flow Profile - Future Development

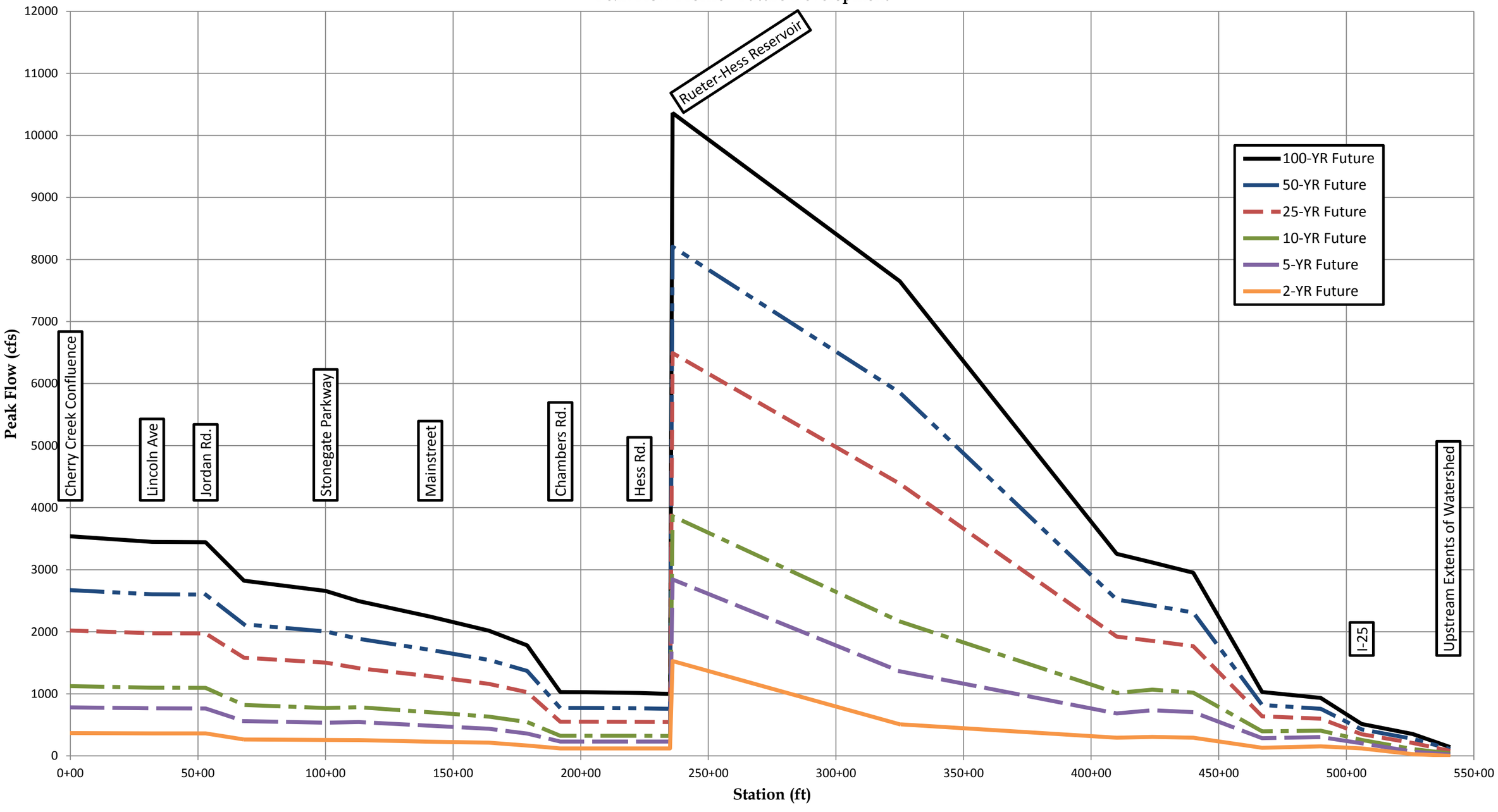


Table B-4
Peak Flow Rates

SWMM Node	Station (ft)	Landmark	3 Square Mile Area Adjustment 2-yr, 5-yr, 10-yr	EXISTING DEVELOPMENT 500-YR (cfs)	100-YR (cfs)	50-YR (cfs)	25-YR (cfs)	10-YR (cfs)	5-YR (cfs)	2-YR (cfs)	FUTURE DEVELOPMENT 500-YR (cfs)	100-YR (cfs)	50-YR (cfs)	25-YR (cfs)	10-YR (cfs)	5-YR (cfs)	2-YR (cfs)
NEWLIN GULCH MAINSTEM																	
NG000	0	Cherry Creek	yes	4291	2843	2090	1514	703	380	183	5161	3539	2670	2021	1125	783	368
NG001	3200	Lincoln Ave (U/S)	yes	4201	2795	2059	1496	691	364	171	5018	3450	2604	1976	1099	766	363
NG002	5300	Jordan Rd. (U/S)	yes	4196	2793	2058	1497	690	363	169	5005	3443	2598	1973	1097	765	362
NG003	6800		yes	3398	2288	1670	1186	498	253	79	4073	2825	2121	1583	820	561	264
NG004	10000	Stonegate Parkway (U/S)	yes	3245	2212	1625	1165	483	245	80	3807	2660	2006	1504	771	534	256
NG005	11300			3064	2101	1546	1112	516	276	79	3560	2493	1885	1414	785	544	255
NG005.5	13800			2880	1991	1479	1074	507	276	84	3262	2291	1744	1311	722	501	238
NG006	14100	Mainstreet (U/S)		2812	1945	1447	1051	496	270	82	3195	2244	1710	1284	703	485	228
NG007	16400			2532	1759	1320	965	459	251	80	2875	2019	1547	1161	633	438	212
NG008	17900			2279	1589	1202	884	429	240	86	2532	1780	1369	1027	546	361	168
NG009	19200	Chambers Rd. (U/S)		1406	905	651	432	257	169	78	1584	1029	773	550	324	232	120
NG010	20200			1405	905	651	432	257	169	78	1581	1027	773	550	324	232	120
NG011	22300	Hess Rd. (U/S)		1379	890	642	427	255	168	77	1557	1015	768	548	323	232	120
NG012	23500	Rueter-Hess Reservoir Outflow		1359	880	637	425	255	168	78	1527	999	760	544	322	232	120
NG220	23600	Rueter-Hess Reservoir Total Inflow	yes	12429	8822	6754	5150	2781	1942	1097	14097	10362	8207	6492	3863	2845	1529
NG013	32500		yes	8737	5871	4187	2935	1204	510	72	10902	7649	5855	4387	2167	1364	508
NG014	41000	Rueter-Hess Reservoir Inflow from Mainstem	yes	3584	2454	1801	1288	537	241	37	4589	3256	2521	1922	1014	683	293
NG015	42400			3424	2357	1735	1247	589	294	42	4385	3116	2425	1852	1067	736	306
NG016	44000			3230	2233	1649	1191	565	288	42	4149	2953	2310	1767	1018	704	293
NG017	46700			1104	763	565	407	190	95	11	1433	1028	822	638	395	285	130
NG018	49000			950	659	492	356	168	86	12	1277	933	758	600	406	304	154
NG019	50600	I-25 (U/S)		609	426	322	236	113	60	8	714	514	427	349	258	203	120
NG020	52600			421	296	227	168	82	45	6	493	352	274	207	110	69	27
NG021	54000	Upstream Extents of Watershed		215	151	116	86	42	22	2	216	152	117	87	42	23	2
JORDAN ROAD TRIBUTARY																	
SJ000	60000	Confluence w/ Newlin Gulch		921	690	557	444	282	211	99	1010	758	615	493	314	239	118
SJ001	63300	Stonegate Parkway (U/S)		762	568	465	377	246	187	89	857	637	524	420	273	213	106
SJ002	64500			550	368	312	262	186	146	71	587	383	324	275	199	159	82
SJ003	66400	Mainstreet		464	302	232	208	157	126	62	487	321	240	214	166	137	73
SJ004	69000			267	197	160	125	82	59	27	290	214	175	138	93	67	33
SANDPIT TRIBUTARY																	
SP000	70000	Confluence w/ Newlin Gulch		942	654	494	360	165	83	10	1081	763	588	441	230	142	44
SP001	72600			839	584	444	325	151	78	10	912	644	498	373	192	116	32
SP002	75700			389	276	214	161	82	48	11	389	276	214	161	82	48	12
CANAL TRIBUTARY																	
CT000	80000	Edge of Reuter-Hess Normal Pool		967	684	537	400	207	118	16	967	684	537	400	207	118	16
CT001	86500			442	313	245	183	95	56	10	442	313	245	183	95	56	10
BIG WINDMILL TRIBUTARY																	
BW000	90000	Edge of Reuter-Hess Normal Pool		1219	857	658	486	237	126	11	1345	956	748	561	297	179	39
BW001	96600			645	453	348	257	123	65	4	751	536	422	320	175	111	31
BW002	97400			376	265	204	151	74	40	3	450	323	255	194	110	71	23

Table B-4
Peak Flow Rates

SWMM Node	Station (ft)	Landmark	3 Square Mile Area Adjustment 2-yr, 5-yr, 10-yr	EXISTING DEVELOPMENT 500-YR (cfs)	100-YR (cfs)	50-YR (cfs)	25-YR (cfs)	10-YR (cfs)	5-YR (cfs)	2-YR (cfs)	FUTURE DEVELOPMENT 500-YR (cfs)	100-YR (cfs)	50-YR (cfs)	25-YR (cfs)	10-YR (cfs)	5-YR (cfs)	2-YR (cfs)
SOUTH NEWLIN GULCH																	
SN000	100000	Edge of Reuter-Hess Normal Pool		2312	1522	1083	741	334	134	7	2531	1707	1251	895	482	296	93
SN001	107100			2071	1388	999	694	317	132	7	2288	1564	1154	835	446	252	82
SN002	109800			1321	891	648	456	210	93	6	1410	964	717	519	273	149	43
SN003	111800			1194	816	599	426	198	91	7	1278	882	659	481	251	138	30
SN004	114600			1049	725	538	387	182	89	8	1115	779	586	430	218	122	23
SN005	117400			815	569	432	316	150	79	8	851	598	459	341	171	98	18
SN006	119700			628	442	340	252	123	67	8	657	465	361	271	140	82	16
SN007	121700			310	219	172	128	66	37	5	324	230	182	137	74	45	10
MESA TRIBUTARY																	
MT000	130000	Edge of Reuter-Hess Normal Pool		715	493	363	261	119	55	3	846	598	457	343	184	114	34
MT001	131900			628	435	324	234	107	52	3	740	524	404	304	162	102	31
MT002	133900			485	338	255	186	86	43	3	572	406	316	238	128	81	27
MT003	136600			219	154	119	89	44	24	3	232	165	129	98	52	32	7
PARKWAY TRIBUTARY																	
PW000	140000	Edge of Reuter-Hess Normal Pool		1022	730	573	435	239	153	46	1515	1121	918	730	483	364	184
PW001	142000	Hess Rd. (D/S)		940	674	531	405	226	147	46	1410	1046	860	686	460	349	180
PW002	144500			579	420	339	263	158	109	44	882	666	556	450	323	251	143
ROUNDTOP TRIBUTARY																	
RT000	150000	Confluence w/ Newlin Gulch		617	429	320	232	106	51	3	713	504	385	288	151	92	27
RT001	152300			515	360	274	200	94	48	4	565	399	308	230	118	70	18
RT002	154400			290	204	158	117	58	32	4	294	208	161	120	61	35	6
SPRING TRIBUTARY																	
ST000	160000	Confluence w/ Newlin Gulch		1455	1009	749	546	267	146	30	1999	1427	1128	870	521	374	175
ST001	162500			1301	906	678	498	249	140	33	1741	1244	983	758	458	332	162
ST002	163800	I-25 (U/S)		808	566	426	316	166	99	31	928	659	524	416	294	222	126
ST003	165800			568	402	309	232	122	75	21	687	491	387	297	171	118	47
ST004	167300			392	280	219	166	91	59	19	453	326	257	198	114	79	31
ST005	169700			222	161	129	100	60	41	16	222	161	129	100	60	41	16

Table B-5
Runoff Volumes - Existing Development

SWMM Node	Station (ft)	Cumulative Drainage Area (ac)	Landmark	3 Square Mile Area Adjustment 2-yr, 5-yr, 10-yr	EXISTING DEVELOPMENT 100-YR (cf)	100-YR (in)	50-YR (cf)	50-YR (in)	25-YR (cf)	25-YR (in)	10-YR (cf)	10-YR (in)	5-YR (cf)	5-YR (in)	2-YR (cf)	2-YR (in)
NEWLIN GULCH MAINSTEM																
NG000	0	9609	Cherry Creek	yes	60,057,128	1.72	47,512,820	1.36	36,664,400	1.05	22,077,031	0.63	14,400,081	0.41	7,114,818	0.20
NG001	3200	9455	Lincoln Ave (U/S)	yes	58,939,681	1.72	46,596,430	1.36	35,928,347	1.05	21,589,092	0.63	14,026,440	0.41	6,891,168	0.20
NG002	5300	9433	Jordan Rd. (U/S)	yes	58,803,860	1.72	46,488,415	1.36	35,842,390	1.05	21,526,395	0.63	13,973,769	0.41	6,854,539	0.20
NG004	10000	8635	Stonegate Parkway (U/S)	yes	53,179,195	1.70	41,885,881	1.34	32,167,341	1.03	19,049,270	0.61	12,135,910	0.39	5,839,359	0.19
NG006	14100	8285	Mainstreet (U/S)		51,154,448	1.70	40,321,536	1.34	30,987,999	1.03	19,747,624	0.66	12,875,706	0.43	5,821,312	0.19
NG009	19200	7271	Chambers Rd. (U/S)		45,506,656	1.72	36,012,701	1.36	27,795,809	1.05	17,964,174	0.68	11,864,402	0.45	5,472,670	0.21
NG011	22300	6974	Hess Rd. (U/S)		43,634,708	1.72	34,525,222	1.36	26,646,813	1.05	17,224,378	0.68	11,372,587	0.45	5,246,346	0.21
NG012	23500	6717	Rueter-Hess Reservoir Outflow		42,265,404	1.73	33,500,283	1.37	25,903,141	1.06	16,847,395	0.69	11,188,106	0.46	5,193,141	0.21
NG220	23600	6717	Rueter-Hess Reservoir Total Inflow	yes	42,270,618	1.73	33,505,363	1.37	25,908,221	1.06	15,785,025	0.65	10,255,273	0.42	5,036,332	0.21
NG014	41000	2042	Rueter-Hess Reservoir Inflow from Mainstem	yes	11,387,826	1.54	8,661,518	1.17	6,381,172	0.86	3,232,963	0.44	1,597,900	0.22	379,924	0.05
NG019	50600	334	I-25 (U/S)		1,832,244	1.51	1,387,752	1.14	1,016,918	0.84	561,731	0.46	290,223	0.24	49,061	0.04

Table B-6
Runoff Volumes - Future Development

SWMM Node	Station (ft)	Cumulative Drainage Area (ac)	Landmark	3 Square Mile Area Adjustment 2-yr, 5-yr, 10-yr	FUTURE DEVELOPMENT 100-YR (cf)	100-YR (in)	50-YR (cf)	50-YR (in)	25-YR (cf)	25-YR (in)	10-YR (cf)	10-YR (in)	5-YR (cf)	5-YR (in)	2-YR (cf)	2-YR (in)
NEWLIN GULCH MAINSTEM																
NG000	0	9609	Cherry Creek	yes	65,834,860	1.89	53,548,424	1.54	42,494,000	1.22	28,230,676	0.81	20,231,285	0.58	10,941,462	0.31
NG001	3200	9455	Lincoln Ave (U/S)	yes	64,715,541	1.89	52,630,029	1.53	41,755,943	1.22	27,740,732	0.81	19,855,639	0.58	10,716,610	0.31
NG002	5300	9433	Jordan Rd. (U/S)	yes	64,579,721	1.89	52,522,014	1.53	41,669,985	1.22	27,677,902	0.81	19,802,968	0.58	10,679,981	0.31
NG004	10000	8635	Stonegate Parkway (U/S)	yes	58,827,389	1.88	47,788,873	1.52	37,866,869	1.21	25,064,554	0.80	17,833,299	0.57	9,565,475	0.31
NG006	14100	8285	Mainstreet (U/S)		56,316,174	1.87	45,718,942	1.52	36,193,171	1.20	25,210,000	0.84	18,055,211	0.60	9,339,953	0.31
NG009	19200	7271	Chambers Rd. (U/S)		49,727,929	1.88	40,429,283	1.53	32,054,647	1.21	22,426,342	0.85	16,100,247	0.61	8,354,985	0.32
NG011	22300	6974	Hess Rd. (U/S)		47,728,315	1.89	38,809,460	1.53	30,777,450	1.22	21,552,330	0.85	15,481,567	0.61	8,042,303	0.32
NG012	23500	6717	Rueter-Hess Reservoir Outflow		46,352,996	1.90	37,778,639	1.55	30,028,430	1.23	21,170,668	0.87	15,293,477	0.63	7,987,092	0.33
NG220	23600	6717	Rueter-Hess Reservoir Total Inflow	yes	46,359,680	1.90	37,783,719	1.55	30,033,510	1.23	20,117,388	0.83	14,376,018	0.59	7,723,739	0.32
NG014	41000	2042	Rueter-Hess Reservoir Inflow from Mainstem	yes	13,512,165	1.82	10,881,306	1.47	8,530,242	1.15	5,505,154	0.74	3,772,637	0.51	1,847,216	0.25
NG019	50600	334	I-25 (U/S)		2,213,238	1.82	1,784,520	1.47	1,401,120	1.15	959,702	0.79	670,548	0.55	321,772	0.27

Table B-7
Sample SWMM Input

```
[TITLE]
Newlin Gulch MDP
Baseline Hydrology Model
Future Development 100-yr no area adjustment

[OPTIONS]
FLOW_UNITS           CFS
INFILTRATION         HORTON
FLOW_ROUTING         KINWAVE
START_DATE           01/01/2005
START_TIME           00:00:00
REPORT_START_DATE    01/01/2005
REPORT_START_TIME    00:00:00
END_DATE             01/10/2005
END_TIME             00:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:15:00
WET_STEP             00:05:00
DRY_STEP             01:00:00
ROUTING_STEP         0:00:30
ALLOW_PONDING        NO
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         0
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         DEPTH
MIN_SLOPE            0

[FILES]
USE INFLOWS "P:\12-050.01 Newlin Gulch MDP - UDFCD\1 HYDROLOGY\Baseline\CUHP 2005
- v. 1.3.3\Output Files\Future\NewlinGulch_FU_100_2hr_CUHP Output.txt"

[EVAPORATION]
;;Type       Parameters
;;---------- ----------
CONSTANT     0.0
DRY_ONLY     NO

[JUNCTIONS]
;;               Invert     Max.       Init.      Surcharge  Ponded
;;Name           Elev.      Depth      Depth      Depth      Area
;;-------------- ---------- ---------- ---------- ---------- ----------
NG001            5802       0          0          0          0
```

A100	5767	0	0	0	0
NG000	5766	0	0	0	0
A104	5803	0	0	0	0
A108	5767	0	0	0	0
A110	5815	0	0	0	0
NG002	5814	0	0	0	0
SJ000	5818	0	0	0	0
NG003	5832	0	0	0	0
A115	5846	0	0	0	0
A120	5833	0	0	0	0
A125	5874	0	0	0	0
NG004	5860	0	0	0	0
A130	5861	0	0	0	0
NG005	5867.5	0	0	0	0
A135	5868.5	0	0	0	0
A140	5868.5	0	0	0	0
NG006	5902	0	0	0	0
A145	5903	0	0	0	0
A155	5903	0	0	0	0
A150	5903	0	0	0	0
NG005.5	5901	0	0	0	0
NG007	5924.5	0	0	0	0
A165	5925.5	0	0	0	0
NG008	5938	0	0	0	0
A170	5939	0	0	0	0
NG009	5948	0	0	0	0
A175	5939	0	0	0	0
A180	5949	0	0	0	0
NG011	5992	0	0	0	0
NG010	5964	0	0	0	0
A200	5965	0	0	0	0
A190	5965	0	0	0	0
A210	5993	0	0	0	0
A205	5993	0	0	0	0
NG012	6216.5	0	0	0	0
A220	6217	0	0	0	0
NG013	6217	0	0	0	0
A221	6218	0	0	0	0
A222	6218	0	0	0	0
A223	6218	0	0	0	0
A224	6218	0	0	0	0
A225	6218	0	0	0	0
A226	6218	0	0	0	0
A227	6218	0	0	0	0
A228	6218	0	0	0	0
NG014	6218	0	0	0	0
A230	6219	0	0	0	0
NG015	6235	0	0	0	0

Table B-7
Sample SWMM Input

A240	6236	0	0	0	0
NG016	6250	0	0	0	0
NG017	6295	0	0	0	0
A250	6251	0	0	0	0
A260	6296	0	0	0	0
NG018	6333	0	0	0	0
A270	6334	0	0	0	0
NG019	6380	0	0	0	0
NG119	6395	0	0	0	0
NG020	6410	0	0	0	0
A280	6381	0	0	0	0
NG021	6450	0	0	0	0
A290	6411	0	0	0	0
A300	6451	0	0	0	0
ST000	6251	0	0	0	0
ST001	6294	0	0	0	0
J100	6252	0	0	0	0
J110	6295	0	0	0	0
ST002	6325	0	0	0	0
ST101	6345	0	0	0	0
J130	6326	0	0	0	0
ST003	6363	0	0	0	0
J120	6346	0	0	0	0
A275	6396	0	0	0	0
J140	6364	0	0	0	0
ST004	6397	0	0	0	0
ST005	6471	0	0	0	0
J150	6398	0	0	0	0
J160	6472	0	0	0	0
ST102	6428	0	0	0	0
J155	6429	0	0	0	0
RT000	6251	0	0	0	0
RT001	6297	0	0	0	0
I100	6252	0	0	0	0
I110	6298	0	0	0	0
RT002	6360	0	0	0	0
I120	6361	0	0	0	0
I115	6361	0	0	0	0
SN000	6218	0	0	0	0
F106	6219	0	0	0	0
F102	6219	0	0	0	0
F104	6219	0	0	0	0
SN001	6219	0	0	0	0
SN002	6264	0	0	0	0
F100	6220	0	0	0	0
SN003	6294	0	0	0	0
F110	6265	0	0	0	0
SN004	6335	0	0	0	0
F120	6295	0	0	0	0
F125	6336	0	0	0	0
F130	6336	0	0	0	0
SN005	6377	0	0	0	0
F140	6378	0	0	0	0
SN006	6415	0	0	0	0
F145	6416	0	0	0	0
F150	6416	0	0	0	0
SN007	6470	0	0	0	0
F155	6471	0	0	0	0
MT000	6220	0	0	0	0
G100	6221	0	0	0	0
MT001	6248	0	0	0	0
G110	6249	0	0	0	0
MT002	6285	0	0	0	0
MT003	6354	0	0	0	0
G120	6286	0	0	0	0
G115	6286	0	0	0	0
G130	6355	0	0	0	0
PW000	6218	0	0	0	0
PW001	6228	0	0	0	0
H100	6219	0	0	0	0
H115	6229	0	0	0	0
PW002	6277	0	0	0	0
H125	6278	0	0	0	0
H120	6278	0	0	0	0
H110	6229	0	0	0	0
BW000	6218	0	0	0	0
BW001	6219	0	0	0	0
BW002	6235	0	0	0	0
E105	6219	0	0	0	0
E115	6219	0	0	0	0
E128	6219	0	0	0	0
E100	6220	0	0	0	0
E110	6220	0	0	0	0
E120	6236	0	0	0	0
E124	6236	0	0	0	0
CT001	6219	0	0	0	0
CT000	6218	0	0	0	0
D110	6220	0	0	0	0
D100	6220	0	0	0	0
D105	6220	0	0	0	0
D115	6219	0	0	0	0
D120	6219	0	0	0	0
D125	6219	0	0	0	0
SP000	5948	0	0	0	0
SP001	5978	0	0	0	0
SP002	6072	0	0	0	0

Table B-7
Sample SWMM Input

```
C115             6012       0          0          0          0
C120             6073       0          0          0          0
C110             5979       0          0          0          0
C100             5949       0          0          0          0
B100             5819       0          0          0          0
SJ001            5874       0          0          0          0
B110             5875       0          0          0          0
SJ002            5884       0          0          0          0
B120             5885       0          0          0          0
SJ003            5903.20    0          0          0          0
B135             5921       0          0          0          0
B130             5921       0          0          0          0
SJ004            5970       0          0          0          0
B140             5971       0          0          0          0
A160             5925.5     0          0          0          0
C125             6073       0          0          0          0

[OUTFALLS]
;;               Invert     Outfall    Stage/Table      Tide
;;Name           Elev.      Type       Time Series      Gate
;;-------------- ---------- ---------- ---------------- ----
NG-OUT           5765       FREE                        NO
```

Table B-7
Sample SWMM Input

```
[STORAGE]
;;                Invert   Max.     Init.    Storage    Curve                      Ponded   Evap.
;;Name           Elev.    Depth    Depth    Curve      Params                     Area     Frac.    Infiltration Parameters
;;-------------- -------- -------- -------- ---------- -------- -------- -------- -------- -------- -----------------------
NG220            6216.7   8        0        TABULAR    A220_STORAGE_RH_AUX-ONLY           0        0
SJ130            5918.7   5929.5   0        TABULAR    B130_STORAGE_PONDIV          0        0

[CONDUITS]
;;                Inlet            Outlet                      Manning    Inlet      Outlet     Init.      Max.
;;Name           Node             Node             Length     N          Offset     Offset     Flow       Flow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ---------- ----------
A10              NG001            NG000            3050       0.065      0          0          0          0
A10.4            NG002            NG001            1578       0.065      0          0          0          0
A100-DF          A100             NG000            10         0.01       0          0          0          0
A104-DF          A104             NG001            10         0.01       0          0          0          0
A108-DF          A108             NG000            10         0.01       0          0          0          0
A11              NG003            NG002            1930       0.085      0          0          0          0
A110-DF          A110             NG002            10         0.01       0          0          0          0
A115             A115             NG003            1050       0.060      0          0          0          0
A12              NG004            NG003            3190       0.085      0          0          0          0
A14              NG005.5          NG005            3090       0.06       0          0          0          0
A14.5            NG006            NG005.5          100        0.065      0          0          0          0
A120-DF          A120             NG003            10         0.01       0          0          0          0
A125             A125             NG004            950        0.065      0          0          0          0
A13              NG005            NG004            1200       0.065      0          0          0          0
A130-DF          A130             NG004            10         0.01       0          0          0          0
A135-DF          A135             NG005            10         0.01       0          0          0          0
A140-DF          A140             NG005            10         0.01       0          0          0          0
A145-DF          A145             NG005.5          10         0.01       0          0          0          0
A15              NG007            NG006            2156       0.06       0          0          0          0
A150-DF          A150             NG006            10         0.01       0          0          0          0
A155-DF          A155             NG006            10         0.01       0          0          0          0
A16              NG008            NG007            1550       0.06       0          0          0          0
A160-DF          A160             NG007            10         0.01       0          0          0          0
A165-DF          A165             NG007            10         0.01       0          0          0          0
A17              NG009            NG008            780        0.06       0          0          0          0
A170-DF          A170             NG008            10         0.01       0          0          0          0
A175-DF          A175             NG008            10         0.01       0          0          0          0
A180-DF          A180             NG009            10         0.01       0          0          0          0
A19              NG010            NG009            1450       0.06       0          0          0          0
A190-DF          A190             NG010            10         0.01       0          0          0          0
A20              NG011            NG010            2075       0.06       0          0          0          0
A200-DF          A200             NG010            10         0.01       0          0          0          0
A205-DF          A205             NG011            10         0.01       0          0          0          0
A21              NG012            NG011            4074       0.08       0          0          0          0
A210-DF          A210             NG011            10         0.01       0          0          0          0
A22              NG014            NG013            10         0.01       0          0          0          0
A220-DF          A220             NG220            10         0.01       0          0          0          0
```

Table B-7
Sample SWMM Input

A221-DF	A221	NG013	10	0.01	0	0	0	0
A222-DF	A222	NG013	10	0.01	0	0	0	0
A223-DF	A223	NG013	10	0.01	0	0	0	0
A224-DF	A224	NG013	10	0.01	0	0	0	0
A225-DF	A225	NG013	10	0.01	0	0	0	0
A226-DF	A226	NG013	10	0.01	0	0	0	0
A227-DF	A227	NG013	10	0.01	0	0	0	0
A228-DF	A228	NG013	10	0.01	0	0	0	0
A23	NG015	NG014	1318	0.06	0	0	0	0
A230-DF	A230	NG014	10	0.01	0	0	0	0
A24	NG016	NG015	1619	0.06	0	0	0	0
A240-DF	A240	NG015	10	0.01	0	0	0	0
A25	NG017	NG016	2673	0.075	0	0	0	0
A250-DF	A250	NG016	10	0.01	0	0	0	0
A26	NG018	NG017	2266	0.075	0	0	0	0
A260-DF	A260	NG017	10	0.01	0	0	0	0
A27	NG019	NG018	1637	0.075	0	0	0	0
A27.5	NG119	NG018	1584	0.065	0	0	0	0
A270-DF	A270	NG018	10	0.01	0	0	0	0
A275-DF	A275	NG119	10	0.01	0	0	0	0
A28	NG020	NG019	1818	0.075	0	0	0	0
A280-DF	A280	NG019	10	0.01	0	0	0	0
A29	NG021	NG020	1474	0.075	0	0	0	0
A290-DF	A290	NG020	10	0.01	0	0	0	0
A300-DF	A300	NG021	10	0.01	0	0	0	0
B10	SJ001	SJ000	3247	0.075	0	0	0	0
B100-DF	B100	SJ000	10	0.01	0	0	0	0
B11	SJ002	SJ001	1261	0.085	0	0	0	0
B110-DF	B110	SJ001	10	0.01	0	0	0	0
B12	SJ003	SJ002	1877	0.085	0	0	0	0
B120-DF	B120	SJ002	10	0.01	0	0	0	0
B13	SJ004	SJ130	3351	0.075	0	0	0	0
B130-DF	B130	SJ130	10	0.01	0	0	0	0
B135-DF	B135	SJ130	10	0.01	0	0	0	0
B140-DF	B140	SJ004	10	0.01	0	0	0	0
BW-OUT	BW000	NG013	10	0.01	0	0	0	0
C10	SP001	SP000	2104	0.075	0	0	0	0
C100-DF	C100	SP000	10	0.01	0	0	0	0
C11	SP002	SP001	3220	0.09	0	0	0	0
C11.5	C115	SP001	1577	0.09	0	0	0	0
C110-DF	C110	SP001	10	0.01	0	0	0	0
C120-DF	C120	SP002	10	0.01	0	0	0	0
C125-DF	C125	SP002	10	0.01	0	0	0	0
CT-OUT	CT000	NG013	10	0.01	0	0	0	0
D10	CT001	CT000	10	0.01	0	0	0	0
D100-DF	D100	CT001	10	0.01	0	0	0	0
D105-DF	D105	CT001	10	0.01	0	0	0	0
D110-DF	D110	CT001	10	0.01	0	0	0	0

Table B-7
Sample SWMM Input

D115-DF	D115	CT000	10	0.01	0	0	0	0
D120-DF	D120	CT000	10	0.01	0	0	0	0
D125-DF	D125	CT000	10	0.01	0	0	0	0
E10.5	BW001	BW000	10	0.01	0	0	0	0
E100-DF	E100	BW001	10	0.01	0	0	0	0
E105-DF	E105	BW000	10	0.01	0	0	0	0
E11	BW002	BW001	770	0.085	0	0	0	0
E110-DF	E110	BW001	10	0.01	0	0	0	0
E115-DF	E115	BW000	10	0.01	0	0	0	0
E120-DF	E120	BW002	10	0.01	0	0	0	0
E124-DF	E124	BW002	10	0.01	0	0	0	0
E128-DF	E128	BW000	10	0.01	0	0	0	0
F10	SN002	SN001	2768	0.075	0	0	0	0
F10.2	SN001	SN000	10	0.01	0	0	0	0
F100-DF	F100	SN001	10	0.01	0	0	0	0
F102-DF	F102	SN000	10	0.01	0	0	0	0
F104-DF	F104	SN000	10	0.01	0	0	0	0
F106-DF	F106	SN000	10	0.01	0	0	0	0
F11	SN003	SN002	1889	0.075	0	0	0	0
F110-DF	F110	SN002	10	0.01	0	0	0	0
F12	SN004	SN003	2764	0.075	0	0	0	0
F120-DF	F120	SN003	10	0.01	0	0	0	0
F125-DF	F125	SN004	10	0.01	0	0	0	0
F13	SN005	SN004	2822	0.075	0	0	0	0
F130-DF	F130	SN004	10	0.01	0	0	0	0
F14	SN006	SN005	2295	0.085	0	0	0	0
F140-DF	F140	SN005	10	0.01	0	0	0	0
F145-DF	F145	SN006	10	0.01	0	0	0	0
F15	SN007	SN006	2047	0.09	0	0	0	0
F150-DF	F150	SN006	10	0.01	0	0	0	0
F155-DF	F155	SN007	10	0.01	0	0	0	0
G10	MT001	MT000	1907	0.075	0	0	0	0
G100-DF	G100	MT000	10	0.01	0	0	0	0
G11	MT002	MT001	1883	0.085	0	0	0	0
G110-DF	G110	MT001	10	0.01	0	0	0	0
G115-DF	G115	MT002	10	0.01	0	0	0	0
G12	MT003	MT002	2682	0.085	0	0	0	0
G120-DF	G120	MT002	10	0.01	0	0	0	0
G130-DF	G130	MT003	10	0.01	0	0	0	0
H10	PW001	PW000	676	0.07	0	0	0	0
H100-DF	H100	PW000	10	0.01	0	0	0	0
H11	PW002	PW001	1853	0.085	0	0	0	0
H110-DF	H110	PW001	10	0.01	0	0	0	0
H115-DF	H115	PW001	10	0.01	0	0	0	0
H120-DF	H120	PW002	10	0.01	0	0	0	0
H125-DF	H125	PW002	10	0.01	0	0	0	0
I10	RT001	RT000	2491	.08	0	0	0	0
I100-DF	I100	RT000	10	0.01	0	0	0	0

Table B-7
Sample SWMM Input

```
I11              RT002            RT001            2223       0.085      0          0          0          0
I110-DF          I110             RT001            10         0.01       0          0          0          0
I115-DF          I115             RT002            10         0.01       0          0          0          0
I120-DF          I120             RT002            10         0.01       0          0          0          0
J10              ST001            ST000            2439       0.06       0          0          0          0
J100-DF          J100             ST000            10         0.01       0          0          0          0
J11              ST002            ST001            1373       0.08       0          0          0          0
J11.5            ST101            ST001            1694       0.08       0          0          0          0
J110-DF          J110             ST001            10         0.01       0          0          0          0
J12              ST102            ST101            3031       0.09       0          0          0          0
J120-DF          J120             ST101            10         0.01       0          0          0          0
J13              ST003            ST002            2060       0.08       0          0          0          0
J130-DF          J130             ST002            10         0.01       0          0          0          0
J14              ST004            ST003            1514       0.09       0          0          0          0
J140-DF          J140             ST003            10         0.01       0          0          0          0
J15              ST005            ST004            2361       0.09       0          0          0          0
J150-DF          J150             ST004            10         0.01       0          0          0          0
J155-DF          J155             ST102            10         0.01       0          0          0          0
J160-DF          J160             ST005            10         0.01       0          0          0          0
MT-OUT           MT000            SN001            10         0.01       0          0          0          0
NG220-IN         NG013            NG220            10         0.01       0          0          0          0
NG-OUT           NG000            NG-OUT           10         0.01       0          0          0          0
PW-OUT           PW000            NG013            10         0.01       0          0          0          0
RT-OUT           RT000            NG016            10         0.01       0          0          0          0
SJ-OUT           SJ000            NG002            10         0.01       0          0          0          0
SN-OUT           SN000            NG013            10         0.01       0          0          0          0
SP-OUT           SP000            NG008            20         0.01       0          0          0          0
ST-OUT           ST000            NG016            10         0.01       0          0          0          0

[OUTLETS]
;;               Inlet            Outlet           Outflow    Outlet          Qcoeff/                    Flap
;;Name           Node             Node             Height     Type            QTable           Qexpon    Gate
;;-------------- ---------------- ---------------- ---------- --------------- ---------------- ---------- ----
NG220-OUT        NG220            NG012            0          TABULAR/DEPTH   A220_OUTFLOW_RH_AUX-ONLY           NO
SJ130-OUT        SJ130            SJ003            0          TABULAR/DEPTH   B130_OUTFLOW_PONDIV           NO
```

Table B-7
Sample SWMM Input

```
[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4
Barrels
;;-------------- ------------ ---------------- ---------- ---------- ---------- --
--------
A10              TRAPEZOIDAL  15               130        6          6          1
A10.4            TRAPEZOIDAL  15               75         6          5          1
A100-DF          DUMMY        0                0          0          0          1
A104-DF          DUMMY        0                0          0          0          1
A108-DF          DUMMY        0                0          0          0          1
A11              TRAPEZOIDAL  15               60         5          5          1
A110-DF          DUMMY        0                0          0          0          1
A115             TRAPEZOIDAL  10               10         5          5          1
A12              TRAPEZOIDAL  10               65         5          5          1
A14              TRAPEZOIDAL  10               109        5          5          1
A14.5            TRAPEZOIDAL  10               109        5          5          1
A120-DF          DUMMY        0                0          0          0          1
A125             TRAPEZOIDAL  10               20         6          6          1
A13              TRAPEZOIDAL  10               110        5          5          1
A130-DF          DUMMY        0                0          0          0          1
A135-DF          DUMMY        0                0          0          0          1
A140-DF          DUMMY        0                0          0          0          1
A145-DF          DUMMY        0                0          0          0          1
A15              TRAPEZOIDAL  10               111        10         3.5        1
A150-DF          DUMMY        0                0          0          0          1
A155-DF          DUMMY        0                0          0          0          1
A16              TRAPEZOIDAL  10               110        20         10         1
A160-DF          DUMMY        0                0          0          0          1
A165-DF          DUMMY        0                0          0          0          1
A17              TRAPEZOIDAL  10               100        6          6          1
A170-DF          DUMMY        0                0          0          0          1
A175-DF          DUMMY        0                0          0          0          1
A180-DF          DUMMY        0                0          0          0          1
A19              TRAPEZOIDAL  10               80         3          5          1
A190-DF          DUMMY        0                0          0          0          1
A20              TRAPEZOIDAL  10               180        10         10         1
A200-DF          DUMMY        0                0          0          0          1
A205-DF          DUMMY        0                0          0          0          1
A21              TRAPEZOIDAL  10               330        5          5          1
A210-DF          DUMMY        0                0          0          0          1
A22              DUMMY        0                0          0          0          1
A220-DF          DUMMY        0                0          0          0          1
A221-DF          DUMMY        0                0          0          0          1
A222-DF          DUMMY        0                0          0          0          1
A223-DF          DUMMY        0                0          0          0          1
A224-DF          DUMMY        0                0          0          0          1
A225-DF          DUMMY        0                0          0          0          1
A226-DF          DUMMY        0                0          0          0          1
A227-DF          DUMMY        0                0          0          0          1
A228-DF          DUMMY        0                0          0          0          1
A23              TRAPEZOIDAL  10               80         10         10         1
A230-DF          DUMMY        0                0          0          0          1
A24              TRAPEZOIDAL  10               80         10         10         1
A240-DF          DUMMY        0                0          0          0          1
A25              TRAPEZOIDAL  10               50         10         10         1
A250-DF          DUMMY        0                0          0          0          1
A26              TRAPEZOIDAL  10               60         10         10         1
A260-DF          DUMMY        0                0          0          0          1
A27              TRAPEZOIDAL  10               32         10         10         1
A27.5            TRAPEZOIDAL  10               20         10         10         1
A270-DF          DUMMY        0                0          0          0          1
A275-DF          DUMMY        0                0          0          0          1
A28              TRAPEZOIDAL  10               30         10         10         1
A280-DF          DUMMY        0                0          0          0          1
A29              TRAPEZOIDAL  10               40         10         10         1
A290-DF          DUMMY        0                0          0          0          1
A300-DF          DUMMY        0                0          0          0          1
B10              TRAPEZOIDAL  10               32         9          5          1
B100-DF          DUMMY        0                0          0          0          1
B11              TRAPEZOIDAL  10               35         10         15         1
B110-DF          DUMMY        0                0          0          0          1
B12              TRAPEZOIDAL  10               35         10         10         1
B120-DF          DUMMY        0                0          0          0          1
B13              TRAPEZOIDAL  10               25         5          5          1
B130-DF          DUMMY        0                0          0          0          1
B135-DF          DUMMY        0                0          0          0          1
B140-DF          DUMMY        0                0          0          0          1
BW-OUT           DUMMY        0                0          0          0          1
C10              TRAPEZOIDAL  10               30         4          4          1
C100-DF          DUMMY        0                0          0          0          1
C11              TRAPEZOIDAL  10               20         4          4          1
C11.5            TRAPEZOIDAL  10               60         15         15         1
C110-DF          DUMMY        0                0          0          0          1
C120-DF          DUMMY        0                0          0          0          1
C125-DF          DUMMY        0                0          0          0          1
CT-OUT           DUMMY        0                0          0          0          1
D10              DUMMY        0                0          0          0          1
D100-DF          DUMMY        0                0          0          0          1
D105-DF          DUMMY        0                0          0          0          1
D110-DF          DUMMY        0                0          0          0          1
D115-DF          DUMMY        0                0          0          0          1
D120-DF          DUMMY        0                0          0          0          1
D125-DF          DUMMY        0                0          0          0          1
E10.5            DUMMY        0                0          0          0          1
E100-DF          DUMMY        0                0          0          0          1
E105-DF          DUMMY        0                0          0          0          1
```

Table B-7
Sample SWMM Input

```
E11             TRAPEZOIDAL 10          30      10      15      1
E110-DF         DUMMY       0           0       0       0       1
E115-DF         DUMMY       0           0       0       0       1
E120-DF         DUMMY       0           0       0       0       1
E124-DF         DUMMY       0           0       0       0       1
E128-DF         DUMMY       0           0       0       0       1
F10             TRAPEZOIDAL 10          60      10      10      1
F10.2           DUMMY       0           0       0       0       1
F100-DF         DUMMY       0           0       0       0       1
F102-DF         DUMMY       0           0       0       0       1
F104-DF         DUMMY       0           0       0       0       1
F106-DF         DUMMY       0           0       0       0       1
F11             TRAPEZOIDAL 10          40      9       10      1
F110-DF         DUMMY       0           0       0       0       1
F12             TRAPEZOIDAL 10          60      10      10      1
F120-DF         DUMMY       0           0       0       0       1
F125-DF         DUMMY       0           0       0       0       1
F13             TRAPEZOIDAL 10          25      10      10      1
F130-DF         DUMMY       0           0       0       0       1
F14             TRAPEZOIDAL 10          20      10      10      1
F140-DF         DUMMY       0           0       0       0       1
F145-DF         DUMMY       0           0       0       0       1
F15             TRAPEZOIDAL 10          20      10      10      1
F150-DF         DUMMY       0           0       0       0       1
F155-DF         DUMMY       0           0       0       0       1
G10             TRAPEZOIDAL 10          35      15      15      1
G100-DF         DUMMY       0           0       0       0       1
G11             TRAPEZOIDAL 10          30      15      10      1
G110-DF         DUMMY       0           0       0       0       1
G115-DF         DUMMY       0           0       0       0       1
G12             TRAPEZOIDAL 10          20      15      11      1
G120-DF         DUMMY       0           0       0       0       1
G130-DF         DUMMY       0           0       0       0       1
H10             TRAPEZOIDAL 10          70      10      10      1
H100-DF         DUMMY       0           0       0       0       1
H11             TRAPEZOIDAL 10          30      15      15      1
H110-DF         DUMMY       0           0       0       0       1
H115-DF         DUMMY       0           0       0       0       1
H120-DF         DUMMY       0           0       0       0       1
H125-DF         DUMMY       0           0       0       0       1
I10             TRAPEZOIDAL 10          35      10      10      1
I100-DF         DUMMY       0           0       0       0       1
I11             TRAPEZOIDAL 10          30      10      10      1
I110-DF         DUMMY       0           0       0       0       1
I115-DF         DUMMY       0           0       0       0       1
I120-DF         DUMMY       0           0       0       0       1
J10             TRAPEZOIDAL 10          40      7       10      1
J100-DF         DUMMY       0           0       0       0       1
J11             TRAPEZOIDAL 10          30      10      10      1
J11.5           TRAPEZOIDAL 10          60      10      10      1
J110-DF         DUMMY       0           0       0       0       1
J12             TRAPEZOIDAL 10          60      10      10      1
J120-DF         DUMMY       0           0       0       0       1
J13             TRAPEZOIDAL 10          25      6       6       1
J130-DF         DUMMY       0           0       0       0       1
J14             TRAPEZOIDAL 10          25      10      10      1
J140-DF         DUMMY       0           0       0       0       1
J15             TRAPEZOIDAL 10          30      10      10      1
J150-DF         DUMMY       0           0       0       0       1
J155-DF         DUMMY       0           0       0       0       1
J160-DF         DUMMY       0           0       0       0       1
MT-OUT          DUMMY       0           0       0       0       1
NG220-IN        DUMMY       0           0       0       0       1
NG-OUT          DUMMY       0           0       0       0       1
PW-OUT          DUMMY       0           0       0       0       1
RT-OUT          DUMMY       0           0       0       0       1
SJ-OUT          DUMMY       0           0       0       0       1
SN-OUT          DUMMY       0           0       0       0       1
SP-OUT          DUMMY       0           0       0       0       1
ST-OUT          DUMMY       0           0       0       0       1

[LOSSES]
;;Link           Inlet      Outlet     Average    Flap Gate
;;-------------- ---------- ---------- ---------- ----------

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
;A rating curve based on the aux. spillway outflow only
A220_OUTFLOW_RH_AUX-ONLY Rating     0.0        0.0
A220_OUTFLOW_RH_AUX-ONLY            0.4        359.0
A220_OUTFLOW_RH_AUX-ONLY            0.9        1220.0
A220_OUTFLOW_RH_AUX-ONLY            1.4        2381.0
A220_OUTFLOW_RH_AUX-ONLY            1.9        3785.0
A220_OUTFLOW_RH_AUX-ONLY            2.4        5403.0
A220_OUTFLOW_RH_AUX-ONLY            2.9        7217.0
A220_OUTFLOW_RH_AUX-ONLY            3.4        9213.0
A220_OUTFLOW_RH_AUX-ONLY            3.9        11380.0
A220_OUTFLOW_RH_AUX-ONLY            4.4        13712.0
A220_OUTFLOW_RH_AUX-ONLY            4.9        16202.0
A220_OUTFLOW_RH_AUX-ONLY            5.4        18846.0
A220_OUTFLOW_RH_AUX-ONLY            5.9        21640.0
A220_OUTFLOW_RH_AUX-ONLY            6.4        24579.0
;Bradbury Ranch Pond IV
;Based on field survey of outlet structure
```

Table B-7
Sample SWMM Input

```
B130_OUTFLOW_PONDIV Rating     0.00       0.00
B130_OUTFLOW_PONDIV            3.00       66.85
B130_OUTFLOW_PONDIV            3.50       94.54
B130_OUTFLOW_PONDIV            4.00       115.79
B130_OUTFLOW_PONDIV            4.50       133.70
B130_OUTFLOW_PONDIV            5.00       149.48
B130_OUTFLOW_PONDIV            5.50       163.75
B130_OUTFLOW_PONDIV            6.00       176.87
B130_OUTFLOW_PONDIV            6.50       189.08
B130_OUTFLOW_PONDIV            7.00       200.55
B130_OUTFLOW_PONDIV            7.50       211.40
B130_OUTFLOW_PONDIV            8.00       221.72
B130_OUTFLOW_PONDIV            8.50       231.58
B130_OUTFLOW_PONDIV            9.00       247.00
B130_OUTFLOW_PONDIV            9.50       290.23
B130_OUTFLOW_PONDIV            10.00      351.23
B130_OUTFLOW_PONDIV            10.50      426.96
B130_OUTFLOW_PONDIV            11.00      516.27
B130_OUTFLOW_PONDIV            11.30      576.13
;Storage curve for RH res. using only the volume above the aux. spillway

A220_STORAGE_RH_AUX-ONLY Storage    0          50660280
A220_STORAGE_RH_AUX-ONLY            1.4        50965200
A220_STORAGE_RH_AUX-ONLY            6.4        53622360
;Bradbury Ranch Pond IV
;Based on Douglas County 5-Foot Contours

B130_STORAGE_PONDIV Storage    0          0
B130_STORAGE_PONDIV            6.3        82308
B130_STORAGE_PONDIV            8.8        150181
B130_STORAGE_PONDIV            11.3       218054

[REPORT]
INPUT      NO
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS 3159265.825 1580659.249 3213328.325 1624721.749
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
NG001            3200434.454        1620248.042
A100             3199970.010        1620764.091
NG000            3202451.782        1621343.740
A104             3199678.939        1619983.260
A108             3201271.874        1620001.381
A110             3198372.235        1619389.734
NG002            3199282.115        1619471.773
SJ000            3199156.882        1619020.601
NG003            3198094.255        1618124.588
A115             3197290.806        1618920.633
A120             3197057.927        1616791.729
A125             3195098.188        1617980.024
NG004            3195670.146        1617209.123
A130             3194762.473        1617225.702
NG005            3195641.134        1616077.641
A135             3194874.378        1615828.963
A140             3195906.390        1615041.484
NG006            3194231.961        1613793.952
A145             3193519.086        1614245.716
A155             3193137.780        1613449.948
A150             3195011.151        1612732.928
NG005.5          3194365.598        1614031.019
NG007            3194447.957        1611819.688
A165             3193686.138        1612676.218
NG008            3193817.912        1610563.717
A170             3194880.340        1609987.206
NG009            3193620.251        1609542.469
A175             3194386.187        1609443.639
A180             3193937.332        1608764.179
NG011            3192067.790        1607137.595
NG010            3192969.618        1608467.688
A200             3193344.350        1607817.054
A190             3192269.569        1608434.745
A210             3190737.697        1607425.850
A205             3192920.202        1605823.973
NG012            3187913.217        1605737.905
A220             3189079.770        1604635.080
NG013            3187199.223        1600654.683
A221             3192630.208        1601386.761
A222             3191847.800        1599039.537
A223             3186560.371        1601880.913
A224             3184451.988        1601263.223
A225             3183611.929        1600489.051
A226             3182640.097        1599311.321
A227             3184050.826        1597685.449
A228             3181973.792        1597703.176
NG014            3181801.525        1596233.164
A230             3182054.183        1595429.252
```

Table B-7
Sample SWMM Input

NG015	3181342.146	1595234.016
A240	3181835.978	1594200.414
NG016	3180193.700	1594510.495
NG017	3178792.595	1592707.434
A250	3179481.663	1592856.732
A260	3178781.111	1591558.987
NG018	3177667.117	1591042.186
A270	3177288.130	1589801.864
NG019	3176231.559	1590376.087
NG119	3176346.404	1591616.409
NG020	3174531.859	1589664.050
A280	3175140.535	1590548.354
NG021	3173119.269	1589204.672
A290	3172981.456	1590123.429
A300	3171408.084	1588860.138
ST000	3179952.526	1594499.010
ST001	3177896.807	1594499.010
J100	3178746.657	1595268.469
J110	3177380.006	1594981.358
ST002	3176667.969	1594751.668
ST101	3176484.218	1593545.800
J130	3175576.945	1595383.314
ST003	3174910.846	1594832.060
J120	3175485.069	1592569.620
A275	3175393.193	1591581.956
J140	3174462.952	1594085.569
ST004	3173601.617	1594453.072
ST005	3172051.214	1592822.278
J150	3172797.704	1593017.514
J160	3171511.444	1592271.024
ST102	3174083.964	1592558.136
J155	3173348.959	1592098.757
RT000	3180342.905	1594247.620
RT001	3180294.275	1592229.463
I100	3180829.208	1593019.705
I110	3180750.184	1590728.003
RT002	3179686.397	1590253.858
I120	3180111.912	1589111.047
I115	3178926.549	1589141.441
SN000	3186307.280	1599343.304
F106	3187030.685	1597199.506
F102	3184580.514	1597121.723
F104	3184914.981	1595721.625
SN001	3185816.056	1595035.028
SN002	3186967.613	1592981.551
F100	3186105.958	1593770.730
SN003	3186927.349	1591274.346
F110	3186548.865	1592039.367
SN004	3185534.206	1589470.507
F120	3187048.142	1589969.784
F125	3185437.572	1588318.950
F130	3184229.644	1589365.820
SN005	3183601.521	1587859.937
F140	3183239.143	1586716.432
SN006	3182095.638	1586635.904
F145	3182039.268	1585427.976
F150	3180992.397	1586772.802
SN007	3180509.226	1585548.769
F155	3179864.998	1585081.703
MT000	3185501.994	1594865.918
G100	3185348.990	1593819.047
MT001	3184745.026	1593843.206
G110	3184543.705	1592828.547
MT002	3183738.420	1592554.750
MT003	3182337.224	1590380.480
G120	3182321.118	1591668.936
G115	3183851.160	1591411.245
G130	3181999.004	1589075.918
PW000	3181829.894	1598602.441
PW001	3181024.609	1598425.279
H100	3181523.886	1599005.084
H115	3179800.575	1599874.792
PW002	3179494.567	1597861.579
H125	3178326.903	1598723.234
H120	3178326.903	1596669.757
H110	3180460.909	1597555.571
BW000	3189200.837	1599595.230
BW001	3188983.065	1596577.241
BW002	3188671.911	1595900.527
E105	3188345.222	1598716.279
E115	3190422.034	1598467.373
E128	3190484.261	1596445.009
E100	3188345.222	1596701.694
E110	3189200.837	1596351.669
E120	3188104.094	1594834.896
E124	3189410.852	1594951.571
CT001	3184871.446	1603034.804
CT000	3187390.478	1603865.758
D110	3183464.713	1602910.488
D100	3185048.105	1602465.568
D105	3184727.501	1603466.638
D115	3185525.740	1604238.706
D120	3184433.069	1605102.374
D125	3187161.475	1605351.006
SP000	3193378.721	1610469.741
SP001	3191378.524	1609929.337

Table B-7
Sample SWMM Input

```
SP002            3189160.763        1608399.362
C115             3189673.094        1610083.738
C120             3188269.447        1608209.870
C110             3190515.282        1610645.197
C100             3192038.238        1609206.459
B100             3198457.573        1617400.937
SJ001            3198772.565        1615926.776
B110             3197922.087        1615384.991
SJ002            3198577.270        1614855.805
B120             3197449.600        1614068.326
SJ003            3198158.692        1613331.669
B135             3197229.106        1612468.169
B130             3197985.086        1612134.278
SJ004            3197985.086        1610464.822
B140             3197418.101        1609872.638
A160             3194441.016        1610864.530
C125             3188689.458        1607247.040
NG-OUT           3202809.768        1621537.649
NG220            3188520.098        1604504.431
SJ130            3198194.942        1613052.542

[VERTICES]
;;Link           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
A100-DF          3199916.049        1620821.678


[BACKDROP]
FILE       "P:\12-050.01 Newlin Gulch MDP - UDFCD\1 HYDROLOGY\Baseline\EPA SWMM -
v. 5.0\Input Files\SWMM_Background.jpg"
DIMENSIONS 3159262.493 1580662.582 3213324.993 1624725.082
```

Table B-8
Sample SWMM Output

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.021)
--------------------------------------------------------------

Newlin Gulch MDP
Baseline Hydrology Model
Future Development 100-yr no area adjustment

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Flow Routing Method ...... KINWAVE
Starting Date ............ JAN-01-2005 00:00:00
Ending Date .............. JAN-10-2005 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:15:00
Routing Time Step ........ 30.00 sec


**************************        Volume         Volume
Flow Routing Continuity        acre-feet       10^6 gal
**************************     ---------      ---------
Dry Weather Inflow .......         0.000          0.000
Wet Weather Inflow .......         0.000          0.000
Groundwater Inflow .......         0.000          0.000
RDII Inflow ..............         0.000          0.000
External Inflow ..........      1487.422        484.699
External Outflow .........      1511.396        492.511
Internal Outflow .........         0.000          0.000
Storage Losses ...........         0.000          0.000
Initial Stored Volume ....         0.000          0.000
Final Stored Volume ......         0.116          0.038
Continuity Error (%) .....        -1.620


*********************************
Highest Flow Instability Indexes
*********************************
Link SJ130-OUT (3)
Link B12 (3)
Link B11 (3)
Link SJ-OUT (3)
Link B10 (3)


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :    30.00 sec
Average Time Step           :    30.00 sec
Maximum Time Step           :    30.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     1.00


******************
Node Depth Summary
******************

----------------------------------------------------------------------
                                Average  Maximum  Maximum  Time of Max
                                  Depth    Depth      HGL   Occurrence
Node                 Type         Feet     Feet     Feet  days hr:min
----------------------------------------------------------------------
NG001                JUNCTION     0.38     5.89  5807.89     0  01:25
A100                 JUNCTION     0.00     0.00  5767.00     0  00:00
NG000                JUNCTION     0.25     3.95  5769.95     0  01:31
A104                 JUNCTION     0.00     0.00  5803.00     0  00:00
A108                 JUNCTION     0.00     0.00  5767.00     0  00:00
A110                 JUNCTION     0.00     0.00  5815.00     0  00:00
NG002                JUNCTION     0.47     6.42  5820.42     0  01:23
SJ000                JUNCTION     0.03     2.81  5820.81     0  01:00
NG003                JUNCTION     0.46     6.44  5838.44     0  01:18
A115                 JUNCTION     0.01     2.48  5848.48     0  00:39
A120                 JUNCTION     0.00     0.00  5833.00     0  00:00
A125                 JUNCTION     0.01     1.67  5875.67     0  00:41
NG004                JUNCTION     0.44     6.13  5866.13     0  01:11
A130                 JUNCTION     0.00     0.00  5861.00     0  00:00
NG005                JUNCTION     0.31     4.36  5871.86     0  01:09
A135                 JUNCTION     0.00     0.00  5868.50     0  00:00
A140                 JUNCTION     0.00     0.00  5868.50     0  00:00
```

Table B-8
Sample SWMM Output

NG006	JUNCTION	0.27	3.60	5905.60	0	01:05	ST001	JUNCTION	0.02	3.23	6297.23	0	00:49
A145	JUNCTION	0.00	0.00	5903.00	0	00:00	J100	JUNCTION	0.00	0.00	6252.00	0	00:00
A155	JUNCTION	0.00	0.00	5903.00	0	00:00	J110	JUNCTION	0.00	0.00	6295.00	0	00:00
A150	JUNCTION	0.00	0.00	5903.00	0	00:00	ST002	JUNCTION	0.02	2.85	6327.85	0	00:58
NG005.5	JUNCTION	0.27	3.60	5904.60	0	01:05	ST101	JUNCTION	0.01	1.50	6346.50	0	00:45
NG007	JUNCTION	0.25	3.13	5927.63	0	01:00	J130	JUNCTION	0.00	0.00	6326.00	0	00:00
A165	JUNCTION	0.00	0.00	5925.50	0	00:00	ST003	JUNCTION	0.02	2.88	6365.88	0	00:51
NG008	JUNCTION	0.25	2.91	5940.91	0	00:58	J120	JUNCTION	0.00	0.00	6346.00	0	00:00
A170	JUNCTION	0.00	0.00	5939.00	0	00:00	A275	JUNCTION	0.00	0.00	6396.00	0	00:00
NG009	JUNCTION	0.28	2.54	5950.54	0	02:41	J140	JUNCTION	0.00	0.00	6364.00	0	00:00
A175	JUNCTION	0.00	0.00	5939.00	0	00:00	ST004	JUNCTION	0.02	2.17	6399.17	0	00:51
A180	JUNCTION	0.00	0.00	5949.00	0	00:00	ST005	JUNCTION	0.01	1.29	6472.29	0	00:45
NG011	JUNCTION	0.16	1.47	5993.47	0	02:45	J150	JUNCTION	0.00	0.00	6398.00	0	00:00
NG010	JUNCTION	0.28	2.54	5966.54	0	02:37	J160	JUNCTION	0.00	0.00	6472.00	0	00:00
A200	JUNCTION	0.00	0.00	5965.00	0	00:00	ST102	JUNCTION	0.00	1.00	6429.00	0	00:38
A190	JUNCTION	0.00	0.00	5965.00	0	00:00	J155	JUNCTION	0.00	0.00	6429.00	0	00:00
A210	JUNCTION	0.00	0.00	5993.00	0	00:00	RT000	JUNCTION	0.02	2.08	6253.08	0	01:07
A205	JUNCTION	0.00	0.00	5993.00	0	00:00	RT001	JUNCTION	0.02	2.12	6299.12	0	00:56
NG012	JUNCTION	0.08	0.80	6217.30	0	02:43	I100	JUNCTION	0.00	0.00	6252.00	0	00:00
A220	JUNCTION	0.00	0.00	6217.00	0	00:00	I110	JUNCTION	0.00	0.00	6298.00	0	00:00
NG013	JUNCTION	0.00	0.00	6217.00	0	00:00	RT002	JUNCTION	0.01	1.48	6361.48	0	00:51
A221	JUNCTION	0.00	0.00	6218.00	0	00:00	I120	JUNCTION	0.00	0.00	6361.00	0	00:00
A222	JUNCTION	0.00	0.00	6218.00	0	00:00	I115	JUNCTION	0.00	0.00	6361.00	0	00:00
A223	JUNCTION	0.00	0.00	6218.00	0	00:00	SN000	JUNCTION	0.00	0.00	6218.00	0	00:00
A224	JUNCTION	0.00	0.00	6218.00	0	00:00	F106	JUNCTION	0.00	0.00	6219.00	0	00:00
A225	JUNCTION	0.00	0.00	6218.00	0	00:00	F102	JUNCTION	0.00	0.00	6219.00	0	00:00
A226	JUNCTION	0.00	0.00	6218.00	0	00:00	F104	JUNCTION	0.00	0.00	6219.00	0	00:00
A227	JUNCTION	0.00	0.00	6218.00	0	00:00	SN001	JUNCTION	0.03	2.68	6221.68	0	01:28
A228	JUNCTION	0.00	0.00	6218.00	0	00:00	SN002	JUNCTION	0.03	3.06	6267.06	0	01:22
NG014	JUNCTION	0.04	4.22	6222.22	0	01:04	F100	JUNCTION	0.00	0.00	6220.00	0	00:00
A230	JUNCTION	0.00	0.00	6219.00	0	00:00	SN003	JUNCTION	0.03	3.07	6297.07	0	01:16
NG015	JUNCTION	0.04	4.47	6239.47	0	01:02	F110	JUNCTION	0.00	0.00	6265.00	0	00:00
A240	JUNCTION	0.00	0.00	6236.00	0	00:00	SN004	JUNCTION	0.03	2.90	6337.90	0	01:13
NG016	JUNCTION	0.04	4.48	6254.48	0	00:58	F120	JUNCTION	0.00	0.00	6295.00	0	00:00
NG017	JUNCTION	0.02	2.99	6297.99	0	00:51	F125	JUNCTION	0.00	0.00	6336.00	0	00:00
A250	JUNCTION	0.00	0.00	6251.00	0	00:00	F130	JUNCTION	0.00	0.00	6336.00	0	00:00
A260	JUNCTION	0.00	0.00	6296.00	0	00:00	SN005	JUNCTION	0.02	2.95	6379.95	0	01:01
NG018	JUNCTION	0.02	2.64	6335.64	0	00:41	F140	JUNCTION	0.00	0.00	6378.00	0	00:00
A270	JUNCTION	0.00	0.00	6334.00	0	00:00	SN006	JUNCTION	0.02	2.87	6417.87	0	00:51
NG019	JUNCTION	0.02	2.15	6382.15	0	00:38	F145	JUNCTION	0.00	0.00	6416.00	0	00:00
NG119	JUNCTION	0.00	1.23	6396.23	0	00:35	F150	JUNCTION	0.00	0.00	6416.00	0	00:00
NG020	JUNCTION	0.02	2.09	6412.09	0	00:52	SN007	JUNCTION	0.01	1.88	6471.88	0	00:42
A280	JUNCTION	0.00	0.00	6381.00	0	00:00	F155	JUNCTION	0.00	0.00	6471.00	0	00:00
NG021	JUNCTION	0.01	1.03	6451.03	0	00:53	MT000	JUNCTION	0.02	2.31	6222.31	0	01:09
A290	JUNCTION	0.00	0.00	6411.00	0	00:00	G100	JUNCTION	0.00	0.00	6221.00	0	00:00
A300	JUNCTION	0.00	0.00	6451.00	0	00:00	MT001	JUNCTION	0.02	2.33	6250.33	0	01:01
ST000	JUNCTION	0.02	3.21	6254.21	0	00:55	G110	JUNCTION	0.00	0.00	6249.00	0	00:00

Table B-8
Sample SWMM Output

MT002	JUNCTION	0.02	2.21	6287.21	0	00:55
MT003	JUNCTION	0.01	1.49	6355.49	0	00:48
G120	JUNCTION	0.00	0.00	6286.00	0	00:00
G115	JUNCTION	0.00	0.00	6286.00	0	00:00
G130	JUNCTION	0.00	0.00	6355.00	0	00:00
PW000	JUNCTION	0.01	2.61	6220.61	0	00:45
PW001	JUNCTION	0.01	2.61	6230.61	0	00:43
H100	JUNCTION	0.00	0.00	6219.00	0	00:00
H115	JUNCTION	0.00	0.00	6229.00	0	00:00
PW002	JUNCTION	0.01	2.51	6279.51	0	00:38
H125	JUNCTION	0.00	0.00	6278.00	0	00:00
H120	JUNCTION	0.00	0.00	6278.00	0	00:00
H110	JUNCTION	0.00	0.00	6229.00	0	00:00
BW000	JUNCTION	0.00	0.00	6218.00	0	00:00
BW001	JUNCTION	0.01	1.94	6220.94	0	00:50
BW002	JUNCTION	0.01	1.94	6236.94	0	00:47
E105	JUNCTION	0.00	0.00	6219.00	0	00:00
E115	JUNCTION	0.00	0.00	6219.00	0	00:00
E128	JUNCTION	0.00	0.00	6219.00	0	00:00
E100	JUNCTION	0.00	0.00	6220.00	0	00:00
E110	JUNCTION	0.00	0.00	6220.00	0	00:00
E120	JUNCTION	0.00	0.00	6236.00	0	00:00
E124	JUNCTION	0.00	0.00	6236.00	0	00:00
CT001	JUNCTION	0.00	0.00	6219.00	0	00:00
CT000	JUNCTION	0.00	0.00	6218.00	0	00:00
D110	JUNCTION	0.00	0.00	6220.00	0	00:00
D100	JUNCTION	0.00	0.00	6220.00	0	00:00
D105	JUNCTION	0.00	0.00	6220.00	0	00:00
D115	JUNCTION	0.00	0.00	6219.00	0	00:00
D120	JUNCTION	0.00	0.00	6219.00	0	00:00
D125	JUNCTION	0.00	0.00	6219.00	0	00:00
SP000	JUNCTION	0.03	3.35	5951.35	0	01:01
SP001	JUNCTION	0.03	3.37	5981.37	0	00:55
SP002	JUNCTION	0.02	2.32	6074.32	0	00:52
C115	JUNCTION	0.00	1.11	6013.11	0	00:38
C120	JUNCTION	0.00	0.00	6073.00	0	00:00
C110	JUNCTION	0.00	0.00	5979.00	0	00:00
C100	JUNCTION	0.00	0.00	5949.00	0	00:00
B100	JUNCTION	0.00	0.00	5819.00	0	00:00
SJ001	JUNCTION	0.03	2.89	5876.89	0	00:48
B110	JUNCTION	0.00	0.00	5875.00	0	00:00
SJ002	JUNCTION	0.03	2.55	5886.55	0	01:07
B120	JUNCTION	0.00	0.00	5885.00	0	00:00
SJ003	JUNCTION	0.02	2.27	5905.47	0	01:09
B135	JUNCTION	0.00	0.00	5921.00	0	00:00
B130	JUNCTION	0.00	0.00	5921.00	0	00:00
SJ004	JUNCTION	0.01	1.93	5971.93	0	00:37
B140	JUNCTION	0.00	0.00	5971.00	0	00:00
A160	JUNCTION	0.00	0.00	5925.50	0	00:00
C125	JUNCTION	0.00	0.00	6073.00	0	00:00
NG-OUT	OUTFALL	0.00	0.00	5765.00	0	00:00
NG220	STORAGE	0.06	0.77	6217.47	0	02:43
SJ130	STORAGE	0.08	9.76	5928.46	0	01:09

Table B-8
Sample SWMM Output

```
*******************
Node Inflow Summary
*******************
```

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal
NG001	JUNCTION	0.00	3450.18	0 01:24	0.000	484.101
A100	JUNCTION	168.16	168.16	0 00:45	4.037	4.037
NG000	JUNCTION	0.00	3538.53	0 01:30	0.000	492.474
A104	JUNCTION	38.27	38.27	0 00:44	0.920	0.920
A108	JUNCTION	159.51	159.51	0 00:44	3.751	3.751
A110	JUNCTION	236.01	236.01	0 00:35	3.269	3.269
NG002	JUNCTION	0.00	3442.67	0 01:21	0.000	483.085
SJ000	JUNCTION	0.00	757.65	0 00:58	0.000	28.595
NG003	JUNCTION	0.00	2824.63	0 01:18	0.000	451.039
A115	JUNCTION	214.82	214.82	0 00:39	4.083	4.083
A120	JUNCTION	281.77	281.77	0 00:43	6.184	6.184
A125	JUNCTION	160.69	160.69	0 00:41	3.299	3.299
NG004	JUNCTION	0.00	2659.53	0 01:11	0.000	440.055
A130	JUNCTION	188.29	188.29	0 00:39	3.423	3.423
NG005	JUNCTION	0.00	2493.25	0 01:09	0.000	433.233
A135	JUNCTION	319.78	319.78	0 00:40	5.618	5.618
A140	JUNCTION	165.99	165.99	0 00:41	3.459	3.459
NG006	JUNCTION	0.00	2243.61	0 01:05	0.000	421.270
A145	JUNCTION	172.39	172.39	0 00:35	2.503	2.503
A155	JUNCTION	217.92	217.92	0 00:35	2.980	2.980
A150	JUNCTION	230.85	230.85	0 00:46	5.896	5.896
NG005.5	JUNCTION	0.00	2291.41	0 01:04	0.000	423.774
NG007	JUNCTION	0.00	2018.62	0 01:00	0.000	412.210
A165	JUNCTION	498.01	498.01	0 00:38	7.852	7.852
NG008	JUNCTION	0.00	1780.36	0 00:58	0.000	403.010
A170	JUNCTION	230.01	230.01	0 00:41	4.693	4.693
NG009	JUNCTION	0.00	1028.95	0 02:39	0.000	371.987
A175	JUNCTION	199.40	199.40	0 00:38	3.269	3.269
A180	JUNCTION	301.77	301.77	0 00:41	5.918	5.918
NG011	JUNCTION	0.00	1014.56	0 02:45	0.000	357.029
NG010	JUNCTION	0.00	1027.45	0 02:37	0.000	365.999
A200	JUNCTION	204.52	204.52	0 00:46	5.601	5.601
A190	JUNCTION	93.98	93.98	0 00:51	3.060	3.060
A210	JUNCTION	243.70	243.70	0 00:49	6.792	6.792
A205	JUNCTION	84.60	84.60	0 00:55	3.040	3.040
NG012	JUNCTION	0.00	999.29	0 02:43	0.000	346.741
A220	JUNCTION	2957.75	2957.75	0 01:07	88.127	88.127

Table B-8
Sample SWMM Output

NG013	JUNCTION	0.00	7648.84	0	00:57	0.000	258.664
A221	JUNCTION	58.31	58.31	0	00:37	0.846	0.846
A222	JUNCTION	393.32	393.32	0	00:36	5.378	5.378
A223	JUNCTION	140.08	140.08	0	00:36	1.843	1.843
A224	JUNCTION	72.34	72.34	0	00:41	1.459	1.459
A225	JUNCTION	137.18	137.18	0	00:43	2.954	2.954
A226	JUNCTION	176.66	176.66	0	00:45	4.157	4.157
A227	JUNCTION	300.10	300.10	0	00:36	4.355	4.355
A228	JUNCTION	159.69	159.69	0	00:32	1.847	1.847
NG014	JUNCTION	0.00	3255.89	0	01:03	0.000	101.077
A230	JUNCTION	390.42	390.42	0	00:36	5.788	5.788
NG015	JUNCTION	0.00	3115.67	0	01:01	0.000	95.234
A240	JUNCTION	451.78	451.78	0	00:36	6.747	6.747
NG016	JUNCTION	0.00	2952.78	0	00:58	0.000	88.405
NG017	JUNCTION	0.00	1028.47	0	00:51	0.000	29.020
A250	JUNCTION	107.06	107.06	0	00:48	3.198	3.198
A260	JUNCTION	147.85	147.85	0	00:48	4.255	4.255
NG018	JUNCTION	0.00	932.83	0	00:41	0.000	24.495
A270	JUNCTION	278.64	278.64	0	00:40	5.467	5.467
NG019	JUNCTION	0.00	514.44	0	00:38	0.000	16.556
NG119	JUNCTION	0.00	166.58	0	00:35	0.000	2.400
NG020	JUNCTION	0.00	351.54	0	00:52	0.000	10.307
A280	JUNCTION	484.76	484.76	0	00:34	6.181	6.181
NG021	JUNCTION	0.00	152.09	0	00:53	0.000	4.882
A290	JUNCTION	237.25	237.25	0	00:42	5.377	5.377
A300	JUNCTION	152.09	152.09	0	00:53	4.882	4.882
ST000	JUNCTION	0.00	1427.27	0	00:52	0.000	39.219
ST001	JUNCTION	0.00	1244.02	0	00:49	0.000	34.052
J100	JUNCTION	304.93	304.93	0	00:37	5.040	5.040
J110	JUNCTION	200.11	200.11	0	00:40	3.962	3.962
ST002	JUNCTION	0.00	659.36	0	00:45	0.000	20.359
ST101	JUNCTION	0.00	418.87	0	00:45	0.000	9.630
J130	JUNCTION	590.31	590.31	0	00:33	7.039	7.039
ST003	JUNCTION	0.00	491.30	0	00:51	0.000	13.251
J120	JUNCTION	340.70	340.70	0	00:39	6.317	6.317
A275	JUNCTION	166.58	166.58	0	00:35	2.400	2.400
J140	JUNCTION	252.76	252.76	0	00:38	4.348	4.348
ST004	JUNCTION	0.00	325.66	0	00:51	0.000	8.875
ST005	JUNCTION	0.00	161.08	0	00:45	0.000	4.296
J150	JUNCTION	216.40	216.40	0	00:40	4.481	4.481
J160	JUNCTION	161.08	161.08	0	00:45	4.296	4.296
ST102	JUNCTION	0.00	175.20	0	00:38	0.000	3.052
J155	JUNCTION	175.20	175.20	0	00:38	3.052	3.052
RT000	JUNCTION	0.00	503.71	0	01:04	0.000	16.546
RT001	JUNCTION	0.00	398.85	0	00:56	0.000	12.581
I100	JUNCTION	156.77	156.77	0	00:43	3.790	3.790
I110	JUNCTION	223.17	223.17	0	00:45	5.874	5.874

Table B-8
Sample SWMM Output

RT002	JUNCTION	0.00	207.96	0	00:51	0.000	6.590
I120	JUNCTION	81.60	81.60	0	00:54	2.879	2.879
I115	JUNCTION	127.87	127.87	0	00:49	3.711	3.711
SN000	JUNCTION	0.00	1706.88	0	01:18	0.000	74.027
F106	JUNCTION	229.46	229.46	0	00:38	3.929	3.929
F102	JUNCTION	119.39	119.39	0	00:40	2.305	2.305
F104	JUNCTION	372.68	372.68	0	00:36	5.426	5.426
SN001	JUNCTION	0.00	1563.88	0	01:22	0.000	62.367
SN002	JUNCTION	0.00	963.51	0	01:20	0.000	37.148
F100	JUNCTION	149.78	149.78	0	00:55	5.482	5.482
SN003	JUNCTION	0.00	882.28	0	01:16	0.000	32.001
F110	JUNCTION	249.58	249.58	0	00:40	5.056	5.056
SN004	JUNCTION	0.00	778.56	0	01:10	0.000	25.936
F120	JUNCTION	255.31	255.31	0	00:42	5.779	5.779
F125	JUNCTION	133.06	133.06	0	00:45	3.524	3.524
F130	JUNCTION	121.48	121.48	0	00:51	3.880	3.880
SN005	JUNCTION	0.00	598.39	0	01:01	0.000	18.349
F140	JUNCTION	164.71	164.71	0	00:51	5.211	5.211
SN006	JUNCTION	0.00	465.13	0	00:51	0.000	12.959
F145	JUNCTION	123.12	123.12	0	00:50	3.846	3.846
F150	JUNCTION	127.15	127.15	0	00:51	4.036	4.036
SN007	JUNCTION	0.00	230.22	0	00:42	0.000	4.951
F155	JUNCTION	230.22	230.22	0	00:42	4.951	4.951
MT000	JUNCTION	0.00	597.93	0	01:08	0.000	19.455
G100	JUNCTION	97.93	97.93	0	00:47	2.859	2.859
MT001	JUNCTION	0.00	523.89	0	01:01	0.000	16.483
G110	JUNCTION	147.92	147.92	0	00:45	3.853	3.853
MT002	JUNCTION	0.00	406.05	0	00:55	0.000	12.527
MT003	JUNCTION	0.00	165.26	0	00:48	0.000	4.700
G120	JUNCTION	166.04	166.04	0	00:43	3.920	3.920
G115	JUNCTION	125.05	125.05	0	00:48	3.751	3.751
G130	JUNCTION	165.26	165.26	0	00:48	4.700	4.700
PW000	JUNCTION	0.00	1120.96	0	00:45	0.000	22.934
PW001	JUNCTION	0.00	1046.06	0	00:43	0.000	21.457
H100	JUNCTION	93.48	93.48	0	00:36	1.460	1.460
H115	JUNCTION	150.38	150.38	0	00:49	4.472	4.472
PW002	JUNCTION	0.00	665.92	0	00:38	0.000	11.777
H125	JUNCTION	238.37	238.37	0	00:41	5.201	5.201
H120	JUNCTION	444.33	444.33	0	00:36	6.576	6.576
H110	JUNCTION	324.93	324.93	0	00:37	5.126	5.126
BW000	JUNCTION	0.00	955.89	0	00:45	0.000	22.961
BW001	JUNCTION	0.00	536.24	0	00:47	0.000	13.641
BW002	JUNCTION	0.00	322.59	0	00:47	0.000	8.887
E105	JUNCTION	129.93	129.93	0	00:38	2.040	2.040
E115	JUNCTION	125.91	125.91	0	00:37	1.888	1.888
E128	JUNCTION	199.53	199.53	0	00:47	5.392	5.392
E100	JUNCTION	172.69	172.69	0	00:41	3.714	3.714

Table B-8
Sample SWMM Output

E110	JUNCTION	58.25	58.25	0	00:38	1.034	1.034
E120	JUNCTION	230.98	230.98	0	00:43	5.620	5.620
E124	JUNCTION	99.45	99.45	0	00:53	3.267	3.267
CT001	JUNCTION	0.00	313.01	0	00:45	0.000	8.233
CT000	JUNCTION	0.00	683.71	0	00:41	0.000	14.825
D110	JUNCTION	160.59	160.59	0	00:50	5.064	5.064
D100	JUNCTION	127.44	127.44	0	00:39	2.260	2.260
D105	JUNCTION	38.60	38.60	0	00:43	0.909	0.909
D115	JUNCTION	66.07	66.07	0	00:41	1.327	1.327
D120	JUNCTION	213.54	213.54	0	00:38	3.520	3.520
D125	JUNCTION	106.58	106.58	0	00:38	1.745	1.745
SP000	JUNCTION	0.00	763.03	0	00:59	0.000	23.040
SP001	JUNCTION	0.00	643.64	0	00:55	0.000	19.199
SP002	JUNCTION	0.00	275.83	0	00:52	0.000	9.198
C115	JUNCTION	194.52	194.52	0	00:38	3.540	3.540
C120	JUNCTION	194.75	194.75	0	00:51	6.279	6.279
C110	JUNCTION	274.99	274.99	0	00:42	6.164	6.164
C100	JUNCTION	183.63	183.63	0	00:41	3.729	3.729
B100	JUNCTION	197.39	197.39	0	00:43	4.380	4.380
SJ001	JUNCTION	0.00	637.40	0	00:48	0.000	23.951
B110	JUNCTION	291.58	291.58	0	00:42	6.182	6.182
SJ002	JUNCTION	0.00	382.84	0	01:07	0.000	17.710
B120	JUNCTION	338.85	338.85	0	00:36	4.919	4.919
SJ003	JUNCTION	0.00	321.36	0	01:09	0.000	12.714
B135	JUNCTION	346.08	346.08	0	00:37	5.358	5.358
B130	JUNCTION	223.83	223.83	0	00:38	3.761	3.761
SJ004	JUNCTION	0.00	214.46	0	00:37	0.000	3.379
B140	JUNCTION	214.46	214.46	0	00:37	3.379	3.379
A160	JUNCTION	37.90	37.90	0	00:51	1.230	1.230
C125	JUNCTION	82.11	82.11	0	00:55	2.918	2.918
NG-OUT	OUTFALL	0.00	3538.53	0	01:30	0.000	492.474
NG220	STORAGE	0.00	10361.85	0	01:03	0.000	346.791
SJ130	STORAGE	0.00	644.40	0	00:41	0.000	12.716

Table B-8
Sample SWMM Output

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**********************
Node Surcharge Summary
**********************

Surcharging occurs when water rises above the top of the highest conduit.
-------------------------------------------------------------------------
                                        Max. Height   Min. Depth
                              Hours     Above Crown    Below Rim
Node                 Type   Surcharged       Feet         Feet
-------------------------------------------------------------------------
A100                 JUNCTION    216.01       0.000        0.000
A104                 JUNCTION    216.01       0.000        0.000
A108                 JUNCTION    216.01       0.000        0.000
A110                 JUNCTION    216.01       0.000        0.000
A120                 JUNCTION    216.01       0.000        0.000
A130                 JUNCTION    216.01       0.000        0.000
A135                 JUNCTION    216.01       0.000        0.000
A140                 JUNCTION    216.01       0.000        0.000
A145                 JUNCTION    216.01       0.000        0.000
A155                 JUNCTION    216.01       0.000        0.000
A150                 JUNCTION    216.01       0.000        0.000
A165                 JUNCTION    216.01       0.000        0.000
A170                 JUNCTION    216.01       0.000        0.000
A175                 JUNCTION    216.01       0.000        0.000
A180                 JUNCTION    216.01       0.000        0.000
A200                 JUNCTION    216.01       0.000        0.000
A190                 JUNCTION    216.01       0.000        0.000
A210                 JUNCTION    216.01       0.000        0.000
A205                 JUNCTION    216.01       0.000        0.000
A220                 JUNCTION    216.01       0.000        0.000
NG013                JUNCTION    216.01       0.000        0.000
A221                 JUNCTION    216.01       0.000        0.000
A222                 JUNCTION    216.01       0.000        0.000
A223                 JUNCTION    216.01       0.000        0.000
A224                 JUNCTION    216.01       0.000        0.000
A225                 JUNCTION    216.01       0.000        0.000
A226                 JUNCTION    216.01       0.000        0.000
A227                 JUNCTION    216.01       0.000        0.000
A228                 JUNCTION    216.01       0.000        0.000
A230                 JUNCTION    216.01       0.000        0.000
A240                 JUNCTION    216.01       0.000        0.000
A250                 JUNCTION    216.01       0.000        0.000
A260                 JUNCTION    216.01       0.000        0.000
A270                 JUNCTION    216.01       0.000        0.000
A280                 JUNCTION    216.01       0.000        0.000
A290                 JUNCTION    216.01       0.000        0.000
A300                 JUNCTION    216.01       0.000        0.000
J100                 JUNCTION    216.01       0.000        0.000
J110                 JUNCTION    216.01       0.000        0.000
J130                 JUNCTION    216.01       0.000        0.000
J120                 JUNCTION    216.01       0.000        0.000
A275                 JUNCTION    216.01       0.000        0.000
J140                 JUNCTION    216.01       0.000        0.000
J150                 JUNCTION    216.01       0.000        0.000
J160                 JUNCTION    216.01       0.000        0.000
J155                 JUNCTION    216.01       0.000        0.000
I100                 JUNCTION    216.01       0.000        0.000
I110                 JUNCTION    216.01       0.000        0.000
I120                 JUNCTION    216.01       0.000        0.000
I115                 JUNCTION    216.01       0.000        0.000
SN000                JUNCTION    216.01       0.000        0.000
F106                 JUNCTION    216.01       0.000        0.000
F102                 JUNCTION    216.01       0.000        0.000
F104                 JUNCTION    216.01       0.000        0.000
F100                 JUNCTION    216.01       0.000        0.000
F110                 JUNCTION    216.01       0.000        0.000
F120                 JUNCTION    216.01       0.000        0.000
F125                 JUNCTION    216.01       0.000        0.000
F130                 JUNCTION    216.01       0.000        0.000
F140                 JUNCTION    216.01       0.000        0.000
F145                 JUNCTION    216.01       0.000        0.000
F150                 JUNCTION    216.01       0.000        0.000
F155                 JUNCTION    216.01       0.000        0.000
G100                 JUNCTION    216.01       0.000        0.000
G110                 JUNCTION    216.01       0.000        0.000
G120                 JUNCTION    216.01       0.000        0.000
G115                 JUNCTION    216.01       0.000        0.000
G130                 JUNCTION    216.01       0.000        0.000
H100                 JUNCTION    216.01       0.000        0.000
H115                 JUNCTION    216.01       0.000        0.000
H125                 JUNCTION    216.01       0.000        0.000
H120                 JUNCTION    216.01       0.000        0.000
H110                 JUNCTION    216.01       0.000        0.000
BW000                JUNCTION    216.01       0.000        0.000
E105                 JUNCTION    216.01       0.000        0.000
E115                 JUNCTION    216.01       0.000        0.000
E128                 JUNCTION    216.01       0.000        0.000
E100                 JUNCTION    216.01       0.000        0.000
E110                 JUNCTION    216.01       0.000        0.000
E120                 JUNCTION    216.01       0.000        0.000
E124                 JUNCTION    216.01       0.000        0.000
CT001                JUNCTION    216.01       0.000        0.000
CT000                JUNCTION    216.01       0.000        0.000
D110                 JUNCTION    216.01       0.000        0.000
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Table B-8
Sample SWMM Output

D100	JUNCTION	216.01	0.000	0.000
D105	JUNCTION	216.01	0.000	0.000
D115	JUNCTION	216.01	0.000	0.000
D120	JUNCTION	216.01	0.000	0.000
D125	JUNCTION	216.01	0.000	0.000
C120	JUNCTION	216.01	0.000	0.000
C110	JUNCTION	216.01	0.000	0.000
C100	JUNCTION	216.01	0.000	0.000
B100	JUNCTION	216.01	0.000	0.000
B110	JUNCTION	216.01	0.000	0.000
B120	JUNCTION	216.01	0.000	0.000
B135	JUNCTION	216.01	0.000	0.000
B130	JUNCTION	216.01	0.000	0.000
B140	JUNCTION	216.01	0.000	0.000
A160	JUNCTION	216.01	0.000	0.000
C125	JUNCTION	216.01	0.000	0.000
NG220	STORAGE	216.01	0.772	7.228

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	E&I Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CFS
NG220	2952.271	1	0	39166.232	9	0 02:43	999.29
SJ130	3.991	0	0	705.859	0	0 01:08	321.36

****

Outfall Loading Summary
****

Outfall Node	Flow Freq. Pcnt.	Avg. Flow CFS	Max. Flow CFS	Total Volume 10^6 gal
NG-OUT	91.89	92.14	3538.53	492.474
System	91.89	92.14	3538.53	492.474

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
A10	CONDUIT	3422.70	0 01:31	5.70	0.09	0.26
A10.4	CONDUIT	3434.27	0 01:25	5.46	0.16	0.39
A100-DF	DUMMY	168.16	0 00:45			
A104-DF	DUMMY	38.27	0 00:44			
A108-DF	DUMMY	159.51	0 00:44			
A11	CONDUIT	2807.68	0 01:23	4.80	0.18	0.43
A110-DF	DUMMY	236.01	0 00:35			
A115	CONDUIT	211.07	0 00:43	3.91	0.04	0.25
A12	CONDUIT	2609.65	0 01:19	4.64	0.38	0.60
A14	CONDUIT	2271.72	0 01:11	5.41	0.14	0.34
A14.5	CONDUIT	2243.62	0 01:05	4.90	0.16	0.36
A120-DF	DUMMY	281.77	0 00:43			
A125	CONDUIT	157.93	0 00:45	3.23	0.02	0.17
A13	CONDUIT	2487.89	0 01:12	4.36	0.22	0.44
A130-DF	DUMMY	188.29	0 00:39			
A135-DF	DUMMY	319.78	0 00:40			
A140-DF	DUMMY	165.99	0 00:41			
A145-DF	DUMMY	172.39	0 00:35			
A15	CONDUIT	2006.08	0 01:05	4.93	0.12	0.31
A150-DF	DUMMY	230.85	0 00:46			
A155-DF	DUMMY	217.92	0 00:35			
A16	CONDUIT	1769.15	0 01:03	4.01	0.09	0.29
A160-DF	DUMMY	37.90	0 00:51			
A165-DF	DUMMY	498.01	0 00:38			
A17	CONDUIT	1028.90	0 02:41	4.30	0.06	0.21

Table B-8
Sample SWMM Output

A170-DF	DUMMY	230.01	0	00:41			
A175-DF	DUMMY	199.40	0	00:38			
A180-DF	DUMMY	301.77	0	00:41			
A19	CONDUIT	1027.27	0	02:41	4.49	0.09	0.25
A190-DF	DUMMY	93.98	0	00:51			
A20	CONDUIT	1014.36	0	02:52	3.54	0.03	0.15
A200-DF	DUMMY	204.52	0	00:46			
A205-DF	DUMMY	84.60	0	00:55			
A21	CONDUIT	998.16	0	02:55	3.74	0.01	0.08
A210-DF	DUMMY	243.70	0	00:49			
A22	DUMMY	3255.89	0	01:03			
A220-DF	DUMMY	2957.75	0	01:07			
A221-DF	DUMMY	58.31	0	00:37			
A222-DF	DUMMY	393.32	0	00:36			
A223-DF	DUMMY	140.08	0	00:36			
A224-DF	DUMMY	72.34	0	00:41			
A225-DF	DUMMY	137.18	0	00:43			
A226-DF	DUMMY	176.66	0	00:45			
A227-DF	DUMMY	300.10	0	00:36			
A228-DF	DUMMY	159.69	0	00:32			
A23	CONDUIT	3108.70	0	01:04	6.05	0.18	0.42
A230-DF	DUMMY	390.42	0	00:36			
A24	CONDUIT	2939.51	0	01:02	5.30	0.20	0.45
A240-DF	DUMMY	451.78	0	00:36			
A25	CONDUIT	988.36	0	01:01	4.36	0.08	0.29
A250-DF	DUMMY	107.06	0	00:48			
A26	CONDUIT	882.86	0	00:51	4.11	0.06	0.26
A260-DF	DUMMY	147.85	0	00:48			
A27	CONDUIT	506.04	0	00:51	4.48	0.04	0.21
A27.5	CONDUIT	157.55	0	00:40	4.30	0.01	0.12
A270-DF	DUMMY	278.64	0	00:40			
A275-DF	DUMMY	166.58	0	00:35			
A28	CONDUIT	345.28	0	00:59	3.34	0.03	0.21
A280-DF	DUMMY	484.76	0	00:34			
A29	CONDUIT	149.52	0	00:59	2.94	0.01	0.10
A290-DF	DUMMY	237.25	0	00:42			
A300-DF	DUMMY	152.09	0	00:53			
B10	CONDUIT	603.39	0	01:00	4.23	0.07	0.28
B100-DF	DUMMY	197.39	0	00:43			
B11	CONDUIT	380.45	0	01:13	2.28	0.05	0.25
B110-DF	DUMMY	291.58	0	00:42			
B12	CONDUIT	316.39	0	01:17	2.50	0.04	0.22
B120-DF	DUMMY	338.85	0	00:36			
B13	CONDUIT	170.17	0	00:51	3.29	0.03	0.17
B130-DF	DUMMY	223.83	0	00:38			
B135-DF	DUMMY	346.08	0	00:37			
B140-DF	DUMMY	214.46	0	00:37			
BW-OUT	DUMMY	955.89	0	00:45			
C10	CONDUIT	636.12	0	01:01	4.44	0.11	0.33
C100-DF	DUMMY	183.63	0	00:41			
C11	CONDUIT	264.43	0	01:04	4.13	0.05	0.23
C11.5	CONDUIT	176.06	0	00:50	2.31	0.01	0.10
C110-DF	DUMMY	274.99	0	00:42			
C120-DF	DUMMY	194.75	0	00:51			
C125-DF	DUMMY	82.11	0	00:55			
CT-OUT	DUMMY	683.71	0	00:41			
D10	DUMMY	313.01	0	00:45			
D100-DF	DUMMY	127.44	0	00:39			
D105-DF	DUMMY	38.60	0	00:43			
D110-DF	DUMMY	160.59	0	00:50			
D115-DF	DUMMY	66.07	0	00:41			
D120-DF	DUMMY	213.54	0	00:38			
D125-DF	DUMMY	106.58	0	00:38			
E10.5	DUMMY	536.24	0	00:47			
E100-DF	DUMMY	172.69	0	00:41			
E105-DF	DUMMY	129.93	0	00:38			
E11	CONDUIT	321.54	0	00:50	3.08	0.03	0.19
E110-DF	DUMMY	58.25	0	00:38			
E115-DF	DUMMY	125.91	0	00:37			
E120-DF	DUMMY	230.98	0	00:43			
E124-DF	DUMMY	99.45	0	00:53			
E128-DF	DUMMY	199.53	0	00:47			
F10	CONDUIT	948.43	0	01:28	4.17	0.07	0.27
F10.2	DUMMY	1563.88	0	01:22			
F100-DF	DUMMY	149.78	0	00:55			
F102-DF	DUMMY	119.39	0	00:40			
F104-DF	DUMMY	372.68	0	00:36			
F106-DF	DUMMY	229.46	0	00:38			
F11	CONDUIT	875.41	0	01:22	4.21	0.08	0.31
F110-DF	DUMMY	249.58	0	00:40			
F12	CONDUIT	758.77	0	01:20	3.79	0.06	0.24
F120-DF	DUMMY	255.31	0	00:42			
F125-DF	DUMMY	133.06	0	00:45			
F13	CONDUIT	576.95	0	01:13	3.81	0.06	0.29
F130-DF	DUMMY	121.48	0	00:51			
F14	CONDUIT	444.29	0	01:02	3.39	0.05	0.28
F140-DF	DUMMY	164.71	0	00:51			
F145-DF	DUMMY	123.12	0	00:50			
F15	CONDUIT	215.89	0	00:52	3.21	0.02	0.18
F150-DF	DUMMY	127.15	0	00:51			
F155-DF	DUMMY	230.22	0	00:42			
G10	CONDUIT	517.18	0	01:09	3.28	0.04	0.23
G100-DF	DUMMY	97.93	0	00:47			
G11	CONDUIT	399.71	0	01:03	3.25	0.03	0.22

Table B-8
Sample SWMM Output

G110-DF	DUMMY	147.92	0	00:45			
G115-DF	DUMMY	125.05	0	00:48			
G12	CONDUIT	152.63	0	01:03	2.88	0.01	0.14
G120-DF	DUMMY	166.04	0	00:43			
G130-DF	DUMMY	165.26	0	00:48			
H10	CONDUIT	1041.74	0	00:45	4.18	0.07	0.26
H100-DF	DUMMY	93.48	0	00:36			
H11	CONDUIT	622.77	0	00:44	4.02	0.04	0.24
H110-DF	DUMMY	324.93	0	00:37			
H115-DF	DUMMY	150.38	0	00:49			
H120-DF	DUMMY	444.33	0	00:36			
H125-DF	DUMMY	238.37	0	00:41			
I10	CONDUIT	386.43	0	01:07	3.42	0.04	0.21
I100-DF	DUMMY	156.77	0	00:43			
I11	CONDUIT	200.89	0	01:01	3.17	0.02	0.14
I110-DF	DUMMY	223.17	0	00:45			
I115-DF	DUMMY	127.87	0	00:49			
I120-DF	DUMMY	81.60	0	00:54			
J10	CONDUIT	1231.42	0	00:55	5.76	0.09	0.32
J100-DF	DUMMY	304.93	0	00:37			
J11	CONDUIT	658.17	0	00:49	4.22	0.06	0.27
J11.5	CONDUIT	413.15	0	00:52	3.78	0.02	0.15
J110-DF	DUMMY	200.11	0	00:40			
J12	CONDUIT	139.21	0	00:55	2.51	0.01	0.09
J120-DF	DUMMY	340.70	0	00:39			
J13	CONDUIT	482.88	0	00:58	4.09	0.07	0.28
J130-DF	DUMMY	590.31	0	00:33			
J14	CONDUIT	321.38	0	00:57	3.26	0.03	0.22
J140-DF	DUMMY	252.76	0	00:38			
J15	CONDUIT	150.58	0	00:58	2.92	0.01	0.12
J150-DF	DUMMY	216.40	0	00:40			
J155-DF	DUMMY	175.20	0	00:38			
J160-DF	DUMMY	161.08	0	00:45			
MT-OUT	DUMMY	597.93	0	01:08			
NG220-IN	DUMMY	7648.84	0	00:57			
NG-OUT	DUMMY	3538.53	0	01:30			
PW-OUT	DUMMY	1120.96	0	00:45			
RT-OUT	DUMMY	503.71	0	01:04			
SJ-OUT	DUMMY	757.65	0	00:58			
SN-OUT	DUMMY	1706.88	0	01:18			
SP-OUT	DUMMY	763.03	0	00:59			
ST-OUT	DUMMY	1427.27	0	00:52			
NG220-OUT	DUMMY	999.29	0	02:43			
SJ130-OUT	DUMMY	321.36	0	01:09			

****

Conduit Surcharge Summary
****

Conduit	Hours Full Both Ends	Hours Full Upstream	Hours Full Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
A100-DF	0.01	0.01	0.01	216.01	0.01
A104-DF	0.01	0.01	0.01	216.01	0.01
A108-DF	0.01	0.01	0.01	216.01	0.01
A110-DF	0.01	0.01	0.01	216.01	0.01
A120-DF	0.01	0.01	0.01	216.01	0.01
A130-DF	0.01	0.01	0.01	216.01	0.01
A135-DF	0.01	0.01	0.01	216.01	0.01
A140-DF	0.01	0.01	0.01	216.01	0.01
A145-DF	0.01	0.01	0.01	216.01	0.01
A150-DF	0.01	0.01	0.01	216.01	0.01
A155-DF	0.01	0.01	0.01	216.01	0.01
A160-DF	0.01	0.01	0.01	216.01	0.01
A165-DF	0.01	0.01	0.01	216.01	0.01
A170-DF	0.01	0.01	0.01	216.01	0.01
A175-DF	0.01	0.01	0.01	216.01	0.01
A180-DF	0.01	0.01	0.01	216.01	0.01
A190-DF	0.01	0.01	0.01	216.01	0.01
A200-DF	0.01	0.01	0.01	216.01	0.01
A205-DF	0.01	0.01	0.01	216.01	0.01
A210-DF	0.01	0.01	0.01	216.01	0.01
A22	0.01	0.01	0.01	216.01	0.01
A220-DF	0.01	0.01	0.01	216.01	0.01
A221-DF	0.01	0.01	0.01	216.01	0.01
A222-DF	0.01	0.01	0.01	216.01	0.01
A223-DF	0.01	0.01	0.01	216.01	0.01
A224-DF	0.01	0.01	0.01	216.01	0.01
A225-DF	0.01	0.01	0.01	216.01	0.01
A226-DF	0.01	0.01	0.01	216.01	0.01
A227-DF	0.01	0.01	0.01	216.01	0.01
A228-DF	0.01	0.01	0.01	216.01	0.01
A230-DF	0.01	0.01	0.01	216.01	0.01
A240-DF	0.01	0.01	0.01	216.01	0.01
A250-DF	0.01	0.01	0.01	216.01	0.01
A260-DF	0.01	0.01	0.01	216.01	0.01
A270-DF	0.01	0.01	0.01	216.01	0.01
A275-DF	0.01	0.01	0.01	216.01	0.01
A280-DF	0.01	0.01	0.01	216.01	0.01
A290-DF	0.01	0.01	0.01	216.01	0.01
A300-DF	0.01	0.01	0.01	216.01	0.01

Table B-8
Sample SWMM Output

B100-DF	0.01	0.01	0.01	216.01	0.01
B110-DF	0.01	0.01	0.01	216.01	0.01
B120-DF	0.01	0.01	0.01	216.01	0.01
B130-DF	0.01	0.01	0.01	216.01	0.01
B135-DF	0.01	0.01	0.01	216.01	0.01
B140-DF	0.01	0.01	0.01	216.01	0.01
BW-OUT	0.01	0.01	0.01	216.01	0.01
C100-DF	0.01	0.01	0.01	216.01	0.01
C110-DF	0.01	0.01	0.01	216.01	0.01
C120-DF	0.01	0.01	0.01	216.01	0.01
C125-DF	0.01	0.01	0.01	216.01	0.01
CT-OUT	0.01	0.01	0.01	216.01	0.01
D10	0.01	0.01	0.01	216.01	0.01
D100-DF	0.01	0.01	0.01	216.01	0.01
D105-DF	0.01	0.01	0.01	216.01	0.01
D110-DF	0.01	0.01	0.01	216.01	0.01
D115-DF	0.01	0.01	0.01	216.01	0.01
D120-DF	0.01	0.01	0.01	216.01	0.01
D125-DF	0.01	0.01	0.01	216.01	0.01
E10.5	0.01	0.01	0.01	216.01	0.01
E100-DF	0.01	0.01	0.01	216.01	0.01
E105-DF	0.01	0.01	0.01	216.01	0.01
E110-DF	0.01	0.01	0.01	216.01	0.01
E115-DF	0.01	0.01	0.01	216.01	0.01
E120-DF	0.01	0.01	0.01	216.01	0.01
E124-DF	0.01	0.01	0.01	216.01	0.01
E128-DF	0.01	0.01	0.01	216.01	0.01
F10.2	0.01	0.01	0.01	216.01	0.01
F100-DF	0.01	0.01	0.01	216.01	0.01
F102-DF	0.01	0.01	0.01	216.01	0.01
F104-DF	0.01	0.01	0.01	216.01	0.01
F106-DF	0.01	0.01	0.01	216.01	0.01
F110-DF	0.01	0.01	0.01	216.01	0.01
F120-DF	0.01	0.01	0.01	216.01	0.01
F125-DF	0.01	0.01	0.01	216.01	0.01
F130-DF	0.01	0.01	0.01	216.01	0.01
F140-DF	0.01	0.01	0.01	216.01	0.01
F145-DF	0.01	0.01	0.01	216.01	0.01
F150-DF	0.01	0.01	0.01	216.01	0.01
F155-DF	0.01	0.01	0.01	216.01	0.01
G100-DF	0.01	0.01	0.01	216.01	0.01
G110-DF	0.01	0.01	0.01	216.01	0.01
G115-DF	0.01	0.01	0.01	216.01	0.01
G120-DF	0.01	0.01	0.01	216.01	0.01
G130-DF	0.01	0.01	0.01	216.01	0.01
H100-DF	0.01	0.01	0.01	216.01	0.01
H110-DF	0.01	0.01	0.01	216.01	0.01
H115-DF	0.01	0.01	0.01	216.01	0.01
H120-DF	0.01	0.01	0.01	216.01	0.01
H125-DF	0.01	0.01	0.01	216.01	0.01
I100-DF	0.01	0.01	0.01	216.01	0.01
I110-DF	0.01	0.01	0.01	216.01	0.01
I115-DF	0.01	0.01	0.01	216.01	0.01
I120-DF	0.01	0.01	0.01	216.01	0.01
J100-DF	0.01	0.01	0.01	216.01	0.01
J110-DF	0.01	0.01	0.01	216.01	0.01
J120-DF	0.01	0.01	0.01	216.01	0.01
J130-DF	0.01	0.01	0.01	216.01	0.01
J140-DF	0.01	0.01	0.01	216.01	0.01
J150-DF	0.01	0.01	0.01	216.01	0.01
J155-DF	0.01	0.01	0.01	216.01	0.01
J160-DF	0.01	0.01	0.01	216.01	0.01
MT-OUT	0.01	0.01	0.01	216.01	0.01
NG220-IN	0.01	0.01	0.01	216.01	0.01
NG-OUT	0.01	0.01	0.01	216.01	0.01
PW-OUT	0.01	0.01	0.01	216.01	0.01
RT-OUT	0.01	0.01	0.01	216.01	0.01
SJ-OUT	0.01	0.01	0.01	216.01	0.01
SN-OUT	0.01	0.01	0.01	216.01	0.01
SP-OUT	0.01	0.01	0.01	216.01	0.01
ST-OUT	0.01	0.01	0.01	216.01	0.01

```
Analysis begun on:  Thu Mar 05 10:29:17 2015
Analysis ended on:  Thu Mar 05 10:29:19 2015
Total elapsed time:  00:00:02
```

Select tables from September 2012 draft of Chapter 4 – Rainfall, Urban Storm Drainage Criteria Manual Volume I

Table 4-1. Storm Duration and Area Adjustment for CUHP Modeling

Design Storm	Watershed Area (square miles)	Suggested Minimum Storm Duration	Apply DRF?
2-, 5-, and 10-Year	A ≤ 2.0	2 hours	No
	2.0 < A < 15.0	2 hours	Yes – Use Table 4-3
	A ≥ 15.0	6 hours	Yes – Use Table 4-3
25-, 50-, 100-, and 500-Year	A < 15.0	2 hours	No
	A ≥ 15.0	6 hours	Yes – Use Table 4-4

Table 4-3. DRFs for Design Rainfall Distributions 2-, 5-, and 10-Year Design Rainfall

Time (minutes)	Correction Factor by Watershed Area in Square Miles[1]								
	2	5	10	15	20	30	40	50	75
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15	1.00	0.97	0.94	0.91	0.90	0.85	0.75	0.65	0.56
20	1.00	0.86	0.75	0.68	0.61	0.55	0.48	0.42	0.35
25	1.00	0.86	0.75	0.68	0.61	0.55	0.48	0.42	0.35
30	1.00	0.86	0.75	0.68	0.61	0.55	0.48	0.42	0.42
35	1.00	0.97	0.94	0.91	0.90	0.90	0.90	0.90	0.89
40	1.00	0.97	0.94	0.91	0.90	0.90	0.90	0.90	0.89
45	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
50	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
55	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
60	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
65	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
70	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
75	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
80	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
85	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
90	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
95	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
100	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
105	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
110	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
115	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
120	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
125-180	N/A	N/A	N/A	1.00	1.00	1.00	1.00	1.00	1.00
185-360	N/A	N/A	N/A	1.23	1.28	1.30	1.32	1.33	1.33

[1]For areas between the values listed in the table, correction factors can be obtained through linear interpolation between columns.

Table 4-4. DRFs for Design Rainfall Distributions 25-, 50-, 100-, and 500-Year Design Rainfall

Time (minutes)	Correction Factor by Watershed Area in Square Miles[1]					
	15	20	30	40	50	75
5	1.15	1.15	1.15	1.15	1.15	1.10
10	1.15	1.15	1.15	1.15	1.15	1.10
15	1.15	1.15	1.15	1.15	1.15	1.10
20	1.25	1.18	1.10	1.05	1.00	0.90
25	0.73	0.69	0.64	0.60	0.58	0.55
30	0.73	0.69	0.64	0.60	0.58	0.55
35	0.73	0.69	0.64	0.60	0.58	0.55
40	1.05	1.02	0.95	0.90	0.85	0.80
45	1.20	1.20	1.20	1.15	1.05	0.95
50	1.15	1.15	1.15	1.15	1.05	0.95
55	1.15	1.15	1.15	1.15	1.15	1.15
60	1.15	1.15	1.15	1.15	1.15	1.15
65	1.08	1.10	1.13	1.15	1.15	1.15
70	1.08	1.10	1.13	1.15	1.15	1.15
75	1.08	1.10	1.13	1.15	1.15	1.15
80	1.08	1.10	1.13	1.15	1.15	1.15
85	1.08	1.10	1.13	1.15	1.15	1.15
90	1.08	1.10	1.13	1.15	1.15	1.15
95	1.08	1.10	1.13	1.15	1.15	1.15
100	1.08	1.10	1.13	1.15	1.15	1.15
105	1.08	1.10	1.13	1.15	1.15	1.15
110	1.08	1.10	1.13	1.15	1.15	1.15
115	1.08	1.10	1.13	1.15	1.15	1.15
120	1.08	1.10	1.13	1.15	1.15	1.15
125-180	1.08	1.10	1.13	1.15	1.25	1.25
185-360	1.05	1.10	1.10	1.10	1.10	1.13

[1]For areas between the values listed in the table, correction factors can be obtained through linear interpolation between columns.

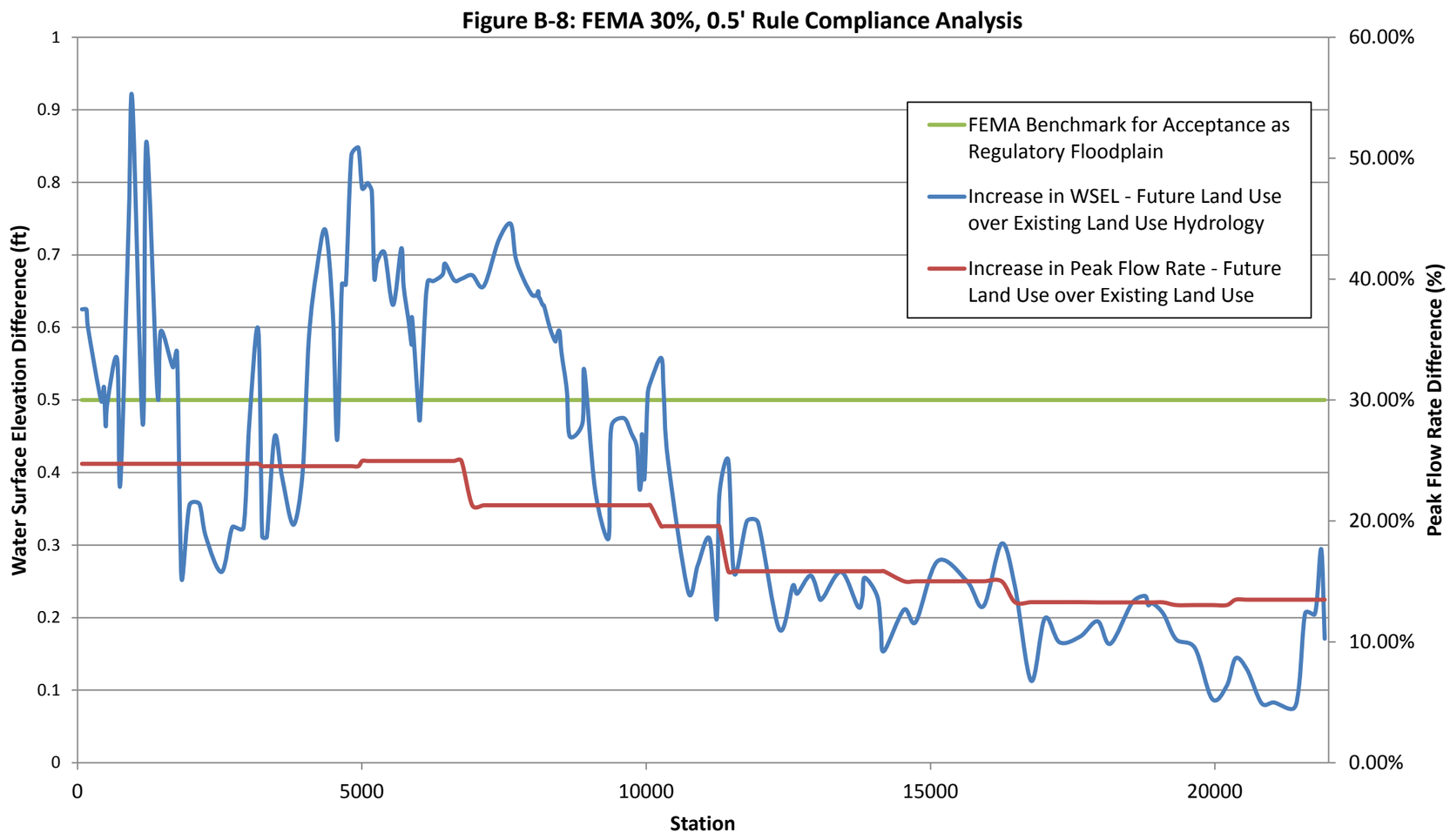


Figure B-8: FEMA 30%, 0.5' Rule Compliance Analysis
Water Surface Elevation Difference (ft)
Peak Flow Rate Difference (%)
Station
FEMA Benchmark for Acceptance as Regulatory Floodplain
Increase in WSEL - Future Land Use over Existing Land Use Hydrology
Increase in Peak Flow Rate - Future Land Use over Existing Land Use
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
0
5000
10000
15000
20000

Appendix C

RUETER-HESS RESERVOIR ROUTING ANALYSIS

MEMORANDUM

To: Shea Thomas and Bill DeGroot / UDFCD
Fred Koch and Brad Robenstein / Douglas County
Tom Williams and Jacob James / Town of Parker

From: Derek Johns / Muller Engineering Company
Jim Wulliman / Muller Engineering Company

Date: May 30, 2013

Project #: 12-050.01

Re: Newlin Gulch Major Drainageway Planning Study,
Rueter-Hess Reservoir Flood Control Benefits

MULLER
Muller Engineering Company, Inc.
Consulting Engineers

777 S. Wadsworth Blvd. #4-100
Lakewood, Colorado 80226
303/988-4969 FAX
303/988-4939
www.mullereng.com

Introduction

This memorandum documents the initial results of a baseline hydrology evaluation completed for the Newlin Gulch watershed located in Douglas County. This work was completed as one of the first components of the Major Drainageway Planning (MDP) study that is currently underway for the Newlin Gulch watershed. One of the key objectives of the MDP is to update hydrologic information provided in the previous Outfall Systems Planning (OSP) study completed in 1993 for the watershed. In addition, hydrologic results will be compared to the 1977 Flood Hazard Area Delineation (FHAD) study which is the basis for the current regulatory floodplain along Newlin Gulch.

The primary issues involved in updating the Newlin Gulch hydrology was to incorporate land use changes in the watershed and evaluate the impacts of Rueter-Hess Reservoir, a large water supply reservoir that was recently constructed on Newlin Gulch. The older OSP and FHAD studies were both completed prior to construction of Rueter-Hess Reservoir and don't recognize any flood detention benefits.

The following sections include a summary of land use changes in the watershed, describe key features of Rueter-Hess Reservoir, document the hydrologic evaluation, and summarize the impacts and flood detention benefits associated with Rueter-Hess Reservoir.

Land Use Changes

Since 1993, there have been significant changes in the existing land use and the projected future land use within the watershed. To-date, most of the development has occurred in the lower portion of the watershed in or near the Town of Parker. Existing imperviousness values in the watershed have been updated based on 2012 aerial photography and information provided in land development drainage reports. Based on this information, the composite watershed imperviousness for existing conditions is currently 22.5%. This value accounts for the Rueter-Hess Reservoir maximum normal pool being at 100% imperviousness. If the reservoir pool is excluded, the composite watershed imperviousness for existing conditions is 12%. In the 1993 OSP, the existing imperviousness was reported to be 4.9%.

The future land use conditions are projected to be much higher than the estimates in the 1993 OSP. In the 1993 OSP, future land use in the upper portion of the watershed was projected to consist primarily of open space and large lot residential development and the overall composite imperviousness cover was estimated to be 12.6%. Based on new land use information provided by the Town of Parker, Douglas County, and the City of Castle Pines, more land development is planned and at higher densities than

what was estimated in 1993. As shown on the Future Land Use Map (Figure 1), there is a significant amount of development ranging from medium density residential areas (40% imperviousness) to business/commercial areas (85 to 90% imperviousness) that is planned in the upper portion of the watershed in Castle Pines. This includes the 3300-acre Canyons residential development that is planned immediately upstream of Rueter-Hess Reservoir along with Castle Pines Town Center and Lagae Ranch developments near I-25. In the lower portion of the watershed (below Rueter-Hess Reservoir), future developments that are planned include the Meridian Business Park (75% imperviousness) and several residential developments. Based on this new land use information, the composite watershed imperviousness for future conditions is estimated to be 35% (26% without Rueter-Hess) which is almost 3 times higher than the 12.6% imperviousness assumed in the 1993 OSP.

Rueter-Hess Reservoir

Rueter-Hess Reservoir is a water supply reservoir owned by Parker Water and Sanitation District (PWSD). It is located on the mainstem of Newlin Gulch in the central portion of the watershed. The construction of the reservoir was completed in 2012 and consists of a 170-foot tall earthen dam that is designed to store 72,000 acre-feet of water. Once it is filled to its maximum normal pool, the reservoir footprint will cover 1.8 square miles or approximately 12% of the entire Newlin Gulch watershed. The reservoir was built for water supply storage and not flood control.

Service Spillway. Outflows from Rueter-Hess reservoir are controlled through a multi-chambered tower that connects to two outlet conduits. The service spillway is comprised of two of the upper chambers on the outlet works tower, each approximately10-feet wide and 5-feet tall. The maximum normal pool elevation for the reservoir is elevation 6215.1 (NAVD88) which is equal to the crest of the service spillway. According to an evaluation conducted by the reservoir design engineer, the service spillway can convey both the 100-year and 500-year storm events.

Auxiliary Spillway. The auxiliary (or emergency) spillway consists of a large concrete labyrinth weir located on the west abutment of the dam. The auxiliary spillway crest is at elevation 6216.7 which is 1.6-feet above the service spillway crest. The auxiliary spillway is designed to convey extreme flood events (greater that the 500-year).

Hydrologic Evaluation

The hydrologic evaluation for the Newlin Gulch watershed was based on updated topographic mapping and land use information. A new subwatershed delineation was performed using the more current mapping and in accordance with UDFCD guidelines to keep the average subwatershed size to approximately 100-acres. The new delineation resulted in subdividing the 15.0 square mile watershed into 111 subwatersheds with an average subwatershed size of approximately 90-acres.

Percent imperviousness values for the subwatersheds were based on the most current land use information for both existing and future conditions. Hydrographs for the subwatersheds were generated using the Colorado Urban Hydrograph Procedure (CUHP). The hydrographs were then routed through the drainageway network using EPA's Storm Water Management Model (SWMM). The SWMM model was also used to evaluate the impacts of routing flood flows through Rueter-Hess Reservoir. Storage/discharge data for the reservoir was incorporated into the SWMM model based on rating curve tables shown on a record drawing provided by PWSD.

The hydrologic modeling was completed for the 100-year event based on future land use conditions. To evaluate the impacts of Rueter-Hess Reservoir, the modeling was performed for conditions with and without the reservoir. The assumptions for these two conditions are described below.

With Rueter-Hess Reservoir. This option accounts for the inherent flood detention/attenuation that the reservoir currently provides.

1. It was decided by the project sponsors to ignore the service spillway and route flows only through the auxiliary spillway. This is a more conservative approach. However, this option would allow some flexibility for future changes to the service spillway configuration.
2. The reservoir was assumed to be full to the auxiliary spillway crest (elevation 6216.7) prior to the storm event. The reservoir subwatershed was modeled at 100% imperviousness.
3. The resulting 100-year peak discharges for this option are presented in Figure 2 and show that discharges downstream of the reservoir would be lower than both the 1977 FHAD and the 1993 OSP discharges. The reservoir surcharge (rise in water level) for this option in the 100-year event would be approximately 0.8-feet.

With-Out Rueter-Hess Reservoir. This option assumes that Rueter-Hess Reservoir is not in place, so there is no reservoir pool or flood detention routing.

1. The reservoir subwatershed was modeled based on historic topographic conditions and 2% imperviousness.
2. The resulting 100-year peak discharges from this option are also shown on Figure 2 and indicate that peak flows are 250 to 750% higher than the "With Rueter-Hess Reservoir" option, 160% percent higher the 1993 OSP discharges, and 190% higher than the 1977 FHAD discharges.

Flood Control Benefits of Rueter-Hess Reservoir

This hydrologic evaluation shows that Rueter-Hess Reservoir provides substantial reductions in peak flood discharges in Newlin Gulch. The reduction in flood discharges is inherent because the reservoir surface area is so large relative to the upstream watershed. In addition, these flood detention benefits occur with the current reservoir configuration and no impacts to reservoir operations or water storage volume.

Recognizing the lower flood discharges from Rueter-Hess Reservoir would provide several benefits for the Newlin Gulch watershed. These benefits include:

1. Prevent Expansion of Regulatory Floodplain: Figure 3 shows a sample map of the 100-year regulatory floodplain in Stonegate Village located downstream of Rueter-Hess Reservoir. The map shows that the regulatory floodplain is in close proximity to the existing residential lots. Recognizing the flood peak reduction from Rueter-Hess Reservoir would maintain discharges below the current regulatory discharges and, therefore, prevent the expansion of the floodplain into residential and commercial properties. If the flood discharge reduction from RH reservoir is not recognized, then the 100-year regulatory discharges would increase by a factor of 2 as shown in the "Without RH Reservoir" option and result in a wider floodplain that would encroach onto numerous residential and commercial properties.
2. Avoid Increases to Flood Insurance Rates: If the floodplain were to expand, flood insurance premium rates for properties would likely increase. Recognizing the lower flood discharges would prevent this situation from occurring.
3. Avoid Lowering Property Values: If the floodplain were to expand, it is possible that property values would decrease. In addition, infrastructure improvements for properties within the expanded floodplain could be limited by floodplain regulations (i.e., it may be prohibited or more costly for a property owner to expand or modify a home or building). Recognizing the lower flood discharges would prevent this from occurring.

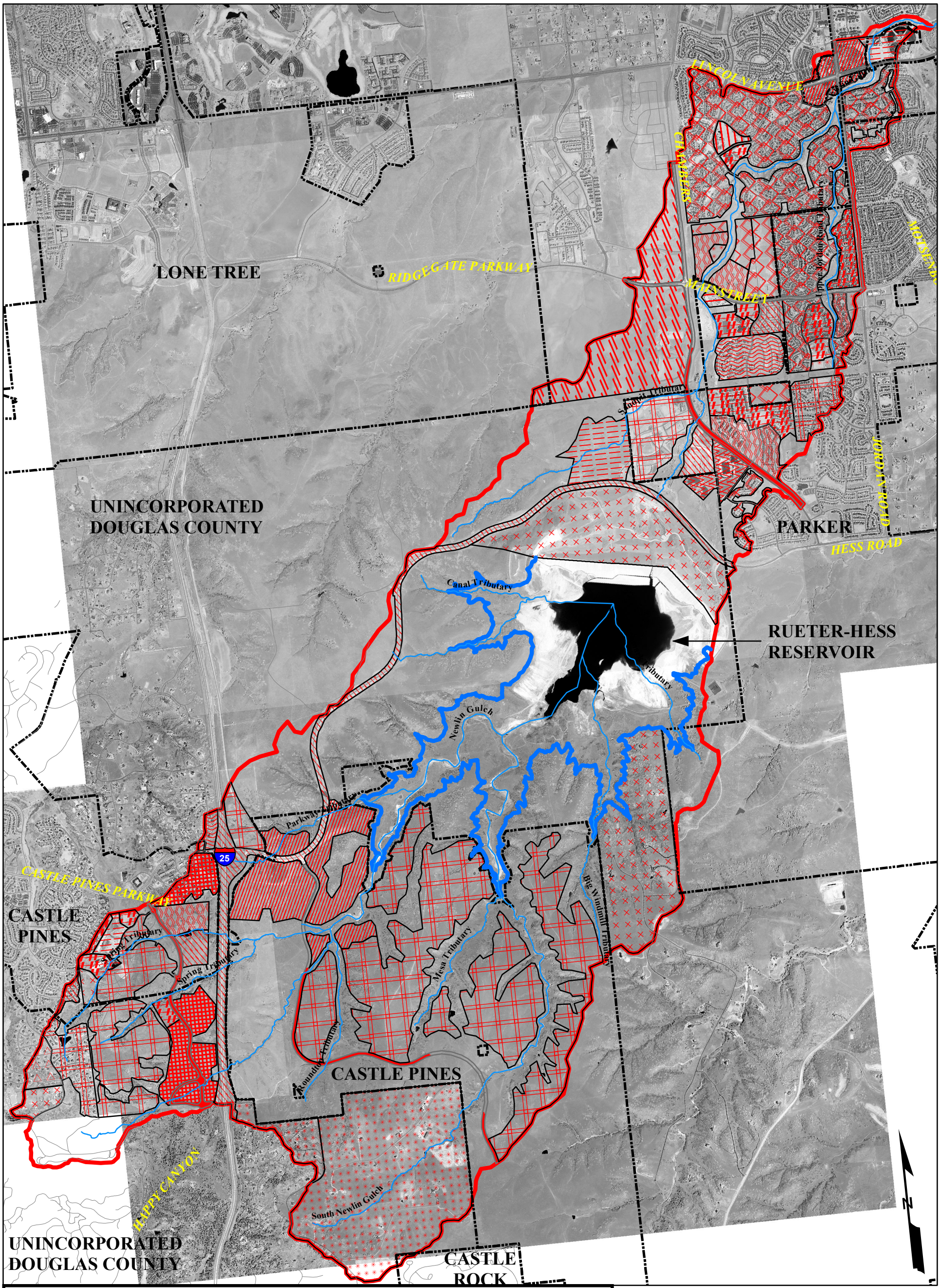
4. Reduce Costs for Roadway Crossings: Recognizing the flood peak reduction from Rueter-Hess Reservoir would also help to reduce costs for future roadway crossings or replacement of existing roadway crossings of Newlin Gulch. For example, if a new bridge crossing over Newlin Gulch needs to be replaced, the bridge span could be shorter using the lower flow rates and, therefore, less costly to construct.

5. Reduce Costs for Future Drainageway Improvements: Future drainageway infrastructure that will likely be needed along Newlin Gulch such as stream stabilization improvements will be more cost effective if they can be designed using the lower flood discharges.

Conclusion

In conclusion, Rueter-Hess Reservoir provides significant reduction in peak flood discharges for the Newlin Gulch drainageway downstream. Recognizing this would provide significant benefits for property owners downstream and would reduce costs for future infrastructure improvements within the Newlin Gulch drainageway.

In order for the flood peak reduction benefits from Rueter-Hess Reservoir to be officially recognized by regulatory agencies (i.e., UDFCD, FEMA, and the Colorado Water Conservation Board), an "adequate assurances" agreement would need to be executed with the reservoir owner, PWSD, ensuring no adverse changes would be made to the existing auxiliary spillway.



Map Legend

Watershed Boundary

Major Tributaries

Municipal Boundaries

Rueter-Hess (max. normal pool elev.)

Future Land Use - Imperviousness (%)

2, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 65, 70, 75, 85, 90, 100

MULLER
Muller Engineering Company, Inc.
Consulting Engineers
777 S. Wadsworth Blvd., STE. 4-100
Lakewood, Colorado 80226-4355
www.mullereng.com
Office: (303) 988-4939
Fax: (303) 988-4969

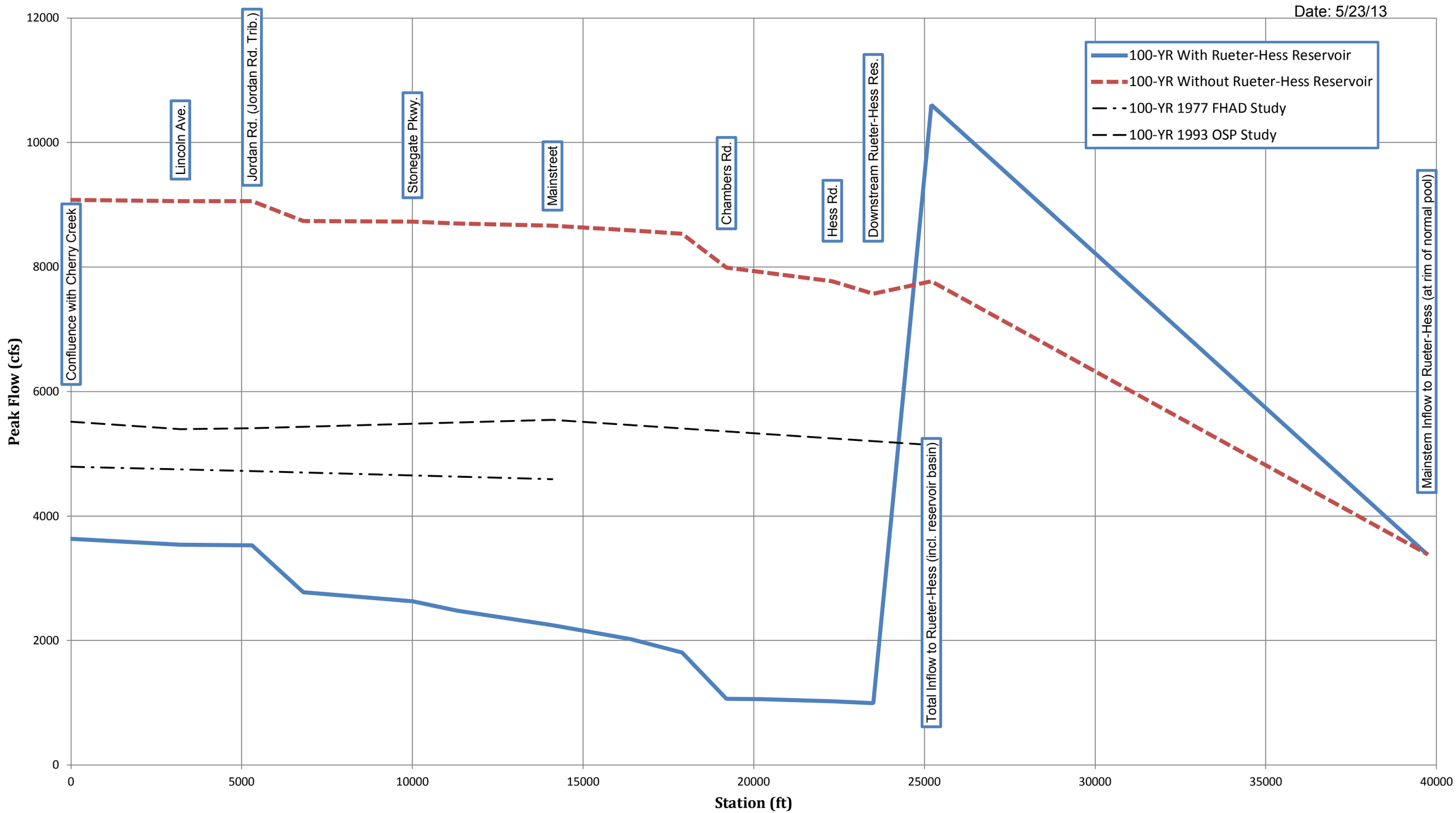
Newlin Gulch Major Drainageway Plan
Figure 1 - Future Land Use Map
(For Rueter-Hess Technical Memo)
May 20, 2013

Urban Drainage and Flood Control District

Town of Parker COLORADO

Douglas County COLORADO

Figure 2 - Newlin Gulch Peak Flow Profile - Future Development



DATE: 5/23/13

FIGURE 3

NEWLIN GULCH REGULATORY FLOODPLAIN

IN THE CENTRAL PORTION OF STONEGATE VILLAGE

NAME: P:\12-050.01 Newlin Gulch MDP - UDFCD\7 AUTOCAD FILES\Basin\Hydrology\12050-Stonegate Regulatory FP.dwg DATE: MAY 23, 2013 TIME: 11:04 AM

Table C-1
Rueter-Hess Reservoir Routing Alternatives

					1993 OSP **		Current Study							
							100-Yr (Existing Land Use)				100-Yr (Future Land Use)			
							With RH		Without RH		With RH		Without RH	
Location	FHAD Cross Section	OSP Design Point	Current Design Point	1977 FHAD * 100-Yr (cfs)	100-Yr Existing (cfs)	100-Yr Future (cfs)	Service Spillway (cfs)	Auxiliary Spillway (cfs)†	I=100% (cfs)	I=2% (cfs)	Service Spillway (cfs)	Auxiliary Spillway (cfs)†	I=100% (cfs)	I=2% (cfs)
Newlin Gulch														
Cherry Creek	28	180	NG000	4790	5357	5513	2843	**2843**	10968	6438	3581	**3581**	12882	8191
Lincoln Ave. (U/S)		177	NG001		5198	5396	2796	**2795**	10945	6430	3486	**3486**	12848	8174
Jordan Rd. (U/S)	23	176	NG002	4720	5220	5412	2793	**2793**	10951	6431	3478	**3478**	12855	8176
Stonegate Parkway (U/S)			NG004				2213	**2212**	10479	6122	2683	**2683**	12300	7839
Mainstreet (U/S)	16	166	NG006	4590	5330	5545	1945	**1945**	10301	6032	2253	**2253**	12092	7784
Chambers Rd. (U/S)			NG009				706	**905**	9306	5551	763	**1025**	10980	7192
Hess Rd.			NG011				325	**890**	9024	5431	325	**1010**	10626	7017
Rueter-Hess Reservoir Outflow			NG012				49	**880**	8822	5309	56	**995**	10381	6838
RH Total Inflow (Including Reservoir Subwatershed)			NG220				8822	**8822**	N/A	N/A	10381	**10381**	N/A	N/A
Mainstem and Tributary Inflow to RH		150	NG013		4969	5138	5871	**5871**	5871	4738	7657	**7657**	7657	6210
Mainstem Inflow to RH			NG014				2454	**2454**	3108	3108	3255	**3255**	4183	4183
I-25 (U/S)		103	NG019		321	311	426	**426**	426	426	514	**514**	514	514
Tributaries														
Jordan Rd. Tributary at Newlin Confluence		276	SJ000		545	785	690	**690**	690	690	755	**755**	755	755
South Newlin at Mesa Confluence		128	SN001		1106	1167	1388	**1388**	1388	1388	1564	**1564**	1564	1564
Mesa Tributary at South Newlin Confluence		224	MT000		420	470	493	**493**	493	493	598	**598**	598	598
Roundtop Tributary at Newlin Confluence		217	RT000		383	393	429	**429**	429	429	504	**504**	504	504
Spring Tributary at Newlin Confluence		219	ST000		773	840	1009	**1009**	1009	1009	1427	**1427**	1427	1427

Notes:
* 1977 FHAD flows based on 24-hour storm and WSP-2 and TR-20 models.
** 1993 OSP flows based on 3-hour storm and CUHP/UDSWMM models.
†Selected Alternative for Baseline Hydrology
Updated June 6, 2013

Appendix D

RUETER-HESS ADEQUATE ASSURANCES AGREEMENT

AGREEMENT REGARDING THE INTENT TO
ASSURE THE FLOOD ROUTING CAPABILITY OF
RUETER-HESS RESERVOIR IN DOUGLAS COUNTY

Agreement No. 14-05.05

THIS AGREEMENT, made this 13th day of November, 2014, by and between URBAN DRAINAGE AND FLOOD CONTROL DISTRICT (hereinafter called "DISTRICT"), PARKER WATER AND SANITATION DISTRICT (hereinafter called "OWNER"), TOWN OF PARKER (hereinafter called "PARKER") and DOUGLAS COUNTY (hereinafter called "DOUGLAS"); (hereinafter DISTRICT, OWNER, PARKER and DOUGLAS shall be collectively known as "PARTIES");

WITNESSETH THAT:

WHEREAS, DISTRICT in a policy statement previously adopted (Resolution No. 14, Series of 1970), expressed an intent to assist public bodies which have heretofore enacted floodplain zoning measures; and

WHEREAS, several of the major drainageways within, or flowing into, DISTRICT have water supply, irrigation, or other non-flood control reservoirs located on them; and

WHEREAS, some of these reservoirs, by virtue of their size and/or their embankment and spillway configuration, provide significant but inadvertent flood routing capabilities which reduce the 100-year flood discharge downstream from the reservoirs; and

WHEREAS, Colorado Revised Statute §37-87-104(2) states that "No such (entity or person who owns, controls, or operates, a water storage reservoir) shall be liable for allowing the inflow to such reservoir to pass through it into the natural stream below such reservoir"; and

WHEREAS, the owners of such reservoirs can, and on occasion do, make changes to their embankment and spillway configurations, up to and including removal of the structure; and

WHEREAS, the above-language from §37-87-104, C.R.S. clearly indicates that it would be unwise public policy to rely upon these non-flood control reservoirs for any flood protection; and

WHEREAS, DISTRICT has previously adopted a "Policy for Delineation of Floodplains Below Water Supply and Other Non-Flood Control Reservoirs" (Resolution No. 36, Series of 1986); and

WHEREAS, the Policy requires that non-flood control reservoirs not be considered in the drainageway hydrology unless adequate assurances have been obtained by the Executive Director of DISTRICT to preserve the flood routing capability of the reservoirs; and

WHEREAS, Rueter-Hess Reservoir (hereinafter called "RESERVOIR") is a water storage reservoir which provides significant inadvertent flood routing capability which reduces the 100-year discharge downstream from RESERVOIR; and

WHEREAS, The Newlin Gulch Major Drainageway Plan & Flood Hazard Area Delineation (hereinafter called "MASTER PLAN") specifies the RESERVOIR's planned 100-year discharge; and

WHEREAS, OWNER is the owner of RESERVOIR, a water storage reservoir located south and east of the intersection of Hess Road and Chambers Road in unincorporated Douglas County; and

WHEREAS, PARTIES desire to make arrangements regarding the preservation of the planned 100-year discharge in the event OWNER plans future changes to RESERVOIR; and

WHEREAS, PARTIES acknowledge there is significant infrastructure cost savings to PARKER, DOUGLAS and DISTRICT as a result of OWNER signing this Agreement, and that OWNER is executing this agreement in the spirit of intergovernmental cooperation for the benefit of PARKER, DOUGLAS and DISTRICT; and

WHEREAS, OWNER is developing long term recreational opportunities and facilities at RESERVOIR which will require partnerships and cooperation from PARKER and DOUGLAS, among others; and

WHEREAS, in the same spirit of cooperation that has resulted in this Agreement, PARKER and DOUGLAS have committed to OWNER that they will participate in the development of recreational improvements at RESERVOIR including both physical improvements and staffing contributions, the details of which PARKER, DOUGLAS and OWNER will determine together in good faith.

NOW, THEREFORE, in consideration of the mutual promises contained herein, PARTIES hereto agree as follows:

1. SCOPE OF AGREEMENT
   This Agreement defines the responsibilities and financial commitments of PARTIES with respect to RESERVOIR.
2. OPPORTUNITY TO MAINTAIN FLOOD ROUTING CAPABILITY
   If OWNER plans physical changes to RESERVOIR which would increase the 100-year discharge above the planned 100-year discharge, OWNER shall provide an opportunity for PARKER, DOUGLAS, and DISTRICT to maintain the 100-year discharge at the planned 100-year discharge, subject to the terms and conditions of Paragraph 6 below.
3. MAINTENANCE OF THE PLANNED 100-YEAR DISCHARGE
   PARKER, DOUGLAS and DISTRICT agree to jointly take whatever actions are necessary, available, and appropriate, based upon the sole discretion of PARKER, DOUGLAS and DISTRICT, to assure that the flood routing capability of RESERVOIR shall be maintained at the planned 100-year discharge, subject to annual budget and appropriation.
4. RECOGNITION OF FLOOD ROUTING CAPABILITY IN MASTER PLAN
   The MASTER PLAN contains specific language recognizing the flood routing capability of RESERVOIR and expressing the need to preserve that routing capability by whatever means are available and appropriate should changes be proposed which would decrease the planned level of flood routing capability and increase the 100-year discharge above the planned 100-year discharge.

The flood routing capability of RESERVOIR, as set forth in the MASTER PLAN, is as follows: During the 100-year flood, RESERVOIR reduces the peak flow from 10,381 cubic feet per second into RESERVOIR to a peak flow of 995 cubic feet per second out of RESERVOIR.

5. PAYMENT OF COSTS

If PARKER, DOUGLAS and/or DISTRICT desire OWNER to limit or attempt to limit the 100-year downstream discharge to the planned 100-year discharge, PARKER and/or DOUGLAS and/or DISTRICT shall pay, in advance, all costs attributable thereto, including but not limited to studies, revisions or additions to plans, physical changes to RESERVOIR or dam structures, and additional construction, subject to annual budget and appropriation. As used in this paragraph, "costs" includes construction, engineering, operation and maintenance, attorney's fees, court costs, and other direct or indirect costs.

6. NOTICE

OWNER shall notify PARKER, DOUGLAS and DISTRICT, in writing, of any plans to make physical changes to RESERVOIR. To take advantage of the opportunity referred to in Paragraph 2, PARKER, DOUGLAS and/or DISTRICT must notify OWNER, in writing, of their intention to do so promptly upon reciving written notification of OWNER's plans to make physical changes to RESERVOIR, and in no event more than 90 days after being notified.

A. The NOTICE contact for OWNER shall be the Chair of the Parker Water & Sanitation District Board of Directors, 18100 East Woodman Drive, Parker, Colorado 80134.

B. The NOTICE contact for PARKER shall be the Director of Public Works, 20120 East Main Street, Parker, Colorado 80138.

C. The NOTICE contact for DOUGLAS shall be the County Engineer, 100 Third Street, Castle Rock, Colorado 80104.

D. The NOTICE contact for DISTRICT shall be the Executive Director, 2480 West 26th Avenue, Suite 156B, Denver, Colorado 80211.

E. Any notices, demands or other communications required or permitted to be given by any provision of this Agreement shall be given in writing, delivered personally or sent by registered mail, postage prepaid and return receipt requested, addressed to PARTIES at the addresses forth above or at such other address as either party may hereafter or from time to time designate by written notice to the other party given when personally delivered or mailed, and shall be considered received in the earlier of either the day on which such notice is actually received by the party to whom it is addressed or the third day after such notice is mailed.

7. OWNER APPROVAL

Notwithstanding any provision herein to the contrary, OWNER retains the right to approve, reject, or approve with conditions, in OWNER's sole discretion, any plans of PARKER, DOUGLAS or DISTRICT to maintain the flood routing capability of RESERVOIR; provided that OWNER shall inform PARKER, DOUGLAS and DISTRICT in writing of OWNER's reasons for a rejection or a conditional approval. OWNER further retains the right to manage all aspects of any work relating

to the maintenance of RESERVOIR's flood routing capability as contemplated by this Agreement, including the selection of contractors performing engineering, design or construction work on property owned or controlled by OWNER. It is the intent of this provision that OWNER retain sole control over all aspects of RESERVOIR while allowing PARKER, DOUGLAS and DISTRICT to preserve the flood control benefits of RESERVOIR.

8. LIABILITY

Each party hereto shall be responsible for any suits, demands, costs or actions at law resulting from its own acts or omissions and may insure against such possibilities as appropriate.

9. AMENDMENTS

This Agreement contains all of the terms agreed upon by and among PARTIES. Any amendments to this Agreement shall be in writing and executed by PARTIES hereto to be valid and binding.

10. SEVERABILITY

If any clause or provision herein contained shall be adjudged to be invalid or unenforceable by a court of competent jurisdiction or by operation of any applicable law, such invalid or unenforceable clause or provision shall not affect the validity of the Agreement as a whole and all other clauses or provisions shall be given full force and effect.

11. APPLICABLE LAWS

This Agreement shall be governed by and construed in accordance with the laws of the State of Colorado. Jurisdiction for any and all legal actions arising under the Agreement shall lie in the District Court in and for the County of Douglas, State of Colorado.

12. ASSIGNABILITY

No party to this Agreement shall assign or transfer any of its rights or obligations hereunder without the prior written consent of the nonassigning party or parties to this Agreement.

13. BINDING EFFECT

The provisions of this Agreement shall bind and shall inure to the benefit of PARTIES hereto and to their respective successors and permitted assigns.

14. ENFORCEABILITY

PARTIES hereto agree and acknowledge that this Agreement may be enforced in law or in equity, by decree of specific performance or damages, or such other legal or equitable relief as may be available subject to the provisions of the laws of the State of Colorado.

15. APPROPRIATIONS

Notwithstanding any other term, condition, or provision herein, each and every obligation of PARKER and/or DOUGLAS and/or OWNER and/or DISTRICT stated in this Agreement is subject to the requirement of a prior appropriation of funds therefore by the appropriate governing body of the OWNER, PARKER, DOUGLAS and/or DISTRICT.

16. NO THIRD PARTY BENEFICIARIES

It is expressly understood and agreed that enforcement of the terms and conditions of this Agreement, and all rights of action relating to such enforcement, shall be strictly reserved to

PARTIES, and nothing contained in this Agreement shall give or allow any such claim or right of action by any other or third person on such Agreement. It is the express intention of PARTIES that any person or party other than the OWNER, PARKER, DOUGLAS or DISTRICT receiving services or benefits under this Agreement shall be deemed to be an incidental beneficiary only.

17. NO WAIVER OF GOVERNMENTAL IMMUNITY ACT

The parties hereto understand and agree that the OWNER, PARKER, DOUGLAS AND DISTRICT, their officials, officers, directors, agents and employees, are relying on, and do not waive or intend to waive by any provisions of this Agreement, the monetary limitations or any other rights, immunities and protections provided by the Colorado Governmental Immunity Act, C.R.S. § 24-10-101, *et seq.*, as from time to time amended, or otherwise available to PARTIES.

18. RECITALS

The Recitals to this Agreement are incorporated herein by this reference.

19. ENTIRETY

This Agreement merges and supercedes all prior negotiations, representations and agreements between the parties hereof and constitutes the entire agreement between the parties concerning the subject matter hereof.

WHEREFORE, PARTIES hereto have caused this instrument to be executed by properly authorized signatures as of the date and year above written.

URBAN DRAINAGE AND
FLOOD CONTROL DISTRICT

(SEAL)

ATTEST:

By Paul A Rudolph

Title Executive Director

Date 11/13/2014

PARKER WATER AND SANITATION
DISTRICT

(SEAL)

ATTEST:

By Ron R. Redd

Title ~~Executive Director~~ District Manager

Date 10/29/14

APPROVED:

Board Resolution

(SEAL)

ATTEST:

Carol Baumgartner, Town Clerk

APPROVED:

James Maloney, Town Attorney

TOWN OF PARKER

By

Mike Waid

Title Mayor

Date 10/6/14

7

BOARD OF COUNTY COMMISSIONERS
OF THE COUNTY OF DOUGLAS

BY:

DOUGLAS J. DEBORD, County Manager

APPROVED AS TO FISCAL CONTENT:

ANDREW COPLAND, Finance Director

APPROVED AS TO LEGAL FORM:

KRISTIN DECKER, Asst. County Attorney

8

AGREEMENT REGARDING THE INTENT TO
ASSURE THE FLOOD ROUTING CAPABILITY OF
RUETER-HESS RESERVOIR IN DOUGLAS COUNTY

Agreement No. 13-

EXHIBIT A: LOCATION

Appendix E

HYDRAULIC ANALYSIS

Table E-1
Manning's n Values

Station	to Station	Description	Manning's n-value		
			LOB	Channel	ROB
22214	21560	Hess Road	0.04	0.04	0.04
21365	18973	Upstream of Chambers Road	0.06	0.06	0.06
18902	18237	Downstream of Chambers Road	0.04	0.1	0.04
18013	15176	Between Mainstreet and Chambers Road	0.04	0.05	0.04
14788	8900	Upstream of Mainstreet to Downstream of Stonegate Parkway	0.04	0.04	0.04
8676	8087	Lower Portion of Stonegate Phase 3 Reach	0.04	0.05	0.04
8012	7171	Downstream of Stonegate Phase 3 Reach	0.04	0.08	0.04
6968	5914	Lower Portion of Stonegate Village Metropolitan District	0.04	0.12	0.04
5904	4384	Jordan Road	0.04	0.08	0.04
4092	3203	Upstream of Lincoln Avenue	0.04	0.04	0.04
3046	2171	Between Lincoln Ave. and Recreation Drive	0.04	0.05	0.03
1997	491	Downstream of Recreation Drive	0.04	0.05	0.04
444	0	Confluence with Cherry Creek	0.04	0.08	0.04

Figure E-1: Existing Hydraulic Structure Photographs

-

Sta 1+83: Pedestrian Trail Crossing near Cherry Creek confluence

Sta 21+71: Recreation Drive At-Grade Crossing

Sta 31+00: Lincoln Avenue Double Span Concrete Bridge

Sta 47+50: Jordan Road Double Span Concrete Bridge

Sta 59+10: Pedestrian Trail Crossing in lower portion of Stonegate Village

Sta 81+30: Pedestrian Trail Crossing in middle portion of Stonegate Village

Sta 100+00: Stonegate Parkway Single Span Concrete Bridge

Sta 140+00: Mainstreet Triple Span Concrete Bridge

Sta 189+50: Chambers Road Single Span Concrete Bridge

Sta 218+50: Hess Road Single Span Concrete Bridge

COMPARISON OF WATER SURFACE ELEVATIONS
NEWLIN GULCH - FHAD v. REGULATORY WSEL

Study by: Douglas County / FEMA
Datum: 1988 NAVD
Project ID: 11-08-004P (Latest Available LOMR for Study Reach)
Study Date: 2011

		100-YEAR FLOW					
		FIS FLOW (cfs)	FHAD FLOW (cfs)	Δ (FHAD MINUS LOMR FLOW) (cfs)	REGULATORY WSEL (ft) (NAVD 88)	FHAD WSEL (ft) (NAVD 88)	Δ (FHAD MINUS REGULATORY) (ft)
FIS Cross Section ID	FHAD Station	100-year	100-year	100-year	100-year	100-year	100-year
A	806	4790	3450	-1340	5783.2	5780.8	-2.4
B	1997	4810	3450	-1360	5801.8	5800.3	-1.5
C	2748	4810	3450	-1360	5805.9	5805.0	-0.9
D	3552	4810	3443	-1367	5812.8	5812.4	-0.4
E	4708	4720	3443	-1277	5820.9	5820.6	-0.3
F	5850	4530	2825	-1705	5830.6	5829.6	-1.0
G	6509	4530	2825	-1705	5836.7	5836.0	-0.7
H	7171	4530	2660	-1870	5842.4	5842.2	-0.2
I	8122	4530	2660	-1870	5848.9	5848.3	-0.6
J	9349	4530	2660	-1870	5857.9	5853.4	-4.5
K	10404	4530	2493	-2037	5868.8	5865.9	-2.9
L	11157	4530	2493	-2037	5872.1	5870.6	-1.6
M	12629	4530	2291	-2239	5885.4	5884.4	-1.0
N	13776	4530	2291	-2239	5902.1	5900.2	-1.9
O	14070	4530	2244	-2286	5909.0	5907.1	-1.9
P	14788	4530	2019	-2511	5917.5	5917.5	-0.1
Q	16007	4530	2019	-2511	5928.0	5926.3	-1.7
R	17706	4820	1780	-3040	5943.9	5941.5	-2.4
S	19393	4820	1029	-3791	5962.0	5959.7	-2.3
T	20220	4820	1027	-3793	5973.3	5969.7	-3.6

Cross Section for Recreation Drive East Street Section

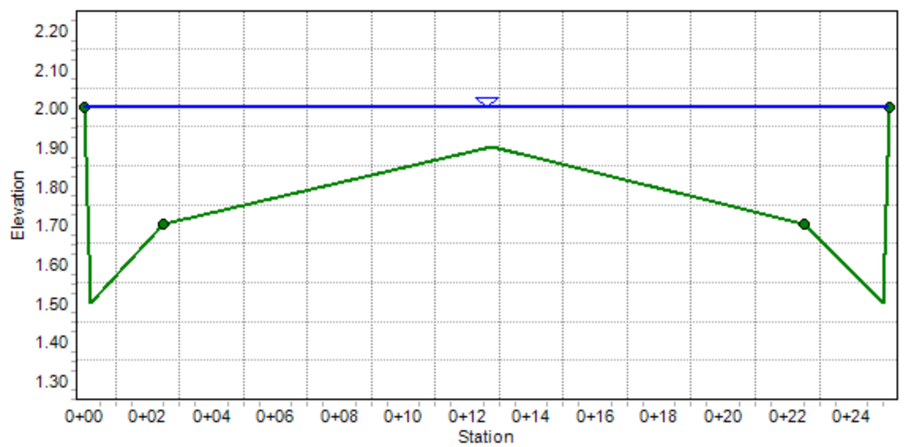
Project Description

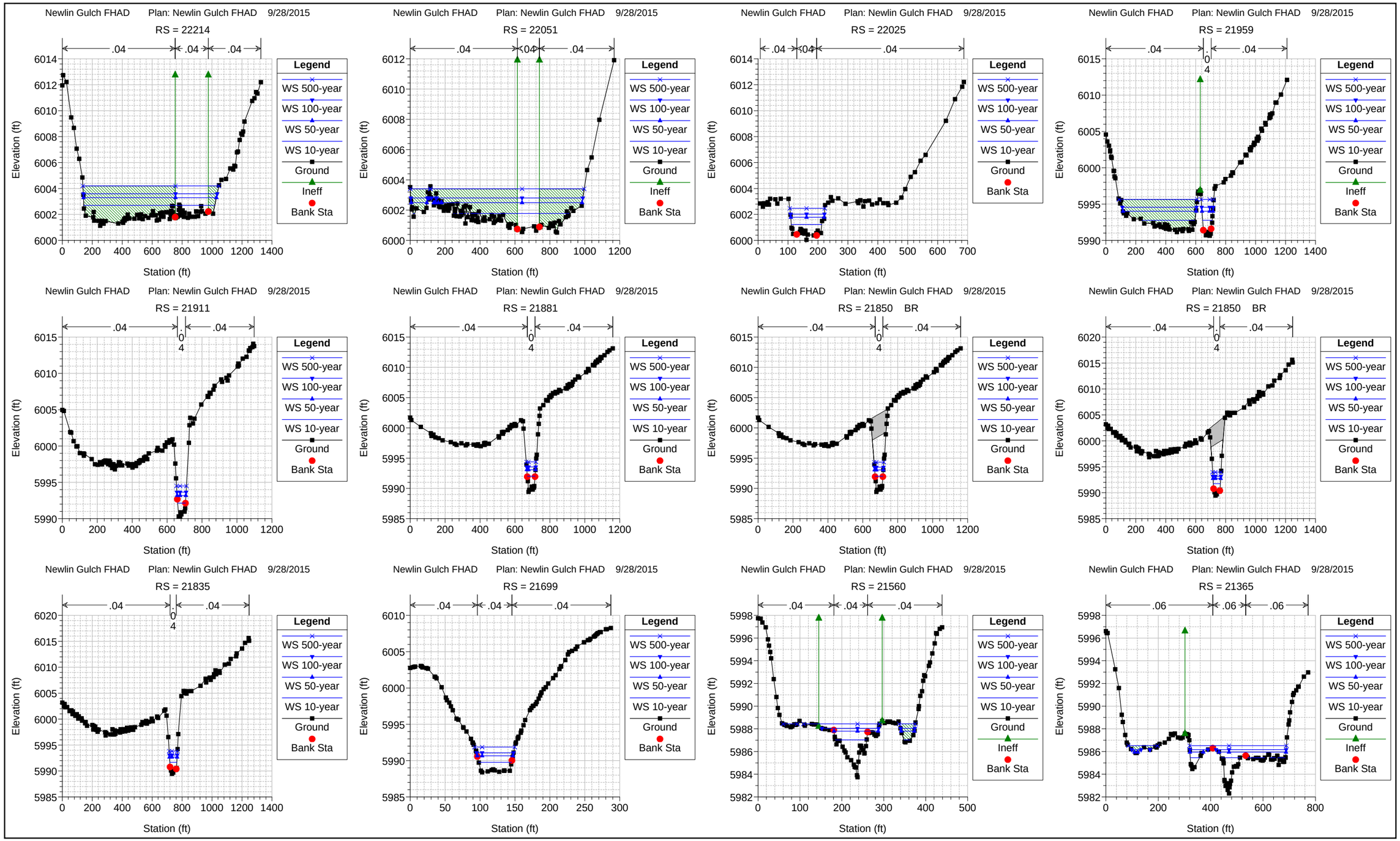
Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.01820	ft/ft
Normal Depth	0.50	ft
Discharge	30.10	ft³/s

Cross Section Image

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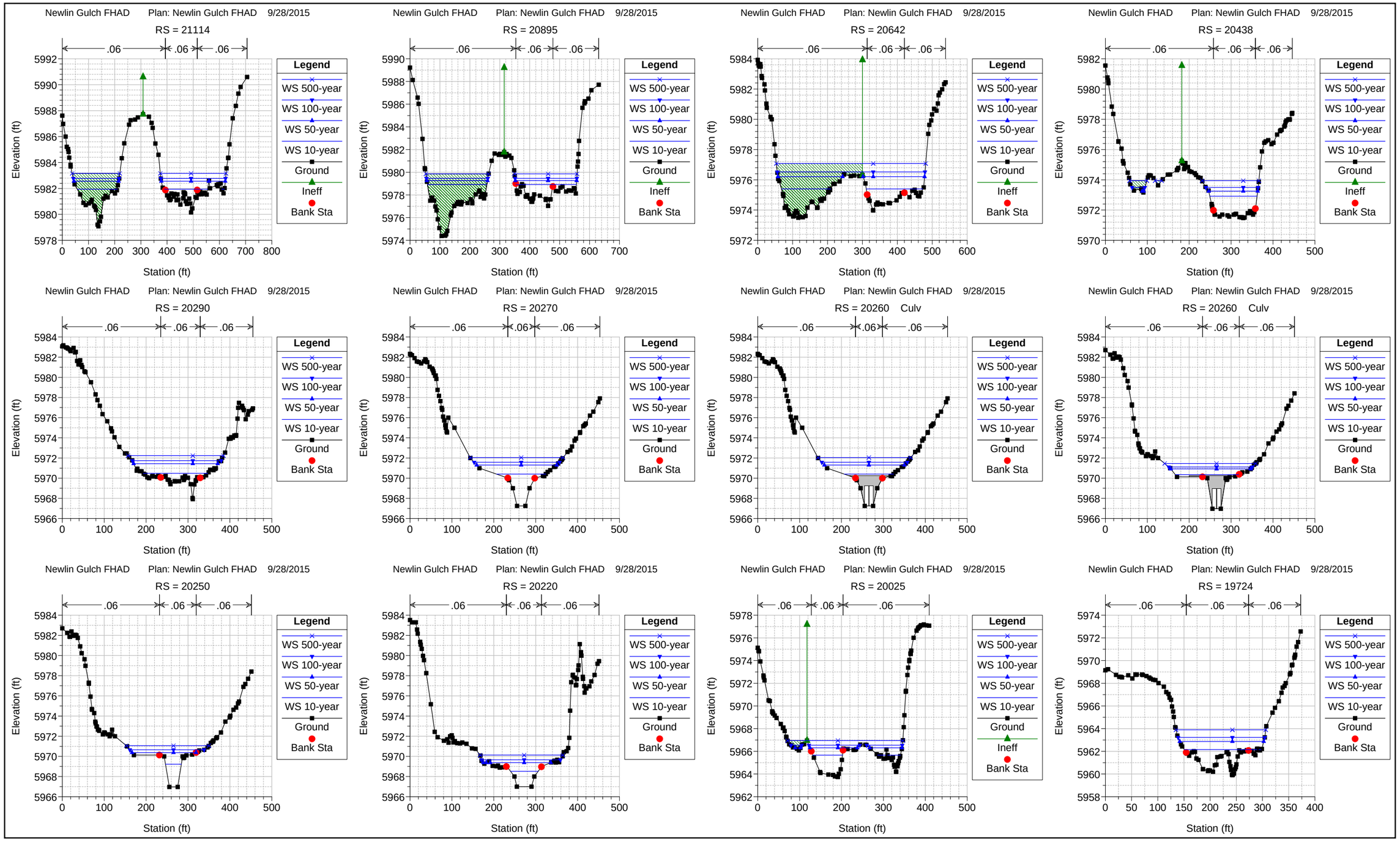
RS = 22214
RS = 22051
RS = 22025
RS = 21959
RS = 21911
RS = 21881
RS = 21850 BR
RS = 21850 BR
RS = 21835
RS = 21699
RS = 21560
RS = 21365
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Ineff
Bank Sta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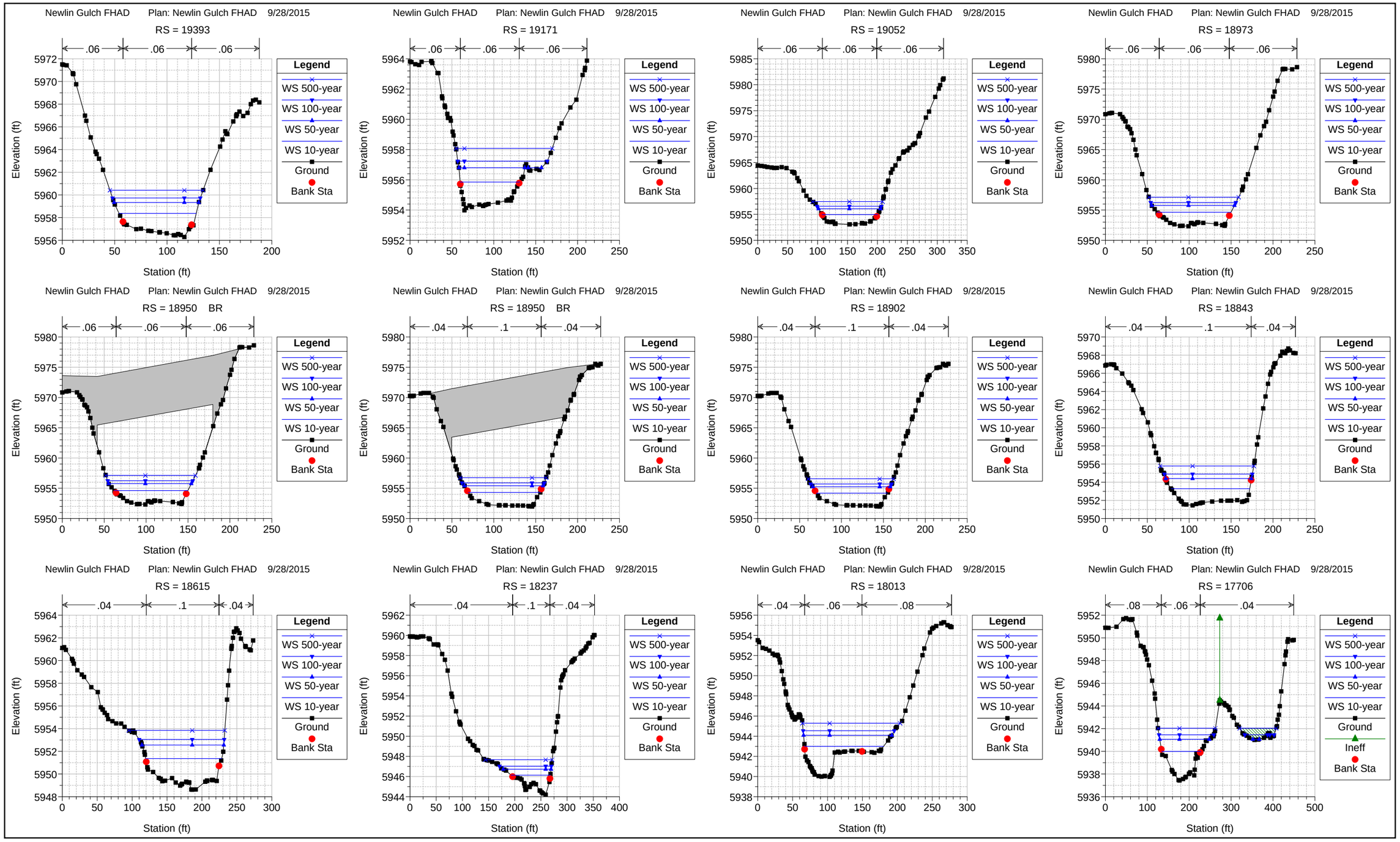
RS = 20260 Culv
RS = 20250
RS = 20220
RS = 20025
RS = 19724
.06
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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RS = 19052
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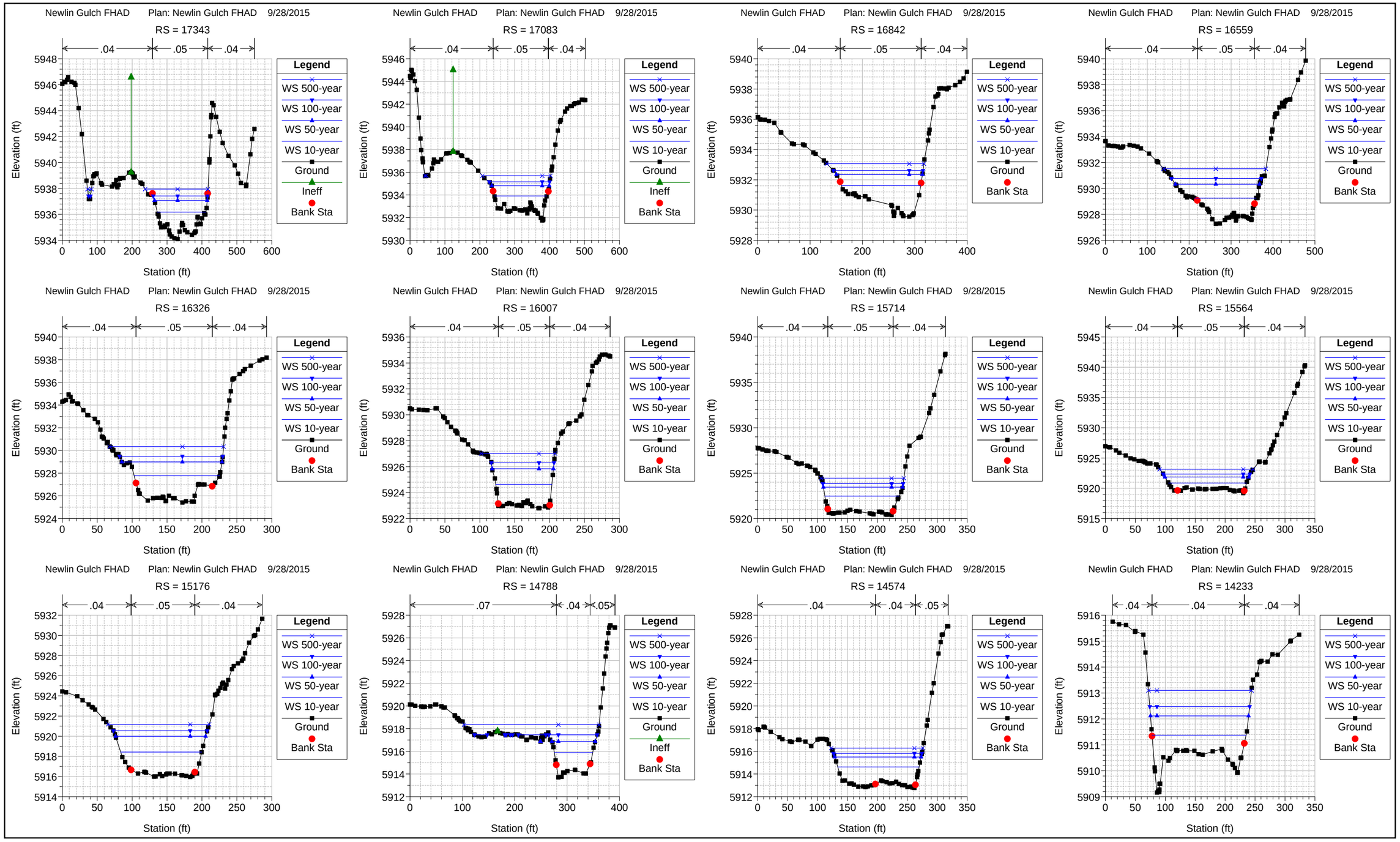
RS = 18950 BR
RS = 18950 BR
RS = 18902
RS = 18843
RS = 18615
RS = 18237
RS = 18013
RS = 17706
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Ineff
Bank Sta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RS = 16007
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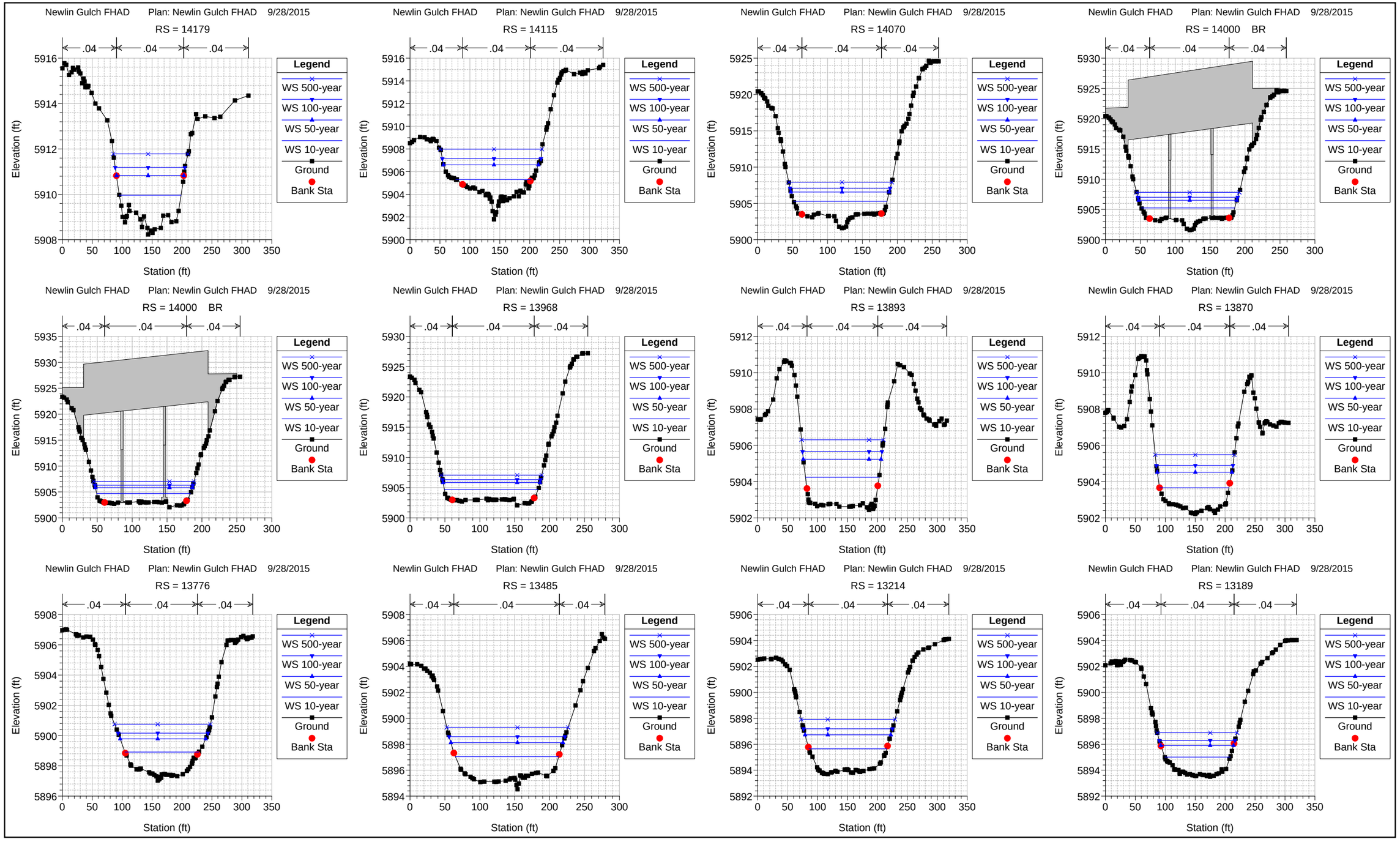
RS = 15564
RS = 15176
RS = 14788
RS = 14574
RS = 14233
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Ineff
Bank Sta


Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
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RS = 14070
RS = 14000 BR
RS = 14000 BR
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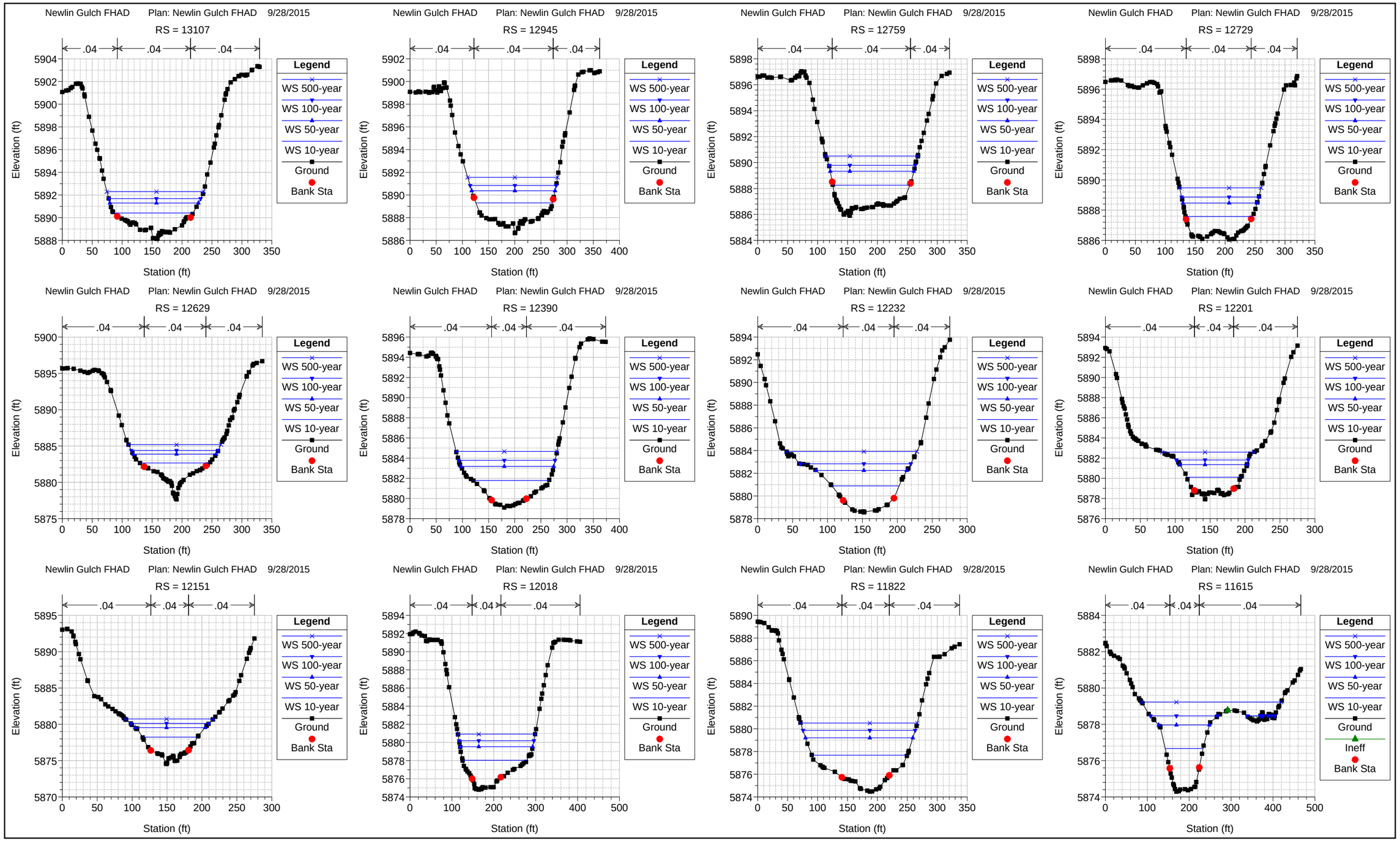
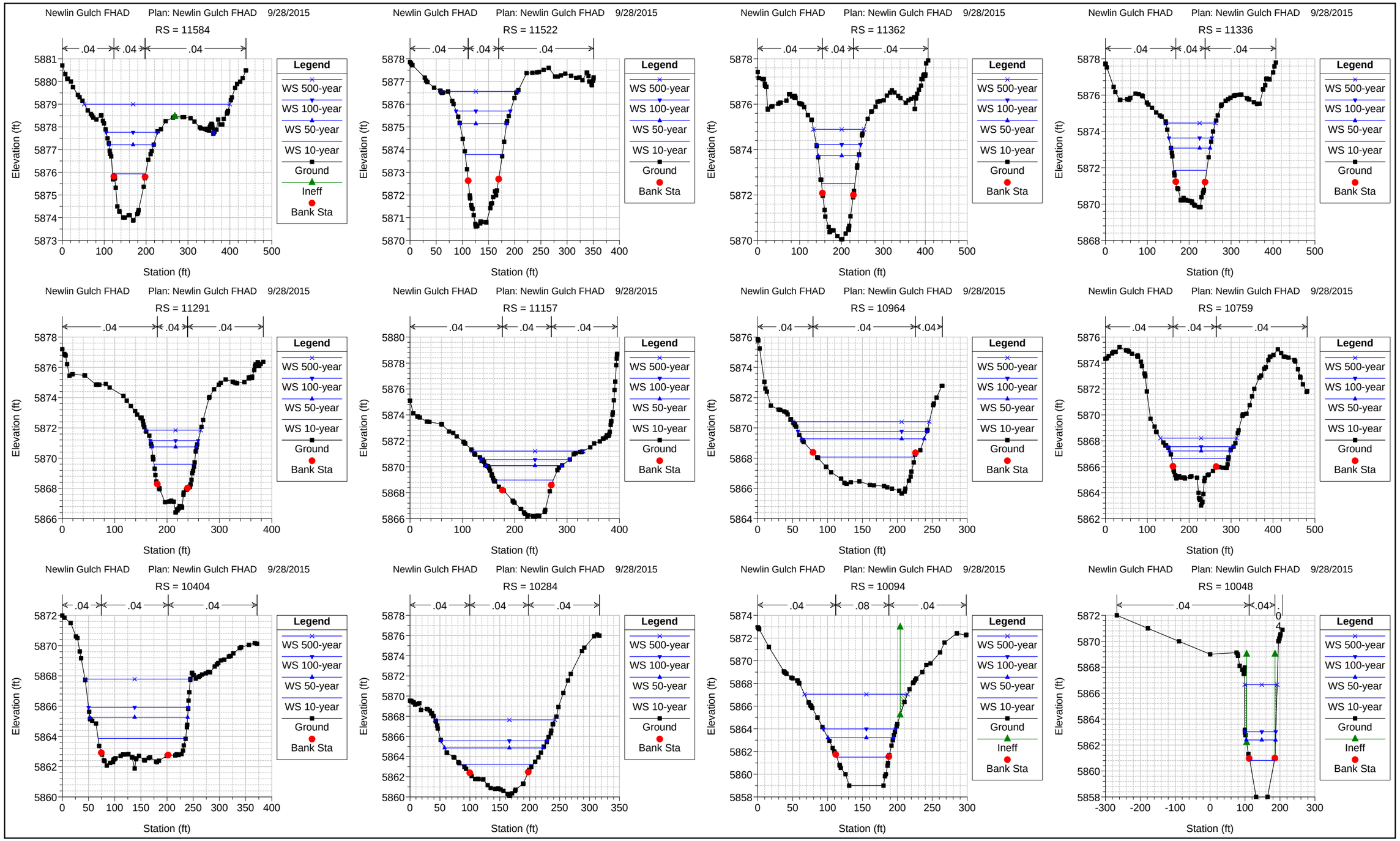
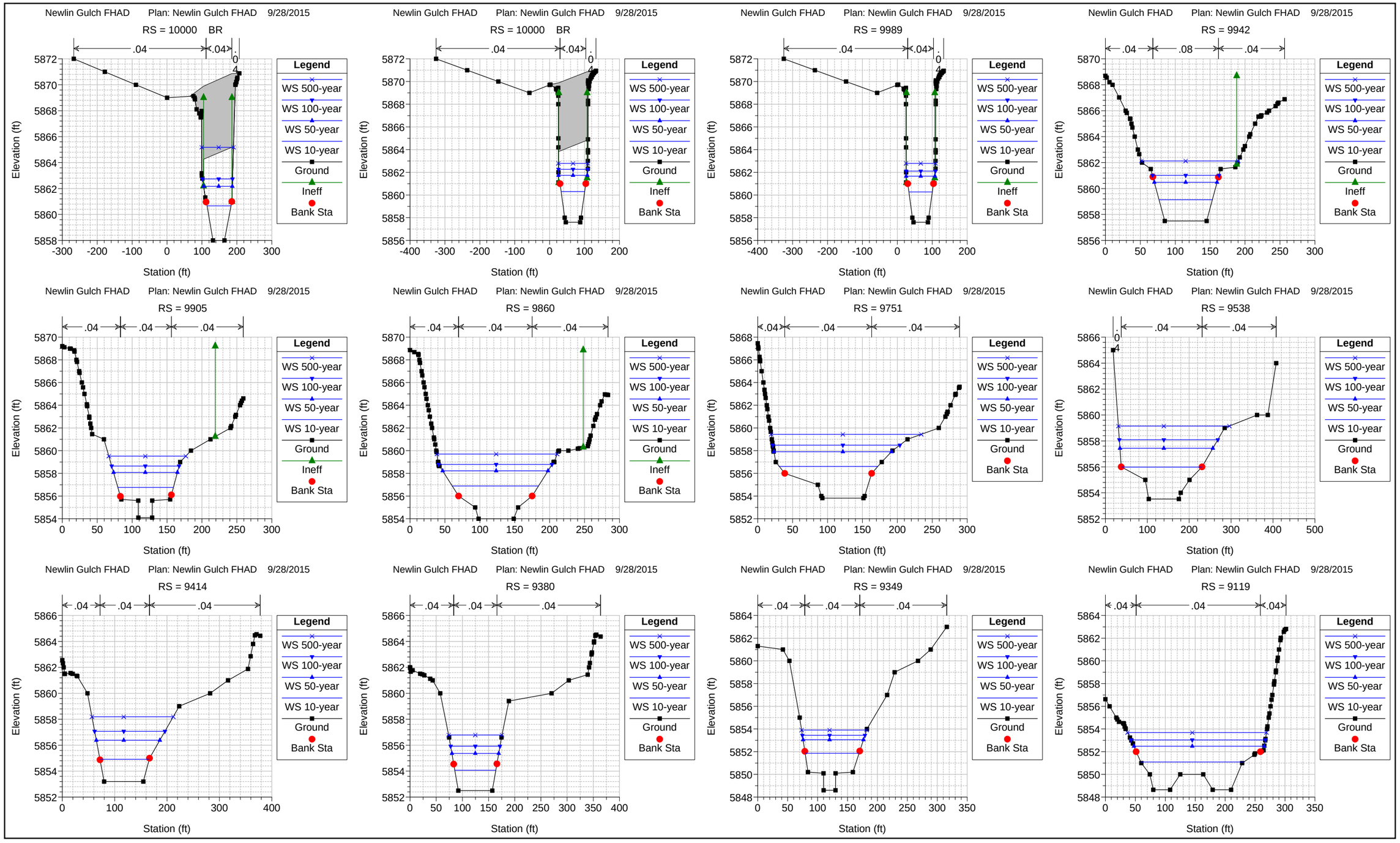
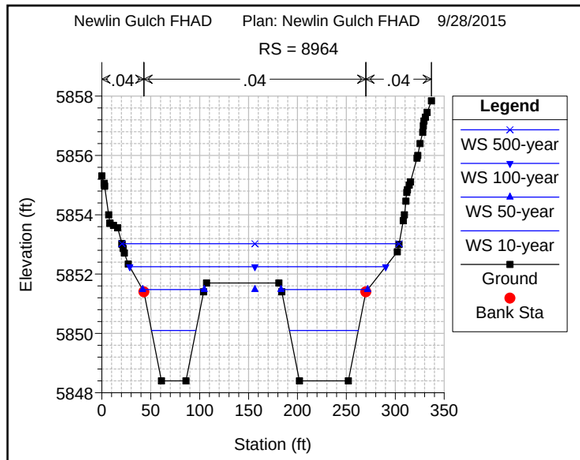
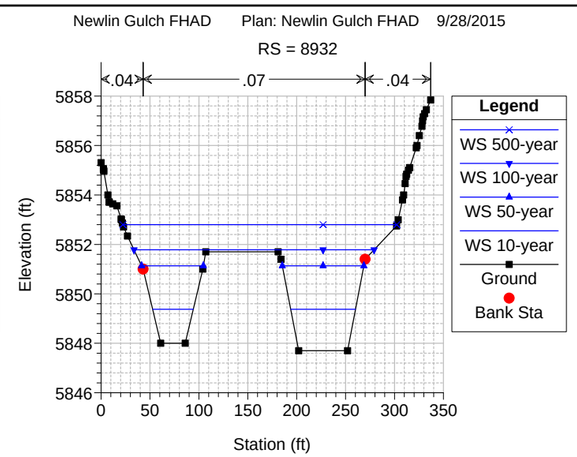
RS = 13870
RS = 13776
RS = 13485
RS = 13214
RS = 13189
.04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

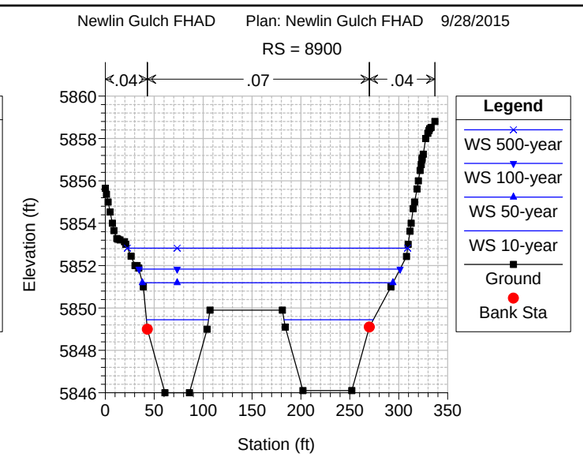

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 13107
RS = 12945
RS = 12759
RS = 12729
RS = 12629
RS = 12390
RS = 12232
RS = 12201
RS = 12151
RS = 12018
RS = 11822
RS = 11615
.04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Ineff
Bank Sta


Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 11584
RS = 11522
RS = 11362
RS = 11336
RS = 11291
RS = 11157
RS = 10964
RS = 10759
RS = 10404
RS = 10284
RS = 10094
RS = 10048
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Ineff
Bank Sta


Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 10000 BR
RS = 9989
RS = 9942
RS = 9905
RS = 9860
RS = 9751
RS = 9538
RS = 9414
RS = 9380
RS = 9349
RS = 9119
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Ineff
Bank Sta


Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8964
.04 .04 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta


Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8932
.04 .07 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta


Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
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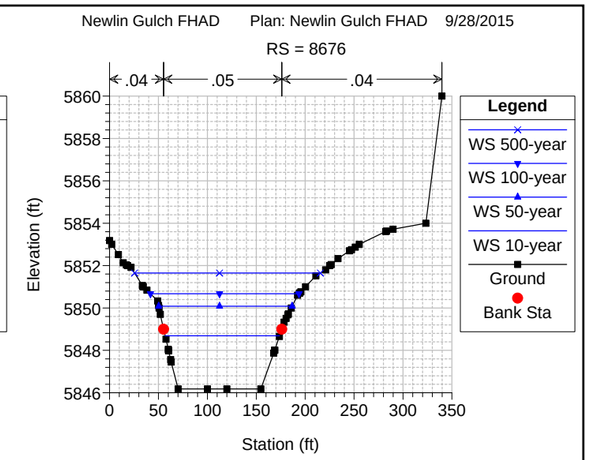
.04 .07 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta


Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
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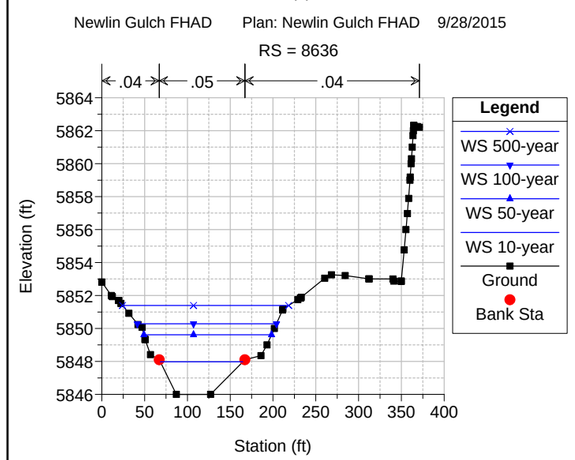
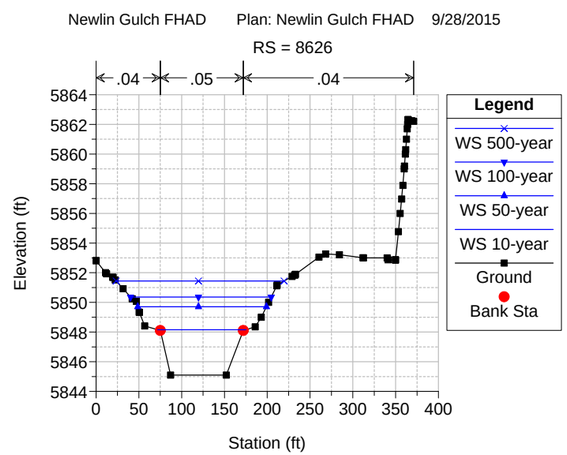
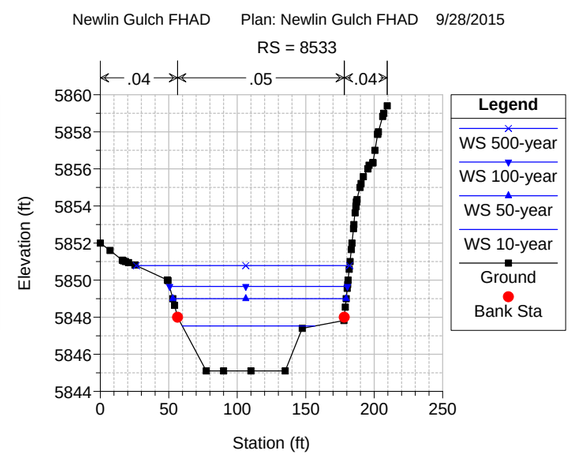
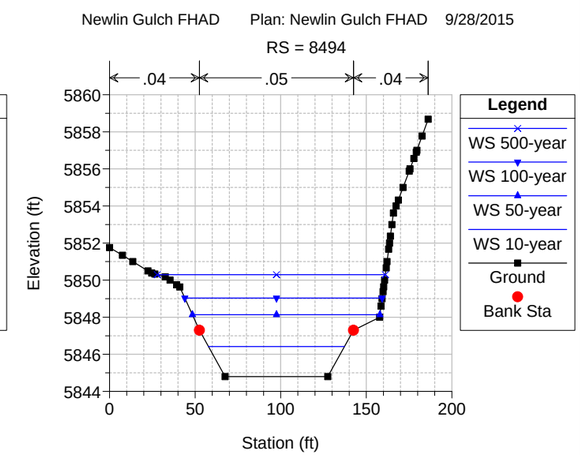
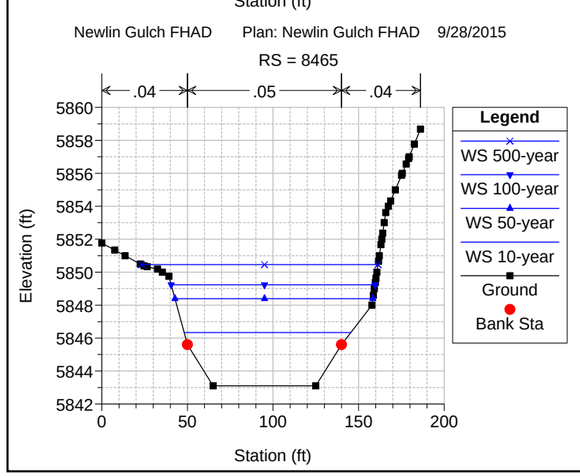
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

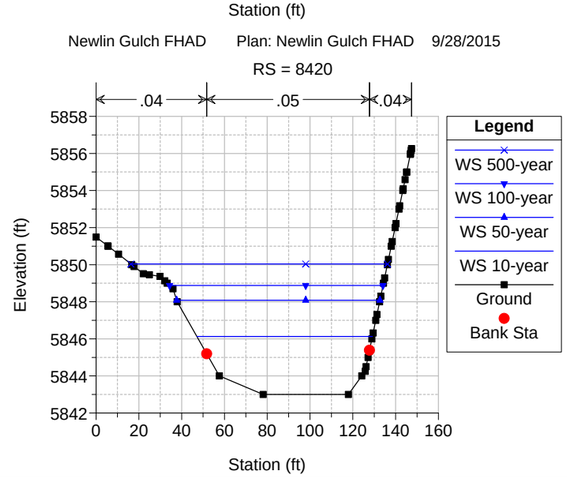

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8636
.04 .05 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

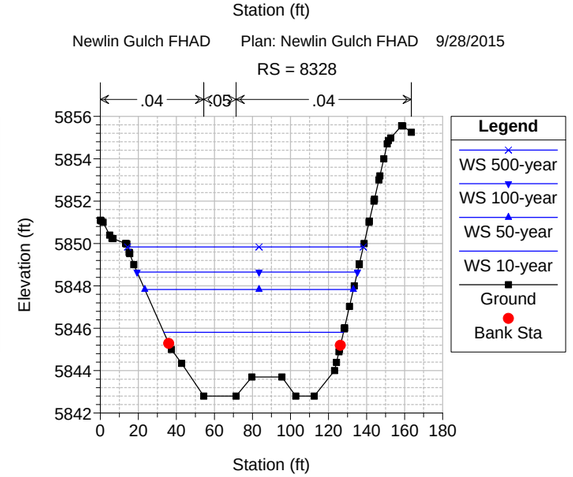

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8626
.04 .05 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

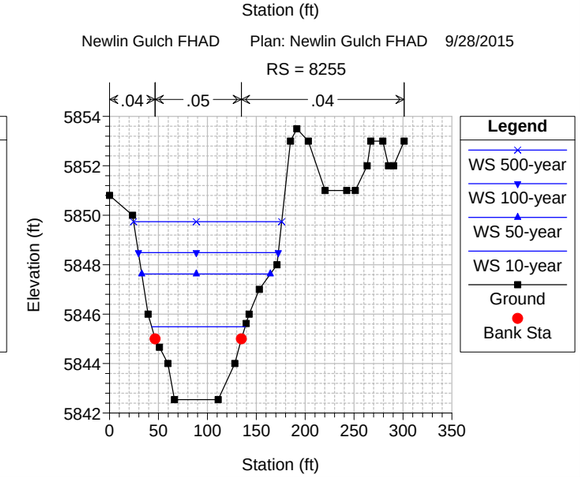

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8533
.04 .05 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

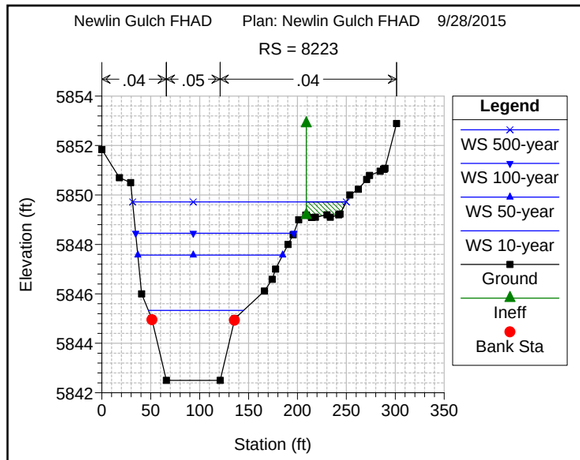

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8494
.04 .05 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

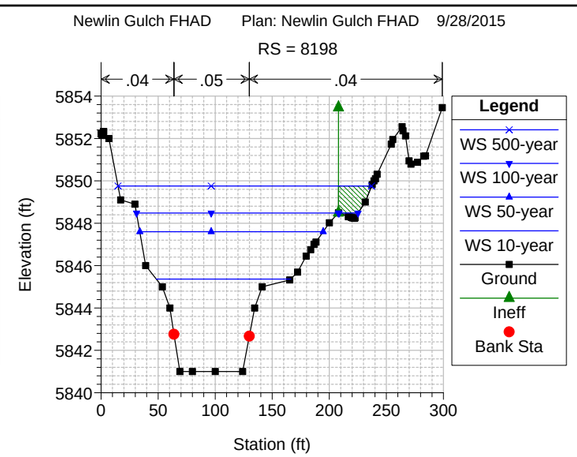

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8465
.04 .05 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

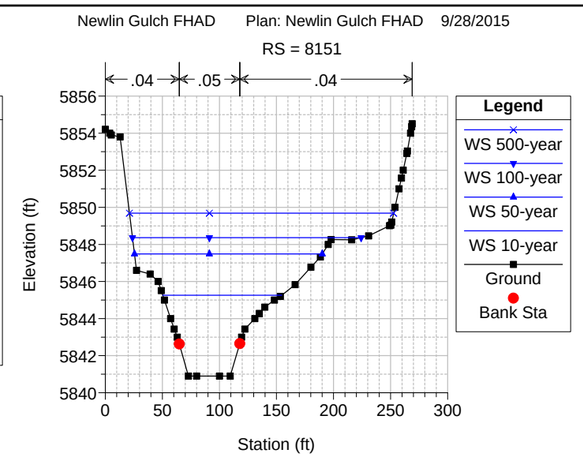

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8420
.04 .05 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

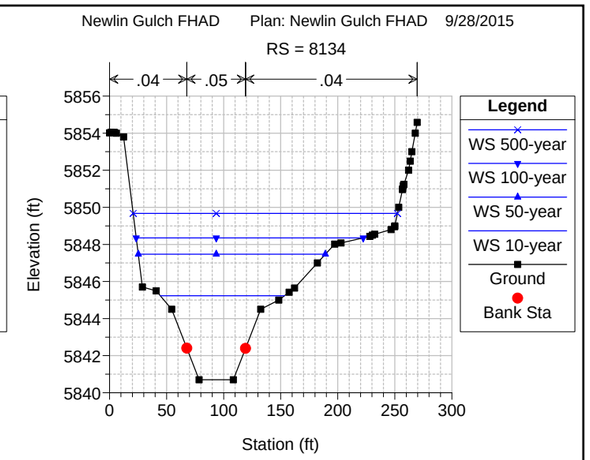

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8328
.04 .05 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

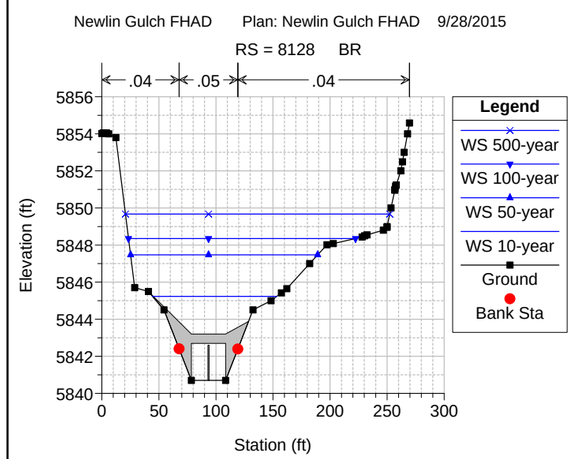

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8255
.04 .05 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

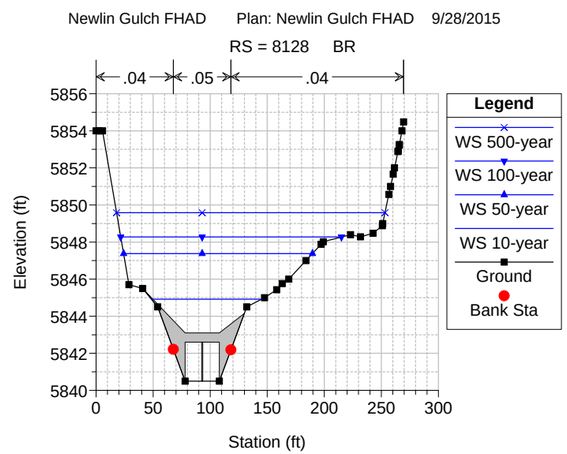

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8223
.04 .05 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Ineff
Bank Sta

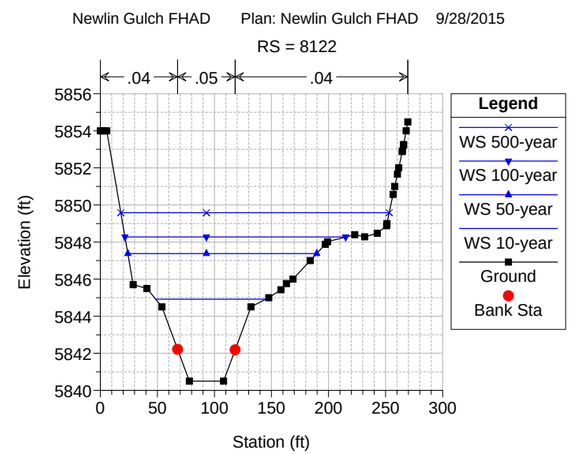

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8198
.04 .05 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Ineff
Bank Sta

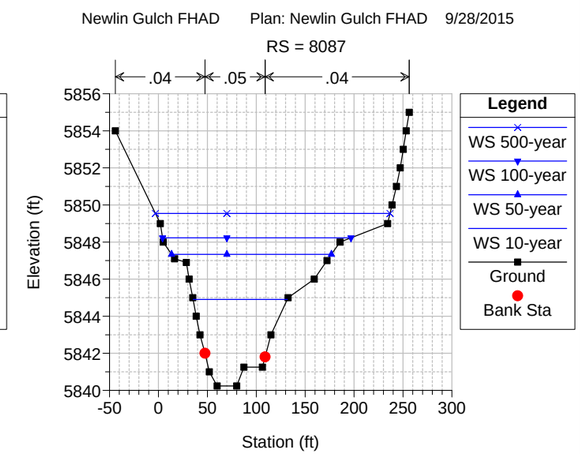

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8151
.04 .05 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

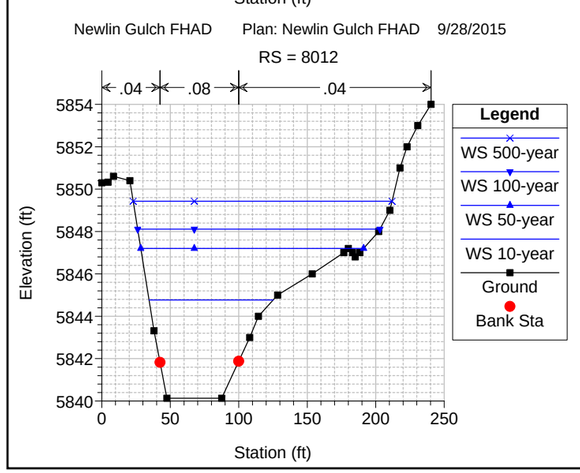

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8134
.04 .05 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

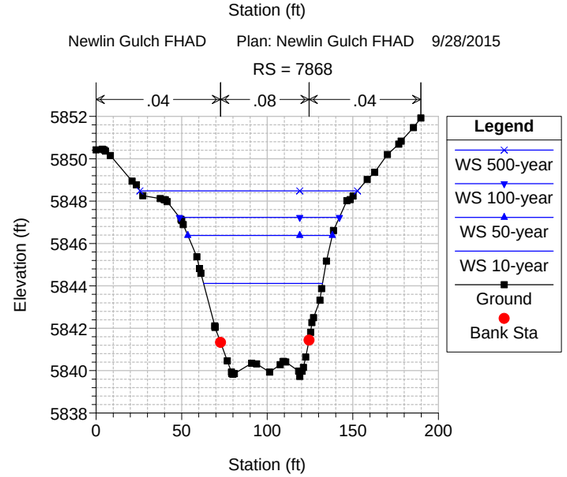

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8128 BR
.04 .05 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

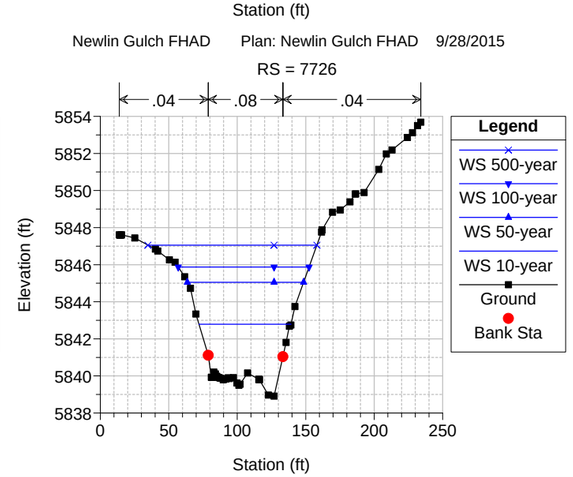

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8128 BR
.04 .05 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

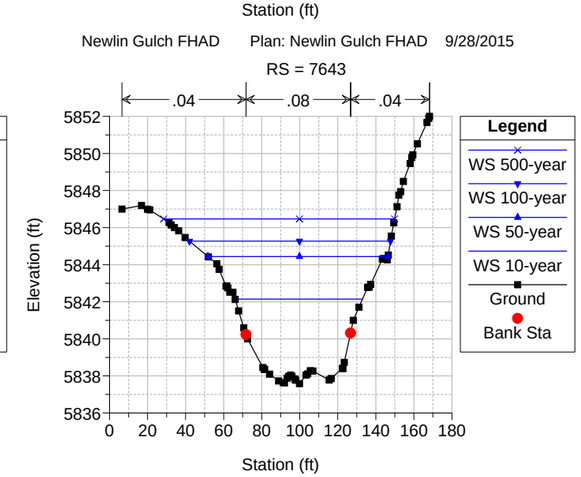

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8122
.04 .05 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

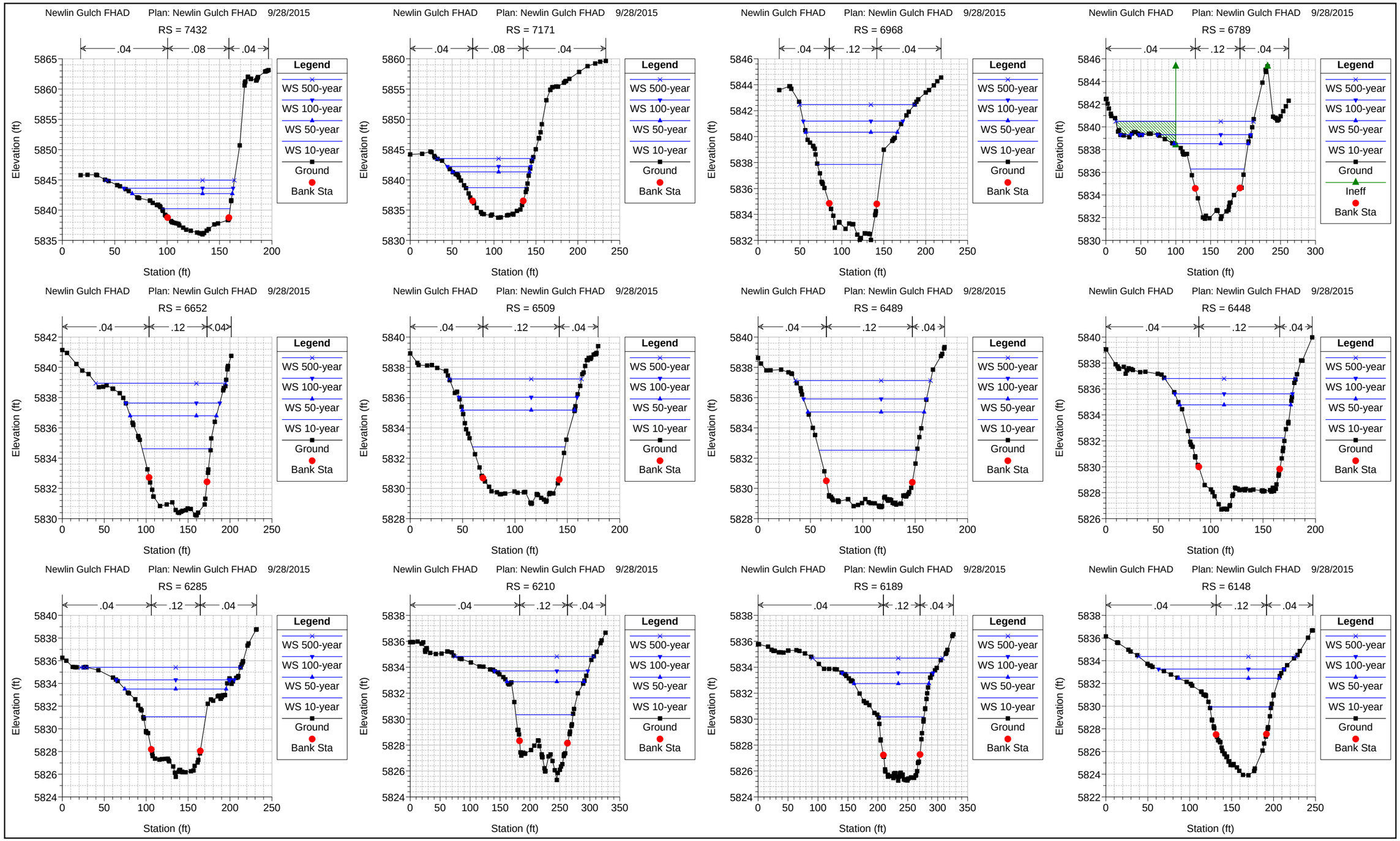

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8087
.04 .05 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

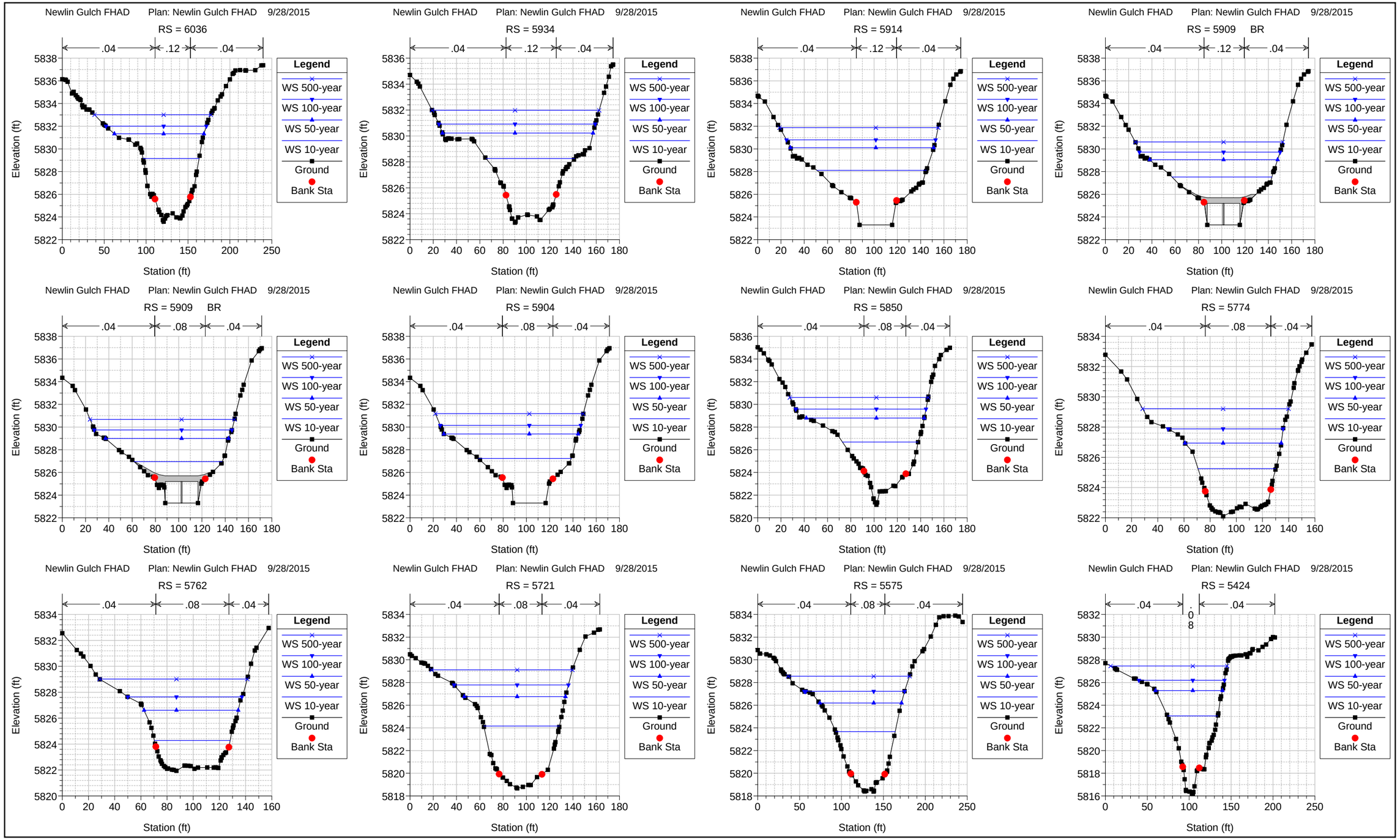

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 8012
.04 .08 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

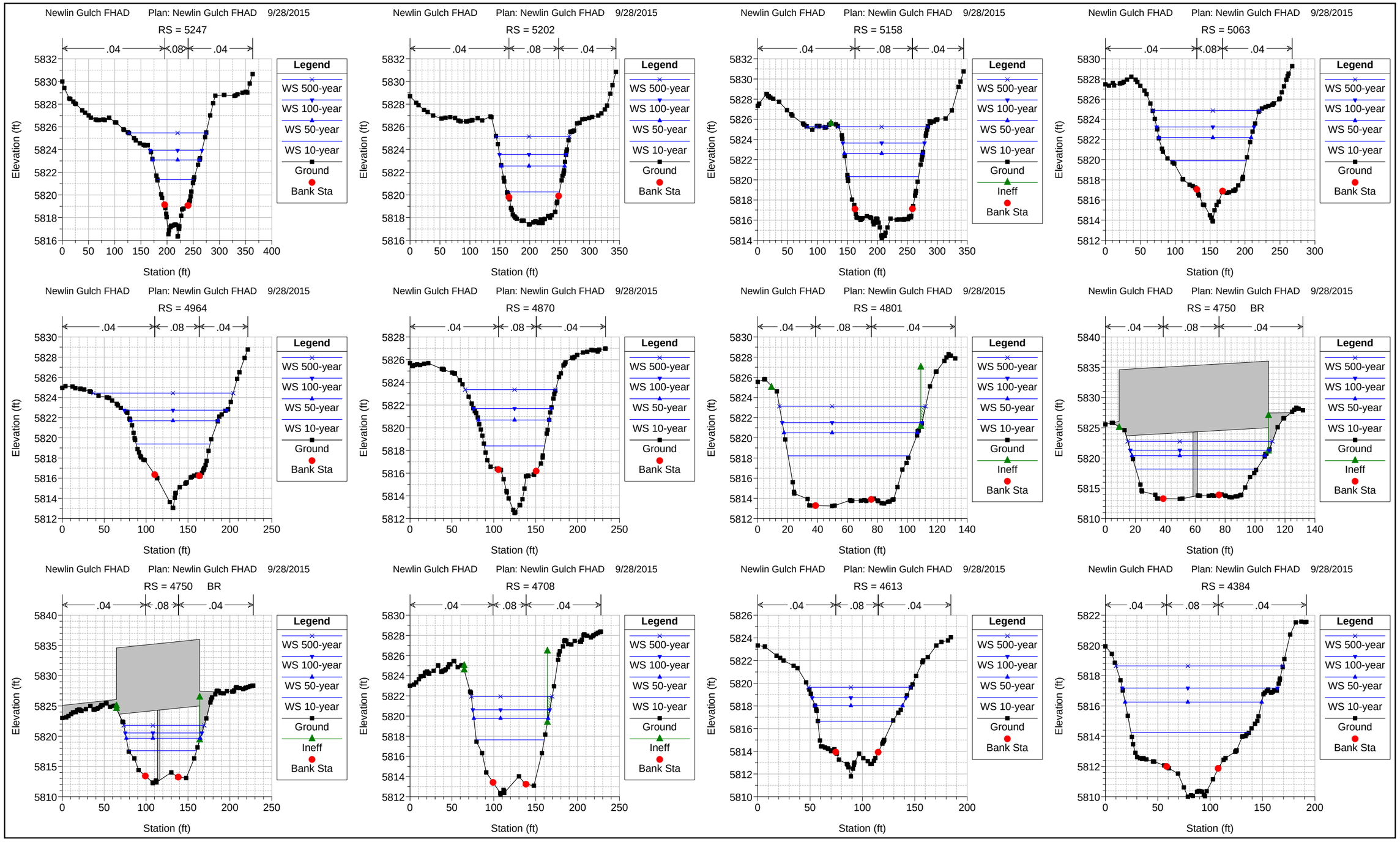

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 7868
.04 .08 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

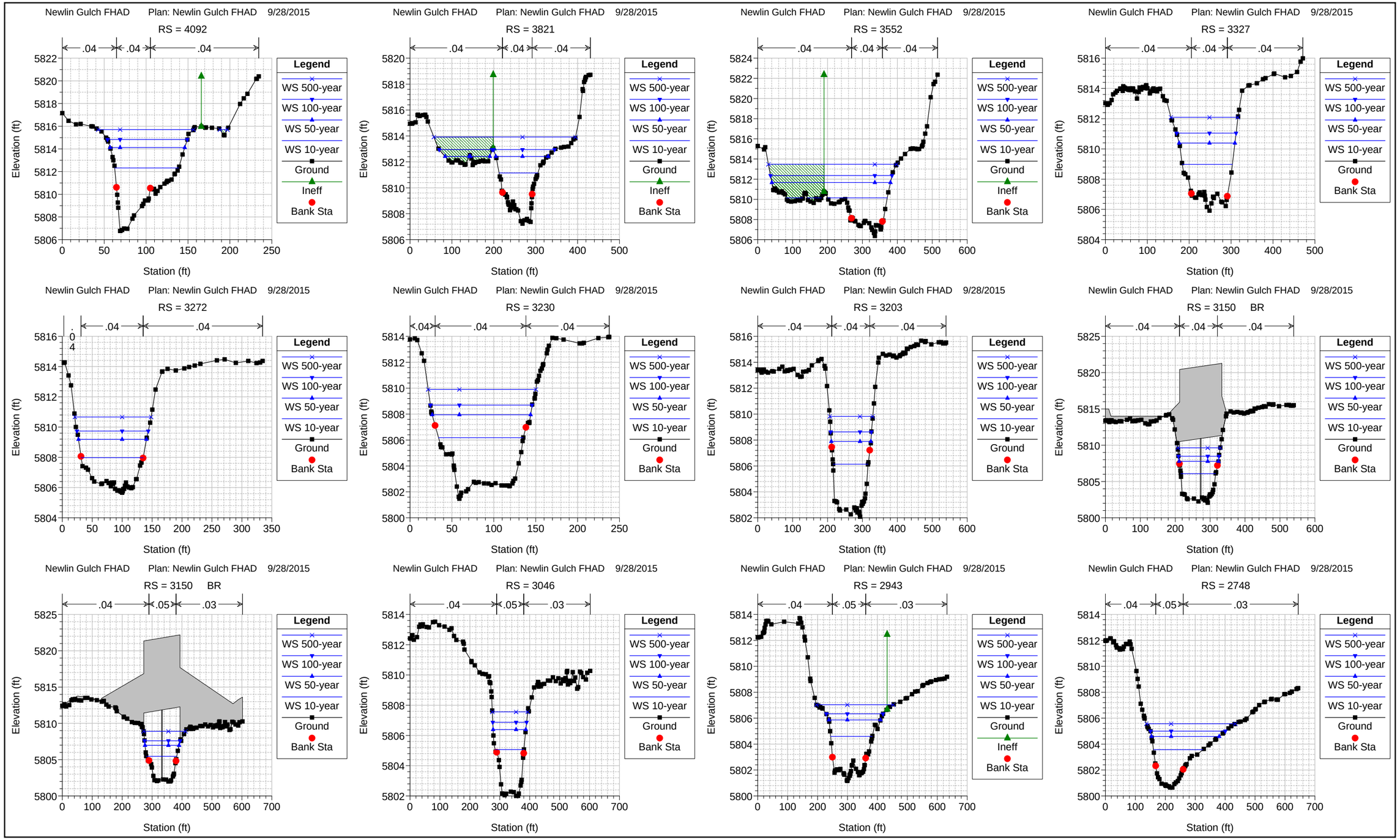

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 7726
.04 .08 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

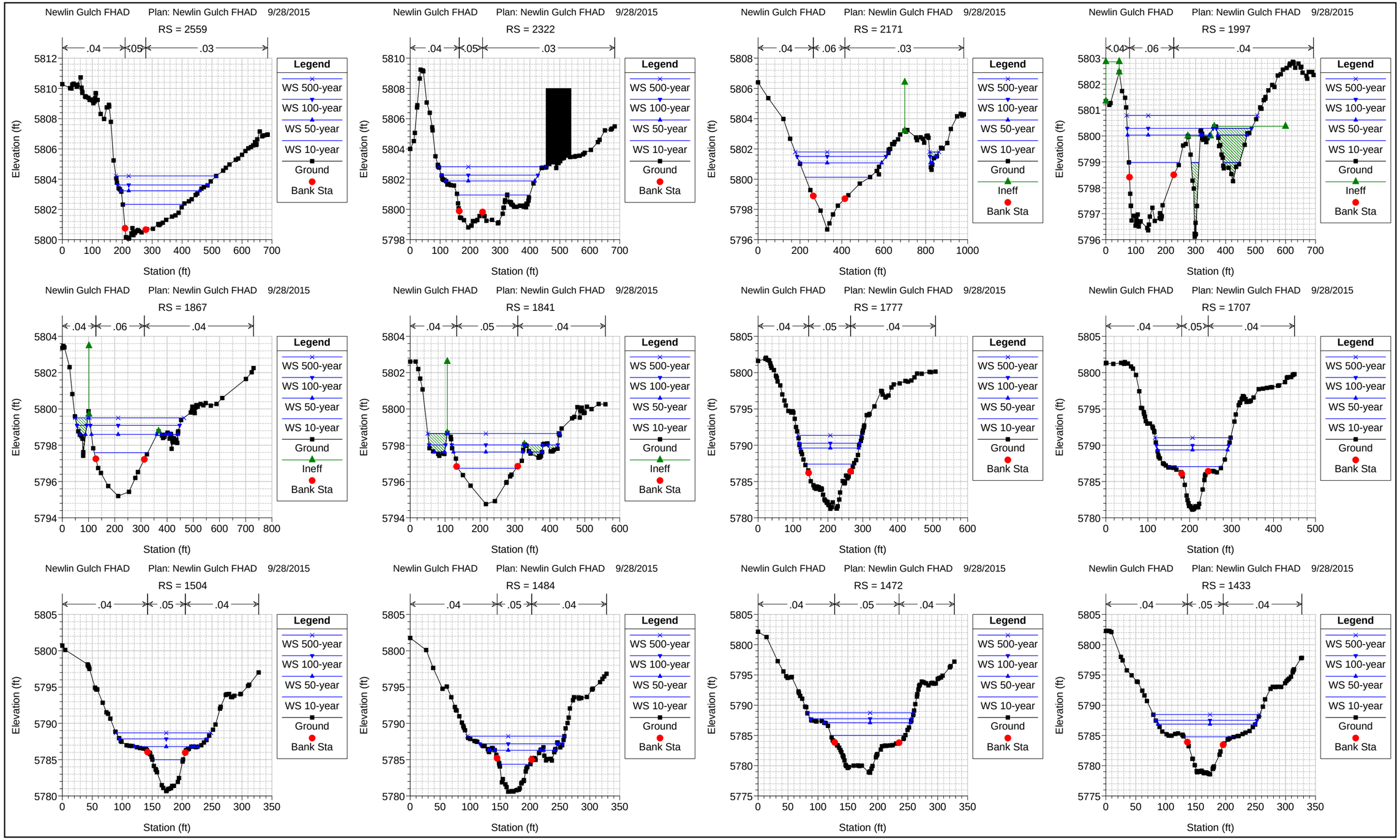

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 7643
.04 .08 .04
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta

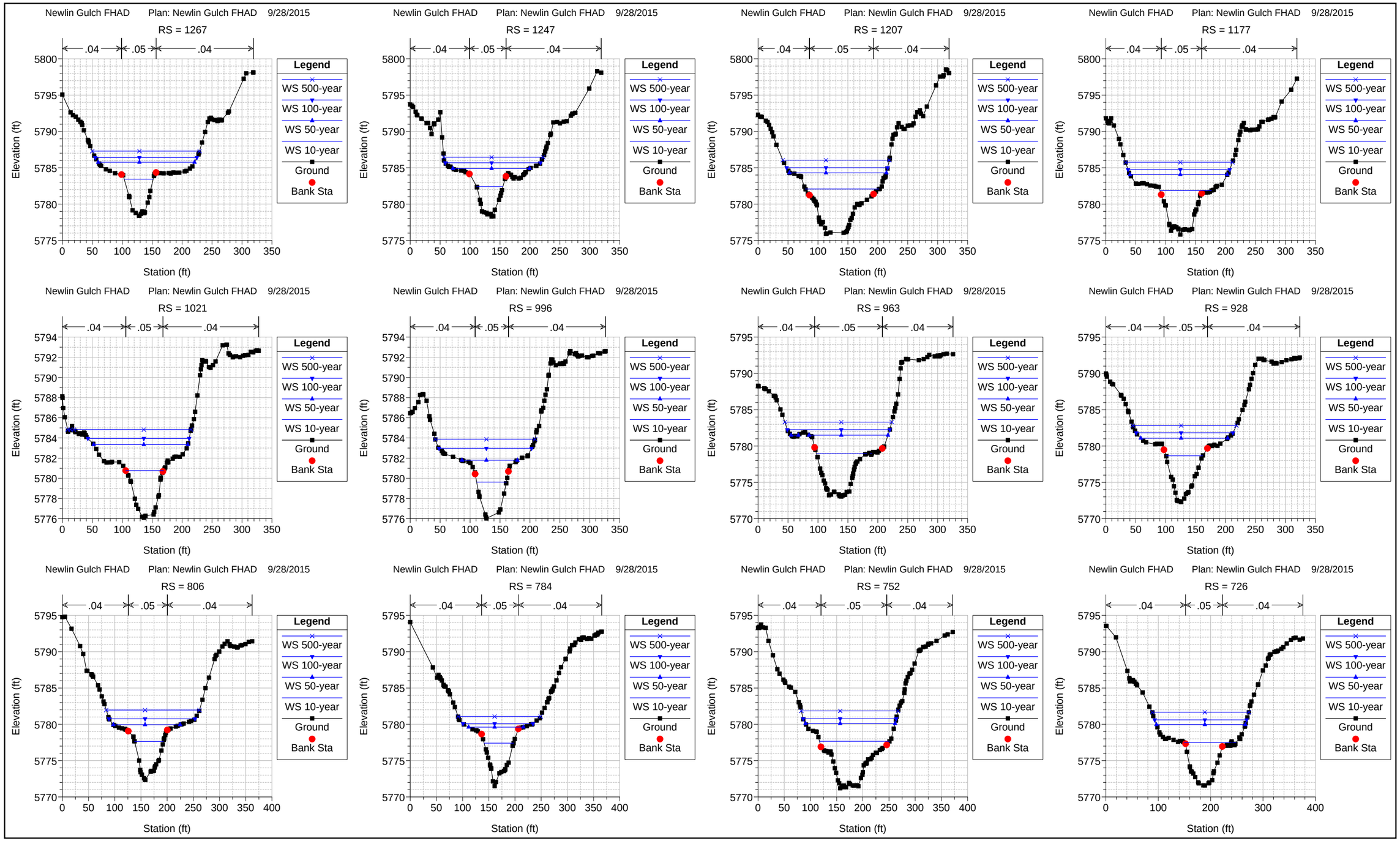

Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 7432
RS = 7171
RS = 6968
RS = 6789
RS = 6652
RS = 6509
RS = 6489
RS = 6448
RS = 6285
RS = 6210
RS = 6189
RS = 6148
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Ineff
Bank Sta


Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 6036
RS = 5934
RS = 5914
RS = 5909 BR
RS = 5909 BR
RS = 5904
RS = 5850
RS = 5774
RS = 5762
RS = 5721
RS = 5575
RS = 5424
.04 .12 .04
.04 .08 .04
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta
Elevation (ft)
Station (ft)


Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 5247
RS = 5202
RS = 5158
RS = 5063
RS = 4964
RS = 4870
RS = 4801
RS = 4750 BR
RS = 4750 BR
RS = 4708
RS = 4613
RS = 4384
.04 .08 .04
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 4092
RS = 3821
RS = 3552
RS = 3327
RS = 3272
RS = 3230
RS = 3203
RS = 3150 BR
RS = 3150 BR
RS = 3046
RS = 2943
RS = 2748
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Ineff
Bank Sta


Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 2559
RS = 2322
RS = 2171
RS = 1997
RS = 1867
RS = 1841
RS = 1777
RS = 1707
RS = 1504
RS = 1484
RS = 1472
RS = 1433
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Ineff
Bank Sta


Newlin Gulch FHAD Plan: Newlin Gulch FHAD 9/28/2015
RS = 1267
RS = 1247
RS = 1207
RS = 1177
RS = 1021
RS = 996
RS = 963
RS = 928
RS = 806
RS = 784
RS = 752
RS = 726
.04 .05 .04
Legend
WS 500-year
WS 100-year
WS 50-year
WS 10-year
Ground
Bank Sta
Elevation (ft)
Station (ft)

Appendix F

FLOODPLAN AND FLOODWAY DATA TABLES

FLOODPLAIN AND FLOODWAY DATA TABLE
NEWLIN GULCH MAINSTEM

REFERENCE LOCATION	RIVER STATION	CROSS SECTION	THALWEG ELEVATION (ft)	FLOW (cfs)				WSEL (ft)				100-YEAR								COMMENTS
				10-YR	50-YR	100-YR	500-YR	10-YR	50-YR	100-YR	500-YR	FLOODPLAIN		0.5' FLOODWAY						
				FLOW (cfs)	FLOW (cfs)	FLOW (cfs)	FLOW (cfs)	WSEL (ft)	WSEL (ft)	WSEL (ft)	WSEL (ft)	WIDTH (ft)	EGL (ft)	WSEL (ft)	TOP WIDTH (ft)	AREA (sq ft)	VELOCITY (fps)	Δ EGL	Δ WSEL	
D/S Study Limits- Confluence w/ Cherry Creek	106	106	5766.1	1125	2670	3539	5161	5771.4	5771.4	5771.4	5771.4	185	5772.0	5771.4	185	560	6.3	0.0	0.0	1
DS Pedestrian Bridge	183	183	5766.1	1125	2670	3539	5161	5771.5	5772.1	5772.5	5773.5	323	5772.9	5772.5	323	678	5.2	0.0	0.0	1 Floodplain top width includes high ground.
US Pedestrian Bridge	193	193	5765.7	1125	2670	3539	5161	5771.7	5772.8	5773.6	5774.7	348	5773.7	5773.6	348	1105	3.2	0.0	0.0	1
	240	240	5766.0	1125	2670	3539	5161	5771.8	5772.9	5773.6	5774.7	171	5774.0	5773.6	171	779	4.5	0.0	0.0	1
	444	444	5767.0	1125	2670	3539	5161	5772.3	5773.8	5774.5	5775.6	187	5774.9	5774.5	187	767	4.6	0.0	0.0	1
	491	491	5766.7	1125	2670	3539	5161	5772.5	5774.0	5774.7	5775.8	187	5775.0	5774.7	187	827	4.3	0.0	0.0	1
	520	520	5771.3	1125	2670	3539	5161	5774.8	5777.2	5777.7	5778.5	156	5779.0	5777.7	156	418	8.5	0.0	0.0	1
	555	555	5770.6	1125	2670	3539	5161	5775.9	5777.8	5778.8	5779.6	156	5780.1	5778.8	156	414	8.6	0.0	0.0	1
	726	726	5771.6	1099	2604	3450	5018	5777.5	5780.0	5780.6	5781.7	176	5781.0	5780.6	176	780	4.4	0.0	0.0	1
	752	752	5771.2	1099	2604	3450	5018	5777.7	5780.1	5780.8	5781.9	178	5781.0	5780.8	178	925	3.7	0.0	0.0	1
	784	784	5771.5	1099	2604	3450	5018	5777.4	5779.6	5780.1	5781.1	134	5781.4	5780.1	134	389	8.9	0.0	0.0	1
	806	806	5772.3	1099	2604	3450	5018	5777.6	5779.9	5780.8	5782.0	164	5781.7	5780.8	164	476	7.2	0.0	0.0	1
	928	928	5772.3	1099	2604	3450	5018	5778.7	5781.1	5781.8	5782.8	162	5782.5	5781.8	162	569	6.1	0.0	0.0	1
	963	963	5773.0	1099	2604	3450	5018	5778.9	5781.5	5782.3	5783.3	171	5782.6	5782.3	171	717	4.8	0.0	0.0	1
	996	996	5776.0	1099	2604	3450	5018	5779.6	5781.8	5783.0	5783.9	154	5784.3	5783.0	154	409	8.4	0.0	0.0	1
	1021	1021	5776.1	1099	2604	3450	5018	5780.8	5783.3	5784.0	5784.8	169	5784.6	5784.0	169	583	5.9	0.0	0.0	1
	1177	1177	5775.8	1099	2604	3450	5018	5781.9	5784.1	5784.8	5785.8	218	5785.2	5784.8	170	678	5.1	0.0	0.0	Floodplain top width includes shallow flooding in ROB from U/S XS 1867.
	1207	1207	5775.9	1099	2604	3450	5018	5782.1	5784.3	5785.0	5786.0	213	5785.3	5785.0	169	831	4.2	0.0	0.0	Floodplain top width includes shallow flooding in ROB from U/S XS 1867.
	1247	1247	5778.3	1099	2604	3450	5018	5782.4	5784.9	5785.7	5786.5	210	5787.0	5785.7	159	415	8.3	0.0	0.0	Floodplain top width includes shallow flooding in ROB from U/S XS 1867.
	1267	1267	5778.4	1099	2604	3450	5018	5783.4	5785.8	5786.4	5787.3	217	5787.2	5786.4	170	521	6.6	0.0	0.0	Floodplain top width includes shallow flooding in ROB from U/S XS 1867.
	1433	1433	5778.6	1099	2604	3450	5018	5784.8	5786.9	5787.5	5788.5	216	5788.0	5787.5	169	673	5.1	0.0	0.0	Floodplain top width includes shallow flooding in ROB from U/S XS 1867.
	1472	1472	5778.9	1099	2604	3450	5018	5785.0	5787.1	5787.8	5788.8	210	5788.1	5787.8	169	776	4.5	0.0	0.0	Floodplain top width includes shallow flooding in ROB from U/S XS 1867.
	1484	1484	5780.6	1099	2604	3450	5018	5784.4	5786.3	5787.2	5788.2	185	5788.7	5787.2	138	379	9.1	0.0	0.0	Floodplain top width includes shallow flooding in ROB from U/S XS 1867.
	1504	1504	5780.7	1099	2604	3450	5018	5785.0	5786.8	5787.9	5788.7	203	5789.2	5787.9	146	398	8.7	0.0	0.0	Floodplain top width includes shallow flooding in ROB from U/S XS 1867.
	1707	1707	5781.1	1099	2604	3450	5018	5787.1	5789.4	5790.0	5791.0	235	5790.4	5790.0	173	732	4.7	0.0	0.0	Floodplain top width includes shallow flooding in ROB from U/S XS 1867.
	1777	1777	5781.3	1099	2604	3450	5018	5787.4	5789.6	5790.3	5791.4	260	5790.5	5790.3	172	925	3.7	0.0	0.0	Floodplain top width includes shallow flooding in ROB from U/S XS 1867.
	1841	1841	5794.8	1099	2604	3450	5018	5796.7	5797.6	5798.0	5798.7	369	5799.0	5798.0	189	416	8.3	0.1	0.0	Floodplain top width includes ineffective flow area.
	1867	1867	5795.2	1099	2604	3450	5018	5797.6	5798.6	5799.1	5799.5	392	5799.5	5799.1	218	627	5.5	0.1	0.0	Floodplain top width includes ineffective flow area.
	1997	1997	5796.4	1099	2604	3450	5018	5799.0	5800.0	5800.3	5800.8	415	5800.8	5800.5	210	575	6.0	0.3	0.2	Floodplain top width includes ineffective flow area.
Recreation Drive	2171	2171	5796.7	1099	2604	3450	5018	5800.1	5801.1	5801.5	5801.8	666	5801.7	5801.7	325	915	3.8	0.3	0.2	Floodplain top width includes ineffective flow area.
	2322	2322	5798.8	1099	2604	3450	5018	5801.0	5801.9	5802.3	5802.8	322	5802.7	5802.3	221	511	6.8	0.4	0.0	
	2559	2559	5800.1	1099	2604	3450	5018	5802.3	5803.2	5803.6	5804.2	301	5804.2	5804.0	204	584	5.9	0.5	0.4	
	2748	2748	5800.7	1099	2604	3450	5018	5803.6	5804.6	5805.0	5805.6	250	5805.6	5805.1	192	545	6.3	0.1	0.1	
	2943	2943	5801.2	1099	2604	3450	5018	5804.6	5805.9	5806.3	5807.0	190	5806.9	5806.3	172	597	5.8	0.0	0.0	
DS Lincoln Avenue	3046	3046	5802.0	1099	2604	3450	5018	5805.1	5806.4	5806.9	5807.6	113	5808.0	5806.9	113	410	8.4	0.0	0.0	
US Lincoln Avenue	3203	3203	5802.1	1099	2604	3450	5018	5806.1	5807.9	5808.6	5809.8	117	5809.2	5808.6	117	591	5.8	0.0	0.0	1

Note: 1) Indicates that, at this cross-section, the floodway is coincident with the floodplain.

FLOODPLAIN AND FLOODWAY DATA TABLE
NEWLIN GULCH MAINSTEM

REFERENCE LOCATION	RIVER STATION	CROSS SECTION	THALWEG ELEVATION (ft)	FLOW (cfs)				WSEL (ft)				100-YEAR								COMMENTS
				10-YR	50-YR	100-YR	500-YR	10-YR	50-YR	100-YR	500-YR	FLOODPLAIN		0.5' FLOODWAY						
				FLOW (cfs)	FLOW (cfs)	FLOW (cfs)	FLOW (cfs)	WSEL (ft)	WSEL (ft)	WSEL (ft)	WSEL (ft)	WIDTH (ft)	EGL (ft)	WSEL (ft)	TOP WIDTH (ft)	AREA (sq ft)	VELOCITY (fps)	Δ EGL	Δ WSEL	
	3230	3230	5801.5	1099	2604	3450	5018	5806.2	5808.0	5808.7	5809.9	121	5809.2	5808.7	121	587	5.9	0.0	0.0	1
	3272	3272	5805.7	1099	2604	3450	5018	5808.0	5809.2	5809.7	5810.7	119	5811.3	5809.7	119	351	9.8	0.0	0.0	1 Adjacent Onsite Detention Basin in LOB.
	3327	3327	5805.9	1099	2604	3450	5018	5809.0	5810.4	5811.0	5812.1	142	5811.9	5811.0	142	498	6.9	0.0	0.0	1
	3552	3552	5806.4	1097	2598	3443	5005	5810.2	5811.7	5812.4	5813.5	348	5812.8	5812.4	348	1025	4.9	0.0	0.0	1 Floodplain top width includes ineffective flow area.
	3821	3821	5807.2	1097	2598	3443	5005	5811.1	5812.4	5813.0	5813.9	275	5814.2	5813.0	275	524	8.1	0.0	0.0	1 Floodplain top width includes ineffective flow area.
	4092	4092	5806.8	1097	2598	3443	5005	5812.3	5814.1	5814.8	5815.7	95	5816.0	5814.8	95	425	8.1	0.0	0.0	1
	4384	4384	5810.0	1097	2598	3443	5005	5814.2	5816.3	5817.2	5818.7	148	5817.7	5817.2	148	634	5.4	0.0	0.0	1
	4613	4613	5811.8	1097	2598	3443	5005	5816.7	5818.0	5818.7	5819.7	90	5820.2	5818.7	90	366	9.4	0.0	0.0	1
DS Jordan Road	4708	4708	5812.3	1097	2598	3443	5005	5817.6	5819.8	5820.6	5821.9	112	5821.3	5820.6	112	554	6.2	0.0	0.0	1 Mapped floodplain width used (Crossing Skewed 35-degrees in HEC-RAS model). Includes ineffective flow area.
US Jordan Road	4801	4801	5813.2	1097	2598	3443	5005	5818.2	5820.5	5821.5	5823.1	113	5822.1	5821.5	113	618	5.6	0.0	0.0	1 Mapped floodplain width used (Crossing Skewed 35-degrees in HEC-RAS model). Includes ineffective flow area.
	4870	4870	5812.5	1097	2598	3443	5005	5818.4	5820.7	5821.7	5823.4	93	5822.5	5821.7	93	481	7.2	0.0	0.0	1
	4964	4964	5813.1	1097	2598	3443	5005	5819.4	5821.7	5822.7	5824.4	122	5823.2	5822.7	122	627	5.5	0.0	0.0	1
	5063	5063	5813.9	1097	2598	3443	5005	5819.9	5822.2	5823.2	5824.9	139	5823.6	5823.2	139	734	4.7	0.0	0.0	1
	5158	5158	5814.2	1097	2598	3443	5005	5820.3	5822.6	5823.7	5825.3	136	5823.9	5823.7	136	886	3.9	0.0	0.0	1
	5202	5202	5817.4	1097	2598	3443	5005	5820.3	5822.6	5823.6	5825.2	111	5824.3	5823.6	111	521	6.6	0.0	0.0	1
	5247	5247	5816.3	1097	2598	3443	5005	5821.4	5823.1	5823.9	5825.5	99	5825.1	5823.9	99	407	8.5	0.0	0.0	1
	5424	5424	5816.2	820	2121	2825	4073	5823.1	5825.3	5826.2	5827.5	102	5826.9	5826.2	102	454	6.2	0.0	0.0	1
	5575	5575	5818.4	820	2121	2825	4073	5823.7	5826.2	5827.2	5828.6	120	5827.6	5827.2	120	570	5.0	0.0	0.0	1
	5721	5721	5818.7	820	2121	2825	4073	5824.2	5826.8	5827.8	5829.1	98	5828.2	5827.8	98	542	5.2	0.0	0.0	1
	5762	5762	5821.9	820	2121	2825	4073	5824.3	5826.6	5827.6	5829.0	87	5828.8	5827.6	87	335	8.4	0.0	0.0	1
	5774	5774	5822.1	820	2121	2825	4073	5825.3	5826.9	5827.9	5829.2	88	5829.1	5827.9	88	321	8.8	0.0	0.0	1
	5850	5850	5821.2	820	2121	2825	4073	5826.7	5828.8	5829.6	5830.6	112	5830.2	5829.6	112	441	6.4	0.0	0.0	1
DS Pedestrian Bridge	5904	5904	5823.3	820	2121	2825	4073	5827.2	5829.4	5830.1	5831.2	121	5830.7	5830.1	121	481	5.9	0.0	0.0	1
US Pedestrian Bridge	5914	5914	5823.3	820	2121	2825	4073	5828.1	5830.1	5830.8	5831.9	128	5831.3	5830.8	128	565	5.0	0.0	0.0	1
	5934	5934	5823.3	820	2121	2825	4073	5828.3	5830.2	5830.9	5832.0	134	5831.5	5830.9	134	508	5.6	0.0	0.0	1
	6036	6036	5823.6	820	2121	2825	4073	5829.2	5831.3	5832.0	5833.0	120	5832.5	5832.0	120	506	5.6	0.0	0.0	1
	6148	6148	5823.9	820	2121	2825	4073	5829.9	5832.5	5833.3	5834.4	150	5833.6	5833.3	150	639	4.4	0.0	0.0	1
	6189	6189	5825.3	820	2121	2825	4073	5830.2	5832.7	5833.6	5834.7	152	5833.9	5833.6	152	671	4.2	0.0	0.0	1
	6210	6210	5825.3	820	2121	2825	4073	5830.3	5832.9	5833.7	5834.8	156	5834.0	5833.7	156	664	4.3	0.0	0.0	1
	6285	6285	5825.8	820	2121	2825	4073	5831.1	5833.5	5834.3	5835.4	141	5834.7	5834.3	141	600	4.7	0.0	0.0	1 Floodplain top width includes high ground.
	6448	6448	5826.7	820	2121	2825	4073	5832.2	5834.8	5835.6	5836.8	112	5835.9	5835.6	112	680	4.2	0.0	0.0	1
	6489	6489	5828.8	820	2121	2825	4073	5832.5	5835.1	5835.9	5837.1	117	5836.3	5835.9	117	642	4.4	0.0	0.0	1
	6509	6509	5829.0	820	2121	2825	4073	5832.7	5835.2	5836.0	5837.2	113	5836.5	5836.0	113	571	5.0	0.0	0.0	1
	6652	6652	5830.2	820	2121	2825	4073	5834.6	5836.8	5837.7	5839.0	112	5838.1	5837.7	112	561	5.0	0.0	0.0	1 Floodplain top width includes high ground.
	6789	6789	5831.9	820	2121	2825	4073	5836.3	5838.5	5839.3	5840.5	187	5839.8	5839.3	107	513	5.5	0.0	0.0	

Note: 1) Indicates that, at this cross-section, the floodway is coincident with the floodplain.

FLOODPLAIN AND FLOODWAY DATA TABLE
NEWLIN GULCH MAINSTEM

REFERENCE LOCATION	RIVER STATION	CROSS SECTION	THALWEG ELEVATION (ft)	FLOW (cfs)				WSEL (ft)				100-YEAR								COMMENTS
				10-YR	50-YR	100-YR	500-YR	10-YR	50-YR	100-YR	500-YR	FLOODPLAIN		0.5' FLOODWAY						
				FLOW (cfs)	FLOW (cfs)	FLOW (cfs)	FLOW (cfs)	WSEL (ft)	WSEL (ft)	WSEL (ft)	WSEL (ft)	WIDTH (ft)	EGL (ft)	WSEL (ft)	TOP WIDTH (ft)	AREA (sq ft)	VELOCITY (fps)	Δ EGL	Δ WSEL	
	6968	6968	5832.0	771	2006	2660	3807	5837.9	5840.3	5841.2	5842.5	119	5841.5	5841.2	119	624	4.3	0.0	0.0	1
	7171	7171	5833.8	771	2006	2660	3807	5838.7	5841.3	5842.2	5843.5	99	5842.6	5842.2	99	564	4.7	0.0	0.0	1
	7432	7432	5836.0	771	2006	2660	3807	5840.2	5842.7	5843.6	5844.9	104	5844.1	5843.6	104	466	5.7	0.0	0.0	1
	7643	7643	5837.6	771	2006	2660	3807	5842.1	5844.4	5845.3	5846.5	106	5845.7	5845.3	106	487	5.5	0.0	0.0	1
	7726	7726	5838.9	771	2006	2660	3807	5842.8	5845.1	5845.9	5847.1	96	5846.5	5845.9	96	418	6.4	0.0	0.0	1
	7868	7868	5839.7	771	2006	2660	3807	5844.1	5846.4	5847.2	5848.5	93	5847.7	5847.2	93	474	5.6	0.0	0.0	1
	8012	8012	5840.1	771	2006	2660	3807	5844.8	5847.2	5848.1	5849.4	177	5848.3	5848.1	177	747	3.6	0.0	0.0	1
	8087	8087	5840.2	771	2006	2660	3807	5844.9	5847.3	5848.2	5849.5	193	5848.5	5848.2	193	770	3.5	0.0	0.0	1
DS Boardwalk Crossing	8122	8122	5840.5	771	2006	2660	3807	5844.9	5847.4	5848.3	5849.6	193	5848.5	5848.3	193	749	3.6	0.0	0.0	1
US Boardwalk Crossing	8134	8134	5840.7	771	2006	2660	3807	5845.2	5847.5	5848.4	5849.7	199	5848.6	5848.4	199	748	3.6	0.0	0.0	1
	8151	8151	5840.9	771	2006	2660	3807	5845.3	5847.5	5848.4	5849.7	200	5848.6	5848.4	200	728	3.7	0.0	0.0	1
	8198	8198	5841.0	771	2006	2660	3807	5845.4	5847.6	5848.5	5849.8	194	5848.7	5848.5	194	781	3.4	0.0	0.0	1 Floodplain top width includes ineffective flow area.
	8223	8223	5842.5	771	2006	2660	3807	5845.3	5847.6	5848.5	5849.7	162	5848.8	5848.5	162	629	4.2	0.0	0.0	1
	8255	8255	5842.5	771	2006	2660	3807	5845.5	5847.6	5848.5	5849.7	143	5848.9	5848.5	143	565	4.7	0.0	0.0	1
	8328	8328	5842.8	771	2006	2660	3807	5845.8	5847.8	5848.7	5849.8	116	5849.1	5848.7	116	516	5.2	0.0	0.0	1
	8420	8420	5843.0	771	2006	2660	3807	5846.1	5848.1	5848.9	5850.0	100	5849.4	5848.9	100	463	5.8	0.0	0.0	1
	8465	8465	5843.1	771	2006	2660	3807	5846.3	5848.4	5849.2	5850.5	119	5849.6	5849.2	119	576	4.6	0.0	0.0	1
	8494	8494	5844.8	771	2006	2660	3807	5846.4	5848.1	5849.0	5850.3	115	5849.9	5849.0	115	373	7.1	0.0	0.0	1
	8533	8533	5845.1	771	2006	2660	3807	5847.5	5849.0	5849.7	5850.8	130	5850.2	5849.7	130	440	6.1	0.0	0.0	1
	8626	8626	5845.1	771	2006	2660	3807	5848.2	5849.7	5850.4	5851.5	164	5850.7	5850.4	164	563	4.7	0.0	0.0	1
	8636	8636	5846.0	771	2006	2660	3807	5848.0	5849.6	5850.3	5851.4	163	5850.9	5850.3	163	455	5.8	0.0	0.0	1
	8676	8676	5846.2	771	2006	2660	3807	5848.7	5850.1	5850.7	5851.7	152	5851.1	5850.7	152	513	5.2	0.0	0.0	1
	8900	8900	5846.0	771	2006	2660	3807	5849.5	5851.2	5851.8	5852.8	267	5852.0	5851.8	267	952	2.8	0.0	0.0	1
	8932	8932	5847.7	771	2006	2660	3807	5849.4	5851.1	5851.8	5852.8	245	5852.3	5851.8	245	474	5.6	0.0	0.0	1
	8964	8964	5848.4	771	2006	2660	3807	5850.1	5851.5	5852.3	5853.0	262	5852.7	5852.3	262	517	5.1	0.0	0.0	1
	9119	9119	5848.7	771	2006	2660	3807	5851.1	5852.5	5853.0	5853.7	224	5853.3	5853.0	224	682	3.9	0.0	0.0	1
	9349	9349	5848.6	771	2006	2660	3807	5851.9	5853.1	5853.4	5853.9	105	5854.5	5853.4	105	326	8.2	0.0	0.0	1
	9380	9380	5852.5	771	2006	2660	3807	5854.1	5855.4	5855.9	5856.8	94	5857.5	5855.9	94	273	9.8	0.0	0.0	1
	9414	9414	5853.2	771	2006	2660	3807	5854.9	5856.4	5857.1	5858.2	134	5857.9	5857.1	134	391	6.8	0.0	0.0	1
	9538	9538	5853.5	771	2006	2660	3807	5856.0	5857.4	5858.1	5859.2	235	5858.3	5858.1	235	726	3.7	0.0	0.0	1
	9751	9751	5853.8	771	2006	2660	3807	5856.6	5857.9	5858.5	5859.4	182	5858.9	5858.5	182	561	4.7	0.0	0.0	1
	9860	9860	5854.0	771	2006	2660	3807	5856.9	5858.2	5858.8	5859.7	163	5859.3	5858.8	163	513	5.2	0.0	0.0	1
	9905	9905	5854.1	771	2006	2660	3807	5856.8	5858.1	5858.6	5859.5	97	5860.1	5858.6	97	279	9.5	0.0	0.0	1
	9942	9942	5857.5	771	2006	2660	3807	5859.1	5860.5	5861.0	5862.1	95	5862.5	5861.0	95	273	9.7	0.0	0.0	1
DS Stonegate Parkway	9989	9989	5857.6	771	2006	2660	3807	5860.3	5861.7	5862.1	5862.8	91	5863.5	5862.1	91	289	9.2	0.0	0.0	1 Mapped floodplain width used (Crossing Skewed 27-degrees in HEC-RAS model). Includes ineffective flow area.

Note: 1) Indicates that, at this cross-section, the floodway is coincident with the floodplain.

FLOODPLAIN AND FLOODWAY DATA TABLE
NEWLIN GULCH MAINSTEM

REFERENCE LOCATION	RIVER STATION	CROSS SECTION	THALWEG ELEVATION (ft)	FLOW (cfs)				WSEL (ft)				100-YEAR								COMMENTS
				10-YR	50-YR	100-YR	500-YR	10-YR	50-YR	100-YR	500-YR	FLOODPLAIN		0.5' FLOODWAY						
				FLOW (cfs)	FLOW (cfs)	FLOW (cfs)	FLOW (cfs)	WSEL (ft)	WSEL (ft)	WSEL (ft)	WSEL (ft)	WIDTH (ft)	EGL (ft)	WSEL (ft)	TOP WIDTH (ft)	AREA (sq ft)	VELOCITY (fps)	Δ EGL	Δ WSEL	
US Stonegate Parkway	10048	10048	5858.0	771	2006	2660	3807	5860.8	5862.4	5863.0	5866.7	98	5864.1	5863.0	98	323	8.3	0.0	0.0	1 Mapped floodplain width used (Crossing Skewed 27-degrees in HEC-RAS model). Includes ineffective flow area.
	10094	10094	5859.0	771	2006	2660	3807	5861.5	5863.2	5864.0	5867.1	104	5864.8	5864.0	104	375	7.1	0.0	0.0	1
	10284	10284	5860.1	785	1885	2493	3560	5863.2	5864.9	5865.6	5867.6	177	5865.9	5865.6	177	569	4.4	0.0	0.0	1
	10404	10404	5861.9	785	1885	2493	3560	5863.9	5865.3	5865.9	5867.8	190	5866.2	5865.9	190	575	4.3	0.0	0.0	1
	10759	10759	5863.0	785	1885	2493	3560	5866.6	5867.2	5867.6	5868.2	158	5868.6	5867.6	158	312	8.0	0.0	0.0	1
	10964	10964	5865.7	785	1885	2493	3560	5868.1	5869.3	5869.8	5870.4	185	5870.2	5869.8	185	499	5.0	0.0	0.0	1
	11157	11157	5866.2	785	1885	2493	3560	5869.0	5870.1	5870.6	5871.2	169	5871.2	5870.6	169	411	6.1	0.0	0.0	1
	11291	11291	5866.4	785	1885	2493	3560	5869.6	5870.7	5871.2	5871.9	91	5872.5	5871.2	91	283	8.8	0.0	0.0	1
	11336	11336	5869.8	785	1885	2493	3560	5871.9	5873.1	5873.6	5874.5	103	5875.1	5873.6	103	273	9.1	0.0	0.0	1
	11362	11362	5870.1	785	1885	2493	3560	5872.5	5873.7	5874.2	5874.9	105	5875.4	5874.2	105	301	8.3	0.0	0.0	1
	11522	11522	5870.6	785	1885	2493	3560	5873.8	5875.1	5875.7	5876.6	104	5876.9	5875.7	104	312	8.0	0.0	0.0	1
	11584	11584	5873.9	785	1885	2493	3560	5875.9	5877.2	5877.8	5879.0	124	5879.0	5877.8	124	293	8.5	0.0	0.0	1 Unlikely ineffective flow area in ROB.
	11615	11615	5874.3	785	1885	2493	3560	5876.7	5878.0	5878.5	5879.2	154	5879.4	5878.5	154	369	6.9	0.0	0.0	1 Unlikely ineffective flow area in ROB.
	11822	11822	5874.5	785	1885	2493	3560	5877.7	5879.2	5879.9	5880.5	187	5880.1	5879.9	187	676	3.7	0.0	0.0	1
	12018	12018	5874.8	722	1744	2291	3262	5878.0	5879.5	5880.2	5880.9	178	5880.4	5880.2	178	643	3.6	0.0	0.0	1
	12151	12151	5874.6	722	1744	2291	3262	5878.2	5879.6	5880.1	5880.7	112	5881.0	5880.1	112	340	6.7	0.0	0.0	1
	12201	12201	5877.9	722	1744	2291	3262	5880.1	5881.4	5881.8	5882.6	103	5883.2	5881.8	103	260	8.8	0.0	0.0	1
	12232	12232	5878.6	722	1744	2291	3262	5880.9	5882.3	5882.8	5883.9	158	5883.5	5882.8	158	392	5.8	0.0	0.0	1
	12390	12390	5879.1	722	1744	2291	3262	5881.8	5883.2	5883.8	5884.7	184	5884.1	5883.8	184	569	4.0	0.0	0.0	1
	12629	12629	5877.7	722	1744	2291	3262	5882.7	5883.9	5884.4	5885.2	145	5884.9	5884.4	145	422	5.4	0.0	0.0	1
	12729	12729	5886.1	722	1744	2291	3262	5887.6	5888.5	5888.9	5889.5	129	5890.0	5888.9	129	277	8.3	0.0	0.0	1
	12759	12759	5885.9	722	1744	2291	3262	5888.3	5889.3	5889.8	5890.5	144	5890.3	5889.8	144	404	5.7	0.0	0.0	1
	12945	12945	5886.7	722	1744	2291	3262	5889.3	5890.4	5890.8	5891.6	164	5891.3	5890.8	164	451	5.1	0.0	0.0	1
	13107	13107	5888.1	722	1744	2291	3262	5890.4	5891.3	5891.7	5892.3	154	5892.4	5891.7	154	335	6.8	0.0	0.0	1
	13189	13189	5893.5	722	1744	2291	3262	5895.0	5895.9	5896.3	5896.9	126	5897.4	5896.3	126	271	8.5	0.0	0.0	1
	13214	13214	5893.7	722	1744	2291	3262	5895.7	5896.7	5897.2	5897.9	149	5897.7	5897.2	149	409	5.6	0.0	0.0	1
	13485	13485	5894.5	722	1744	2291	3262	5897.1	5898.1	5898.6	5899.3	166	5899.0	5898.6	166	468	4.9	0.0	0.0	1
	13776	13776	5897.0	722	1744	2291	3262	5898.9	5899.8	5900.2	5900.8	150	5901.0	5900.2	150	319	7.2	0.0	0.0	1
	13870	13870	5902.2	703	1710	2244	3195	5903.7	5904.5	5904.9	5905.5	128	5906.0	5904.9	128	271	8.3	0.0	0.0	1
	13893	13893	5902.4	703	1710	2244	3195	5904.2	5905.2	5905.7	5906.3	133	5906.3	5905.7	133	361	6.2	0.0	0.0	1
DS Mainstreet	13968	13968	5902.1	703	1710	2244	3195	5904.7	5905.8	5906.3	5907.1	141	5906.7	5906.3	141	459	4.9	0.0	0.0	1
US Mainstreet	14070	14070	5901.6	703	1710	2244	3195	5905.3	5906.6	5907.1	5907.9	144	5907.4	5907.1	144	516	4.3	0.0	0.0	1
	14115	14115	5901.8	703	1710	2244	3195	5905.3	5906.6	5907.1	5908.0	165	5907.6	5907.1	165	431	5.2	0.0	0.0	1
	14179	14179	5908.2	633	1547	2019	2875	5910.0	5910.8	5911.2	5911.8	116	5912.3	5911.2	116	242	8.3	0.0	0.0	1
	14233	14233	5909.2	633	1547	2019	2875	5911.4	5912.1	5912.5	5913.1	167	5913.2	5912.5	167	310	6.5	0.0	0.0	1

Note: 1) Indicates that, at this cross-section, the floodway is coincident with the floodplain.

FLOODPLAIN AND FLOODWAY DATA TABLE
NEWLIN GULCH MAINSTEM

REFERENCE LOCATION	RIVER STATION	CROSS SECTION	THALWEG ELEVATION (ft)	FLOW (cfs)				WSEL (ft)				100-YEAR								COMMENTS
				10-YR	50-YR	100-YR	500-YR	10-YR	50-YR	100-YR	500-YR	FLOODPLAIN		0.5' FLOODWAY						
				FLOW (cfs)	FLOW (cfs)	FLOW (cfs)	FLOW (cfs)	WSEL (ft)	WSEL (ft)	WSEL (ft)	WSEL (ft)	WIDTH (ft)	EGL (ft)	WSEL (ft)	TOP WIDTH (ft)	AREA (sq ft)	VELOCITY (fps)	Δ EGL	Δ WSEL	
	14574	14574	5912.8	633	1547	2019	2875	5914.6	5915.5	5915.8	5916.3	148	5916.3	5915.8	148	366	5.5	0.0	0.0	1
	14788	14788	5913.7	633	1547	2019	2875	5915.9	5916.9	5917.5	5918.4	234	5918.7	5917.5	234	259	7.9	0.0	0.0	1 Floodplain top width includes high ground and ineffective flow area.
	15176	15176	5916.0	633	1547	2019	2875	5918.4	5920.0	5920.6	5921.2	134	5920.8	5920.6	134	495	4.1	0.0	0.0	1
	15564	15564	5919.2	633	1547	2019	2875	5920.9	5921.9	5922.4	5923.2	145	5922.9	5922.4	145	336	6.0	0.0	0.0	1
	15714	15714	5920.4	633	1547	2019	2875	5922.5	5923.5	5923.8	5924.5	134	5924.3	5923.8	134	387	5.2	0.0	0.0	1
	16007	16007	5922.8	633	1547	2019	2875	5924.6	5925.8	5926.3	5927.0	90	5927.2	5926.3	90	266	7.6	0.0	0.0	1
	16326	16326	5925.4	633	1547	2019	2875	5927.8	5929.0	5929.5	5930.3	148	5929.9	5929.5	148	426	4.7	0.0	0.0	1
	16559	16559	5927.3	546	1369	1780	2532	5929.3	5930.3	5930.8	5931.5	214	5931.0	5930.8	214	471	3.8	0.0	0.0	1
	16842	16842	5929.6	546	1369	1780	2532	5931.6	5932.4	5932.6	5933.1	171	5933.1	5932.6	171	330	5.4	0.0	0.0	1
	17083	17083	5931.8	546	1369	1780	2532	5933.9	5934.8	5935.2	5935.7	173	5935.5	5935.2	173	377	4.7	0.0	0.0	1
	17343	17343	5934.1	546	1369	1780	2532	5936.2	5937.1	5937.4	5938.0	158	5937.8	5937.4	158	357	5.0	0.0	0.0	1 Unlikely ineffective flow area in LOB.
	17706	17706	5937.4	546	1369	1780	2532	5940.0	5941.1	5941.5	5942.0	131	5942.0	5941.5	131	321	5.9	0.0	0.0	1 Unlikely ineffective flow area in ROB.
	18013	18013	5940.0	324	773	1029	1584	5943.0	5944.1	5944.5	5945.3	131	5944.7	5944.5	131	330	3.1	0.0	0.0	1
	18237	18237	5944.2	324	773	1029	1584	5946.1	5946.7	5947.0	5947.7	99	5947.8	5947.0	99	147	7.0	0.0	0.0	1
	18615	18615	5948.6	324	773	1029	1584	5951.4	5952.6	5953.1	5953.9	122	5953.2	5953.1	122	397	2.6	0.0	0.0	1
	18843	18843	5951.5	324	773	1029	1584	5953.3	5954.4	5954.9	5955.8	105	5955.1	5954.9	105	288	3.6	0.0	0.0	1
DS Chambers Road	18902	18902	5952.0	324	773	1029	1584	5954.2	5955.2	5955.7	5956.6	97	5955.9	5955.7	97	283	3.6	0.0	0.0	1
US Chambers Road	18973	18973	5952.3	324	773	1029	1584	5954.6	5955.8	5956.3	5957.1	102	5956.4	5956.3	102	304	3.4	0.0	0.0	1
	19052	19052	5953.1	324	773	1029	1584	5955.0	5956.1	5956.6	5957.5	108	5956.8	5956.6	108	301	3.4	0.0	0.0	1
	19171	19171	5954.0	324	773	1029	1584	5955.9	5956.8	5957.2	5958.1	107	5957.7	5957.2	107	210	4.9	0.0	0.0	1
	19393	19393	5956.3	324	773	1029	1584	5958.4	5959.3	5959.7	5960.4	84	5960.1	5959.7	84	213	4.8	0.0	0.0	1
	19724	19724	5959.9	324	773	1029	1584	5962.2	5962.9	5963.2	5963.9	166	5963.4	5963.2	166	282	3.7	0.0	0.0	1
	20025	20025	5963.7	324	773	1027	1581	5965.7	5966.3	5966.5	5967.0	266	5966.8	5966.5	223	261	3.9	0.0	0.0	Floodplain top width includes high ground and ineffective flow area.
	20220	20220	5967.0	324	773	1027	1581	5968.5	5969.4	5969.7	5970.1	189	5970.1	5969.7	189	207	5.0	0.0	0.0	1
DS Trail Crossing - Double 10' x 2' CBC	20250	20250	5967.0	324	773	1027	1581	5969.2	5970.4	5970.7	5971.1	177	5971.2	5970.7	177	185	5.6	0.0	0.0	1 Trail crossing overtopping.
US Trail Crossing - Double 10' x 2' CBC	20270	20270	5967.3	324	773	1027	1581	5970.4	5971.3	5971.6	5972.0	204	5971.8	5971.6	204	339	3.0	0.0	0.0	1
	20290	20290	5967.9	324	773	1027	1581	5970.5	5971.4	5971.7	5972.2	212	5971.9	5971.7	212	322	3.2	0.0	0.0	1
	20438	20438	5971.5	324	773	1027	1581	5972.9	5973.3	5973.5	5973.9	301	5973.9	5973.5	125	198	5.2	0.0	0.0	Floodplain top width includes ineffective flow area.
	20642	20642	5974.0	323	768	1015	1557	5975.4	5976.2	5976.5	5977.1	423	5976.7	5976.5	179	299	3.4	0.0	0.0	Floodplain top width includes ineffective flow area.
	20895	20895	5977.0	323	768	1015	1557	5978.9	5979.3	5979.5	5979.9	502	5979.7	5979.5	206	264	3.8	0.0	0.0	Floodplain delineated based on backwater from cross section 20642.
	21114	21114	5980.2	323	768	1015	1557	5982.0	5982.6	5982.8	5983.2	248	5983.0	5982.8	248	294	3.5	0.0	0.0	Unlikely ineffective flow area in LOB.
	21365	21365	5982.3	323	768	1015	1557	5985.5	5986.0	5986.2	5986.5	370	5986.3	5986.3	273	307	3.3	0.1	0.1	Unlikely ineffective flow area in LOB.
	21560	21560	5983.7	323	768	1015	1557	5987.0	5987.8	5988.0	5988.4	222	5988.6	5988.1	139	192	5.3	0.0	0.1	Floodplain top width includes ineffective flow area.
	21699	21699	5988.4	323	768	1015	1557	5989.8	5990.7	5991.1	5991.9	53	5992.2	5991.1	53	118	8.6	0.0	0.0	1
DS Hess Road	21835	21835	5989.5	323	768	1015	1557	5991.7	5992.7	5993.1	5993.8	52	5993.9	5993.1	52	144	7.1	0.0	0.0	1

Note: 1) Indicates that, at this cross-section, the floodway is coincident with the floodplain.

FLOODPLAIN AND FLOODWAY DATA TABLE
NEWLIN GULCH MAINSTEM

REFERENCE LOCATION	RIVER STATION	CROSS SECTION	THALWEG ELEVATION (ft)	FLOW (cfs)				WSEL (ft)				100-YEAR								COMMENTS
				10-YR	50-YR	100-YR	500-YR	10-YR	50-YR	100-YR	500-YR	FLOODPLAIN		0.5' FLOODWAY						
				FLOW (cfs)	FLOW (cfs)	FLOW (cfs)	FLOW (cfs)	WSEL (ft)	WSEL (ft)	WSEL (ft)	WSEL (ft)	WIDTH (ft)	EGL (ft)	WSEL (ft)	TOP WIDTH (ft)	AREA (sq ft)	VELOCITY (fps)	Δ EGL	Δ WSEL	
US Hess Road	21881	21881	5989.4	323	768	1015	1557	5992.0	5993.1	5993.5	5994.4	52	5994.3	5993.5	52	153	6.7	0.0	0.0	1
	21911	21911	5990.3	323	768	1015	1557	5992.1	5993.2	5993.7	5994.5	52	5994.6	5993.7	52	133	7.6	0.0	0.0	1
	21959	21959	5990.6	323	768	1015	1557	5992.8	5994.0	5994.6	5995.6	608	5994.9	5994.6	78	231	4.4	0.0	0.0	Floodplain top width includes ineffective flow area.
	22025	22025	6000.1	323	768	1015	1557	6001.2	6001.8	6002.0	6002.5	113	6002.7	6002.0	113	155	6.6	0.0	0.0	1
	22051	22051	6000.6	323	768	1015	1557	6001.8	6002.5	6002.8	6003.4	985	6003.1	6002.8	126	256	4.0	0.0	0.0	Floodplain top width includes ineffective flow area.
U/S Limits of Detailed Study	22214	22214	6001.7	323	768	1015	1557	6002.7	6003.3	6003.6	6004.2	894	6003.7	6003.6	221	345	2.9	0.0	0.0	Floodplain top width includes ineffective flow area.

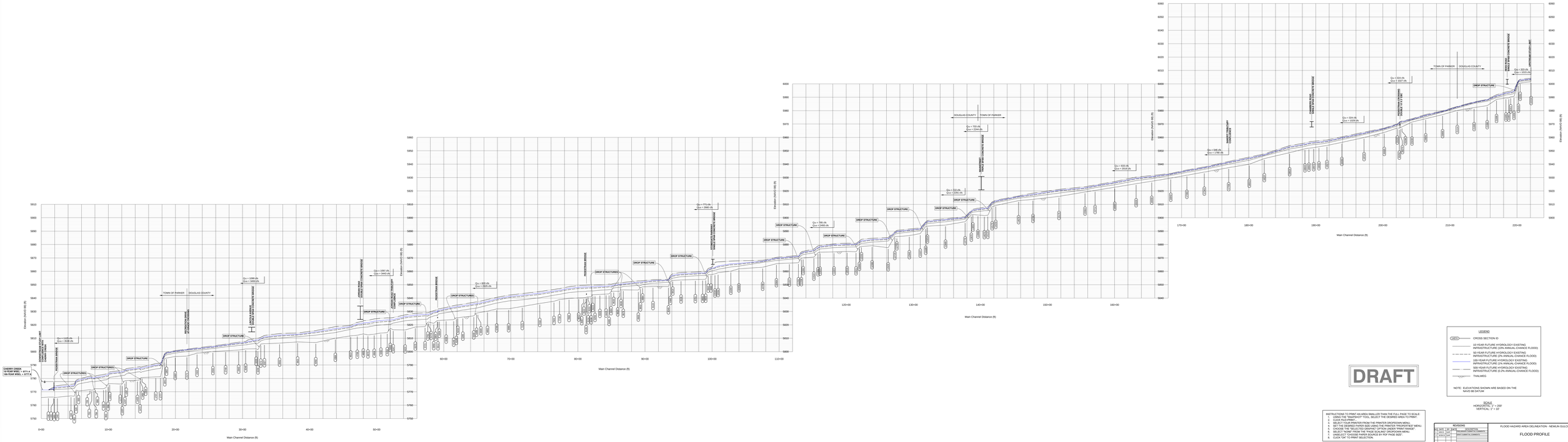
Note: 1) Indicates that, at this cross-section, the floodway is coincident with the floodplain.

Appendix G

FLOOD MAP

Appendix H

FLOOD PROFILES



DRAFT

LEGEND

0+00	CROSS SECTION ID
	10-YEAR FUTURE HYDROLOGY EXISTING INFRASTRUCTURE (10% ANNUAL-CHANCE FLOOD)
	50-YEAR FUTURE HYDROLOGY EXISTING INFRASTRUCTURE (2% ANNUAL-CHANCE FLOOD)
	100-YEAR FUTURE HYDROLOGY EXISTING INFRASTRUCTURE (1% ANNUAL-CHANCE FLOOD)
	500-YEAR FUTURE HYDROLOGY EXISTING INFRASTRUCTURE (0.2% ANNUAL-CHANCE FLOOD)
	THALWEG

NOTE: ELEVATIONS SHOWN ARE BASED ON THE NAVD 88 DATUM

SCALE
HORIZONTAL: 1" = 200'
VERTICAL: 1" = 10'

INSTRUCTIONS TO PRINT AN AREA SMALLER THAN THE FULL PAGE TO SCALE:
1. CLICK ON "SNAPSHOT" TOOL, SELECT THE DESIRED AREA TO PRINT
2. CLICK FILE>PRINT
3. SELECT YOUR PRINTER FROM THE PRINTER DROPDOWN MENU
4. CHOOSE "PRINT WHAT" OPTION UNDER "PRINT RANGE" DROPDOWN MENU.
5. CHOOSE THE "SELECTED GRAPHIC" OPTION UNDER "PRINT RANGE".
6. SELECT "NONE" FROM THE "PAGE SCALING" DROPDOWN MENU.
7. CHOOSE "PRINT SELECTED GRAPHIC" IN "PAGE SETUP"
8. CLICK "OK" TO PRINT SELECTION.

REVISIONS			
REV. NO.	BY	DATE	DESCRIPTION
1	MBG	5/2/16	PRELIMINARY DRAFT FOR COMMENTS
2	MBG	9/28/16	DRAFT SUBMITTAL FOR REVIEW
3			
4			
5			

MUELLER ENGINEERING CO., INC.
CONSULTING ENGINEERS
999 N. ALAMEDA BLVD., STE. 5-100
LAS CRUCES, NEW MEXICO 88005

FLOOD HAZARD AREA DELINEATION - NEWLIN GULCH

FLOOD PROFILE

DESIGNED	GAR	DATE	SEPT. 2015
DRAWN	MBG	SCALE	AS SHOWN
CHECKED	GAR	FILE NO.	1109-01
PLAN	11X36	SHEET	14 OF

NAME: P:\12-0501-01 Newlin Gulch\MDP - LOD\CD12\1109DfcEarlyCAD Files\1109DrPPF.dwg DATE: SEP 28, 2016 TIME: 3:03 PM