Final Drainage Report

Austin Bluffs Parkway Corridor Project Phase 3

Segment 3

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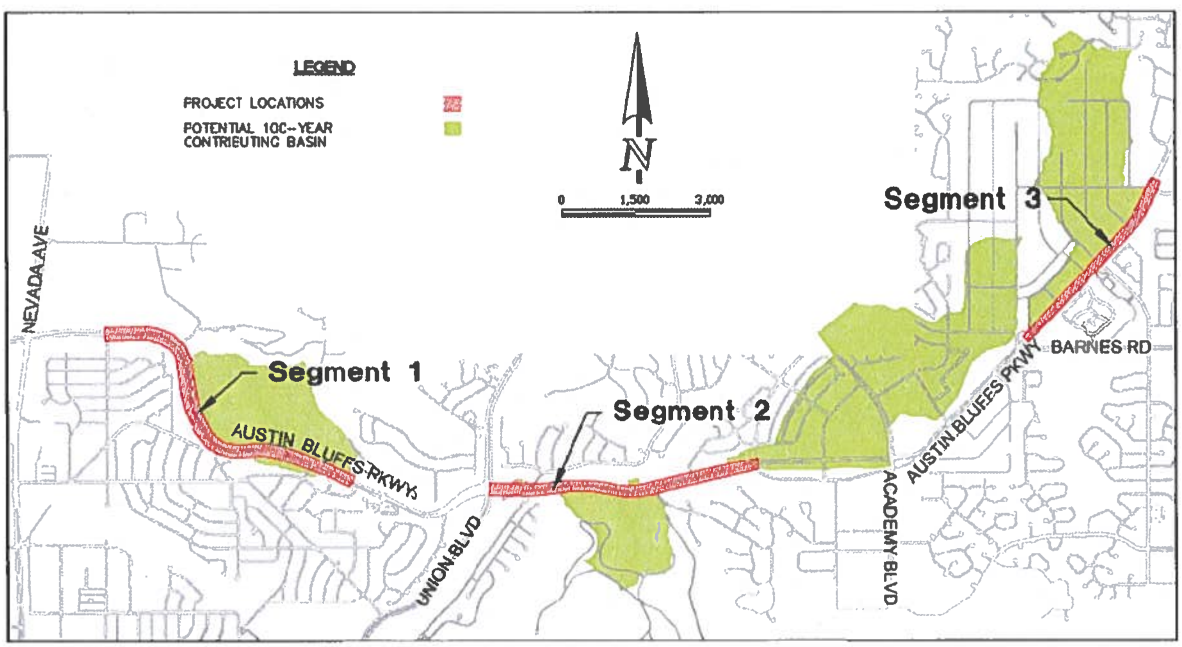
Introduction

The Austin Bluffs Parkway (ABP) Corridor Phase 3 project will expand the roadway to three through lanes in each direction as well as adding turn lanes, medians and other traffic capacity and safety enhancement. Noise mitigation walls and aesthetic enhancements will also be added in some sections of the corridor. The project will be focused on three segments of the roadway as shown on the map at the bottom of this page. Segment 1 includes improvements between Mallow Road and the Regents Circle access from ABP. Segment 2 includes improvements from Union Boulevard to Meadowland Boulevard/American Drive. Segment 3 includes improvements from Barnes Road to Ruby/Old Farm Drive.

The project segments are being designed by Matrix Design Group and Wilson and Company for the Pikes Peak Rural Transportation Authority (PPRTA) and the City of Colorado Springs. The majority of the project improvements will be located within existing or future City right-of-way.

The purpose of this report is to document the drainage analysis of the proposed roadway and drainage improvements to be constructed with Segment 3 of the roadway project. The format of this report is structured to first provide general information regarding the analysis procedures for the project and then discuss the drainage conditions and improvements included for Segment 3. Relevant calculations and exhibits are included in the appendix sections of this report.



Project Location Map

General Drainage Criteria and Calculation Methods

Drainage Criteria

Austin Bluffs Parkway was built as a four lane arterial roadway in the early 1980(s). Minor additions to the parkway such as turn lane additions occurred as specific locations were developed. However, the majority of the adjacent downstream subdivisions were built before the original Austin Bluffs Parkway Project. The majority of the drainage outfall systems date from the 1970(s) or earlier. As such, they were designed under different drainage criteria than the current criteria. It is not surprising that the design storm calculations performed under the current criteria show that some of the existing systems are not capable of carrying the full design storm. The City's drainage criterion has become more conservative over the years. This outfall capacity issue is common to designing roadway improvements in older areas of the City.

The Pikes Peak Rural Transportation Authority Projects were approved by City Council and the voters in 2004. The goal of the projects is to improve road safety and capacity throughout the City. Each project was given a set budget based on estimates done in 2003 and since inflated for construction price changes. The project estimates did not include significant drainage outfall improvements beyond the roadway limits. It is important to note that some of these outfall deficiencies are not directly caused by the widening of Austin Bluffs Parkway but are existing issues with the current roadway configuration based on current drainage criteria. The intent of the PPRTA program was to identify drainage outfall deficiencies and include those improvements in the storm water management program, rather than the roadway improvement program. Stormwater system deficiencies will be added to the backlog of future drainage improvements needed throughout the City. When funding becomes available, stormwater improvement projects will be prioritized by the City and completed as funds allow.

Austin Bluffs Parkway is an arterial street. The City of Colorado Springs Drainage Criteria Manual includes the following design criteria regarding allowable street capacity:

- Arterial Streets
  - 5-yr maximum flow depth of 6" at flowline
  - 5-yr maximum flow of 34 cfs per side
  - 5-year spread, must keep one 10-foot lane free of water in each direction
  - 100-year maximum flow depth of 8" at flowline (no curb overtopping allowed)

The City of Colorado Springs Municipal Stormwater Discharge (MS4) Permit requires post construction controls to reduce the discharge of pollutants after construction of new development or significant redevelopment projects. The current project is considered a significant redevelopment project. The City of Colorado Springs Drainage Criteria Manual Volume 2 indicates that Water Quality Capture Volume (WQCV) based BMPs should be provided for significant redevelopment projects. A memorandum from City Engineering dated July 6, 2006 allows for use of underground, proprietary BMPs on public road improvement projects where limited space is available for use of WQCV based BMPs. City Engineering has indicated that use of underground, proprietary BMPs will be acceptable on the current project in areas where it is not practical to utilize extended detention basins (EDBs).

Peak Runoff Calculations

Peak runoff was calculated for the drainage areas contributing to Segment 3 based on the characteristics of each area. Peak runoff calculations were performed for small areas with the Rational Method and for larger areas with SCS Unit Hydrograph methodology and the HEC-HMS computer program. These calculation methods and resources utilized to determine watershed characteristics are further discussed in the following paragraphs.

SCS Runoff Analysis with HEC-HMS

The U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) Version 3.5 was utilized for hydrologic analysis of the basins contributing to Segment 3. HEC-HMS models were developed using the SCS runoff analysis due to the relatively large size (larger than 100 acres) of the offsite contributing basins in accordance with the recommendations of the City of Colorado Springs Drainage Criteria Manual (DCM). Peak rates for the 5-year and 100-year storm events were calculated in this analysis.

The SCS runoff analysis uses runoff curve numbers (CNs) to represent the physical characteristics of a watershed when calculating excess rainfall from a storm event. Factors such as hydrologic soil group, cover type, land treatment, hydrologic condition, and antecedent moisture condition contribute to the CN value and in turn influence calculated runoff rates and volumes. The relationship between CN and excess rainfall is such that increased CN values correlate to higher runoff values. SCS runoff curve numbers were developed and used in the HEC-HMS model to represent the existing land use for the contributing drainage basins based on recommended values from the DCM. Rainfall depths used in the HEC-HMS model for the 5-year and 100-year storm events were 2.5 and 4.6 inches, respectively. These rainfall depths were applied to the model with a user defined rainfall distribution to represent the Type IIa storm event.

The SCS Unit Hydrograph methodology was used within HEC-HMS for runoff transformation and the SCS Runoff Curve Number method was used to determine infiltration losses. Hydrographs were routed through all of the assigned downstream elements in the model to the major outfall point at the intersection of ABP and Platinum Drive. A network of routing reaches was defined to convey flows to appropriate junctions within the model using the Muskingum-Cunge and Lag Time routing methods. Diversions were also utilized within the model to split flows at specific locations. Specific input data and results from the HEC-HMS model along with a schematic of the model elements are included in Appendix D.

Rational Method Analysis

Rational Method hydrologic analysis was utilized to determine 5 and 100-year peak runoff rates for drainage basins less than 100 acres in accordance with the DCM. Rational analysis calculates peak rates based on a Rational "C" coefficient, rainfall intensity, and basin area. Rational "C" coefficients were determined for each of the basins based on recommended "C" values from the DCM for various land uses and hydrologic soil groups. The rainfall intensity was determined based on the time of concentration for each basin with a minimum time of concentration value of five minutes. The area of each drainage basin is also a parameter in the Rational analysis.

Rational Method drainage calculations are included in Appendix C. These calculations include weighted "C" coefficient calculations, time of concentration calculations, surface, and pipe routing summaries.

Soils

Soil characteristics influence runoff potential by affecting the rate that precipitation is able to infiltrate. The infiltration rate is the key factor in determining the amount of rainfall that will be held in the soil and how much contributes to surface runoff. Soils with a high infiltration rate have low runoff potential while soils with a low infiltration rate have a high runoff potential.

Analysis for this project focused on the hydrologic soil group associated with each particular soil class as defined by the Natural Resources Conservation Service (NRCS). Soil boundaries were obtained from the NRCS and are shown on the soils map in Appendix A of this report. The NRCS designates hydrologic soil groups based on the rate of water infiltration with Group A soils having high infiltration rates and low runoff potential and Group D soils having low infiltration rates and high runoff potential. The contributing watershed for Segment 3 includes Hydrologic Soil Groups B and C.

Topographic Mapping

Topographic mapping for the project corridor and contributing drainage basins consisted of 1-foot aerial contour data and 2-foot FIMS contour data. Wilson and Company conducted low altitude aerial mapping to produce the 1-foot contour data along the project segment. Areas outside of the limits of the 1-foot aerial mapping were supplemented with 2-foot FIMS contour data obtained from the City of Colorado Springs. This topographic mapping was utilized to delineate drainage basins, estimate basin and conveyance slopes, and lengths of major flow paths utilized in the peak runoff calculations.

Hydraulic Analysis

FlowMaster Analysis

The Bentley FlowMaster program was utilized to perform normal depth calculations using Manning's equation for various drainage system and component locations within the project segment. FlowMaster output summaries for Segment 3 are included in Appendix H. Inlet interception calculations were also performed using Excel for the proposed inlets proposed for Segment 3 and are included in Appendix C.

Hydraulic Gradeline Calculations

Hydraulic gradeline calculations were performed for existing and proposed storm sewer systems to analyze storm sewer capacities for the design storm flows. Calculations were primarily grouped by storm sewer sections and include losses for entrances, manholes, inlets, junctions, bends, and inline water quality treatment units. The outfalls to existing storm sewer systems at the intersection of ABP and Barnes Road were evaluated based on limited available hydraulic information for the existing systems to determine the appropriate starting hydraulic gradeline elevations to use in calculations for the proposed storm sewer system. Spreadsheets summarizing the hydraulic gradeline calculations are included in Appendix G.

HEC-RAS Analysis

The USACE Hydrologic Engineering Center River Analysis System (HEC-RAS) Version 4.1 was utilized for hydraulic analysis of the concrete box culvert at the intersection ABP and Platinum Drive. The HEC-RAS analysis was utilized to determine the water surface elevation in the channel downstream of the box culvert as well as through the existing and proposed sections of the box culvert. Flow change locations were utilized within the program to account for the addition of flow to the system through lateral storm pipes. The HEC-RAS model for the box culvert was utilized in evaluating the effectiveness of the facility in conveying flow from the future expansion of the storm sewer system northwest along Platinum Drive. Additional discussion of the HEC-RAS model is included in the "Proposed Drainage Conditions" section of this report. Output from the HEC-RAS model is included in Appendix F.

Permanent Storm Water Quality Treatment

Underground Water Quality Treatment Units

The proposed BMP for water quality treatment of storm water runoff for the Segment 3 project area consists of underground water quality treatment units. The proposed locations of underground treatment units that will treat runoff from the project area as well as the approximate watershed areas that they will treat are shown on the exhibit in Appendix E. This type of BMP is described in greater detail in the following paragraphs.

Underground water quality treatment units are proposed to treat storm water runoff up to a specified flow rate (water quality peak flow rate). An underground treatment unit cleans storm water through hydraulic separation to remove trash, sediment and pollutants. The removed solids are retained within the unit until they are removed through maintenance activities. Flows in excess of the water quality peak flow rate are allowed to bypass the treatment chamber without causing re-suspension of previously captured solids thus allowing the unit to function properly in water quality storm events and major storm events. Maintenance requirements include cleaning of the units to remove the captured solids typically through the use of a vacuum truck.

Water quality peak flow rates for treatment were calculated using the Rational method, 5-year runoff coefficients, and intensities based on treatment area time of concentrations and 0.5" one-hour precipitation depth. Copies of the calculations are included in Appendix E.

Six underground treatment units are proposed to be utilized in the treatment of runoff from the Segment 3 project corridor. Specific water quality treatment information for the units is discussed in the "Proposed Drainage Conditions" section of this report.

FEMA Floodplain Issues

Segment 3 does not include any areas mapped as a FEMA regulatory 100-year floodplain within or adjacent to the proposed roadway improvements. Therefore, a Floodplain Development Permit is not anticipated to be required for construction activities associated with Segment 3. Flood Insurance Rate Maps (FIRMs) for the areas encompassing the Segment 3 corridor are included in Appendix B.

Existing Drainage Conditions

General

Segment 3 consists of approximately 4,000 LF of ABP located between Barnes Road/Park Vista Drive and Ruby/Old Farm Drive as shown on Page 1 and the drainage exhibit included in Appendix C. From a drainage perspective it is logical to divide Segment 3 into an upper and lower section each draining to a separate major outfall point. Runoff from the upper section of the segment, located between Platinum Drive/Oro Blanco Drive and Ruby/Old Farm Drive, outfalls to an existing concrete lined channel located along the northeast side of Oro Blanco Drive. Runoff from the lower section of the segment, located between Barnes Road/Park Vista Drive and Platinum/Oro Blanco Drive, outfalls to two existing storm sewers located in ABP.

Runoff in the Segment 3 roadway corridor flows from northeast to southwest. A small roadside ditch and cross culverts convey runoff along the westbound side of the roadway. Curb and gutter conveys runoff along the eastbound side of the roadway. A portion of the runoff from both of the sections is collected by existing facilities at their lower ends. The remaining flow continues in the roadway corridor. As shown on Drainage Map DM 3 in Appendix D, runoff from a large offsite drainage area located northwest of the ABP corridor, contributes runoff to the upper section of the segment. As shown on Drainage Map DM 1 in Appendix C, runoff from smaller offsite basins along both sides of the lower section contribute runoff to the lower section.

Upper Section

A limited number of existing storm sewer collection and conveyance facilities are located within the upper section of the Segment 3. An existing 5 ft x 8 ft concrete box culvert is located at the intersection of ABP and Platinum/Oro Blanco Drive. This box culvert conveys flow from the northwest side of ABP to an existing concrete drainage channel that runs southeast along Oro Blanco Drive and serves as the primary outfall for the upper section of Segment 3. A small curb inlet that is connected to the box culvert collects runoff from the eastbound lanes of ABP. 30" and 36" RCP flared end sections and storm sewers connected to the upstream end of the box culvert collect runoff from the roadside ditch along the westbound lanes of ABP at a low point adjacent to the northwest corner of the ABP and Platinum Drive intersection.

The large offsite contributing drainage basin is generally developed with large residential and commercial lots and rural street sections. Roadside ditches and cross culverts are relatively small and are only able to convey runoff from small, frequent storm events. Larger storms overwhelm the ditches and the flow is conveyed overland though the residential and commercial lots. A portion of this offsite area does not contribute runoff to the upper segment in the existing condition due to lack of adequate capacity in the drainage ditches in the area.

The Templeton Gap DBPS (1977) planned for 100-year runoff from the upper section of Segment 3 and the large offsite contributing watershed to outfall to the existing concrete lined channel along the northeast side of Oro Blanco Drive. The existing box culvert at the Oro Blanco intersection and a future storm sewer system extending in ABP from the box culvert to Turquoise Drive then extending up Turquoise Drive into the watershed were the major system components proposed by the DBPS to collect the runoff from this area. The proposed storm sewer system in ABP and Turquoise Drive was indicated to be sized for 5-year capacity and the box culvert was indicated to be sized of 100-year capacity.

Another storm sewer collection system also exists at the intersection of ABP and Old Farm Drive which collects runoff from areas upstream of Segment 3 and discharges to an existing concrete lined drainage channel located east of ABP. Research of previous reports and the current analysis indicates that this storm sewer system allows some runoff to bypass and enter the upstream end of the Segment 3 project area. The bypass flow is further discussed in the proposed condition section of this report.

Lower Section

The existing storm sewer collection and conveyance facilities in the lower section of Segment 3 includes a RCP flared end section and connecting 36" RCP storm sewer system along the northwest side of ABP extending approximately 500 feet northeast of the intersection of ABP and Barnes Road. This storm sewer system collects runoff from the roadside ditch adjacent to the westbound side of ABP and outfalls to an existing 42" storm sewer that extends to the southwest from the Barnes Road intersection in the westbound side of ABP and ultimately outfalls to the Templeton Gap Floodway. Existing sump inlets located at the northwest corner of the intersection of ABP and Barnes Road also collect runoff from the lower section and are connected to the existing 42" storm sewer.

A second existing storm sewer system is located in the eastbound side of ABP. This system includes sump inlets located at the northeast corner of the intersection of ABP and Barnes Road. These existing sump inlets intercept a portion of the existing flow from the project corridor and discharge to an existing 36" RCP storm sewer that extends southwest in the eastbound side of ABP and ultimately outfalls to the Templeton Gap Floodway. Bypass flow from these inlets travels southwest in ABP.

The "Draft Final Drainage Report for Austin Bluffs Parkway Phase III", by Centennial Engineering, appears to indicate that that 5-year runoff from the eastbound lanes of ABP in the lower section is to discharge to the existing storm sewer system in the eastbound lanes and 5-year runoff from the westbound lanes is to discharge to the existing storm sewer in the westbound lanes. Hydraulic information from this report for these two existing storm sewer systems was utilized in the hydraulic gradeline calculations and are included in Appendix G.

Proposed Drainage Conditions

General

Proposed roadway improvements for Segment 3 include widening existing four lane portions to three through lanes in each direction, and adding curb and gutter and sidewalks along the northwest side of the roadway. This will eliminate the existing roadside ditch along most of the northwest side of the roadway.

In both the upper and lower sections, the majority of the runoff from the project area will be routed in the proposed roadway from northeast to southwest to the lower end of the section where it will be collected by inlets and treated to enhance water quality. Runoff will receive water quality treatment in underground treatment units and then discharged to existing conveyance facilities. Storm sewers will be constructed in portions of Segment 3 to collect runoff from offsite areas and above cross slope transitions of the roadway. These storm sewer systems have been designed to segregate onsite and offsite runoff to the extent practical in order to minimize the cost and maintenance required for water quality treatment units for the project.

The proposed outfall locations are consistent with the existing condition outfalls with the upper section of Segment 3 discharging to an existing concrete lined channel adjacent to Oro Blanco Drive and the lower section of the segment discharging to existing storm sewer systems at the intersection of ABP and Barnes Road. Proposed drainage improvements for Segment 3 are shown on Drainage Map DM 1 in Appendix C. Drainage calculations are also included Appendix C and D of this report.

Peak runoff rates were determined using both Rational analysis and SCS analysis. The size of the watershed contributing runoff to the concrete box culvert at ABP and Platinum Drive warranted the use of SCS analysis to determine the peak rate for the design of modifications to the box culvert. The peak rates determined from SCS analysis for offsite **Basins A and B** were utilized for **Basins S and V** in the Rational analysis to facilitate routing calculations through the proposed storm sewer system.

Upper Section

The proposed drainage improvements for the upper section of Segment 3 are designed to provide drainage collection and conveyance for proposed roadway improvements between Platinum/Oro Blanco Drive and Ruby/Old Farm Drive. Drainage improvements for this section of Segment 3 have been designed to intercept runoff from the 100-year storm event above the Platinum/Oro Blanco Drive intersection. The improvements are also designed to provide water quality treatment for the project area. More specific details about the proposed drainage conditions and improvements are provided below.

- ***Bypass Flow from Old Farm Drive*** - A section of the runoff from the upstream Old Farm Subdivision is intercepted by existing inlets located along Old Farm Drive near ABP. A limited analysis of the upstream watershed was conducted with this study to estimate the amount of runoff that is intercepted by the inlets on Old Farm Drive and the resulting bypass flow entering the eastbound side of the project corridor. The analysis indicated that bypass flow to Segment 3 will be approximately Q_5=13 cfs and Q_{100}=42 cfs with a time of concentration of approximately 14.4 minutes. A limited analysis was also conducted for westbound ABP north of Ruby Drive to estimate bypass flow that may enter the westbound side of the project corridor at Ruby Drive. The bypass flow rates to Segment 3 at this location were estimated at Q_5=4 cfs and Q_{100}=6 cfs with a 5 minute time of concentration.

- ***Ruby Drive*** - **Design Point 14** northwest of the intersection of ABP and Ruby Drive accepts runoff from offsite basins northwest of this intersection. Runoff at **Design Point 14** is collected with a proposed Type D area inlet. The analysis conducted with this project indicates that this existing Type C inlet lacks sufficient capacity to collect all of the 100-yr runoff from the offsite basins. The proposed improvements for this area include the addition of one Type C inlet at **Design Point 13** on the south side of Ruby Drive. The proposed Type C inlet will serve as a collection point for ditch flow on the south side of Ruby Drive prior to flow entering the ABP roadway. The combination of the proposed Type C and Type D inlets is planned to provide interception of the 100-year flow at **Design Points 13 and 14** and, thus, no offsite runoff is anticipated to enter the ABP roadway at this location.

- ***Roadway Collection at Design Point 11*** - Bypass flow from Old Farm Drive enters the eastbound side of ABP and travels south to a proposed at-grade Triple Type 16 combination inlet at **Design Point 11**. A section of ABP between Silver Drive and Old Farm Drive includes a super elevated roadway section with a cross slope of approximately 5%. The proposed roadway at this location includes a proposed "carry" curb along the east side of ABP to convey nuisance flow along the curb section rather than allowing it to follow the reverse in the roadway cross slope. This section of the roadway is directly upstream and adjacent to **Design Point 11**. The significant amount of 100-year flow entering the project corridor from the upstream watershed and the super elevation of the roadway at this location contribute to a maximum flow depth of nine inches along a short segment of the median of the roadway where a steep roadway cross slope exists. The 9" depth at the flowline is well within the DCM allowable depth standard for arterial street cross flow areas. The hydraulic calculations indicate that a minimum of 18 feet of the street section in this area will remain free of concentrated flow during the major storm event. The proposed roadway includes a 9" tall median curb adjacent to and extending approximately 250 ft upstream of **Design Point 11** to prevent overtopping of the median curb during the major storm event.

Runoff intercepted at **Design Point 11** will receive water quality treatment with underground water quality treatment Unit 6. A proposed storm sewer system along the westbound side of ABP will convey flows south to the proposed concrete box culvert expansion near Platinum Drive. Bypass flow from **Design Point 11** travels south along the roadway to **Design Point 10** near Platinum Drive.

- ***Design Point 10*** - Runoff at **Design Point 10** is intercepted with a series of four proposed at-grade Triple Type 16 combination inlets and will receive water quality treatment in underground treatment Unit 1. The proposed inlets at **Design Point 10** are designed to intercept the 100-year runoff at this location. The water quality treatment is proposed to discharge to the adjacent existing concrete box culvert which ultimately discharges to the concrete lined open channel along the northeast side of Oro Blanco Drive.

- ***Church Site Southwest of ABP/Ruby Drive*** - The existing church site included in **Basin L** southwest of the intersection of ABP and Ruby Drive generally drains to the south and east. Runoff from the site is anticipated to sheet flow across the parking area and be collected in a proposed drainage swale adjacent to the west right-of-way for ABP. The proposed grading for ABP indicates that the right-of-way will be approximately 1 foot above the adjacent parking lot for approximately the northern third of the existing parking area. The existing grade of the parking lot indicates that the main direction of flow for the northern portion of the church site will be to the south and parallel to the ABP corridor. The direction of flow from the parking area transitions gradually to the southeast and perpendicular to the ABP corridor. As sheet flow exits the parking area it is collected by a proposed drainage swale. Temporary erosion control fabric is proposed for the swale bottom and side slopes adjacent to the parking area to provide erosion protection until vegetation is established. The proposed drainage swale, which consists of a minimum bottom width of 4.4 feet and 3:1 and 4:1 side slopes, will intercept and convey runoff from **Basins L, M, and N** south to **Design Point 15** at Silver Drive. A 30" RCP flared end section is proposed to intercept runoff at **Design Point 15** and discharge it to the proposed storm sewer system in ABP. FlowMaster hydraulic calculations for the proposed drainage swale are included in Appendix H of this report. The proposed storm sewer system in Silver Drive will also intercept runoff from the south ditch of the roadway at **Design Point 16** with a flared end section and discharge it to the ABP storm sewer system.

- ***Sidewalk Chase*** - A drainage swale southwest of the intersection of ABP and Ruby Drive is proposed to provide drainage for a portion of **Basin P**. Flow from this swale will discharge to the ABP curb and gutter through a 14" wide sidewalk chase and be collected at **Design Point 19**. Peak flow rates through the chase are Q_5=0.2 cfs and Q_{100}=0.5 cfs. Sizing calculations for the chase are included in Appendix H.

- ***Basin Q/Lee Parcel Drainage Swales***- Two small drainage swales are proposed for a private parcel located at the northwest corner of the intersection of ABP and Turquoise Drive which is referred to as the "Lee Parcel". A drainage swale along the rear (north side) of the parcel will collect and convey runoff from **Basin Q** to **Design Point 18** where it will be collected with a proposed 4 ft diameter Type II manhole with a grated lid. A swale along the south side of the parcel will collect and convey flows from the parcel to a 30"x19" RCP flared end section at Turquoise Drive. FlowMaster hydraulic calculations for the drainage swales are included in Appendix H.

- ***Westbound ABP Roadway from Ruby Drive to Turquoise Drive*** - Surface runoff along the westbound section of the project will be conveyed southwest from Ruby Drive to **Design Point 19** at Turquoise Drive. A cross-pan is proposed across Silver Drive at the intersection with ABP. A proposed at-grade D-10-R inlet will be located along the northwest side of ABP just northeast of the Turquoise Drive intersection. This inlet will intercept a portion of the runoff conveyed down ABP. The intercepted flow will be routed through underground water quality treatment Unit 5 before entering the ABP storm sewer system at Storm Manhole 9.

- ***Turquoise Drive*** - Bypass flow from the at-grade inlet at **Design Point 19** will travel to a sump location on Turquoise Drive just northwest of ABP. The proposed Turquoise Drive roadway section includes roadside ditches on the north and south sides. Bypass flow from **Design Point 19** and ditch flow from **Basin S** will be intercepted with a proposed 30"x19" RCP flared end section in each ditch. Concrete slope paving is proposed around the flared end sections to prevent erosion of the ditch from flows exiting the roadway. The proposed storm sewer system at this location also includes a stub for future expansion of a storm sewer system to the northwest along Turquoise Drive to collect the 5-year runoff from **Basin SCS-A** as shown on Exhibit DM 3. This future expansion was outlined in the Templeton Gap DBPS (1977) and has been provided for with the design of the storm sewer improvements for this project. The downstream system has been designed assuming a flow of Q_5=83 cfs will enter this stub in the future condition. The proposed storm sewer in Turquoise Drive combines with the ABP storm sewer at Storm Manhole 9. The ABP storm sewer then conveys flows south to the concrete box culvert outfall.

- ***Design Point 20*** - A 2 ft by 2 ft ductile iron combination inlet is proposed at **Design Point 20** to collect runoff from **Basin U**. A retaining wall and curb and gutter are proposed along the northwest side of the ABP right-of-way at this location. Runoff is to be collected and conveyed southwest along the proposed curb and gutter adjacent to the northwest side of the retaining wall and collected by the proposed inlet in the southwest corner of the existing parking area. Runoff collected by this inlet is discharged to the proposed ABP storm sewer system.

- ***Westbound ABP Roadway from Turquoise Drive to Platinum Drive*** - Runoff from westbound ABP between Turquoise Drive and Platinum Drive will be intercepted by two at-grade D-10-R inlets at **Design Point 21**. Inlets at this location are designed to intercept the 100-year runoff event. Flow from the inlets will be routed to underground water quality treatment Unit 4. The treatment unit will outfall to the existing concrete box culvert adjacent to this location which ultimately discharges to the concrete lined open channel along the northeast side of Oro Blanco Drive.

- ***Concrete Box Culvert at Platinum/Oro Blanco Drive*** - The proposed ABP storm sewer system will convey flows south to the proposed concrete box culvert extension directly upstream of Platinum Drive. The existing 5 ft rise by 8 ft span box culvert is approximately 80 feet long and discharges to a concrete lined drainage channel along Oro Blanco Drive. The box culvert is proposed to be extended 50 feet to the northwest to accommodate the expansion of the ABP roadway. The outfall of the 54" RCP ABP storm sewer system will discharge to the proposed section of the box culvert. The upstream end of the proposed box culvert includes a proposed inlet box to collect runoff at **Design Point 22**. The proposed 16 ft by 7.5 ft inlet box includes a trash rack at a 3:1 slope. The inlet box is sized to accept the design flow rate of 107 cfs at a depth of 2.16 feet with an inlet clogging factor of 1.30.

  The design flow for the inlet box was based on the existing collection capacity of the 30" and 36" storm sewer collection system which was estimated to be 107 cfs using an inlet control nomograph for RCP culverts. As discussed in the existing condition section of this report, only a portion of the runoff from offsite **Basins S and V** is capable of reaching **Design Point 22** in the existing condition. Interim **Basins I-SV1 and I-SV2** have been delineated to estimate the flow that is able to reach interim **Design Point I-22** in the "Interim Condition" that is expected to exist immediately after construction of the ABP improvements. These basins are illustrated on Drainage Map 2 in Appendix C. The existing capacity of the 30" and 36" RCP pipes at this location exceeds the flow anticipated to reach **Design Point I-22** in the existing and interim condition based on the existing topography of the basins and the general trend of flow to travel south across Platinum Drive near Garnet Drive. However, the box culvert inlet has been sized to match the existing collection capacity at the upstream end of the box culvert to ensure that no reduction in collection capacity occurs as a result of the proposed project. Both the 100-year and interim 100-year flows through the box culvert have been included with the HEC-RAS hydraulic model presented in Appendix F.

- ***Future Storm Sewer System in Platinum Drive*** - The Templeton Gap DBPS (1977) indicates that 100-year runoff contributing to the intersection of ABP and Platinum Drive is to be collected and conveyed to the existing concrete lined channel along Oro Blanco Drive. **SCS Basins A through E** (shown on Drainage Map DM 3) are generally consistent with the watershed indicated to be discharged to the Oro Blanco Drive channel at ABP by the 1977 DBPS. **SCS Basins A and B** are referred to as **Basins S and V**, respectively, in the Rational analysis for ABP Segment 3. The construction of a future storm sewer collection system along Platinum Drive will be required to collect all runoff from **Basins S and V**. Until this future system is constructed, some runoff is anticipated to continue to cross Platinum Drive and travel southwest in the major storm event. Interim **Basins I-SV1 and I-SV2** (as shown on Drainage Map 2) have been delineated to represent the anticipated basin area to contribute to the box culvert in the interim condition. The extension of the box culvert has been designed with the anticipation that a future storm sewer system will be constructed along Platinum Drive to collect flow in accordance with the DBPS. A HEC-RAS hydraulic model was utilized for hydraulic analysis of the box culvert. Flow change locations were included at locations where additional storm sewer flows enter the box culvert. The future flow at the upstream end of the box culvert was determined to be 290 cfs for the 100-year storm event based on SCS runoff analysis of the upstream watershed. This flow is anticipated to be received from a storm sewer system with upstream collection along Platinum Drive. Output from the HEC-RAS analysis of the box culvert is included in Appendix F.

- ***Proposed Water Quality Treatment*** – Water quality treatment for the upper section of Segment 3 is proposed to be accomplished by four underground water quality treatment units. These underground treatment units have been designed to provide inline treatment for water quality runoff from the project area. The general location of each of these proposed treatment facilities and the watershed that they are proposed to treat are shown on an exhibit contained in Appendix E of this report.

    - Proposed underground treatment Unit 3 at **Design Point 10** should be sized to treat flow rates up to 1 cfs and accommodate a 100-year flow rate of 32 cfs.
    - Proposed underground treatment Unit 6 at **Design Point 11** should be sized to treat flow rates up to 1 cfs and accommodate a 100-year flow rate of 20 cfs.
    - Proposed underground treatment Unit 5 at **Design Point 19** should be sized to treat flow rates up to 3 cfs and accommodate a 100-year flow rate of 15 cfs.
    - Proposed underground treatment Unit 4 at **Design Point 21** should be sized to treat flow rates up to 1 cfs and accommodate a 100-year flow rate of 6 cfs.

    Treatment flow rates discussed above refer to the water quality peak flow rates discussed in the "Permanent Storm Water Quality Treatment" section of this report.

Lower Section

The lower section of Segment 3 includes drainage improvements between Barnes Road and Platinum Drive. Runoff in this section of the project segment generally travels from northeast to southwest following the topography of the segment. The proposed storm sewer improvements for the lower section of Segment 3 have been designed to intercept runoff from the 5-year storm event consistent with the capacity of the downstream storm sewer system. The proposed improvements have also been designed to provide water quality treatment for the project area.

In order to limit the size and cost of water quality treatment facilities required for the project and facilitate drainage from intersecting streets, a storm sewer will be constructed between Saphire Drive and Pearl Drive to collect and convey runoff from offsite areas directly to the outfall storm sewer. Runoff from the project area will be routed in the roadway to proposed collection and water quality treatment facilities to be located at the downstream end of the project area. More specific details about the proposed drainage conditions and improvements are provided below.

- ***Saphire Drive and Vanadium Drive*** - Runoff from **Basins C, D, and F** will be collected in proposed roadside ditches along Saphire Drive and Vanadium Drive and will be routed directly to the proposed storm sewer system. Offsite runoff intercepted at these locations will not receive water quality treatment with this project. Type C area inlets are proposed to intercept runoff from the ditches at **Design Points 3 and 4** at Saphire Drive and **Design Point 6** at Vanadium Drive.

- ***Interception at Cobalt/Pearl Drive*** - A large portion of the contributing watershed northwest of ABP follows the existing topography and travels southwest to the intersection of Cobalt Drive and Pearl Drive. Runoff from this **Basin H** will be prevented from entering the ABP roadway due to the raised elevation of the right-of-way with respect to the adjacent land. Runoff from **Basin H** will be concentrated at **Design Point 8** where it will be intercepted by a proposed Type D area inlet and routed to the proposed storm sewer system in ABP. The Templeton Gap DBPS (1977) called for a future 36" RCP storm sewer system at the intersection of Cobalt Drive and Pearl Drive and, therefore, a 36" RCP is proposed to connect the Type D inlet to the ABP storm sewer system to allow for this future addition to the storm sewer system.

- ***Westbound ABP*** - Runoff along the westbound side of ABP is conveyed southwest along the proposed curb and gutter between Platinum Drive and Barnes Road with cross-pans proposed at the intersections of Saphire Drive and Vanadium Drive. The street capacity for this section will be 64 cfs for the major storm. Two at-grade D-10-R inlets at **Design Point 7** approximately 300 ft north of Barnes Road are proposed to intercept peak flow rates up to and exceeding the 5-year rates from the westbound side of ABP. Runoff intercepted by these inlets will be routed through proposed underground water quality treatment Unit 2. Flow from the treatment unit will combine with other flow collected in the proposed ABP storm sewer system at a proposed manhole and discharge to the existing 36" storm sewer system in ABP southwest **Design Point 7**.

- ***Eastbound ABP*** - Runoff from the eastbound side of ABP and adjacent offsite areas between Platinum Drive and Barnes Road travels southwest along the roadway to **Design Point 2** where two at-grade D-10-R inlets are proposed to intercept peak flow rates up to and exceeding the 5-year rates. Flow intercepted by these inlets will be routed through proposed underground water quality treatment Unit 1. The water quality treatment provided at this location includes treatment for onsite and offsite areas in **Basins A and B** that drain to the ABP roadway and are routed southwest to **Design Point 2**. Flow from the treatment unit will be routed southwest through a proposed storm sewer system and combine with flow in the existing storm sewer system at an existing manhole at the intersection of ABP and Barnes Road.

- ***Proposed Water Quality Treatment*** – The lower section of Segment 3 includes areas where runoff will be allowed to enter the roadway and areas where the right-of-way will be elevated above the adjacent area, preventing runoff from entering the roadway. Areas where runoff will be allowed to enter the roadway have been included in the water quality treatment calculations for Segment 3.

  Water quality treatment for the lower section of Segment 3 is proposed to be accomplished by two underground water quality treatment units. These underground treatment units have been designed to provide inline treatment for water quality runoff from the project area. The general location of each of these proposed treatment facilities and the watershed that they are proposed to treat are shown on an exhibit contained in Appendix E of this report.

  - Proposed underground treatment Unit 1 at **Design Point 2** should be sized to treat flow rates up to 6 cfs and accommodate a 100-year flow rate of 33 cfs.
  - Proposed underground treatment Unit 2 at **Design Point 7** should be sized to treat flow rates up to 6 cfs and accommodate a 100-year flow rate of 33 cfs.

  Treatment flow rates discussed above refer to the water quality peak flow rates discussed in the "Permanent Storm Water Quality Treatment" section of this report.

Potential Concerns

The proposed storm sewer system for the section of Segment 3 between Barnes Road and Platinum Drive is designed to provide collection for the 5-year runoff event. It should be noted that larger storm events may result in additional runoff interception by the storm sewer collection system, therefore, resulting in larger storm sewer flows than were anticipated for the 5-year design. Manhole lids that bolt down are recommended for this section of Segment 3 to ensure that lids remain in place in the event that surcharging of the storm sewer system occurs.

Summary

The proposed drainage improvements have been designed to minimize negative drainage impacts from the construction of the project to the extent practical in consideration of the project budget and direction from PPRTA and City personnel. Given this, not all areas of the proposed project will conform to current drainage standards. However, in nearly all areas of the project, roadway drainage will be improved over the existing condition.

References

City of Colorado Springs and El Paso County Drainage Criteria Manual, 1994.

City of Colorado Springs Standard Specifications, 1995.

City & County of Denver Storm Drainage Design and Technical Criteria, City of Denver, January 2006.

Draft Final Drainage Report for Austin Bluffs Parkway Phase III, Centennial Engineering, Inc., October 1993.

Drainage Report for Final Submittal, Austin Bluffs Parkway Interchange at Union Boulevard, CH2MHill, November 2006.

Engineering Study and Revision of the North Shook's Run-Templeton Gap Drainage Basin Planning Study, Lincoln DeVore, 1977.

Final Drainage Report, Austin Bluffs / Nevada Intersection Improvement Project, URS Corporation, August 24, 2006.

M&S Standard Plans, Colorado Department of Transportation, 2006.

Urban Storm Drainage Criteria Manual Volumes 1, 2, and 3, Urban Drainage and Flood Control District, June 2001, Revised April 2008.

Appendices

Appendix A - Soils Map

Appendix B - FEMA Floodplain Maps

Appendix C - Rational Drainage Calculations

Appendix D - SCS Drainage Calculations

Appendix E - Water Quality

Appendix F - Platinum Box Culvert Hydraulic Calculations

Appendix G - Hydraulic Gradeline Calculations

Appendix H - Supplemental Hydraulic Calculations

Appendix A

Soils Map

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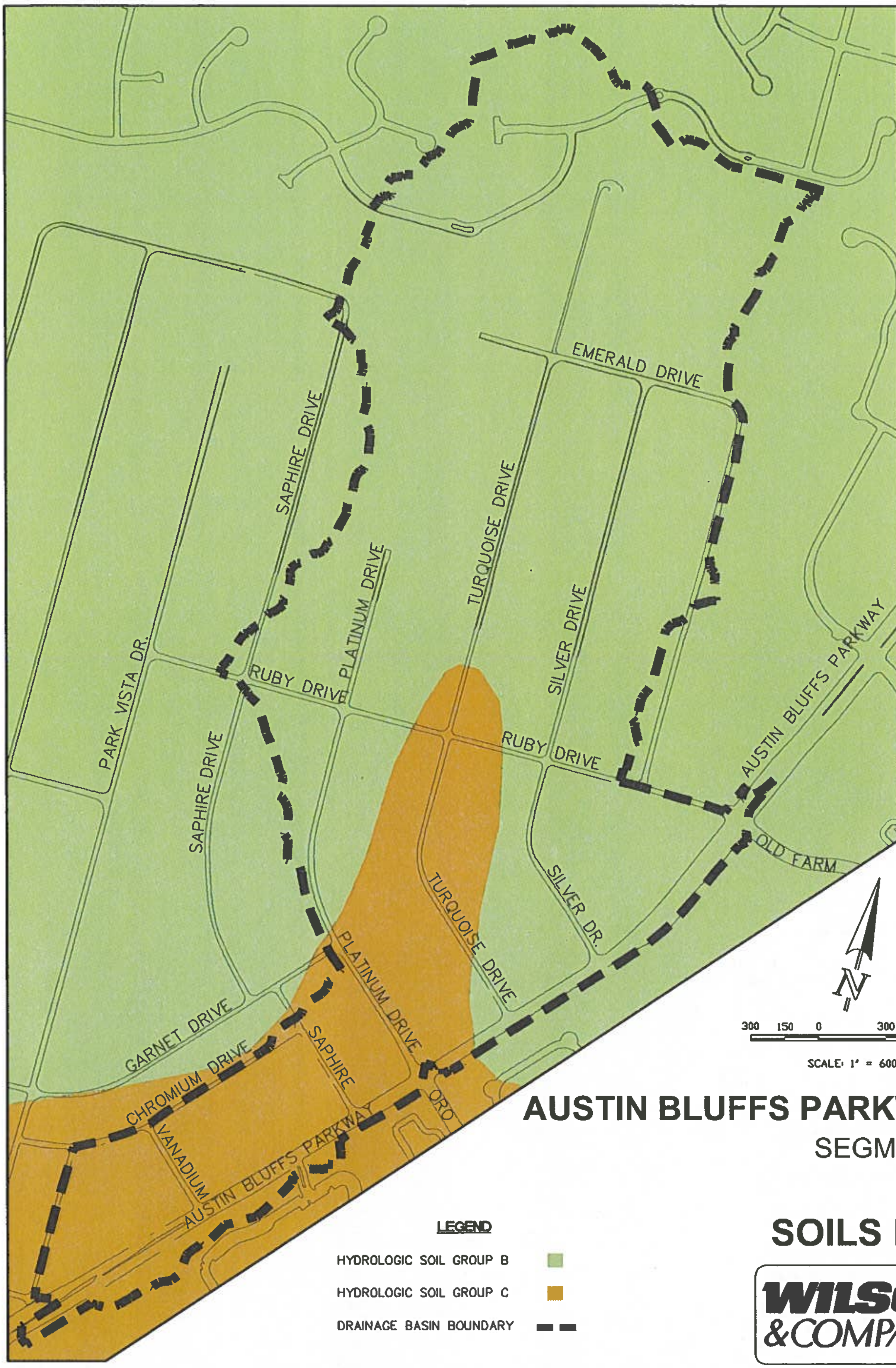

AUSTIN BLUFFS PARKWAY

SEGMENT 3

SOILS MAP

WILSON & COMPANY

Appendix B

FEMA Floodplain Maps

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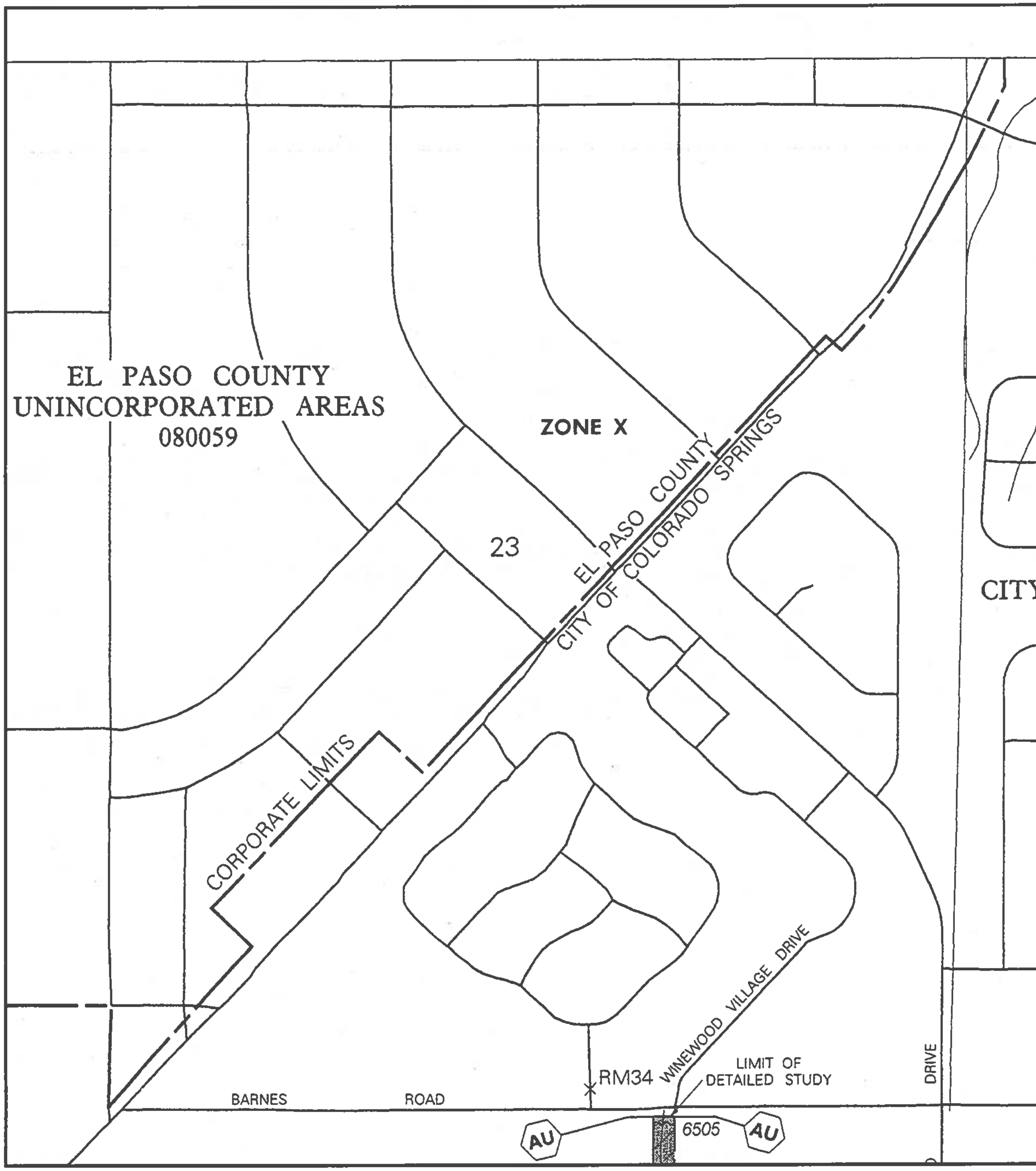


APPROXIMATE SCALE IN FEET

500 0 500

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

EL PASO COUNTY,
COLORADO AND
INCORPORATED AREAS

PANEL 538 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

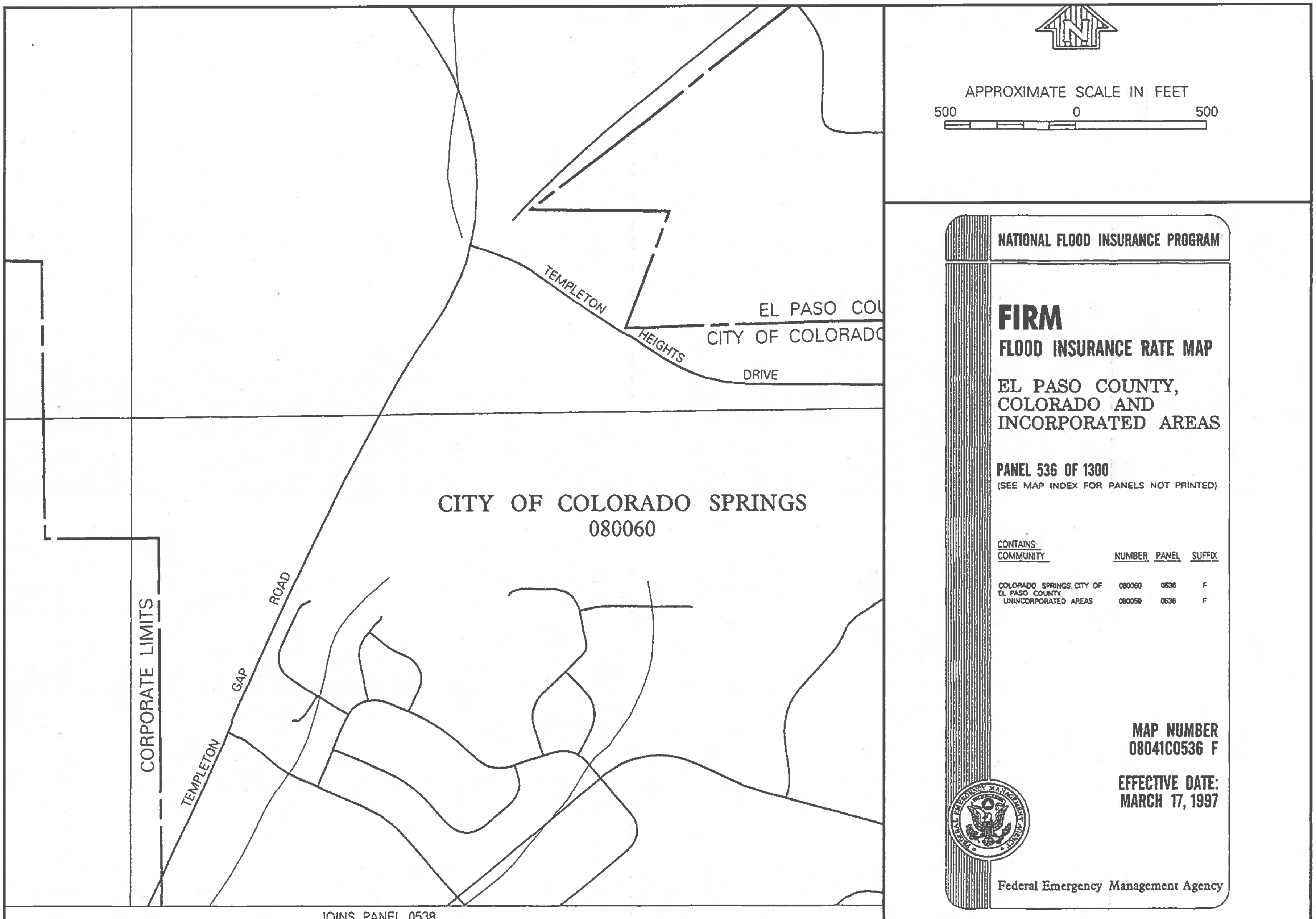
COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0538	F
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0538	F

MAP NUMBER
08041C0538 F

EFFECTIVE DATE:
MARCH 17, 1997

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 536 OF 1300
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS: COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0536	F
EL PASO COUNTY, UNINCORPORATED AREAS	080059	0536	F

MAP NUMBER
08041C0536 F

EFFECTIVE DATE:
MARCH 17, 1997

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Appendix C

Rational Drainage Calculations

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WILSON & COMPANY
5755 MARK DABLING BOULEVARD SUITE 220
COLORADO SPRINGS, CO 80919
PHONE: 719-520-5800
FAX: 719-520-0108
www.wilsonco.com

CONSULTANTS

SEAL

PROJECT NAME: AUSTIN BLUFFS PARKWAY CITY OF COLORADO SPRINGS, EL PASO COUNTY, COLORADO

MARK	DATE	DESCRIPTION

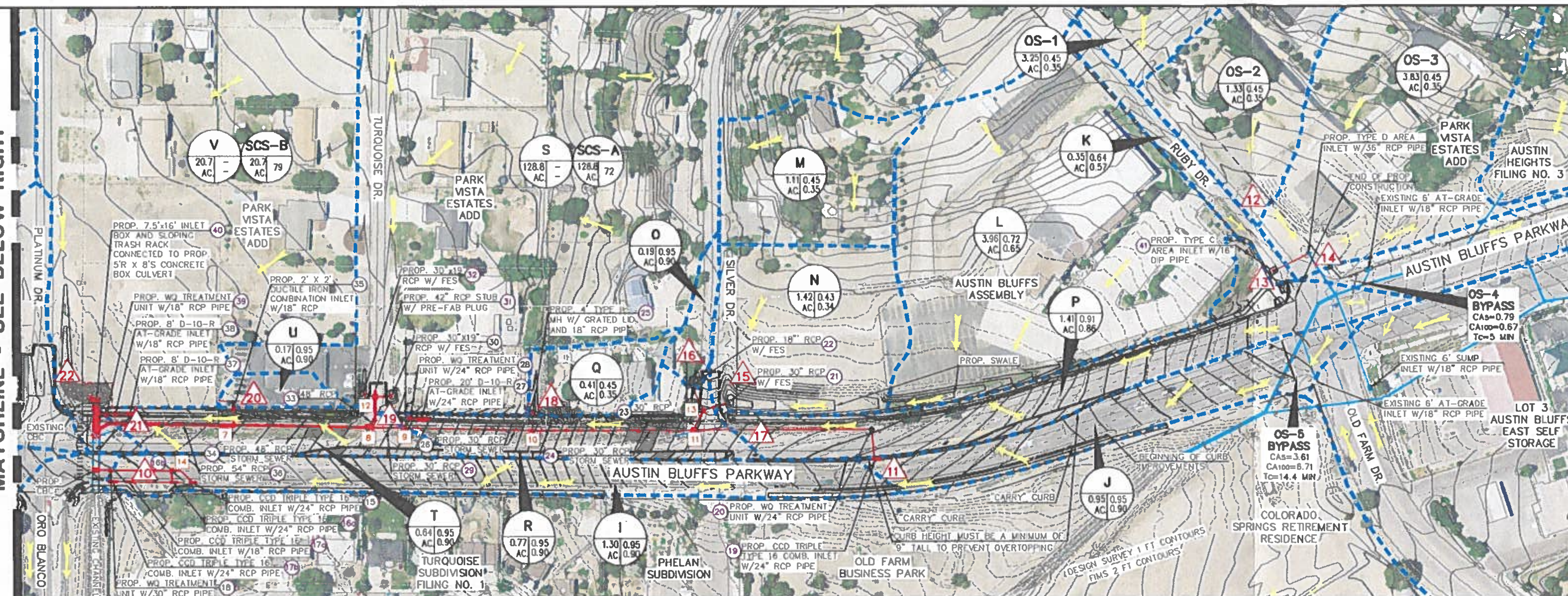
PROJECT NO:	
DESIGNED BY:	DLM
DRAWN BY:	DLM
CHECKED BY:	VSF
DATE:	
SHEET TITLE	DRAINAGE MAP SEGMENT 3 ONSITE AREAS
SHEET NO:	DM 1

LEGEND

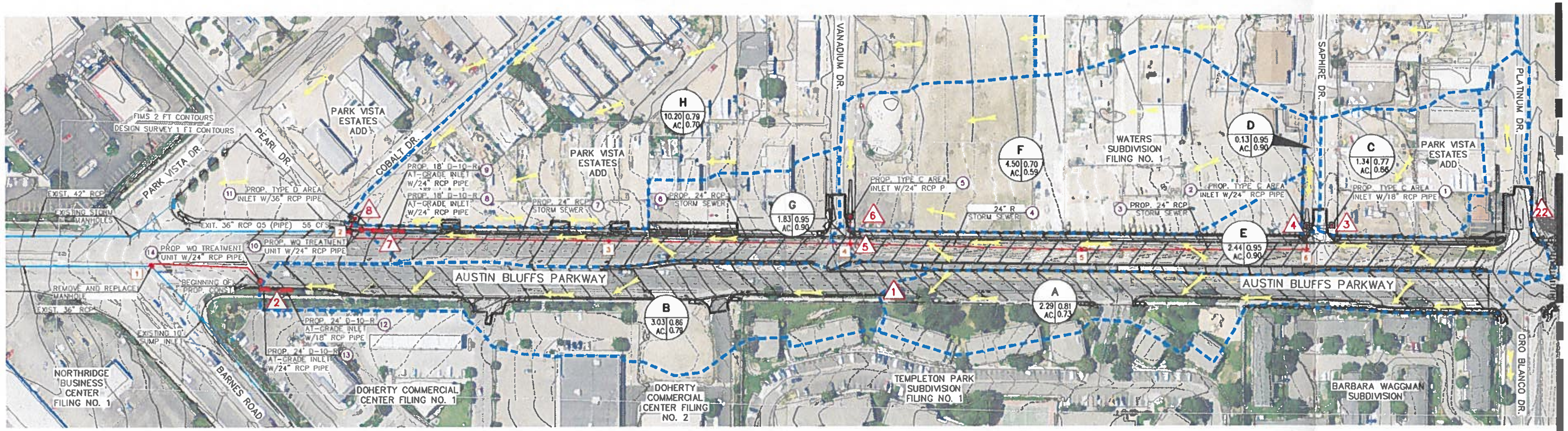
- EXISTING GROUND CONTOUR (5909)
- PROPOSED FINISHED CONTOUR (5910)
- PROPERTY LINES
- DRAINAGE BASIN BOUNDARY
- DIRECTION OF DRAINAGE
- EXISTING STORM SEWER
- EXISTING STORM INLET
- PROPOSED STORM SEWER W/ MANHOLE
- MANHOLE I.D.
- PIPE RUN I.D.
- SURFACE FLOW DESIGN POINT

SUB-BASIN ID; BASIN IDENTIFIER (M); AREA IN ACRES (1.11 AC); 100-YR RUNOFF COEFFICIENT (0.45); 5-YR RUNOFF COEFFICIENT (0.35)

SCALE: 1" = 200' (100 50 0 100 200)



PLATINUM DR./ORO BLANCO DR. TO RUBY DR./OLD FARM DR.



BARNES RD. TO PLATINUM DR./ORO BLANCO DR.

BASIN RUNOFF SUMMARY

BASIN	Q5 (CFS)	Q100 (CFS)
A	9	17
B	12	24
C	5	9
D	1	1
E	11	21
F	11	23
G	8	16
H	27	55
I	4	8
J	4	8
K	1	2
L	11	22
M	2	4

BASIN RUNOFF SUMMARY

BASIN	Q5 (CFS)	Q100 (CFS)
N	2	5
O	1	2
P	6	12
Q	1	2
R	4	7
S	74	94
T	3	6
U	1	1
V	24	71
OS-1	4	10
OS-2	2	5
OS-3	5	13

SURFACE FLOW DESIGN POINT SUMMARY

DESIGN POINT	Q5 (CFS)	Q100 (CFS)
1	9	17
2	19	37
3	5	9
4	1	1
5	11	21
6	11	23
7	18	35
8	27	55
9	THIS # NOT USED	
10	9	32
11	15	46

SURFACE FLOW DESIGN POINT SUMMARY

DESIGN POINT	Q5 (CFS)	Q100 (CFS)
12	6	14
13	1	2
14	11	26
15	14	29
16	1	2
17	12	22
18	1	2
19	15	27
20	1	1
21	3	6
22	31*/24**	71*/290**

*Interim Condition/**Ultimate Condition

PIPE RUN SUMMARY

PIPE	Q5	PIPE SIZE
1	5	18"
2	5	24"
3	5	24"
4	5	24"
5	11	24"
6	15	24"
7	15	24"

PIPE RUN SUMMARY

PIPE	Q5	PIPE SIZE
8	12	24"
9	19	24"
10	19	24"
11	27	36"
12	13	18"
13	19	24"
14	19	24"

PIPE RUN SUMMARY

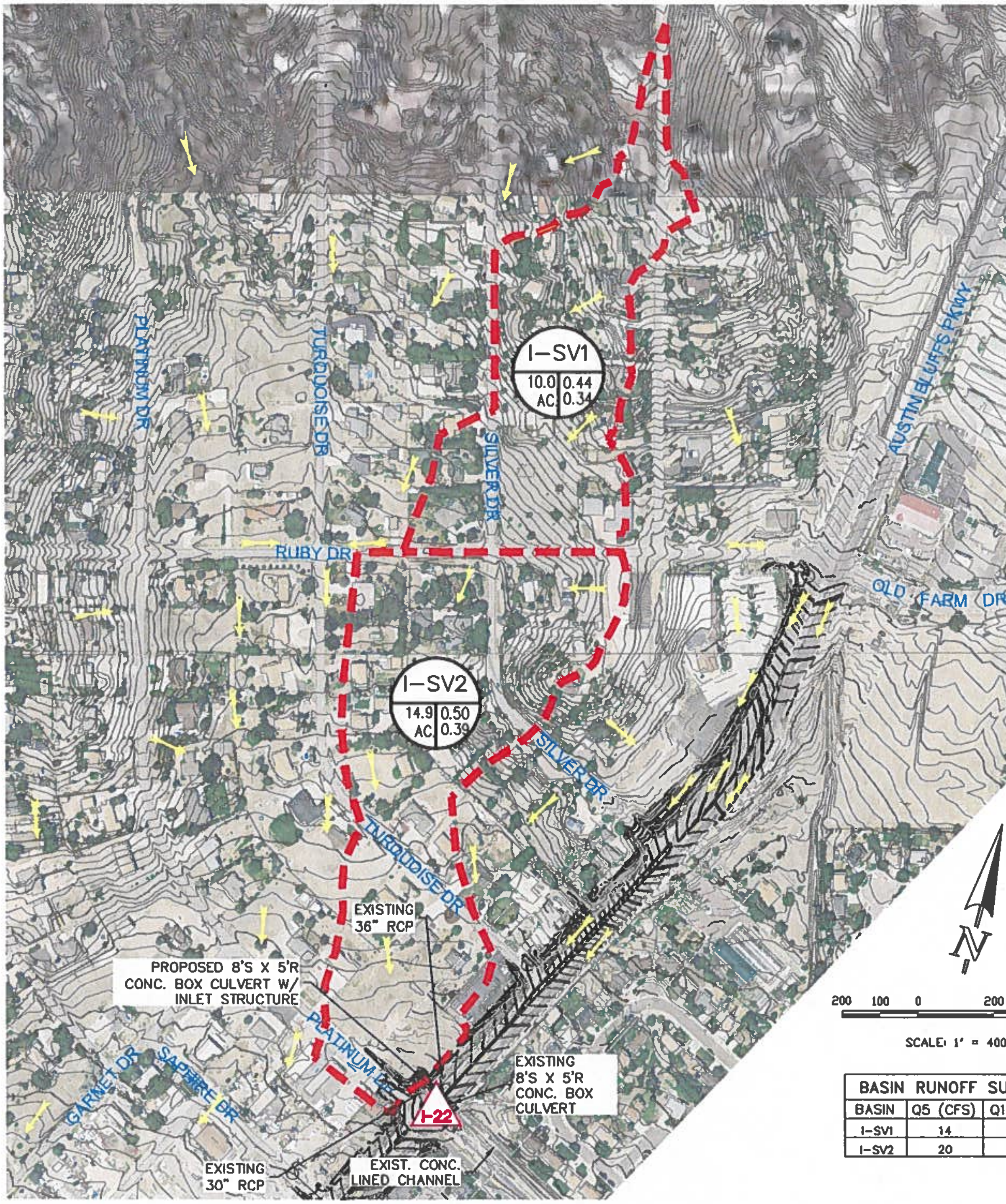
PIPE	Q5	Q100	PIPE SIZE
15	6	14	24"
16a	3	9	24"
16b	9	23	30"
17a	1	6	18"
17b	1	8	24"
18	9	31	30"
19	9	20	24"
20	9	20	24"
21	14	29	30"
22	1	2	18"

PIPE RUN SUMMARY

PIPE	Q5	Q100	PIPE SIZE
23	15	30	30"
24	21	44	30"
25	1	2	18"
26	22	45	30"
27	10	15	24"
28	10	15	24"
29	28	55	30"
30	12	14	30"x19"
31	83	83	42"
32	12	14	30"x19"

PIPE RUN SUMMARY

PIPE	Q5	Q100	PIPE SIZE
33	107	112	48"
34	131	163	48"
35	1	1	18"
36	130	162	54"
37	2	4	18"
38	3	6	18"
39	3	6	18"
40	24	290	5'X8' CBC
41	1	2	16" DIP



BASIN RUNOFF SUMMARY		
BASIN	Q5 (CFS)	Q100 (CFS)
I-SV1	14	31
I-SV2	20	45

LEGEND

- EXISTING GROUND CONTOUR — 5910
- PROPOSED FINISHED CONTOUR — 5910
- SCS BASIN BOUNDARY
- DIRECTION OF DRAINAGE
- DESIGN POINT — 1
- SUB-BASIN ID
- BASIN IDENTIFIER — M
- AREA IN ACRES — 1.19 AC
- 100-YR RUNOFF COEFFICIENT — 0.45
- 5-YR RUNOFF COEFFICIENT — 0.35

AUSTIN BLUFFS PARKWAY

SEGMENT 3

DRAINAGE MAP 2

C.B.C. INTERIM OFFSITE BASIN

SURFACE FLOW DESIGN POINT SUMMARY		
DESIGN POINT	Q5 (CFS)	Q100 (CFS)
I-22	31	71

THIS MAP DEPICTS THE OFFSITE BASINS THAT ARE EXPECTED TO CONTRIBUTE RUNOFF TO THE WEST END OF THE BOX CULVERT AT THE COMPLETION OF THE ABP PHASE III CONSTRUCTION.

WILSON & COMPANY

JOB NAME: *Austin Bluffs Parkway-Segment 3 Barnes to Platinum/Oro Blanco*
JOB NUMBER: *09-100-305-00*
DATE: *5/1/2012*
CALCULATED BY: *DLM*
CHECKED BY: *JCH*

FINAL DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY

					C SOILS									
		IMPERVIOUS AREA / STREETS			DEVELOPED			UNDEVELOPED/LANDSCAPING			WEIGHTED		WEIGHTED CA	
BASIN	TOTAL AREA (AC)	AREA (AC)	C(5)	C(100)	AREA (AC)	C(5)	C(100)	AREA (AC)	C(5)	C(100)	C(5)	C(100)	CA(5)	CA(100)
A	2.29	1.65	0.90	0.95	0.00	0.90	0.95	0.64	0.30	0.45	0.73	0.81	**1.68**	**1.86**
B	3.03	2.47	0.90	0.95	0.00	0.90	0.95	0.56	0.30	0.45	0.79	0.86	**2.39**	**2.60**
C	1.34	0.00	0.90	0.95	1.22	0.70	0.80	0.12	0.30	0.45	0.66	0.77	**0.89**	**1.03**
D	0.13	0.13	0.90	0.95	0.00	0.90	0.95	0.00	0.30	0.45	0.90	0.95	**0.12**	**0.12**
E	2.44	2.44	0.90	0.95	0.00	0.90	0.95	0.00	0.30	0.45	0.90	0.95	**2.20**	**2.32**
F	4.50	0.00	0.90	0.95	3.26	0.70	0.80	1.24	0.30	0.45	0.59	0.70	**2.65**	**3.17**
G	1.83	1.83	0.90	0.95	0.00	0.90	0.95	0.00	0.30	0.45	0.90	0.95	**1.65**	**1.74**
H	10.20	0.99	0.90	0.95	8.61	0.70	0.80	0.59	0.30	0.45	0.70	0.79	**7.10**	**8.10**

JOB NAME: *Austin Bluffs Parkway-Segment 3 Barnes to Platinum/Oro Blanco*
JOB NUMBER: *09-100-305-00*
DATE: *5/1/2012*
CALCULATED BY: *DLM*
CHECKED BY: *JCH*

FINAL DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY

BASIN	WEIGHTED		OVERLAND				STREET / CHANNEL FLOW				Tc	INTENSITY		FLOW	FLOW
	CA(5)	CA(100)	C(5)	Length *(ft)*	Height *(ft)*	Tc *(min)*	Length *(ft)*	Slope *(%)*	Velocity *(fps)*	Tc *(min)*	TOTAL *(min)*	I(5) (in/hr)	I(100) (in/hr)	Q(5) *(cfs)*	Q(100) *(cfs)*
A	1.68	1.86	0.9	90	3.0	2.4	1040	2.7%	9.7	1.8	5.0	5.10	9.07	9	17
B	2.39	2.60	0.9	90	2.7	2.5	1030	2.8%	9.8	1.7	5.0	5.10	9.07	12	24
C	0.89	1.03	0.9	70	1.5	2.4	310	3.9%	11.5	0.4	5.0	5.10	9.07	5	9
D	0.12	0.12	0.9	30	0.5	1.7	150	3.7%	11.2	0.2	5.0	5.10	9.07	1	1
E	2.20	2.32	0.9	70	2.1	2.2	270	1.5%	7.1	0.6	5.0	5.10	9.07	11	21
							1130	2.7%	9.7	1.9					
F	2.65	3.17	0.7	300	11.5	8.3	480	3.2%	4.8	1.7	10.0	4.10	7.29	11	23
G	1.65	1.74	0.9	30	1.0	1.4	130	0.8%	5.1	0.4	5.0	5.10	9.07	8	16
							770	2.7%	9.7	1.3					
H	7.10	8.10	0.7	110	4.0	5.1	970	2.9%	4.6	3.5	12.0	3.82	6.78	27	55
							710	2.7%	5.1	2.3					
							350	1.4%	5.6	1.0					

JOB NAME:	*Austin Bluffs Parkway-Segment 3 Barnes to Platinum/Oro Blanco*
JOB NUMBER:	*09-100-305-00*
DATE:	*5/1/2012*
CALCULATED BY:	*DLM*
CHECKED BY:	*JCH*

FINAL DRAINAGE REPORT ~ ROUTING SUMMARY

Design Point(s)	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		Outfall
					I(5)	I(100)	Q(5)	Q(100)	
1	Basin A	1.68	1.86	5.0	5.10	9.07	9	17	AT-GRADE INLETS @ DP2
2	DP1 + Basin B	4.07	4.45	6.7	4.69	8.34	19	37	AT-GRADE INLETS @ DP2
3	Basin C	0.89	1.03	5.0	5.10	9.07	5	9	TYPE C INLET @ DP3
4	Basin D	0.12	0.12	5.0	5.10	9.07	1	1	TYPE C INLET @ DP4
5	Basin E	2.20	2.32	5.0	5.10	9.07	11	21	AT-GRADE INLETS @ DP7
6	Basin F	2.65	3.17	10.0	4.10	7.29	11	23	TYPE C INLET @ DP6
7	DP5 + Basin G	3.84	4.06	6.3	4.79	8.51	18	35	AT-GRADE INLETS @ DP7
8	Basin H	7.10	8.10	12.0	3.82	6.78	27	55	TYPE D INLET @ DP8
Total Flow at MH 2	DP3 + DP4 + DP6 + DP7 + DP8	14.60	16.47	12.0	3.82	6.78	56	112	OUTFALL TO EXISTING 36" STORM SEWER AT BARNES ROAD

JOB NAME: *Austin Bluffs Parkway-Segment 3 Barnes to Platinum/Oro Blanco*
JOB NUMBER: *09-100-305-00*
DATE: *5/1/2012*
CALCULATED BY: *DLM*
CHECKED BY: *JCH*

FINAL DRAINAGE REPORT ~ ROUTING SUMMARY

Pipe Run	Contributing Basins/Design Points	Equivalent CA(5)	Maximum Tc	Intensity I(5)	Flow Q(5)	Pipe Size
1	DP3	0.89	5.0	5.10	5	18" RCP
2	Pipe 1 + DP4	1.01	5.1	5.09	5	24" RCP
3	Pipe 2	1.01	5.1	5.07	5	24" RCP
4	Pipe 3	1.01	5.8	4.91	5	24" RCP
5	DP6	2.65	10.0	4.10	11	24" RCP
6	Pipe 4 + Pipe 5	3.66	10.1	4.09	15	24" RCP
7	Pipe 6	3.66	10.8	3.99	15	24" RCP
8	Inlet 7A Intercept	2.61	6.3	4.79	12	24" RCP
9	Pipe 8 + Inlet 7B Intercept	3.88	6.3	4.79	19	24" RCP
10	Pipe 9	3.88	6.3	4.79	19	24" RCP
11	DP8	7.10	12.0	3.82	27	36" RCP
12	Inlet 2A Intercept	2.79	6.3	4.79	13	18" RCP
13	Pipe 12 + Inlet 2B Intercept	3.97	6.3	4.79	19	24" RCP
14	Pipe 13	3.97	6.5	4.74	19	24" RCP

JOB NAME:	*Austin Bluffs Parkway-Segment 3 Barnes to Platinum/Oro Blanco*
JOB NUMBER:	*09-100-305-00*
DATE:	*5/1/2012*
CALCULATED BY:	*DLM*

DESIGN POINT 2A — 100 YEAR FLOW

Q(100)	37	I(100)	8.3		
DEPTH	0.58	Fr	2.36	Inlet size ? L(i) =	24
SPREAD	22.5	L(1)	45.2	If Li < L(2) then Qi =	20
CROSS SLOPE	2.8%	L(2)	29.1	If Li > L(2) then Qi =	22
STREET SLOPE	2.5%	L(3)	87.6	FB =	17
				CA(eqv.)=	2.09

5 YEAR FLOW

Q(5)	19	I(5)	4.7		
DEPTH	0.46	Fr	2.23	Inlet size ? L(i) =	24
SPREAD	16.8	L(1)	31.9	If Li < L(2) then Qi =	14
CROSS SLOPE	2.8%	L(2)	20.5	If Li > L(2) then Qi =	13
STREET SLOPE	2.5%	L(3)	61.8	FB =	6
				CA(eqv.)=	1.28

JOB NAME:	*Austin Bluffs Parkway-Segment 3 Barnes to Platinum/Oro Blanco*
JOB NUMBER:	*09-100-305-00*
DATE:	*5/1/2012*
CALCULATED BY:	*DLM*

DESIGN POINT **2B** **100 YEAR FLOW**

Q(100)	17	I(100)	8.3		
DEPTH	0.45	Fr	2.21	Inlet size ? L(i) =	24
SPREAD	16.0	L(1)	30.2	If Li < L(2) then Qi =	14
CROSS SLOPE	2.8%	L(2)	19.4	If Li > L(2) then Qi =	12
STREET SLOPE	2.5%	L(3)	58.5	FB =	5
				CA(eqv.)=	0.63

5 YEAR FLOW

Q(5)	6	I(5)	4.7		
DEPTH	0.31	Fr	1.97	Inlet size ? L(i) =	24
SPREAD	9.0	L(1)	15.1	If Li < L(2) then Qi =	10
CROSS SLOPE	2.8%	L(2)	9.7	If Li > L(2) then Qi =	6
STREET SLOPE	2.5%	L(3)	29.3	FB =	0
				CA(eqv.)=	0.10

JOB NAME: ***Austin Bluffs Parkway-Segment 3 Barnes to Platinum/Oro Blanco***
JOB NUMBER: ***09-100-305-00***
DATE: ***5/1/2012***
CALCULATED BY: ***DLM***

DESIGN POINT 3

Total Flow: Q(5) = 5 cfs
Q(100) = 9 cfs

Maximum allowable ponding depth at sump:

D(5) = 0.60 (d)
D(100) = 0.60 (dmax)

Qi = [(3.0)(P)(d^1.5)]/F (Weir Conditions)

Clogging Factor (F) = 2

5-Year Event: 7.2 foot perimeter required

100-Year Event: 12.9 foot perimeter required

INSTALL A PUBLIC Type C AREA INLET TO ACCEPT 5YR DEVELOPED FLOWS AT THIS DESIGN POINT.

JOB NAME: ***Austin Bluffs Parkway-Segment 3 Barnes to Platinum/Oro Blanco***
JOB NUMBER: ***09-100-305-00***
DATE: ***5/1/2012***
CALCULATED BY: ***DLM***

DESIGN POINT 4

Total Flow: Q(5) = 1 cfs
Q(100) = 1 cfs

Maximum allowable ponding depth at sump:

D(5) = 0.85 (d)
D(100) = 0.85 (dmax)

Qi = [(3.0)(P)(d^1.5)]/F (Weir Conditions)

Clogging Factor (F) = 2

5-Year Event: 0.9 foot perimeter required

100-Year Event: 0.9 foot perimeter required

INSTALL A PUBLIC Type C AREA INLET TO ACCEPT BOTH 5YR & 100 YR DEVELOPED FLOWS AT THIS DESIGN POINT.

JOB NAME: ***Austin Bluffs Parkway-Segment 3 Barnes to Platinum/Oro Blanco***
JOB NUMBER: ***09-100-305-00***
DATE: ***5/1/2012***
CALCULATED BY: ***DLM***

DESIGN POINT 6

Total Flow: Q(5) = 11 cfs
Q(100) = 23 cfs

Maximum allowable ponding depth at sump:

D(5) = 0.80 (d)
D(100) = 0.80 (dmax)

Qi = [(3.0)(P)(d^1.5)]/F (Weir Conditions)

Clogging Factor (F) = 2

5-Year Event: 10.2 foot perimeter required

100-Year Event: 21.4 foot perimeter required

INSTALL A PUBLIC Type C AREA INLET TO ACCEPT 5YR DEVELOPED FLOWS AT THIS DESIGN POINT.

JOB NAME:	*Austin Bluffs Parkway-Segment 3 Barnes to Platinum/Oro Blanco*
JOB NUMBER:	*09-100-305-00*
DATE:	*5/1/2012*
CALCULATED BY:	*DLM*

DESIGN POINT	7A			100 YEAR FLOW	
Q(100)	35	I(100)	8.5		
DEPTH	0.55	Fr	1.85	Inlet size ? L(i) =	18
SPREAD	21.0	L(1)	29.5	If Li < L(2) then Qi =	21
CROSS SLOPE	1.9%	L(2)	17.5	If Li > L(2) then Qi =	21
STREET SLOPE	1.8%	L(3)	64.2	FB =	14
				CA(eqv.)=	1.62

				5 YEAR FLOW	
Q(5)	18	I(5)	4.8		
DEPTH	0.45	Fr	1.77	Inlet size ? L(i) =	18
SPREAD	16.3	L(1)	21.8	If Li < L(2) then Qi =	15
CROSS SLOPE	1.9%	L(2)	12.9	If Li > L(2) then Qi =	12
STREET SLOPE	1.8%	L(3)	47.4	FB =	6
				CA(eqv.)=	1.23

JOB NAME:	*Austin Bluffs Parkway-Segment 3 Barnes to Platinum/Oro Blanco*
JOB NUMBER:	*09-100-305-00*
DATE:	*5/1/2012*
CALCULATED BY:	*DLM*

DESIGN POINT **7B** **100 YEAR FLOW**

Q(100)	14	I(100)	8.5		
DEPTH	0.34	Fr	1.40	Inlet size ? L(i) =	18
SPREAD	10.5	L(1)	8.6	If Li < L(2) then Qi =	29
CROSS SLOPE	0.8%	L(2)	4.3	If Li > L(2) then Qi =	12
STREET SLOPE	1.8%	L(3)	24.3	FB =	2
				CA(eqv.)=	0.18

5 YEAR FLOW

Q(5)	6	I(5)	4.8		
DEPTH	0.28	Fr	1.32	Inlet size ? L(i) =	18
SPREAD	7.8	L(1)	6.0	If Li < L(2) then Qi =	18
CROSS SLOPE	0.8%	L(2)	3.0	If Li > L(2) then Qi =	6
STREET SLOPE	1.8%	L(3)	16.8	FB =	0
				CA(eqv.)=	-0.03

JOB NAME: ***Austin Bluffs Parkway-Segment 3 Barnes to Platinum/Oro Blanco***
JOB NUMBER: ***09-100-305-00***
DATE: ***5/1/2012***
CALCULATED BY: ***DLM***

DESIGN POINT 8

Total Flow: Q(5) = 27 cfs
Q(100) = 55 cfs

Maximum allowable ponding depth at sump:

D(5) = 1.0 (d)
D(100) = 1.0 (dmax)

Qi = [(3.0)(P)(d^1.5)]/F (Weir Conditions)

Clogging Factor (F) = 2

5-Year Event: 17.0 foot perimeter required

100-Year Event: 34.5 foot perimeter required

INSTALL A PUBLIC Type D AREA INLET TO ACCEPT 5YR DEVELOPED FLOWS AT THIS DESIGN POINT.

JOB NAME: ***Austin Bluffs Parkway-Segment 3 Barnes to Platinum/Oro Blanco***
JOB NUMBER: ***09-100-305-00***
DATE: ***5/1/2012***
CALCULATED BY: ***DLM***

DESIGN POINT 8 (Interim)

Total Flow: Q(5) = 11 cfs
Q(100) = 11 cfs

Maximum allowable ponding depth at sump:

D(5) = 1.0 (d)
D(100) = 1.0 (dmax)

Qi = [(3.0)(P)(d^1.5)]/F (Weir Conditions)

Clogging Factor (F) = 2

5-Year Event: 7.3 foot perimeter required

100-Year Event: 6.9 foot perimeter required

INSTALL A PUBLIC Type D AREA INLET TO ACCEPT BOTH 5YR AND 100YR DEVELOPED FLOWS AT THIS DESIGN POINT.

JOB NAME:	*Austin Bluffs Parkway-Segment 3 Platinum/Oro Blanco to Ruby*
JOB NUMBER:	*09-100-305-00*
DATE:	*5/26/2012*
CALCULATED BY:	*DLM*
CHECKED BY:	*JCH*

PRELIMINARY DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY

					B SOILS						C SOILS									
		IMPERVIOUS AREA / STREETS			DEVELOPED			UNDEVELOPED / LANDSCAPING			DEVELOPED			UNDEVELOPED / LANDSCAPING			WEIGHTED		WEIGHTED CA	
BASIN	TOTAL AREA (AC)	AREA (AC)	C(5)	C(100)	AREA (AC)	C(5)	C(100)	AREA (AC)	C(5)	C(100)	AREA (AC)	C(5)	C(100)	AREA (AC)	C(5)	C(100)	C(5)	C(100)	CA(5)	CA(100)
I	1.30	1.30	0.90	0.95	0.00	0.50	0.60	0.00	0.25	0.35	0.00	0.90	0.95	0.00	0.30	0.45	0.90	0.95	1.17	1.24
J	0.95	0.95	0.90	0.95	0.00	0.50	0.60	0.00	0.25	0.35	0.00	0.90	0.95	0.00	0.30	0.45	0.90	0.95	0.86	0.90
K	0.35	0.17	0.90	0.95	0.00	0.50	0.60	0.18	0.25	0.35	0.00	0.90	0.95	0.00	0.30	0.45	0.57	0.64	0.20	0.22
L	3.96	2.26	0.90	0.95	0.27	0.80	0.85	1.34	0.25	0.35	0.00	0.90	0.95	0.00	0.30	0.45	0.65	0.72	2.59	2.85
M	1.11	0.00	0.90	0.95	1.11	0.35	0.45	0.00	0.25	0.35	0.00	0.90	0.95	0.00	0.30	0.45	0.35	0.45	0.39	0.50
N	1.42	0.13	0.90	0.95	0.07	0.80	0.85	1.22	0.25	0.35	0.00	0.90	0.95	0.00	0.30	0.45	0.34	0.43	0.48	0.61
O	0.19	0.19	0.90	0.95	0.00	0.50	0.60	0.00	0.25	0.35	0.00	0.90	0.95	0.00	0.30	0.45	0.90	0.95	0.17	0.18
P	1.41	1.32	0.90	0.95	0.00	0.50	0.60	0.09	0.25	0.35	0.00	0.90	0.95	0.00	0.30	0.45	0.86	0.91	1.21	1.29
Q	0.41	0.00	0.90	0.95	0.41	0.35	0.45	0.00	0.25	0.35	0.00	0.90	0.95	0.00	0.30	0.45	0.35	0.45	0.14	0.18
R	0.77	0.77	0.90	0.95	0.00	0.50	0.60	0.00	0.25	0.35	0.00	0.90	0.95	0.00	0.30	0.45	0.90	0.95	0.69	0.73
S*	128.80																		24.37	17.28
T	0.64	0.64	0.90	0.95	0.00	0.50	0.60	0.00	0.25	0.35	0.00	0.90	0.95	0.00	0.30	0.45	0.90	0.95	0.58	0.61
U	0.17	0.17	0.90	0.95	0.00	0.50	0.60	0.00	0.25	0.35	0.00	0.90	0.95	0.00	0.30	0.45	0.90	0.95	0.15	0.16
V*	20.70																		6.72	11.29
OS-1	3.25	0.00	0.90	0.95	3.25	0.35	0.45	0.00	0.25	0.35	0.00	0.90	0.95	0.00	0.30	0.45	0.35	0.45	1.14	1.46
OS-2	1.33	0.00	0.90	0.95	1.33	0.35	0.45	0.00	0.25	0.35	0.00	0.90	0.95	0.00	0.30	0.45	0.35	0.45	0.47	0.60
OS-3	3.83	0.00	0.90	0.95	3.83	0.35	0.45	0.00	0.25	0.35	0.00	0.90	0.95	0.00	0.30	0.45	0.35	0.45	1.34	1.72
OS-4																			1.18	1.05
OS-5																			3.61	6.71
I-SV1	9.96	0.00	0.90	0.95	8.64	0.35	0.45	1.32	0.25	0.35	0.00	0.90	0.95	0.00	0.30	0.45	0.34	0.44	3.35	4.35
I-SV2	14.85	0.00	0.90	0.95	5.43	0.35	0.45	0.00	0.25	0.35	6.86	0.45	0.55	2.56	0.30	0.45	0.39	0.50	5.76	7.37

* Peak flow rates determined from HEC-HMS model were used to back-calculate CA values to allow equilavent Rational peak flow rates to be determined and routed through the pipe system.

JOB NAME: *Austin Bluffs Parkway-Segment 3 Platinum/Oro Blanco to Ruby*
JOB NUMBER: *09-100-305-00*
DATE: *5/26/2012*
CALCULATED BY: *DLM*
CHECKED BY: *JCH*

PRELIMINARY DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY

	WEIGHTED		OVERLAND				STREET / CHANNEL FLOW				Tc	INTENSITY		TOTAL FLOWS	
BASIN	CA(5)	CA(100)	C(5)	Length *(ft)*	Height *(ft)*	Tc *(min)*	Length *(ft)*	Slope *(%)*	Velocity *(fps)*	Tc *(min)*	TOTAL *(min)*	I(5) (in/hr)	I(100) (in/hr)	Q(5) *(cfs)*	Q(100) *(cfs)*
I	1.17	1.24	0.9	30	1.0	1.4	1080	3.6%	11.1	1.6	14.4	3.53	6.27	4	8
J	0.86	0.90	0.9	90	4.0	2.2	650	2.4%	9.0	1.2	5.0	5.10	9.07	4	8
K	0.20	0.22	0.9	30	2.0	1.1	410	3.9%	11.6	0.6	5.0	5.10	9.07	1	2
L	2.59	2.85	0.25	60	3.0	7.2	310	5.5%	6.3	0.8	9.0	4.27	7.58	11	22
							150	2.7%	9.6	0.3					
							210	2.6%	5.1	0.7					
M	0.39	0.50	0.25	100	6.5	8.6	190	11.6%	9.1	0.3	8.9	4.28	7.61	2	4
N	0.48	0.61	0.25	70	10.0	5.5	120	2.5%	9.3	0.2	6.7	4.70	8.36	2	5
							30	16.7%	12.8	0.0					
							210	1.4%	3.7	0.9					
O	0.17	0.18	0.90	30	1.0	1.4	170	4.7%	10.2	0.3	5.0	5.10	9.07	1	2
P	1.21	1.29	0.90	140	5.0	2.9	820	2.6%	9.4	1.5	5.0	5.10	9.07	6	12
Q	0.14	0.18	0.70	50	1.5	3.7	140	10.7%	10.2	0.2	5.0	5.10	9.07	1	2
							80	1.9%	3.2	0.4					
R	0.69	0.73	0.90	90	3.0	2.4	440	4.8%	12.8	0.6	5.0	5.10	9.07	4	7
S*	24.37	17.28	0.25	150	12.0	9.8	1330	9.0%	9.4	2.4	19.5	3.05	5.43	74	94
							2750	4.0%	6.3	7.3					
T	0.58	0.61	0.90	100	5.0	2.2	370	2.4%	9.1	0.7	5.0	5.10	9.07	3	6
U	0.15	0.16	0.90	20	0.5	1.2	150	2.0%	8.3	0.3	5.0	5.10	9.07	1	1
V*	6.72	11.29	0.25	160	18.5	9.0	270	9.6%	8.3	0.5	14.3	3.54	6.29	24	71
							1000	3.6%	5.9	2.8					
							500	1.8%	4.2	2.0					
OS-1	1.14	1.46	0.25	110	6.0	9.5	800	8.9%	9.3	1.4	11.0	3.95	7.03	4	10
OS-2	0.47	0.60	0.25	110	12.5	7.5	290	4.8%	5.9	0.8	8.3	4.39	7.80	2	5
OS-3	1.34	1.72	0.25	130	14.5	8.2	520	10.6%	8.7	1.0	10.0	4.10	7.29	5	13
							140	3.6%	5.9	0.4					
							150	3.3%	5.7	0.4					
OS-4	0.79	0.67									5.0	5.10	9.07	4	6
OS-5	3.61	6.71									14.4	3.53	6.27	13	42
I-SV1	3.35	4.35	0.25	150	18.0	8.6	785	5.1%	7.1	1.9	10.4	4.04	7.18	14	31
I-SV2	5.76	7.37	0.25	120	4.0	11.7	1295	3.2%	5.6	3.8	15.5	3.41	6.06	20	45

* Peak flow rates determined from the HEC-HMS model were used to back-calculate CA values to allow equilavent Rational peak flow rates to be determined and routed through the pipe system.

JOB NAME:	*Austin Bluffs Parkway-Segment 3 Platinum/Oro Blanco to Ruby*
JOB NUMBER:	*09-100-305-00*
DATE:	*5/26/2012*
CALCULATED BY:	*DLM*
CHECKED BY:	*JCH*

PRELIMINARY DRAINAGE REPORT ~ ROUTING SUMMARY

Design Point(s)	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		Outfall
					I(5)	I(100)	Q(5)	Q(100)	
10	Basin I + Flow-By from DP11	2.86	5.54	17.2	3.25	5.77	9	32	AT-GRADE COMBINATION INLETS @ DP10
11	OS-5 + Basin J	4.47	7.61	15.6	3.40	6.04	15	46	AT-GRADE COMBINATION INLET @ DP11
12	Basin OS-1 + Basin OS-2	1.60	2.06	11.7	3.85	6.84	6	14	OFFSITE BASIN FLOW
13	Basin K	0.20	0.22	5.0	5.10	9.07	1	2	TYPE C INLET @ DP13
14	DP12 + Basin OS-3	2.94	3.78	12.1	3.80	6.75	11	26	TYPE D INLET @ DP14
15	Basin L + Basin M + Basin N	3.45	3.96	9.9	4.11	7.31	14	29	FES AND 30" RCP
16	Basin O	0.17	0.18	5.0	5.10	9.07	1	2	FES AND 18" RCP
17	Basin P + Flow-By from Basin OS-4 + DP13	2.59	2.56	6.5	4.76	8.46	12	22	AT-GRADE INLET @ DP19/TURQUOISE FES
18	Basin Q	0.14	0.18	5.0	5.10	9.07	1	2	GRATE INLET @ DP18
19	Basin R + DP17	3.28	3.29	7.0	4.64	8.24	15	27	AT-GRADE INLET @ DP19/TURQUOISE FES
20	Basin U	0.15	0.16	5.0	5.10	9.07	1	1	2' x 2' COMBINATION INLET @ DP 20
21	Basin T	0.58	0.61	5.0	5.10	9.07	3	6	AT-GRADE INLETS @ DP21
22	Basin V + Basin S 100-YR Diversion	7.87	53.41	19.5	3.05	5.43	24	290	ULTIMATE FLOW TO CBC
I-22	Basin I-SV1 + Basin I-SV2	9.11	11.72	15.5	3.41	6.06	31	71	AREA INLET FOR CBC (INTERIM)
	Existing Capacity of 30"/36" RCP		16.50	15.5	3.41	6.06	0	100	DESIGNED INLET AT CBC (INTERIM)

JOB NAME: *Austin Bluffs Parkway-Segment 3 Platinum/Oro Blanco to Ruby*
JOB NUMBER: *09-100-305-00*
DATE: *5/26/2012*
CALCULATED BY: *DLM*
CHECKED BY: *JCH*

PRELIMINARY DRAINAGE REPORT ~ PIPE ROUTING SUMMARY

Pipe Run	Contributing Basins/Design Points	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		Pipe Size
					I(5)	I(100)	Q(5)	Q(100)	
15	Inlet 10A Interception	1.85	2.39	17.2	3.25	5.77	6	14	24" RCP
16a	Inlet 10B Interception	0.80	1.61	17.2	3.25	5.77	3	9	24" RCP
16b	Pipe 15 + Pipe 16a	2.65	4.00	17.3	3.24	5.76	9	23	30" RCP
17a	Inlet 10C Interception	0.16	1.04	17.2	3.25	5.77	1	6	18" RCP
17b	Pipe 17a + Inlet 10D Interception	0.16	1.46	17.2	3.25	5.77	1	8	24" RCP
18	Pipe 16b + Pipe 17b	2.81	5.46	17.4	3.23	5.74	9	31	30" RCP
19	Inlet 11 Interception	2.78	3.31	15.6	3.40	6.04	9	20	24" RCP
20	Pipe 19	2.78	3.31	15.7	3.39	6.03	9	20	24" RCP
21	DP15	3.45	3.96	9.9	4.11	7.31	14	29	30" RCP
22	DP16	0.17	0.18	5.0	5.10	9.07	1	2	18" RCP
23	Pipe 21 + Pipe 22	3.62	4.14	9.9	4.11	7.31	15	30	30" RCP
24	Pipe 20 + Pipe 23	6.40	7.45	16.1	3.35	5.96	21	44	30" RCP
25	DP18	0.14	0.18	5.0	5.10	9.07	1	2	18" RCP
26	Pipe 24 + Pipe 25	6.55	7.63	16.5	3.32	5.89	22	45	30" RCP
27	Inlet 19 (At-Grade) Interception	2.12	1.82	7.0	4.64	8.24	10	15	24" RCP
28	Pipe 27	2.12	1.82	7.0	4.64	8.24	10	15	24" RCP
29	Pipe 26 + Pipe 28	8.67	9.45	16.8	3.29	5.84	28	55	30" RCP

JOB NAME:	*Austin Bluffs Parkway-Segment 3 Platinum/Oro Blanco to Ruby*
JOB NUMBER:	*09-100-305-00*
DATE:	*5/26/2012*
CALCULATED BY:	*DLM*
CHECKED BY:	*JCH*

PRELIMINARY DRAINAGE REPORT ~ PIPE ROUTING SUMMARY

Pipe Run	Contributing Basins/Design Points	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		Pipe Size
					I(5)	I(100)	Q(5)	Q(100)	
30	1/2 of Inlet 19 Bypass + 10 cfs Turquoise North Ditch Flow	3.49	2.38	15.5	3.41	6.06	12	14	30" x 19" RCP
31*	Stub for Future 5-YR System (Basin S 5-yr Flow)	24.37	13.70	15.5	3.41	6.06	83	83	42" RCP
32	1/2 of Inlet 19 Bypass + 10 cfs Turquoise South Ditch Flow	3.49	2.38	15.5	3.41	6.06	12	14	30" x 19" RCP
33	Pipe 30 + Pipe 31 + Pipe 32	31.34	18.45	15.5	3.41	6.06	107	112	48" RCP
34	Pipe 29 + Pipe 33	40.00	27.91	16.9	3.28	5.83	131	163	48" RCP
35	DP20	0.15	0.16	5.0	5.10	9.07	1	1	18" RCP
36	Pipe 34 + Pipe 35	40.16	28.07	17.2	3.25	5.78	130	162	54" RCP
37	Inlet 21A Interception	0.45	0.43	5.0	5.10	9.07	2	4	18" RCP
38	Pipe 37 + Inlet21B Interception	0.60	0.63	5.0	5.10	9.07	3	6	18" RCP
39	Pipe 38	0.60	0.63	5.0	5.10	9.07	3	6	18" RCP
40	DP22	7.87	53.41	19.5	3.05	5.43	24	290	5' x 8' CBC
40-I	DPI22 (MATCH CAP.)		17.60	15.5		6.06		107	5' x 8' CBC
40-I-A**	40-I At 17.5 Minutes		17.60	17.5		5.73		101	5' x 8' CBC
40-I-B**	40-I-A + Pipe 39		18.23	17.5		5.73		104	5' x 8' CBC
40-I-C**	40-I-B + Pipe 36 (w/o 5yr stub)		33.08	17.5		5.73		189	5' x 8' CBC
40-I-D**	40-I-C + Pipe 18		38.53	17.7		5.69		219	5' x 8' CBC
41	DP13	0.20	0.22	5.0	5.10	9.07	1	2	16" DIP

*Time of concentration reduced to 15.5 minutes to account for routing through proposed storm sewer system between Turquoise and Ruby.

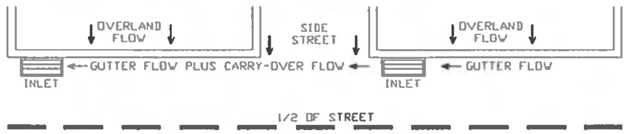
**Interim flows utilized for the Platinum CBC Interim 100-Yr HEC-RAS model. Tc for 40-I-A was increased to 17.5 min to represent surface flow in the interim condition.

Worksheet Protected

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

Project: Austin Bluffs Parkway
Inlet ID: Inlet DP 10A - Denver Triple Type 16 Combination Inlet

Design Flow = Gutter Flow + Carry-over Flow



Show Details

Design Flow: ONLY if already determined through other methods:
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):

	Minor Storm	Major Storm	
*Q =	9.0	32.0	cfs

* If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)

<--- FILL IN THIS SECTION OR…
FILL IN THE SECTIONS BELOW. <---

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site Type:
- ● Site is Urban
- ○ Site is Non-Urban

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

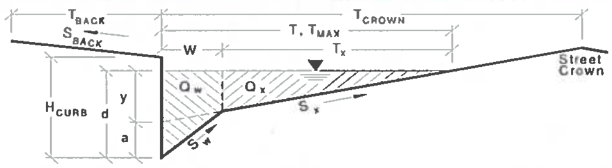
Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c)^{C_3}$

	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =			cfs
Total Design Peak Flow, Q =	9.0	32.0	cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Austin Bluffs Parkway
Inlet ID: Inlet DP 10A - Denver Triple Type 16 Combination Inlet



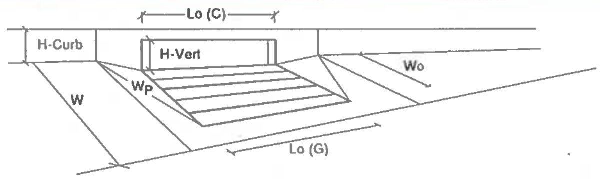
Gutter Geometry (Enter data in the blue cells)				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =			ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.020		
Height of Curb at Gutter Flow Line	H_{CURB} =	8.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	40.0		ft
Gutter Depression	a =	1.30		inches
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.029		ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.023		ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.015		
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	13.4	19.4	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.0	8.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	Q_{allow} =	**16.1**	**32.2**	**cfs**

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'
Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: Austin Bluffs Parkway

Inlet ID: Inlet DP 10A - Denver Triple Type 16 Combination Inlet



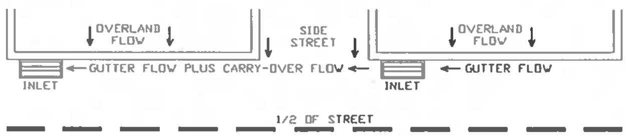
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	Q_o =	9.0	32.0	cfs
Water Spread Width	T =	10.3	17.2	ft
Water Depth at Flowline (outside of local depression)	d =	4.9	7.3	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.517	0.321	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	4.3	21.7	cfs
Discharge within the Gutter Section W	Q_w =	4.7	10.3	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	1.64	4.37	sq ft
Velocity within the Gutter Section W	V_W =	5.5	7.3	fps
Water Depth for Design Condition	d_{LOCAL} =	6.9	9.3	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	9.00	9.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.472	0.288	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	3.09	3.09	fps
Interception Rate of Frontal Flow	R_f =	0.78	0.62	
Interception Rate of Side Flow	R_x =	0.59	0.46	
Interception Capacity	Q_i =	6.1	16.1	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	1.75	1.75	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	0.29	0.29	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	6.38	6.38	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	2.81	2.81	fps
Interception Rate of Frontal Flow	R_f =	0.76	0.59	
Interception Rate of Side Flow	R_x =	0.39	0.28	
Actual Interception Capacity	Q_a =	5.1	11.7	cfs
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	3.9	20.3	cfs
Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.100	0.073	ft/ft
Required Length L_T to Have 100% Interception	L_T =	12.20	32.56	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	9.00	9.00	ft
Interception Capacity	Q_i =	1.1	2.9	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	8.70	8.70	ft
Actual Interception Capacity	Q_a =	0.9	2.1	cfs
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	Q_b =	3.0	18.2	cfs
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	6.0	13.8	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	3.0	18.2	cfs
Capture Percentage = Q_a/Q_o =	C% =	67	43	%

Worksheet Protected

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

Project: Austin Bluffs Parkway
Inlet ID: Inlet DP 10B - Denver Triple Type 16 Combination Inlet

Design Flow = Gutter Flow + Carry-over Flow



Show Details

Design Flow: ONLY if already determined through other methods:

		Minor Storm	Major Storm	
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):	*Q =	3.0	18.2	cfs

* If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)

<--- FILL IN THIS SECTION OR... FILL IN THE SECTIONS BELOW. <---

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site Type:
- (●) Site is Urban
- ( ) Site is Non-Urban

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c)^{C_3}$

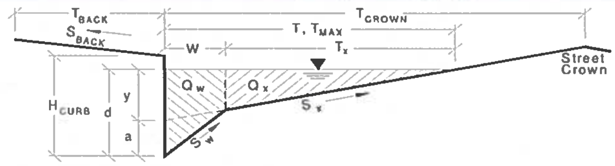
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =			cfs
Total Design Peak Flow, Q =	3.0	18.2	cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Austin Bluffs Parkway

Inlet ID: Inlet DP 10B - Denver Triple Type 16 Combination Inlet



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	8.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	38.5	ft
Gutter Depression	a =	1.33	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.028	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.025	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.015	

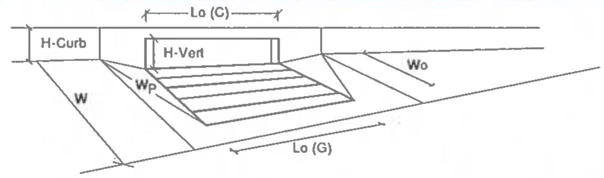
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	13.9	20.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.0	12.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	Q_{allow} =	**16.0**	**46.9**	cfs

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'
Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: Austin Bluffs Parkway
Inlet ID: Inlet DP 10B - Denver Triple Type 16 Combination Inlet



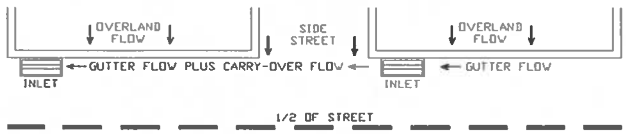
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	Q_o =	3.0	18.2	cfs
Water Spread Width	T =	6.3	13.8	ft
Water Depth at Flowline (outside of local depression)	d =	3.4	6.0	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.759	0.400	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.7	10.9	cfs
Discharge within the Gutter Section W	Q_w =	2.3	7.3	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.66	2.77	sq ft
Velocity within the Gutter Section W	V_W =	4.5	6.6	fps
Water Depth for Design Condition	d_{LOCAL} =	5.4	8.0	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	9.00	9.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.706	0.361	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	3.09	3.09	fps
Interception Rate of Frontal Flow	R_f =	0.87	0.69	
Interception Rate of Side Flow	R_x =	0.66	0.50	
Interception Capacity	Q_i =	2.4	10.3	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	1.75	1.75	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	0.29	0.29	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	6.38	6.38	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	2.81	2.81	fps
Interception Rate of Frontal Flow	R_f =	0.84	0.66	
Interception Rate of Side Flow	R_x =	0.46	0.31	
Actual Interception Capacity	Q_a =	2.2	7.9	cfs
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	0.8	10.3	cfs
Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.133	0.083	ft/ft
Required Length L_T to Have 100% Interception	L_T =	4.79	21.79	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	4.79	9.00	ft
Interception Capacity	Q_i =	0.4	1.8	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	8.70	8.70	ft
Actual Interception Capacity	Q_a =	0.4	1.4	cfs
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	Q_b =	0.4	8.9	cfs
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	2.6	9.3	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	0.4	8.9	cfs
Capture Percentage = Q_a/Q_o =	C% =	86	51	%

Worksheet Protected

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

Project: Austin Bluffs Parkway
Inlet ID: Inlet DP 10C - Denver Triple Type 16 Combination Inlet

Design Flow = Gutter Flow + Carry-over Flow



Show Details

Design Flow: ONLY if already determined through other methods:

	Minor Storm	Major Storm	
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments): *Q =	0.4	8.9	cfs

* If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)

<— FILL IN THIS SECTION OR… FILL IN THE SECTIONS BELOW. <—

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site Type:
- ● Site is Urban
- ○ Site is Non-Urban

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c)^{C_3}$

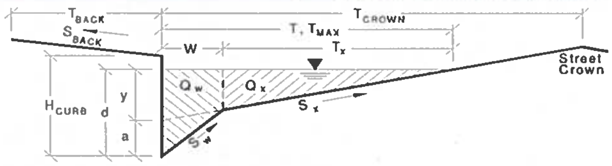
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =			cfs
Total Design Peak Flow, Q =	0.4	8.9	cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Austin Bluffs Parkway

Inlet ID: Inlet DP 10C - Denver Triple Type 16 Combination Inlet



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	8.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	38.5	ft
Gutter Depression	a =	1.28	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.030	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.023	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.015	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	13.1	18.8	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.0	8.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

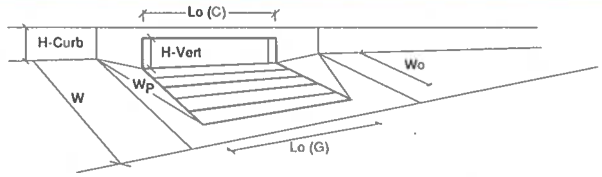
		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	Q_{allow} =	**15.8**	**31.4**	cfs

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: Austin Bluffs Parkway
Inlet ID: Inlet DP 10C - Denver Triple Type 16 Combination Inlet



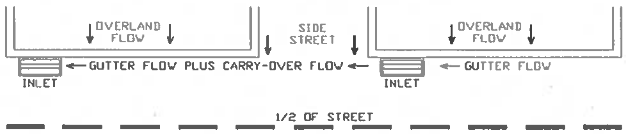
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	Q_o =	0.4	8.9	cfs
Water Spread Width	T =	1.8	10.0	ft
Water Depth at Flowline (outside of local depression)	d =	1.8	4.9	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	1.001	0.526	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.0	4.2	cfs
Discharge within the Gutter Section W	Q_w =	0.4	4.7	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.13	1.62	sq ft
Velocity within the Gutter Section W	V_W =	3.1	5.5	fps
Water Depth for Design Condition	d_{LOCAL} =	3.8	6.9	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	9.00	9.00	ft
Ratio of Grate Flow to Design Flow	$E_{o-GRATE}$ =	0.998	0.479	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	3.09	3.09	fps
Interception Rate of Frontal Flow	R_f =	1.00	0.78	
Interception Rate of Side Flow	R_x =	0.80	0.59	
Interception Capacity	Q_i =	0.4	6.1	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	1.75	1.75	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	0.29	0.29	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	6.38	6.38	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	2.81	2.81	fps
Interception Rate of Frontal Flow	R_f =	0.97	0.76	
Interception Rate of Side Flow	R_x =	0.65	0.40	
Actual Interception Capacity	Q_a =	0.4	5.1	cfs
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	0.0	3.8	cfs
Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.167	0.102	ft/ft
Required Length L_T to Have 100% Interception	L_T =	0.48	11.98	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	0.48	9.00	ft
Interception Capacity	Q_i =	0.1	1.1	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	8.70	8.70	ft
Actual Interception Capacity	Q_a =	0.1	0.9	cfs
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	Q_b =	0.0	2.9	cfs
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	0.5	6.0	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	0.0	2.9	cfs
Capture Percentage = Q_a/Q_o =	C% =	100	67	%

Worksheet Protected

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

Project: Austin Bluffs Parkway
Inlet ID: Inlet DP 10D - Denver Triple Type 16 Combination Inlet

Design Flow = Gutter Flow + Carry-over Flow



Show Details

Design Flow: ONLY if already determined through other methods:

		Minor Storm	Major Storm	
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):	*Q =	0.0	2.9	cfs

* If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)

<--- FILL IN THIS SECTION OR… FILL IN THE SECTIONS BELOW. <---

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site Type:
- ● Site is Urban
- ○ Site is Non-Urban

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ {C_3}$

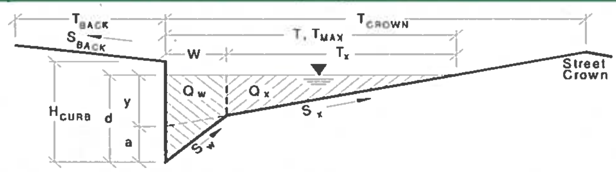
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =			cfs
Total Design Peak Flow, Q =	0.0	2.9	cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Austin Bluffs Parkway

Inlet ID: Inlet DP 10D - Denver Triple Type 16 Combination Inlet



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	8.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	38.5	ft
Gutter Depression	a =	1.11	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.037	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.031	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.015	

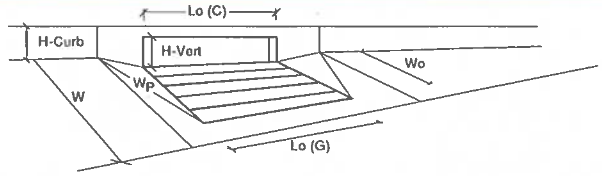
		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	11.0	15.6	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.0	8.0	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	Q_{allow} =	**12.8**	**24.9**	**cfs**

Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'
Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: Austin Bluffs Parkway
Inlet ID: Inlet DP 10D - Denver Triple Type 16 Combination Inlet



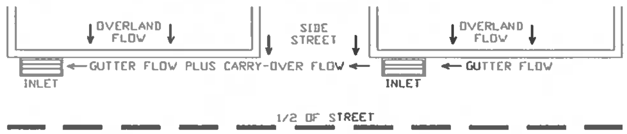
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	Q_o =	0.0	2.9	cfs
Water Spread Width	T =	0.4	5.0	ft
Water Depth at Flowline (outside of local depression)	d =	0.4	3.3	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	1.032	0.822	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.0	0.5	cfs
Discharge within the Gutter Section W	Q_w =	0.0	2.4	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.01	0.56	sq ft
Velocity within the Gutter Section W	V_W =	1.3	5.2	fps
Water Depth for Design Condition	d_{LOCAL} =	2.4	5.3	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	9.00	9.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	1.407	0.768	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	3.09	3.09	fps
Interception Rate of Frontal Flow	R_f =	1.00	0.81	
Interception Rate of Side Flow	R_x =	0.96	0.67	
Interception Capacity	Q_i =	0.0	2.3	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	1.75	1.75	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	0.29	0.29	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	6.38	6.38	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	2.81	2.81	fps
Interception Rate of Frontal Flow	R_f =	1.00	0.79	
Interception Rate of Side Flow	R_x =	0.91	0.48	
Actual Interception Capacity	Q_a =	0.0	2.1	cfs
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	0.0	0.8	cfs
Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.167	0.143	ft/ft
Required Length L_T to Have 100% Interception	L_T =	0.00	4.76	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	0.00	4.76	ft
Interception Capacity	Q_i =	0.0	0.4	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	8.70	8.70	ft
Actual Interception Capacity	Q_a =	0.0	0.4	cfs
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	Q_b =	0.0	0.5	cfs
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	0.0	2.4	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	0.0	0.5	cfs
Capture Percentage = Q_a/Q_o =	C% =	100	84	%

Worksheet Protected

DESIGN PEAK FLOW FOR ONE-HALF OF STREET BY THE RATIONAL METHOD

Project: Austin Bluffs Parkway
Inlet ID: Design Point 11 - Denver Triple Type 16 Combination Inlet

Design Flow = Gutter Flow + Carry-over Flow



Show Details

Design Flow: ONLY if already determined through other methods:

		Minor Storm	Major Storm	
(local peak flow for 1/2 of street, plus flow bypassing upstream subcatchments):	*Q =	15.0	46.0	cfs

* If you entered a value here, skip the rest of this sheet and proceed to sheet Q-Allow)

<--- FILL IN THIS SECTION OR... FILL IN THE SECTIONS BELOW. <---

Geographic Information: (Enter data in the blue cells):

Subcatchment Area =		Acres
Percent Imperviousness =		%
NRCS Soil Type =		A, B, C, or D

Site Type:
- ● Site is Urban
- ○ Site is Non-Urban

	Slope (ft/ft)	Length (ft)
Overland Flow =		
Gutter Flow =		

Rainfall Information: Intensity I (inch/hr) = $C_1 * P_1 / (C_2 + T_c) ^ C_3$

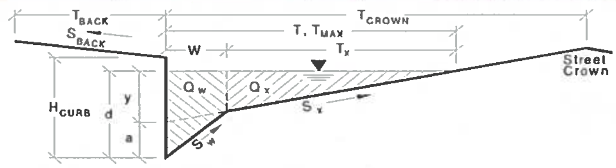
	Minor Storm	Major Storm	
Design Storm Return Period, T_r =			years
Return Period One-Hour Precipitation, P_1 =			inches
C_1 =			
C_2 =			
C_3 =			
User-Defined Storm Runoff Coefficient (leave this blank to accept a calculated value), C =			
User-Defined 5-yr. Runoff Coefficient (leave this blank to accept a calculated value), C_5 =			
Bypass (Carry-Over) Flow from upstream Subcatchments, Q_b =			cfs
Total Design Peak Flow, Q =	15.0	46.0	cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Austin Bluffs Parkway

Inlet ID: Design Point 11 - Denver Triple Type 16 Combination Inlet



Gutter Geometry (Enter data in the blue cells)

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	1.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.330	ft. vert. / ft. horiz
Manning's Roughness Behind Curb	n_{BACK} =	0.015	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	33.0	ft
Gutter Depression	a =	1.38	inches
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.026	ft. vert. / ft. horiz
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.017	ft. vert. / ft. horiz
Manning's Roughness for Street Section	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Water Spread for Minor & Major Storm	T_{MAX} =	16.4	26.0	ft
Max. Allowable Depth at Gutter Flow Line for Minor & Major Storm	d_{MAX} =	6.0	9.6	inches
Allow Flow Depth at Street Crown (leave blank for no)		☐	☐	check = yes

		Minor Storm	Major Storm	
Max. Allowable Gutter Capacity Based on Minimum of Q_T or Q_d	Q_{allow} =	**15.1**	**63.1**	**cfs**

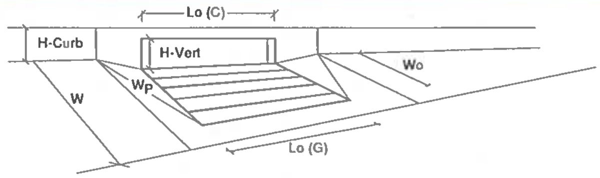
Minor storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

Major storm max. allowable capacity GOOD - greater than flow given on sheet 'Q-Peak'

INLET ON A CONTINUOUS GRADE

Project: Austin Bluffs Parkway

Inlet ID: Design Point 11 - Denver Triple Type 16 Combination Inlet



		MINOR	MAJOR	
Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	Denver No. 16 Combination		
Local Depression (additional to continuous gutter depression 'a' from 'Q-Allow')	a_{LOCAL} =	2.0	2.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	3	3	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	3.00	3.00	ft
Width of a Unit Grate (cannot be greater than W from Q-Allow)	W_o =	1.73	1.73	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f-G =	0.50	0.50	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f-C =	0.10	0.10	
Street Hydraulics: OK - Q < maximum allowable from sheet 'Q-Allow'		MINOR	MAJOR	
Design Discharge for Half of Street (from Sheet *Q-Peak*)	Q_o =	15.0	46.0	cfs
Water Spread Width	T =	14.8	22.9	ft
Water Depth at Flowline (outside of local depression)	d =	6.0	8.5	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.379	0.245	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	9.3	34.6	cfs
Discharge within the Gutter Section W	Q_w =	5.7	11.2	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.2	cfs
Flow Area within the Gutter Section W	A_W =	2.96	6.94	sq ft
Velocity within the Gutter Section W	V_W =	5.1	6.6	fps
Water Depth for Design Condition	d_{LOCAL} =	8.0	10.5	inches
Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	9.00	9.00	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	0.343	0.219	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	3.09	3.09	fps
Interception Rate of Frontal Flow	R_f =	0.82	0.68	
Interception Rate of Side Flow	R_x =	0.59	0.47	
Interception Capacity	Q_i =	10.1	23.8	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoef =	1.75	1.75	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	0.29	0.29	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	6.38	6.38	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	2.81	2.81	fps
Interception Rate of Frontal Flow	R_f =	0.80	0.66	
Interception Rate of Side Flow	R_x =	0.40	0.29	
Actual Interception Capacity	Q_a =	8.0	16.9	cfs
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	Q_b =	7.0	28.8	cfs
Curb or Slotted Inlet Opening Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.079	0.061	ft/ft
Required Length L_T to Have 100% Interception	L_T =	17.37	40.57	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	9.00	9.00	ft
Interception Capacity	Q_i =	1.8	4.3	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoef =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.06	0.06	
Effective (Unclogged) Length	L_e =	8.70	8.70	ft
Actual Interception Capacity	Q_a =	1.4	3.0	cfs
Carry-Over Flow = $Q_{b(GRATE)}$-Q_a	Q_b =	5.5	25.8	cfs
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	Q =	9.5	20.0	cfs
Total Inlet Carry-Over Flow (flow bypassing inlet)	Q_b =	5.5	26.0	cfs
Capture Percentage = Q_a/Q_o =	C% =	63	43	%

JOB NAME:	***Austin Bluffs Parkway-Segment 3 Platinum/Oro Blanco to Ruby***
JOB NUMBER:	***09-100-305-00***
DATE:	***5/26/2012***
CALCULATED BY:	***DLM***

DESIGN POINT 13

Total Flow: Q(5) = 1 cfs

Q(100) = 2 cfs

Maximum allowable ponding depth at sump:

D(5) = 1.00 (d)

D(100) = 1.00 (dmax)

Qi = [(3.0)(P)(d^1.5)]/F (Weir Conditions)

Clogging Factor (F) = 2

5-Year Event: 0.7 foot perimeter required

100-Year Event: 1.4 foot perimeter required

INSTALL A PUBLIC Type C AREA INLET TO ACCEPT BOTH 5YR & 100 YR DEVELOPED FLOWS AT THIS DESIGN POINT.

JOB NAME:	*Austin Bluffs Parkway-Segment 3 Platinum/Oro Blanco to Ruby*
JOB NUMBER:	*09-100-305-00*
DATE:	*5/26/2012*
CALCULATED BY:	*DLM*

DESIGN POINT 14

Total Flow: Q(5) = 11 cfs
Q(100) = 26 cfs

Maximum allowable ponding depth at sump:

D(5) = 0.90 (d)
D(100) = 0.90 (dmax)

Qi = [(3.0)(P)(d^1.5)]/F (Weir Conditions)

Clogging Factor (F) = 2

5-Year Event: 8.7 foot perimeter required

100-Year Event: 20.0 foot perimeter required

EXISTING PUBLIC Type D AREA INLET TO ACCEPT BOTH 5YR & 100 YR DEVELOPED FLOWS AT THIS DESIGN POINT.

JOB NAME:	*Austin Bluffs Parkway-Segment 3 Platinum/Oro Blanco to Ruby*
JOB NUMBER:	*09-100-305-00*
DATE:	*5/26/2012*
CALCULATED BY:	*DLM*

DESIGN POINT 19 **100 YEAR FLOW**

Q(100)	27	I(100)	8.2		
DEPTH	0.44	Fr	2.97	Inlet size ? L(i) =	20
SPREAD	15.5	L(1)	35.9	If Li < L(2) then Qi =	15
CROSS SLOPE	2.1%	L(2)	21.8	If Li > L(2) then Qi =	16
STREET SLOPE	5.0%	L(3)	75.9	FB =	12
				CA(eqv.)=	1.45

5 YEAR FLOW

Q(5)	15	I(5)	4.6		
DEPTH	0.37	Fr	2.83	Inlet size ? L(i) =	20
SPREAD	12.3	L(1)	27.1	If Li < L(2) then Qi =	11
CROSS SLOPE	2.1%	L(2)	16.5	If Li > L(2) then Qi =	10
STREET SLOPE	5.0%	L(3)	57.3	FB =	5
				CA(eqv.)=	1.11

JOB NAME:	*Austin Bluffs Parkway-Segment 3 Platinum/Oro Blanco to Ruby*
JOB NUMBER:	*09-100-305-00*
DATE:	*5/26/2012*
CALCULATED BY:	*DLM*

DESIGN POINT **21A** **100 YEAR FLOW**

Q(100)	6	**I(100)**	9.1		
DEPTH	0.32	**Fr**	1.53	**Inlet size ? L(i) =**	8
SPREAD	9.5	**L(1)**	10.8	**If Li < L(2) then Qi =**	4
CROSS SLOPE	1.8%	**L(2)**	6.4	**If Li > L(2) then Qi =**	4
STREET SLOPE	1.7%	**L(3)**	24.0	**FB =**	2
				CA(eqv.)=	0.24

5 YEAR FLOW

Q(5)	3	**I(5)**	5.1		
DEPTH	0.26	**Fr**	1.42	**Inlet size ? L(i) =**	8
SPREAD	6.8	**L(1)**	7.1	**If Li < L(2) then Qi =**	3
CROSS SLOPE	1.8%	**L(2)**	4.2	**If Li > L(2) then Qi =**	2
STREET SLOPE	1.7%	**L(3)**	15.8	**FB =**	1
				CA(eqv.)=	0.14

JOB NAME:	*Austin Bluffs Parkway-Segment 3 Platinum/Oro Blanco to Ruby*
JOB NUMBER:	*09-100-305-00*
DATE:	*5/26/2012*
CALCULATED BY:	*DLM*

DESIGN POINT 21B — 100 YEAR FLOW

Q(100)	2	I(100)	9.1		
DEPTH	0.23	Fr	1.31	Inlet size ? L(i) =	8
SPREAD	5.0	L(1)	4.9	If Li < L(2) then Qi =	3
CROSS SLOPE	1.8%	L(2)	2.9	If Li > L(2) then Qi =	2
STREET SLOPE	1.7%	L(3)	10.8	FB =	0
				CA(eqv.)=	0.03

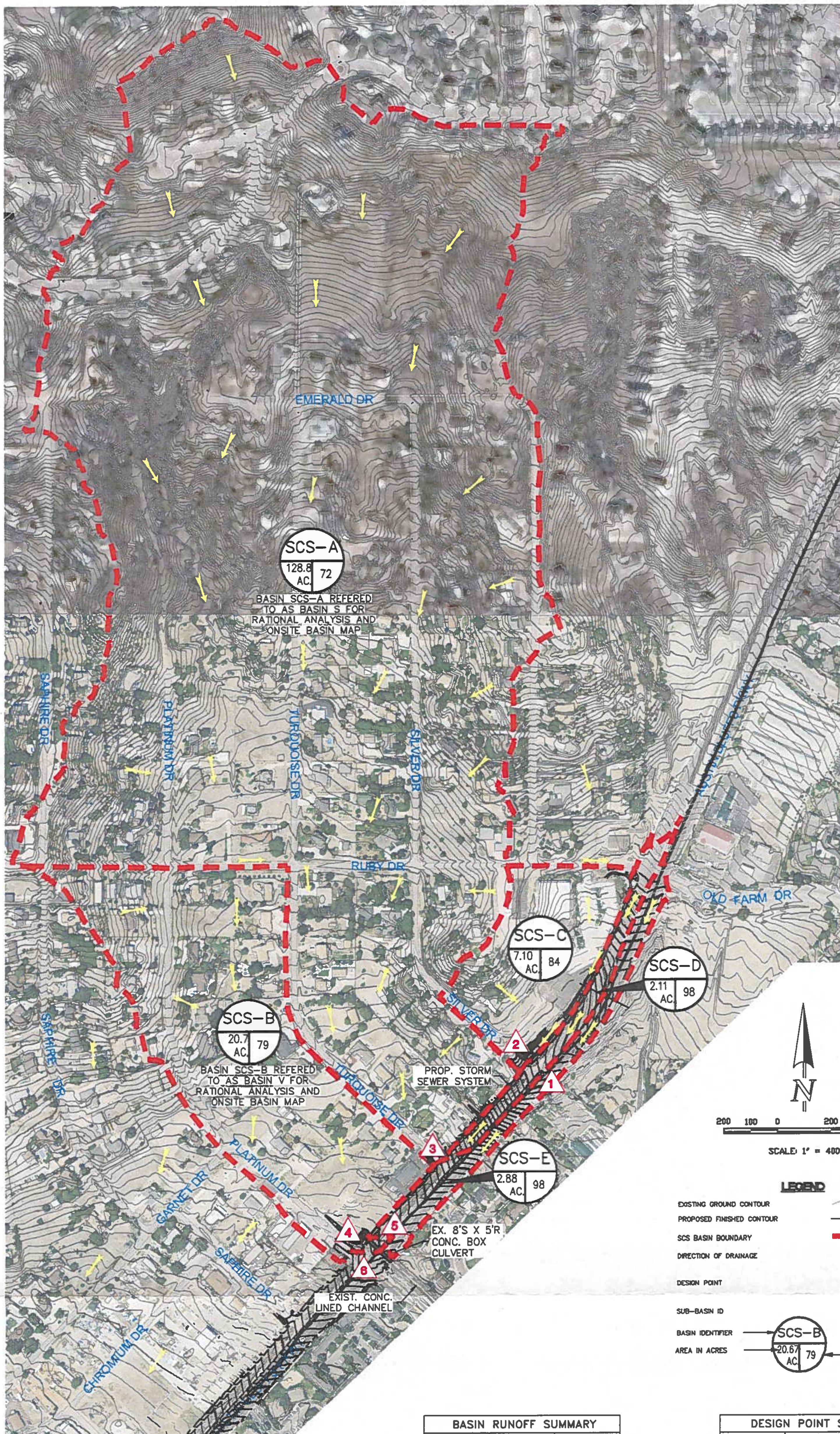
5 YEAR FLOW

Q(5)	1	I(5)	5.1		
DEPTH	0.19	Fr	1.13	Inlet size ? L(i) =	8
SPREAD	3.3	L(1)	2.8	If Li < L(2) then Qi =	2
CROSS SLOPE	1.8%	L(2)	1.6	If Li > L(2) then Qi =	1
STREET SLOPE	1.7%	L(3)	6.1	FB =	0
				CA(eqv.)=	-0.02

Appendix D

SCS Drainage Calculations

WILSON
&COMPANY



BASIN RUNOFF SUMMARY

BASIN	Q5 (CFS)	Q100 (CFS)
SCS-A	75	307
SCS-B	24	72
SCS-C	12	31
SCS-D	6	12
SCS-E	9	18

DESIGN POINT SUMMARY

DESIGN PT	Q5 (CFS)	Q100 (CFS)
1	13	24
2	12	31
3	97	151
4	24	290
5	21	40
6	137	453

SHEET NO: DM 3

SHEET TITLE: DRAINAGE MAP SEGMENT 3 SCS DRAINAGE BASINS

PROJECT NO:
DESIGNED BY: DLM
DRAWN BY: DLM
CHECKED BY: VSF
DATE:

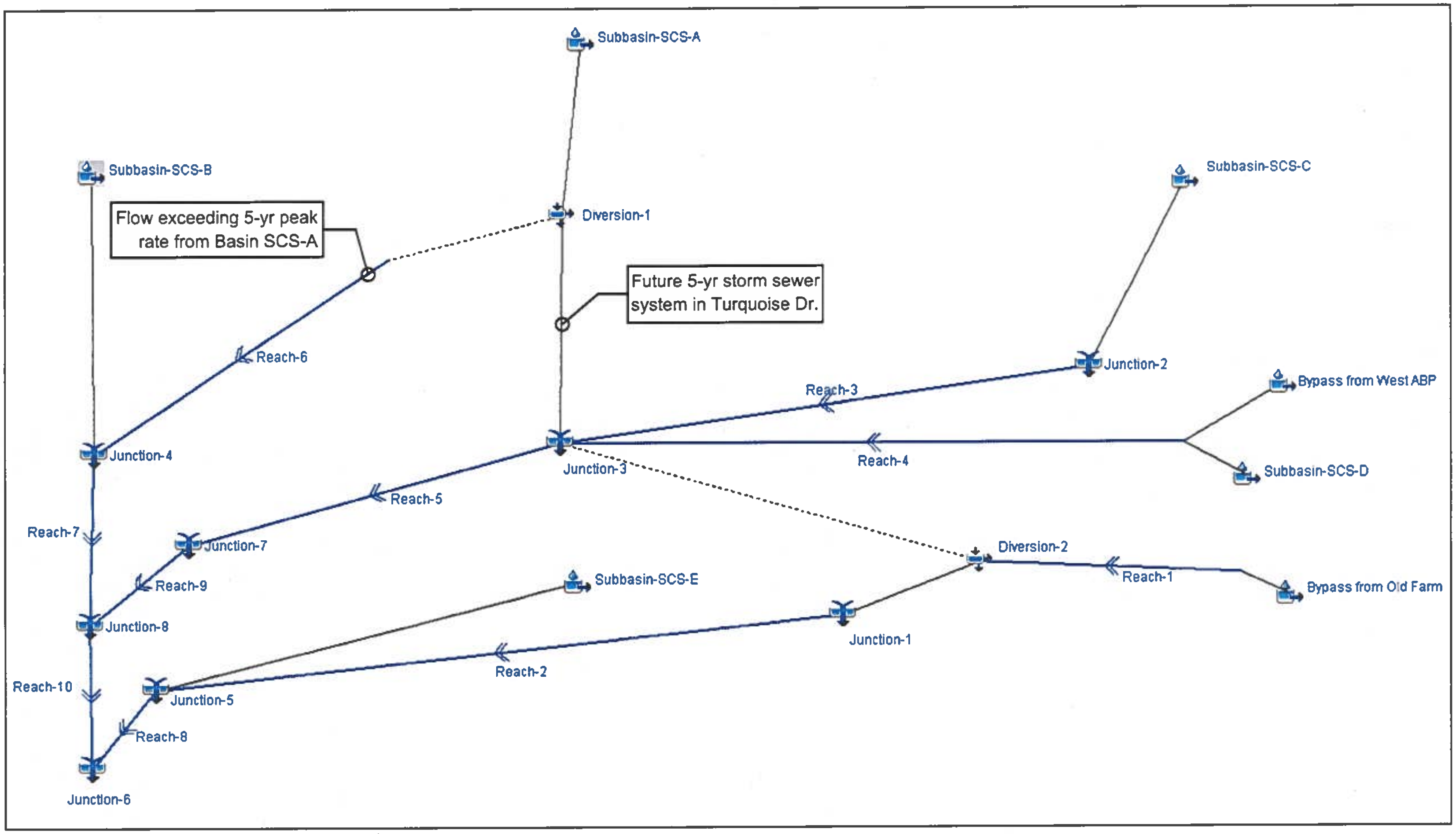
MARK	DATE	DESCRIPTION

PROJECT NAME: AUSTIN BLUFFS PARKWAY CITY OF COLORADO SPRINGS, EL PASO COUNTY, COLORADO

SEAL

CONSULTANTS

WILSON & COMPANY
5755 MARK DABLING BOULEVARD SUITE 220
COLORADO SPRINGS, CO 80919
PHONE: 719-520-5800
FAX: 719-520-0108
www.wilsonco.com



HEC-HMS ROUTING DIAGRAM
SEGMENT 3

Austin Bluffs Parkway - Platinum/Oro Blanco to Ruby/Old Farm
HEC-HMS RESULTS SUMMARY
5/26/2011

Element	Area (sq mi)	Q5 (cfs)	Q100 (cfs)	V5 (ac-ft)	V100 (ac-ft)
Basin SCS-A	0.2013	75	307	5.7	20.3
Basin SCS-B	0.0323	24	72	1.4	4.2
Basin SCS-C	0.0111	12	31	0.7	1.7
Basin SCS-D	0.0033	6	12	0.4	0.8
Basin SCS-E	0.0045	9	16	0.5	1
Bypass from Old Farm	0.0123	22	43	1.4	2.8
Bypass from West ABP	0.0017	3	6	0.2	0.4
Diversion 1	0.2013	75	94	5.7	14.8
Diversion 2	0.0123	13	24	0.8	1.6
Reach-1	0.0123	22	42	1.4	2.8
Reach-2	0.0123	13	24	0.8	1.6
Reach-3	0.0111	12	31	0.7	1.7
Reach-4	0.0050	10	18	0.6	1.2
Reach-5	0.2174	97	151	7.5	18.8
Reach-6	Diversion	0	227	0	5.5
Reach-7	0.0323	24	290	1.4	9.7
Reach-8	0.0168	21	40	1.4	2.7
Reach-9	0.2174	97	151	7.5	18.8
Reach-10	0.2497	121	421	8.9	28.6
Junction-1	0.0123	13	24	0.8	1.6
Junction-2	0.0111	12	31	0.7	1.7
Junction-3	0.2174	97	151	7.5	18.8
Junction-4	0.0323	24	290	1.4	9.7
Junction-5	0.0168	21	40	1.4	2.7
Junction-6	0.2665	137	453	10.3	31.2
Junction-7	0.2174	97	151	7.5	18.8
Junction-8	0.2497	121	422	8.9	28.6

Austin Bluffs Parkway - Segment 3 - Platinum/Oro Blanco to Ruby/Old Farm

Preliminary Drainage Report

SCS Basin Runoff Curve Number Summary

4/29/2011

			SOIL TYPE: B																		SOIL TYPE: C						
			1			2			3			4			5			6			1			2			WEIGHTED
BASIN	TOTAL AREA (AC)	TOTAL AREA (SQ MI)	AREA (AC)	DESC.	CN(100)	AREA (AC)	DESC.	CN(100)	AREA (AC)	DESC.	CN(100)	AREA (AC)	DESC.	CN(100)	AREA (AC)	DESC.	CN(100)	AREA (AC)	DESC.	CN(100)	AREA (AC)	DESC.	CN(100)	AREA (AC)	DESC.	CN(100)	CN(100)
SCS-A	128.83	0.2013	54.6	1/2 AC	73	20.7	1/2 AC	70	13.3	OPEN/PAST	68	18.3	OPEN/PAST	68	11.5	RES/PAST	69	2.0	1/8 AC	85	8.4	1/2 AC	82	0.0		0	72
SCS-B	20.67	0.0323	9.3	1/2 AC	73	0.0		0	0.0		0	0.0		0	0.0		0	0.0		0	9.7	1/2 AC	82	1.7	COMM.	95	79
SCS-C	7.10	0.0111	5.3	CHURCH	85	0.6	IMP	98	1.2	OPEN/PAST	73	0.0		0	0.0		0	0.0		0	0.0		0	0.0		0	84
SCS-D	2.11	0.0033	2.1	IMP	98	0.0		0	0.0		0	0.0		0	0.0		0	0.0		0	0.0		0	0.0		0	98
SCS-E	2.88	0.0045	2.9	IMP	98	0.0		0	0.0		0	0.0		0	0.0		0	0.0		0	0.0		0	0.0		0	98
Total Area	161.60																										

Austin Bluffs Parkway - Segment 3 - Platinum/Oro Blanco to Ruby/Old Farm

Preliminary Drainage Report

SCS Basin Lag Time Summary

4/29/2011

Basin ID	INITIAL OVERLAND						SHALLOW CONCENTRATED FLOW							CHANNELIZED FLOW							Tc	Tc	Lag
	Initial C(5)	Length (ft)	Max El. (ft)	Min El. (ft)	Slope (%)	Tc (min)	Manning's n	Length (ft)	Max El. (ft)	Min El. (ft)	Slope (%)	Vel (fps)	Tt (min)	Manning's n	Length (ft)	Max El. (ft)	Min El. (ft)	Slope (%)	Vel (fps)	Tt (min)	TOTAL (min)	TOTAL (hrs)	(min)
SCS-A	0.25	150	6804	6792	8.0%	9.8	0.030	1330	6782	6672	0.083	9.0	2.5	0.030	2750	6672	6562	0.040	6.3	7.3	19.5	0.3	11.7
SCS-B	0.25	160	6639	6621	11.6%	9.0	0.035 0.030	270 1000	6621 6594	6594 6558	0.098 0.036	8.4 5.9	0.5 2.8	0.030	500	6558	6549	0.018	4.2	2.0	14.3	0.2	8.6
SCS-C	0.25	60	6619	6616	5.0%	7.2	0.035 0.016 0.030	310 150 210	6616 6599 6595	6599 6595 6590	0.055 0.027 0.026	6.3 9.6 5.1	0.8 0.3 0.7	0.030	210	6589.5	6586	0.017	4.2	0.8	9.8	0.2	5.9
SCS-D	0.90	90	6610	6606	4.4%	2.2	0.016 0.016	650 1080	6606 6591	6591 6553	0.023 0.04	8.9 11.0	1.2 1.6								5.0	0.1	3.0
SCS-E	0.90	140	6612	6607	3.6%	2.9	0.016 0.016	820 810	6607 6586	6586 6554	0.03 0.04	9.4 11.7	1.5 1.2								5.5	0.1	3.3

Appendix E

Water Quality

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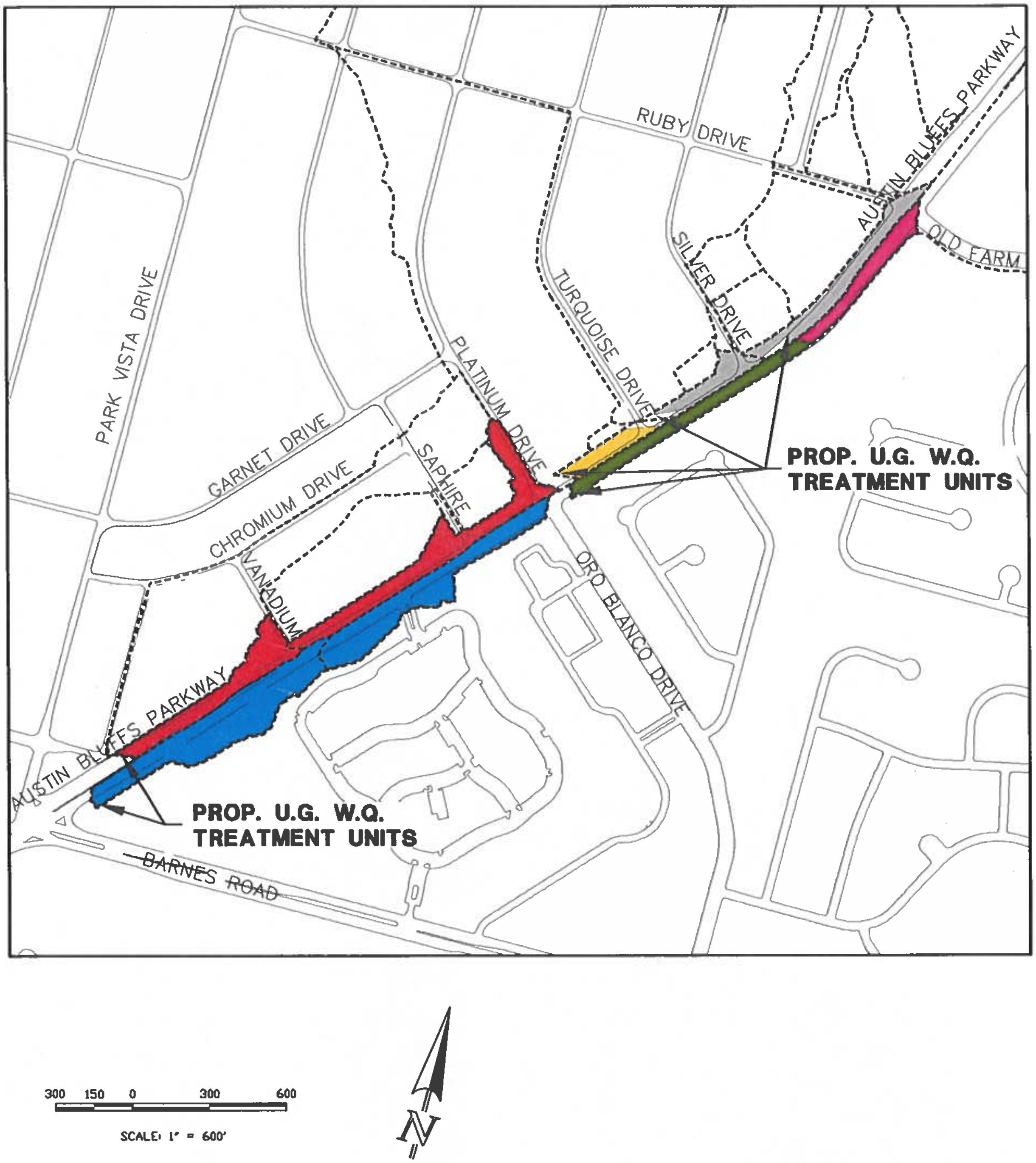

AUSTIN BLUFFS PARKWAY
SEGMENT 3

LEGEND

DRAINAGE BASIN BOUNDARY	- - -
WATER QUALITY UNIT 1 AT DESIGN POINT 2 TREATMENT AREA	(blue)
WATER QUALITY UNIT 2 AT DESIGN POINT 7 TREATMENT AREA	(red)
WATER QUALITY UNIT 3 AT DESIGN POINT 10 TREATMENT AREA	(green)
WATER QUALITY UNIT 4 AT DESIGN POINT 21 TREATMENT AREA	(yellow)
WATER QUALITY UNIT 5 AT DESIGN POINT 19 TREATMENT AREA	(gray)
WATER QUALITY UNIT 6 AT DESIGN POINT 11 TREATMENT AREA	(pink)

WATER QUALITY TREATMENT AREA EXHIBIT

WILSON & COMPANY

JOB NAME:	*Austin Bluffs Parkway-Segment 3 Barnes to Platinum/Oro Blanco*
JOB NUMBER:	*09-100-305-00*
DATE:	*5/1/2012*
CALCULATED BY:	*DLM*
CHECKED BY:	*JCH*

FINAL DRAINAGE REPORT ~ WATER QUALTIY FLOW SUMMARY

						Intensity	Flow
Design Point(s)	Contributing Basins	Area (ac)	% Impervious C(5)	(1) Equivalent CA(5)	(1) Maximum Tc	(2) I(WQ)	(3) Q(WQ)
2	Basin A + Basin B	5.32	0.76	4.07	6.7	1.56	6
7	Basin E + Basin G	4.27	0.90	3.84	6.3	1.60	6

Notes:
1. Refer to Rational calculations in Appendix C for composite C and Tc calculations.
2. I (WQ) = (26.65*0.5)/((Tc+10)^0.76). A rainfall depth of 0.5" was used to determine water quality rainfall intensity.
3. Q(WQ) was calculated using the Rational method with Q(WQ) = C*I(WQ)*A and refers to water quality peak flow rate.

JOB NAME:	*Austin Bluffs Parkway-Segment 3 Platinum/Oro Blanco to Ruby*
JOB NUMBER:	*09-100-305-00*
DATE:	*5/26/2012*
CALCULATED BY:	*DLM*
CHECKED BY:	*JCH*

PRELIMINARY DRAINAGE REPORT ~ WATER QUALITY FLOW SUMMARY

Design Point(s)	Contributing Basins	Area (ac)	% Impervious C(5)	(1) Equivalent CA(5)	(1) Maximum Tc	Intensity (2) I(WQ)	Flow (3) Q(WQ)
10	Basin I	1.30	0.90	1.17	14.4	1.18	1
11	Basin J	0.95	0.90	0.86	5.0	1.70	1
19	Basin P + Basin R	2.18	0.87	1.90	5.6	1.65	3
21	Basin T	0.64	0.90	0.58	5.0	1.70	1

Notes:
1. Refer to Rational calculations in Appendix C for composite C and Tc calculations.
2. I (WQ) = (26.65*0.5)/((Tc+10)^0.76). A rainfall depth of 0.5" was used to determine water quality rainfall intensity.
3. Q(WQ) was calculated using the Rational method with Q(WQ) = C*I(WQ)*A and refers to water quality peak flow rate.

Appendix F

Platinum Box Culvert Hydraulic Calculations

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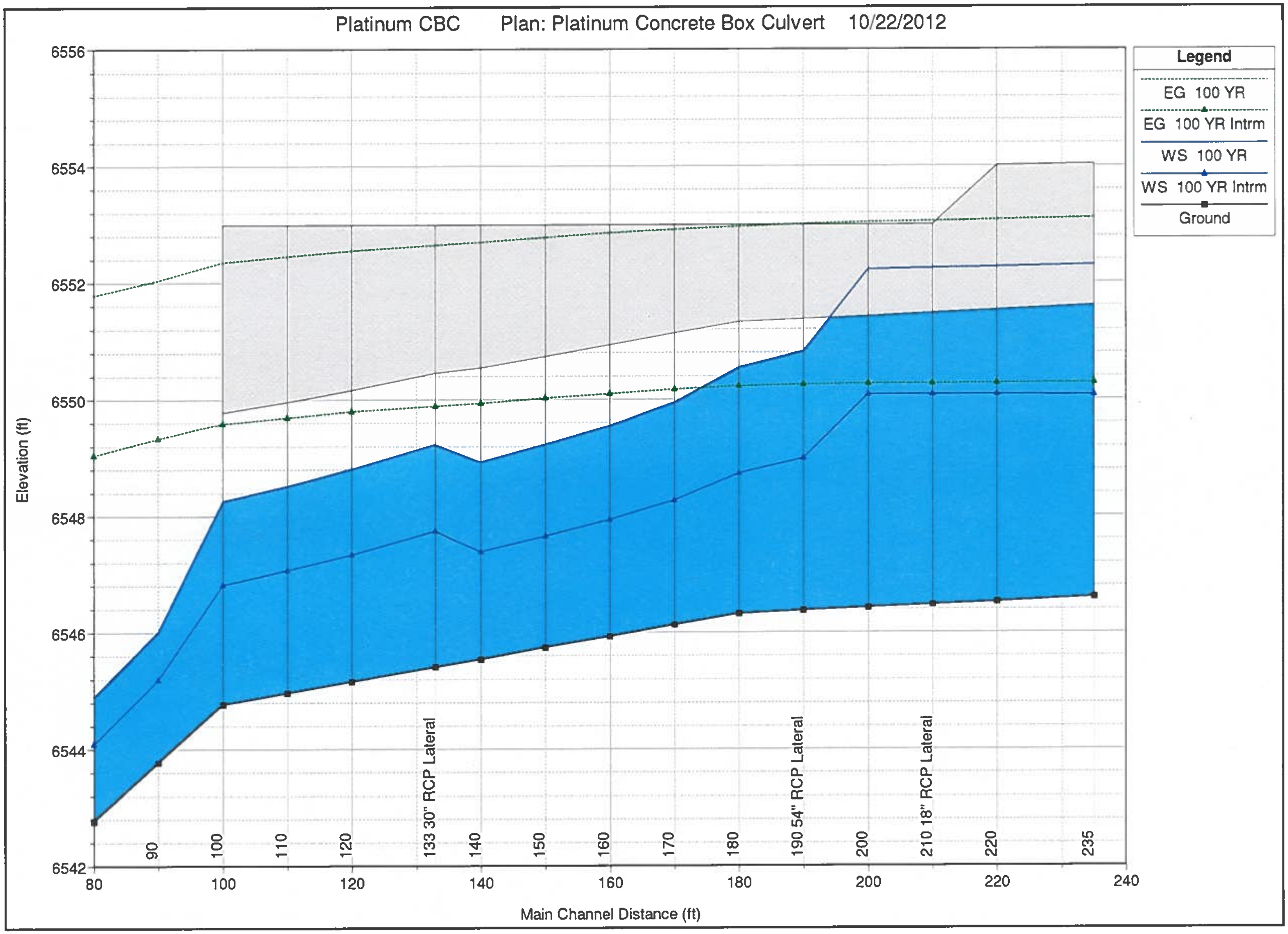


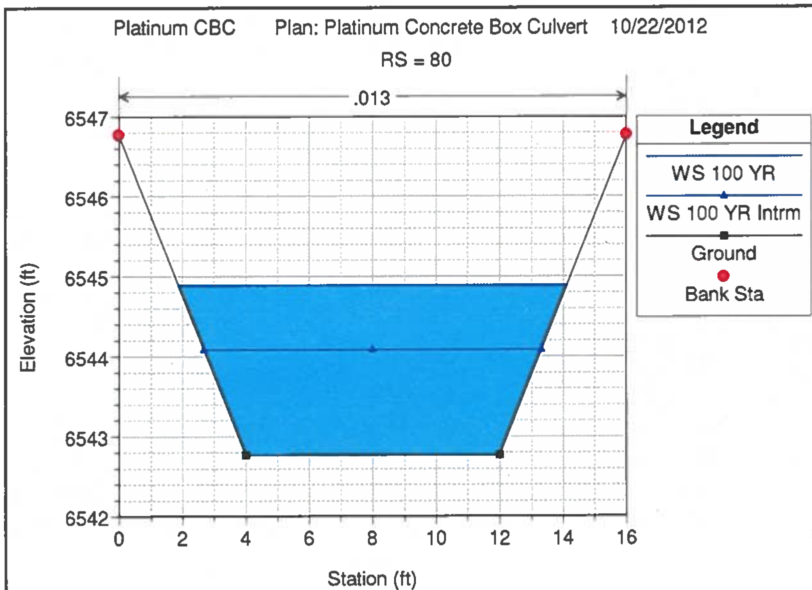
Platinum CBC Plan: Platinum Concrete Box Culvert 10/22/2012
Legend
EG 100 YR
EG 100 YR Intrm
WS 100 YR
WS 100 YR Intrm
Ground
Elevation (ft)
6556
6554
6552
6550
6548
6546
6544
6542
90
100
110
120
133 30" RCP Lateral
140
150
160
170
180
190 54" RCP Lateral
200
210 18" RCP Lateral
220
235
80
100
120
140
160
180
200
220
240
Main Channel Distance (ft)

HEC-RAS Plan: Platinum CBC River: Platinum CBC Reach: Platinum CBC

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Platinum CBC	235	100 YR	290.00	6546.60	6552.30	6550.06	6553.11	0.002265	7.25	40.00		0.54
Platinum CBC	235	100 YR Intrm	101.00	6546.60	6550.08	6548.31	6550.28	0.000442	3.63	27.79	8.00	0.34
Platinum CBC	220	100 YR	290.00	6546.52	6552.26	6549.98	6553.08	0.002265	7.25	40.00		0.53
Platinum CBC	220	100 YR Intrm	101.00	6546.52	6550.08	6548.22	6550.27	0.000415	3.55	28.45	8.00	0.33
Platinum CBC	210	100 YR	290.00	6546.47	6552.24	6549.93	6553.06	0.002265	7.25	40.00		0.53
Platinum CBC	210	100 YR Intrm	101.00	6546.47	6550.08	6548.18	6550.27	0.000399	3.50	28.86	8.00	0.32
Platinum CBC	200	100 YR	290.00	6546.42	6552.22	6549.85	6553.03	0.002265	7.25	40.00		0.53
Platinum CBC	200	100 YR Intrm	101.00	6546.42	6550.08	6548.13	6550.27	0.000384	3.45	29.28	8.00	0.32
Platinum CBC	190	100 YR	422.00	6546.37	6550.82	6550.82	6553.00	0.003983	11.86	35.59	8.01	0.99
Platinum CBC	190	100 YR Intrm	189.00	6546.37	6548.99	6548.99	6550.25	0.003390	9.04	20.92	8.00	0.98
Platinum CBC	180	100 YR	422.00	6546.32	6550.54	6550.77	6552.97	0.004574	12.49	33.77	8.01	1.07
Platinum CBC	180	100 YR Intrm	189.00	6546.32	6548.73	6548.94	6550.23	0.004290	9.82	19.24	8.00	1.12
Platinum CBC	170	100 YR	422.00	6546.13	6549.94	6550.58	6552.92	0.006001	13.83	30.50	8.01	1.25
Platinum CBC	170	100 YR Intrm	189.00	6546.13	6548.26	6548.74	6550.17	0.006048	11.08	17.06	8.00	1.34
Platinum CBC	160	100 YR	422.00	6545.93	6549.54	6550.38	6552.86	0.006942	14.60	28.90	8.00	1.35
Platinum CBC	160	100 YR Intrm	189.00	6545.93	6547.93	6548.54	6550.10	0.007247	11.80	16.02	8.00	1.47
Platinum CBC	150	100 YR	422.00	6545.74	6549.23	6550.19	6552.78	0.007610	15.11	27.93	8.00	1.43
Platinum CBC	150	100 YR Intrm	189.00	6545.74	6547.66	6548.36	6550.02	0.008264	12.35	15.31	8.00	1.57
Platinum CBC	140	100 YR	422.00	6545.54	6548.93	6549.99	6552.69	0.008262	15.57	27.10	8.00	1.49
Platinum CBC	140	100 YR Intrm	189.00	6545.54	6547.38	6548.10	6549.94	0.009228	12.82	14.74	8.00	1.66
Platinum CBC	133	100 YR	453.00	6545.41	6549.23	6550.08	6552.65	0.006901	14.84	30.53	8.01	1.34
Platinum CBC	133	100 YR Intrm	219.00	6545.41	6547.74	6548.29	6549.89	0.006337	11.77	18.60	8.00	1.36
Platinum CBC	120	100 YR	453.00	6545.16	6548.81	6549.83	6552.55	0.007798	15.53	29.17	8.00	1.43
Platinum CBC	120	100 YR Intrm	219.00	6545.16	6547.34	6548.02	6549.79	0.007649	12.57	17.42	8.00	1.50
Platinum CBC	110	100 YR	453.00	6544.96	6548.52	6549.63	6552.45	0.008327	15.91	28.47	8.00	1.49
Platinum CBC	110	100 YR Intrm	219.00	6544.96	6547.07	6547.82	6549.70	0.008443	13.01	16.83	8.00	1.58
Platinum CBC	100	100 YR	453.00	6544.77	6548.26	6549.44	6552.35	0.008776	16.22	27.92	8.00	1.53

HEC-RAS Plan: Platinum CBC River: Platinum CBC Reach: Platinum CBC (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Platinum CBC	100	100 YR Intrm	219.00	6544.77	6546.82	6547.63	6549.59	0.009096	13.36	16.40	8.00	1.64
Platinum CBC	90	100 YR	453.00	6543.77	6546.02	6547.67	6552.04	0.015826	19.69	23.00	12.49	2.56
Platinum CBC	90	100 YR Intrm	219.00	6543.77	6545.19	6546.31	6549.33	0.017622	16.32	13.42	10.85	2.59
Platinum CBC	80	100 YR	453.00	6542.77	6544.90	6546.67	6551.78	0.019151	21.05	21.52	12.25	2.80
Platinum CBC	80	100 YR Intrm	219.00	6542.77	6544.09	6545.31	6549.05	0.023040	17.87	12.25	10.63	2.93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6544
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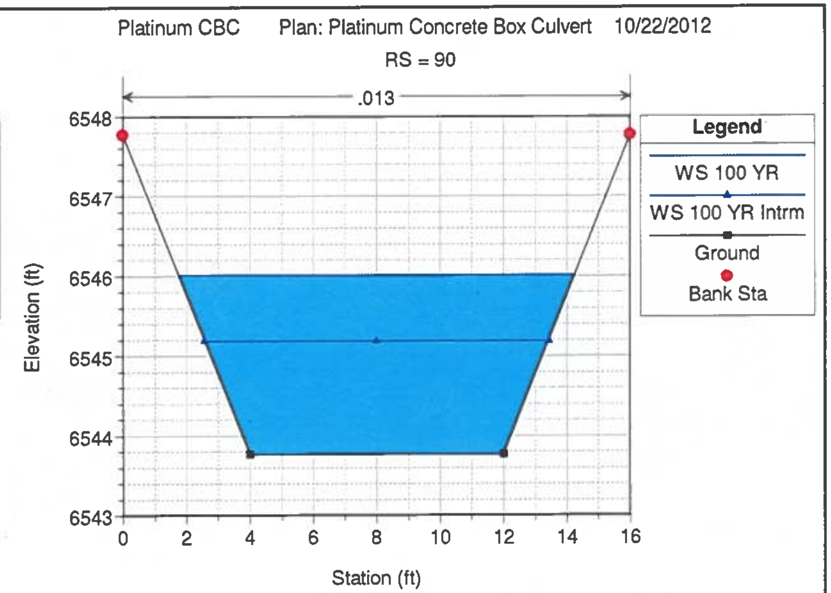
Legend
WS 100 YR
WS 100 YR Intrm
Ground
Bank Sta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Elevation (ft)
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Station (ft)
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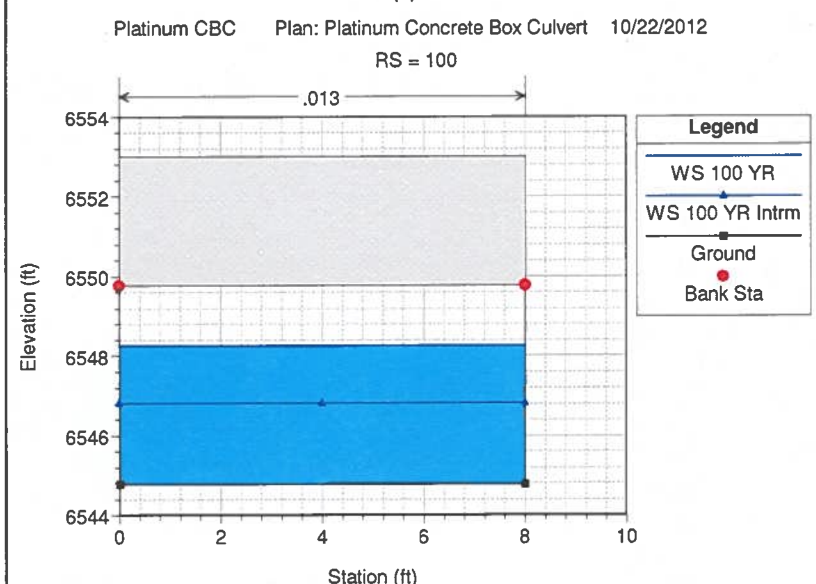
Legend
WS 100 YR
WS 100 YR Intrm
Ground
Bank Sta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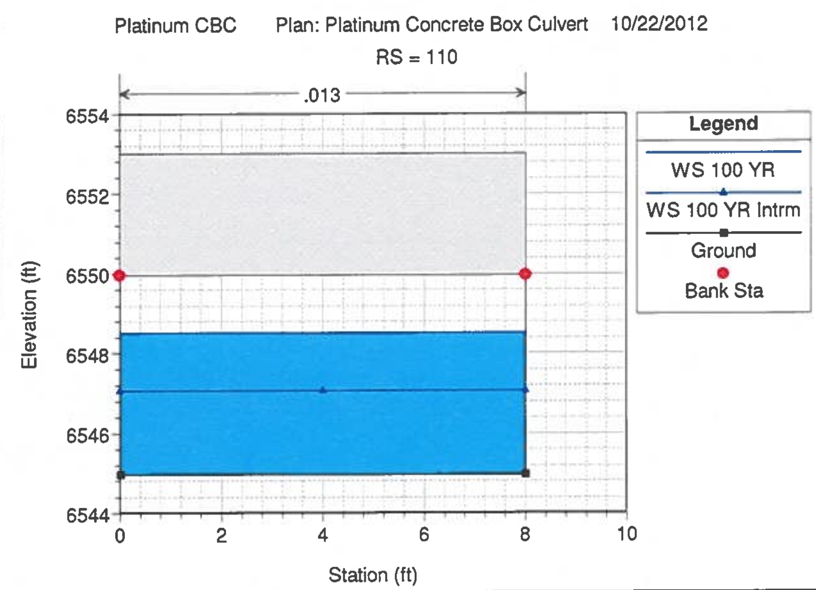
WS 100 YR Intrm
Ground
Bank Sta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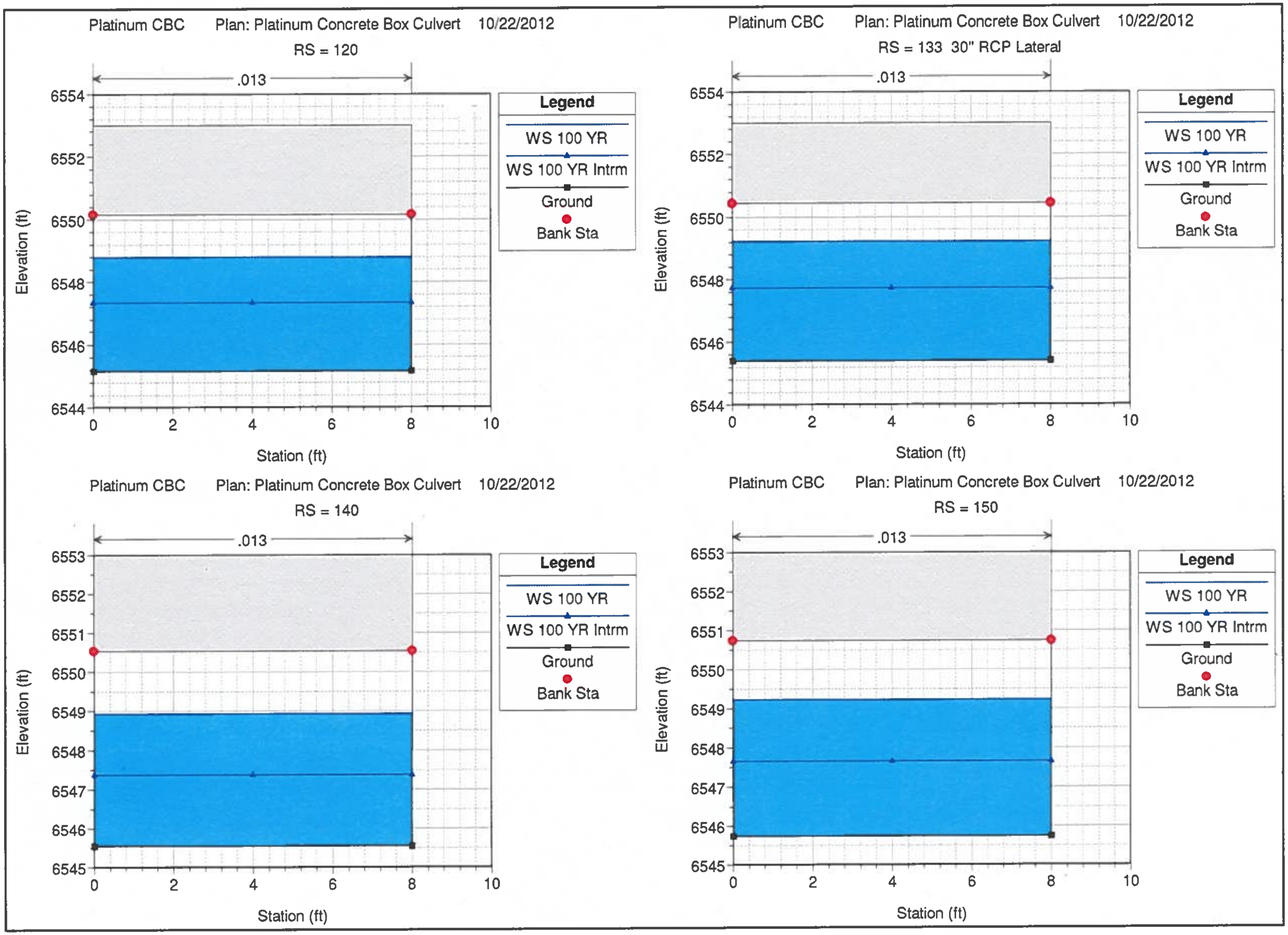
WS 100 YR Intrm
Ground
Bank Sta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WS 100 YR Intrm
Ground
Bank Sta
Elevation (ft)
Station (ft)
Platinum CBC Plan: Platinum Concrete Box Culvert 10/22/2012
RS = 133 30" RCP Lateral
.013
Legend
WS 100 YR
WS 100 YR Intrm
Ground
Bank Sta
Elevation (ft)
Station (ft)
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Ground
Bank Sta
Elevation (ft)
Station (ft)
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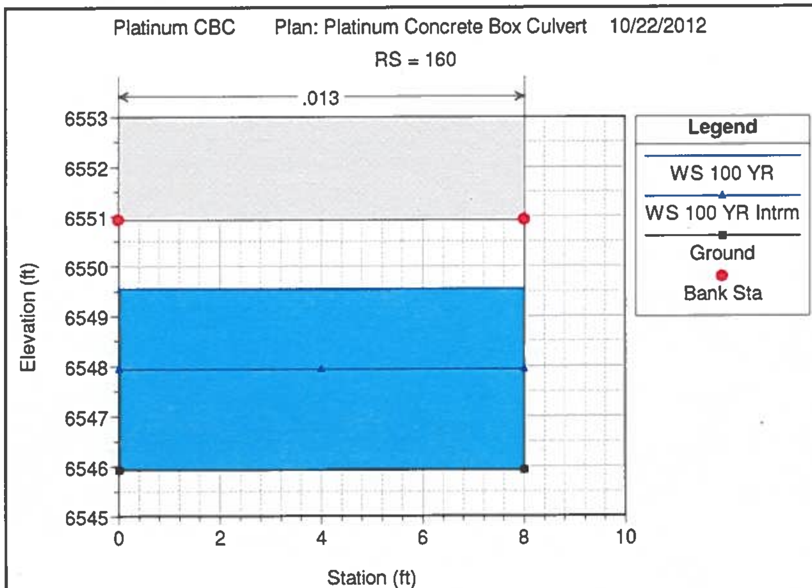
Bank Sta
Elevation (ft)
Station (ft)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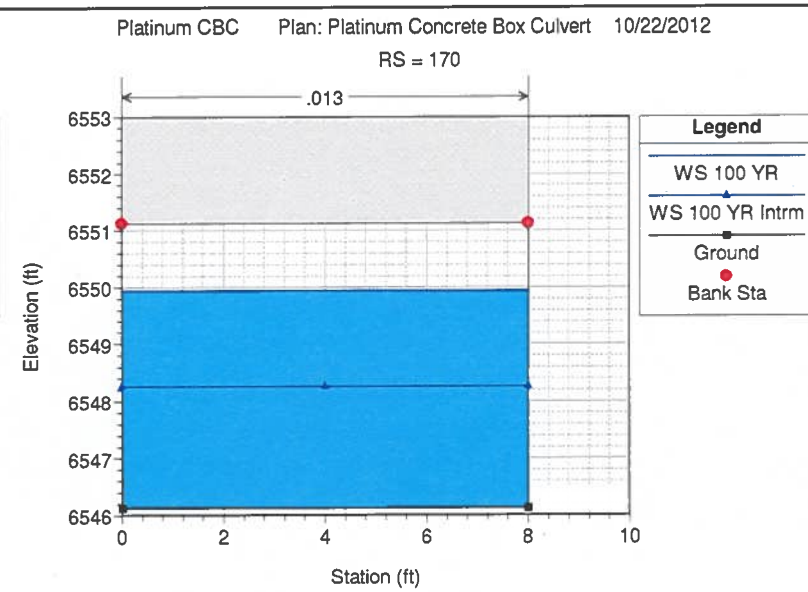
Legend
WS 100 YR
WS 100 YR Intrm
Ground
Bank Sta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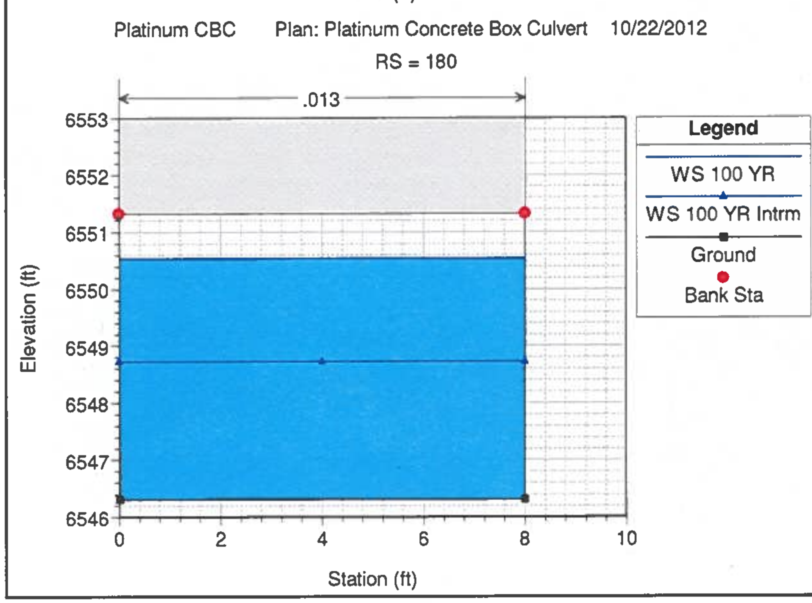
Legend
WS 100 YR
WS 100 YR Intrm
Ground
Bank Sta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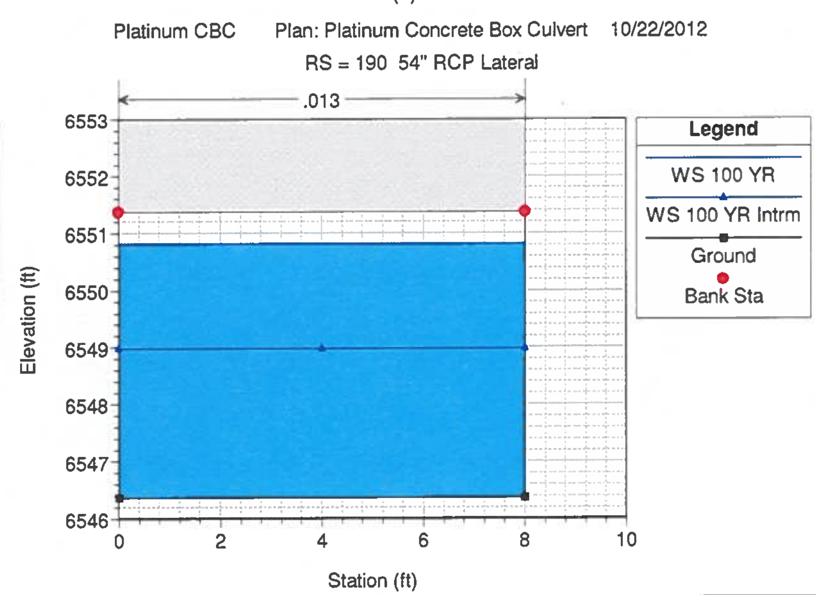
10
Legend
WS 100 YR
WS 100 YR Intrm
Ground
Bank Sta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Elevation (ft)
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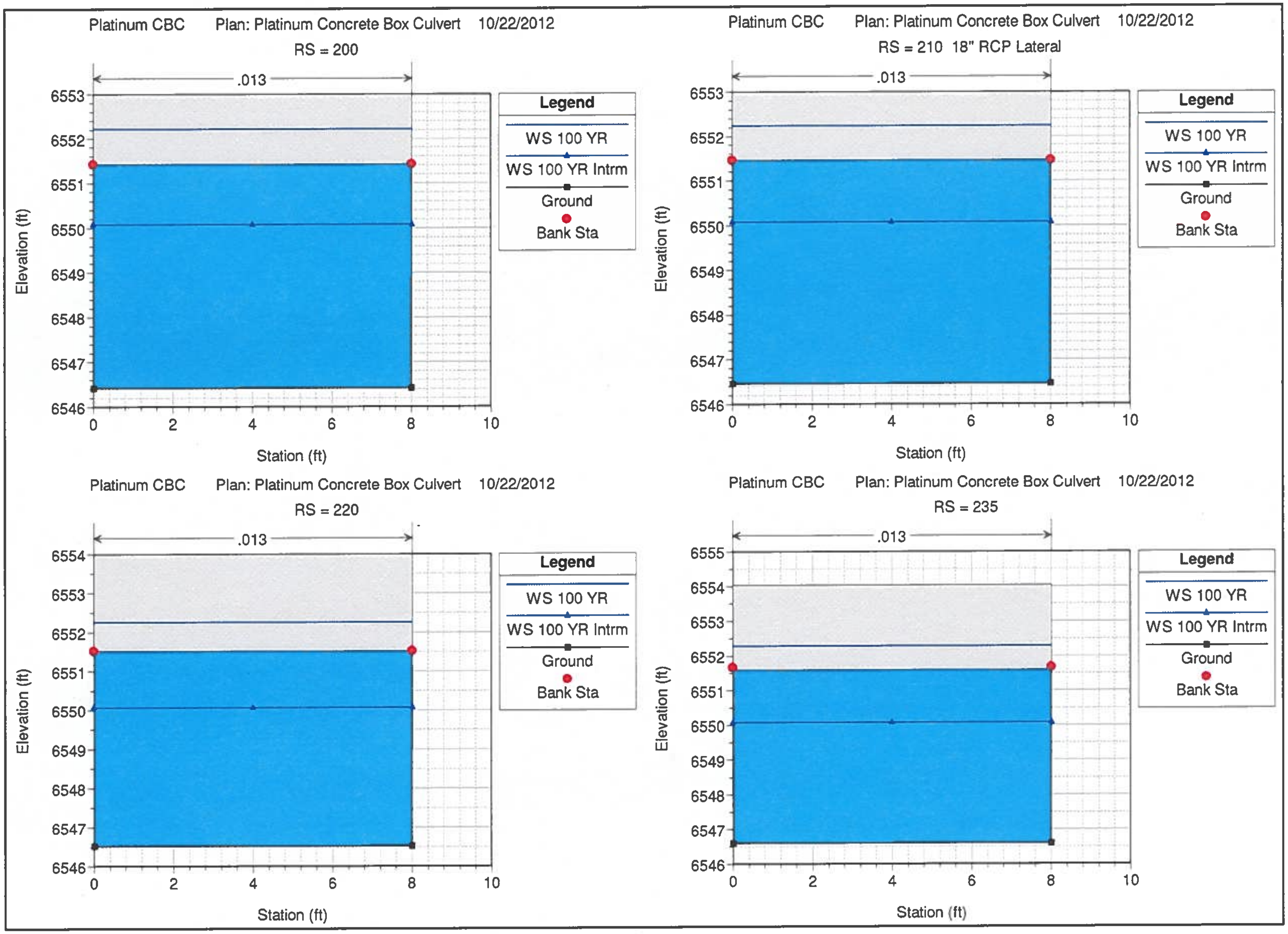
6551
6550
6549
6548
6547
6546
Station (ft)
0
2
4
6
8
10
Legend
WS 100 YR
WS 100 YR Intrm
Ground
Bank Sta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.013
Legend
WS 100 YR
WS 100 YR Intrm
Ground
Bank Sta
Elevation (ft)
6553
6552
6551
6550
6549
6548
6547
6546
0 2 4 6 8 10
Station (ft)
Platinum CBC Plan: Platinum Concrete Box Culvert 10/22/2012
RS = 210 18" RCP Lateral
.013
Legend
WS 100 YR
WS 100 YR Intrm
Ground
Bank Sta
Elevation (ft)
6553
6552
6551
6550
6549
6548
6547
6546
0 2 4 6 8 10
Station (ft)
Platinum CBC Plan: Platinum Concrete Box Culvert 10/22/2012
RS = 220
.013
Legend
WS 100 YR
WS 100 YR Intrm
Ground
Bank Sta
Elevation (ft)
6554
6553
6552
6551
6550
6549
6548
6547
6546
0 2 4 6 8 10
Station (ft)
Platinum CBC Plan: Platinum Concrete Box Culvert 10/22/2012
RS = 235
.013
Legend
WS 100 YR
WS 100 YR Intrm
Ground
Bank Sta
Elevation (ft)
6555
6554
6553
6552
6551
6550
6549
6548
6547
6546
0 2 4 6 8 10
Station (ft)

HEC-RAS Version 4.1.0 Jan 2010
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```
X     X  XXXXXX   XXXX        XXXX       XX      XXXX
X     X  X       X    X       X   X     X  X    X
X     X  X       X            X   X    X    X   X
XXXXXXX  XXXX    X      XXX   XXXX     XXXXXX    XXXX
X     X  X       X            X  X     X    X        X
X     X  X       X    X       X   X    X    X        X
X     X  XXXXXX   XXXX        X    X   X    X   XXXXX
```

PROJECT DATA
Project Title: Platinum CBC
Project File : PlatinumCBC.prj
Run Date and Time: 10/22/2012 4:56:53 PM

Project in English units

PLAN DATA

Plan Title: Platinum Concrete Box Culvert
Plan File : m:\TRN\09-100-305-00\CADD\DESIGN\Hydraulics\AE_ DATA\Final\HEC-RAS\PlatinumCBC.p05

Geometry Title: 5x8 CBC Extension at 0.5%
Geometry File : m:\TRN\09-100-305-00\CADD\DESIGN\Hydraulics\AE_ DATA\Final\HEC-RAS\PlatinumCBC.g01

Flow Title : 100-YR
Flow File : m:\TRN\09-100-305-00\CADD\DESIGN\Hydraulics\AE_ DATA\Final\HEC-RAS\PlatinumCBC.f01

Plan Summary Information:

Number of:				
Cross Sections =	16		Multiple Openings =	0
Culverts =	0		Inline Structures =	0
Bridges =	0		Lateral Structures =	0

Computational Information
Water surface calculation tolerance = 0.01
Critical depth calculation tolerance = 0.01
Maximum number of iterations = 20
Maximum difference tolerance = 0.3
Flow tolerance factor = 0.001

Computation Options
Critical depth computed only where necessary
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Mixed Flow

FLOW DATA

Flow Title: 100-YR
Flow File : m:\TRN\09-100-305-00\CADD\DESIGN\Hydraulics\AE_ DATA\Final\HEC-RAS\PlatinumCBC.f01

Flow Data (cfs)

River	Reach	RS	100 YR	100 YR Intrm
Platinum CBC	Platinum CBC	235	290	101
Platinum CBC	Platinum CBC	190	422	189
Platinum CBC	Platinum CBC	133	453	219

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Platinum CBC	Platinum CBC	100 YR	Normal S = 0.005	Normal S = 0.02

GEOMETRY DATA

Geometry Title: 5x8 CBC Extension at 0.5%
Geometry File : m:\TRN\09-100-305-00\CADD\DESIGN\Hydraulics\AE_ DATA\Final\HEC-RAS\PlatinumCBC.g01

CROSS SECTION

RIVER: Platinum CBC
REACH: Platinum CBC RS: 235

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	6551.67	.01	6546.6	8	6546.6	8.01	6551.67

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	8.01	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	8.01	15	15	15	0	0

Cross Section Lid

num= 2

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	6554.03	6551.6	8.01	6554.03	6551.6

CROSS SECTION OUTPUT Profile #100 YR

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	6553.11	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.82	Wt. n-Val.		0.013	
W.S. Elev (ft)	6552.30	Reach Len. (ft)	15.00	15.00	15.00
Crit W.S. (ft)	6550.06	Flow Area (sq ft)		40.00	
E.G. Slope (ft/ft)	0.002265	Area (sq ft)		40.00	
Q Total (cfs)	290.00	Flow (cfs)		290.00	
Top Width (ft)		Top Width (ft)			
Vel Total (ft/s)	7.25	Avg. Vel. (ft/s)		7.25	
Max Chl Dpth (ft)	5.70	Hydr. Depth (ft)			
Conv. Total (cfs)	6092.9	Conv. (cfs)		6092.9	
Length Wtd. (ft)	15.00	Wetted Per. (ft)		26.00	
Min Ch El (ft)	6546.60	Shear (lb/sq ft)		0.22	
Alpha	1.00	Stream Power (lb/ft s)	8.01	0.00	0.00
Frctn Loss (ft)	0.03	Cum Volume (acre-ft)		0.11	
C & E Loss (ft)	0.00	Cum SA (acres)		0.02	

CROSS SECTION OUTPUT Profile #100 YR Intrm

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	6550.28	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.21	Wt. n-Val.		0.013	
W.S. Elev (ft)	6550.08	Reach Len. (ft)	15.00	15.00	15.00
Crit W.S. (ft)	6548.31	Flow Area (sq ft)		27.79	
E.G. Slope (ft/ft)	0.000442	Area (sq ft)		27.79	
Q Total (cfs)	101.00	Flow (cfs)		101.00	
Top Width (ft)	8.00	Top Width (ft)		8.00	
Vel Total (ft/s)	3.63	Avg. Vel. (ft/s)		3.63	
Max Chl Dpth (ft)	3.47	Hydr. Depth (ft)		3.47	
Conv. Total (cfs)	4803.3	Conv. (cfs)		4803.3	
Length Wtd. (ft)	15.00	Wetted Per. (ft)		14.94	
Min Ch El (ft)	6546.60	Shear (lb/sq ft)		0.05	
Alpha	1.00	Stream Power (lb/ft s)	8.01	0.00	0.00
Frctn Loss (ft)	0.01	Cum Volume (acre-ft)		0.07	
C & E Loss (ft)	0.00	Cum SA (acres)		0.03	

CROSS SECTION

RIVER: Platinum CBC
REACH: Platinum CBC RS: 220

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	6551.52	.01	6546.52	8	6546.52	8.01	6551.52

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	8.01	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	8.01	10	10	10	0	0

Cross Section Lid
num= 2

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	6554	6551.52	8.01	6554	6551.52

CROSS SECTION OUTPUT Profile #100 YR

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	6553.08	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.82	Wt. n-Val.		0.013	
W.S. Elev (ft)	6552.26	Reach Len. (ft)	10.00	10.00	10.00
Crit W.S. (ft)	6549.98	Flow Area (sq ft)		40.00	
E.G. Slope (ft/ft)	0.002265	Area (sq ft)		40.00	
Q Total (cfs)	290.00	Flow (cfs)		290.00	
Top Width (ft)		Top Width (ft)			
Vel Total (ft/s)	7.25	Avg. Vel. (ft/s)		7.25	
Max Chl Dpth (ft)	5.74	Hydr. Depth (ft)			
Conv. Total (cfs)	6093.1	Conv. (cfs)		6093.1	
Length Wtd. (ft)	10.00	Wetted Per. (ft)		26.00	
Min Ch El (ft)	6546.52	Shear (lb/sq ft)		0.22	
Alpha	1.00	Stream Power (lb/ft s)	8.01	0.00	0.00
Frctn Loss (ft)	0.02	Cum Volume (acre-ft)		0.10	
C & E Loss (ft)	0.00	Cum SA (acres)		0.02	

CROSS SECTION OUTPUT Profile #100 YR Intrm

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	6550.27	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.20	Wt. n-Val.		0.013	
W.S. Elev (ft)	6550.08	Reach Len. (ft)	10.00	10.00	10.00
Crit W.S. (ft)	6548.22	Flow Area (sq ft)		28.45	
E.G. Slope (ft/ft)	0.000415	Area (sq ft)		28.45	
Q Total (cfs)	101.00	Flow (cfs)		101.00	
Top Width (ft)	8.00	Top Width (ft)		8.00	
Vel Total (ft/s)	3.55	Avg. Vel. (ft/s)		3.55	
Max Chl Dpth (ft)	3.56	Hydr. Depth (ft)		3.55	
Conv. Total (cfs)	4959.7	Conv. (cfs)		4959.7	
Length Wtd. (ft)	10.00	Wetted Per. (ft)		15.11	
Min Ch El (ft)	6546.52	Shear (lb/sq ft)		0.05	
Alpha	1.00	Stream Power (lb/ft s)	8.01	0.00	0.00
Frctn Loss (ft)	0.00	Cum Volume (acre-ft)		0.06	
C & E Loss (ft)	0.00	Cum SA (acres)		0.03	

CROSS SECTION

```
RIVER: Platinum CBC
REACH: Platinum CBC        RS: 210

INPUT
Description: 18" RCP Lateral
Station Elevation Data    num=        4
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0 6551.47      .01 6546.47        8 6546.47     8.01 6551.47

Manning's n Values         num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .013        0     .013     8.01     .013

Bank Sta: Left   Right     Lengths: Left Channel    Right      Coeff Contr.   Expan.
             0    8.01                10       10       10                0        0
Cross Section Lid
    num=          2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
       0    6553 6551.47     8.01    6553 6551.47

CROSS SECTION OUTPUT  Profile #100 YR

  E.G. Elev (ft)              6553.06    Element                  Left OB    Channel   Right OB
  Vel Head (ft)                  0.82    Wt. n-Val.                           0.013
  W.S. Elev (ft)              6552.24    Reach Len. (ft)            10.00      10.00      10.00
  Crit W.S. (ft)              6549.93    Flow Area (sq ft)                     40.00
  E.G. Slope (ft/ft)         0.002265    Area (sq ft)                          40.00
  Q Total (cfs)                290.00    Flow (cfs)                           290.00
  Top Width (ft)                         Top Width (ft)
  Vel Total (ft/s)               7.25    Avg. Vel. (ft/s)                       7.25
  Max Chl Dpth (ft)              5.77    Hydr. Depth (ft)
  Conv. Total (cfs)            6093.1    Conv. (cfs)                          6093.1
  Length Wtd. (ft)              10.00    Wetted Per. (ft)                      26.00
  Min Ch El (ft)              6546.47    Shear (lb/sq ft)                       0.22
  Alpha                          1.00    Stream Power (lb/ft s)      8.01       0.00       0.00
  Frctn Loss (ft)                0.02    Cum Volume (acre-ft)                   0.09
  C & E Loss (ft)                0.00    Cum SA (acres)                         0.02


CROSS SECTION OUTPUT  Profile #100 YR Intrm

  E.G. Elev (ft)              6550.27    Element                  Left OB    Channel   Right OB
  Vel Head (ft)                  0.19    Wt. n-Val.                           0.013
  W.S. Elev (ft)              6550.08    Reach Len. (ft)            10.00      10.00      10.00
  Crit W.S. (ft)              6548.18    Flow Area (sq ft)                     28.86
  E.G. Slope (ft/ft)         0.000399    Area (sq ft)                          28.86
  Q Total (cfs)                101.00    Flow (cfs)                           101.00
  Top Width (ft)                 8.00    Top Width (ft)                         8.00
  Vel Total (ft/s)               3.50    Avg. Vel. (ft/s)                       3.50
  Max Chl Dpth (ft)              3.61    Hydr. Depth (ft)                       3.61
  Conv. Total (cfs)            5057.6    Conv. (cfs)                          5057.6
  Length Wtd. (ft)              10.00    Wetted Per. (ft)                      15.21
  Min Ch El (ft)              6546.47    Shear (lb/sq ft)                       0.05
  Alpha                          1.00    Stream Power (lb/ft s)      8.01       0.00       0.00
  Frctn Loss (ft)                0.00    Cum Volume (acre-ft)                   0.05
  C & E Loss (ft)                0.00    Cum SA (acres)                         0.02


CROSS SECTION


RIVER: Platinum CBC
REACH: Platinum CBC        RS: 200

INPUT
Description:
Station Elevation Data    num=        4
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0 6551.42      .01 6546.42        8 6546.42     8.01 6551.42

Manning's n Values         num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .013        0     .013     8.01     .013

Bank Sta: Left   Right     Lengths: Left Channel    Right      Coeff Contr.   Expan.
             0    8.01                10       10       10                0        0
Cross Section Lid
    num=          2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
       0    6553 6551.42     8.01    6553 6551.42

CROSS SECTION OUTPUT  Profile #100 YR

  E.G. Elev (ft)              6553.03    Element                  Left OB    Channel   Right OB
  Vel Head (ft)                  0.82    Wt. n-Val.                           0.013
  W.S. Elev (ft)              6552.22    Reach Len. (ft)            10.00      10.00      10.00
  Crit W.S. (ft)              6549.85    Flow Area (sq ft)                     40.00
  E.G. Slope (ft/ft)         0.002265    Area (sq ft)                          40.00
  Q Total (cfs)                290.00    Flow (cfs)                           290.00
  Top Width (ft)                         Top Width (ft)
  Vel Total (ft/s)               7.25    Avg. Vel. (ft/s)                       7.25
  Max Chl Dpth (ft)              5.80    Hydr. Depth (ft)
  Conv. Total (cfs)            6093.1    Conv. (cfs)                          6093.1
  Length Wtd. (ft)              10.00    Wetted Per. (ft)                      26.00
  Min Ch El (ft)              6546.42    Shear (lb/sq ft)                       0.22
  Alpha                          1.00    Stream Power (lb/ft s)      8.01       0.00       0.00
  Frctn Loss (ft)                0.03    Cum Volume (acre-ft)                   0.08
  C & E Loss (ft)                0.00    Cum SA (acres)                         0.02

Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may indicate the need for additional cross sections.

CROSS SECTION OUTPUT  Profile #100 YR Intrm

  E.G. Elev (ft)              6550.27    Element                  Left OB    Channel   Right OB
  Vel Head (ft)                  0.18    Wt. n-Val.                           0.013
```

```
W.S. Elev (ft)          6550.08   Reach Len. (ft)        10.00     10.00      10.00
Crit W.S. (ft)          6548.13   Flow Area (sq ft)                29.28
E.G. Slope (ft/ft)     0.000384   Area (sq ft)                     29.28
Q Total (cfs)            101.00   Flow (cfs)                      101.00
Top Width (ft)             8.00   Top Width (ft)                    8.00
Vel Total (ft/s)           3.45   Avg. Vel. (ft/s)                  3.45
Max Chl Dpth (ft)          3.66   Hydr. Depth (ft)                  3.66
Conv. Total (cfs)        5154.8   Conv. (cfs)                     5154.8
Length Wtd. (ft)          10.00   Wetted Per. (ft)                 15.31
Min Ch El (ft)          6546.42   Shear (lb/sq ft)                  0.05
Alpha                      1.00   Stream Power (lb/ft s)  8.01      0.00       0.00
Frctn Loss (ft)            0.01   Cum Volume (acre-ft)              0.05
C & E Loss (ft)            0.00   Cum SA (acres)                    0.02
```

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Platinum CBC
REACH: Platinum CBC   RS: 190

```
INPUT
Description: 54" RCP Lateral
Station Elevation Data    num=        4
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0 6551.37      .01 6546.37        8 6546.37     8.01 6551.37

Manning's n Values        num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
       0     .013        0     .013     8.01     .013

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0    8.01                 10      10      10                 0        0
Cross Section Lid
    num=          2
     Sta Hi Cord Lo Cord       Sta Hi Cord Lo Cord
       0    6553 6551.37      8.01    6553 6551.37
```

CROSS SECTION OUTPUT   Profile #100 YR

```
E.G. Elev (ft)          6553.00   Element                Left OB   Channel   Right OB
Vel Head (ft)              2.18   Wt. n-Val.                         0.013
W.S. Elev (ft)          6550.82   Reach Len. (ft)        10.00     10.00      10.00
Crit W.S. (ft)          6550.82   Flow Area (sq ft)                35.59
E.G. Slope (ft/ft)     0.003983   Area (sq ft)                     35.59
Q Total (cfs)            422.00   Flow (cfs)                      422.00
Top Width (ft)             8.01   Top Width (ft)                    8.01
Vel Total (ft/s)          11.86   Avg. Vel. (ft/s)                 11.86
Max Chl Dpth (ft)          4.45   Hydr. Depth (ft)                  4.44
Conv. Total (cfs)        6686.2   Conv. (cfs)                     6686.2
Length Wtd. (ft)          10.00   Wetted Per. (ft)                 16.89
Min Ch El (ft)          6546.37   Shear (lb/sq ft)                  0.52
Alpha                      1.00   Stream Power (lb/ft s)  8.01      0.00       0.00
Frctn Loss (ft)            0.04   Cum Volume (acre-ft)              0.07
C & E Loss (ft)            0.00   Cum SA (acres)                    0.02
```

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: The cross section had to be extended vertically during the critical depth calculations.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION OUTPUT   Profile #100 YR Intrm

```
E.G. Elev (ft)          6550.25   Element                Left OB   Channel   Right OB
Vel Head (ft)              1.27   Wt. n-Val.                         0.013
W.S. Elev (ft)          6548.99   Reach Len. (ft)        10.00     10.00      10.00
Crit W.S. (ft)          6548.99   Flow Area (sq ft)                20.92
E.G. Slope (ft/ft)     0.003390   Area (sq ft)                     20.92
Q Total (cfs)            189.00   Flow (cfs)                      189.00
Top Width (ft)             8.00   Top Width (ft)                    8.00
Vel Total (ft/s)           9.04   Avg. Vel. (ft/s)                  9.04
Max Chl Dpth (ft)          2.62   Hydr. Depth (ft)                  2.61
Conv. Total (cfs)        3246.0   Conv. (cfs)                     3246.0
Length Wtd. (ft)          10.00   Wetted Per. (ft)                 13.22
Min Ch El (ft)          6546.37   Shear (lb/sq ft)                  0.33
Alpha                      1.00   Stream Power (lb/ft s)  8.01      0.00       0.00
Frctn Loss (ft)            0.03   Cum Volume (acre-ft)              0.04
C & E Loss (ft)            0.00   Cum SA (acres)                    0.02
```

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: Platinum CBC
REACH: Platinum CBC   RS: 180

```
INPUT
Description:
Station Elevation Data    num=        4
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0 6551.32      .01 6546.32        8 6546.32     8.01 6551.32

Manning's n Values        num=        3
```

```
     Sta   n Val     Sta   n Val     Sta   n Val
      0    .013       0    .013     8.01   .013

Bank Sta: Left   Right    Lengths: Left Channel    Right      Coeff Contr.    Expan.
            0    8.01                10       10      10               0          0
Cross Section Lid
     num=        2
      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
       0    6553 6551.32    8.01    6553 6551.32
```

CROSS SECTION OUTPUT Profile #100 YR

```
  E.G. Elev (ft)            6552.97    Element                   Left OB     Channel    Right OB
  Vel Head (ft)                2.42    Wt. n-Val.                              0.013
  W.S. Elev (ft)            6550.54    Reach Len. (ft)             10.00       10.00       10.00
  Crit W.S. (ft)            6550.77    Flow Area (sq ft)                       33.77
  E.G. Slope (ft/ft)       0.004574    Area (sq ft)                            33.77
  Q Total (cfs)              422.00    Flow (cfs)                             422.00
  Top Width (ft)               8.01    Top Width (ft)                           8.01
  Vel Total (ft/s)            12.49    Avg. Vel. (ft/s)                        12.49
  Max Chl Dpth (ft)            4.22    Hydr. Depth (ft)                         4.22
  Conv. Total (cfs)          6240.0    Conv. (cfs)                            6240.0
  Length Wtd. (ft)            10.00    Wetted Per. (ft)                        16.44
  Min Ch El (ft)            6546.32    Shear (lb/sq ft)                         0.59
  Alpha                        1.00    Stream Power (lb/ft s)       8.01        0.00        0.00
  Frctn Loss (ft)              0.04    Cum Volume (acre-ft)                     0.06
  C & E Loss (ft)              0.00    Cum SA (acres)                           0.02
```

Warning: The cross section had to be extended vertically during the critical depth calculations.
Note: Program found supercritical flow starting at this cross section.

CROSS SECTION OUTPUT Profile #100 YR Intrm

```
  E.G. Elev (ft)            6550.23    Element                   Left OB     Channel    Right OB
  Vel Head (ft)                1.50    Wt. n-Val.                              0.013
  W.S. Elev (ft)            6548.73    Reach Len. (ft)             10.00       10.00       10.00
  Crit W.S. (ft)            6548.94    Flow Area (sq ft)                       19.24
  E.G. Slope (ft/ft)       0.004290    Area (sq ft)                            19.24
  Q Total (cfs)              189.00    Flow (cfs)                             189.00
  Top Width (ft)               8.00    Top Width (ft)                           8.00
  Vel Total (ft/s)             9.82    Avg. Vel. (ft/s)                         9.82
  Max Chl Dpth (ft)            2.41    Hydr. Depth (ft)                         2.41
  Conv. Total (cfs)          2885.5    Conv. (cfs)                            2885.5
  Length Wtd. (ft)            10.00    Wetted Per. (ft)                        12.80
  Min Ch El (ft)            6546.32    Shear (lb/sq ft)                         0.40
  Alpha                        1.00    Stream Power (lb/ft s)       8.01        0.00        0.00
  Frctn Loss (ft)              0.04    Cum Volume (acre-ft)                     0.04
  C & E Loss (ft)              0.00    Cum SA (acres)                           0.02
```

Note: Program found supercritical flow starting at this cross section.

CROSS SECTION

RIVER: Platinum CBC
REACH: Platinum CBC   RS: 170

```
INPUT
Description:
Station Elevation Data    num=        4
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0  6551.13      .01  6546.13        8  6546.13     8.01  6551.13

Manning's n Values        num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
      0    .013       0    .013     8.01   .013

Bank Sta: Left   Right    Lengths: Left Channel    Right      Coeff Contr.    Expan.
            0    8.01                10       10      10               0          0
Cross Section Lid
     num=        2
      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
       0    6553 6551.13    8.01    6553 6551.13
```

CROSS SECTION OUTPUT Profile #100 YR

```
  E.G. Elev (ft)            6552.92    Element                   Left OB     Channel    Right OB
  Vel Head (ft)                2.97    Wt. n-Val.                              0.013
  W.S. Elev (ft)            6549.94    Reach Len. (ft)             10.00       10.00       10.00
  Crit W.S. (ft)            6550.58    Flow Area (sq ft)                       30.50
  E.G. Slope (ft/ft)       0.006001    Area (sq ft)                            30.50
  Q Total (cfs)              422.00    Flow (cfs)                             422.00
  Top Width (ft)               8.01    Top Width (ft)                           8.01
  Vel Total (ft/s)            13.83    Avg. Vel. (ft/s)                        13.83
  Max Chl Dpth (ft)            3.81    Hydr. Depth (ft)                         3.81
  Conv. Total (cfs)          5447.5    Conv. (cfs)                            5447.5
  Length Wtd. (ft)            10.00    Wetted Per. (ft)                        15.62
  Min Ch El (ft)            6546.13    Shear (lb/sq ft)                         0.73
  Alpha                        1.00    Stream Power (lb/ft s)       8.01        0.00        0.00
  Frctn Loss (ft)              0.05    Cum Volume (acre-ft)                     0.06
  C & E Loss (ft)              0.00    Cum SA (acres)                           0.02
```

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

CROSS SECTION OUTPUT Profile #100 YR Intrm

```
  E.G. Elev (ft)            6550.17    Element                   Left OB     Channel    Right OB
  Vel Head (ft)                1.91    Wt. n-Val.                              0.013
  W.S. Elev (ft)            6548.26    Reach Len. (ft)             10.00       10.00       10.00
  Crit W.S. (ft)            6548.74    Flow Area (sq ft)                       17.06
  E.G. Slope (ft/ft)       0.006048    Area (sq ft)                            17.06
  Q Total (cfs)              189.00    Flow (cfs)                             189.00
  Top Width (ft)               8.00    Top Width (ft)                           8.00
```

Vel Total (ft/s)	11.08	Avg. Vel. (ft/s)		11.08	
Max Chl Dpth (ft)	2.13	Hydr. Depth (ft)		2.13	
Conv. Total (cfs)	2430.3	Conv. (cfs)		2430.3	
Length Wtd. (ft)	10.00	Wetted Per. (ft)		12.26	
Min Ch El (ft)	6546.13	Shear (lb/sq ft)		0.53	
Alpha	1.00	Stream Power (lb/ft s)	8.01	0.00	0.00
Frctn Loss (ft)	0.05	Cum Volume (acre-ft)		0.03	
C & E Loss (ft)	0.00	Cum SA (acres)		0.02	

CROSS SECTION

RIVER: Platinum CBC
REACH: Platinum CBC RS: 160

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	6550.93	.01	6545.93	8	6545.93	8.01	6550.93

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	8.01	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	8.01	10	10	10	0	0

Cross Section Lid
num= 2

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	6553	6550.93	8.01	6553	6550.93

CROSS SECTION OUTPUT Profile #100 YR

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	6552.86	Wt. n-Val.		0.013	
Vel Head (ft)	3.31	Reach Len. (ft)	10.00	10.00	10.00
W.S. Elev (ft)	6549.54	Flow Area (sq ft)		28.90	
Crit W.S. (ft)	6550.38	Area (sq ft)		28.90	
E.G. Slope (ft/ft)	0.006942	Flow (cfs)		422.00	
Q Total (cfs)	422.00	Top Width (ft)		8.00	
Top Width (ft)	8.00	Avg. Vel. (ft/s)		14.60	
Vel Total (ft/s)	14.60	Hydr. Depth (ft)		3.61	
Max Chl Dpth (ft)	3.61	Conv. (cfs)		5065.0	
Conv. Total (cfs)	5065.0	Wetted Per. (ft)		15.22	
Length Wtd. (ft)	10.00	Shear (lb/sq ft)		0.82	
Min Ch El (ft)	6545.93	Stream Power (lb/ft s)	8.01	0.00	0.00
Alpha	1.00	Cum Volume (acre-ft)		0.05	
Frctn Loss (ft)	0.06	Cum SA (acres)		0.02	
C & E Loss (ft)	0.00				

CROSS SECTION OUTPUT Profile #100 YR Intrm

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	6550.10	Wt. n-Val.		0.013	
Vel Head (ft)	2.16	Reach Len. (ft)	10.00	10.00	10.00
W.S. Elev (ft)	6547.93	Flow Area (sq ft)		16.02	
Crit W.S. (ft)	6548.54	Area (sq ft)		16.02	
E.G. Slope (ft/ft)	0.007247	Flow (cfs)		189.00	
Q Total (cfs)	189.00	Top Width (ft)		8.00	
Top Width (ft)	8.00	Avg. Vel. (ft/s)		11.80	
Vel Total (ft/s)	11.80	Hydr. Depth (ft)		2.00	
Max Chl Dpth (ft)	2.00	Conv. (cfs)		2220.2	
Conv. Total (cfs)	2220.2	Wetted Per. (ft)		12.00	
Length Wtd. (ft)	10.00	Shear (lb/sq ft)		0.60	
Min Ch El (ft)	6545.93	Stream Power (lb/ft s)	8.01	0.00	0.00
Alpha	1.00	Cum Volume (acre-ft)		0.03	
Frctn Loss (ft)	0.07	Cum SA (acres)		0.02	
C & E Loss (ft)	0.00				

CROSS SECTION

RIVER: Platinum CBC
REACH: Platinum CBC RS: 150

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	6550.74	.01	6545.74	8	6545.74	8.01	6550.74

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	8.01	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	8.01	10	10	10	0	0

Cross Section Lid
num= 2

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	6553	6550.74	8.01	6553	6550.74

CROSS SECTION OUTPUT Profile #100 YR

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	6552.78	Wt. n-Val.		0.013	
Vel Head (ft)	3.54	Reach Len. (ft)	10.00	10.00	10.00
W.S. Elev (ft)	6549.23	Flow Area (sq ft)		27.93	
Crit W.S. (ft)	6550.19	Area (sq ft)		27.93	
E.G. Slope (ft/ft)	0.007610	Flow (cfs)		422.00	
Q Total (cfs)	422.00	Top Width (ft)		8.00	
Top Width (ft)	8.00	Avg. Vel. (ft/s)		15.11	
Vel Total (ft/s)	15.11	Hydr. Depth (ft)		3.49	
Max Chl Dpth (ft)	3.49	Conv. (cfs)		4837.4	
Conv. Total (cfs)	4837.4				

```
 Length Wtd. (ft)          10.00   Wetted Per. (ft)                  14.98
 Min Ch El (ft)          6545.74   Shear (lb/sq ft)                   0.89
 Alpha                      1.00   Stream Power (lb/ft s)     8.01    0.00       0.00
 Frctn Loss (ft)            0.07   Cum Volume (acre-ft)               0.04
 C & E Loss (ft)            0.00   Cum SA (acres)                     0.01
```

CROSS SECTION OUTPUT Profile #100 YR Intrm

```
 E.G. Elev (ft)          6550.02   Element                 Left OB  Channel  Right OB
 Vel Head (ft)              2.37   Wt. n-Val.                         0.013
 W.S. Elev (ft)          6547.66   Reach Len. (ft)           10.00    10.00     10.00
 Crit W.S. (ft)          6548.36   Flow Area (sq ft)                  15.31
 E.G. Slope (ft/ft)     0.008264   Area (sq ft)                       15.31
 Q Total (cfs)            189.00   Flow (cfs)                        189.00
 Top Width (ft)             8.00   Top Width (ft)                     8.00
 Vel Total (ft/s)          12.35   Avg. Vel. (ft/s)                  12.35
 Max Chl Dpth (ft)          1.92   Hydr. Depth (ft)                   1.91
 Conv. Total (cfs)        2079.0   Conv. (cfs)                       2079.0
 Length Wtd. (ft)          10.00   Wetted Per. (ft)                  11.82
 Min Ch El (ft)          6545.74   Shear (lb/sq ft)                   0.67
 Alpha                      1.00   Stream Power (lb/ft s)     8.01    0.00       0.00
 Frctn Loss (ft)            0.08   Cum Volume (acre-ft)               0.03
 C & E Loss (ft)            0.00   Cum SA (acres)                     0.01
```

CROSS SECTION

RIVER: Platinum CBC
REACH: Platinum CBC   RS: 140

```
INPUT
Description:
Station Elevation Data    num=        4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 6550.54     .01 6545.54       8 6545.54    8.01 6550.54

Manning's n Values        num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013    8.01    .013

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0    8.01                 7       7       7              0        0
Cross Section Lid
     num=        2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
       0    6553 6550.54     8.01    6553 6550.54
```

CROSS SECTION OUTPUT Profile #100 YR

```
 E.G. Elev (ft)          6552.69   Element                 Left OB  Channel  Right OB
 Vel Head (ft)              3.77   Wt. n-Val.                         0.013
 W.S. Elev (ft)          6548.93   Reach Len. (ft)            7.00     7.00      7.00
 Crit W.S. (ft)          6549.99   Flow Area (sq ft)                  27.10
 E.G. Slope (ft/ft)     0.008262   Area (sq ft)                       27.10
 Q Total (cfs)            422.00   Flow (cfs)                        422.00
 Top Width (ft)             8.00   Top Width (ft)                     8.00
 Vel Total (ft/s)          15.57   Avg. Vel. (ft/s)                  15.57
 Max Chl Dpth (ft)          3.39   Hydr. Depth (ft)                   3.39
 Conv. Total (cfs)        4642.6   Conv. (cfs)                       4642.6
 Length Wtd. (ft)           7.00   Wetted Per. (ft)                  14.77
 Min Ch El (ft)          6545.54   Shear (lb/sq ft)                   0.95
 Alpha                      1.00   Stream Power (lb/ft s)     8.01    0.00       0.00
 Frctn Loss (ft)            0.08   Cum Volume (acre-ft)               0.04
 C & E Loss (ft)            0.00   Cum SA (acres)                     0.01
```

CROSS SECTION OUTPUT Profile #100 YR Intrm

```
 E.G. Elev (ft)          6549.94   Element                 Left OB  Channel  Right OB
 Vel Head (ft)              2.55   Wt. n-Val.                         0.013
 W.S. Elev (ft)          6547.38   Reach Len. (ft)            7.00     7.00      7.00
 Crit W.S. (ft)          6548.10   Flow Area (sq ft)                  14.74
 E.G. Slope (ft/ft)     0.009228   Area (sq ft)                       14.74
 Q Total (cfs)            189.00   Flow (cfs)                        189.00
 Top Width (ft)             8.00   Top Width (ft)                     8.00
 Vel Total (ft/s)          12.82   Avg. Vel. (ft/s)                  12.82
 Max Chl Dpth (ft)          1.84   Hydr. Depth (ft)                   1.84
 Conv. Total (cfs)        1967.4   Conv. (cfs)                       1967.4
 Length Wtd. (ft)           7.00   Wetted Per. (ft)                  11.68
 Min Ch El (ft)          6545.54   Shear (lb/sq ft)                   0.73
 Alpha                      1.00   Stream Power (lb/ft s)     8.01    0.00       0.00
 Frctn Loss (ft)            0.09   Cum Volume (acre-ft)               0.02
 C & E Loss (ft)            0.00   Cum SA (acres)                     0.01
```

CROSS SECTION

RIVER: Platinum CBC
REACH: Platinum CBC   RS: 133

```
INPUT
Description: 30" RCP Lateral
Station Elevation Data    num=        4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 6550.45     .01 6545.41       8 6545.41    8.01 6550.45

Manning's n Values        num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013    8.01    .013

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.   Expan.
             0    8.01                13      13      13              0        0
Cross Section Lid
```

num= 2

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	6553	6550.45	8.01	6553	6550.45

CROSS SECTION OUTPUT Profile #100 YR

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	6552.65	Element	Left OB	Channel	Right OB
Vel Head (ft)	3.42	Wt. n-Val.		0.013	
W.S. Elev (ft)	6549.23	Reach Len. (ft)	13.00	13.00	13.00
Crit W.S. (ft)	6550.08	Flow Area (sq ft)		30.53	
E.G. Slope (ft/ft)	0.006901	Area (sq ft)		30.53	
Q Total (cfs)	453.00	Flow (cfs)		453.00	
Top Width (ft)	8.01	Top Width (ft)		8.01	
Vel Total (ft/s)	14.84	Avg. Vel. (ft/s)		14.84	
Max Chl Dpth (ft)	3.82	Hydr. Depth (ft)		3.81	
Conv. Total (cfs)	5453.1	Conv. (cfs)		5453.1	
Length Wtd. (ft)	13.00	Wetted Per. (ft)		15.62	
Min Ch El (ft)	6545.41	Shear (lb/sq ft)		0.84	
Alpha	1.00	Stream Power (lb/ft s)	8.01	0.00	0.00
Frctn Loss (ft)	0.05	Cum Volume (acre-ft)		0.03	
C & E Loss (ft)	0.00	Cum SA (acres)		0.01	

CROSS SECTION OUTPUT Profile #100 YR Intrm

E.G. Elev (ft)	6549.89	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.15	Wt. n-Val.		0.013	
W.S. Elev (ft)	6547.74	Reach Len. (ft)	13.00	13.00	13.00
Crit W.S. (ft)	6548.29	Flow Area (sq ft)		18.60	
E.G. Slope (ft/ft)	0.006337	Area (sq ft)		18.60	
Q Total (cfs)	219.00	Flow (cfs)		219.00	
Top Width (ft)	8.00	Top Width (ft)		8.00	
Vel Total (ft/s)	11.77	Avg. Vel. (ft/s)		11.77	
Max Chl Dpth (ft)	2.33	Hydr. Depth (ft)		2.33	
Conv. Total (cfs)	2751.0	Conv. (cfs)		2751.0	
Length Wtd. (ft)	13.00	Wetted Per. (ft)		12.64	
Min Ch El (ft)	6545.41	Shear (lb/sq ft)		0.58	
Alpha	1.00	Stream Power (lb/ft s)	8.01	0.00	0.00
Frctn Loss (ft)	0.05	Cum Volume (acre-ft)		0.02	
C & E Loss (ft)	0.00	Cum SA (acres)		0.01	

CROSS SECTION

RIVER: Platinum CBC
REACH: Platinum CBC RS: 120

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	6550.16	.01	6545.16	8	6545.16	8.01	6550.16

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	8.01	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	8.01	10	10	10	.1	.3

Cross Section Lid
num= 2

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	6553	6550.16	8.01	6553	6550.16

CROSS SECTION OUTPUT Profile #100 YR

E.G. Elev (ft)	6552.55	Element	Left OB	Channel	Right OB
Vel Head (ft)	3.74	Wt. n-Val.		0.013	
W.S. Elev (ft)	6548.81	Reach Len. (ft)	10.00	10.00	10.00
Crit W.S. (ft)	6549.83	Flow Area (sq ft)		29.17	
E.G. Slope (ft/ft)	0.007798	Area (sq ft)		29.17	
Q Total (cfs)	453.00	Flow (cfs)		453.00	
Top Width (ft)	8.00	Top Width (ft)		8.00	
Vel Total (ft/s)	15.53	Avg. Vel. (ft/s)		15.53	
Max Chl Dpth (ft)	3.65	Hydr. Depth (ft)		3.64	
Conv. Total (cfs)	5129.8	Conv. (cfs)		5129.8	
Length Wtd. (ft)	10.00	Wetted Per. (ft)		15.28	
Min Ch El (ft)	6545.16	Shear (lb/sq ft)		0.93	
Alpha	1.00	Stream Power (lb/ft s)	8.01	0.00	0.00
Frctn Loss (ft)	0.10	Cum Volume (acre-ft)		0.02	
C & E Loss (ft)	0.00	Cum SA (acres)		0.01	

CROSS SECTION OUTPUT Profile #100 YR Intrm

E.G. Elev (ft)	6549.79	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.45	Wt. n-Val.		0.013	
W.S. Elev (ft)	6547.34	Reach Len. (ft)	10.00	10.00	10.00
Crit W.S. (ft)	6548.02	Flow Area (sq ft)		17.42	
E.G. Slope (ft/ft)	0.007649	Area (sq ft)		17.42	
Q Total (cfs)	219.00	Flow (cfs)		219.00	
Top Width (ft)	8.00	Top Width (ft)		8.00	
Vel Total (ft/s)	12.57	Avg. Vel. (ft/s)		12.57	
Max Chl Dpth (ft)	2.18	Hydr. Depth (ft)		2.18	
Conv. Total (cfs)	2504.0	Conv. (cfs)		2504.0	
Length Wtd. (ft)	10.00	Wetted Per. (ft)		12.35	
Min Ch El (ft)	6545.16	Shear (lb/sq ft)		0.67	
Alpha	1.00	Stream Power (lb/ft s)	8.01	0.00	0.00
Frctn Loss (ft)	0.09	Cum Volume (acre-ft)		0.01	
C & E Loss (ft)	0.00	Cum SA (acres)		0.01	

CROSS SECTION

```
RIVER: Platinum CBC
REACH: Platinum CBC       RS: 110

INPUT
Description:
Station Elevation Data    num=        4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 6549.96     .01 6544.96       8 6544.96    8.01 6549.96

Manning's n Values        num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013    8.01    .013

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             0     8.01                10       10       10                .1        .3
Cross Section Lid
    num=        2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
       0    6553 6549.96     8.01    6553 6549.96

CROSS SECTION OUTPUT  Profile #100 YR

  E.G. Elev (ft)              6552.45    Element                   Left OB    Channel    Right OB
  Vel Head (ft)                  3.93    Wt. n-Val.                            0.013
  W.S. Elev (ft)              6548.52    Reach Len. (ft)             10.00      10.00       10.00
  Crit W.S. (ft)              6549.63    Flow Area (sq ft)                      28.47
  E.G. Slope (ft/ft)         0.008327    Area (sq ft)                           28.47
  Q Total (cfs)                453.00    Flow (cfs)                            453.00
  Top Width (ft)                 8.00    Top Width (ft)                          8.00
  Vel Total (ft/s)              15.91    Avg. Vel. (ft/s)                       15.91
  Max Chl Dpth (ft)              3.56    Hydr. Depth (ft)                        3.56
  Conv. Total (cfs)            4964.3    Conv. (cfs)                           4964.3
  Length Wtd. (ft)              10.00    Wetted Per. (ft)                       15.11
  Min Ch El (ft)              6544.96    Shear (lb/sq ft)                        0.98
  Alpha                          1.00    Stream Power (lb/ft s)       8.01       0.00        0.00
  Frctn Loss (ft)                0.08    Cum Volume (acre-ft)                    0.02
  C & E Loss (ft)                0.02    Cum SA (acres)                          0.01

CROSS SECTION OUTPUT  Profile #100 YR Intrm

  E.G. Elev (ft)              6549.70    Element                   Left OB    Channel    Right OB
  Vel Head (ft)                  2.63    Wt. n-Val.                            0.013
  W.S. Elev (ft)              6547.07    Reach Len. (ft)             10.00      10.00       10.00
  Crit W.S. (ft)              6547.82    Flow Area (sq ft)                      16.83
  E.G. Slope (ft/ft)         0.008443    Area (sq ft)                           16.83
  Q Total (cfs)                219.00    Flow (cfs)                            219.00
  Top Width (ft)                 8.00    Top Width (ft)                          8.00
  Vel Total (ft/s)              13.01    Avg. Vel. (ft/s)                       13.01
  Max Chl Dpth (ft)              2.10    Hydr. Depth (ft)                        2.10
  Conv. Total (cfs)            2383.3    Conv. (cfs)                           2383.3
  Length Wtd. (ft)              10.00    Wetted Per. (ft)                       12.20
  Min Ch El (ft)              6544.96    Shear (lb/sq ft)                        0.73
  Alpha                          1.00    Stream Power (lb/ft s)       8.01       0.00        0.00
  Frctn Loss (ft)                0.08    Cum Volume (acre-ft)                    0.01
  C & E Loss (ft)                0.02    Cum SA (acres)                          0.01

CROSS SECTION


RIVER: Platinum CBC
REACH: Platinum CBC       RS: 100

INPUT
Description:
Station Elevation Data    num=        4
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 6549.77     .01 6544.77       8 6544.77    8.01 6549.77

Manning's n Values        num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .013       0    .013    8.01    .013

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             0     8.01                10       10       10                .1        .3
Cross Section Lid
    num=        2
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
       0    6553 6549.77     8.01    6553 6549.77

CROSS SECTION OUTPUT  Profile #100 YR

  E.G. Elev (ft)              6552.35    Element                   Left OB    Channel    Right OB
  Vel Head (ft)                  4.09    Wt. n-Val.                            0.013
  W.S. Elev (ft)              6548.26    Reach Len. (ft)             10.00      10.00       10.00
  Crit W.S. (ft)              6549.44    Flow Area (sq ft)                      27.92
  E.G. Slope (ft/ft)         0.008776    Area (sq ft)                           27.92
  Q Total (cfs)                453.00    Flow (cfs)                            453.00
  Top Width (ft)                 8.00    Top Width (ft)                          8.00
  Vel Total (ft/s)              16.22    Avg. Vel. (ft/s)                       16.22
  Max Chl Dpth (ft)              3.49    Hydr. Depth (ft)                        3.49
  Conv. Total (cfs)            4835.5    Conv. (cfs)                           4835.5
  Length Wtd. (ft)              10.00    Wetted Per. (ft)                       14.97
  Min Ch El (ft)              6544.77    Shear (lb/sq ft)                        1.02
  Alpha                          1.00    Stream Power (lb/ft s)       8.01       0.00        0.00
  Frctn Loss (ft)                0.09    Cum Volume (acre-ft)                    0.01
  C & E Loss (ft)                0.02    Cum SA (acres)                          0.01

CROSS SECTION OUTPUT  Profile #100 YR Intrm

  E.G. Elev (ft)              6549.59    Element                   Left OB    Channel    Right OB
  Vel Head (ft)                  2.77    Wt. n-Val.                            0.013
  W.S. Elev (ft)              6546.82    Reach Len. (ft)             10.00      10.00       10.00
  Crit W.S. (ft)              6547.63    Flow Area (sq ft)                      16.40
```

E.G. Slope (ft/ft)	0.009096	Area (sq ft)		16.40	
Q Total (cfs)	219.00	Flow (cfs)		219.00	
Top Width (ft)	8.00	Top Width (ft)		8.00	
Vel Total (ft/s)	13.36	Avg. Vel. (ft/s)		13.36	
Max Chl Dpth (ft)	2.05	Hydr. Depth (ft)		2.05	
Conv. Total (cfs)	2296.3	Conv. (cfs)		2296.3	
Length Wtd. (ft)	10.00	Wetted Per. (ft)		12.09	
Min Ch El (ft)	6544.77	Shear (lb/sq ft)		0.77	
Alpha	1.00	Stream Power (lb/ft s)	8.01	0.00	0.00
Frctn Loss (ft)	0.09	Cum Volume (acre-ft)		0.01	
C & E Loss (ft)	0.01	Cum SA (acres)		0.00	

CROSS SECTION

RIVER: Platinum CBC
REACH: Platinum CBC RS: 90

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	6547.77	4	6543.77	12	6543.77	16	6547.77

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	16	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	16	10	10	10	.1	.3

CROSS SECTION OUTPUT Profile #100 YR

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	6552.04	Element	Left OB	Channel	Right OB
Vel Head (ft)	6.02	Wt. n-Val.		0.013	
W.S. Elev (ft)	6546.02	Reach Len. (ft)	10.00	10.00	10.00
Crit W.S. (ft)	6547.67	Flow Area (sq ft)		23.00	
E.G. Slope (ft/ft)	0.015826	Area (sq ft)		23.00	
Q Total (cfs)	453.00	Flow (cfs)		453.00	
Top Width (ft)	12.49	Top Width (ft)		12.49	
Vel Total (ft/s)	19.69	Avg. Vel. (ft/s)		19.69	
Max Chl Dpth (ft)	2.25	Hydr. Depth (ft)		1.84	
Conv. Total (cfs)	3600.9	Conv. (cfs)		3600.9	
Length Wtd. (ft)	10.00	Wetted Per. (ft)		14.35	
Min Ch El (ft)	6543.77	Shear (lb/sq ft)		1.58	
Alpha	1.00	Stream Power (lb/ft s)	16.00	0.00	0.00
Frctn Loss (ft)	0.12	Cum Volume (acre-ft)		0.01	
C & E Loss (ft)	0.19	Cum SA (acres)		0.00	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

CROSS SECTION OUTPUT Profile #100 YR Intrm

E.G. Elev (ft)	6549.33	Element	Left OB	Channel	Right OB
Vel Head (ft)	4.14	Wt. n-Val.		0.013	
W.S. Elev (ft)	6545.19	Reach Len. (ft)	10.00	10.00	10.00
Crit W.S. (ft)	6546.31	Flow Area (sq ft)		13.42	
E.G. Slope (ft/ft)	0.017622	Area (sq ft)		13.42	
Q Total (cfs)	219.00	Flow (cfs)		219.00	
Top Width (ft)	10.85	Top Width (ft)		10.85	
Vel Total (ft/s)	16.32	Avg. Vel. (ft/s)		16.32	
Max Chl Dpth (ft)	1.42	Hydr. Depth (ft)		1.24	
Conv. Total (cfs)	1649.7	Conv. (cfs)		1649.7	
Length Wtd. (ft)	10.00	Wetted Per. (ft)		12.03	
Min Ch El (ft)	6543.77	Shear (lb/sq ft)		1.23	
Alpha	1.00	Stream Power (lb/ft s)	16.00	0.00	0.00
Frctn Loss (ft)	0.12	Cum Volume (acre-ft)		0.00	
C & E Loss (ft)	0.14	Cum SA (acres)		0.00	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Platinum CBC
REACH: Platinum CBC RS: 80

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	6546.77	4	6542.77	12	6542.77	16	6546.77

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.013	0	.013	16	.013

Bank Sta: Left	Right	Coeff Contr.	Expan.
0	16	.1	.3

CROSS SECTION OUTPUT Profile #100 YR

E.G. Elev (ft)	6551.78	Element	Left OB	Channel	Right OB
Vel Head (ft)	6.88	Wt. n-Val.		0.013	
W.S. Elev (ft)	6544.90	Reach Len. (ft)			
Crit W.S. (ft)	6546.67	Flow Area (sq ft)		21.52	
E.G. Slope (ft/ft)	0.019151	Area (sq ft)		21.52	
Q Total (cfs)	453.00	Flow (cfs)		453.00	
Top Width (ft)	12.25	Top Width (ft)		12.25	
Vel Total (ft/s)	21.05	Avg. Vel. (ft/s)		21.05	
Max Chl Dpth (ft)	2.13	Hydr. Depth (ft)		1.76	
Conv. Total (cfs)	3273.5	Conv. (cfs)		3273.5	
Length Wtd. (ft)		Wetted Per. (ft)		14.01	

Min Ch El (ft)	6542.77	Shear (lb/sq ft)		1.84	
Alpha	1.00	Stream Power (lb/ft s)	16.00	0.00	0.00
Frctn Loss (ft)	0.17	Cum Volume (acre-ft)			
C & E Loss (ft)	0.09	Cum SA (acres)			

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

CROSS SECTION OUTPUT Profile #100 YR Intrm

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	6549.05	Element	Left OB	Channel	Right OB
Vel Head (ft)	4.96	Wt. n-Val.		0.013	
W.S. Elev (ft)	6544.09	Reach Len. (ft)			
Crit W.S. (ft)	6545.31	Flow Area (sq ft)		12.25	
E.G. Slope (ft/ft)	0.023040	Area (sq ft)		12.25	
Q Total (cfs)	219.00	Flow (cfs)		219.00	
Top Width (ft)	10.63	Top Width (ft)		10.63	
Vel Total (ft/s)	17.87	Avg. Vel. (ft/s)		17.87	
Max Chl Dpth (ft)	1.32	Hydr. Depth (ft)		1.15	
Conv. Total (cfs)	1442.8	Conv. (cfs)		1442.8	
Length Wtd. (ft)		Wetted Per. (ft)		11.72	
Min Ch El (ft)	6542.77	Shear (lb/sq ft)		1.50	
Alpha	1.00	Stream Power (lb/ft s)	16.00	0.00	0.00
Frctn Loss (ft)	0.20	Cum Volume (acre-ft)			
C & E Loss (ft)	0.08	Cum SA (acres)			

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

SUMMARY OF MANNING'S N VALUES

River:Platinum CBC

Reach	River Sta.	n1	n2	n3
Platinum CBC	235	.013	.013	.013
Platinum CBC	220	.013	.013	.013
Platinum CBC	210	.013	.013	.013
Platinum CBC	200	.013	.013	.013
Platinum CBC	190	.013	.013	.013
Platinum CBC	180	.013	.013	.013
Platinum CBC	170	.013	.013	.013
Platinum CBC	160	.013	.013	.013
Platinum CBC	150	.013	.013	.013
Platinum CBC	140	.013	.013	.013
Platinum CBC	133	.013	.013	.013
Platinum CBC	120	.013	.013	.013
Platinum CBC	110	.013	.013	.013
Platinum CBC	100	.013	.013	.013
Platinum CBC	90	.013	.013	.013
Platinum CBC	80	.013	.013	.013

SUMMARY OF REACH LENGTHS

River: Platinum CBC

Reach	River Sta.	Left	Channel	Right
Platinum CBC	235	15	15	15
Platinum CBC	220	10	10	10
Platinum CBC	210	10	10	10
Platinum CBC	200	10	10	10
Platinum CBC	190	10	10	10
Platinum CBC	180	10	10	10
Platinum CBC	170	10	10	10
Platinum CBC	160	10	10	10
Platinum CBC	150	10	10	10
Platinum CBC	140	7	7	7
Platinum CBC	133	13	13	13
Platinum CBC	120	10	10	10
Platinum CBC	110	10	10	10
Platinum CBC	100	10	10	10
Platinum CBC	90	10	10	10
Platinum CBC	80			

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: Platinum CBC

Reach	River Sta.	Contr.	Expan.
Platinum CBC	235	0	0
Platinum CBC	220	0	0
Platinum CBC	210	0	0
Platinum CBC	200	0	0
Platinum CBC	190	0	0
Platinum CBC	180	0	0
Platinum CBC	170	0	0
Platinum CBC	160	0	0
Platinum CBC	150	0	0
Platinum CBC	140	0	0
Platinum CBC	133	0	0
Platinum CBC	120	.1	.3
Platinum CBC	110	.1	.3
Platinum CBC	100	.1	.3
Platinum CBC	90	.1	.3
Platinum CBC	80	.1	.3

FROM: Austin Bluffs Parkway

WILSON &COMPANY

DATE: 8/21/12

TO:

FILE:

SUBJECT: (Platinum / Austin Bluffs)

Estimate Capacity of 36" & 30" RCP @ Platinum

(The purpose of this analysis is to determine the existing surface flow collection capacity at the upstream end of the CBC)

Assume fs in pipes negligible
Base capacity off of HW/D @ Exposed Culvert Ends

Existing Capacity of 36"/30" RCP - based upon HW.

36" RCP

Inv = 6548.95

nearby surface shot = 6553.7 (near overflow pt)

Assumed HW = 6553.7 - 6548.95 = 4.75'

HW/D = 1.58

Groove end w/ headwall on nomograph (B.P.R. Chart 2)

Q ≈ 65 cfs

30" RCP

Inv = 6547.11

nearby overflow elev = 6551.0

Assumed HW = 6551.0 - 6547.11 = 3.89'

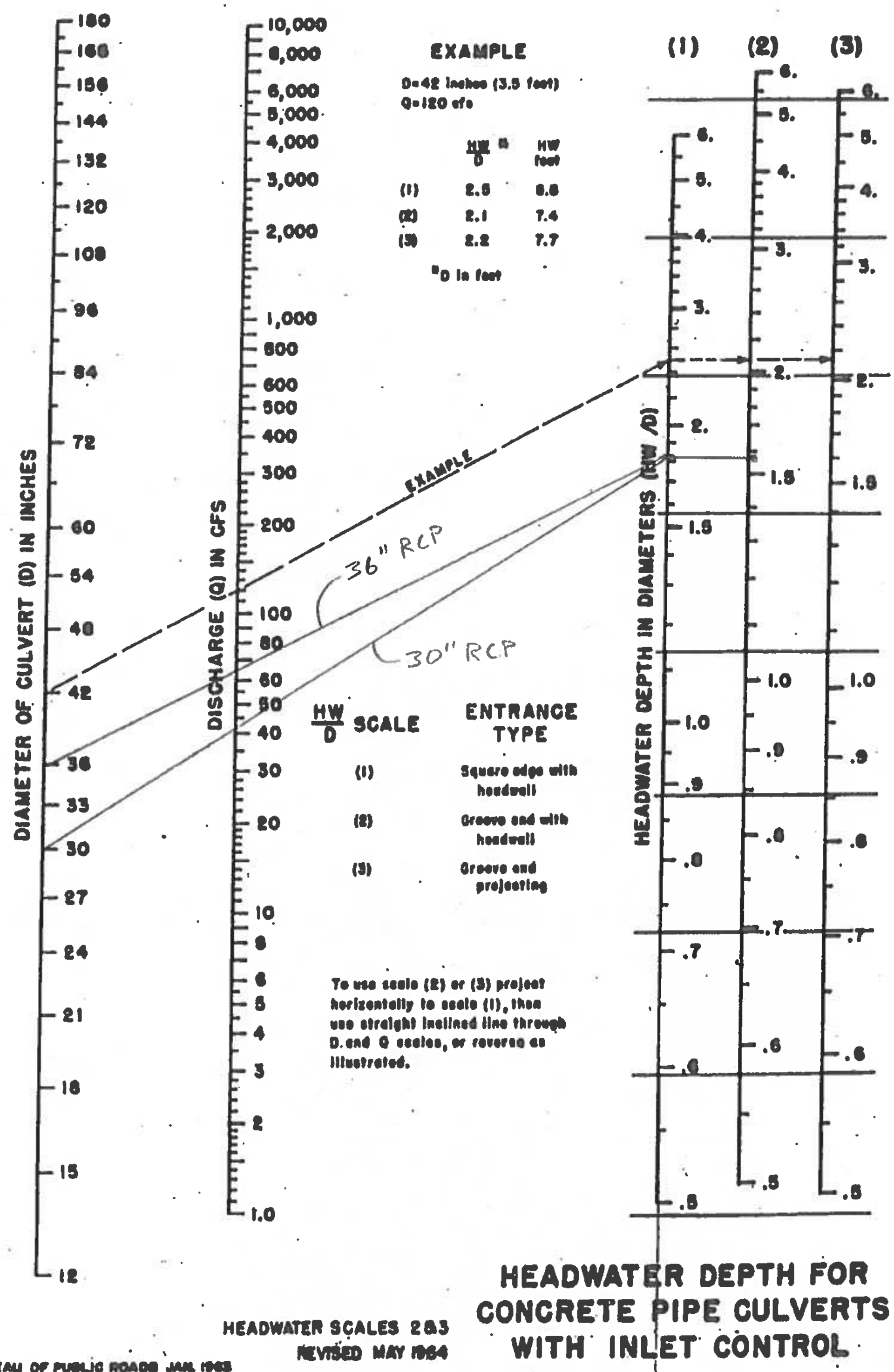
HW/D = 1.56'

Groove end w/ headwall on nomograph (B.P.R. Chart 2)

Q ≈ 42 cfs

Q_{TOTAL} = 65 cfs + 42 cfs = 107 cfs (EXIST. COND.) →

HIGHER Relationships



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HDR Infrastructure, Inc.
A Centerra Company

The City of Colorado Springs / El Paso County
Drainage Criteria Manual

EXISTING CULVERT CAPACITY AT PLATINUM (CONNECTED TO CBC)

Date
OCT. 1987

Figure
9-34

FROM: Austin Bluffs Parkway

WILSON & COMPANY

DATE: 8/17/12

TO:

FILE:

SUBJECT: Inlet Box @ Box Culvert

Size Riprap for Slopes adjacent to Inlet Structure

Flow antipated to reach slopes

① Drainage Map = 71 cfs

→ ② Existing Capacity ≈ 107 cfs *

* Conservative to utilize existing capacity

* Conservative to utilize as portion of runoff likely reaches ditch upstream of riprap slope

Assume 100 cfs equally distributed across north and west sides of protected slope

length of slope = 90' long perimeter

Unit cfs = 100 cfs / 90' = 1.11 cfs / LF

Using Steep slope riprap design table for 6' wide (Surface Mining Water Diversion Design Manual)

° Assumes 2:1 SS (Cons.) 6' x 1.11 / LF = 6.66 cfs

Nomograph @ 3:1 >10 cfs = 0.75' = D_{50}

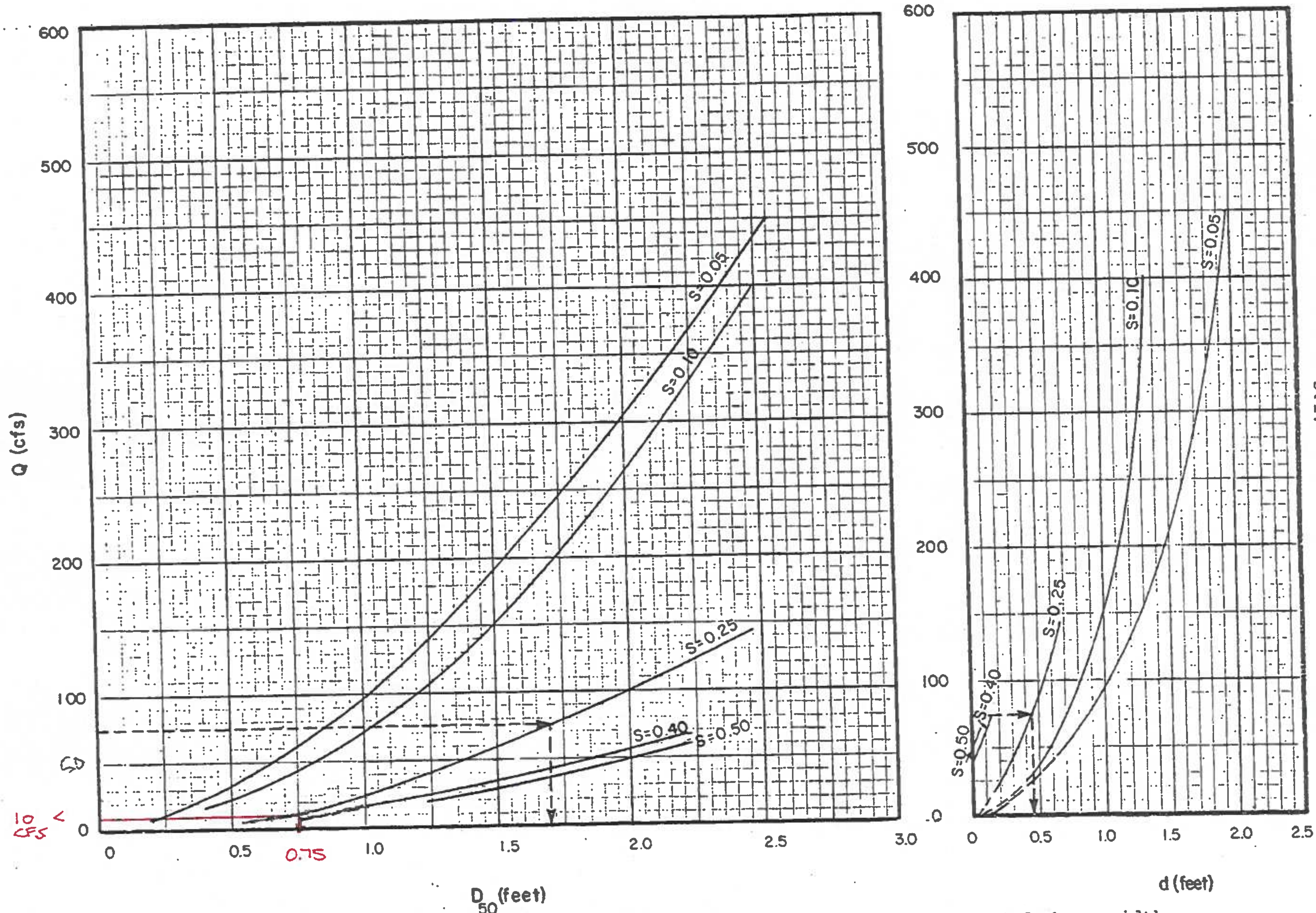


Figure 5.4. Steep slope riprap design, trapezoidal channels; 2:1 sideslopes, 6 ft base width.

SOURCE: SURFACE MINING WATER DIVERSION DESIGN MANUAL, 1982

Riprap Slope Protection @ Inlet Box
Qmax 100cfs
QUNIT = 6.6cfs

FROM: Austin Bluffs Parkway

TO:

DATE: 8/21/12

FILE:

SUBJECT:

Box Culvert Design - Inlet Structure

Elev of Flow in Box = 6550.01 (Per HEC-RAS)

Entrance Loss = $1.5 \times V_h$

$V_h = V^2/2g$

Approx Velocity = $\frac{107\text{ cfs}}{40\text{ sq ft}} = \frac{Q}{A} \Rightarrow V = 2.68\text{ '/s}$

Velocity Head = $(2.68)^2 / [2(32.2)] = 0.11'$

Loss @ Entrance = $1.5 \times 0.11'$

= $0.17'$

WSE @ Upstream End of Box Culvert

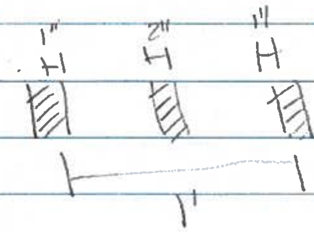
6550.01 + 0.17 = 6550.18'

Assume Open Area Req'd for Weir to develop above 6550.18

Assume 30% clogging factor and assume bar spacing @ 6" o.c.

Assume 2" ⌀ bars

Thus open space for every 1' =



12" - 4" = 8" OPEN SPACE

FROM: Austin Bluffs Parkway

WILSON & COMPANY

DATE: 8/21/12

TO:

FILE:

SUBJECT:

BOX CULVERT DESIGN - INLET STRUCTURE

PONDING = 52.4 - 50.18 = 2.22'

- ASSUME 0.5' OF CORNERS OF BOX INEFFECTIVE FLOW AREA
- FRONT & REAR OF RACK 8" OPEN AREA FOR EVERY 12'
- Q_{100} = 107 CFS (INTERIM FLOW)
- CLOGGING FACTOR = 30%
- WEIR FLOW WILL GOVERN

$Q_{100CL} = 1.3 \times 107 = 139.1$ CFS

$$Q_{FRONT} = 3.1\left(\frac{0.667}{1}\right)(16-1.0)(H)^{1.5} =$$

+

$$Q_{SIDES} = 3.1(7.25-0.5)\left(\frac{H-(0.5\times0.33)}{2}\right)^{1.5} \times 2.0 = 140.2 \text{ CFS}$$

H = 2.16' (to achieve 16' w box)

$H_{MIN} = 2.16 + 50.18 = 52.34'$

HIGHER Relationships

WILSON & COMPANY

FROM: Austin Bluffs Parkway

TO:

DATE: 8/21/12

FILE:

SUBJECT: Box Culvert Flow Rate Design Determination

- Flows estimated to reach Box Culvert

Per Rational Analysis = 71 cfs

Existing Capacity of Culverts @ Box > 107 cfs

Design box culvert to pass 107 cfs →

Appendix G

Hydraulic Gradeline Calculations

WILSON
&COMPANY

Austin Bluffs Parkway-Barnes to Platinum
5-YR HGL CALCULATION
Storm 1
Pipes 12, 13, 14
10/25/2012 12:48

MANNINGS n = 0.013

6483.80 — ASSUMED DOWNSTREAM HGL BEFORE ENTRANCE LOSS OF K=1.5. SEE HANDCALC FOR EXPLANATION

STATION	STRUCTURE	PIPE SIZE (inches)	PEAK RATE (cfs)	FLOW AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	JUNCTION DATA LENGTH (ft)	JUNCTION DATA LATERAL SIZE (inches)	JUNCTION DATA LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MH/BEND LOSS K	MH/BEND LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)	EXIST/PROP PIPE FL (elevation)	PROP. CROWN OR WEIR CREST. (elevation)	ADJUSTED EGL (elevation)	HGL ADJUSTED TO CROWN
	Outlet	36	54	7.065	7.64	666	0.00658	0.00			0.00								6483.80				
100.00	Storm MH 1 (M1)	36	54	7.065	7.64	666	0.00658	0.00			0.00			1.50	1.37	1.37	6485.17	0.91	6485.17	6479.48	6482.48	6483.39	NO
100.00	Storm MH 1 (M1)	24	19	3.140	6.05	226	0.00710	0.00			0.00					0.00	6485.73	0.57	6485.17	6481.48	6483.48	6484.05	NO
106.40	Pipe 14	24	19	3.140	6.05	226	0.00710	6.40			0.05					0.05	6485.78	0.57	6485.21	6481.58	6483.58	6484.15	NO
106.40	45 Bend	24	19	3.140	6.05	226	0.00710	0.00			0.00	0.35	0.20			0.20	6485.98	0.57	6485.41				
265.05	Pipe 14	24	19	3.140	6.05	226	0.00710	158.65			1.13					1.13	6488.75	0.57	6488.18	6486.18	6488.18	6488.75	YES
265.05	45 Bend	24	19	3.140	6.05	226	0.00710	0.00			0.00	0.35	0.20			0.20	6488.95	0.57	6488.38				
294.12	Pipe 14	24	19	3.140	6.05	226	0.00710	29.07			0.21					0.21	6489.37	0.57	6488.80	6486.53	6488.53	6489.10	NO
294.12	WQ MH 1	24	19	3.140	6.05	226	0.00710	0.00			0.00		1.50			1.50	6490.87	0.57	6490.30	6486.63	6488.80	6489.37	YES
308.63	Pipe 13	24	19	3.140	6.05	226	0.00710	14.51			0.10					0.10	6490.97	0.57	6490.40	6488.05	6490.05	6490.62	NO
308.63	Inlet	24	19	3.140	6.05	226	0.00710	0.00			0.00			1.30	0.74	0.74	6491.71	0.57	6491.14				
330.63	Inlet	18	13	1.766	7.36	105	0.01544	22.00			0.34					0.34	6492.05	0.84	6491.21	6489.18	6490.68	6491.52	NO
346.63	Pipe 12	18	13	1.766	7.36	105	0.01544	16.00			0.25					0.25	6492.29	0.84	6491.45	6489.82	6491.32	6492.16	NO
346.63	Inlet End	18	13	1.766	7.36	105	0.01544	0.00			0.00			1.50	1.26	1.26	6493.56	0.84	6492.71				

Flowline Elevation= 6493.84
Available Freeboard= 1.13

Inline water quality treatment units are assumed to require the use of a diversion weir to direct flow into the treatment chamber. The EGL elevation has been adjusted at WQ Vault #1 based on the assumption that an operational head loss of approximatly 1.5 ft will occur due to the diversion weir for flow in excess of the water quality peak flow rate. This loss is assumed to occur above a weir crest which has been estimated to be approximate 26" above the upstream pipe invert.

Austin Bluffs Parkway-Barnes to Platinum
5-YR HGL CALCULATION
Storm 2
Pipe 11
10/25/2012 12:48

MANNINGS n = 0.013

STATION	STRUCTURE	PIPE SIZE (inches)	PEAK RATE (cfs)	FLOW AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	JUNCTION DATA LENGTH (ft)	JUNCTION DATA LATERAL SIZE (inches)	JUNCTION DATA LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MH/BEND LOSS K	MANHOLE LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)	PROPOSED PIPE FL (elevation)	PROPOSED CROWN (elevation)	ADJUSTED EGL (elevation)	HGL ADJUSTED TO CROWN
94.04	Outlet	36	56																6491.00				
100.83	Junct Drop MH 2	36	27	7.065	3.82	666	0.00164	0.00			0.00					0.00	6491.23	0.23	6491.00	6487.60	6490.60	6490.83	NO
120.90	Pipe 11	36	27	7.065	3.82	666	0.00164	20.00			0.03					0.03	6494.03	0.23	6493.80	6490.80	6493.80	6494.03	
120.90	Inlet End	36	27	7.065	3.82	666	0.00164	0.00			0.00			1.50	0.34	0.34	6494.37	0.23	6494.14				

Flowline Elevation= 6496.30
Available Freeboard= 2.16

Austin Bluffs Parkway-Barnes to Platinum
5-YR HGL CALCULATION
Storm 3
Pipe 8, 9, 10
10/25/2012 12:48

MANNINGS n = 0.013

STATION	STRUCTURE	PIPE SIZE (inches)	PEAK RATE (cfs)	FLOW AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	JUNCTION DATA LENGTH (ft)	JUNCTION DATA LATERAL SIZE (inches)	JUNCTION DATA LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MH/BEND LOSS K	MANHOLE LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)	PROPOSED PIPE FL (elevation)	PROP. CROWN OR WEIR CREST. (elevation)	ADJUSTED EGL (elevation)	HGL ADJUSTED TO CROWN
94.04	Outlet	36	56																6491.00				
102.04	Junct Drop MH 2	24	19	3.140	6.05	226	0.00710	0.00			0.00					0.00	6491.57	0.57	6491.00	6489.00	6491.00	6491.57	YES
115.39	Pipe 10	24	19	3.140	6.05	226	0.00710	13.35			0.09					0.09	6493.24	0.57	6492.67	6490.40	6492.40	6492.97	NO
115.39	WQ MH 2	24	19	3.140	6.05	226	0.00710	0.00			0.00		1.50			1.50	6494.74	0.57	6494.17	6490.50	6492.67	6493.24	YES
140.82	Pipe 9	24	19	3.140	6.05	226	0.00710	25.43			0.18					0.18	6495.68	0.57	6495.11	6493.11	6495.11	6495.68	YES
140.82	Inlet	24	19	3.140	6.05	226	0.00710	0.00			0.00			1.30	0.74	0.74	6496.42	0.57	6495.85				
158.82	Inlet	24	12	3.140	3.82	226	0.00283	18.00			0.05					0.05	6496.35	0.23	6496.12	6494.12	6496.12	6496.35	YES
174.33	Pipe 8	24	12	3.140	3.82	226	0.00283	33.51			0.09					0.09	6497.15	0.23	6496.92	6494.92	6496.92	6497.15	YES
174.33	Inlet End	24	12	3.140	3.82	226	0.00283	0.00			0.00			1.50	0.34	0.34	6497.49	0.23	6497.26				

Flowline Elevation= 6498.40
Available Freeboard= 1.14

Inline water quality treatment units are assumed to require the use of a diversion weir to direct flow into the treatment chamber. The EGL elevation has been adjusted at WQ Vault #2 based on the assumption that an operational head loss of approximatly 1.5 ft will occur due to the diversion weir for flow in excess of the water quality peak flow rate. This loss is assumed to occur above a weir crest which has been estimated to be approximate 26" above the upstream pipe invert.

Austin Bluffs Parkway-Barnes to Platinum
5-YR HGL CALCULATION
Storm 4
Pipe 1, 2, 3, 4, 6, 7
10/19/2012 13:33

MANNINGS n = 0.013

6481.00 ASSUMED DOWNSTREAM HGL BEFORE ENTRANCE LOSS OF K=1.5. SEE HANDCALC FOR EXPLANATION

STATION	STRUCTURE	PIPE SIZE (inches)	PEAK RATE (cfs)	AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	LENGTH (ft)	JUNCTION DATA LATERAL SIZE (inches)	JUNCTION DATA LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MH/BEND LOSS K	MANHOLE LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)	EXIST/PROP PIPE FL (elevation)	PROPOSED CROWN (elevation)	ADJUSTED EGL (elevation)	HGL ADJUSTED TO CROWN
	Outlet	42	102	9.616	10.61	1005	0.01030	0.00			0.00								6481.00				
-372.52	Exist. MH M2	42	102	9.616	10.61	1005	0.01030	0.00			0.00			1.50	2.62	2.62	6483.62	1.75	6483.62	6477.83	6481.33	6483.08	NO
-372.52	Exist. MH M2	36	73	7.065	10.33	666	0.01202	0.00			0.00					0.00	6485.28	1.66	6483.62	6477.83	6480.83	6482.49	NO
-352.52	Exist Pipe	36	73	7.065	10.33	666	0.01202	20.00			0.24					0.24	6485.52	1.66	6483.86	6478.37	6481.37	6483.03	NO
-352.52	Existing MH M2B	36	73	7.065	10.33	666	0.01202	0.00			0.00	0.80	1.33			1.33	6486.85	1.66	6485.19				
-2.52	Exist Pipe	36	56	7.065	7.93	666	0.00707	350.00			2.48					2.48	6489.32	0.98	6488.35	6484.64	6487.64	6488.62	NO
-2.52	Junct Drop MH 2	24	15	3.140	4.78	226	0.00442	0.00			0.00	1.50	1.46			1.46	6491.35	0.35	6491.00	6489.00	6491.00	6491.35	YES
16.08	Pipe 7	24	15	3.140	4.78	226	0.00442	12.40			0.05					0.05	6491.70	0.35	6491.35	6489.35	6491.35	6491.70	YES
16.08	45 Bend	24	15	3.140	4.78	226	0.00442	0.00			0.00	0.35	0.12			0.12	6491.83	0.35	6491.47				
545.04	Pipe 7	24	15	3.140	4.78	226	0.00442	528.96			2.34					2.34	6503.80	0.35	6503.45	6501.45	6503.45	6503.80	YES
545.04	Straight MH 3	24	15	3.140	4.78	226	0.00442	0.00			0.00	0.15	0.05			0.05	6504.00	0.35	6503.65	6501.65	6503.65	6504.00	YES
809.00	Pipe 6	24	15	3.140	4.78	226	0.00442	263.96			1.17					1.17	6511.62	0.35	6511.27	6509.27	6511.27	6511.62	YES
809.00	Grade Break	24	15	3.140	4.78	226	0.00442	0.00			0.00					0.00	6511.62	0.35	6511.27				
954.85	Pipe 6	24	15	3.140	4.78	226	0.00442	145.85			0.65					0.65	6512.35	0.35	6512.00	6510.00	6512.00	6512.35	YES
954.85	Junct Drop MH 4	24	15	3.140	4.78	226	0.00442	0.00			0.00	1.50	0.53			0.53	6515.35	0.35	6515.00	6513.00	6515.00	6515.35	YES
1345.64	Pipe 4	24	5	3.140	1.59	226	0.00049	390.79			0.19					0.19	6526.36	0.04	6526.32	6524.32	6526.32	6526.36	YES
1345.64	Straight MH 5	24	5	3.140	1.59	226	0.00049	0.00			0.00	0.15	0.01			0.01	6526.56	0.04	6526.52	6524.52	6526.52	6526.56	YES
1727.25	Pipe 3	24	5	3.140	1.59	226	0.00049	381.61			0.19					0.19	6536.64	0.04	6536.60	6534.60	6536.60	6536.64	YES
1727.25	90 MH 6	24	5	3.140	1.59	226	0.00049	0.00			0.00	1.05	0.04			0.04	6536.84	0.04	6536.80	6534.80	6536.80	6536.84	YES
1768.52	Pipe 2	24	5	3.140	1.59	226	0.00049	41.27			0.02					0.02	6538.70	0.04	6538.66	6536.66	6538.66	6538.70	YES
1768.52	Type C Inlet	24	5	3.140	1.59	226	0.00049	0.00			0.00			1.30	0.05	0.05	6538.75	0.04	6538.71				
1771.44	Type C Inlet	18	5	1.766	2.83	105	0.00228	2.92			0.01					0.01	6538.82	0.12	6538.70	6537.20	6538.70	6538.82	YES
1782.45	Pipe 1	18	5	1.766	2.83	105	0.00228	11.01			0.03					0.03	6540.33	0.12	6540.21	6538.71	6540.21	6540.33	YES
1782.45	Vert Bend	18	5	1.766	2.83	105	0.00228	0.00			0.00	0.10	0.01			0.01	6540.35	0.12	6540.22				
1812.45	Pipe 1	18	5	1.766	2.83	105	0.00228	30.00			0.07					0.07	6540.78	0.12	6540.66	6539.16	6540.66	6540.78	YES
1812.45	Inlet End	18	5	1.766	2.83	105	0.00228	0.00			0.00			1.50	0.19	0.19	6540.97	0.12	6540.85				

Flowline Elevation= 6542.60
Available Freeboard= 1.75

Austin Bluffs Parkway-Barnes to Platinum
5-YR HGL CALCULATION
Storm 5
Pipe 5
10/19/2012 13:33

MANNINGS n = 0.013

STATION	STRUCTURE	PIPE SIZE (inches)	PEAK RATE (cfs)	FLOW AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	LENGTH (ft)	JUNCTION DATA LATERAL SIZE (inches)	JUNCTION DATA LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MANHOLE LOSS K	MANHOLE LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)	PROPOSED PIPE FL (elevation)	PROPOSED CROWN (elevation)	ADJUSTED EGL (elevation)	HGL ADJUSTED TO CROWN
100.00	Outlet	24	15																6515.00				
102.00	Junct MH 4	24	11	3.140	3.50	226	0.00238	0.00			0.00					0.00	6515.19	0.19	6515.00	6513.00	6515.00	6515.19	NO
144.29	Pipe 5	24	11	3.140	3.50	226	0.00238	42.29			0.10					0.10	6515.29	0.19	6515.10				
144.29	Inlet End	24	11	3.140	3.50	226	0.00238	0.00			0.00			1.50	0.29	0.29	6515.58	0.19	6515.39				

Flowline Elevation= 6519.40
Available Freeboard= 4.01

Austin Bluffs Parkway-Platinum to Ruby
100-YR HGL CALCULATION
Storm 6

Pipes 15, 16b, 18
10/25/2012 12:48

MANNINGS n = 0.013

6549.29 STARTING HGL PROVIDED BY HEC RAS ANALYSIS OF BOX CULVERT

STATION	STRUCTURE	PIPE SIZE (inches)	PEAK RATE (cfs)	AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	JUNCTION DATA: LENGTH (ft)	JUNCTION DATA: LATERAL SIZE (inches)	JUNCTION DATA: LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MH/BEND LOSS K	MH/BEND LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)	PROPOSED PIPE FL (elevation)	PROP. CROWN OR WEIR CREST. (elevation)	ADJUSTED EGL (elevation)	HGL ADJUSTED TO CROWN
	Outlet	30	31																6549.29				
104.02	CBC Pipe 40	30	31	4.906	6.32	409	0.00574	0.00			0.00					0.00	6549.91	0.62	6549.29	6546.50	6549.00	6549.62	NO
118.33	Pipe 18	30	31	4.906	6.32	409	0.00574	14.31			0.08					0.08	6550.15	0.62	6549.53	6546.83	6549.33	6549.95	NO
118.33	WQ MH 3	30	31	4.906	6.32	409	0.00574	0.00			0.00		1.50			1.50	6551.65	0.62	6551.03	6547.03	6549.53	6550.15	NO
205.9	Pipe 16b	30	23	4.906	4.69	409	0.00316	87.57			0.28					0.28	6552.34	0.34	6552.00	6549.5	6552.00	6552.34	YES
205.9	Junct Drop MH 14	24	23	3.140	7.32	226	0.01040	0.00			0.00	0.80	0.27			0.27	6552.83	0.83	6552.00	6550.00	6552.00	6552.83	YES
220.81	Pipe 15	24	14	3.140	4.46	226	0.00385	14.91			0.06					0.06	6553.14	0.31	6552.83	6550.83	6552.83	6553.14	YES
220.81	45 Bend	24	14	3.140	4.46	226	0.00385	0.00			0.00	0.35	0.11			0.11	6553.25	0.31	6552.94				
241.64	Pipe 15	24	14	3.140	4.46	226	0.00385	20.83			0.08					0.08	6554.71	0.31	6554.40	6552.4	6554.4	6554.71	YES
241.64	Inlet	24	14	3.140	4.46	226	0.00385	0.00			0.00	1.50	0.46			0.46	6555.17	0.31	6554.86				

Flowline Elevation= 6556.01
Available Freeboard= 1.15

Inline water quality treatment units are assumed to require the use of a diversion weir to direct flow into the treatment chamber. The EGL elevation has been adjusted at WQ Vault #3 based on the assumption that an operational head loss of approximatly 1.5 ft will occur due to the diversion weir for flow in excess of the water quality peak flow rate. This loss is assumed to occur above a weir crest which has been estimated to be approximate 17" above the upstream pipe invert.

Austin Bluffs Parkway-Platinum to Ruby
100-YR HGL CALCULATION
Storm 7

Pipe 17a, 17b
10/25/2012 12:48

MANNINGS n = 0.013

STATION	STRUCTURE	PIPE SIZE (inches)	PEAK RATE (cfs)	AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	JUNCTION DATA: LENGTH (ft)	JUNCTION DATA: LATERAL SIZE (inches)	JUNCTION DATA: LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MH/BEND LOSS K	MH/BEND LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)	PROPOSED PIPE FL (elevation)	PROPOSED CROWN (elevation)	ADJUSTED EGL (elevation)	HGL ADJUSTED TO CROWN
103.00	Outlet	24	8																6551.03				
103.00	WQ MH 3	24	8	3.140	2.55	226	0.00126	0.00			0.00					0.00	6551.13	0.10	6551.03	6547.03	6549.03	6549.13	NO
114.97	Pipe 17b	24	8	3.140	2.55	226	0.00126	11.97			0.02					0.02	6551.15	0.10	6551.05	6549.00	6551.00	6551.10	NO
114.97	Inlet	24	8	3.140	2.55	226	0.00126	0.00			0.00			1.50	0.15	0.15	6551.30	0.00	6551.30				
124.06	Inlet	18	6	1.766	3.40	105	0.00329	9.09			0.03					0.03	6551.33	0.18	6551.15	6549.51	6551.01	6551.19	NO
136.06	Pipe 17a	18	6	1.766	3.40	105	0.00329	12.00			0.04					0.04	6551.43	0.18	6551.25	6549.75	6551.25	6551.43	YES
136.06	Inlet End	18	6	1.766	3.40	105	0.00329	0.00			0.00			1.50	0.27	0.27	6551.70	0.18	6551.52				

Flowline Elevation= 6553.87
Available Freeboard= 2.35

Austin Bluffs Parkway-Platinum to Ruby
100-YR HGL CALCULATION
Storm 7a

Pipe 16a
10/25/2012 12:48

MANNINGS n = 0.013

STATION	STRUCTURE	PIPE SIZE (inches)	PEAK RATE (cfs)	AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	JUNCTION DATA: LENGTH (ft)	JUNCTION DATA: LATERAL SIZE (inches)	JUNCTION DATA: LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MH/BEND LOSS K	MH/BEND LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)	PROPOSED PIPE FL (elevation)	PROPOSED CROWN (elevation)	ADJUSTED EGL (elevation)	HGL ADJUSTED TO CROWN
102.45	Outlet	24	9																6552.00				
102.45	Junct Drop MH 14	24	9	3.140	2.87	226	0.00159	0.00			0.00					0.00	6552.13	0.13	6552.00	6547.50	6549.50	6549.63	NO
114.73	Pipe 16a	24	9	3.140	2.87	226	0.00159	12.28			0.02					0.02	6553.92	0.13	6553.79	6551.79	6553.79	6553.92	YES
114.73	Inlet	24	9	3.140	2.87	226	0.00159	0.00			0.00			1.50	0.19	0.19	6554.11	0.13	6553.98				

Flowline Elevation= 6555.36
Available Freeboard= 1.38

Austin Bluffs Parkway-Platinum to Ruby
100-YR HGL CALCULATION
Storm 8

Pipes 37, 38, 39
10/25/2012 12:48

MANNINGS n = 0.013

6552.24 STARTING HGL PROVIDED BY HEC RAS ANALYSIS OF BOX CULVERT

STATION	STRUCTURE	PIPE SIZE (inches)	PEAK RATE (cfs)	AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	JUNCTION DATA: LENGTH (ft)	JUNCTION DATA: LATERAL SIZE (inches)	JUNCTION DATA: LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MH/BEND LOSS K	MH/BEND LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)	PROPOSED PIPE FL (elevation)	PROPOSED CROWN (elevation)	ADJUSTED EGL (elevation)	HGL ADJUSTED TO CROWN
	Outlet	18	6																6552.24				
104.00	CBC Pipe 40	18	6	1.766	3.40	105	0.00329	0.00			0.00					0.00	6552.42	0.18	6552.24	6549.00	6550.50	6550.68	NO
112.50	Pipe 39	18	6	1.766	3.40	105	0.00329	8.50			0.03					0.03	6552.45	0.18	6552.27	6549.20	6550.70	6550.88	NO
112.50	WQ MH 4	18	6	1.766	3.40	105	0.00329	0.00			0.00	1.46	0.26			0.26	6552.71	0.18	6552.53	6549.50	6551.00	6551.18	NO
123.49	Pipe 38	18	6	1.766	3.40	105	0.00329	10.99			0.04					0.04	6552.74	0.18	6552.57				
123.49	Inlet	18	6	1.766	3.40	105	0.00329	0.00			0.00	1.30	0.23			0.23	6552.98	0.18	6552.80	6549.70	6551.20	6551.38	NO
131.49	Inlet	18	4	1.766	2.26	105	0.00146	8.00			0.01					0.01	6552.99	0.08	6552.91	6550.00	6551.50	6551.58	NO
143.50	Pipe 37	18	4	1.766	2.26	105	0.00146	12.01			0.02					0.02	6553.01	0.08	6552.93	6550.3	6551.80	6551.88	NO
143.50	Inlet End	18	4	1.766	2.26	105	0.00146	0.00			0.00			1.50	0.12	0.12	6553.13	0.08	6553.05				

Flowline Elevation= 6554.77
Available Freeboard= 1.72

Austin Bluffs Parkway-Platinum to Ruby
100-YR HGL CALCULATION
Storm 9

See HEC-RAS Output for Concrete Box Culvert HGL Determination

Austin Bluffs Parkway-Platinum to Ruby
100-YR HGL CALCULATION
Storm 10

Pipes 19, 20, 24, 26, 29, 34, 36

10/19/2012 13:33

MANNINGS n = 0.013

6551.40 — STARTING HGL ASSUMED TO BE TOP OF BOX CULVERT. CONSERVATIVE OVER REPORT HGL IN HEC-RAS ANALYSIS

STATION	STRUCTURE	PIPE SIZE (inches)	PEAK RATE (cfs)	FLOW AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	JUNCTION DATA: LENGTH (ft)	JUNCTION DATA: LATERAL SIZE (inches)	JUNCTION DATA: LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MH/BEND LOSS K	MH/BEND LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)	PROPOSED PIPE FL (elevation)	PROPOSED CROWN (elevation)	ADJUSTED EGL (elevation)	HGL ADJUSTED TO CROWN
	Outlet	54	162																6551.40				
104.64	CBC Pipe 40	54	162	15.896	10.19	1966	0.00679	0			0.00					0.00	6553.01	1.61	6551.40	6546.70	6551.20	6552.81	NO
120.14	Pipe 36	54	162	15.896	10.19	1966	0.00679	15.50			0.11					0.11	6553.12	1.61	6551.51	6546.86	6551.36	6552.97	NO
120.14	30 Bend	54	162	15.896	10.19	1966	0.00679	0.00			0.00	0.20	0.32			0.32	6553.44	1.61	6551.83				
294.44	Pipe 36	54	162	15.896	10.19	1966	0.00679	174.30			1.18					1.18	6554.71	1.61	6553.10	6548.60	6553.10	6554.71	YES
294.44	Junct MH 7	54	162	15.896	10.19	1966	0.00679	0.00	18	90	0.00	0.15	0.24			0.24	6554.95	1.61	6553.34				
298.35	Junct MH 7	48	163	12.560	12.98	1435	0.01290	3.91			0.05					0.05	6555.72	2.62	6553.10	6549.10	6553.10	6555.72	YES
484.57	Pipe 34	48	163	12.560	12.98	1435	0.01290	186.22			2.40					2.40	6558.12	2.62	6555.50	6551.40	6555.40	6558.02	NO
484.57	Junct MH 8	48	163	12.560	12.98	1435	0.01290	0.00	48	45	0.00	1.00	2.62			2.62	6560.73	2.62	6558.12	6552.00	6556.00	6558.62	NO
536.90	Pipe 29	30	55	4.906	11.21	409	0.01807	52.33			0.95					0.95	6561.68	1.95	6559.73	6553.11	6555.61	6557.56	NO
536.90	Junct MH 9	30	55	4.906	11.21	409	0.01807	0.00	18	60	0.00	1.00	1.95			1.95	6563.63	1.95	6561.68	6554.80	6557.30	6559.25	NO
718.58	Pipe 26	30	45	4.906	9.17	409	0.01209	181.68			2.20					2.20	6569.81	1.31	6568.50	6566.00	6568.50	6569.81	YES
718.58	Junct MH 10	30	45	4.906	9.17	409	0.01209	0.00	18	90	0.00	0.50	0.65			0.65	6570.46	1.31	6569.15				
722.58	Junct MH 10	30	44	4.906	8.97	409	0.01156	4.00			0.05					0.05	6570.75	1.25	6569.50	6567.00	6569.50	6570.75	YES
948.34	Pipe 24	30	44	4.906	8.97	409	0.01156	225.76			2.61					2.61	6580.91	1.25	6579.66	6577.16	6579.66	6580.91	YES
948.34	Junct MH 11	30	44	4.906	8.97	409	0.01156	0.00	30	60	0.00	1.00	1.25			1.25	6582.16	1.25	6580.91	6578.16	6580.66	6581.91	NO
1198.23	Pipe 20	24	20	3.140	6.37	226	0.00787	249.89			1.97					1.97	6586.49	0.63	6585.86	6583.86	6585.86	6586.49	YES
1198.23	WQ MH 6	24	20	3.140	6.37	226	0.00787	0.00			0.00		1.33			1.33	6587.82	0.63	6587.19				
1245.29	Pipe 19	24	20	3.140	6.37	226	0.00787	47.06			0.37					0.37	6588.19	0.63	6587.56	6585.50	6587.50	6588.13	NO
1245.29	Inlet End	24	20	3.140	6.37	226	0.00787	0.00			0.00			1.50	0.94	0.94	6589.14	0.63	6588.51				

Flowline Elevation= 6590.87

Available Freeboard= 2.36

Austin Bluffs Parkway-Platinum to Ruby
100-YR HGL CALCULATION
Storm 11

Pipe 35

10/19/2012 13:33

MANNINGS n = 0.013

STATION	STRUCTURE	PIPE SIZE (inches)	PEAK RATE (cfs)	AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	JUNCTION DATA: LENGTH (ft)	JUNCTION DATA: LATERAL SIZE (inches)	JUNCTION DATA: LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MH/BEND LOSS K	MH/BEND LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)	PROPOSED PIPE FL (elevation)	PROPOSED CROWN (elevation)	ADJUSTED EGL (elevation)	HGL ADJUSTED TO CROWN
102.45	Outlet	18	1																				
102.45	Outlet	18	1	1.766	0.57	105	0.00009	0.00			0.00					0.00	6553.35	0.00	6553.34	6551.60	6553.10	6553.10	NO
122.76	Pipe 35	18	1	1.766	0.57	105	0.00009	20.31			0.00					0.00	6556.50	0.00	6556.50	6555.00	6556.50	6556.50	YES
122.76	Inlet End	18	1	1.766	0.57	105	0.00009	0.00			0.00			1.50	0.01	0.01	6556.51	0.00	6556.51				

Flowline Elevation= 6561.30

Available Freeboard= 4.79

Austin Bluffs Parkway-Platinum to Ruby
100-YR HGL CALCULATION
Storm 12

Pipes 31, 33

10/19/2012 13:33

MANNINGS n = 0.013

STATION	STRUCTURE	PIPE SIZE (inches)	PEAK RATE (cfs)	AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	JUNCTION DATA: LENGTH (ft)	JUNCTION DATA: LATERAL SIZE (inches)	JUNCTION DATA: LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MH/BEND LOSS K	MH/BEND LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)	PROPOSED PIPE FL (elevation)	PROPOSED CROWN (elevation)	ADJUSTED EGL (elevation)	HGL ADJUSTED TO CROWN
102.92	Outlet	48	112																				
102.92	Outlet	48	112	12.560	8.92	1435	0.00609	0.00			0.00					0.00	6559.35	1.23	6558.12	6552.00	6556.00	6557.23	NO
113.51	Pipe 33	48	112	12.560	8.92	1435	0.00609	10.59			0.06					0.06	6559.42	1.23	6558.18	6552.50	6556.50	6557.73	NO
113.51	45 Bend	48	112	12.560	8.92	1435	0.00609	0.00			0.00	0.35	0.43			0.43	6559.85	1.23	6558.61				
143.54	Pipe 33	48	112	12.560	8.92	1435	0.00609	30.03			0.18					0.18	6560.03	1.23	6558.80	6553.91	6557.91	6559.14	NO
143.54	Junct MH 12	48	112	12.560	8.92	1435	0.00609	0.00	24	90	0.00	1.00	1.23			1.23	6561.27	1.23	6560.03				
156.54	Pipe 31	42	83	9.616	8.63	1005	0.00682	13.00			0.09					0.09	6561.35	1.16	6560.20	6554.49	6557.99	6559.15	NO
156.54	Inlet End	42	83	9.616	8.63	1005	0.00682	0.00			0.00					0.00	6561.35	1.16	6560.20				

(FUTURE)

Flowline Elevation= 6562.06

Available Freeboard= 1.86

Austin Bluffs Parkway-Platinum to Ruby
100-YR HGL CALCULATION
Storm 13
Pipe 30
10/19/2012 13:33

MANNINGS n = 0.013

STATION	STRUCTURE	PIPE * SIZE (inches)	PEAK RATE (cfs)	AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	JUNCTION DATA LENGTH (ft)	JUNCTION DATA LATERAL SIZE (inches)	JUNCTION DATA LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MH/BEND LOSS K	MH/BEND LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)	PROPOSED PIPE FL (elevation)	PROPOSED CROWN (elevation)	ADJUSTED EGL (elevation)	HGL ADJUSTED TO CROWN
103.00	Outlet	30"x19"	14																				
103.00	Junct MH 12	30"x19"	14	3.280	4.27	232	0.00364	0			0.00					0.00	6560.31	0.28	6560.03	6552.00	6553.58	6553.87	NO
113.25	Pipe 30	30"x19"	14	3.280	4.27	232	0.00364	10.25			0.04					0.04	6561.06	0.28	6560.77	6559.19	6560.77	6561.06	YES
113.25	11 Vert Bend	30"x19"	14	3.280	4.27	232	0.00364	0.00			0.00	0.15	0.04			0.04	6561.10	0.28	6560.82				
123.37	Pipe 30	30"x19"	14	3.280	4.27	232	0.00364	10.12			0.04					0.04	6561.97	0.28	6561.68	6560.10	6561.68	6561.97	YES
123.37	Inlet End	30"x19"	14	3.280	4.27	232	0.00364	0.00			0.00			1.30	0.37	0.37	6562.33	0.28	6562.05				

Flowline Elevation= 6562.40
Available Freeboard= 0.35
(FES-OK)

Austin Bluffs Parkway-Platinum to Ruby
100-YR HGL CALCULATION
Storm 14
Pipe 32
10/19/2012 13:33

MANNINGS n = 0.013

STATION	STRUCTURE	PIPE SIZE (inches)	PEAK RATE (cfs)	AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	JUNCTION DATA LENGTH (ft)	JUNCTION DATA LATERAL SIZE (inches)	JUNCTION DATA LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MH/BEND LOSS K	MH/BEND LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)	PROPOSED PIPE FL (elevation)	PROPOSED CROWN (elevation)	ADJUSTED EGL (elevation)	HGL ADJUSTED TO CROWN
103.00	Outlet	30"x19"	14																				
103.00	Junct MH 12	30"x19"	14	3.280	4.27	232	0.00364	0			0.00					0.00	6560.31	0.28	6560.03	6552.00	6553.58	6553.87	NO
118.00	Pipe 32	30"x19"	14	3.280	4.27	232	0.00364	15.00			0.05					0.05	6561.67	0.28	6561.38	6559.80	6561.38	6561.67	YES
118.00	Inlet End	30"x19"	14	3.280	4.27	232	0.00364	0			0.00			1.30	0.37	0.37	6562.03	0.28	6561.75				

Flowline Elevation= 6562.07
Available Freeboard= 0.32
(FES-OK)

Austin Bluffs Parkway-Platinum to Ruby
100-YR HGL CALCULATION
Storm 15
Pipes 27, 28
10/19/2012 13:33

MANNINGS n = 0.013

STATION	STRUCTURE	PIPE SIZE (inches)	PEAK RATE (cfs)	AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	JUNCTION DATA LENGTH (ft)	JUNCTION DATA LATERAL SIZE (inches)	JUNCTION DATA LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MH/BEND LOSS K	MH/BEND LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)	PROPOSED PIPE FL (elevation)	PROPOSED CROWN (elevation)	ADJUSTED EGL (elevation)	HGL ADJUSTED TO CROWN
102.66	Outlet	24	15																				
102.66	Storm MH 9	24	15	3.140	4.78	226	0.00442	0			0.00					0.00	6562.03	0.35	6561.68	6557.28	6559.28	6559.63	NO
118.00	Pipe 28	24	15	3.140	4.78	226	0.00442	15.34			0.07					0.07	6562.10	0.35	6561.75	6558.53	6560.53	6560.88	NO
118.00	WQ MH 5	24	15	3.140	4.78	226	0.00442	0.00			0.00		1.20			1.20	6563.30	0.35	6562.95	6558.63	6560.63	6560.98	NO
124.72	Pipe 27	24	15	3.140	4.78	226	0.00442	6.72			0.03					0.03	6563.33	0.35	6562.98	6559.44	6561.44	6561.79	NO
124.72	Inlet End	24	15	3.140	4.78	226	0.00442	0.00			0.00			1.50	0.53	0.53	6563.86	0.35	6563.51				

Flowline Elevation= 6565.13
Available Freeboard= 1.62

Austin Bluffs Parkway-Platinum to Ruby
100-YR HGL CALCULATION
Storm 16
Pipe 25
10/19/2012 13:33

6569.03 STARTING HGL ASSUMED TO BE CROWN OF PIPE

MANNINGS n = 0.013

STATION	STRUCTURE	PIPE SIZE (inches)	PEAK RATE (cfs)	AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	JUNCTION DATA LENGTH (ft)	JUNCTION DATA LATERAL SIZE (inches)	JUNCTION DATA LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MH/BEND LOSS K	MH/BEND LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)	PROPOSED PIPE FL (elevation)	PROPOSED CROWN (elevation)	ADJUSTED EGL (elevation)	HGL ADJUSTED TO CROWN
102.00	Outlet	18	2																6569.03				
102.00	Storm MH 10	18	2	1.766	1.13	105	0.00037	0.00			0.00					0.00	6569.05	0.02	6569.03	6567.53	6569.03	6569.05	YES
124.24	Pipe 25	18	2	1.766	1.13	105	0.00037	22.24			0.01					0.01	6569.27	0.02	6569.25	6567.75	6569.25	6569.27	YES
124.24	Inlet End	18	2	1.766	1.13	105	0.00037	0.00			0.00			1.50	0.03	0.03	6569.30	0.02	6569.28				

Flowline Elevation= 6573.00
Available Freeboard= 3.72

Austin Bluffs Parkway-Platinum to Ruby
100-YR HGL CALCULATION
Storm 17
Pipes 21, 23
10/19/2012 13:33

MANNINGS n = 0.013

STATION	STRUCTURE	PIPE SIZE (inches)	PEAK RATE (cfs)	AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	JUNCTION DATA LENGTH (ft)	JUNCTION DATA LATERAL SIZE (inches)	JUNCTION DATA LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MH/BEND LOSS K	MH/BEND LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)	PROPOSED PIPE FL (elevation)	PROPOSED CROWN (elevation)	ADJUSTED EGL (elevation)	HGL ADJUSTED TO CROWN
102.00	Outlet	30	30																				
102.00	Storm MH 11	30	30	4.906	6.11	409	0.00538	0.00			0.00					0.00	6581.49	0.58	6580.91				
128.85	Pipe 23	30	30	4.906	6.11	409	0.00538	26.85			0.14					0.14	6581.63	0.58	6581.05	6578.05	6580.55	6581.13	NO
128.85	Storm MH 13	30	30	4.906	6.11	409	0.00538	0.00	18	60	0.00	1.00	0.58			0.58	6582.21	0.58	6581.63				
132.00	Storm MH 13	30	29	4.906	5.91	409	0.00502	3.15			0.02					0.02	6583.09	0.54	6582.55	6580.05	6582.55	6583.09	YES
169.96	Pipe 21	30	29	4.906	5.91	409	0.00502	37.96			0.19					0.19	6587.04	0.54	6586.50	6584.00	6586.50	6587.04	YES
169.96	Inlet End	30	29	4.906	5.91	409	0.00502	0.00			0.00			1.30	0.71	0.71	6587.75	0.54	6587.21				

Flowline Elevation= 6587.50
Available Freeboard= 0.29
(FES-OK)

Austin Bluffs Parkway-Platinum to Ruby
100-YR HGL CALCULATION
Storm 18
Pipe 22
10/19/2012 13:33

MANNINGS n = 0.013

6582.20 STARTING HGL ASSUMED TO BE CROWN OF PIPE

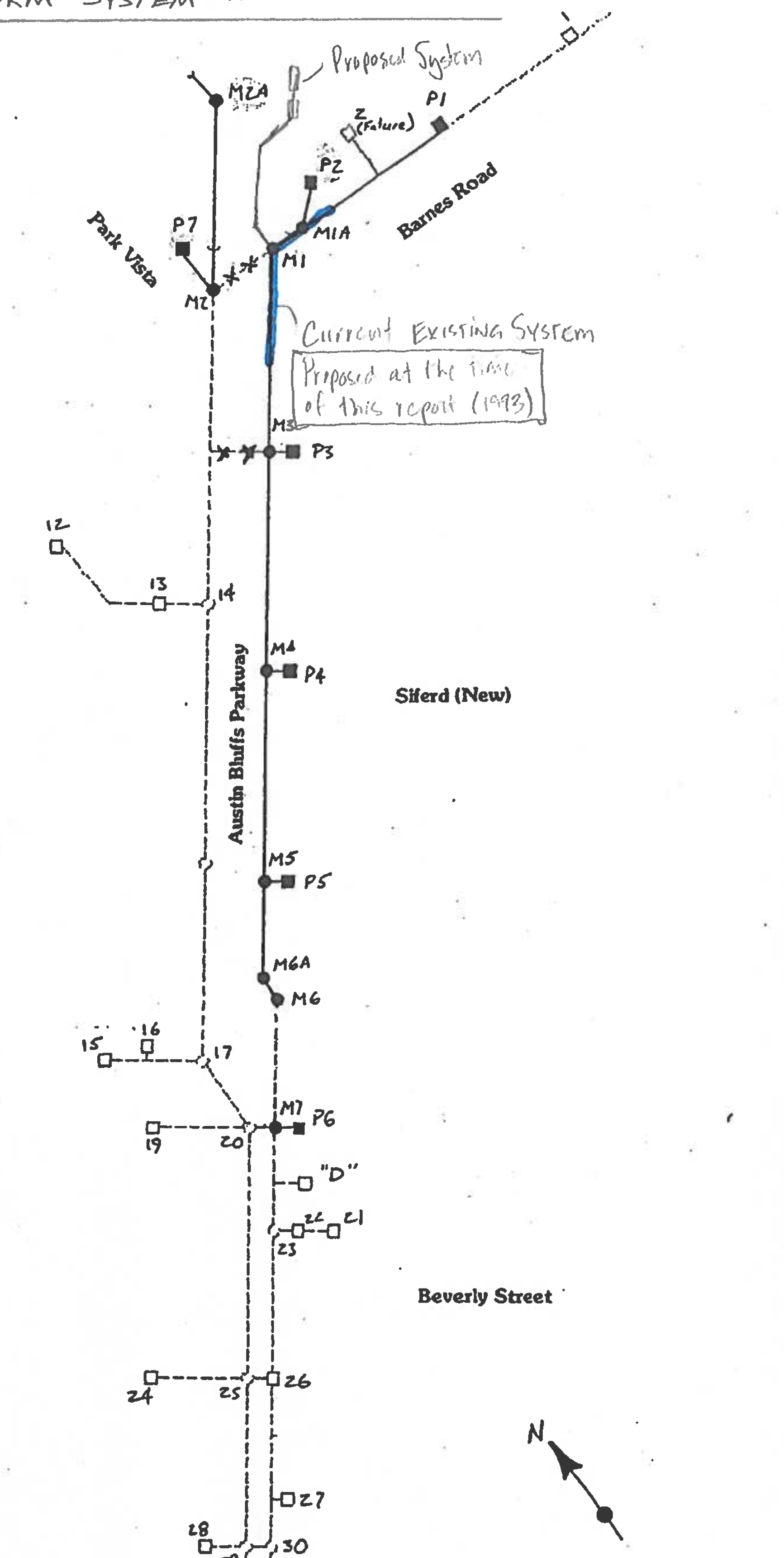
STATION	STRUCTURE	PIPE SIZE (inches)	PEAK RATE (cfs)	AREA (sf)	VELOCITY (fps)	CONV. K	FRICTION SLOPE (ft/ft)	JUNCTION DATA LENGTH (ft)	JUNCTION DATA LATERAL SIZE (inches)	JUNCTION DATA LATERAL ANGLE (degrees)	FRICTION LOSS (ft)	MH/BEND LOSS K	MH/BEND LOSS (ft)	ENTRANCE LOSS K	ENTRANCE LOSS (ft)	TOTAL LOSS (ft)	ENERGY GRADE LINE (elevation)	VELOCITY HEAD (ft)	HYDRAULIC GRADE LINE (elevation)	PROPOSED PIPE FL (elevation)	PROPOSED CROWN (elevation)	ADJUSTED EGL (elevation)	HGL ADJUSTED TO CROWN
102.50	Outlet	18	2																6582.20				
102.50	Storm MH 13	18	2	1.766	1.13	105	0.00037	0.00			0.00					0.00	6582.22	0.02	6582.20	6580.70	6582.20	6582.22	YES
129.18	Pipe 22	18	2	1.766	1.13	105	0.00037	26.68			0.01					0.01	6587.61	0.02	6587.59	6586.01	6587.59	6587.61	YES
129.18	30 Bend	18	2	1.766	1.13	105	0.00037	0.00			0.00	0.15	0.00			0.00	6587.62	0.02	6587.60				
141.15	Pipe 22	18	2	1.766	1.13	105	0.00037	11.97			0.00					0.00	6588.60	0.02	6588.58	6587.00	6588.58	6588.60	YES
141.15	Inlet End	18	2	1.766	1.13	105	0.00037	0.00			0.00			1.50	0.03	0.03	6588.63	0.00	6588.63				

Flowline Elevation= 6589.00
Available Freeboard= 0.37
(FES-OK)

Appendix G Subsection

The purpose of this subsection is to provide backup information used to calculate hydraulic gradeline elevations for the existing storm sewer systems at the intersection of Austin Bluffs Parkway and Barnes Road. These calculated existing HGL elevations were used as starting HGL elevations for Storm 1 (eastbound side) and Storm 4 (westbound side) of the proposed ABP storm sewer system.

STORM 1 EXISTING STORM SYSTEM HGL HAND CALC.



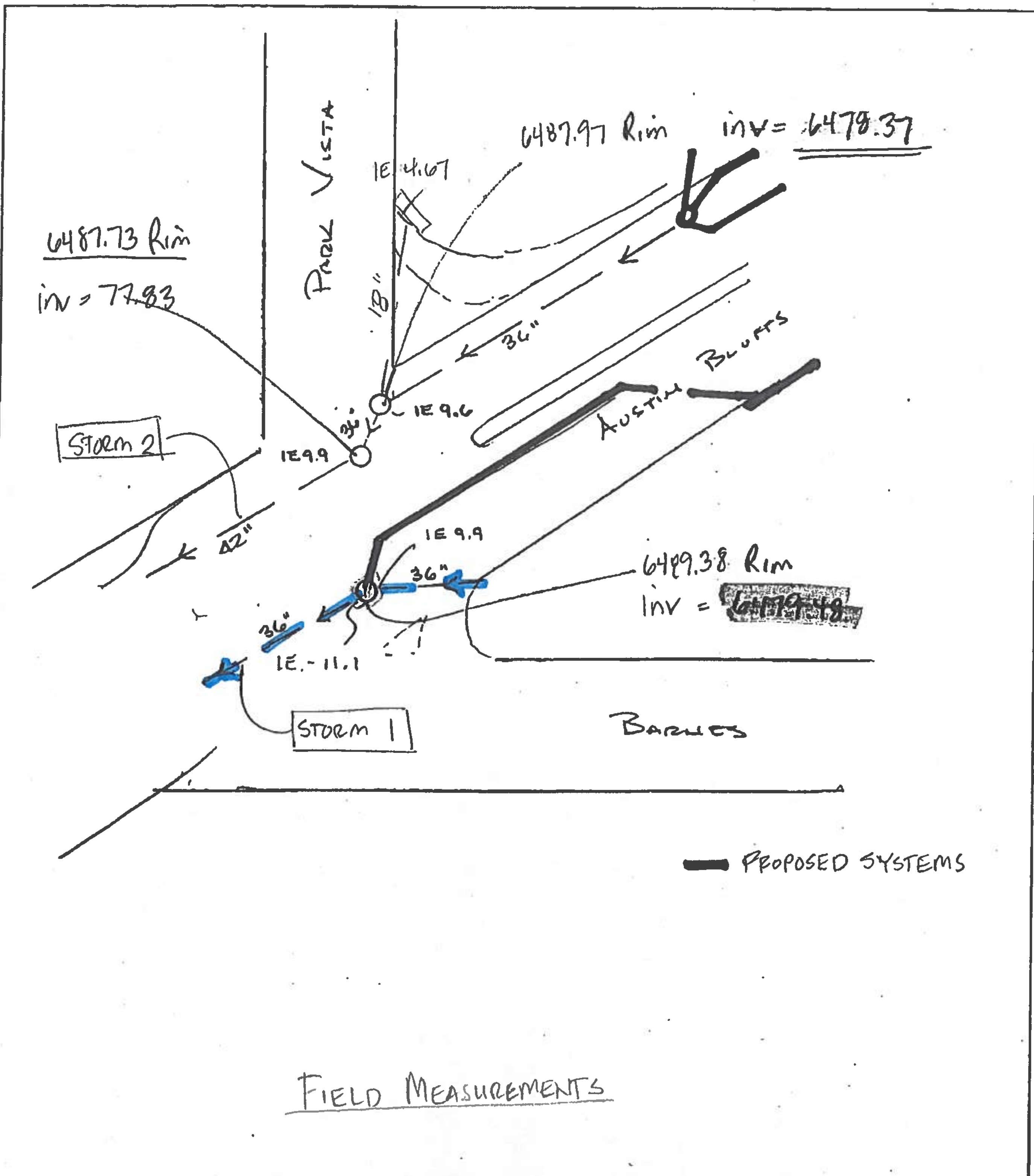
ANALSIS SCHEMATIC FROM DRAFT FINAL DRAINAGE REPORT FOR AUSTIN BLUFFS PARKWAY - PHASE III

CENTENNIAL ENGINEERING INC
OCTOBER 1993

Matrix Design Group, Inc.
An Employee Owned Company

Project: Austin Bluffs
Subject: Barnes Storm System

Job. No. 09.069.024
Date 4/29/11
Sheet 2 of 3
By RLM



FROM: Austin Bluffs Parkway
TO: Segment 3

WILSON & COMPANY

DATE: 5/11/12
FILE:

SUBJECT: HGL Calculations - Storm 1

Sources

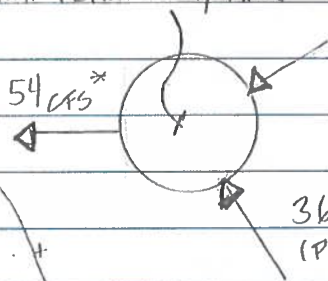
1. – Austin Bluffs & Barnes Storm Sewer Improvement Plans - Rev. 8/29/96, SHT 39X
2. – Draft Final Drainage Report for Austin Bluffs Parkway Ph III Oct 1993
3. – Final Drainage Letter - Doherty Commercial Center Filing No 1 - June 1998

Q_5 = 54 cfs per plans (Q_5 ≈ 52 cfs per Wilson Analysis)
@ MH #1 (previously M1)

MH REPLACED W/ TYPE I

Prop 30" RCP
19 cfs (WILSON)

ASSUME ALL INT Q_5 *



PLANS SHOW 30" RCP
54 cfs*
INV (DS) = 78.19
HGL below crown
@ APPROX 79.0 +

Very Close

FIELD MEASUREMENT
INDICATES 36" ⌀ PIPE
INV (DS) = 78.28

36 cfs (PEAK) *
(P1 - M1A)

Per Doherty Report
Value Could Be
As Low As 31 CFS

PLANS SHOW 30" RCP
INV (US) = 80.75
HGL* @ Crown w/ 45° BEND MH
≈ 83.25

FIELD MEASUREMENT
INDICATES 30" ⌀ PIPE
INV = 79.48 CROWN ≈ 82.0
(INV. SLIGHTLY LOWER.)

* CONSERVATIVE ASSUMPTIONS FOR HGL

- ASSUME DOWNSTREAM PIPE = 36" FOR HGL ANALYSIS
- ASSUME FLOW IN INLET WILL HAVE NO FORWARD VELOCITY @ MH
- SET DS HGL @ CROWN = 83.8 OF UPSTREAM FIELD MEASUREMENT.
- ASSUMES ALL 5 YR FLOWS INTERCEPTED BY UPSTREAM INLETS.

FROM: Austin Bluffs Parkway

WILSON & COMPANY

DATE: 5/11/12

TO:

FILE:

SUBJECT: HGL Calculations - Storm 1 (cont)

Assuming DS HGL = 83.8 ⇐ (GREATER THAN MAX HGL SHOWN on Plan @ MH)
(≈ to crown PLANNED US 36")

AND

Assuming no forward velocity @ MH

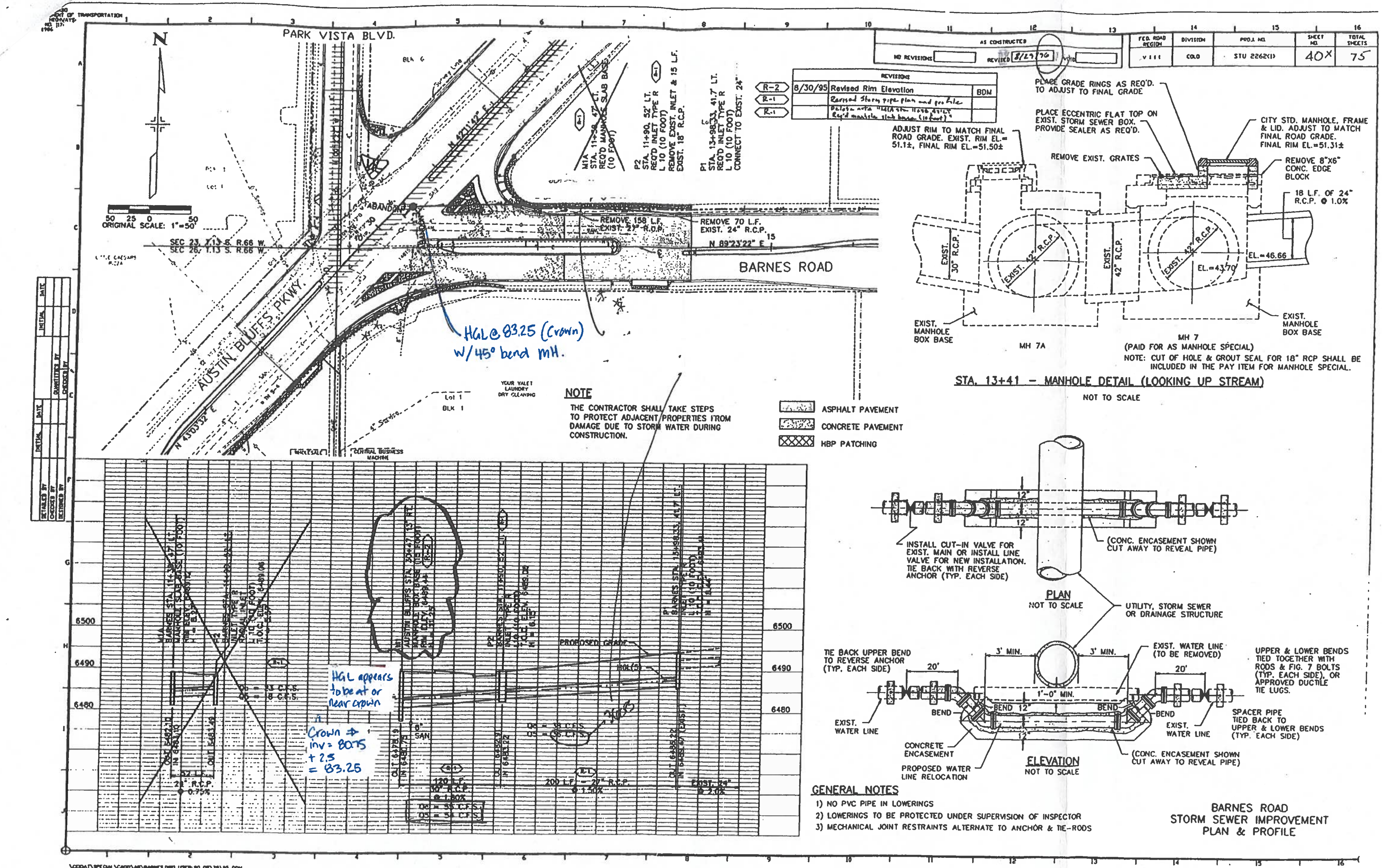
Add $1.5 \times V_H$ to Assumed DS HGL to obtain upstream HGL

$A_{36} = 7.065$ $Q_5 = 54$ cfs $V = 7.64$ '/s

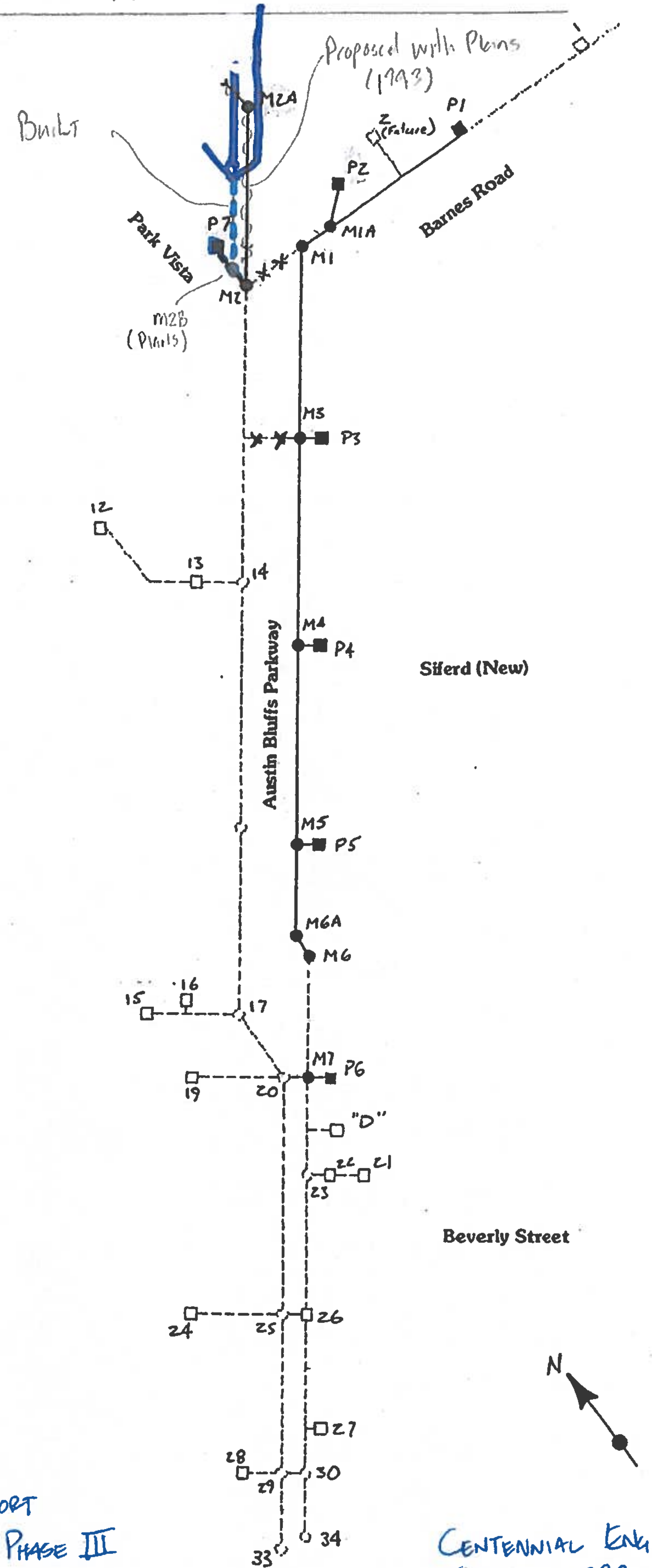
$1.5 V^2/2g = 1.37'$ total Head loss

HGL @ upstream end of MH = 83.8 + 1.37 = 85.17

CHECK IF NECESSARY TO RAISE HGL TO CROWN OF UPSTREAM PIPE TO CONTINUE w/ FULL FLOW ASSUMPTION


PARK VISTA BLVD.
BARNES ROAD
AUSTIN BLUFFS PKWY.
N
50 25 0 50
ORIGINAL SCALE: 1"=50'
SEC 23, T.13 S. R.66 W.
SEC 26, T.13 S. R.66 W.
REMOVE 158 L.F. EXIST. 27" R.C.P.
REMOVE 70 L.F. EXIST. 24" R.C.P.
N 89°23'22" E
N 43°03'32" E
ABANDON
M1A STA. 11+38, 47' LT. REQ'D MANHOLE SLAB BASE (10 FOOT)
P2 STA. 11+90, 52' LT. REQ'D INLET TYPE R L 10 (10 FOOT) REMOVE EXIST. INLET & 15 L.F. EXIST. 18" R.C.P.
P1 STA. 13+98.33, 41.7' LT. REQ'D INLET TYPE R L 10 (10 FOOT) CONNECT TO EXIST. 24"
HGL @ 83.25 (Crown) w/45° bend MH.
HGL appears to be at or near crown
Crown ⇒ Inv = 80.75 + 2.5 = 83.25
NOTE
THE CONTRACTOR SHALL TAKE STEPS TO PROTECT ADJACENT PROPERTIES FROM DAMAGE DUE TO STORM WATER DURING CONSTRUCTION.
ASPHALT PAVEMENT
CONCRETE PAVEMENT
HBP PATCHING
PROPOSED GRADE
6500
6490
6480
Q5 = 33 C.F.S.
Q5 = 8 C.F.S.
Q5 = 38 C.F.S.
Q5 = 35 C.F.S.
Q5 = 34 C.F.S.
52 L.F. 18" R.C.P. @ 0.75%
120 L.F. 30" R.C.P. @ 1.80%
200 L.F. - 27" R.C.P. @ 1.50%
EXIST. 24" @ 2.0%
8" SAN
REVISIONS
R-2 8/30/95 Revised Rim Elevation BDM
R-1
AS CONSTRUCTED
NO REVISIONS
REVISED 8/29/96
FED. ROAD REGION VIII
DIVISION COLO
PROJ. NO. STU 2262(1)
SHEET NO. 40X
TOTAL SHEETS 75
PLACE GRADE RINGS AS REQ'D. TO ADJUST TO FINAL GRADE
PLACE ECCENTRIC FLAT TOP ON EXIST. STORM SEWER BOX. PROVIDE SEALER AS REQ'D.
ADJUST RIM TO MATCH FINAL ROAD GRADE. EXIST. RIM EL.= 51.1±, FINAL RIM EL.=51.50±
REMOVE EXIST. GRATES
CITY STD. MANHOLE, FRAME & LID. ADJUST TO MATCH FINAL ROAD GRADE. FINAL RIM EL.=51.31±
REMOVE 8"X6" CONC. EDGE BLOCK
18 L.F. OF 24" R.C.P. @ 1.0%
EXIST. 30" R.C.P.
EXIST. 42" R.C.P.
EL.=46.66
EL.=43.70
EXIST. MANHOLE BOX BASE
MH 7A
MH 7
(PAID FOR AS MANHOLE SPECIAL)
NOTE: CUT OF HOLE & GROUT SEAL FOR 18" RCP SHALL BE INCLUDED IN THE PAY ITEM FOR MANHOLE SPECIAL.
STA. 13+41 - MANHOLE DETAIL (LOOKING UP STREAM)
NOT TO SCALE
INSTALL CUT-IN VALVE FOR EXIST. MAIN OR INSTALL LINE VALVE FOR NEW INSTALLATION. TIE BACK WITH REVERSE ANCHOR (TYP. EACH SIDE)
(CONC. ENCASEMENT SHOWN CUT AWAY TO REVEAL PIPE)
PLAN
NOT TO SCALE
UTILITY, STORM SEWER OR DRAINAGE STRUCTURE
TIE BACK UPPER BEND TO REVERSE ANCHOR (TYP. EACH SIDE)
3' MIN.
1'-0" MIN.
EXIST. WATER LINE (TO BE REMOVED)
UPPER & LOWER BENDS TIED TOGETHER WITH RODS & FIG. 7 BOLTS (TYP. EACH SIDE), OR APPROVED DUCTILE TIE LUGS.
BEND
EXIST. WATER LINE
CONCRETE ENCASEMENT
PROPOSED WATER LINE RELOCATION
SPACER PIPE TIED BACK TO UPPER & LOWER BENDS (TYP. EACH SIDE)
ELEVATION
NOT TO SCALE
GENERAL NOTES
1) NO PVC PIPE IN LOWERINGS
2) LOWERINGS TO BE PROTECTED UNDER SUPERVISION OF INSPECTOR
3) MECHANICAL JOINT RESTRAINTS ALTERNATE TO ANCHOR & TIE-RODS
BARNES ROAD
STORM SEWER IMPROVEMENT
PLAN & PROFILE

STORM 4 EXISTING STORM SYSTEM HGL HAND CALC.



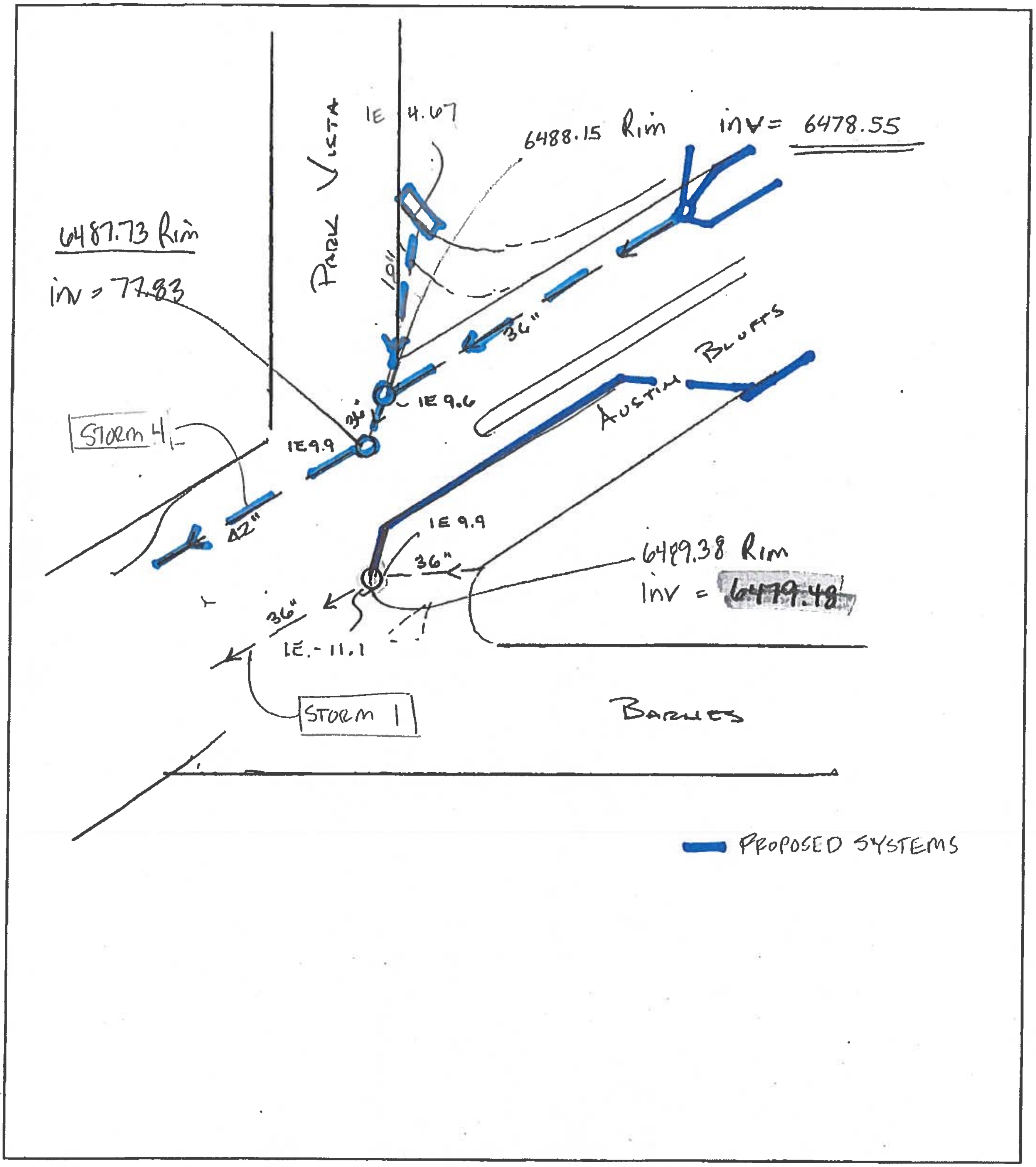
ANALSIS SCHEMATIC FROM
DRAFT FINAL DRAINAGE REPORT
FOR AUSTIN BLUFFS PARKWAY - PHASE III

CENTENNIAL ENGINEERING INC
OCTOBER 1993

Matrix Design Group, Inc
An Employee Owned Company

Project: Austin Bluffs
Subject: Barnes Storm System

Job. No. 09.069.024
Date 4/29/11
Sheet 2 of 3
By RLM



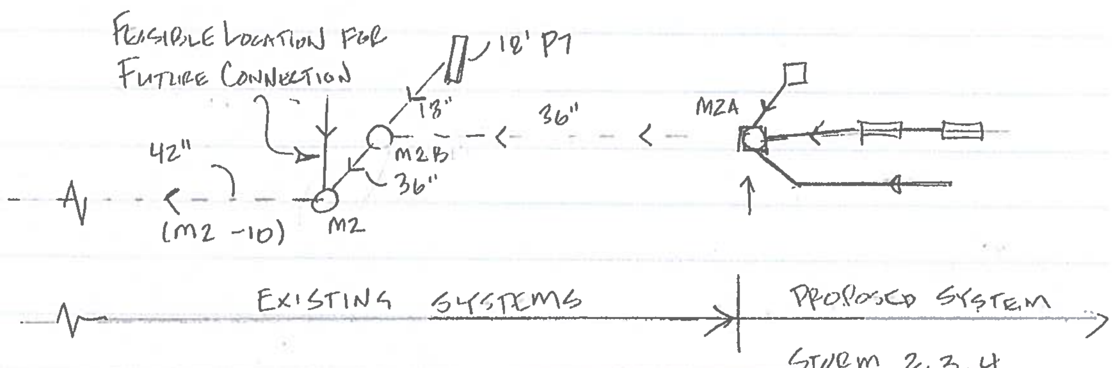
FROM: Austin Bluffs Parkway

TO: Segment 3

DATE: 5/11/12 FILE

SUBJECT:

HGL Calculations - Storm 4

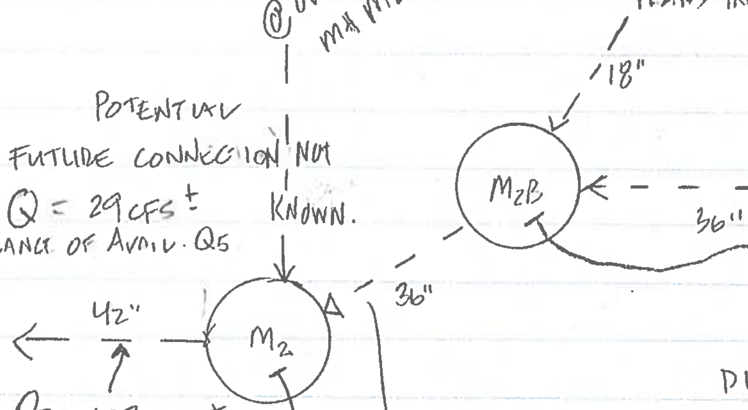


- SYSTEM DESIGN TO CONVEY APPROX 5-YR FLOWS (≈ 75% OF 10 YR EVENT) - "FINAL DRAFT" REPORT

EXISTING 18" from Inlet (P7)
PLANS INDICATE Q_5 = 17 CFS

@ or BELOW MH M2

POTENTIAL FUTURE CONNECTION NOT KNOWN.
Q = 29 CFS ± (BALANCE OF AVAIL. Q_5)



Q_5 = 56 CFS (PLANNED)
FIELD MEASUREMENT INDICATES 36" ⌀
INV = 78.55

Q_5 = 102 CFS *

PLANS SHOW 42"
INV (DS) = 77.68
HGL NOT SHOWN

PLANS ANTICIPATE 90 CFS and 42" RCP
ANTIC. INV IN = 77.94
→ HGL SHOWN BELOW CROWN AT 80.5 ±

DIRECT ADDITION
Q_5 = 17 + 56 = 73 CFS
(larger of two flows)

FIELD MEASUREMENT INDICATES 42"
INV = 77.83 ℄
CROWN = 81.33

⇒ WILL NOW CONVEY 73 CFS, VERSUS PLANNED 90 CFS

FROM: Austin Bluffs Parkway **WILSON & COMPANY** DATE: 5/11/12 FILE

TO: Segment 3 SUBJECT:

CHECK HGL AGAINST FULL FLOW ASSUMPTION HGL = CROWN

CROWN = INV + PIPE ⌀

INV EL = 77.94 + 3.0 ≈ 81.00 ← Higher than anlc HGL
USE CROWN FOR DS HGL

AS CONSERVATIVE MEASURE, ASSUME NO FORWARD VELOCITY AT MANHOLE M2B, DS HGL begins @ crown.

Add $1.5 \times V_h$ to Assumed DS HGL to obtain Upstream HGL

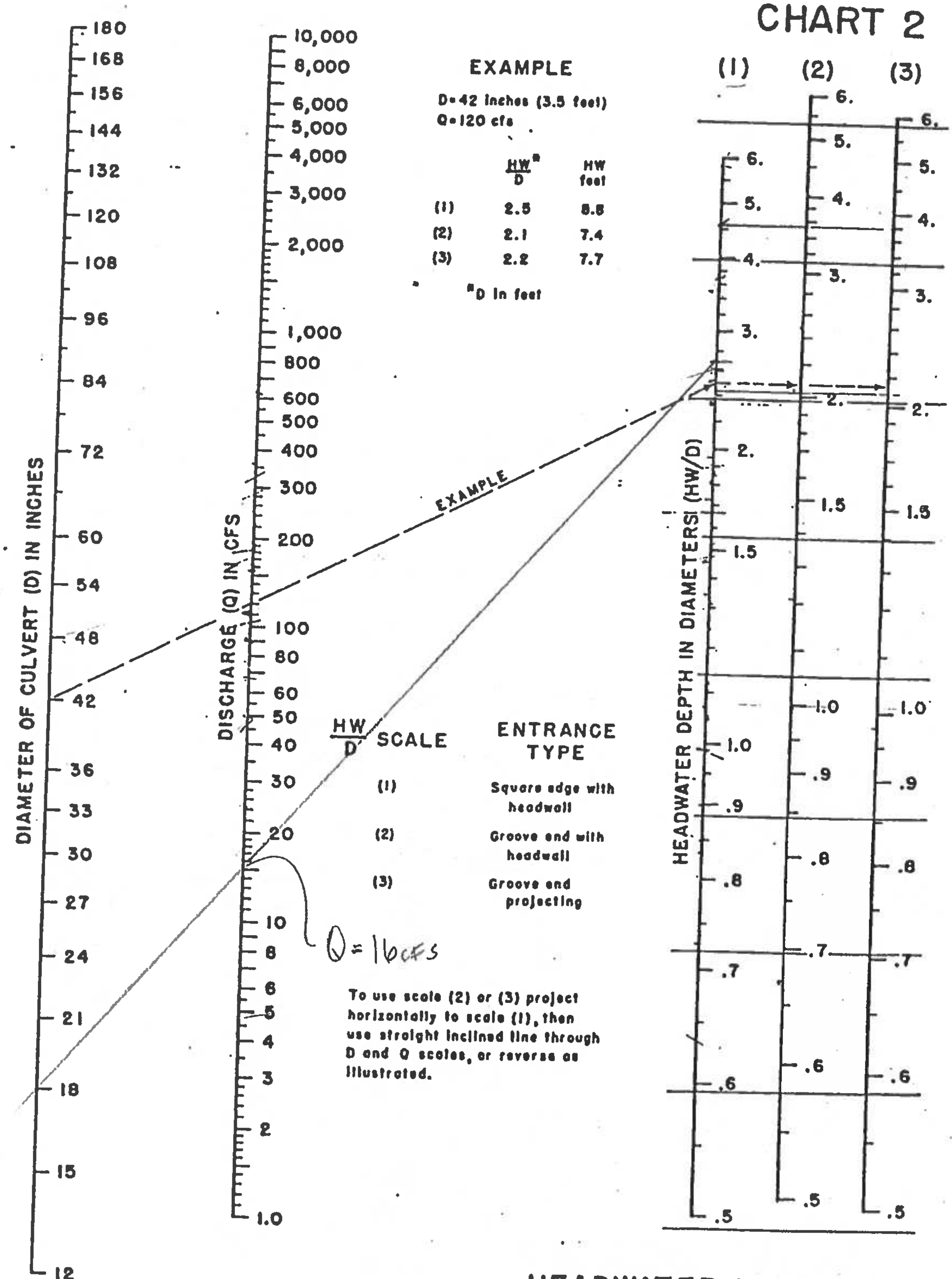
$A_{42} = 9.616$ sqft $Q_5 = 102$ cfs $V = 10.61'/s$

$1.5\, V^2/2g = 1.75 \times 1.5 = 2.62'$

Use

Upstream HGL @ MH M2 = 81.0 + 2.6 = 83.6

CHART 2



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER SCALES 2&3
REVISED MAY 1964

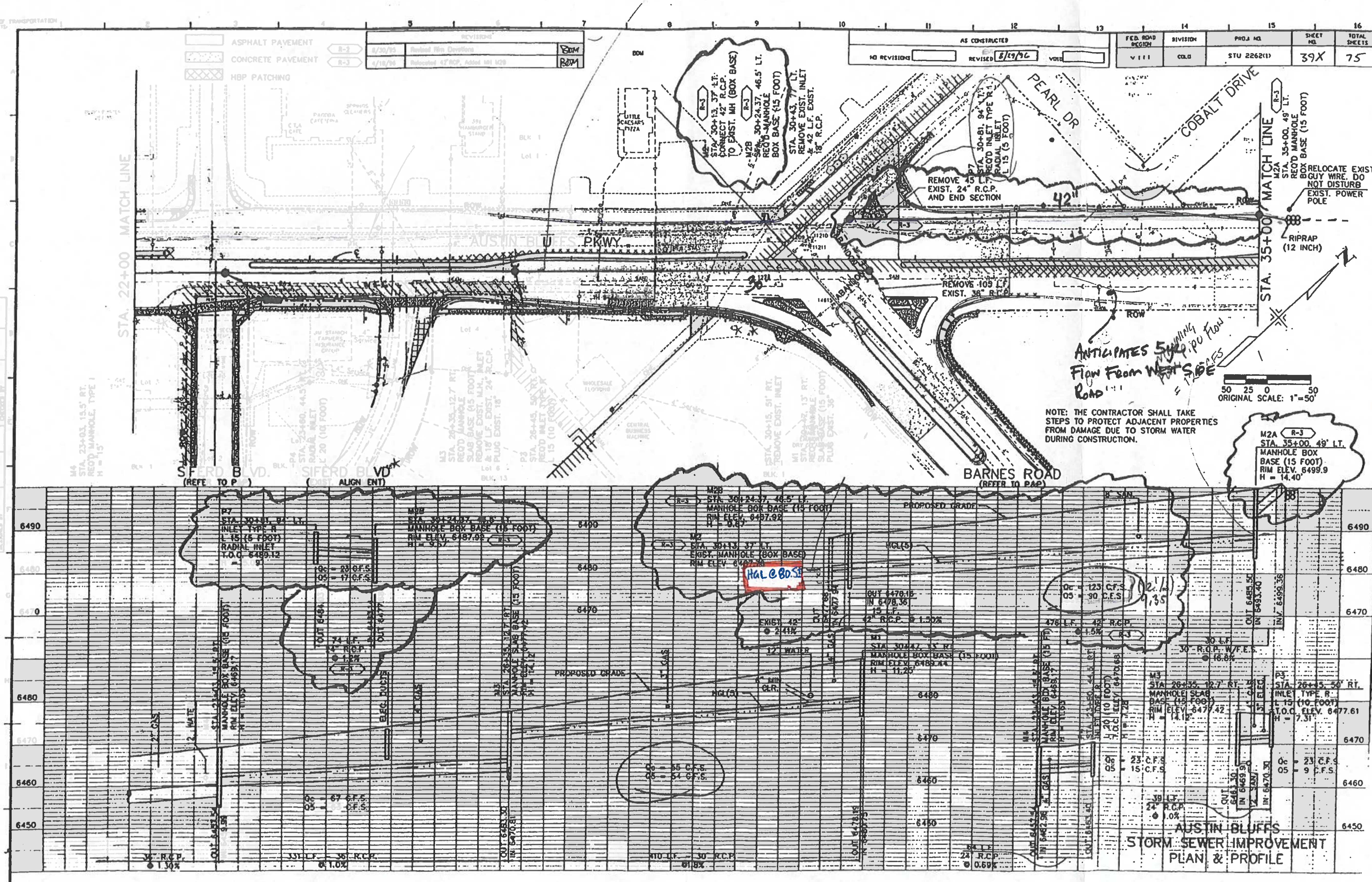
HW = 4.0 (to FL). (measured by Wilson)
D = 1.5
HW/D = 2.67'

Inlet P7

Qint = 16cfs

Use Report Value of 17cfs.

Austin Phase III



Appendix H

Supplemental Hydraulic Calculations

WILSON
&COMPANY

Depth of Flow in Austin Bluffs Eastbound @ DP2 - 5-YR

Project Description

Solve For	Spread

Input Data

Channel Slope	0.02500	ft/ft
Discharge	19.00	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.03	ft/ft
Roughness Coefficient	0.015	

Results

Spread	14.21	ft
Flow Area	2.90	ft²
Depth	0.47	ft
Gutter Depression	0.07	ft
Velocity	6.56	ft/s

Depth of Flow in Austin Bluffs Eastbound @ DP2 - 100-YR

Project Description

Solve For	Spread

Input Data

Channel Slope	0.02500	ft/ft
Discharge	37.00	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.03	ft/ft
Roughness Coefficient	0.015	

Results

Spread	18.39	ft
Flow Area	4.80	ft²
Depth	0.58	ft
Gutter Depression	0.07	ft
Velocity	7.70	ft/s

Depth of Flow in Austin Bluffs Westbound @ DP7 - 5-YR

Project Description

Solve For	Spread

Input Data

Channel Slope	0.01800	ft/ft
Discharge	18.00	ft^3/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.015	

Results

Spread	18.85	ft
Flow Area	3.46	ft^2
Depth	0.45	ft
Gutter Depression	0.09	ft
Velocity	5.20	ft/s

Depth of Flow in Austin Bluffs Westbound @ DP7 - 100-YR

Project Description

Solve For	Spread

Input Data

Channel Slope	0.01800	ft/ft
Discharge	35.00	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.015	

Results

Spread	24.39	ft
Flow Area	5.74	ft²
Depth	0.55	ft
Gutter Depression	0.09	ft
Velocity	6.10	ft/s

Westbound Austin Bluffs Street Capacity-Barnes to Platinum - 0.67 ft

Project Description

Solve For	Spread

Input Data

Channel Slope	0.02000	ft/ft
Discharge	64.00	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.015	

Results

Spread	29.16	ft
Flow Area	8.59	ft²
Depth	0.67	ft
Gutter Depression	0.09	ft
Velocity	7.45	ft/s

East Side of Vanadium Prop Trap. Swale - Section 1 - 11 cfs

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.01000	ft/ft
Left Side Slope	6.00	ft/ft (H:V)
Right Side Slope	6.00	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	11.00	ft³/s

Results

Normal Depth	0.57	ft
Flow Area	4.20	ft²
Wetted Perimeter	10.90	ft
Hydraulic Radius	0.39	ft
Top Width	10.80	ft
Critical Depth	0.48	ft
Critical Slope	0.01900	ft/ft
Velocity	2.62	ft/s
Velocity Head	0.11	ft
Specific Energy	0.67	ft
Froude Number	0.74	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.57	ft
Critical Depth	0.48	ft
Channel Slope	0.01000	ft/ft

East Side of Vanadium Prop Trap. Swale - Section 2 - 11 cfs

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.01000	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	11.00	ft³/s

Results

Normal Depth	0.62	ft
Flow Area	3.80	ft²
Wetted Perimeter	8.49	ft
Hydraulic Radius	0.45	ft
Top Width	8.32	ft
Critical Depth	0.53	ft
Critical Slope	0.01827	ft/ft
Velocity	2.90	ft/s
Velocity Head	0.13	ft
Specific Energy	0.75	ft
Froude Number	0.76	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.62	ft
Critical Depth	0.53	ft
Channel Slope	0.01000	ft/ft

Prop. Rundown at the Upstream End of the Vanadium Swale - 3 cfs

Project Description

Friction Method	Manning Formula	
Solve For	Normal Depth	

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.10000	ft/ft
Left Side Slope	6.00	ft/ft (H:V)
Right Side Slope	6.00	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	3.00	ft³/s

Results

Normal Depth	0.15	ft
Flow Area	0.75	ft²
Wetted Perimeter	5.86	ft
Hydraulic Radius	0.13	ft
Top Width	5.84	ft
Critical Depth	0.23	ft
Critical Slope	0.02327	ft/ft
Velocity	3.98	ft/s
Velocity Head	0.25	ft
Specific Energy	0.40	ft
Froude Number	1.95	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.15	ft
Critical Depth	0.23	ft
Channel Slope	0.10000	ft/ft

West Side of Saphire Drive - 4' Swale - 1cfs

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.04600	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	1.00	ft³/s

Results

Normal Depth	0.10	ft
Flow Area	0.46	ft²
Wetted Perimeter	4.85	ft
Hydraulic Radius	0.09	ft
Top Width	4.83	ft
Critical Depth	0.12	ft
Critical Slope	0.02772	ft/ft
Velocity	2.19	ft/s
Velocity Head	0.07	ft
Specific Energy	0.18	ft
Froude Number	1.26	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.10	ft
Critical Depth	0.12	ft
Channel Slope	0.04600	ft/ft

East Side of Saphire Drive - 4' Swale - Section 1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.03330	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	2.00	ft³/s

Results

Normal Depth	0.17	ft
Flow Area	0.79	ft²
Wetted Perimeter	5.40	ft
Hydraulic Radius	0.15	ft
Top Width	5.36	ft
Critical Depth	0.19	ft
Critical Slope	0.02440	ft/ft
Velocity	2.52	ft/s
Velocity Head	0.10	ft
Specific Energy	0.27	ft
Froude Number	1.15	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.17	ft
Critical Depth	0.19	ft
Channel Slope	0.03330	ft/ft

East Side of Saphire Drive - 4' Swale - Section 2

Project Description

Friction Method	Manning Formula	
Solve For	Normal Depth	

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.02000	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	4.00	ft
Discharge	5.00	ft³/s

Results

Normal Depth	0.33	ft
Flow Area	1.75	ft²
Wetted Perimeter	6.71	ft
Hydraulic Radius	0.26	ft
Top Width	6.63	ft
Critical Depth	0.33	ft
Critical Slope	0.02085	ft/ft
Velocity	2.86	ft/s
Velocity Head	0.13	ft
Specific Energy	0.46	ft
Froude Number	0.98	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.33	ft
Critical Depth	0.33	ft
Channel Slope	0.02000	ft/ft

Depth of Flow in Austin Bluffs Eastbound @ DP10 - 2.3% - 9 cfs- 2.8%

Project Description

Solve For	Spread

Input Data

Channel Slope	0.02300	ft/ft
Discharge	9.00	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.03	ft/ft
Roughness Coefficient	0.015	

Results

Spread	10.76	ft
Flow Area	1.69	ft²
Depth	0.37	ft
Gutter Depression	0.07	ft
Velocity	5.33	ft/s

Depth of Flow in Austin Bluffs Eastbound @ DP10 - 2.3% - 32 cfs- 2.8%

Project Description

Solve For	Spread	

Input Data

Channel Slope	0.02300	ft/ft
Discharge	32.00	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.03	ft/ft
Roughness Coefficient	0.015	

Results

Spread	17.67	ft
Flow Area	4.44	ft²
Depth	0.56	ft
Gutter Depression	0.07	ft
Velocity	7.20	ft/s

Depth of Flow in Austin Bluffs Westbound @ DP21 - 1.7% - 3 cfs- 1.8%

Project Description

Solve For	Spread

Input Data

Channel Slope	0.01700	ft/ft
Discharge	3.00	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.015	

Results

Spread	9.43	ft
Flow Area	0.89	ft²
Depth	0.26	ft
Gutter Depression	0.09	ft
Velocity	3.38	ft/s

Depth of Flow in Austin Bluffs Westbound @ DP21 - 1.7% - 6 cfs- 1.8%

Project Description

Solve For	Spread

Input Data

Channel Slope	0.01700	ft/ft
Discharge	6.00	ft^3/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.015	

Results

Spread	12.69	ft
Flow Area	1.54	ft^2
Depth	0.32	ft
Gutter Depression	0.09	ft
Velocity	3.90	ft/s

WILSON
&COMPANY

FROM: Austin Bluffs Parkway
TO: Segment 3
DATE: 6/8/12
FILE:
SUBJECT:

INLET 14

Check Inlet Grate Size for Campbell Home Property

$Q_{100} = 1.0$ cfs

To function in "Sump" Condition in paved parking lot atop Eccentric MH Riser

Base of Grate > 30" < 42" w/ flush or convex lid

Maximize open area, Fit in 6" curb

Combination Inlet Frame Grate Curb Box (Adj)

R-3236 Heavy Duty

SQ FT OPENING = 1.2

WEIR PERIMETER = 4.9

CHECK WEIR   USE CLOGGING FACTOR = 2.0   C = 3.1

$C.F \times Q_{100} = C L H^{1.5}$

$2.0 \times 1.0 = 3.1 (4.9) H^{1.5}$

$H = 0.26' < 0.5'$

CHECK ORIFICE

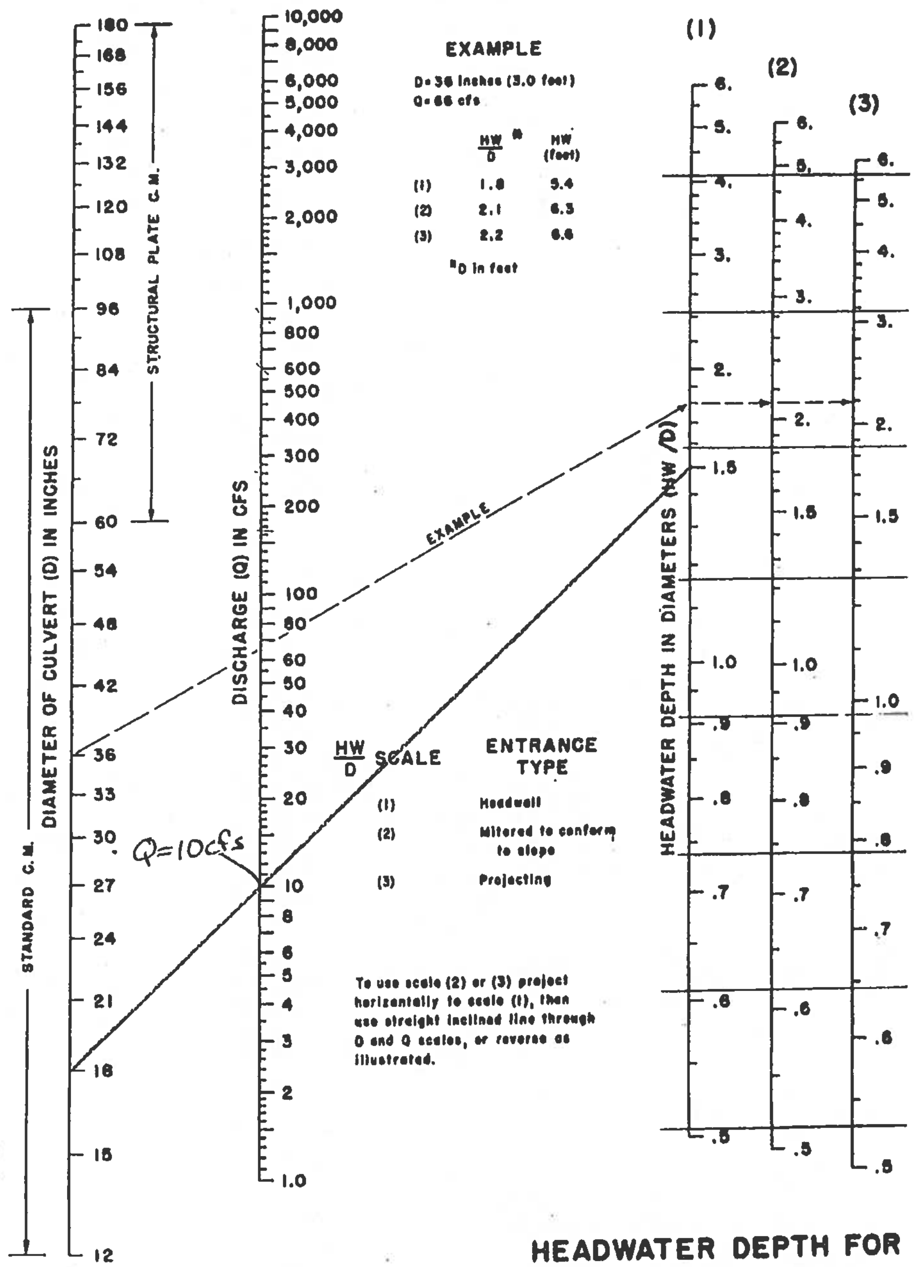
$C.F. \times Q_{100} = C A \sqrt{2gh}$ $C = 0.6$

$2.0 \times 1.0 = 0.6 (1.2) \sqrt{2 \cdot 32.2 \times h}$

$H = 0.12' < 0.5'$

Use R-3236 or Approved Equal

HIGHER Relationships



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

EXISTING DRIVEWAY CULVERT CAPACITY ESTIMATE – TURQUOISE DR.

The City of Colorado Springs / El Paso County
Drainage Criteria Manual

HDR Infrastructure, Inc.
A Centerra Company

Date: OCT. 1987

Figure 9-37

Depth of Flow in Austin Bluffs Westbound @ DP19 - 5.0% - 15 cfs- 2.1%

Project Description

Solve For	Spread

Input Data

Channel Slope	0.05000	ft/ft
Discharge	15.00	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.015	

Results

Spread	13.87	ft
Flow Area	2.01	ft²
Depth	0.36	ft
Gutter Depression	0.09	ft
Velocity	7.46	ft/s

Depth of Flow in Austin Bluffs Westbound @ DP19 - 5.0% - 27 cfs- 2.1%

Project Description

Solve For	Spread

Input Data

Channel Slope	0.05000	ft/ft
Discharge	27.00	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.015	

Results

Spread	17.52	ft
Flow Area	3.16	ft²
Depth	0.44	ft
Gutter Depression	0.09	ft
Velocity	8.56	ft/s

WILSON
&COMPANY

FROM: Lee Parcel - Inlet 16

DATE:

FILE: JCH

TO: Back Swale Inlet Grate

SUBJECT: 5/31/12

Capacity Check

Basin Q → $Q_{100} = 2$ cfs

Inlet Grate for Neenah R-2556-A capacity check:

Open Area = 1.4 sq. ft.

Weir Perimeter = 6.7 ft

Inlet Weir Check:

$Q_{weir} = 3.0 (L) H^{3/2}$ for Q = 2 cfs

Use Q = 4 cfs for clogging factor of 2.

$4 \text{ cfs} = 3.0 (6.7 \text{ ft}) H^{3/2}$

H = 0.34 ft → ponding depth required for Q = 4 cfs < 1 ft ✓

Inlet Orifice Check:

$Q = CA\sqrt{2gH}$ Use C = 0.6

$4 \text{cfs} = 0.6 (1.4 \text{ ft}^2)\sqrt{2(32.2 \text{ ft/s}^2)(H)}$

H = 0.35 ft < 1 ft ✓ Orifice Governs

Inlet provides sufficient capacity with a ponding depth of 0.35 ft

HIGHER Relationships

WILSON & COMPANY

FROM: Hydrology Calculations
TO: for Lee Parcel Swales
DATE:
FILE: JCH
SUBJECT: 5/31/12

Front and Side Swales → Contributing Area = 0.18 acres

Imp. Area = 0.05 ac (C_{100}=0.95)

Pervious Area = 0.13 ac (C_{100}=0.35)

Use C_{100} = 0.55 with T_c = 5 min

Intensity_{100} = 9.07 in/hr

Q_{100} = CIA = 0.55 (9.07 in/hr) 0.18 ac = **0.9 cfs**

Back Swale → Q_{100} from Basin Q = **2 cfs**

HIGHER *Relationships*

Lee Parcel South Side Swale -Section 1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	0.06500	ft/ft
Left Side Slope	20.00	ft/ft (H:V)
Right Side Slope	20.00	ft/ft (H:V)
Discharge	0.90	ft³/s

Results

Normal Depth	0.16	ft
Flow Area	0.51	ft²
Wetted Perimeter	6.41	ft
Hydraulic Radius	0.08	ft
Top Width	6.40	ft
Critical Depth	0.17	ft
Critical Slope	0.05357	ft/ft
Velocity	1.76	ft/s
Velocity Head	0.05	ft
Specific Energy	0.21	ft
Froude Number	1.09	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.16	ft
Critical Depth	0.17	ft
Channel Slope	0.06500	ft/ft
Critical Slope	0.05357	ft/ft

Lee Parcel South Side Swale - Section 2

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	0.04200	ft/ft
Left Side Slope	7.00	ft/ft (H:V)
Right Side Slope	7.00	ft/ft (H:V)
Discharge	0.90	ft³/s

Results

Normal Depth	0.26	ft
Flow Area	0.47	ft²
Wetted Perimeter	3.65	ft
Hydraulic Radius	0.13	ft
Top Width	3.61	ft
Critical Depth	0.25	ft
Critical Slope	0.04710	ft/ft
Velocity	1.93	ft/s
Velocity Head	0.06	ft
Specific Energy	0.32	ft
Froude Number	0.95	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.26	ft
Critical Depth	0.25	ft
Channel Slope	0.04200	ft/ft
Critical Slope	0.04710	ft/ft

Lee Parcel Back (North Side) Swale

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	0.03200	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Discharge	2.00	ft³/s

Results

Normal Depth	0.51	ft
Flow Area	0.78	ft²
Wetted Perimeter	3.22	ft
Hydraulic Radius	0.24	ft
Top Width	3.05	ft
Critical Depth	0.49	ft
Critical Slope	0.04003	ft/ft
Velocity	2.58	ft/s
Velocity Head	0.10	ft
Specific Energy	0.61	ft
Froude Number	0.90	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.51	ft
Critical Depth	0.49	ft
Channel Slope	0.03200	ft/ft
Critical Slope	0.04003	ft/ft

Depth of Flow in Austin Bluffs Westbound @ DP17 - 2.8% - 12 cfs- 2.0%

Project Description

Solve For	Spread

Input Data

Channel Slope	0.02800	ft/ft
Discharge	12.00	ft³/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.015	

Results

Spread	14.25	ft
Flow Area	2.12	ft²
Depth	0.37	ft
Gutter Depression	0.09	ft
Velocity	5.67	ft/s

Depth of Flow in Austin Bluffs Westbound @ DP17 - 2.8% - 22 cfs- 2.0%

Project Description

Solve For	Spread

Input Data

Channel Slope	0.02800	ft/ft
Discharge	22.00	ft^3/s
Gutter Width	2.00	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.015	

Results

Spread	18.12	ft
Flow Area	3.37	ft^2
Depth	0.45	ft
Gutter Depression	0.09	ft
Velocity	6.53	ft/s

WILSON & COMPANY

FROM: Austin Bluffs Parkway
TO: Segment 3

DATE: 6/6/12
FILE:
SUBJECT:

Check capacity of street above DP-11

Station 135+50

Use Flows from DP-11 *

$Q_5 = 15$ $Q_{100} = 46$

Long. Slope - 2.60%
X Slope - 1.30%

Reported Depth's / Spreads taken from Flowmaster

$Spread_5$ = 21.2' (OK)
$Depth_5$ = 0.3' (OK) $Depth_{100}$ = 0.45' (OK)

Station 135+40

Use $Q_5 = 15$ $Q_{100} = 46$

Long Slope - 2.0 %
X Slope - 2.4 %

$Spread_5$ = 15.2' (OK)
$Depth_5$ = 0.38' (OK) $Depth_{100}$ = 0.57' > 0.5 (median)

Note 100yr flow depth higher than median curb

→ Need to RAISE median stamped concrete prior to Station 135+50 to contain 100-yr flow and prevent X-flows.

* Conservative.

HIGHER Relationships

WILSON &COMPANY

FROM: Austin Bluffs Parkway
TO: Segment 3
DATE: 6/6/12
FILE:
SUBJECT:

Determine max depth before inlet at DP-11

Check Depth @ Multiple Stations

Station 135+00

Long slope - 2.2 %
X slope - 4.0 %

$Spread_5$ = 10.9' ok
$Depth_5$ = 0.44' ok $Depth_{100}$ = 0.66' > 0.5 (med)

Station 134+50

Long slope - 2.2 %
X slope - 4.8

$Spread_5$ = 9.7' ok
$Depth_5$ = 0.47 ok $Depth_{100}$ = 0.71' > 0.5' (med.)

Station 134+25

Long slope - 2.1%
X slope - 4.6% $Depth_{100}$ = 0.70' > 0.5 (med.)

$Spread_5$ = 0.46' ok
$Depth_5$ = 10.4' ok

HIGHER Relationships

WILSON & COMPANY

FROM: Austin Bluffs Parkway
TO: Segment 3

DATE: 6/6/12 FILE:
SUBJECT:

Station 133+75

Long Slope - 2.1%
X slope - 3.5%

Spread₅ = 0.42' OK Depth₁₀₀ = 0.64 < 0.5' (med.)
Depth₅ = 11.9' OK

@ Inlet @ Station 133+35

Long Slope - 1.7%
X Slope = 2.6%

Spread₅ = 15.24 OK
Depth₅ = 0.41' Depth₁₀₀ = 0.62' ≥ 0.5 (med)

Check flow depth below inlet

Station 133+00 (Q_5 = 5.5 cfs / Q_{100} = 26.0 cfs)

Long Slope - 2.5%
X slope - 0.7%

Spread₅ - 21.5'
Depth₅ - 0.19'
Depth₁₀₀ - 0.31'

RAISE MEDIAN HT TO 0.3' ABOVE TBC
FROM STA 135+50 -
TO STA 133+00

HIGHER Relationships

Depth of Flow in Austin Bluffs Eastbound at DP11 - 5.6% - 15 cfs- 2.7%

Project Description

Solve For	Spread

Input Data

Channel Slope	0.01700	ft/ft
Discharge	15.00	ft³/s
Gutter Width	1.00	ft
Gutter Cross Slope	0.04	ft/ft
Road Cross Slope	0.03	ft/ft
Roughness Coefficient	0.016	

Results

Spread	15.24	ft
Flow Area	3.04	ft²
Depth	0.41	ft
Gutter Depression	0.02	ft
Velocity	4.94	ft/s

Depth of Flow in Austin Bluffs Eastbound at DP11 - 5.6% - 46 cfs- 2.7%

Project Description

Solve For	Spread

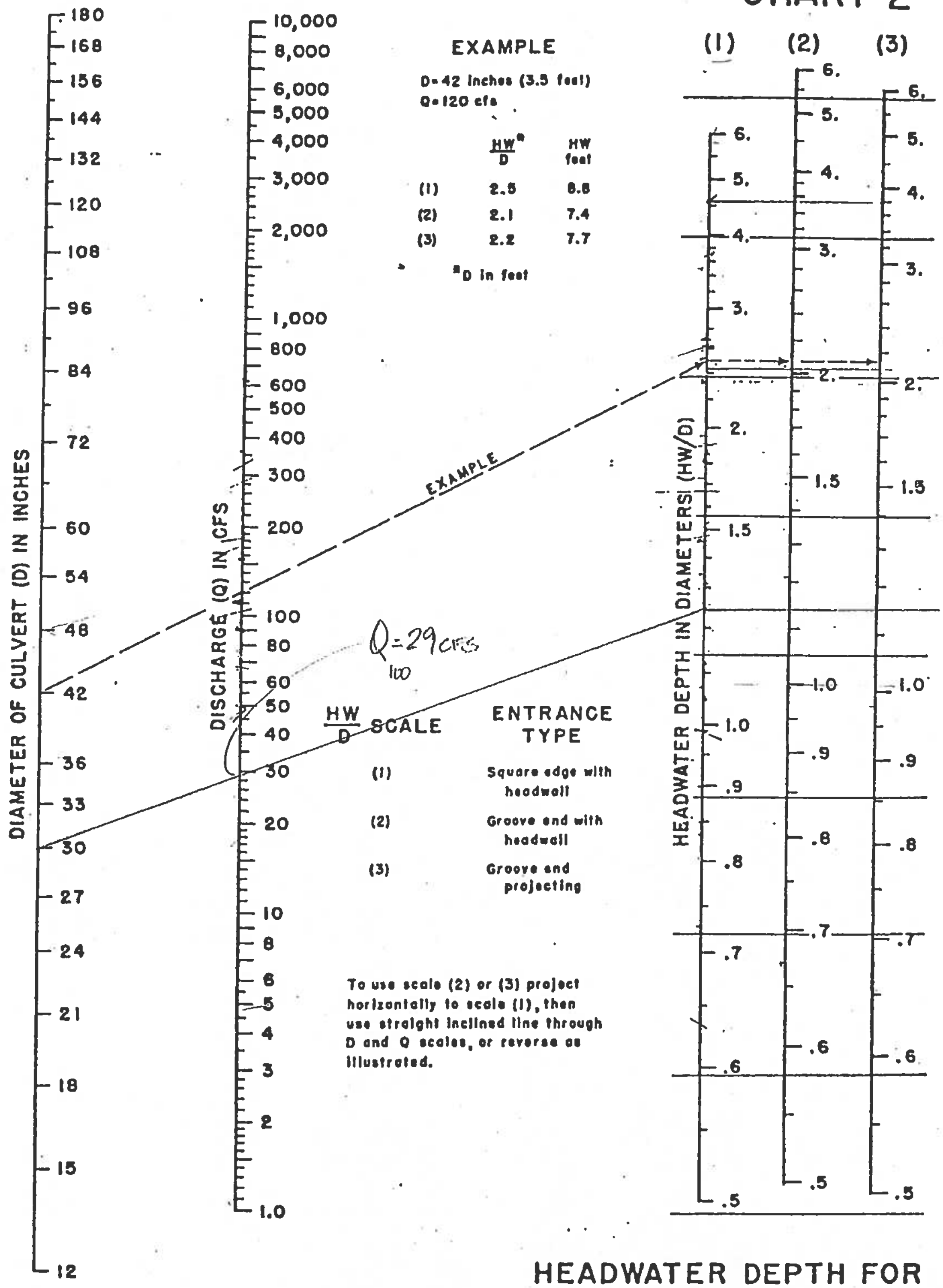
Input Data

Channel Slope	0.01700	ft/ft
Discharge	46.00	ft³/s
Gutter Width	1.00	ft
Gutter Cross Slope	0.04	ft/ft
Road Cross Slope	0.03	ft/ft
Roughness Coefficient	0.016	

Results

Spread	23.22	ft
Flow Area	7.04	ft²
Depth	0.62	ft
Gutter Depression	0.02	ft
Velocity	6.53	ft/s

CHART 2



HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HW/D = 1.25

HW = 1.25 x 2.5 = 3.2'

Silver - 30" RCP

WILSON
&COMPANY

FROM: Austin Bluffs Parkway
TO: Segment 3

DATE: 6/6/12 FILE:

SUBJECT:

Sizing Ditch along East Side of Silver

Flow reaching Ditch from portion of Basin M & N.

Area ≈ 1.0 ac.

Use C_5 & C_{100} values from Basin M.

$C_5 = 0.35$ / $C_{100} = 0.45$

Time of Conc. ≈ 10 mins $I_5 = 4.10$ $I_{100} = 7.29$

$Q_5 = 0.35 \times 4.10 \times 1.0 = 1.44$ cfs

$Q_{100} = 0.45 \times 7.29 \times 1.0 = 3.3$ cfs

Assume 4' wide ditch section for Disturbed areas @ 14% 3:1 SS

Flowmaster = Normal Depth = <0.2'

Velocity = 4.9'/s

Velocity 5' wide 3:1 SS = 4.6'/s

6' wide 3:1 SS = 4.3'/s

HIGHER Relationships

East Side of Silver Swale - 14% - 3.3 cfs

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.14000	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	6.00	ft
Discharge	3.30	ft³/s

Results

Normal Depth	0.12	ft
Flow Area	0.76	ft²
Wetted Perimeter	6.76	ft
Hydraulic Radius	0.11	ft
Top Width	6.72	ft
Critical Depth	0.20	ft
Critical Slope	0.02323	ft/ft
Velocity	4.33	ft/s
Velocity Head	0.29	ft
Specific Energy	0.41	ft
Froude Number	2.26	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.12	ft
Critical Depth	0.20	ft
Channel Slope	0.14000	ft/ft

Church Swale-2% 22 cfs

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.02000	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	4.40	ft
Discharge	22.00	ft³/s

Results

Normal Depth	0.73	ft
Flow Area	4.79	ft²
Wetted Perimeter	9.00	ft
Hydraulic Radius	0.53	ft
Top Width	8.76	ft
Critical Depth	0.77	ft
Critical Slope	0.01640	ft/ft
Velocity	4.60	ft/s
Velocity Head	0.33	ft
Specific Energy	1.06	ft
Froude Number	1.10	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.73	ft
Critical Depth	0.77	ft
Channel Slope	0.02000	ft/ft

WILSON
&COMPANY

FROM: Austin Bluffs Parkway DATE: 5/23/12 FILE:

TO: SUBJECT:

Discharge From Church Parking Lot to Swale

Discharge to 4:1 slope, Calc Discharge per LF

→ Flow from Basin L1 = 1 cfs / 3 cfs
Length of parking lot to be discharged from = 37 FT
Portion not obstructed by parking blocks (2/8) = 0.25

= 37 x 0.25 = 9.25'

Discharge / LF = 5yr = 1 / 9.25 = 0.108 cfs / FT
100yr = 3 / 9.25 0.324 cfs / FT

Determine Velocity & Depth down 4:1 slope using Flowmaster Cross Section 1' wide

5yr
$n = 0.03$ $s = 0.25$ $Q_5 = 0.108 \Rightarrow V_5 = 2.72$ '/s $D_5 = 0.04'$

100yr
$n = 0.03$ $s = 0.25$ $Q_{100} = 0.324$ $V_{100} = 4.13$ $D_5 = 0.08$

Flow from Basin L2 = 4 cfs / 8 cfs
Length of parking lot to be discharge from = 114'
Portion not obstructed by blocks (2/8) = 0.25

= 114' x 0.25 = 28.5'

Discharge / LF = 5yr = 4 / 28.5 = 0.14 cfs / FT
100yr = 8 / 28.5 = 0.28 cfs / FT

HIGHER *Relationships*

WILSON & COMPANY

FROM: Austin Bluffs Parkway DATE: 5/23/12 FILE:

TO: SUBJECT:

Discharge From Church Parking Lot to Swale

Determine Velocity & Depth down 4:1 slope

5yr.

$n = 0.03$ $S = 0.25$ $Q_5 = 0.14$ => $V_5 = 3.02$ $D_5 = 0.05$

100yr

$n = 0.03$ $S = 0.25$ $Q_{100} = 0.28$ => $V_{100} = 3.9$ $D_{100} = 0.07$

Flow from basin L3 = 5 cfs / 10 cfs

Length of Parking lot to be discharged from = 72'

(Portion of basin L3 redirected by 6" x 6" Timber)

Portion not obstructed by parking blocks (2/8) = 0.25

∴ 72 x 0.25 = 18'

Discharge / LF = 5yr 5/18 = 0.278 cfs/FT

100yr 10/18 = 0.556 cfs/FT

Determine Velocity & Depth down 4:1 slope

5yr = 1

$n = 0.03$ $S = 0.25$ $Q_5 = 0.278$ => $V_5 = 3.89$ $D_5 = 0.07'$

100yr

$n = 0.03$ $S = 0.25$ $Q_{100} = 0.556$ => $V_{100} = 5.01$ $D_5 = 0.11'$

HIGHER *Relationships*

WILSON
&COMPANY

FROM: Austin Bluffs Parkway

DATE: 5/23/12 FILE:

TO:

SUBJECT:

Discharge From Church Parking lot to Swale

Calculate shear stress on slope based upon maximum Discharge/LF

Basin L3 - 100-YR = 0.556 cfs/LF

Flowmaster Depth = 0.11'

$\tau = \gamma \times d \times S$

$= 62.4\ \#/ft \times 0.11\ ft \times 0.25\ ft/ft$

$\tau = 1.716 \approx 1.72\ lb/ft^2$

HIGHER Relationships

Sheet Flow from Church Parking Lot to Church Swale

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.33300	ft/ft
Bottom Width	1.00	ft
Discharge	0.14	ft³/s

Results

Normal Depth		0.04	ft
Flow Area		0.04	ft²
Wetted Perimeter		1.08	ft
Hydraulic Radius		0.04	ft
Top Width		1.00	ft
Critical Depth		0.08	ft
Critical Slope		0.03679	ft/ft
Velocity		3.31	ft/s
Velocity Head		0.17	ft
Specific Energy		0.21	ft
Froude Number		2.84	
Flow Type	Supercritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.04	ft
Critical Depth	0.08	ft
Channel Slope	0.33300	ft/ft
Critical Slope	0.03679	ft/ft

Sheet Flow from Church Parking Lot to Church Swale 0.108 cfs/lf

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.25000	ft/ft
Bottom Width	1.00	ft
Discharge	0.11	ft³/s

Results

Normal Depth	0.04	ft
Flow Area	0.04	ft²
Wetted Perimeter	1.08	ft
Hydraulic Radius	0.04	ft
Top Width	1.00	ft
Critical Depth	0.07	ft
Critical Slope	0.03777	ft/ft
Velocity	2.72	ft/s
Velocity Head	0.12	ft
Specific Energy	0.15	ft
Froude Number	2.41	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.04	ft
Critical Depth	0.07	ft
Channel Slope	0.25000	ft/ft
Critical Slope	0.03777	ft/ft

Sheet Flow from Church Parking Lot to Church Swale 0.140 cfs/lf

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.25000	ft/ft
Bottom Width	1.00	ft
Discharge	0.14	ft³/s

Results

Normal Depth	0.05	ft
Flow Area	0.05	ft²
Wetted Perimeter	1.09	ft
Hydraulic Radius	0.04	ft
Top Width	1.00	ft
Critical Depth	0.08	ft
Critical Slope	0.03679	ft/ft
Velocity	3.02	ft/s
Velocity Head	0.14	ft
Specific Energy	0.19	ft
Froude Number	2.47	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.05	ft
Critical Depth	0.08	ft
Channel Slope	0.25000	ft/ft
Critical Slope	0.03679	ft/ft

Sheet Flow from Church Parking Lot to Church Swale 0.278 cfs/lf

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.25000	ft/ft
Bottom Width	1.00	ft
Discharge	0.28	ft³/s

Results

Normal Depth	0.07	ft
Flow Area	0.07	ft²
Wetted Perimeter	1.14	ft
Hydraulic Radius	0.06	ft
Top Width	1.00	ft
Critical Depth	0.13	ft
Critical Slope	0.03517	ft/ft
Velocity	3.89	ft/s
Velocity Head	0.24	ft
Specific Energy	0.31	ft
Froude Number	2.57	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.07	ft
Critical Depth	0.13	ft
Channel Slope	0.25000	ft/ft
Critical Slope	0.03517	ft/ft

Sheet Flow from Church Parking Lot to Church Swale 0.280 cfs/lf

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.25000	ft/ft
Bottom Width	1.00	ft
Discharge	0.28	ft^3/s

Results

Normal Depth	0.07	ft
Flow Area	0.07	ft^2
Wetted Perimeter	1.14	ft
Hydraulic Radius	0.06	ft
Top Width	1.00	ft
Critical Depth	0.13	ft
Critical Slope	0.03517	ft/ft
Velocity	3.90	ft/s
Velocity Head	0.24	ft
Specific Energy	0.31	ft
Froude Number	2.57	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.07	ft
Critical Depth	0.13	ft
Channel Slope	0.25000	ft/ft
Critical Slope	0.03517	ft/ft

Sheet Flow from Church Parking Lot to Church Swale 0.324 cfs/lf

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.25000	ft/ft
Bottom Width	1.00	ft
Discharge	0.32	ft³/s

Results

Normal Depth	0.08	ft
Flow Area	0.08	ft²
Wetted Perimeter	1.16	ft
Hydraulic Radius	0.07	ft
Top Width	1.00	ft
Critical Depth	0.15	ft
Critical Slope	0.03503	ft/ft
Velocity	4.13	ft/s
Velocity Head	0.27	ft
Specific Energy	0.34	ft
Froude Number	2.60	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.08	ft
Critical Depth	0.15	ft
Channel Slope	0.25000	ft/ft
Critical Slope	0.03503	ft/ft

Sheet Flow from Church Parking Lot to Church Swale 0.556 cfs/lf

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.25000	ft/ft
Bottom Width	1.00	ft
Discharge	0.56	ft^3/s

Results

Normal Depth	0.11	ft
Flow Area	0.11	ft^2
Wetted Perimeter	1.22	ft
Hydraulic Radius	0.09	ft
Top Width	1.00	ft
Critical Depth	0.21	ft
Critical Slope	0.03524	ft/ft
Velocity	5.01	ft/s
Velocity Head	0.39	ft
Specific Energy	0.50	ft
Froude Number	2.65	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.11	ft
Critical Depth	0.21	ft
Channel Slope	0.25000	ft/ft
Critical Slope	0.03524	ft/ft

WILSON & COMPANY

FROM: Austin Bluffs Parkway
TO: Segment 3
DATE: 5/21/12
FILE:
SUBJECT:

Chase Calculation - Portion of Basin P.

Approximate contributing Area = $\frac{5000 \text{ sq ft}}{43560 \text{ sqft/ac}}$ = 0.12 Ac

C = 0.30/0.45 I = 5.1 / 9.07

Q_5 = 0.3 x 5.1 x 0.12 = 0.18 ≈ 0.2 cfs
Q_{100} = 0.45 x 9.07 x 0.12 = 0.49 ≈ 0.5 cfs

Size Chase (8" curb)

Max Flow depth = 5" (to allow room for 1½" support & 3/8" top)

Weir Calculation $Q = C_0 L D^{3/2}$ $C_0 = 3.1$
L = Chase Opening

$0.5 = 3.1 (L)\, 0.416^{3/2}$
0.5 cfs = 3.1 x 0.27 x L
$\frac{0.5}{0.83}$ = L
L = 0.6' min. = refer to as C

NOTE:
As area services landscaping area
Use safety factor of 2 ∴ 2 x C = 1.2' or 14"

Min Requirement = 14" opening

Install 14" opening w 16 3/8" width floor plate

HIGHER Relationships

Capacity of Upper Portion of Swale along Ruby

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00500	ft/ft
Normal Depth	0.75	ft
Left Side Slope	5.00	ft/ft (H:V)
Right Side Slope	5.00	ft/ft (H:V)

Results

Discharge	5.06	ft^3/s
Flow Area	2.81	ft^2
Wetted Perimeter	7.65	ft
Hydraulic Radius	0.37	ft
Top Width	7.50	ft
Critical Depth	0.58	ft
Critical Slope	0.02038	ft/ft
Velocity	1.80	ft/s
Velocity Head	0.05	ft
Specific Energy	0.80	ft
Froude Number	0.52	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.75	ft
Critical Depth	0.58	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.02038	ft/ft

Typical Roadway Capacity for Major Storm

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.03000	ft/ft
Normal Depth	0.67	ft

Section Definitions

Station (ft)	Elevation (ft)
0+00	1.07
0+11	0.86
0+20	0.67
0+20	0.67
0+20	0.00
0+22	0.13
0+66	0.79
0+67	0.83
0+67	1.33

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 1.07)	(0+11, 0.86)	0.013
(0+11, 0.86)	(0+20, 0.67)	0.030
(0+20, 0.67)	(0+22, 0.13)	0.013
(0+22, 0.13)	(0+66, 0.79)	0.015
(0+66, 0.79)	(0+67, 1.33)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Typical Roadway Capacity for Major Storm

Results

Discharge		82.76	ft³/s
Elevation Range	0.00 to 1.33 ft		
Flow Area		11.04	ft²
Wetted Perimeter		38.74	ft
Hydraulic Radius		0.29	ft
Top Width		38.06	ft
Normal Depth		0.67	ft
Critical Depth		0.91	ft
Critical Slope		0.00447	ft/ft
Velocity		7.50	ft/s
Velocity Head		0.87	ft
Specific Energy		1.54	ft
Froude Number		2.45	
Flow Type	Supercritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.67	ft
Critical Depth	0.91	ft
Channel Slope	0.03000	ft/ft
Critical Slope	0.00447	ft/ft