STAFF REPORT FOR THE PLANNING COMMISSION MEETING OF APRIL 26, 2023

FILE NO: **SUB-2023-0061** **AGENDA ITEM: 6.B**

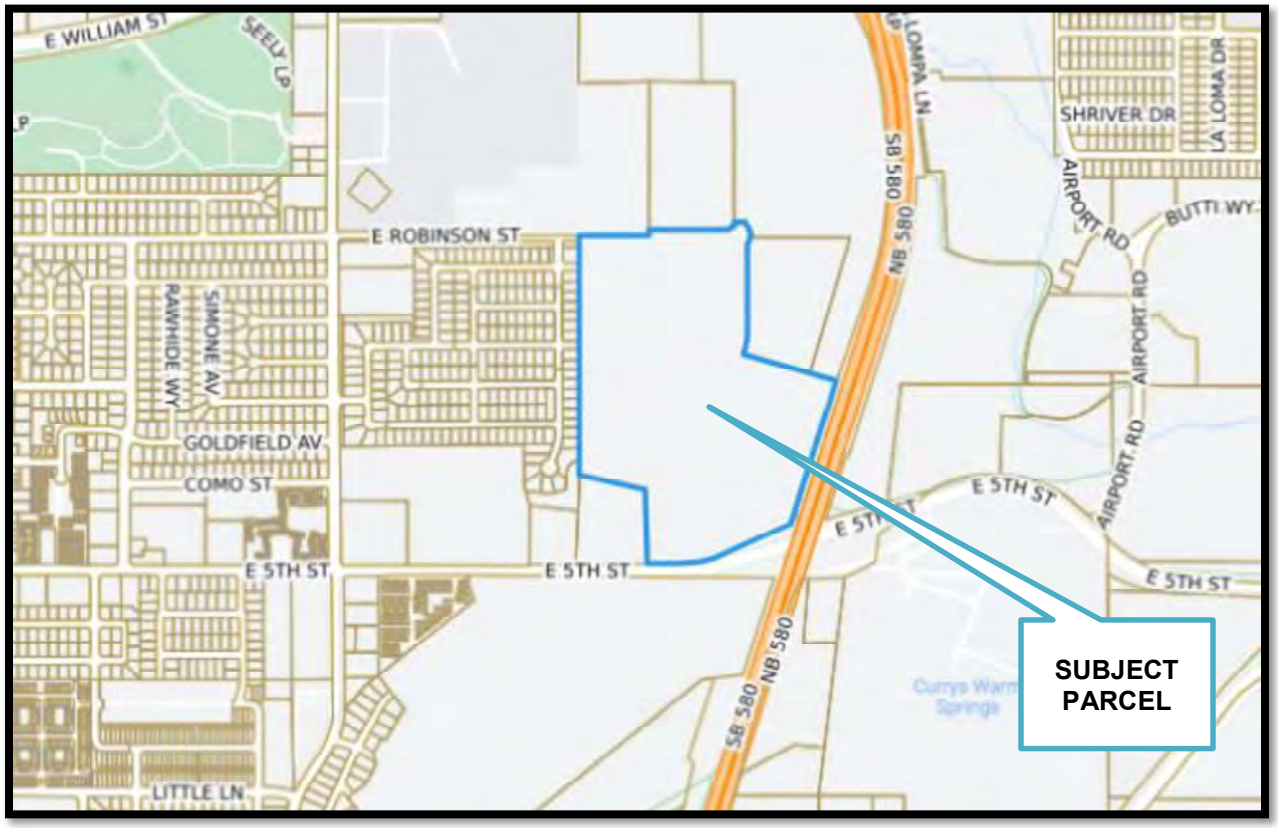
STAFF CONTACT: Heather Manzo, Associate Planner

AGENDA TITLE:
For Possible Action: Discussion and Possible action regarding a request from Steve Thomsen ("Applicant") for a recommendation to the Board of Supervisors ("Board") concerning a tentative subdivision map known as Blackstone Ranch Phase 2, to create 204 single family residential lots on a ±58.52 acre site within the Lompa Ranch North Specific Plan Area ("SPA") zoned Single Family 6,000 Square Feet ("SF6-SPA") and Multifamily Duplex ("MFD-SPA") located at 2230 East 5th Street, Assessor's Parcel Number ("APN") 010-041-40. (Heather Manzo, hmanzo@carson.org)

Summary: The Applicant is requesting to subdivide a ±58.52 acre site into 204 single family residential lots with a minimum lot size of 6,000 square feet. The Board is authorized to approve the tentative subdivision map. The Planning Commission makes a recommendation to the Board.

RECOMMENDED MOTIONS:
"I move to recommend approval of Tentative Subdivision Map SUB-2023-0061 based on the ability to make the required findings and subject to the conditions of approval."

VICINITY MAP:



RECOMMENDED CONDITIONS OF APPROVAL:

The following are conditions of approval are recommended consistent with Carson City Municipal Code ("CCMC") 18.02.105 (5) for a tentative map:

1. All final maps shall be in substantial accord with the approved tentative map.

2. Prior to submittal of any final map, the Carson City Public Works Department, Development Engineering Division ("Development Engineering") shall approve all on-site and off-site improvements. The applicant shall provide construction plans to Development Engineering for all required on-site and off-site improvements, prior to any submittals for approval of a final map. The plan must adhere to the recommendations contained in the project soils and geotechnical report.

3. Lots not planned for immediate development shall be left undisturbed and mass grading and clearing of natural vegetation shall not be allowed. Any and all grading shall comply with City standards. A permit from the Nevada Division of Environmental Protection shall be obtained prior to any grading. Noncompliance with this provision shall cause a cease-and-desist order to halt all grading work.

4. All lot areas and lot widths shall meet the zoning requirements approved as part of this tentative map with the submittal of any final map.

5. With the submittal of any final maps, the applicant shall provide evidence to the Carson City Community Development Department, Planning Division from the Carson City Health and Human Services Department and the Carson City Fire Department ("Fire Department") indicating the agencies' concerns or requirements have been satisfied. Said correspondence shall be included in the submittal package for any final maps and shall include approval by the Fire Department of all hydrant locations.

6. The following note shall be placed on all final maps stating: *"These parcels are subject to Carson City's Growth Management Ordinance and all property owners shall comply with provisions of said ordinance."*

7. Placement of all utilities, including AT&T Cablevision, shall be underground within the subdivision. Any existing overhead facilities shall be relocated prior to the submittal of a final map.

8. The applicant must sign and return the Notice of Decision for conditions for approval within ten (10) days of receipt of notification after the Board meeting. If the Notice of Decision is not signed and returned within ten (10) days, then the item may be rescheduled for the next Planning Commission meeting for further consideration.

9. Prior to the issuance of each site improvement permit, the applicant shall add a note to the plans stating: *"Hours of construction shall be limited to between the hours of 7:00 a.m. and 7:00 p.m., Monday through Friday, and between 7:00 a.m. and 5:00 p.m. on Saturday and Sunday. If the hours of construction are not adhered to, the Carson City Building Department will issue a warning for the first violation, and upon a second violation, will have the ability to cause work at the site to cease immediately."*

10. The applicant shall adhere to all City standards and requirements for water and sewer systems, grading, drainage, and street improvements.

11. The applicant shall obtain a dust control permit from the Nevada Division of Environmental Protection. The site grading must incorporate proper dust control and erosion control measures.

12. A detailed storm drainage analysis, water system analysis, and sewer system analysis shall be submitted to Development Engineering prior to approval of a final map.

13. Prior to the recordation of the final map for any phase of the project, the improvements associated with the project must either be constructed and approved by Carson City, or the specific performance of said work secured, by providing the City with a proper surety in the amount of one hundred fifty percent (150%) of the engineer's estimate. In either case, upon acceptance of the improvements by the City, the developer shall provide the City with a proper surety in the amount of ten percent (10%) of the engineer's estimate to secure the developer's obligation to repair defects in workmanship and materials which appear in the work within one (1) year of acceptance by the City.

14. A "will serve" letter from the water and wastewater utilities shall be provided to the Nevada Health Division prior to recordation of the first final map.

15. The District Attorney's Office shall approve any Covenants, Conditions & Restrictions ("CC&R's") prior to recordation of the first final map.

Other Conditions of Approval:

16. Prior to the final Engineering inspection for improvements for the first phase of Blackstone Ranch Phase 2, the right of way extension improvements of East Robinson Street and Matterhorn Drive shown as "existing" on the plans (which are permitted by permit ENG-2021-2549), must be completed and accepted by the City.

17. Prior to the recordation of the first final map, the project must pay its pro-rata share for the construction cost for the installation of a traffic signal at the intersection of Saliman Road and Robinson Street. The projects share shall be 60% of the estimated cost of construction (not to exceed $972,900) unless future projects are approved which contribute a.m. peak hour trips to the intersection of Saliman Road and Robinson Street. The future school site shall not be a contributing project in the calculation of the pro-rata share.

18. Should the developer be the first to record a final map which results in the 460th residential lot, the developer shall provide the materials for the traffic signal. Materials shall include, but are not limited to poles, mast arms, and signal heads. The developer shall not be responsible for providing the signal control cabinet.

19. If the project is developed in phases, each phase shall stand alone. The site improvement permit for the first phase of this development shall include identified mitigations for the entire project, including but not limited to: a looped water system, secondary access, and other mitigations or improvements that are necessary to support this project at buildout.

20. Prior to the issuance of a site improvement permit that includes any local roadways, the applicant shall demonstrate that all local roads shall have a minimum asphaltic concrete thickness of 4 inches.

21. Prior to the submittal of the first final map, the applicant shall demonstrate that the Kings and Ash Canyon Channels are substantially complete. The Kings and Ash Canyon Channels shall be dedicated to the City with the first final map.

22. The CC&R's shall clearly state that a LMD is required for maintaining the private storm drain infrastructure including any mains, basins, and Low Impact Development ("LID") infrastructure.

23. Prior to the recordation of the first final map, a homeowner's association (HOA) or similar entity shall be formed for maintenance, including landscaping and irrigation, of all common area parcels, and landscaping within the public rights-of-way ("ROW"). The final map and CC&Rs shall note that the landscaping and irrigation located within the public ROW shall be privately maintained.

24. All multi-use paths will be designed and constructed to a 10-foot wide (minimum) American Association of State Highway and Transportation Officials ("AASHTO") standard concrete multi-use path (off street/paved/shared) with an adjacent 3-foot-wide decomposed granite path. In addition to landscaping, the applicant shall incorporate pedestrian amenities that may include benches, dog waste stations, and trash receptacles along the path system, to the approval of the Parks Department.

25. Prior to the issuance of a site improvement permit(s), the Applicant shall include landscape and irrigation plans for any common areas and along the public ROW which abut the project that include:

    a. Subsurface materials that include appropriate soils to support tree and shrub growth as recommended by a licensed Landscape Architect.

    b. Carson City is a Bee City USA. As a result, the developer shall use approximately 50% pollinator friendly plant material for any required landscaping on the project site. Also, any remaining landscape plant material selection needs to be consistent with the City's approved tree species list or other tree species, as approved by the City. The Carson City Pollinator Plant list and other plant selection resources can be found at www.carson.org/beecityusa

26. Prior to the issuance of any site improvement permit, the applicant shall incorporate "best management practices" into their construction documents and specifications to reduce the spread of noxious weeds, to the approval of the Development Engineering and Parks Department.

27. Where possible, deciduous trees must be planted a minimum of 5 feet from any city/public street, sidewalk or pathway and evergreen trees must be planted a minimum of 10 feet from any city/public street, sidewalk or pathway. Fruit bearing, "non-fruiting" flowering or any other trees that drop debris such as seed pods shall be prohibited near or placed where they will eventually hang over public sidewalks or pathways.

28. Prior to the recordation of a final map, the applicant shall demonstrate that a LMD has been established for the Lompa Ranch North SPA, inclusive of all properties within the SPA on the west side of I-580.

29. Prior to the recordation of the first final map, the applicant shall demonstrate that the developer has entered into an agreement with the Parks Department for the design and construction of the 10-acre site. Additionally, the conceptual site plan for the park site

shall be submitted to the Parks Department prior to the issuance of the Certificate of Occupancy for the 400th residential unit within the Lompa Ranch North SPA, west of I-580. The planning process and public meetings shall be coordinated through and agreed upon by the Parks Department.

30. Prior to the issuance of the Certificate of Occupancy for the 750th residential unit, the Applicant shall demonstrate that the 10-acre park site has been constructed to the satisfaction of the Carson City Parks, Recreation and Open Space Department, and dedicated to the City.

31. Prior to the recordation of the first final map, the applicant shall coordinate with staff to develop a plan for the tracking of approved or recorded residential units and Certificates of Occupancy for the properties within Lompa Ranch North SPA, west of I-580.

LEGAL REQUIREMENTS: CCMC 17.05 (Tentative Maps); CCMC 17.07 (Findings); NRS 278.330

SITE DEVELOPMENT INFORMATION:
SUBJECT SITE AREA: ±58.52 acres
EXISTING LAND USE: Vacant

MASTER PLAN DESIGNATION: Medium Density Residential (3-8 du/ac) and Open Space. All properties are within the Lompa Ranch North Specific Plan Area.

ZONING: Single Family – 6,000 Square Feet ("SF6-SPA") and Multifamily Duplex ("MFD-SPA"). All properties are located within the Lompa Ranch North SPA.

KEY ISSUES: Is the tentative map consistent with the required findings? Does the proposal meet the tentative map requirements, Lompa Ranch North SPA handbook and other applicable requirements?

SURROUNDING ZONING AND LAND USE INFORMATION

NORTH:	P, MFD-SPA & GC-SPA / Carson High School and vacant land
SOUTH:	MFD-SPA & A / I-580 and vacant land
EAST:	MFD-SPA, SF6-SPA, Agricultural ("A") / Interstate 580 & vacant
WEST:	SF6-SPA / Single family development

ENVIRONMENTAL INFORMATION:
FLOOD ZONES: X Shaded and AE, and AO
SLOPE: Generally flat
SEISMIC ZONE: Zone I (Greatest Severity)
FAULT: Beyond 500 feet

Previous Reviews:

MPA-15-162: (March 17, 2016) Adoption of the Lompa Ranch North Specific Plan.

MISC-17-001 (March 17, 2016) Approval of the Lompa Ranch North Phasing Plan

ZMA-15-163: (April 7, 2016) Adoption of a Zoning Map Amendment with an effective date of the date of a change of ownership.

TSM-17-184 (October 24, 2018) Approval of a tentative map for Blackstone Ranch Phase 2, expired October 24, 2022.

CSM-2022-0013 (December 9, 2022) Conceptual subdivision map for 204 lots in Phase 2.

BACKGROUND:

Lompa Ranch is one of four areas identified in the Master Plan that are designated as a Specific Plan Area. The Specific Plan designation requires development proposals within the area to be reviewed in a comprehensive manner. The policies contained in the Lompa Ranch North Specific Plan Area Handbook ("SPA Handbook") adopted on March 17, 2016, provide a framework for development in the area.

The Lompa Ranch North SPA is ±251.33 acres in size located on the east and west side of Interstate 580 ("I-580"), generally south of East William Street and north of East 5th Street. The SPA is intended to include a mix of uses including residential areas of various densities, commercial areas, two park sites, pedestrian connectivity, and a ten-acre school site. The SPA Handbook addresses design standards, parks, open space, trails, sanitary sewer, water service, stormwater management, utility services, roadways and traffic, fire and police protection, and schools.

With respect to infrastructure and public services, the SPA Handbook includes a phasing plan that addresses storm water and drainage, traffic and roadways, water, and sanitary sewer planning for the west side of the SPA. The SPA Handbook also addresses parks, open space, and trail amenities, as well as fire mitigation. Per the SPA Handbook, these improvements will be constructed by the developer and maintained via a homeowner's association, landscape maintenance district, or combination thereof. The ten-acre park on the west side is to be constructed and dedicated to the City prior to the 750th residential unit west of Interstate 580. Conditions are recommended to ensure that milestones are met at the appropriate time in development. One of which includes submittal of a parks conceptual plan at the time of the 400 residential unit and execution of related agreements for development located to the west of Interstate 580. The intent is to ensure the required improvements do not result in a construction delay, but rather are being planned concurrent with other construction activities.

In addition to the SPA Handbook, the property is subject to a development agreement that was adopted by Ordinance No. 2017-25. The development agreement includes voluntary contributions to mitigate the impacts of the development on fire services, in lieu of residential construction tax ("RCT"), and to go toward the cost of the Carson City School District ("School District") purchase of the school site. These contributions are paid at the time of building permit.

The project boundary encompasses the remaining residential phase on the west side of I-580.

DISCUSSION:
The proposed subdivision is located on the west side of I-580, to the south of Robinson Street and north of East 5th Street. Primary access to the site will be from Matterhorn Lane (previously known as Spine Road) or from Robinson Street. The local streets will include a 50-foot right-of-way with a 5-foot sidewalk on both sides of the street and on-street parking on one side of the street. Homes are anticipated to each have a standard two-car garage and a minimum 20-foot-long driveway.

The maximum allowable density in the SF6 and MFD zoning district is 7.26 and 14.52 dwelling units per acre, respectively. The project proposes 3.49 dwelling units per acre, consistent with the zoning and the SPA Handbook density range of between 4 and 36 dwelling units per acre. The applicant proposes to subdivide a ±58.52 acre site to create 204 single family residential lots with a minimum lot size of 6,000 square feet with an average lot size of 6,706 square feet in size. A total of ±10.2 acres of common open space is proposed and each lot will have private yards.

The Planning Commission conducts a public hearing and advises the Board if the proposed tentative map is consistent with the provisions of the CCMC and NRS 278.320.

PUBLIC COMMENTS: Public notices were mailed on April 13, 2023 to 38 property owners within 1,100 feet of the subject site pursuant to the provisions of NRS and CCMC for the Tentative Subdivision Map application. No comments were received at the time this report was prepared. Any written comments that are received after this report is completed will be submitted prior to or at the Planning Commission meeting on April 26, 2023 depending upon their submittal date to the Planning Division.

OTHER CITY DEPARTMENT OR OUTSIDE AGENCY COMMENTS: The following comments were received from City departments. Recommendations have been incorporated into the recommended conditions of approval, where applicable.

Development Engineering:

Development Engineering has no preference or objection to the tentative map request and offers the following conditions of approval:

- If this project is to be developed in phases, each phase must be able to stand alone, but should also mitigate cumulative impacts across all phases.
- All multi-use paths will be designed and constructed to a 10-foot wide (minimum) AASHTO standard concrete multi-use path (off street/paved/shared) with an adjacent 3-foot-wide decomposed granite ("DG") path.
- The multi-use path amenities shall include, but are not limited to, path benches/seating area (per 1000 lineal feet of trail along the path), pet waste stations/trash cans, and signage depicting direction and trail distance.
- Local roads will have a minimum AC pavement thickness of 4-inches.
- The CC&R's must clearly state that a LMD is required for maintaining the private storm drain infrastructure including any mains, basins, and LID infrastructure.
- Prior to the recording of the first final map that would result in 460 total housing units, the project must provide materials for a traffic signal at the intersection of Saliman Road and Robinson Street including poles, mast arms, and signal heads. The signal control cabinet will not be included.
- The project must pay its pro-rata share for the construction cost for the installation of a traffic signal at the intersection of Saliman Road and Robinson Street. The projects share shall be 60% of the estimated cost of construction (not to exceed $972,900) unless future projects are approved which contribute

a.m. peak hour trips to the intersection of Saliman Road and Robinson Street. The future school site shall not be a contributing project in the calculation of the pro-rata share.

- The Ash and Kings Canyon Channels must be completed, separate parcels created, and offered for dedication prior to the submittal of the first final map.
- The drainage and flood channels shall be substantially complete prior to the recordation of the first final map.
- The Flood Channel LMD must be established prior to the recordation of the first final map.

FINDINGS:
Development Engineering has reviewed the application within our areas of purview relative to adopted standards and practices and to the provisions of CCMC 17.07.005. The following Tentative Map Findings by Development Engineering are based on approval of the above conditions of approval:

1. *Environmental and health laws and regulations concerning water and air pollution, the disposal of solid waste, facilities to supply water, community or public sewage disposal and, where applicable, individual systems for sewage disposal.*

The existing infrastructure has been found sufficient to supply the water and sanitary sewer needs of the subdivision, and the City has the capacity to meet the water and sewer demand. The Blackstone Phase 2 Roadway and Phase 2 east of the roadway, south of the park site was approved to have substandard sewer by the city and NDEP. The substandard sewer that was approved was an 8-inch PVC sewer main at a slope at or greater than 0.002 ft/ft which is less than Carson City and Ten State design standards however it was analyzed by the city and was found to not have a negative impact on city infrastructure and was preferred by the city engineer and the sewer utility manager in order to avoid having an additional lift station.

2. *The availability of water which meets applicable health standards and is sufficient in quantity for the reasonably foreseeable needs of the subdivision.*

The City has sufficient system capacity and water rights to meet the required water allocation for the subdivision.

3. *The availability and accessibility of utilities.*

Water, storm water, and sanitary sewer utilities are available and accessible.

4. *The availability and accessibility of public services such as schools, police protection, transportation, recreation, and parks.*

The Manual on Uniform Traffic Control Devices ("MUTCD") triggers will not be met with this project or the previously approved projects based on the traffic impact study submitted for SUB-2021-0399 (Blackstone Ranch Phase 3); however, the SPA handbook calls for a traffic signal at the intersection of Saliman Road and East Robinson Street no later than the completion of the 460th housing unit that contributes trips directly to Robinson Street. Therefore, the developer that is the first to record a final map which results in the 460th residential lot shall be required to provide the material for the traffic light.

Additionally, a pro-rata share for the installation of the traffic signal will be triggered with the first final map for this project. A condition is recommended to require the project to pay a pro-rata share for the construction cost of the installation of a traffic signal at the intersection of

Saliman Road and Robinson Street. The projects share shall be 60% of the estimated cost of construction (not to exceed $972,900) unless future projects are approved which contribute a.m. peak hour trips to the intersection of Saliman Road and Robinson Street. The future school site shall not be a contributing project in the calculation of the pro-rata share.

5. Access to public lands. Any proposed subdivision that is adjacent to public lands shall incorporate public access to those lands or provide an acceptable alternative.

There are public trails proposed along the proposed drainage channels.

6. Conformity with the zoning ordinance and land use element of the city's master plan.

Development engineering has no comment on this finding.

7. General conformity with the city's master plan for streets and highways.

The development is in conformance with the City's master plan for streets and highways.

8. *The effect of the proposed subdivision on existing public streets and the need for new streets or highways to serve the subdivision*.

The pavement condition of East Robinson Street and East 5th Street is "Good" per the 2022 Pavement Condition Index. This project will be intersecting East Robinson Street and East 5thStreet via Matterhorn Drive. The intersection of Matterhorn Drive and East Robinson Street will have a roundabout. The intersection of Matterhorn Drive and East 5th Street will be stop controlled but it will not meet the triggers to require a traffic signal or roundabout at East 5th Street and Matterhorn Drive. The project is required to dedicate sufficient right-of-way to accommodate either improvement if future projects meet this trigger.

There is a site improvement permit for the construction of roadway improvements from the terminus of East Robinson Street via a roundabout to Matterhorn Drive that will connect to East 5th Street (ENG-2021-2549). The completion of these improvements is necessary to provide access to the proposed project. Matterhorn Drive will be a collector street while East 5th Street is an arterial street. East Robinson Street is currently considered a local street however with Blackstone Ranch Phase 1, Robinson Street was widened to be a collector street and the widening will continue with this project. The internal streets are wide enough to accommodate parking on one side of the street with additional parking provided via the driveways and garages. East 5th Street and East Robinson Street does not allow on-street parking as well as the future Matterhorn Drive will not accommodate on-street parking.

The Lompa Ranch Specific Plan Design Standards Handbook calls for the development to provide a traffic signal at the intersection of Saliman Road and Robinson Street no later than the completion of 460 housing units that contribute trips directly to Robinson Street. Based on the currently entitled projects, with this project, there are 530 applicable housing units. Staff is recommending a condition requiring the first final map that would result in 460 total housing units contributing trips to Robinson Street to provide the materials for a traffic signal.

The MUTCD triggers will not be met with this project or the previously approved projects based on the traffic impact study submitted for SUB-2021-0399 (Blackstone Ranch Phase 3); however, the SPA handbook calls for a traffic signal at the intersection of Saliman Road and East Robinson Street no later than the completion of the 460th housing unit that contributes trips directly to Robinson Street. Therefore, the developer that is the first to record a final map

which results in the 460th residential lot shall be required to provide the material for the traffic light.

The percentage of the pro-rata share is based on the peak AM trips expected for projects contributing to Robinson Street. Two projects are anticipated to contribute trips that will trigger the installation of the traffic signal. SUB-2021-0399 is triggering 101 peak AM trips while this project is contributing 151 peak AM trips which is why this project is required to pay 60% of the installation costs. If future projects are approved that contribute trips to Robinson Street, those projects will be required to pay their portion of peak AM trips which will decrease the percentage for the two projects above. The proposed school site is exempt from contributing to the cost of installation.

9. The physical characteristics of the land such as flood plains, earthquake faults, slope and soil.

Earthquake faults: The closest fault is over 500 feet away with a slip rate of less than 0.2 mm/yr.

FEMA flood zones: The Letter of Map Revision is currently in process of being reviewed by FEMA and meets city standards. Per city and FEMA floodplain regulations, the homes located in Zone AO (1 ft) zone, must have 2 feet of freeboard above base floor elevation (finished floor shall be a minimum of 3-feet above the existing ground. All homes constructed prior to the Letter of Map Revision is approved by FEMA will require elevation certificates demonstrating this per FEMA regulations.

Site slope: The site's slope is minimal with a slope less than two percent.

Soils: The soil is primarily silty sand and clayey sand. The project must meet the recommendations provided in the geotechnical report.

10. The recommendations and comments of those entities reviewing the subdivision request pursuant to NRS 278.330 thru 278.348, inclusive.

Development Engineering has no comment on this finding.

11. The availability and accessibility of fire protection including, but not limited to, the availability and accessibility of water and services for the prevention and containment of fires including fires in wild lands.

The subdivision has sufficient secondary access, and sufficient fire water flows.

12. *Recreation and trail easements*.

This project will provide recreation via a multi-use path connecting East 5th Street to Robinson Street. The condition above requires this project to provide trail amenities including, but not limited to, park benches/seating areas, pet waste stations/trash cans, and signage depicting direction and trail distance per the Lompa Ranch Specific Plan Design Standards.

Fire Department:

1. The project must comply with the International Fire Code and Northern Nevada Fire Code amendments as adopted by Carson City.

2. Two separate means of access shall be provided and maintained in accordance with the Fire Code.

3. Water supply and fire hydrants shall be provided and approved by Carson City Public Works and Carson City Fire Departments.

4. Exterior addressing shall be approved by the Fire Department.

5. The project shall contribute per-unit Fire Department funds in accordance with the Lompa Ranch North Development Agreement.

Parks, Recreation & Open Space Department:

1. The City will not be responsible for any landscape or irrigation system maintenance on the project. All landscaping and landscape maintenance in the right of way will be the sole responsibility of the owner. The developer is required to maintain all common landscape and open space areas within the development including any landscaping in the street(s) right of ways in perpetuity.

2. Carson City is a Bee City, USA. As a result, the developer shall use approximately 50% pollinator friendly plant material for any required landscaping on the project site. Also, any remaining landscape plant material selection needs to be consistent with the City's approved tree species list or other tree species, as approved by the City. The Carson City Pollinator Plant list and other plant selection resources can be found on the City's website: www.carson.org/beecityusa

3. The site improvement plan should be required to include preliminary landscape and common open space improvement plans. Where landscaped areas are planned, subsurface materials must include appropriate soils to support tree and shrub growth in accordance with CCMC. The applicant should consult with CCMC and a licensed landscape architect for proper subsurface treatment, tree, and plant selections within the public right of way and within public open space areas.

4. The developer is required to incorporate "best management practices" into their construction documents and specifications to reduce the spread of noxious weeds. The spread of invasive and noxious weeds is a significant issue in construction projects that involve land disturbance. Earth moving activities contribute to the spread of weeds, as does the use of contaminated construction fill, seed, or erosion-control products. Experience has demonstrated that prevention is the least expensive and most effective way to halt the spread of noxious and invasive weeds. Preventing the establishment or spread of weeds relies upon:
   - Educating workers about the importance of managing weeds on an ongoing basis;
   - Properly identifying weed species to determine most appropriate treatment strategies;
   - Avoiding or treating existing weed populations; and
   - Incorporating measures into projects that prevent weed seeds or other plant parts from establishing new or bigger populations such as certification of weed-free products.

For more information on "best management practices" please contact The Parks Department.

5. Where possible, deciduous trees must be planted a minimum of 5 feet from any city/public street, sidewalk or pathway. Evergreen trees must be planted a minimum of 10 feet from any city/public street, sidewalk or pathway. Fruit bearing, "non-fruiting" flowering or any other trees that drop debris such as seed pods will not be permitted near or placed where they will eventually hang over city/public sidewalks or pathways.

6. Carson City Municipal Code: Title 18, Division 3 should be reviewed by any/all parties involved in the proposed landscape design prior to landscape plans being submitted to the city for final approval of a building permit.

7. Proposed common area parcels which connect more than one residential and/or collector streets should provide pathways for off-street connectivity throughout the development.

8. Public pathways shall be reserved with public use easements and all common areas within the project should be maintained solely by the HOA. Public parks, open space and drainage areas are subject to approval and must be maintained by a LMD or similar approved instrument, as required by the SPA Handbook and the development agreement.

9. A conceptual site plan for the 10-acre park site must be submitted no later than the time that a final map is submitted containing the 400th residential unit within Lompa Ranch North SPA, west of I-580. The park plan is subject to review, approval, and execution of agreed upon terms and conditions memorialized in the developer's agreement. The planning process and public meetings shall be coordinated through and agreed upon by the Parks Department.

10. Development proposed adjacent to the park site shall include vehicle and pedestrian connections to the future park site. Where development roadways are adjacent to the park site, frontage landscaped area should be provided by this development, to the approval of the Community Development and Parks Departments.

11. Per the SPA Handbook, at the applicant's expense, the park will be constructed, accepted, and the land dedicated to the city prior to the issuance of the certificate of occupancy for the 750th residential unit on the west side of I-580 within the SPA. Upon successful completion, final project acceptance of said work will be done to the satisfaction of the City, through its Parks Department.

12. Per Section 2.6 of the Development Agreement, the developer is required to submit a voluntary deposit of funds equivalent to the money that would otherwise have been collected as RCT. These funds are collected with fees collected for each individual house permit.

13. Common area parcels should be landscaped.

14. For additional requirements related to the Lompa Ranch North SPA, please refer to the SPA Handbook and Development Agreement.

TENTATIVE MAP FINDINGS: Staff recommends approval of the tentative subdivision map based on the findings below and in the information contained in the attached reports and documents, pursuant to CCMC 17.05 (Tentative Maps); 17.07 (Findings) and NRS 278.349, subject to the recommended conditions of approval, and further substantiated by the applicant's

written justification. In making findings for approval, the Planning Commission and Board must consider:

1. Environmental and health laws and regulations concerning water and air pollution, the disposal of solid waste, facilities to supply water, community or public sewage disposal and, where applicable, individual systems for sewage disposal.

The development is required to comply with all applicable environmental and health laws concerning water and air pollution and disposal of solid waste. A copy of the proposed tentative map was submitted to the Nevada Division of Water Resources and the Nevada Division of Environmental Protection ("NDEP"). An intent to serve or a will serve letter from the municipal sewer service provider is required at the time the final map is presented to the state for final approval and signature. The Public Works Department has advised of adequate capacity to provide sewer services to the project.

2. The availability of water which meets applicable health standards and is sufficient in quantity for the reasonably foreseeable needs of the subdivision.

Water supplied to the development will meet applicable health standards. The City has sufficient system capacity and water rights to meet the required water allocation for the subdivision.

3. The availability and accessibility of utilities.

All utilities are available in the area to serve this development. The utility design will be reviewed at the time of a site improvement permit to ensure it meets all applicable standards, including applicable conditions of approval.

4. The availability and accessibility of public services such as schools, police protection, transportation, recreation and parks.

With the recommended conditions of approval, the project will not negatively impact the availability and accessibility of public services. Conditions are recommended to address transportation related concerns including pro-rata share contributions and signal equipment for improvements needed at the intersection of Saliman Road and Robinson Street.

The project is located adjacent to a future 10+ acre school site which is to the east of Carson High School. The approved development agreement requires a $1,000 per unit contribution to be collected by the School District and placed in escrow for use in the School District's future purchase of the school site. A per-unit contribution to the Fire Department is collected with each permit to construct a residence. The applicant is required to contribute $1,000 per residential unit in lieu of RCT, based on the Lompa Ranch North development agreement. In addition to a per-unit contribution, the applicant is required to enter into an agreement with the City for the design, construction, and eventual dedication of the park site. A condition is recommended to require the applicant to demonstrate that all necessary agreements between the developer and the Parks Department are approved at the appropriate time as related to the residential housing unit count noted in the SPA Handbook.

5. Access to public lands. Any proposed subdivision that is adjacent to public lands shall incorporate public access to those lands or provide an acceptable alternative.

While there are no public lands adjacent or easily accessed from the site, the applicant has proposed continuation of the 10-foot-wide multi-use system that abuts the site. The proposed pedestrian and multi-use improvements are consistent with the SPA Handbook and will provide

residents with convenient means of non-vehicular access to public facilities within proximity to the site.

6. Conformity with the zoning ordinance and land use element of the City's Master Plan.

The proposed project conforms with the zoning ordinance and land use element of the City's Master Plan. The zoning for the project includes Single-Family 6,000 and Multi-Family Duplex. The Master Plan designations for the site are Medium Density Residential (3-8 du/ac) and Open Space. All properties are within the Lompa Ranch North Specific Plan Area. The site is subject to the provisions of the SPA Handbook. As proposed, and with recommended conditions, the proposal is consistent with the adopted Master Plan and Elements.

It should be noted that in addition to standards for single family development in CCMC, the SPA Handbook addresses a variety of design requirements as outlined in Sections: 2.2 (Single Family Residential Areas) and 2.4 (Architecture Standards and Guidelines). Of particular note are:

- 2.2.2 (a) which encourages forward architecture that places entries, windows, front porches and living spaces closest to the street on "most" house plans.
- 2.2.2 (c) which states that garages shall not be the dominant feature of the building façade facing the street and should be offset through architectural detailing when the garage forward elevation is used.
- 2.2.2(h) states that setbacks should be varied, and this standard allows for a reduction to the 20 foot setback requirement by up to 5 feet, for living space only. In reviewing past residential development within the SPA, setbacks should not only be 15 or 20, but should also provide for setbacks in between, or greater than 20 feet. Having more variety in house placement helps to break up a pattern than can arise from utilizing one or two setback standards for house placement.
- 2.4.2 speaks to architectural elements required for residential development.
- 2.4.8 through 2.4.10 outlines the standards for single family massing and form, roof form, and use of materials and colors. These standards include several requirements for residential development. Of particular note is a requirement to have at least 3 unique house plans, distinct front elevations, and varied setbacks.
- 2.4.11(a) states that garages shall (must) include at least 5 feet of offset from habitable (living) space. Front elevations should provide a focus on living areas, not garages.
- 2.4.11(b) states that plans shall incorporate either 1) recessed garages back at least 5 feet in relationship to the front of the house, or 2) utilize side loaded garages to eliminate the continuous view of the garage from the street.
- 2.4.11(c) when garage forward plans are utilized, an offset between the garage faces shall be at least 5 feet. This standard is intended for 3 car garage design as illustrated by the text and illustrations.

7. General conformity with the City's Master plan for streets and highways.

The development is in conformance with the City's Master Plan for streets and highways.

8. The effect of the proposed subdivision on existing public streets and the need for new streets or highways to serve the subdivision.

Transportation related impacts associated with this subdivision are mitigated through the proposed design and the recommended conditions of approval. Specifically, the project is required to construct the roadway extension from the terminus of East Robinson Street, the roundabout at East Robinson and Matterhorn Drive, and to construct Matterhorn Drive between the roundabout to East 5th Street (ENG-2021-2549). The completion of these improvements is

necessary to provide access to the proposed project. The project is also required to dedicate sufficient right-of-way to accommodate either a traffic signal or roundabout at Matterhorn Drive and East 5th Street; provide for the materials for a traffic signal at Saliman Road and Robinson Street; and pay a pro-rata share for the construction costs of a traffic signal at Matterhorn and Robinson intersection. Additionally, the local streets are designed with a 50-foot wide right of way that will accommodate parking on one side of the street; and each lot will provide for a minimum of two parking spaces, typically via a two-car garage.

9. The physical characteristics of the land such as flood plains, earthquake faults, slope and soil.

Potential impact related to flooding will be mitigated with a Letter of Map Revision. The Letter of Map Revision is currently in the process of being reviewed by FEMA and meets city standards. Per city and FEMA floodplain regulations, the homes located in Zone AO (1 ft) zone, must have 2 feet of freeboard above base floor elevation (finished floor shall be a minimum of 3-feet above the existing ground. All homes constructed prior to the Letter of Map Revision is approved by FEMA will require elevation certificates demonstrating this per FEMA regulations.

10. The recommendations and comments of those entities reviewing the subdivision request pursuant to NRS 278.330 thru 278.348, inclusive.

The proposed tentative map has been routed to the NDEP and the Nevada Division of Water Resources. A will serve letter for the sewer and water services will be required prior to the recordation of any final map.

11. The availability and accessibility of fire protection including, but not limited to, the availability and accessibility of water and services for the prevention and containment of fires including fires in wild lands.

As noted in the SPA Handbook, the development of Lompa Ranch North will impact the Fire Department's level of service. In response to this concern, the project development agreement addresses per unit contributions and improvements relative to fire safety. The terms of the development agreement apply to this project. The subject site is not located within a wildland/urban interface area.

12. Recreation and trail easements.

The Lompa Ranch Specific Plan specifically addresses Parks, Open Space and Trails. The trail system is required to conform with the standards and policies of the Unified Pathways Master Plan. Parks Department staff has reviewed the tentative map for compliance with the requirements of the Specific Plan and finds, subject to the incorporation of the conditions of approval, the proposed tentative map will be in compliance with the requirements.

This request will result in entitlement of more than 750 dwelling units within the SPA located to the west of I-580. The Specific Plan includes a requirement for the construction and dedication of a ten-acre park at the time of the 750th-dwelling unit on the west side of Interstate 580. The Specific Plan also obligates a landscape maintenance district be formed for purposes of maintaining landscaped areas, open space and drainage facilities, trails, parks, and recreation facilities. Since there are unit triggers for park agreements, submittal and approval of the conceptual plan for the design of the park site, and construction of the park site, conditions of approval are recommended to require park site design, construction and a method of tracking residential unit counts to be established to ensure that the timing of development and associated triggers can be met.

Attachments:

Application- SUB-2023-0061

Carson City Planning Division
108 E. Proctor Street· Carson City NV 89701
Phone: (775) 887-2180 • E-mail: planning@carson.org

FOR OFFICE USE ONLY:

CCMC 17.06 and 17.07

TENTATIVE SUBDIVISION MAP

FEE*: $3,500.00 + noticing fee
*Due after application is deemed complete by staff

FILE #

APPLICANT	PHONE #
Steve Thomsen	775-823-3788

MAILING ADDRESS, CITY, STATE, ZIP
985 Damonte Ranch Pkwy, Ste. 140, Reno, NV 89521

EMAIL
steve@ryderhomes.com

PROPERTY OWNER	PHONE #
RD Lompa, LLC	775-823-3788

MAILING ADDRESS, CITY, STATE, ZIP
same as applicant

EMAIL
same as applicant

APPLICANT AGENT/REPRESENTATIVE	PHONE #
Ken Anderson	775.507.7008

MAILING ADDRESS, CITY, STATE, ZIP
1311 N. McCarran Blvd, Ste. 103, Sparks, NV 89434

EMAIL
ken@jkaedesign.com

Project's Assessor Parcel Number(s)
010-041-40

Project's Street Address
2230 East 5th Street

Nearest Major Cross Street(s)
N. Saliman Road & E. Robinson Street

Project's Master Plan Designation
Lompa Ranch North Specific Plan Area - Single-family 6,000 (SF6-SPA) & Multi-family duplex (MFD-SPA)

Project's Current Zoning
Agriculture (A)

- [X] **SUBMITTAL PACKET – 5 Complete Packets (1 Unbound Original and 4 Copies) including:**
  - [X] Application Form including Applicant's Acknowledgment
  - [X] Property Owner Affidavit
  - [X] Copy of Conceptual Subdivision Map Letter
  - [X] Detailed Written Project Description
  - [X] Proposed Street Names
  - [X] Master Plan Policy Checklist
  - [X] Wet Stamped Tentative Map (24" x 36")
  - [X] Reduced Tentative Map (11" x 17")
  - [X] Conceptual Drainage Study
  - [X] Geotechnical Report
  - [X] Traffic Study (if applicable)
  - [X] Documentation of Taxes Paid to Date
- [X] **CD or USB DRIVE with complete application in PDF**
- [X] **STATE AGENCY SUBMITTAL including:**
  - [X] 2 Wet-stamped copies of Tentative Map (24" x 36")
  - [X] Check made out to NDEP for $400.00 + $3/lot
  - [X] Check made out to Division of Water Resources for $180.00 + $1/lot

Application Reviewed and Received By:

_____

Submittal Deadline: Planning Commission application submittal schedule.

Note: Submittals must be of sufficient clarify and detail for all departments to adequately review the request. Additional information may be required.

Project Name
Blackstone Ranch Phase 2

Total Project Area	Number of Lots	Smallest Parcel Size
±58.52 acres	204	6,000 square feet

Please provide a brief description of your proposed project below. Provide additional pages to describe your request in more detail.
This is an application to reinstate the previously approved tentative subdivision map for the second phase of the Blackstone Ranch project. The map inadvertently expired prior to a final map being recorded. This project consists of 204 single family homes with roadway infrastructure to connect E. Robinson St. to E. 5th St.

NOTE: If your project is located within the Historic District or airport area, it may need to be scheduled before the Historic Resources Commission or the Airport Authority in addition to being scheduled for review by the Planning Commission. Planning staff can help you make this determination.

ACKNOWLEDGMENT OF APPLICANT: (a) I certify that the foregoing statements are true and correct to the best of my knowledge and belief; (b) I agree to fulfill all conditions established by the Board of Supervisors.

Applicant's Signature

Date 2/7/2023

PROPERTY OWNER'S AFFIDAVIT

I, Steve Thomsen (Print Name), being duly deposed, do hereby affirm that I am the record owner of the subject property located at 2230 E. 5th Street (Property Address and APN), and that I have knowledge of, and I agree to, the filing of this Tentative Subdivision Map application.

Signature

985 Damonte Ranch Pkwy, Ste. 140, Reno, NV 89521
Address

2/7/2023
Date

Use additional page(s) if necessary for other names.

STATE OF NEVADA)
COUNTY)

APRYL LYNNE CHAVEZ
NOTARY PUBLIC
STATE OF NEVADA
My Appt. Exp. Mar. 15, 2023
No. 19-1703-3

On February 7th, 2023, personally appeared before me, a notary public, Steven Michael Thomsen, personally known (or proved) to me to be the person whose name is subscribed to the foregoing document and who acknowledged to me that he/she executed the foregoing document.

Notary Public

CARSON CITY
PLANNING DIVISION

108 E. Proctor Street
Carson City, Nevada 89701
(775) 887-2180
Hearing Impaired: 711

December 9, 2022

RD Lompa LLC
Attn Steve Thomsen
985 Damonte Ranch Pkwy, Ste 140
Reno, NV 89521

Digitally delivered to: steve@ryderhomes.com

Conceptual Map: CSM-2022-0013

Project Description: A tentative map for a 204-unit subdivision known as Blackstone Ranch Phase 2 was approved in October 2018. The applicant had applied for several site improvement permits that are at various stages in the review process. One site improvement permit for the backbone infrastructure to include the construction of Matterhorn Drive, which will connect Robinson to East 5th Street has been issued, however construction has not commenced. All other permits require additional action prior to their issuance. The tentative map approval was to expire if a final map was not recorded within 4 years of the date the Board of Supervisor's approved the request. The tentative map has expired and the applicant is seeking re-approval of the previously approved tentative map.

Review Date: November 21, 2022

Conceptual Map Comments

The Conceptual Map Committee has reviewed the proposed plans for the subdivision. The following requirements and comments are provided for your use in preparing final plans and submittals for the project. Please be advised that the comments presented in this letter are based on the plans submitted with the conceptual map application and may not include all the requirements or conditions which may be placed on the project at the time of submittal of tentative map. It is hoped, however, that this review will expedite the completion of your project.

Some of the requirements noted below may have already been shown or otherwise indicated in the plans and need only be submitted in the final improvement plan form. Final on- and off-site improvement plans shall be submitted to the Permit Center, (108 E. Proctor Street). These plans must contain all appropriate requirements of Development Engineering, Health, Utilities, Fire, and Planning Divisions/Departments.

SITE INFORMATION:

Address: 2230 East 5th Street
APN: 010-041-40
Parcel Size: ±58.52 acres
Master Plan Designation: Medium Density Residential and Open Space
Zoning: Lompa Ranch North Specific Plan Area - Single Family 6,000 (SF6-SPA) and Multifamily Duplex (MFD-SPA)

PLANNING DIVISION
Heather Manzo, Associate Planner

1. Permitted Use – CCMC 18.04.100, 18.04.105, and the Lompa Ranch North SPA Handbook.

   Single family residential development is allowed with the approval of a tentative map and subsequent recordation of a final map.

2. The conceptual subdivision map application includes minimal information so conformance to the SPA Handbook and development standards will be evaluated at the time of tentative map. It is anticipated that the development will conform with the standards as the Planning and Zoning code and SPA Handbook have not changed since the previous application was approved.

3. The tentative map application will need to include all items identified in the tentative map checklist located on the top right corner of the first page of the application.

4. The tentative map application needs to include a list of the previously approved conditions, a narrative describing the status of the condition as it relates to the new tentative map request and should provide justification for any conditions of approval that should be modified based on improvements or changes that have occurred since the original map for Phase 2 was approved.

5. The allowable density for the MFD zone is up to 14.52 du/ac and the allowable density in the SF6 zone is up to 7.26 du/ac. The minimum lot size for each zone is 6,000 square feet. The tentative map application will need to include density and lot characteristics to allow staff to confirm the standards for the zone are met. Other lot dimension criteria is included in CCMC 18.04.190. The previously approved project was found to be in conformance with the zoning standards and Master Plan policies.

6. The proposal is subject to the Lompa Ranch North SPA Handbook, Development Agreement, and approved Phasing Plan. The tentative map application will need to include plans and information to demonstrate conformance with the governing documents.

7. If the project is intended to be constructed in multiple phases, please provide a colored phasing plan that demonstrates improvements will be constructed for each phase so the phase can stand alone and not depend on future phases to meet requirements and standards.

8. Signs - Carson City Development Standards, Division 4.7.1 Single-Family Residential Uses and Lompa Ranch North SPA Handbook.

   All signs must be consistent with Division 4.7.2 of the Development Standards and the SPA Handbook.

9. Landscaping - Carson City Development Standards, Division 3

   Landscaping must be consistent with Division 3 of the Development Standards. Since a conceptual landscape plan was not provided, staff is unable to determine whether or not the request would meet CCMC standards based on Carson City Development Standards, Division 3.

10. Parking and Loading – Carson City Development Standards, Division 2

    The parking standard is 2 spaces per unit. Plus the provision of on-street parking via standard street width or by providing 1 additional off-street parking space per 2 units in designated guest parking areas. Please refer to the previously stated PUD parking comments.

11. Lighting - Carson City Development Standards, Division 1
    Lighting for the clubhouse and other community parking lots must meet the standards outlined in Development Standards 1.3.

12. Trash Storage - Carson City Development Standards, Division 1
    Trash storage must meet the standards outlined in Carson City Development Standards 1.2.6.

DEVELOPMENT ENGINEERING
Stephen Pottey

1. The original impact reports must be updated to include demand imposed by other projects which have been entitled between the original Blackstone Ranch Phase 2 entitlement and now. Any necessary mitigation must be included in the design.
2. If new improvements are required to mitigate impacts, the improvement plans must be updated to include these improvements.
3. The project must meet the requirements of the City's new drainage manual.
4. The original CSM and TSM conditions will still apply unless changes due to the above requirements necessitate a change.

FIRE DEPARTMENT
Michael Wilkinson, Fire Marshal

1. Project must comply with the currently adopted IFC and Northern Nevada Fire Code Amendment as adopted by Carson City.

BUILDING DIVISION
Thomas Marshall, Building Official

1. Designs to the 2018 Code Series and Northern Nevada Amendments (Building and Fire), Please verify plans follow the Nevada Blue Book guidelines
2. Following the entitlement process, permit applications shall be submitted through the Carson City permit center at permitcenter.carson.org.
3. Provide design criteria on cover pages along with complete set of plans.
4. Permits will require a Nevada Licensed contractor.

PARKS, RECREATION, AND OPEN SPACE DEPARTMENT
Nick Wentworth, Parks Department

1. The City will not be responsible for any landscape or irrigation system maintenance on the project. All landscaping and landscape maintenance in the right of way will be the sole

responsibility of the owner. The developer is required to maintain all common landscape and open space areas within the development including any landscaping in the street(s) right of ways in perpetuity.

2. Carson City is a Bee City, USA. As a result, the developer shall use approximately 50% pollinator friendly plant material for any required landscaping on the project site. Also, any remaining landscape plant material selection needs to be consistent with the City's approved tree species list or other tree species, as approved by the City. The Carson City Pollinator Plant list and other plant selection resources can be found at www.carson.org/beecityusa

The City's approved tree species list for commercial projects can be found at https://www.carson.org/Home/ShowDocument?id=15225

3. The conceptual map should include preliminary landscape and common open space improvement plans. Where landscaped areas are planned, subsurface materials shall include appropriate soils to support tree and shrub growth in accordance with CCMC. Please consult with the code and your licensed landscape architect for proper subsurface treatment and tree and plant selections within the public right of way and within public open space areas.

4. The developer is required to incorporate "best management practices" into their construction documents and specifications to reduce the spread of noxious weeds. The spread of invasive and noxious weeds is a significant issue in construction projects that involve land disturbance. Earth moving activities contribute to the spread of weeds, as does the use of contaminated construction fill, seed, or erosion-control products. Experience has demonstrated that prevention is the least expensive and most effective way to

halt the spread of noxious and invasive weeds. Preventing the establishment or spread of weeds relies upon:

- Educating workers about the importance of managing weeds on an ongoing basis
- Properly identifying weed species to determine most appropriate treatment strategies
- Avoiding or treating existing weed populations; and
- Incorporating measures into projects that prevent weed seeds or other plant parts from establishing new or bigger populations such as certification of weed-free products.

For more information on "best management practices" please contact The Carson City Parks, Rec. and Open Space Dept.

5. Deciduous trees must be planted a minimum of 5' from any city/public street, sidewalk or pathway. Evergreen trees must be planted a minimum of 10' from any city/public street, sidewalk or pathway. Fruit bearing, "non-fruiting" flowering or any other trees that drop debris such as seed pods will not be permitted near or placed where they will eventually hang over city/public sidewalks or pathways.

6. Carson City Municipal Code: Title 18, Division 3 should be reviewed by any/all parties involved in the proposed landscape design prior to landscape plans being submitted to the city for final approval of a building or site improvement permit. https://library.municode.com/nv/carson_city/codes/code_of_ordinances?nodeId=TIT18_APPENDIXCADEST_DIV3LA

7. Proposed common open space areas which connect more than one residential and/or collector streets shall provide pathways for off street connectivity throughout the development.

8. Areas which do not contain public open space amenities and public pathways shall be reserved as private open space and maintained solely by the HOA. Public open space is subject to approval and the applicant will enter into an agreement with the City for a Landscape Maintenance District (LMD) as required by the SPA Handbook and the development agreement.

9. Development proposed adjacent to the park site shall include vehicle and pedestrian connections to the future park site. Where development roadways are adjacent to the park site, frontage landscaped area should be provided by this development, to the approval of the Community Development and Parks Departments.

10. A conceptual site plan for the 10 acre park site must be submitted no later than the issuance of the certificate of occupancy for the 400th residential unit subject to review, approval, and execution of agreed upon terms and conditions memorialized in the developer's agreement. The planning process and public meetings shall be coordinated through and agreed upon by the Carson City Parks, Recreation and Open Space Department.

11. At the applicant's expense, the park will be constructed, accepted, and the land dedicated to the city prior to the issuance of the certificate of occupancy for the 750th residential unit. Upon successful completion, final project acceptance of said work will be done to the satisfaction of the City, through its Parks, Recreation and Open Space Department.

12. The development is required to submit a voluntary deposit of funds equivalent to the money that would otherwise have been collected as RCT. Please refer to Section 2.6 of the Development Agreement for terms related to this comment.

13. For additional requirements related to the Lompa Ranch North SPA, please refer to the SPA Handbook and Development Agreement.

Conclusion:
The proposal is the same as the previously entitled Blackstone Ranch Phase 2 subdivision map (TSM-17-184) which recently expired. The master infrastructure improvement plans have been issued which will provide for the roadway connections between Robinson and 5th Street to serve this project. The applicant should move forward with submittal of the tentative map for Planning Commission recommendation and Board of Supervisors possible approval.

These comments are based on a very general site plan and do not indicate a complete review. All pertinent requirements of Nevada State Law, Carson City Code, and Carson City Development Standards will still apply whether mentioned in this letter or not.

Sincerely,
Community Development Department, Planning Division

Heather Manzo, Associate Planner

cc: CSM-2022-0013
Ken Anderson ken@jkaedesign.com

Carson City Planning Division
108 E. Proctor St.
Carson City, Nevada 89701
(775) 887-2180
Planning@carson.org
www.carson.org

BOARD OF SUPERVISORS
October 18, 2018

NOTICE OF DECISION – TSM-17-184

A request was received to approve a Tentative Subdivision Map for a 204 lot single family residential subdivision in the Lompa Ranch North Specific Plan Area on property zoned Multi-Family Duplex and Single Family 6000, located south of East Robinson Street, west of Highway 395, and north of East Fifth Street, APN 001-041-71.

The Board of Supervisors considered the request on October 18, 2018 in conformance with the City and State legal requirements approving TSM-17-184 based on the findings contained in the staff report and subject to the conditions of approval contained in the staff report.

The following are conditions of approval required per CCMC 18.02.105.5:

1. All final maps shall be in substantial accord with the approved tentative map.
2. Prior to submittal of any final map, the Development Engineering Department shall approve all on-site and off-site improvements. The applicant shall provide construction plans to the Development Engineering Department for all required on-site and off-site improvements, prior to any submittals for approval of a final map. The plan must adhere to the recommendations contained in the project soils and geotechnical report.
3. Lots not planned for immediate development shall be left undisturbed and mass grading and clearing of natural vegetation shall not be allowed. Any and all grading shall comply with City standards. A grading permit from the Nevada Division of Environmental Protection shall be obtained prior to any grading. Noncompliance with this provision shall cause a cease and desist order to halt all grading work.
4. All lot areas and lot widths shall meet the zoning requirements approved as part of this tentative map with the submittal of any final map.
5. With the submittal of any final maps, the applicant shall provide evidence to the Planning and Community Development Department from the Health and Fire Departments indicating the agencies' concerns or requirements have been satisfied. Said correspondence shall be included in the submittal package for any final maps and shall include approval by the Fire Department of all hydrant locations.
6. The following note shall be placed on all final maps stating:
"These parcels are subject to Carson City's Growth Management Ordinance and all property owners shall comply with provisions of said ordinance."
7. Placement of all utilities, including AT&T Cablevision, shall be underground within the subdivision. Any existing overhead facilities shall be relocated prior to the submittal of a final map.

8. The applicant must sign and return the Notice of Decision for conditions for approval within ten (10) days of receipt of notification after the Board of Supervisors meeting. If the Notice of Decision is not signed and returned within ten (10) days, then the item may be rescheduled for the next Planning Commission meeting for further consideration.
9. Hours of construction will be limited to 7:00 a.m. to 7:00 p.m., Monday through Friday, and 7:00 a.m. to 5:00 p.m. on Saturday and Sunday. If the hours of construction are not adhered to, the Carson City Building Department will issue a warning for the first violation, and upon a second violation, will have the ability to cause work at the site to cease immediately.
10. The applicant shall adhere to all City standards and requirements for water and sewer systems, grading and drainage, and street improvements.
11. The applicant shall obtain a dust control permit from the Nevada Division of Environmental Protection. The site grading must incorporate proper dust control and erosion control measures.
12. A detailed storm drainage analysis, water system analysis, and sewer system analysis shall be submitted to the Development Engineering Department prior to approval of a final map.
13. Prior to the recordation of the final map for any phase of the project, the improvements associated with the project must either be constructed and approved by Carson City, or the specific performance of said work secured, by providing the City with a proper surety in the amount of one hundred fifty percent (150%) of the engineer's estimate. In either case, upon acceptance of the improvements by the City, the developer shall provide the City with a proper surety in the amount of ten percent (10%) of the engineer's estimate to secure the developer's obligation to repair defects in workmanship and materials which appear in the work within one (1) year of acceptance by the City. Improvements associated with the Conditional Letter of Map Revision must be constructed and may not be secured for in lieu of construction.
14. A "will serve" letter from the water and wastewater utilities shall be provided to the Nevada Health Division prior to approval of a final map.
15. The District Attorney shall approve any CC&R's prior to recordation of the first final map.

Specific Conditions to be included in the Design of the Improvement Plans, to be met prior to approval of construction permit:

16. The improvement plans shall include all improvements identified in the approved Phasing Plan, which is part of the Lompa Ranch Specific Plan.
17. The flood channels and associated access must be on separate parcels to be dedicated to the City. Maintenance of these lands will be funded through a maintenance district or similar instrument, to be established prior to Final Map approval.
18. The dimensions of the flood channels will be designed to accommodate the 100 year flow plus a minimum one foot of freeboard as approved under the FEMA Conditional Letter of Map Revision (CLOMR). These channels must be constructed prior to or with the development of the first subdivision. Bonding for these improvements will not be allowed.

19. The site improvement grading plans must include contours showing the base flood elevation plus two (2) feet, of adjacent channels to confirm that building pads are at least 2 feet above the channel base flood elevations.
20. Low impact design (LID) features must be included as part of this subdivision. LID features will be designed to the Truckee Meadows Low Impact Development Manual standards and must be privately owned and maintained by a Homeowner's Association or similar entity. Note 6 on Page C1 is to be revised to reflect this condition.
21. Sidewalk, curb, and gutter must be installed in front of apns 010-041-34 and 010-041-35 and drainage for these parcels must be tied into the flood channel.
22. All street and sidewalk improvements on the spine road and on Robinson Street will be installed as full street improvements, consistent with note 30 of the general notes. To the satisfaction of the City Engineer, local street construction shall also include all street and sidewalk improvements unless only a portion of the street is included in the approved phase, in which case only the portion included in the subject phase is required to be improved. Nothing in this condition shall be deemed to waive any requirements of the fire code.
23. All roundabout geometry must meet AASHTO geometric design standards.
24. The following street names may not be used: Appaloosa, Emily, and Sophia.
25. Looped streets must maintain the same name throughout the loop.
26. Aiden Ave and Aiden Ct must have the same suffix.
27. All streets will have a minimum 4 inch thick asphalt section.
28. Per the geotechnical report, areas with clay subgrade will have a minimum of 6 to 8 inches of base and sub-base section. Either a map of these areas must be provided by a geotechnical engineer to determine which streets require which base and sub-base thickness, or all streets must meet a this minimum 8 inch base thickness requirement. The Engineering Division will review this condition based on the geotechnical report prepared and submitted at the time of application for improvement plans.
29. The 12 inch water main in the spine road must connect all the way from Robinson Street to 5th Street per the Lompa Ranch North phasing plan.
30. Cast in place manholes are not permitted in this subdivision.
31. Sheet C1: General Notes 4, 6, 27, and 35 reference a landscape maintenance district. Consistent with the development agreement, these amenities are to be maintained by a homeowner's association (HOA) or a landscape maintenance association. A landscape maintenance district will only be formed if the HOA (or similar entity) ceases to exist or remain functional. These notes and any other related notes on the drawings must be modified to be consistent with the development agreement.
32. Sheet C1: Regarding note 10, modify plans to recognize the irrigation system will only utilize a Reduced Pressure Principle Backflow Preventer. It will <u>not</u> utilize a Pressure Vacuum Breaker.
33. Sheet CS2: Modify the detail for the Spine Road's multi-use path to show a 10 foot wide landscape strip, a 10 foot wide concrete multi-use path, and a 3 foot wide DG path adjacent. The landscape strip should be adjacent to the roadway.
34. Sheet CS0: Demonstrate that the drainage channel located on the ten acre park area is at the northern edge of the park so as to not interfere with park programming, and will not exceed a width of 52 feet including the service road. No additional drainage facilities, including drainage easements, will be allowed on the

park property and all drainage should be perpetuated within the channel or other facilities constructed outside of the park property.

35. Sheet CS2: Curve the multi-use path along Robinson Street to connect to the pedestrian crossing on the Spine Road. Create connections from the multi-use path to the pedestrian crossing.
36. The multi-use path on the north side of Fifth Street is to connect to the Linear Park's multi-use path west of the freeway.
37. The project's improvement plans are subject to review and approval by the Parks Recreation and Open Space (PROS) department.
38. PROS Department is to sign off on the project improvements prior to final inspection by the Engineering Department.
39. The Conditional Letter of Map Revision (CLOMR) must be approved by FEMA prior to approval of any construction permits. All improvements associated with the CLOMR must be included in the improvement plans.
40. The CC&R's must clearly state that a Landscape Maintenance Association (LMA), a Home Owners Association (HOA) or similar entity is responsible for maintaining private storm drain infrastructure including any mains, basins, and LID infrastructure.
41. Landscaping plans for the construction permit must include site distance triangles showing that sight distance is not inhibited.
42. Landscaping plans for the construction permit must show distances to existing and proposed water, sewer and storm drain mains to ensure a minimum of 10 foot spacing from trees.
43. A geotechnical report will be required for the subdivision prior to approval of any construction permits.
44. Note that no water main shall have more than 15 services without looping.
45. Plans must show and note that all flood channels (Vicee Canyon, Ash Canyon, and Kings Canyon) must provide sufficient access for City maintenance equipment along the full length, with access points spaced out no more than every 660 feet, and must note that Robinson St, the Spine Road, E 5th St, and N Saliman Rd are not to be considered part of this access.
46. The developer must design the Kings Canyon flood channel such that the drainage and/or any water rights associated with parcels 010-041-34 and 010-041-035 are not adversely affected.
47. The parcels provided to accommodate the drainage swales must be at least as wide as the top width of the channel plus 10 feet, or a total of 20 feet wide, whichever is wider per Carson City Development Standards.
48. All drainage swales that receive drainage from City Streets must be shown as being on City owned property and be City maintained.

Conditions to be Addressed with the Final Map

49. At the time of Final Map submittal, the applicant must demonstrate that the project complies with all identified conditions, as well as with the terms of the Development Agreement.
50. The final mylar will be presented to the State Engineer for approval and signature.

The decision was made on a vote of 5 ayes, 0 nays, 0 absent.

_____
Hope Sullivan, AICP
Planning Manager

HS:lr

Emailed on: _____ By: _____

Please sign and return this notice of decision with 10 days of receipt.

I have read and acknowledge the Conditions of Approval as approved by the Carson City Board of Supervisors.

_____ _____
APPLICANT and/or OWNER SIGNATURE DATE

_____
(Applicant/Owner Printed Name)

RETURN TO:
Carson City Planning Division
108 E. Proctor Street
Carson City, NV 89706

BLACKSTONE RANCH PHASE 2

TENTATIVE SUBDIVISION MAP APPLICATION

Prepared for:

RD Lompa, LLC

985 Damonte Ranch Pkwy, Suite 140

Reno, NV 89521

Prepared by:

JK Architecture Engineering

1311 N. McCarran Blvd, Suite 103

Sparks, NV 89434

(775) 507-7008

February 9, 2023

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LIST OF FIGURES

Introduction

This application includes the following request:

- A reinstatement of the previously approved tentative map for Blackstone Ranch Phase 2 (TSM-17-184) approved by the Board of Supervisors on October 18, 2018. The map inadvertently expired prior to a final map being recorded.
- A Tentative Subdivision Map Application to allow for a 204-unit single family residential subdivision within the Lompa Ranch North Specific Plan.

Project Location

Blackstone Ranch Phase 2 is located within the Lompa Ranch North Specific Plan area which encompasses ±203 acres and is located on the west side of Interstate 580, north of East 5th Street, east of N. Saliman Road, southeast of the existing terminus of Robinson Street on the west side of Lompa Ranch. Phase 2 will include ±58.52 acres located on parcel 10-041-40. Figure 1 below) depicts the project location.

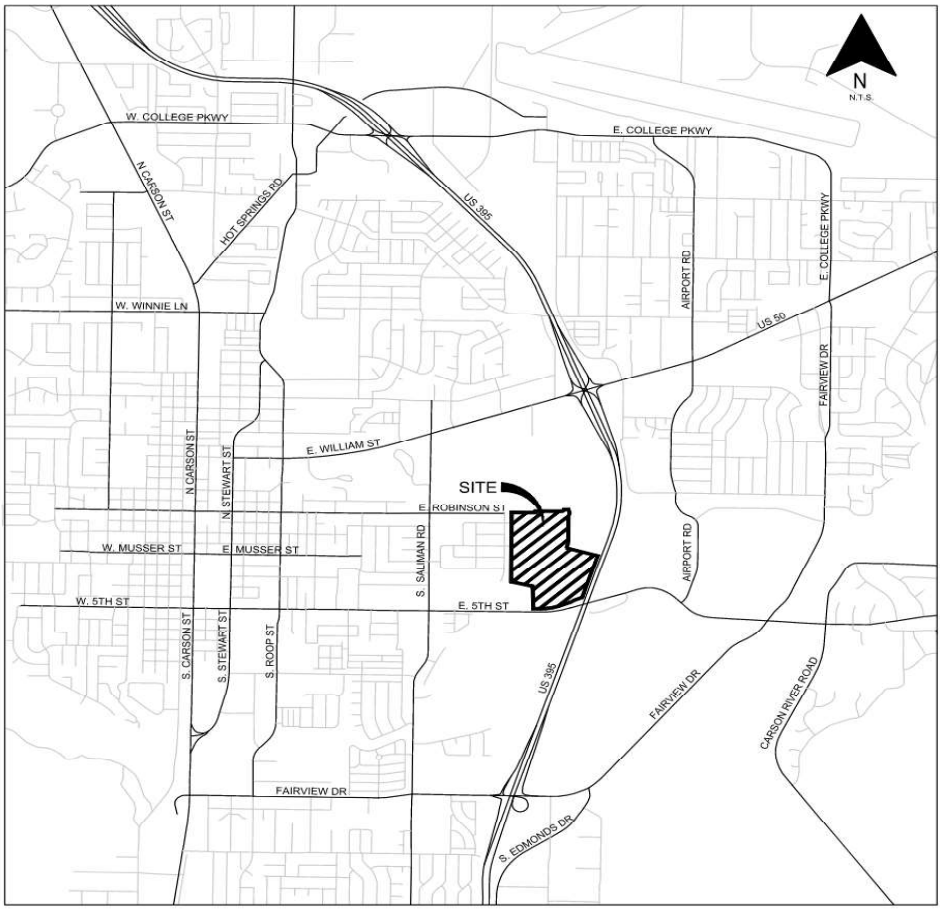

Figure 1 – Vicinity Map

Existing Conditions

Currently, the project site is vacant and consists primarily of pasture land. Figure 2 (below) depicts the existing onsite conditions.

Southwesterly view from the South bound lane on U.S. 395 (below):

Northerly view from East Fifth Street (below):

Figure 2 – Existing Conditions

As noted previously, the subject property is located within the Lompa Ranch North Specific Plan (SPA). The SPA designates the Blackstone Ranch Phase 2 site as Medium Density Residential (Master Plan) and SF-6/MFD (zoning). Figure 3 (below) depicts the Master Plan land use, while Figure 4 (following page) depicts the adopted zoning.

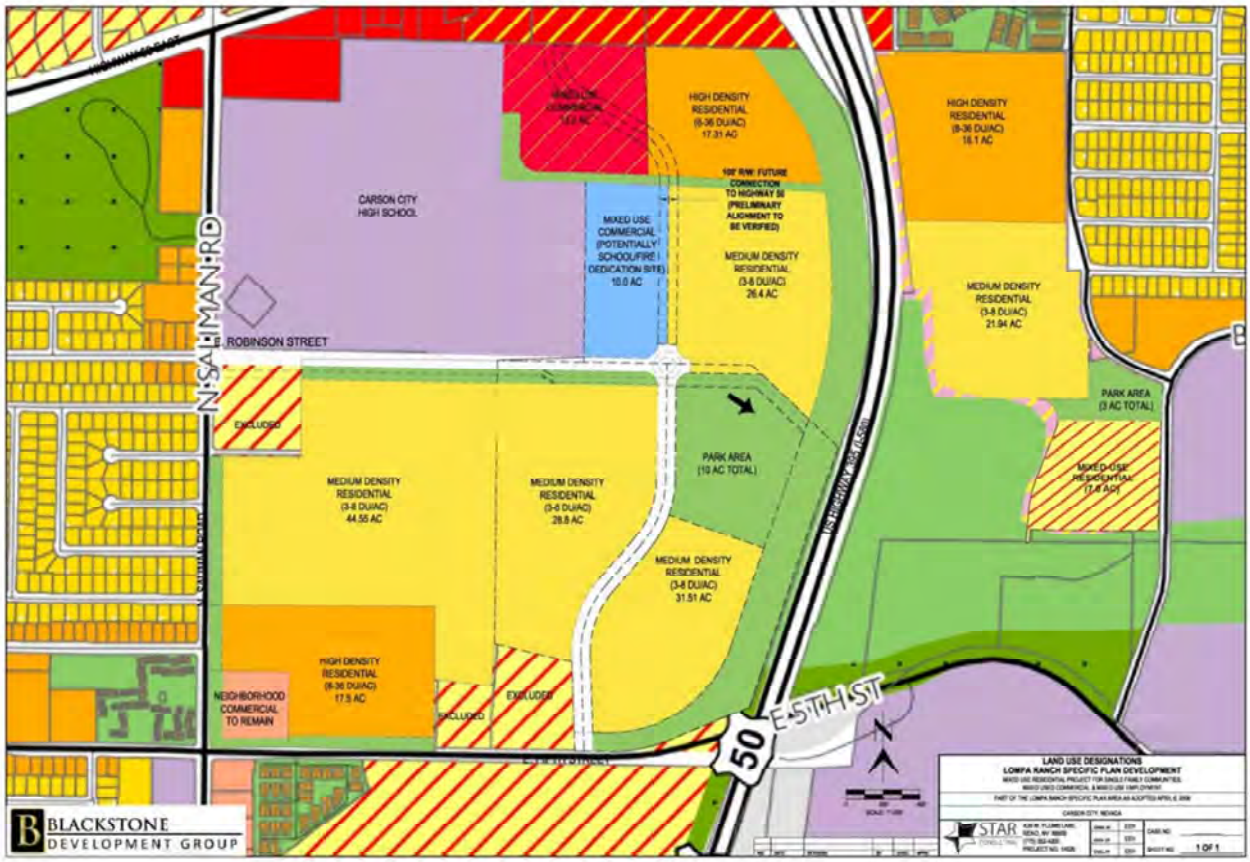

Figure 3 – Master Plan Land Use

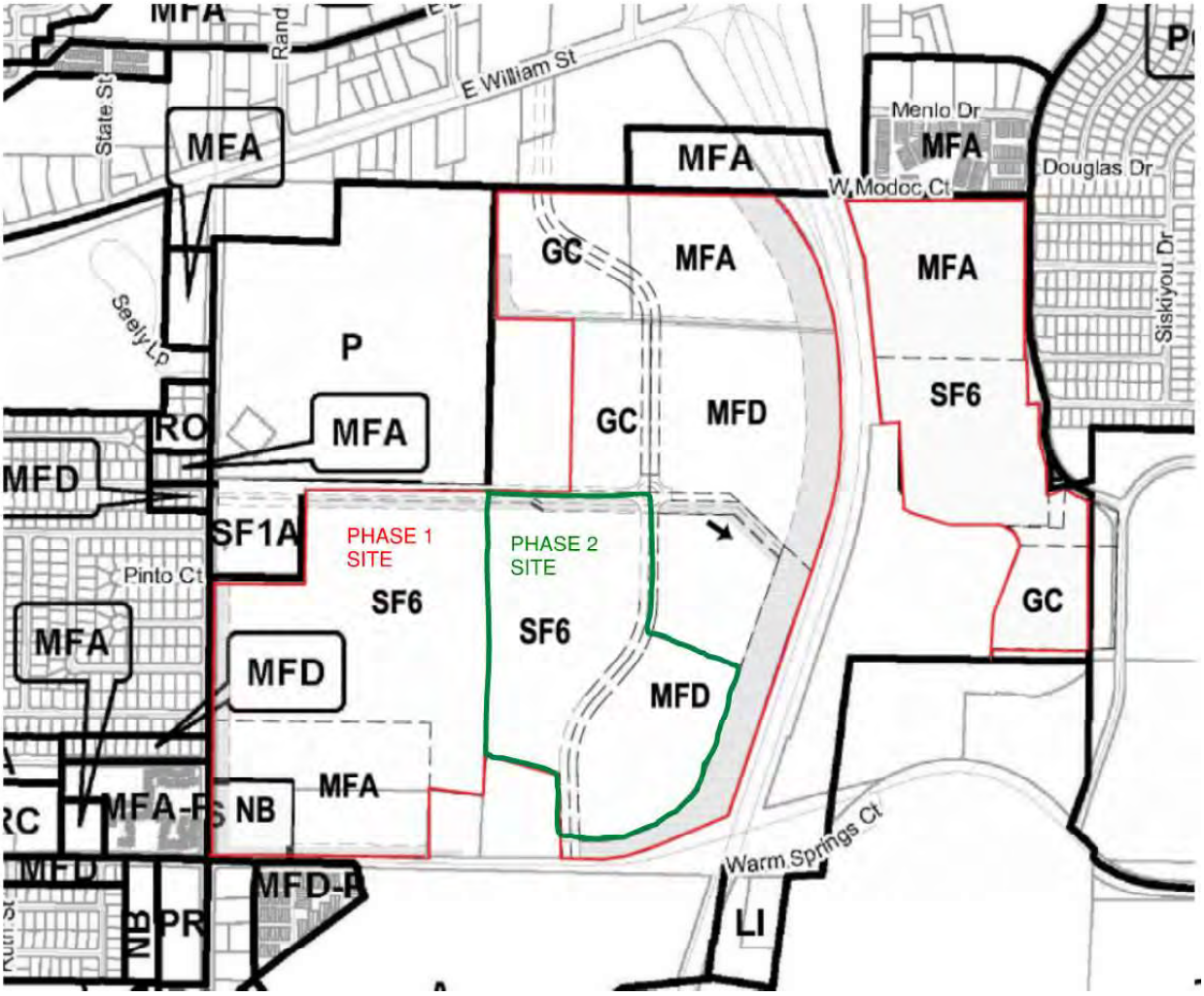

Figure 4 – Zoning Map

Land uses of adjacent properties to the Blackstone Ranch Phase 2 project are the following:

- To the west, single family homes that are part of Blackstone Ranch Phase 1
- To the north, vacant land and the Carson High School solar array
- To the south, a single-family residence and vacant land
- To the east, Interstate 580

Project Description

This Tentative Subdivision Map application is for the second phase of the overall Lompa Ranch Project. A Tentative Map has been previously approved for this project by the Board of Supervisor on October 18, 2018. The Tentative Map has expired prior to recordation of the first Final Map. Currently, all 204 lots and roadway infrastructure have been submitted for approval to Carson City and NDEP under four separate permits. The Roadway Improvement Plans for E. Robinson Street, E. 5th Street and the spine road (Matterhorn Drive) have been approved for construction by Carson City and NDEP (Permit # ENG-2021-2549). A pre-construction meeting has taken place and construction is anticipated to begin this spring. The Subdivision Improvement Plans have been submitted under three separate permits. Blackstone Ranch Phase 2-A (Permit #ENG-2022-0640), Blackstone Ranch Phase 2-B (Permit #ENG-2022-0903) and Blackstone Ranch Phase 2-C (Permit #ENG-2022-1518). These Improvement Plans have been reviewed and approved by both Carson City and NDEP. The Conditions from the Notice of Decision, dated October 18, 2018 related to the Improvement Plans have been addressed in the final design documents. The remaining conditions related to the Final Map will be addressed during the submittal and review process of the first Final Map of the project.

Blackstone Ranch Phase 2 is proposed for single family homes. Primary access to the development will be via an extension of E. Robinson Street at the north end of the project and E. 5th Street and from the south end. A new north/south spine road (Matterhorn Drive) has been approved for construction and will connect E. Robinson Street with E. 5th Street. Neighborhood access points will include “split” entries with a landscape median island and will allow for the location of entry monuments that will identify the community, as called out in the Lompa Ranch North Specific Plan.

Consistent with the existing SF-6 and MFD zoning, lot sizes will range from ±6,000 square feet to ±10,924 square feet, with an overall average lot size of ±6,706 square feet. It is anticipated that the single-family homes that are currently being constructed in Blackstone Ranch Phase 1 will carry over to this phase of the project. Elevations must comply with the standards included within the Specific Plan. This includes the use of varied materials and a minimum of three different elevation options for each model. Additionally, “staggered” setbacks are required to ensure that a monotonous streetscape does not occur.

The Carson City Municipal Code requires a minimum of 150 square feet of open space area to be provided for each individual unit. Based on 204 units, a total of 30,600 square feet of open space is required. As proposed, a total of ±444,310 square feet of open space is provided. A homeowners' association along with covenants, conditions and restrictions (CC&R's) will be created for the project and will be responsible for the maintenance of all open space/common areas.

The following table provides an overall summary of Blackstone Ranch Phase 2:

DEVELOPMENT STANDARD	PROPOSED WITH BLACKSTONE RANCH PHASE 2
Total Project Area	±58.52 acres
Total Units	204 single family homes
Total Lot Area	±31.41 acres
Right-of-Way Area	±16.91 acres
Common Area/Open Space	±10.2 acres
Project Density	3.49 dwelling units/acre
Minimum Lot Size	±6,000 square feet
Maximum Lot Size	±10,924 square feet
Average Lot Size	±6,706 square feet

Consistent with the Lompa Ranch Specific Plan standards, a pedestrian trail will be constructed along the E. Robinson Street frontage, adjacent to the proposed open channel as well as along the new north/south spine road (Matterhorn Drive). The trail(s) will be paved and constructed to the Unified Pathways Master Plan standards. Improvement Plans for Matterhorn Drive have been reviewed and approved by Carson City Community Development (permit no. ENG-2021-2549). The roadway construction is anticipated to begin in the Spring of 2023.

In terms of impacts, Blackstone Ranch Phase 2 is compatible with the surrounding area and will not unduly burden existing public services and infrastructure. A comprehensive traffic impact analysis completed by Traffic Works is attached. Based on typical Institute of Transportation Engineers (ITE) estimates, Blackstone Ranch Phase 2 will generate approximately 1,818 average daily trips (ADT) with 141 am peak hour trips and 186 pm peak hour trips. The traffic impact analysis describes all necessary mitigation measures and/or improvements that will be made to ensure appropriate levels of service are maintained. These measures have been incorporated into the roadway infrastructure plans.

RD Lompa, LLC, the Master Developer, has worked with Carson City and the Federal Emergency Management Agency (FEMA) to obtain an approval for a Conditional Letter of Map Revision (CLOMR) to remove the property from the floodplain. The Letter of Map Revision (LOMR) has been submitted and is in the final stage of the approval process. Public noticing has been made earlier this year for final stage of the approval process. A master drainage analysis is attached and includes a network of storm water channels and improvements that will remove the subject property from the FEMA flood plain. Also, a preliminary drainage report was completed with the Lompa Ranch North Specific Plan. A more refined report that specifically addresses Blackstone Ranch Phase2 is included as an attachment to this report.

With only 204 units, overall project impacts will be minimal. The project, as proposed, is consistent with the adopted zoning and Specific Plan standards. The project will be required to pay all applicable impact and City fees, including the adopted fire impact fee included within the Lompa Ranch Specific Plan. Park tax will not be required as the Lompa Ranch Master Developer will be required to construct a 10-acre community park with construction of the 750th unit.

As an infill development, emergency services are already occurring within the area. The project is not anticipated to unduly impact existing levels of service and is in fact providing fire mitigation funds that can help support the construction of an additional fire station in the future.

Figure 5 (next page) depicts the layout proposed for Phase2:

Figure 5 – Preliminary Site Plan

Master Plan Policy Checklist

Consistent with Carson City Tentative Subdivision Map application requirements, this section is taken directly from Carson City documents and forms part of the ***Tentative Map*** application process. Responses to the checklist questions are included in this section and are printed in **bold** type.

PURPOSE

The purpose of a development checklist is to provide a list of questions that address whether a development proposal is in conformance with the goals and objectives of the 2006 Carson City Master Plan that are related to Master Plan Map Amendments and Zoning Map Amendments. This checklist is designed for developers, staff, and decision-makers and is intended to be used as a guide only.

Development Name: Blackstone Ranch Phase 2

Reviewed By: _____

Date of Review: _____

DEVELOPMENT CHECKLIST

The following five themes are those themes that appear in the Carson City Master Plan and which reflect the community's vision at a broad policy level. Each theme looks at how a proposed development can help achieve the goals of the Carson City Master Plan. A check mark indicates that the proposed development meets the applicable Master Plan policy. The Policy Number is indicated at the end of each policy statement summary. Refer to the Comprehensive Master Plan for complete policy language.

CHAPTER 3: A BALANCED LAND USE PATTERN

The Carson City Master Plan seeks to establish a balance of land uses within the community by providing employment opportunities, a diverse choice of housing, recreational opportunities, and retail services.

Is or does the proposed development:

- Consistent with the Master Plan Land Use Map in location and density?

  As proposed, Blackstone Ranch Phase 2 is in direct compliance with the existing Medium Density Residential Master Plan designation and SF6/MFD

zoning. Additionally, the project is in full compliance with the standards and requirements included within the Lompa Ranch North Specific Plan.

- Meet the provisions of the Growth Management Ordinance (1.1d, Municipal Code 18.12)?

  This project meets the provisions of the Growth Management Ordinance by locating housing in an area that is adjacent to existing roadways and services. The project is an infill development and serves to better maximize the use of Carson City's infrastructure. Infill residential is encouraged within the Master Plan. The project has convenient access to all community services and is appealing to a wide range of potential residents.

- Encourage the use of sustainable building materials and construction techniques to promote water and energy conservation (1.1.e, f)?

  New development must comply with the standards included within the Lompa Ranch North Specific Plan which include energy efficient building materials as well as locating building envelopes with solar orientation in mind (to the extent possible).

- Located in a priority infill development area (1.2a)?

  The project site is not in a priority infill area, but it is an infill project.

- Provide pathway connections and easements consistent with the adopted Unified Pathways Master Plan and maintain access to adjacent public lands (1.4a)?

  The overall Lompa Ranch project will provide a comprehensive trail network. As such, Phase 2 will include the links to the ultimate network in accordance with the Specific Plan standards.

- Encourage cluster development techniques, particularly at the urban interface with surrounding public lands, as appropriate, and protect distinctive site features (1.4b, c, 3.2a)?

  The project clusters development and retains significant open space. This open space then serves as an access point to trails and undeveloped areas and exceeds the required minimum by over 9 acres.

- At adjacent county boundaries, coordinated with adjacent existing or planned development with regards to compatibility, access and amenities (1.5a)?

The site is not located along a county boundary.

- Located to be adequately served by city services including fire and sheriff services and coordinated with the School District to ensure the adequate provision of schools (1.5d)?

  As an infill parcel, the site is bordered by existing development and is within existing service boundaries. City and area services are already occurring within the area and can be provided to this site as well. Also, the project is subject to fire impact fees as adopted in the Lompa Ranch Specific Plan.

- In identified Mixed-Use areas, promote mixed-use development patterns as appropriate for the surrounding context consistent with the land use descriptions of the applicable Mixed-Use designation, and meet the intent of the Mixed-Use Evaluation Criteria (2.1b, 2.2b, 2.3b, Land Use Districts, Appendix C)?

  This site is not within an identified mixed-use area. However, the overall Lompa Ranch project will be a highly integrated mixed-use development. This is simply a single phase in a much larger overall development

- Provide a variety of housing models and densities within the urbanized area appropriate to the development size, location and surrounding neighborhood context (2.2a, 9.1a)?

  The project will provide new housing options in east Carson City and serves to fill a defined demand for new homes in the area. New homes will incorporate design standards from the Lompa Ranch North Specific Plan and overall density/lot size is consistent with existing single family uses to the west.

- Protect environmentally sensitive areas through proper setbacks, dedication, or other mechanisms (3.1b)?

  There are no environmentally sensitive areas on the site. A threatened and endangered species evaluation memo is included as an attachment to this report.

- If at the urban interface, provide multiple access points, maintain defensible space (for fires) and are constructed of fire-resistant materials (3.3b)?

  The site is not within an urban/wildlife interface area.

- Sited outside the primary floodplain and away from geologic hazard areas or follow the required setbacks or other mitigation measures (3.3d, e)?

As noted previously, a CLOMR/LOMR process is currently underway which will remove the subject site from the FEMA flood hazard area(s). A condition will be placed on the tentative map that requires completion of this process prior to construction.

- Provide for levels of services (i.e., water, sewer, road improvements, sidewalks, etc.) consistent with the Land Use designation and adequate for the proposed development (Land Use table descriptions)?

  The project proposes to provide levels of service consistent with what is seen in the area now. As an infill site, it is possible to coordinate the project design with development that adjoins the site. Roads, sidewalks, and utilities will therefore be commensurate with what the neighborhood enjoys now. Trail connections and open space will be improved.

- If located within an identified Specific Plan Area (SPA), meet the applicable policies of that SPA (Land Use Map, Chapter 8)?

  The project, as proposed, is in full compliance with Lompa Ranch North Specific Plan.

CHAPTER 4: EQUITABLE DISTRIBUTION OF RECREATIONAL OPPORTUNITIES

The Carson City Master Plan seeks to continue providing a diverse range of park and recreational opportunities to include facilities and programming for all ages and varying interests to serve both existing and future neighborhoods.

Is or does the proposed development:

- Provide park facilities commensurate with the demand created and consistent with the City's adopted standards (4.1b, c)?

  The project will provide substantial open space area that will benefit the neighborhood. The project is therefore proposing amenities well above what is required by Code and by normal planning practices. Also, as the Lompa Ranch Master Plan develops, a new community park and trail network will be provided per the Lompa Ranch North Specific Plan.

- Consistent with the Open Space Master Plan and Carson River Master Plan (4.3a)?

This project advances the goals of the Open Space Master Plan through its use of an infill site and through the provision of park/open space area. The project does not extend development into wildland areas.

CHAPTER 5: ECONOMIC VITALITY

The Carson City Master Plan seeks to maintain its strong diversified economic base by promoting principles which focus on retaining and enhancing the strong employment base, include a broader range of retail services in targeted areas, and include the roles of technology, tourism, recreational amenities, and other economic strengths vital to a successful community.

Is or does the proposed development:

- Incorporating public facilities and amenities that will improve residents' quality of life (5.5e)?

  As detailed above, the project will provide public amenities in the form of park space and enhanced trails.

- Promote revitalization of the Downtown core (5.6a)?

  Not applicable.

- Incorporate additional housing in and around Downtown, including lofts, condominiums, duplexes, live-work units (5.6c)?

  Not applicable.

CHAPTER 6: LIVABLE NEIGHBORHOODS AND ACTIVITY CENTERS

The Carson City Master Plan seeks to promote safe, attractive and diverse neighborhoods, compact mixed use activity centers, and a vibrant, pedestrian-friendly Downtown.

Is or does the proposed development:

- Provide variety and visual interest through the incorporation of varied lot sizes, building styles and colors, garage orientation and other features (6.1b)?

  As required per the Specific Plan, new homes will be required to provide a mix of building materials in order to provide for more diverse architecture. This, coupled with staggered setbacks will ensure a visually appealing streetscape. Also, all floor plans will be required to have a minimum of 3 distinct elevations.

This ensures that the neighborhood has visual interest and that all of the homes will not look alike.

- Provide variety and visual interest through the incorporation of well-articulated building facades, clearly identified entrances and pedestrian connections, landscaping and other features consistent with the Development Standards (6.1c)?

  The Lompa Ranch North Specific Plan standards far exceed the requirements of the Carson City Municipal Code. This ensures that there will be enhanced landscaping, distinctive entry monuments, upscale architecture, etc.

- Provide appropriate height, density and setback transitions and connectivity to surrounding development for infill projects or adjacent to existing rural neighborhoods (6.2a, 9.3b, 9.4a)?

  The project will be complementary to surrounding development in terms of height, setbacks, and use and will therefore be directly compatible.

- If located in an identified Mixed-Use Activity Center area, contain the appropriate mix, size and density of land uses consistent with the Mixed-Use district policies (7.1a, b)?

  The project is not in a mixed-use activity center.

- If located Downtown:

  - Integrate an appropriate mix and density of uses (8.1a, e)?

    Not applicable.

  - Include buildings at the appropriate scale for the applicable Downtown Character Area (8.1b)?

    This project is not located downtown

  - Incorporate appropriate public spaces, plazas and other amenities (8.1d)?

    The project is not located downtown however it does include public spaces.

CHAPTER 7: A CONNECTED CITY

The Carson City Master Plan seeks to promote a sense of community by linking its many neighborhoods, employment areas, activity centers, parks, recreational amenities and schools

with an extensive system of interconnected roadways, multi-use pathways, bicycle facilities, and sidewalks.

Is or does the proposed development:

- Promote transit-supportive development patterns (e.g. mixed-use, pedestrian-oriented, higher density) along major travel corridors to facilitate future transit (11.2b)?

  The project is located along existing streets and is within walking distance of schools and commercial uses. Also, the site is within walking distance of existing transit stops.

- Maintain and enhance roadway connections and networks consistent with the Transportation Master Plan (11.2c)?

  The project is accessed by the existing roadway network. It will also fill some existing gaps in the roadway network by providing additional improvements as depicted on the attached plans.

- Provide appropriate pathways through the development and to surrounding lands, including parks and public lands, consistent with the Unified Pathways Master Plan (12.1a, c)?

  The project will provide for a pedestrian path as called out in the Specific Plan, consistent with the Unified Pathways Master Plan.

Tentative Map Findings

Section 17.07.005 of the Carson City Municipal Code establishes findings that the Planning Commission and/or Board of Supervisors must make in approving a tentative subdivision map. These findings are listed below and are addressed in **bold face** type.

In considering parcel maps, planned unit developments and tentative subdivision maps the director shall consider the following:

1. Environmental and health laws and regulations concerning water and air pollution, the disposal of solid waste, facilities to supply water, community, or public sewage disposal and, where applicable, individual systems for sewage disposal.

   Blackstone Ranch Phase 2 serves as an infill project within an established area of the City. Therefore, all necessary infrastructure and municipal services necessary to serve the project are in place or can easily be extended (at the expense of the developer). The project will be served by municipal water and sewer, solid waste disposal, NV Energy, Southwest Gas, cable television, etc. in accordance with Carson City and State of Nevada standards.

2. The availability of water which meets applicable health standards and is sufficient in quantity for the reasonably foreseeable needs of the subdivision.

   Blackstone Ranch Phase 2 will be served by the existing municipal water and it will be demonstrated by the project applicant that sufficient water rights have been dedicated/acquired to serve the project.

3. The availability and accessibility of utilities.

   As an infill development, all necessary utilities are in place or can be easily extended to serve the project.

4. The availability and accessibility of public services such as schools, police protection, transportation, recreation and parks.

   The project is located within the developed core of the City and is therefore located in an area where all City services and infrastructure exist. Additionally, as part of the overall Lompa Ranch SPA, new schools, parks, and community amenities are planned and mandated through the SPA.

5. Access to public lands. Any proposed subdivision that is adjacent to public lands shall incorporate public access to those lands or provide an acceptable alternative.

   Not applicable. However, the project does provide pedestrian trail links per the requirements of the Lompa Ranch SPA.

6. Conformity with the zoning ordinance and land use element of the city's master plan.

   The project is in direct compliance with the existing Master Plan designation. Furthermore, the project complies with the SF-6 and MFD zoning in terms of overall density and character.

7. General conformity with the city's master plan for streets and highways.

   With only 204 units, the project will be adequately served by the existing roadway network and will result in negligible impacts. A comprehensive traffic impact analysis is attached and provides specific details and mitigation measures.

8. The effect of the proposed subdivision on existing public streets and the need for new streets or highways to serve the subdivision.

   As outlined in the attached traffic impact analysis, all impacts associated with Blackstone Ranch Phase 2 can easily be mitigated and no significant impacts are anticipated.

9. The physical characteristics of the land such as flood plains, earthquake faults, slope and soil.

   The project is well suited for the type of development proposed, especially given the planned drainage improvements (as noted in the attached drainage report). The project site contains no faults or unusual soils. Attached to this report are detailed engineering plans, reports, and analyses that provide further details. The site is in an infill area and is part of the developed core of Carson City.

10. The recommendations and comments of those entities reviewing the subdivision request pursuant to NRS 278.330 thru 278.348, inclusive.

    This application package will be sent to reviewing agencies per the requirements of the Carson City Municipal Code and Nevada Revised Statutes

(NRS). Once comments are received, they can be incorporated into the final design of the project or included as conditions of approval of this tentative subdivision map request.

11. The availability and accessibility of fire protection including, but not limited to, the availability and accessibility of water and services for the prevention and containment of fires including fires in the wild lands.

Fire suppression will be provided for Blackstone Ranch Phase 2. This is accomplished by providing fire hydrants per Carson City standards and to the approval of the Carson City Fire and Engineering Departments. It is also important to note that new homes within the Lompa Ranch SPA are required to contribute $1,000.00 per unit as a fire mitigation fee.

12. Recreation and trail easements.

Trail connections will be constructed within Blackstone Ranch Phase 2 per the requirements of the Lompa Ranch SPA. All necessary public use easements, etc. will be dedicated with final map.

Nevada Revised Statutes

Per item 34 of the tentative subdivision map application, the provisions NRS 278.349(3) are addressed in this section. Like the tentative map findings, NRS considerations are addressed in **bold face** type. Some NRS considerations are repetitive to Carson City adopted findings but are included to ensure complete compliance.

The governing body, or planning commission if it is authorized to take final action on a tentative map, shall consider:

(a) Environmental and health laws and regulations concerning water and air pollution, the disposal of solid waste, facilities to supply water, community or public sewage disposal and, where applicable, individual systems for sewage disposal;

Blackstone Ranch Phase 2 will connect to City services. Waste disposal will therefore be managed in the same manner as other residential developments in the City. By utilizing the existing zoning and overall density, impacts from the project will be consistent with the City's goals and expectations.

(b) The availability of water which meets applicable health standards and is sufficient in quantity for the reasonably foreseeable needs of the subdivision;

The area served by municipal utilities, including water. Additionally, fire hydrants will be provided per City standards. Water rights will be secured to serve the project, to the satisfaction of Carson City Engineering Department.

(c) The availability and accessibility of utilities;

The site is bordered by municipal utilities. They are therefore both available and accessible.

(d) The availability and accessibility of public services such as schools, police protection, transportation, recreation and parks;

The site is served by existing roads and is within walking distance of Mills Park and Carson High. Public services already extend to development that adjoins the site. In effect, the site is fully served by City services. It is also important to note that new public facilities, including a 10-acre community park will be included within the Lompa Ranch SPA as it continues to build-out.

(e) Conformity with the zoning ordinances and master plan, except that if any existing zoning ordinance is inconsistent with the master plan, the zoning ordinance takes precedence;

The current SF-6 and MFD zoning is consistent with the current Master Plan designation. This zoning is to remain in place with this project. The overall density of the site and the proposed structures are consistent with the zoning regulations.

(f) General conformity with the governing body's master plan of streets and highways;

The project conforms to the Master Plan for streets in that it locates development along an existing street. No changes to streets or highways are required.

(g) The effect of the proposed subdivision on existing public streets and the need for new streets or highways to serve the subdivision;

As noted above, no new streets or highways are required. A comprehensive traffic impact analysis is attached to this report.

(h) Physical characteristics of the land such as floodplain, slope and soil;

Engineering improvements, including new drainage improvements, will be implemented to ensure that all new units are not located within areas prone to flooding. There are no slope or soil constraints that would preclude development at the densities being proposed.

(i) The recommendations and comments of those entities and persons reviewing the tentative map pursuant to NRS 278.330 to 278.3485, inclusive;

Comments received on this application will be reviewed and discussed as needed. Any required amendments to the project will be incorporated or resolved to the satisfaction of Carson City staff.

(j) The availability and accessibility of fire protection, including, but not limited to, the availability and accessibility of water and services for the prevention and containment of fires, including fires in wild lands;

The project site is not located within a wildland fire zone. Fire hydrants will be provided per City standards and the project will ultimately contribute $204,000 in fire mitigation fees.

(k) The potential impact to wildlife and wildlife habitat;

(l) The submission by the subdivider of an affidavit stating that the subdivider will make provisions for payment of the tax imposed by chapter 375 of NRS and for compliance

with the disclosure and recording requirements of paragraph (f) of subsection 1 of NRS 598.0923, if applicable, by the subdivider or any successor in interest.

A tax certificate for the parcel included within this application is included as an attachment to this application.

Carson City Planning Division

108 E. Proctor St.
Carson City, Nevada 89701
(775) 887-2180
Planning@carson.org
www.carson.org

Carson City Road Name Reservation/Approval Application

Request Date: February 9, 2023	**Requested By:** Ken Anderson
Phone Number: 775.507.5008	**Email:** kanderson@jkaedesigns.com
Total Number of Roads: 12	**Subdivision Name:** Blackstone Ranch Phase 2

Road #	Proposed Road Name	Public or Private	Accepted or Denied	Reason for Denial	Comments
1	Aiken Peak Street	Public			previously approved by Stephen Pottey
2	Brawley Peak Drive	Public			previously approved by Stephen Pottey
3	Duckwater Peak Drive	Public			previously approved by Stephen Pottey
4	Duffer Peak Drive	Public			previously approved by Stephen Pottey
5	Fletcher Peak Street/Court	Public			previously approved by Stephen Pottey
6	Hayford Peak Street	Public			previously approved by Stephen Pottey
7	Matterhorn Drive	Public			previously approved by Stephen Pottey
8	McAfee Peak Drive	Public			previously approved by Stephen Pottey
9	Morey Peak Drive	Public			previously approved by Stephen Pottey
10	Sawmill Peak Drive	Public			previously approved by Stephen Pottey
11	Soldier Peak Drive	Public			previously approved by Stephen Pottey
12	Taft Peak Street	Public			previously approved by Stephen Pottey

This application is not complete without the road layout map with the proposed street names shown.

MOUNTAIN PEAKS

Mount Moriah
Mount Currant
Toiyabe Dome
Troy Peak
Aiken Peak
Mount Grafton
Pearl Peak
Matterhorn
Pilot Peak
McAfee Peak
Morey Peak
Becky Peak
Hayford Peak
Star Peak
Mount Tobin
Mount Siegel
Duffer Peak
Kawich Peak
Boundary Peak
Pyramid Peak
Quartzite Peak
Taft Peak
Granite Peak
Duckwater Peak
Girffith Peak

Wines Peak
Tipton Peak
French Peak
Greys Peak
Masket Peak
Wildcat Peak
Hamels Peak
Fletcher Peak
Relay Peak
Soldier Peak
Divide Peak
Ninemile Peak
Tamarack Peak
Shingle Peak
Mahogany Peak
Sawmill Peak
Lovell Peak
Monitor Peak
Brawley Peak
Porter Peak
Secret Peak
Gilson Peak
Connor Peak
Meeker Peak
Tule Peak

Ken Anderson

From: Stephen Pottey <SPottey@carson.org>
Sent: Tuesday, September 26, 2017 12:13 PM
To: Ken Anderson; Dave Ruben
Cc: Guillermo Munoz
Subject: RE: Street names
Attachments: Street Names - Lompa Ranch Ryder Homes.docx

Ken,

Please see attached. Green names are reserved for Ryder-Lompa subdivisions, red cannot be used. If they want to use these for a project in another part of town just let us know when it comes up and we can switch them over.

Stephen Pottéy P.E.
Senior Project Manager, Development Engineering
Direct: 775.283.7079
spottey@carson.org

From: Ken Anderson [mailto:ken@odysseyreno.com]
Sent: Tuesday, September 19, 2017 4:58 PM
To: Dave Ruben
Cc: Stephen Pottey; Guillermo Munoz
Subject: RE: Street names

Thanks Dave.

Sincerely,

Kenneth W. Anderson, P.E.
Odyssey Engineering Incorporated
895 Roberta Lane, Suite 104
Sparks, NV 89431
Office 775-359-3303 ext 556
Direct 775-236-0556
Mobile 775-225-9409
Fax 775-359-3329

From: Dave Ruben [mailto:DRuben@carson.org]
Sent: Tuesday, September 19, 2017 2:03 PM
To: Ken Anderson <ken@odysseyreno.com>
Cc: Stephen Pottey <SPottey@carson.org>; Guillermo Munoz <GMunoz@carson.org>
Subject: Re: Street names

Ken, since this is an engineering decision, I forwarded your question to Guillermo Munoz from the Engineering Division. He is covering for Stephen.

Thanks

Dave

Sent from my iPad

On Sep 19, 2017, at 10:28 AM, Ken Anderson <ken@odysseyreno.com> wrote:

> This message originated outside of Carson City's email system. Use caution if this message contains attachments, links, or requests for information.
>
> ---
>
> Thank you Dave. So can I assume that all other names submitted are approved?
>
> Sincerely,
>
> Kenneth W. Anderson, P.E.
> **Odyssey Engineering Incorporated**
> 895 Roberta Lane, Suite 104
> Sparks, NV 89431
> Office 775-359-3303 ext 556
> Direct 775-236-0556
> Mobile 775-225-9409
> Fax 775-359-3329
>
> ---
>
> **From:** Dave Ruben [mailto:DRuben@carson.org]
> **Sent:** Tuesday, September 19, 2017 10:26 AM
> **To:** Ken Anderson <ken@odysseyreno.com>
> **Cc:** Stephen Pottey <SPottey@carson.org>
> **Subject:** Street names
>
> Ken, Stephen asked me to forward our comments on street names for Lompa Ranch/Ryder homes to you.
>
> These names are not approved due to conflicts with existing street names:
>
> Divide Peak
> Star Peak
> Quartzite Peak
> Granite Peak
> Ninemile Peak
> Tamarack Peak
> Secret Peak
> Connor Peak
>
> ***Dave Ruben***
> Fire Marshal
> Carson City Fire Department

777 S. Stewart Street
Carson City, NV 89701

Direct 775-283-7153
Main 775-887-2210
FAX 775-887-2209

MASTER TECHNICAL DRAINAGE STUDY

FOR

BLACKSTONE RANCH PHASES 2A & 2B
(APN 010-041-40)

Prepared for

RD Lompa, LLC
985 Damonte Ranch Parkway, Suite 140
Reno, NV 89521

Prepared by

JK Architecture Engineering Incorporated
1311 McCarran Blvd, Suite 103
Sparks, Nevada 89431
(775) 507-7009

May 2022
Updated July 2022

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APPENDICES

I. Overview

A. DRAINAGE STUDY INFORMATION FORM

Name of Development: Blackstone Ranch Phases 2-A and 2-B Development

Location of Development: The Blackstone Ranch Phase 2 development is located west of I-580, north of E. 5th Street, east of N. Saliman Road, and south of E. Robinson Street (Figure #1 – Vicinity Map) within the Carson City Limits.

Name of Owner: RD Lompa, LLC

Contact Person: Steve Thomsen **Telephone No.:** 775-823-3788

Firm: Ryder Homes
Address: 985 Damonte Ranch Parkway, Suite 140, Reno, NV 89521

Type of Development: Residential

Total Site Acreage: 24.54 acres (*)
*Area excludes portions of previously studied roadway infrastructure drainage analysis

Total Proposed Units: 130 Residential Units

Approximate offsite area that drains to site: 0 acres

Existing Conditions On-site Peak Flows:
10-year: 5.59 cfs
100-year: 27.34 cfs

Proposed Conditions On-site Peak Flows:
2-year: 15.76 cfs
10-year: 26.12 cfs
100-year: 66.84 cfs

Proposed Detention Conditions (South Basin):
2-year (in): 3.5 cfs
10-year (in): 5.8 cfs
100-year (in): 15.8 cfs (Assumes normal condition model)

100-year (in): 26.9 cfs (Assumes Kings Canyon Peak Flow)
2-year (out): 3.4 cfs (4.9 ft of free-board at spillway)
10-year (out): 5.6 cfs (4.7' of free-board at spillway)
100-year (out): 14.6 cfs (4.4 ft of free-board at spillway under normal condition model)
100-year (out): 26.1 cfs (1.3 ft of free-board at spillway with Kings Canyon Peak Flow)

Proposed Low Impact Development Channel Conditions (South of Future Park Site):
Peak 2-year flow into channel: 8.7 cfs
Max. depth of flow (2-year): 1.5 ft
Max Velocity (2-year): 2.2 fps
Peak 10-year flow into channel: 14.2 cfs
Max. depth of flow (10-year): 1.8 ft (4.2 ft of free-board to top of channel)
Max Velocity (10-year): 2.5 fps
Peak 100-year flow into channel: 33.1 cfs (Assumes normal condition)
Max. depth of flow (100-year): 2.4 ft (3.6 ft of free-board to top of channel)
Max Velocity (100-year): 3.0 fps

Proposed Construction Schedule for the Subject Property:

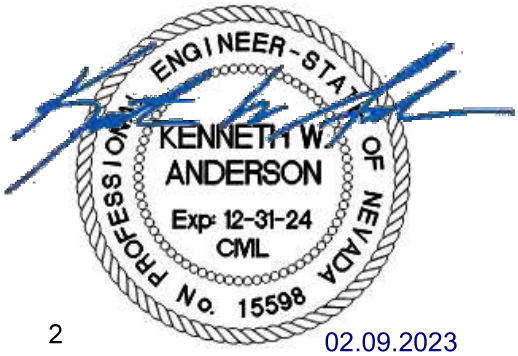
1. On-Site Grading Activities: Summer 2022
2. Backbone Improvements (On-Site Roads, Model Lots): Fall 2022-Spring 2023
3. Start Construction of Initial Model Lots: Spring 2023
4. Start production Lots: Summer 2023

B. PROJECT NAME, TYPE OF STUDY, DATE OF PREPARATION, AND REVISIONS

Project Name: Blackstone Ranch Phases 2-A & Phase 2-B
Type of Study: Master Technical Drainage Study
Date of Preparation: May 26, 2022
Revisions: N/A

C. PREPARER'S NAME, SEAL AND SIGNATURE

Preparers Name: Kenneth Anderson, P.E.



02.09.2023

II. GENERAL LOCATION AND DEVELOPMENT DESCRIPTION

A. Location of Property

The Blackstone Ranch Phase 2 Project (BRPH2 Project) which is located west of I-580, north of E. 5th Street, east of S. Saliman Road, and south of E. Robinson Street (APN #010-041-40) within the Carson City Limits. The BRPH2 Project will consist of a multi-phased proposed 130-unit single family residential development and is located within Section 16, Township 15 North, and Range 20 East M.D.M., lying within Carson City, State of Nevada.

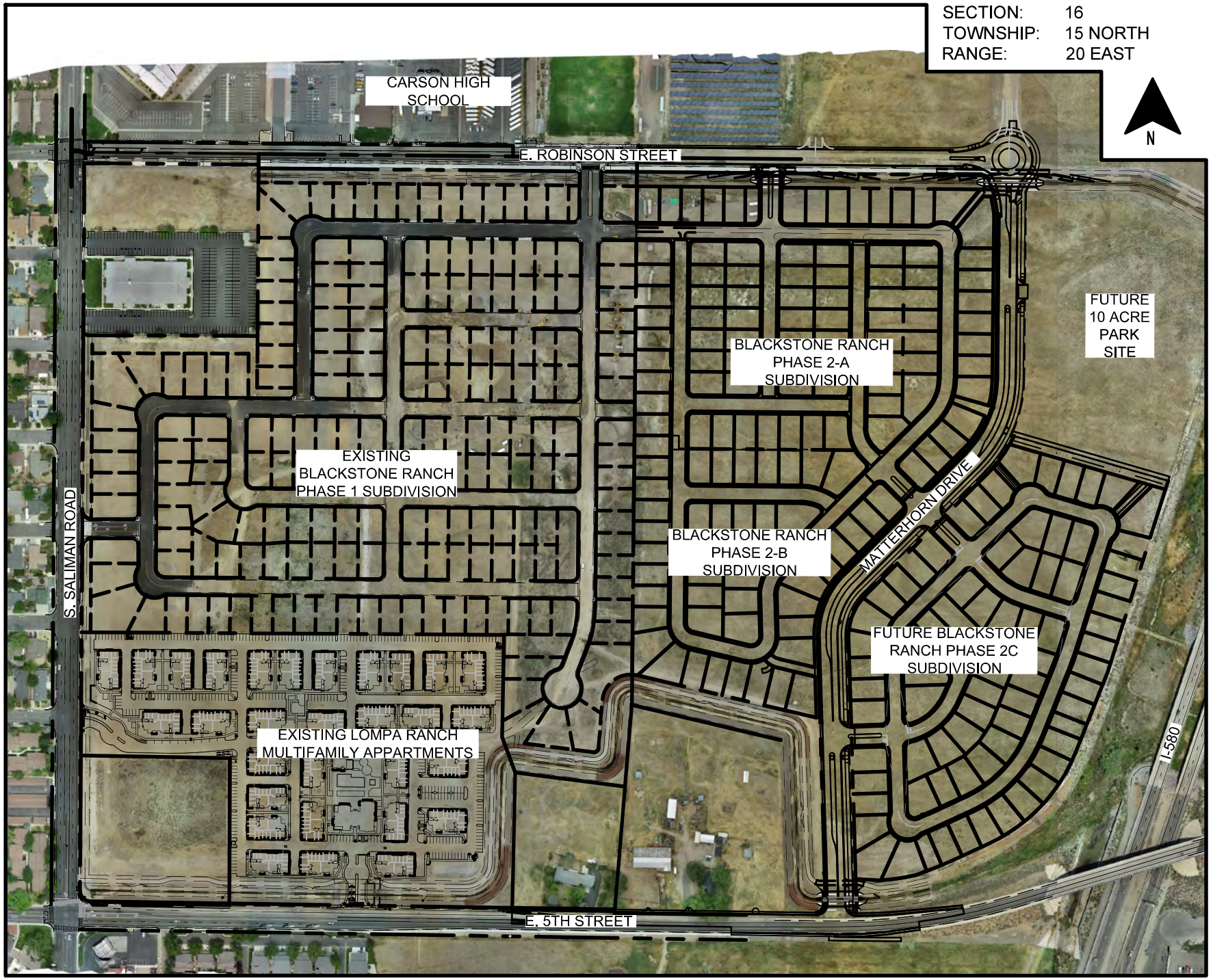
The project site consists of undeveloped open space that generally drains from the west to the east. According to the previously approved "Drainage Master Plan" prepared by Kimley-Horn & Associates (Kimley-Horn Report), historically Ash Canyon Creek (ACC), Kings Canyon Creek (KCC), and Tributary H & I, as well as the local, unnamed ditches that contribute to the Kings Creek drainage system historically discharged onto the proposed site. There are existing drainage facilities adjacent to the site, such as the civil improvements in S. Saliman Road and the triple barrel concrete box culvert that runs under I-580. With the construction of the previously approved ACC and KCC channels, the proposed site will no longer receive any of the upstream flows from either the Ash Canyon or Kings Canyon watersheds.

B. Description of Property

The 27.10-acre site is currently undeveloped and consists of native vegetation. Site topography slopes generally to the northeast and southeast with slopes ranging from 0% to 0.5%. Rainfall runoff from the developed portion of the site flows in an east-northeasterly direction towards existing culverts that cross under U.S. Highway 395 (Hwy 395). Currently, there are existing drainage facilities adjacent to the proposed site, which include the ACC and KCC engineered channels and the triple barrel concrete box culvert that runs under I-580. The proposed site is located directly south and east of the approved Blackstone Ranch Phases 1A-1C (Refer to Figure 1, Vicinity Map).

C. Project Description

The BRPH2 Project will consist of the multi-phased proposed 130-unit single family residential project. Phase 2-A and Phase 2-B will have an estimated net import of 45,120 cubic yards.



VICINITY MAP

N.T.S.

III. DRAINAGE BASIN DESCRIPTION

A. Off-Site drainage description

The project site consists of undeveloped open space that generally drains from the west to the east. According to the previously approved Kimley-Horn Report, ACC, KCC, Tributaries H & I, as well as the local, unnamed ditches that contribute to the Kings Creek drainage system historically discharged upstream flows onto the proposed site. However, with the construction of the ACC and KCC channels, the offsite flows will no longer enter the proposed site. Reference Figure 3 of the Kimley-Horn Report for off-site basins in Appendix F.

B. On-site drainage description

The existing hydrologic analysis was based on the native vegetation and the existing hydrologic sub-basins were delineated based on the property boundaries. The project site has been used a working ranch for several decades. For the existing catchments, a time of concentration (T_C) and Rational Method coefficient were selected based on the Rational Method (Appendix A), taking into consideration the catchment characteristics, which include catchment area, slope and length of the longest channel, watershed boundaries, urbanization, and land cover. Table 1 and Figure 2 summarize the characteristics of the existing on-site catchment areas in the study area. Reference Appendix B for the complete existing conditions Rational Method analysis. Reference Figure 2 (Existing Hydrology Display) for the existing hydrology drainage map and the associated hydrologic sub-area.

Table 1 – Existing Conditions Rational Method Model Summary for BRPH2 Project, Carson City, NV.

Sub-Basin	Area (Ac.)	Rational Method Coefficient (C_{10}/C_{100})	Time of Concentration (min)	Rainfall Intensity (I_5/I_{100}) (in/hr.)	10-Year Peak Flows (cfs)	100-Year Peak Flows (cfs)
X-01	24.54	0.20/0.50	23.76	1.14/2.30	5.59	27.34
TOTAL	**24.54**	**-----**	**-----**	**-----**	**5.59**	**27.34**

C. Floodplain Information

The site is located in the floodways of Ash Canyon Creek and Kings Canyon Creek as portrayed on the effective FEMA Firmette which is map number 3200010111G dated December 22, 2016 (Appendix A). BRPH2 will be designed so that the finished floor elevation of each residential lot is a minimum two-feet higher than the 100-year water surface elevation determined in the previously approved Kimley–Horn Report.

D. Previous Drainage Studies

The Kimley-Horn Report was the main reference for this study. The following studies were in the Kimley-Horn Report:

1) Kimley-Horn and Associates; *Lompa Ranch FEMA Conditional Letter of Map Amendment*, submitted to FEMA January 2017
2) Resource Concepts Inc; *Preliminary Geotechnical Investigation, Lompa Ranch Project,* October 2016

3) Rubicon Design Group LLC; *Lompa Ranch North - Specific Plan*, Adopted March 17, 2016
4) HDR, *Draft Hydrologic Analyses and Results for Carson City Flood Insurance Study*, June 2010
5) HDR; *Draft Hydraulic Analyses and Results for the Carson City Flood Insurance Study*, July 2010
6) Kimley-Horn and Associates; *Southwest Carson City Flood Study*, February 2014
7) Manhard Consulting, LTD; SW Carson City Regional Hydrologic Analysis Final Report, March 2010
8) Northwest Hydraulic Consultants; *Summary Findings for Vicee Canyon Channel HEC-RAS Analysis Preliminary FIS/FIRM Review Support Carson City, NV*, September 2001

IV. PROPOSED DRAINAGE FACILITIES

A. General Description

Hydrologic analyses were performed based on the Carson City Drainage Manual (CCDM) (dated effective July 1, 2021) to determine the peak discharge for the 10-year and 100-year peak flow events. *AutoDesk Storm and Sanitary Analysis (SSA)* was used to perform a *Rational Method* analysis to model the hydrologic basins that contribute in the BRPH2 Project single family development existing and proposed conditions. The Rational Method was utilized in accordance with the CCDM to analyze the existing and proposed conditions. The proposed storm drain system was designed to convey the 10-year storm event in a "gravity flow" condition with the pipes below full flow capacity and in a "surcharged" or pressurized condition in the 100-year event. According to the approved Kimley-Horn Report, the ACC and KCC flood control channel were “sized to convey the 100-year storm with a minimum freeboard of at least 1-foot to the top of the channel banks and 18-inches to the top of the roadway crossings. Bottomless concrete culverts are proposed for all flood control channel crossings”. However, the Saliman Channel analyzed in the Kimley-Horn Report is not designed to convey the 100-year peak flow event. Flows will overtop the channel and will eventually be routed to the KCC channel.

Riprap or other approved erosion resistant channel bank lining will be provided at each culvert transition. A smooth channel bank lining will be installed along the outside bank of all bends in the flood control channels to prevent erosion of the channel bank and minimize the decrease in channel velocities due to the change of flow direction”. Additionally, the previously approved Kimley-Horn Report determined that the proposed BRPH2 Project will not adversely affect downstream properties and is not required to provide detention on-site.

A minimum time of concentration of 10- minutes was used for all sub-basins. The rainfall characteristics were modeled using the NOAA database (http://dipper.nws.noaa.gov/hdsc/pfds/sa/nv_pfds.html) to determine site specific depth of precipitation (Appendix A).

Rational Formula: ***Q=CiA***

Q=Peak Discharge (cfs)
C=Runoff Coefficient (dimensionless)
i=Precipitation Intensity (in/hr.)
A=Watershed Area (Acres)

B. Compliance with Regulations and Adopted Plans

The proposed BRPH2 Project is compliant with FEMA floodplain regulations and the Carson City Drainage Manual (CCDM).

C. Hydrologic Criteria

Parameters for peak storm flow and runoff volume estimates presented herein were determined using the data and methodologies presented in the CCDM. In instances where the CCDM was lacking information or specificity, the Truckee Meadows Regional Drainage Design Manual (TMRDM) and/or the other appropriate sources and software user manuals were referenced. The Rational Method was utilized in accordance with the CCDM to analyze the existing and proposed conditions. A minimum time of concentration of 10- minutes was used for all sub-basins, the NRCS TR-55 method was used for one of the subbasins in the future development (PH-2C). The rainfall characteristics were modeled using the NOAA database (http://dipper.nws.noaa.gov/hdsc/pfds/sa/nv_pfds.html) to determine site specific depth of precipitation (Appendix A).

The sub-areas accounted for the proposed on-site flows that affect the site. The associated calculated 2-year, 10-year and 100-year peak flows can be found in Table 2 and Figure 3 (Appendix C). Both pipe sizes and catch basins have been sized to accommodate the proposed flows. Reference Figure 3 in the map pocket for the associated hydrologic sub-areas and the proposed catch basins. All drainage for the basins will be contained in swales and the roadway and will travel to the catch basins. A portion of the discharge of the proposed sub-basins (Table 2) are directed through the storm drain system to the detention facility located within the residential portion of the project with the remaining sub-basins discharging directly into the engineered channels adjacent to the project site that were designed in the previously approved Kimley-Horn report. The outlet of the detention pond will discharge to the existing engineered channel at southeast portion of the site. Refer to Table 2 and Appendix C, Proposed Conditions Hydrologic Analysis for all data and supporting calculations using the Rational Method.

Table 2 – Proposed Rational Method Model Summary for BRPH2 Project, Carson City, NV.

Sub-Basin	Area (Ac.)	Rational Method Coefficient (C_2-C_{10}/C_{100})	Time of Concentration (min)	Rainfall Intensity (I_2/I_{10}/I_{100}) (in/hr.)	2-Year Peak Flows (cfs)	10-Year Peak Flows (cfs)	100-Year Peak Flows (cfs)
2A-01	0.43	0.60/0.78	10.00	1.08/1.79/3.51	0.28	0.46	1.18
2A-02	0.17	0.60/0.78	10.00	1.08/1.79/3.51	0.11	0.18	0.47
2A-03	0.81	0.60/0.78	10.00	1.08/1.79/3.51	0.53	0.87	2.22
2A-04	1.84	0.60/0.78	10.00	1.08/1.79/3.51	1.19	1.98	5.04
2A-05	0.43	0.60/0.78	10.00	1.08/1.79/3.51	0.28	0.46	1.18
2A-06	0.79	0.60/0.78	10.00	1.08/1.79/3.51	0.51	0.85	2.16
2A-07	0.83	0.60/0.78	10.00	1.08/1.79/3.51	0.54	0.89	2.27
2A-08	0.47	0.60/0.78	10.00	1.08/1.79/3.51	0.31	0.51	1.29
2A-09	0.69	0.60/0.78	10.00	1.08/1.79/3.51	0.45	0.74	1.89
2A-10	0.58	0.60/0.78	10.00	1.08/1.79/3.51	0.38	0.62	1.59
2A-11	0.93	0.60/0.78	10.00	1.08/1.79/3.51	0.60	1.00	2.55
2A-12	0.77	0.60/0.78	10.00	1.08/1.79/3.51	0.50	0.83	2.11
2A-13	1.65	0.60/0.78	10.00	1.08/1.79/3.51	1.07	1.77	4.52
2A-14	0.95	0.60/0.78	10.00	1.08/1.79/3.51	0.62	1.02	2.60
2A-15	2.44	0.60/0.78	10.00	1.08/1.79/3.51	1.58	2.62	6.68
2A-16	0.54	0.60/0.78	10.00	1.08/1.79/3.51	0.35	0.58	1.48
2A-OFF-01	0.66	0.60/0.78	10.00	1.08/1.79/3.51	0.43	0.71	1.81
2A-OFF-02	1.09	0.60/0.78	10.00	1.08/1.79/3.51	0.71	1.17	2.98
2B-01	0.56	0.60/0.78	10.00	1.08/1.79/3.51	0.36	0.60	1.53
2B-02	0.57	0.60/0.78	10.00	1.08/1.79/3.51	0.37	0.61	1.56
2B-03	1.12	0.60/0.78	10.00	1.08/1.79/3.51	0.73	1.20	3.07
2B-04	0.82	0.60/0.78	10.00	1.08/1.79/3.51	0.53	0.88	2.25
2B-05	0.34	0.60/0.78	10.00	1.08/1.79/3.51	0.22	0.37	0.93
2B-06	0.47	0.60/0.78	10.00	1.08/1.79/3.51	0.31	0.51	1.29
2B-07	0.62	0.60/0.78	10.00	1.08/1.79/3.51	0.40	0.67	1.70
2B-08	1.41	0.60/0.78	10.00	1.08/1.79/3.51	0.91	1.51	3.86
2B-09	1.85	0.60/0.78	10.00	1.08/1.79/3.51	1.20	1.99	5.07
2B-10	0.26	0.41/0.63	10.00	1.08/1.79/3.51	0.12	0.19	0.58
2B-OFF-01	0.21	0.20/0.50	10.00	1.08/1.79/3.51	0.05	0.08	0.37
2B-OFF-02	0.24	0.60/0.78	10.00	1.08/1.79/3.51	0.16	0.26	0.66
**AREA R-05	0.24	0.60/0.78	10.00	1.08/1.79/3.51	0.16	0.26	0.66
**AREA R-07	0.41	0.60/0.78	10.00	1.08/1.79/3.51	0.27	0.44	1.12

**AREA R-09A	0.49	0.60/0.78	10.00	1.08/1.79/3.51	0.32	0.53	1.34
**AREA R-09B	0.65	0.60/0.78	10.00	1.08/1.79/3.51	0.42	0.70	1.78
**AREA R-11	0.24	0.59/0.75	10.00	1.08/1.79/3.51	0.15	0.25	0.63
**AREA R-13	1.36	0.60/0.78	10.00	1.08/1.79/3.51	0.88	1.46	3.72
**AREA R-15	0.53	0.60/0.78	10.00	1.08/1.79/3.51	0.34	0.57	1.45
***TOTAL**	**28.46**	**-----**	**-----**	**-----**	18.30	30.32	77.55

*Total subbasin area does not match total acreage of the site due to some lots adjacent to the spine road draining to existing roadway drainage areas.
**Area from PH2 Roadway infrastructure hydrology report.

Additionally, the Lompa Ranch North Specific Plan Area (SPA) and the Kimley-Horn Report determined that the proposed BRPH2 Project will not adversely affect downstream properties and is not required to provide detention on-site due to the single-family residential development and the associated civil improvements. As stated in the previously approved Kimley-Horn Report, "Although post-construction stormwater detention is required by the Specific Plan in the commercial and multi-family residential developments, it should not be required in the single-family residential developments. Due to the location of the project within the lower portions of the KCC, ACC, and VCC watersheds, providing detention may actually increase peak flows and water surface elevations downstream of the proposed development" (Kimley-Horn Report, page 10).

D. Facility Design Calculation

The hydraulic model utilized routing of the peak flows through proposed storm drain to the engineered channels. Runoff will be collected in catch basins, storm drain, and the LID facilities, which are routed toward the ACC and KCC channels designed by Kimley-Horn. All drainage from the sub-basins will be contained in the swales and roadway and will travel to the catch basins, the detention basin, ACC, and the KCC channels. Additionally, the proposed storm drain system was designed to convey the 10-year storm event in a "gravity flow" condition with the pipes below full flow capacity and in a "surcharged" or pressurized condition in the 100-year event. Each of the proposed inlet capacities were designed based on Table 4 of CCDM. Additionally, JK Architecture Engineering used the 100-year water surface elevations in the ACC and KCC channels from the Kimley-Horn study to analyze the back-water effects on the proposed storm drain system, which is a conservative approach, due to the fact that the peak flows from BRPH2 would be significantly downstream of the peak flows analyzed by the previously approved Kimley-Horn Report.
As part of the hydrologic and hydraulic analysis of the proposed residential infrastructure a detention pond is added in the south portion of the subdivision that ultimately discharges into the drainage channels designed by Kimley-Horn. A portion of the subdivision drains to the storm drain system constructed with the roadway infrastructure which leads to a drainage facility located east of Matterhorn Drive and directly north of the future residential development Phase 2-C. A portion of the proposed storm drain system will discharge into the proposed channel which was designed to convey the 100-year peak flow event with two-feet of free-board.

The proposed outlet hydraulics were analyzed using TMRDM equations 842, 843, 859, 861, and 862 (Appendix A). The calculated flows for the proposed from the 100-year peak discharges at locations where the proposed storm drain discharges into the existing engineered channels, or the newly proposed channel located on the southern portion of the property are summarized below. Riprap aprons will be designed at outlets that produces exit velocities greater than 5.0 ft/sec. The outlets were analyzed using the previously mentioned equations for outlet protection. Table 3 summarizes the channel and outlet hydraulic (Appendix E).

Table 3 – Proposed Outlet Protection Summary for BRPH2 Project, Carson City, NV.

Outlet ID	Q_{100} Peak Flow (cfs)	Velocity (ft./sec)	Outlet Diameter (ft.)	Tailwater Depth (ft.)	Length (ft.)	Width (ft.)	Rock Diameter (D_{50})
FES 2B-01	26.9	3.78	2.0	2.00	49	25	0.32
FES 2B-03	26.1	9.35	2.0	1.17	66	25	0.52

Channel stabilization methods were employed to mitigate the erosive properties of flood events. Riprap was designed and provided at each outlet to minimize erosion of the native soils.

According to the Kimley-Horn Report, the offsite flows will be conveyed in the proposed ACC and KCC channels. Reference Kimley-Horn Report for the associated calculations. FEMA floodplain/floodway calculations were also determined in the Kimley-Horn Report.

The proposed storm drain system was analyzed during the 100-year peak flow event. Catch basins were located for the 100-year storm to not inundate structures. Refer to Appendix D for the associated cross-sectional analyses. The proposed storm drain system will be maintained by the Carson City.

The Energy and Hydraulic Grade Lines (HGL) can be viewed in the civil improvement plans. All of the HGL's are a minimum of one foot below the proposed rim with the exceptions of SDMH_2A-01, SDMH_2A-02, SDMH_2A-04, SDMH_2B-04 & SDMH_2B-05. Due to these manholes having two HGL's having a minimum of one foot clearance below rim grades, bolt down lids will be required.

According to Table 3 in the Carson City Drainage Manual, a local roadway shall contain flow to not inundate structures during the 100-year peak flow event. The maximum depth at gutter flow line shall be 1 foot. Table

4 summarizes the 100-year peak flow inlet hydraulics for all local roads from right of way to right of way (ROW) within the subdivision for Phase 2-A and 2-B (Appendix D).

Table 4 – Proposed 10-year/100-year Dry Lane Summary for BRPH2 Project, Carson City, NV.

Outlet ID	Inlet Condition	10-Year Peak Flow (cfs)	100-Year Peak Flow (cfs)	Peak Flow Intercepted Q_{10}/Q_{100} (cfs)	Peak Flow Bypassing Q_{10}/Q_{100} (cfs)	Max Gutter Spread Q_{10}/Q_{100} (ft.)
CB2A-01	On Sag	0.46	1.18	0.46/1.18	N/A	2.26/6.22
CB2A-02	On Sag	0.18	0.47	0.18/0.47	N/A	1.68/2.27
CB2A-03	On Grade	0.87	2.22	0.69/1.38	0.18/0.84	6.83/10.45
CB2A-04	On Sag	1.97	5.04	1.97/5.04	N/A	9.23/18.19
CB2A-05	On Sag	0.46	1.18	0.46/1.18	N/A	2.26/6.22
CB2A-06	On Grade	0.85	2.16	0.68/1.36	0.17/0.80	6.74/10.27
CB2A-07	On Grade	0.89	2.27	0.71/1.41	0.18/0.87	6.88/10.54
CB2A-08	On Grade	0.50	1.29	0.45/0.93	0.05/0.35	5.14/8.21
CB2A-09	On Grade	0.74	1.89	0.62/1.24	0.12/0.65	6.02/9.37
CB2A-10	On Grade	0.62	1.59	0.54/1.10	0.08/0.49	5.49/8.70
CB2A-11	On Grade	1.00	2.55	0.77/1.52	0.23/1.02	7.28/11.03
CB2A-12	On Grade	0.83	2.11	0.67/1.33	0.16/0.77	6.65/10.19
CB2A-13	On Sag	3.39	11.52	3.39/11.52	N/A	10.59/11.22
CB2A-14	On Sag	1.20	3.43	1.20/3.43	N/A	2.88/10.68
CB2A-15	On Grade	3.10	9.19	1.76/3.47	1.34/5.72	11.05/17.38
CB2A-16	On Grade	0.74	2.25	0.68/1.53	0.07/0.72	4.49/7.99
CB2B-01	On Grade	0.78	3.71	0.67/2.04	0.11/1.66	5.42/11.14
CB2B-02	On Sag	0.61	1.56	0.61/1.56	N/A	2.53/7.73
CB2B-03	On Grade	1.20	3.07	0.89/1.73	0.32/1.33	7.96/11.94
CB2B-04	On Grade	0.88	2.24	0.70/1.39	0.18/0.85	6.86/10.50
CB2B-05	On Sag	0.36	0.93	0.36/0.93	N/A	2.08/5.16
CB2B-06	On Grade	0.50	1.29	0.46/0.94	0.05/0.35	4.85/7.90
CB2B-07	On Grade	0.67	1.70	0.56/1.14	0.10/0.56	5.96/9.33
CB2B-08	On Sag	1.62	4.42	1.62/4.42	N/A	7.95/16.57

Note 1 – These catch basins are located on a local street.

The detention basin in the southern portion of the subdivision was modeled with and without a backwater effect. The anticipated flow was based on the Kimley-Horn attenuated flow and the 100-year WSE in the channel. Even with the 100-year WSE in the channel, the adjacent lots have approximately 1.5' of freeboard before the water reached the lowest lot line elevation. In the 100-year peak flow event there is approximately 0.5' of freeboard at the lowest design elevation of the spillway.

Water quality control measures have been incorporated into the project in an attempt to prevent storm drainage leaving the site from adversely affecting downstream uses. A portion of the project (6.43 acres) will discharge into the proposed detention basin located at the southern end of the site adjacent to the Kings Canyon Channel, while the remaining portion of the site (16.43 acres) will discharge into the engineered linear channel constructed as a part of the Phase 2 Roadway Infrastructure plans located adjacent to the future park site to the south. These items have been designed to capture stormwater and allow for infiltration during the storm event.

The calculations listed below for the Volume-Based Water Quality Control Design were obtained from section 2.1.1.3 in the CCDM and the are listed in Table 5 below:

Water Quality Volume Calculation: **$WQ_v=[(P)(R_v)(A)]/12$**
$R_v=0.05 + 0.009I$
WQ_v=Water quality volume (ft^3)
P=the 90^{th} percentile precipitation depth (in.)
I=percent of basin impervious area
A=drainage area (ft^2)

Table 5 – Water Quality Volume Calculation for BRPH2 Project, Carson City, NV.

	P (inches)	I (%)	A (ft^2)	R_v	WQ_v (ft^3) (Required)	WQ_v (ft^3) (Provided)
Detention Pond	0.5	0	280,091	0.05	584	793 @ 1' depth
Linear Channel	0.5	0	715,691	0.05	1,491	1,640 @2' depth

All underground storm drain facilities shall be owned and maintained by Carson City while maintenance of all common areas including all stormwater treatment facilities shall be the responsibility of a homeowner's maintenance association.

V. CONCLUSIONS

A. Compliance with drainage laws

This Technical Drainage Study is compliant with all local and federal requirements and specifications. The proposed on-site civil improvements meet or exceed the minimum design standards set forth by Carson City and FEMA.

B. Compliance with the CCMC

JK Architecture Engineering Inc., has coordinated with Carson City engineering and planners during the planning and design phases of the BRPH2 project.

C. Compliance with FEMA requirements

This analysis is based on the Kimley-Horn Report which is in compliance with FEMA requirements. All design recommendations have been based on the ACC, KCC, and tributaries H and I channel designs.

D. Compliance with development standards

The BRPH2 Project is in complete compliance with the Carson City developmental standards.

E. Effectiveness of proposed drainage facilities to control storm runoff

All drainage from the sub-basins will be contained in the lot swales and roadways and will travel to the catch basins, the detention basin, and the approved ACC and KCC channels. Additionally, the proposed storm drain system was be designed to convey the 10-year storm event in a "gravity flow" condition with the pipes below full flow capacity and in a "surcharged" or pressurized condition in the 100-year. Each of the proposed inlet capacities were designed based on Table 4 (Allowable Storm Inlet Types and Capacity Factors) in the CCDM (Appendix D). Additionally, JK Architecture Engineering used the 100-year water surface elevations in the proposed ACC and KCC channels from the previously approved Kimley-Horn study to analyze the back-water effects on the proposed storm drain system, which is a conservative approach due to the fact that the peak flows from the BRPH2 would be significantly downstream of the peak flows from the upstream basins analyzed by Kimley-Horn study. Additionally, the proposed catch basins in the local roads within the subdivision were spaced so flow contained will not inundate the structures during the 100-year peak flow event.

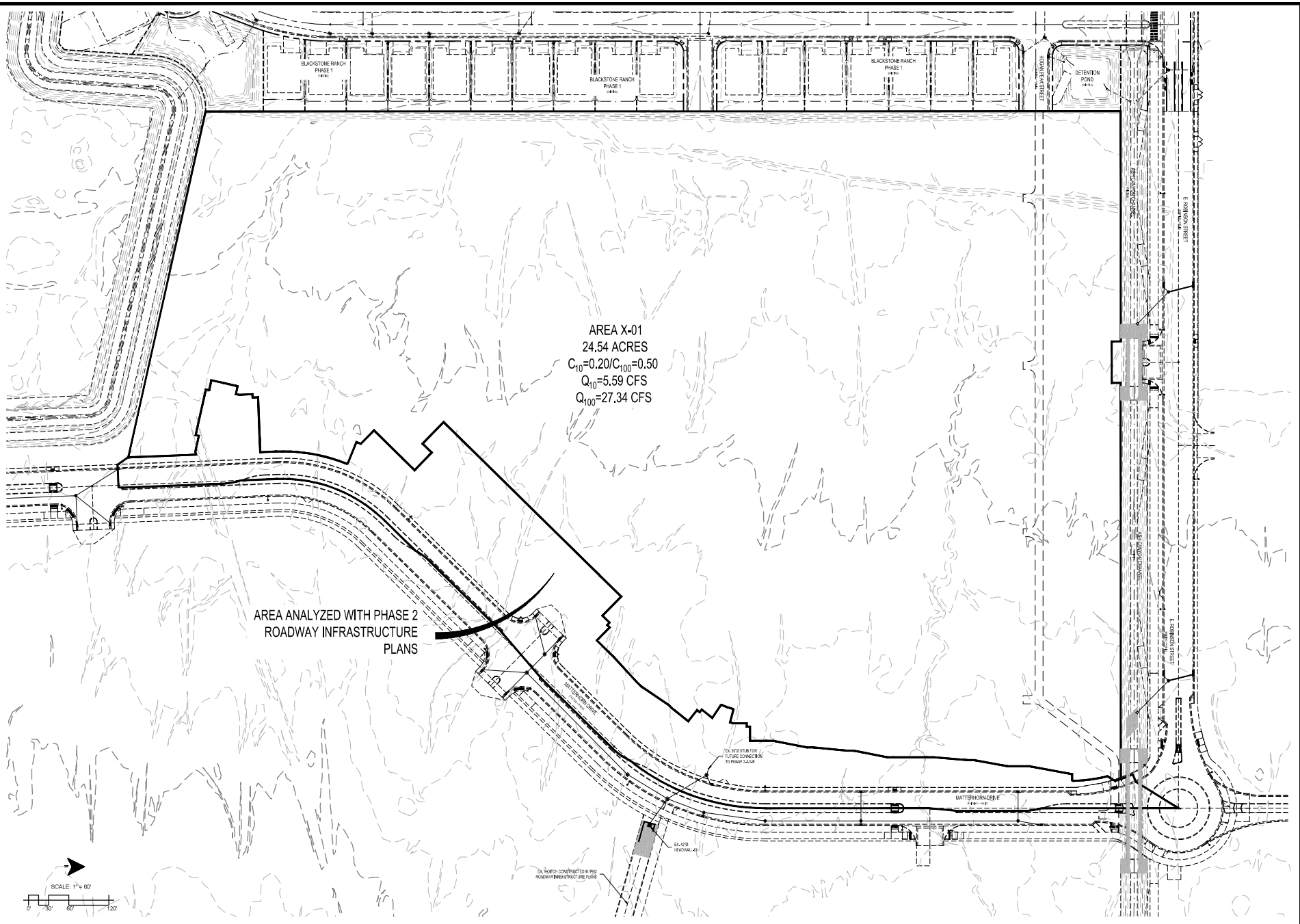
The proposed detention facility located at the southern portion of the project was designed to slightly decrease the overall net increase in the 100-year peak flow. The detention facility has an approximate storage capacity of 13,000 ft^3 with approximately 0.5' of freeboard below the emergency spillway. The detention facility has a low flow channel to assist in storm water treatment.

F. Impact of proposed development on off-site property and facilities

There will be no impact to the off-site property and facilities due to the proposed BRPH2 Project. The proposed peak flows will be significantly downstream of the peak flows in the proposed channels analyzed in the Kimley-Horn Report and will have no impact downstream.

G. Mitigation of impacts and implementation schedule

The proposed BRPH2 Project development will be phased in an attempt to control the potential sedimentation due to precipitation runoff. Additionally, Best Management Practices will be employed during all phases to reduce the associated environmental impacts. The 2-year peak flow event was calculated as part of the Low Impact Development (LID) analysis (Appendix C). Water quality measures have been designed to collect and treat the calculated flows.



JK ARCHITECTURE ENGINEERING
AUBURN | TAHOE CITY | RENO | SAN JOSE
www.jkaedesign.com

Drawn By: KM
Checked By: KA
Project No.: 21-100
Date: MARCH 2022

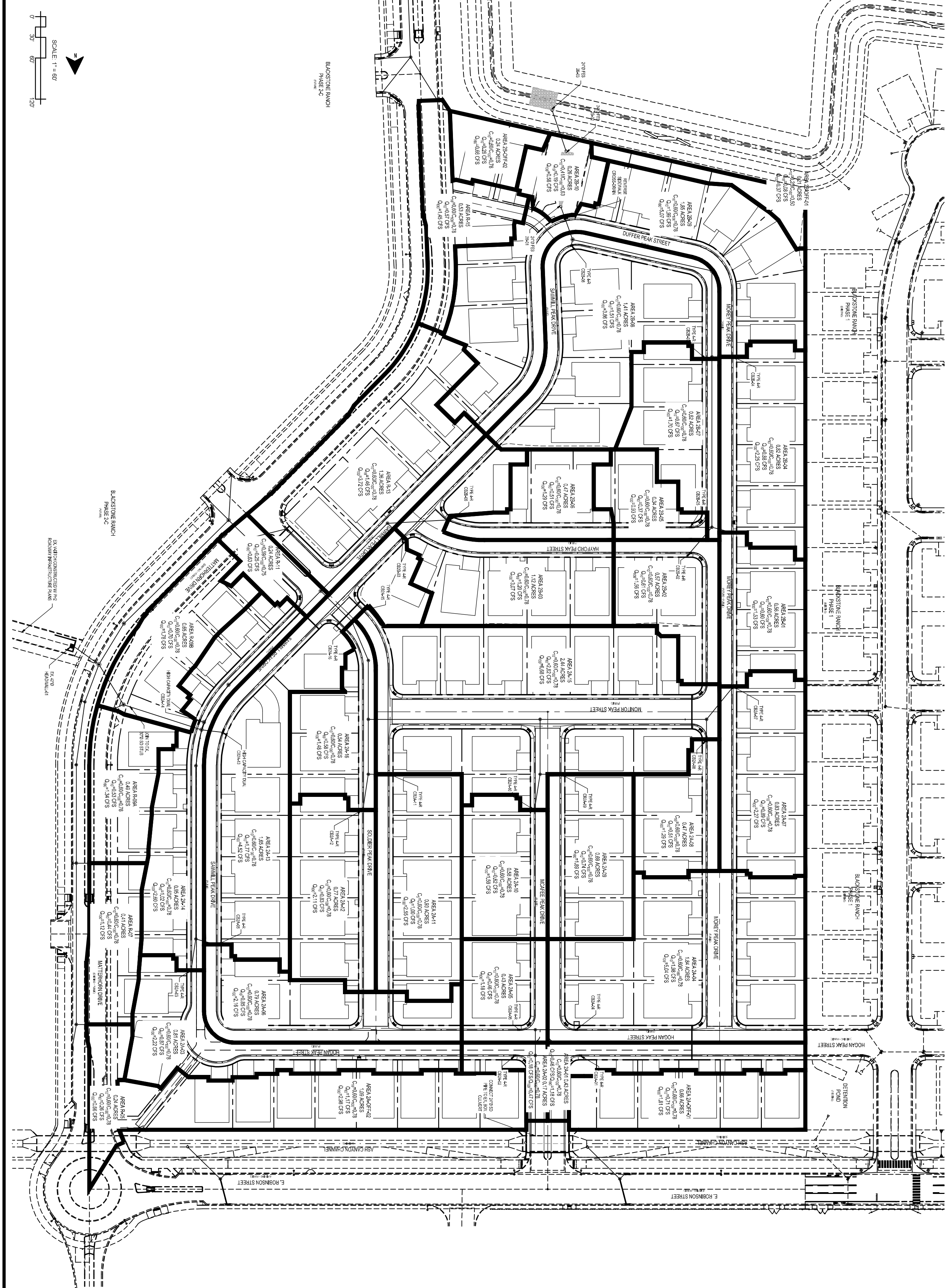
NO.	DATE	ISSUE

Seal

Drawing Title
EXISTING HYDROLOGY DISPLAY

Project
CIVIL IMPROVEMENT PLANS
BLACKSTONE RANCH PHASE 2 PHASE 2A & 2B SUBDIVISION CARSON CITY, NEVADA

1 OF 2



Project
CIVIL IMPROVEMENT PLANS

BLACKSTONE RANCH PHASE 2
PHASE 2A & 2B SUBDIVISION
CARSON CITY, NEVADA

2 OF 2

Drawing Title
PROPOSED HYDROLOGY DISPLAY

Seal

NO.	DATE	ISSUE

Drawn By: KM
Checked By: KA
Project No.: 21-100
Date: MARCH 2022

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APPENDIX A

SUPPORTING DATA

National Flood Hazard Layer FIRMette

FEMA

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance / Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 11/16/2021 at 7:20 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

NOAA Atlas 14, Volume 1, Version 5
Location name: Carson City, Nevada, USA*
Latitude: 39.1647°, Longitude: -119.7452°
Elevation: 4636.4 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	1.14 (0.984-1.34)	1.42 (1.22-1.68)	1.90 (1.62-2.26)	2.35 (2.00-2.80)	3.11 (2.56-3.68)	3.79 (3.02-4.54)	4.61 (3.56-5.57)	5.59 (4.14-6.86)	7.15 (5.00-8.96)	8.56 (5.70-10.9)
10-min	0.864 (0.744-1.02)	1.08 (0.930-1.28)	1.44 (1.24-1.71)	1.79 (1.52-2.12)	2.36 (1.94-2.81)	2.89 (2.30-3.45)	3.51 (2.71-4.24)	4.26 (3.16-5.23)	5.44 (3.80-6.82)	6.51 (4.34-8.30)
15-min	0.716 (0.616-0.844)	0.892 (0.772-1.06)	1.19 (1.02-1.42)	1.48 (1.26-1.76)	1.95 (1.61-2.32)	2.38 (1.90-2.85)	2.90 (2.24-3.50)	3.52 (2.61-4.32)	4.50 (3.14-5.64)	5.38 (3.58-6.86)
30-min	0.482 (0.414-0.568)	0.600 (0.520-0.712)	0.802 (0.688-0.952)	0.996 (0.848-1.18)	1.31 (1.08-1.56)	1.61 (1.28-1.92)	1.95 (1.51-2.36)	2.37 (1.76-2.91)	3.03 (2.12-3.80)	3.62 (2.41-4.62)
60-min	0.298 (0.257-0.352)	0.371 (0.321-0.440)	0.497 (0.426-0.590)	0.616 (0.524-0.732)	0.813 (0.670-0.967)	0.994 (0.794-1.19)	1.21 (0.933-1.46)	1.47 (1.09-1.80)	1.87 (1.31-2.35)	2.24 (1.49-2.86)
2-hr	0.202 (0.180-0.232)	0.250 (0.223-0.288)	0.320 (0.282-0.366)	0.382 (0.333-0.436)	0.474 (0.403-0.545)	0.557 (0.462-0.646)	0.650 (0.526-0.764)	0.764 (0.597-0.910)	0.958 (0.716-1.19)	1.14 (0.822-1.44)
3-hr	0.161 (0.144-0.181)	0.200 (0.180-0.227)	0.252 (0.224-0.284)	0.294 (0.260-0.331)	0.354 (0.308-0.401)	0.405 (0.346-0.463)	0.462 (0.387-0.533)	0.535 (0.438-0.628)	0.655 (0.519-0.798)	0.769 (0.594-0.972)
6-hr	0.111 (0.100-0.124)	0.139 (0.125-0.156)	0.173 (0.154-0.193)	0.200 (0.177-0.224)	0.236 (0.207-0.266)	0.265 (0.229-0.300)	0.294 (0.249-0.336)	0.327 (0.272-0.380)	0.377 (0.305-0.444)	0.421 (0.333-0.504)
12-hr	0.073 (0.065-0.082)	0.091 (0.082-0.103)	0.115 (0.102-0.130)	0.134 (0.118-0.150)	0.159 (0.139-0.180)	0.178 (0.154-0.203)	0.198 (0.168-0.228)	0.218 (0.182-0.254)	0.245 (0.199-0.292)	0.267 (0.212-0.322)
24-hr	0.048 (0.043-0.053)	0.060 (0.054-0.066)	0.075 (0.069-0.083)	0.088 (0.080-0.097)	0.105 (0.095-0.116)	0.119 (0.107-0.131)	0.134 (0.119-0.148)	0.148 (0.131-0.165)	0.169 (0.146-0.189)	0.185 (0.158-0.209)
2-day	0.028 (0.026-0.032)	0.036 (0.032-0.040)	0.045 (0.041-0.051)	0.053 (0.048-0.059)	0.064 (0.057-0.072)	0.073 (0.064-0.082)	0.082 (0.072-0.092)	0.091 (0.079-0.104)	0.104 (0.089-0.120)	0.115 (0.097-0.133)
3-day	0.021 (0.019-0.023)	0.026 (0.023-0.029)	0.033 (0.030-0.038)	0.039 (0.035-0.044)	0.048 (0.042-0.054)	0.054 (0.048-0.061)	0.061 (0.053-0.070)	0.069 (0.059-0.079)	0.079 (0.067-0.091)	0.087 (0.073-0.102)
4-day	0.017 (0.015-0.019)	0.021 (0.019-0.024)	0.028 (0.024-0.031)	0.032 (0.029-0.037)	0.040 (0.035-0.045)	0.045 (0.039-0.051)	0.051 (0.044-0.058)	0.057 (0.049-0.066)	0.066 (0.056-0.077)	0.074 (0.061-0.086)
7-day	0.011 (0.010-0.013)	0.014 (0.013-0.016)	0.018 (0.016-0.021)	0.022 (0.019-0.024)	0.026 (0.023-0.030)	0.030 (0.026-0.034)	0.034 (0.029-0.039)	0.038 (0.033-0.043)	0.043 (0.037-0.050)	0.048 (0.040-0.056)
10-day	0.009 (0.008-0.010)	0.011 (0.010-0.012)	0.014 (0.013-0.016)	0.017 (0.015-0.019)	0.020 (0.018-0.023)	0.023 (0.020-0.026)	0.026 (0.022-0.029)	0.029 (0.025-0.032)	0.032 (0.028-0.037)	0.035 (0.030-0.041)
20-day	0.005 (0.005-0.006)	0.007 (0.006-0.007)	0.009 (0.008-0.010)	0.010 (0.009-0.011)	0.012 (0.011-0.013)	0.014 (0.012-0.015)	0.015 (0.013-0.017)	0.016 (0.014-0.019)	0.018 (0.016-0.021)	0.020 (0.017-0.023)
30-day	0.004 (0.004-0.004)	0.005 (0.005-0.006)	0.006 (0.006-0.007)	0.008 (0.007-0.008)	0.009 (0.008-0.010)	0.010 (0.009-0.011)	0.011 (0.010-0.012)	0.012 (0.011-0.014)	0.014 (0.012-0.015)	0.015 (0.013-0.017)
45-day	0.003 (0.003-0.003)	0.004 (0.004-0.004)	0.005 (0.005-0.006)	0.006 (0.005-0.006)	0.007 (0.006-0.008)	0.008 (0.007-0.008)	0.008 (0.007-0.009)	0.009 (0.008-0.010)	0.010 (0.009-0.011)	0.011 (0.009-0.012)
60-day	0.003 (0.002-0.003)	0.003 (0.003-0.004)	0.004 (0.004-0.005)	0.005 (0.005-0.006)	0.006 (0.005-0.006)	0.006 (0.006-0.007)	0.007 (0.006-0.008)	0.008 (0.007-0.008)	0.008 (0.007-0.009)	0.009 (0.008-0.010)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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PF graphical

I. Introduction

Stormwater runoff and the drainage systems that convey the runoff through the community, both naturally occurring and manmade, are integral elements of the watershed and the developed environment. While stormwater runoff is part of a natural hydrologic process, development and other human activities can change natural drainage patterns and add pollutants to streams, rivers, and lakes. Carson City's efforts to control stormwater discharge focus on both the quantity and quality of the stormwater. This Manual is an effort to improve stormwater management by improving stormwater quality and reducing the quantity of stormwater conveyed through the City's stormwater drainage system.

This Carson City Drainage Manual (Manual) includes and promotes the use of Low Impact Development (LID) practices. LID is a stormwater management approach to land development and redevelopment that works to manage stormwater close to its source. Design principles are used that minimize disturbance, maintain or create perviousness, and use on-site stormwater treatment techniques. LID practices can be effective in reducing runoff quantity, enhancing groundwater recharge, preserving flood plain storage, and removing pollutants by filtration and biological processes before entering the City's storm drainage system.

The Manual supersedes and has been created from the former Stormwater Division 14 of the City's Development Standards. The Manual is an update of the previous stormwater criteria for Carson City and incorporates LID practices and requirements for new and redeveloped properties in the City. The new Manual's formatting has been adjusted to include LID Best Management Practices (BMPs) that are most likely to be used in Carson City.

I.1 Purpose

The Manual's purpose is to reduce pollutants and control drainage by providing guidance on the selection, design, implementation, and management of stormwater source control and structural treatment control BMPs and LID measures for Carson City. The Manual provides information and potential references to aid in making informed selections of BMPs and LID practices.

I.2 NPDES Stormwater Permit and Legal Authority

Carson City is required to implement and enforce a Stormwater Management Program (SWMP) to reduce the pollutants in its stormwater and discharge through its Municipal Separate Storm Sewer System (MS4). Also required is the development of policies and procedures to implement and enforce the operation and maintenance of source controls and structural treatment controls for new development and redevelopment within the City. The requirements for the SWMP and a permit to discharge pollutants into waters of the United States from a MS4 are contained in Section 402 of the Federal Clean Water Act (CWA).

In 2021, Carson City amended and updated the provisions pertaining to drainage, stormwater, LID, and related topics in Titles 12 and 18 of its Municipal Code. As part of this update, Division 14, Storm Drainage, of the Title18 Appendix was removed from the Code and replaced by this Manual.

I.3 Relationship to Other Standards and References

Users of this Manual should be aware of other City standards that may be applicable to the development or redevelopment of property within Carson City. Users may also consult references cited in this Manual for more information and alternative practices. Pertinent Carson City and regional standards include, but are not limited to, those listed below.

- Carson City Municipal Code, Title 18 Appendix, Development Standards.
- Standard Specifications for Public Works Construction (SSPWC) (The "Orange Book") (2012 or the most current edition) provides general provisions, material specifications, and construction

methods for typical public works installations, including storm drainage infrastructure and landscaping.
- Truckee Meadows Structural Controls Design and Low Impact Development Manual.
- Truckee Meadows Structural Controls Design Manual, together with all addenda.
- Truckee Meadows Construction Site Best Management Practices Handbook, together with all addenda.
- Truckee Meadows Industrial Commercial Best Management Practices Handbook, together with all addenda.
- Chapter 4 of the Tahoe Regional Planning Agency Best Management Practices Handbook, together with all referenced addenda.

The standards, criteria, and requirements in this Manual are minimum standards that may not necessarily be adequate to address the highly variable conditions that must be covered by effective low impact development measures.

I.4 Updates and Revisions

Innovation and improvement continue to advance BMPs, LID practices, and the science and technology related to stormwater management and stormwater quality. The City Engineer may make technical engineering and clerical revisions to this manual at any time. For revisions that may have minor cost implications to the development community to comply with the specifications in this manual, the City Engineer must provide an opportunity for public input and update the Board of Supervisors prior to making the revisions. For major revisions that may have significant cost implications to the development community, the City Engineer must provide an opportunity for public input and obtain Board of Supervisor approval prior to making the major revision. Any revisions must be posted to the Carson City website where this manual is available for a period of 30 days before the revisions become effective.

1. Drainage Policy Introduction and Basic Principles

Adequate drainage systems shall be provided in order to preserve and promote the general health, welfare, and economic well-being of the region. Drainage is a regional feature that affects all of Carson City. Drainage plans shall be consistent with and integrated with BMPs, LID measures, and the Carson City Drainage Master Plan upon adoption. This characteristic of drainage requires coordination and cooperation from both the public and private sectors.

Stormwater drainage systems are an integral part of the development process. The planning of drainage facilities, BMPs, and LID measures shall be integrated into the development process and in preparation of improvement plans. Onsite stormwater drainage systems shall include BMPs and LID measures to reduce runoff and improve stormwater quality unless it is demonstrated to the satisfaction of the City Engineer that the site is not suitable.

Drainage systems require space to accommodate conveyance, storage, and treatment functions. When the space requirements are considered, the provision for adequate drainage becomes a competing use for space along with other land uses.

Storm drainage planning for all development and redevelopment shall include the allocation of space for drainage facility construction and maintenance, which may entail the dedication of right-of-way and/or easements. The provision of multi-use facilities such as combining with parks, open space, and recreation needs is strongly encouraged.

New development. New development is the conversion of previously undeveloped or pervious surfaces to impervious surfaces and managed landscape areas.

Redevelopment. Redevelopment is the replacement of impervious surfaces on a developed site. All new impervious surfaces added during redevelopment are considered new development.

The long-term goal of the redevelopment standard is to reduce stormwater pollution from existing developed sites, especially when the site is being upgraded to a use with a greater potential to contribute pollution to the receiving waters.

1.1 Water Rights

All drainage systems shall be planned and constructed with consideration given to the existing water rights and applicable water laws.

1.2 Reasonable Use of Drainage

Downstream properties shall not be unreasonably burdened with increased flow rates, negative impacts, or unreasonable changes in the manner of flow from upstream properties. Drainage problems shall not be transferred from one location to another. However, downstream properties cannot block natural or existing runoff through their site and shall accept runoff from upstream properties.

“Reasonable Use of Drainage” is defined for planning purposes, as providing an economic and hydraulically efficient drainage system which is demonstrated not to adversely and unreasonably impact downstream properties within reason. This “Reasonable Use of Drainage” therefore allows development to occur while preserving the rights of adjacent property owners.

1.3 Change in Manner of Flow

Development shall tend to concentrate existing natural sheet flow into point flows at property lines. These point flows are generally associated with outlets from gutter flow, storm drains, and detention facilities. Downstream properties may experience a longer duration of storm flows, and greater flows in general due to a shortened time of concentration. Discharge of point flows on downstream property can cause

increased erosion at the discharge point and further downstream. The manner by which runoff is discharged from the project site must not cause a significant adverse impact to downstream receiving waters and down-gradient properties. Therefore, downstream facilities shall be evaluated for runoff capacity during the design and review process. Mitigation of these point flows can be accomplished through energy dissipaters or flow spreaders. Point flows shall be discharged to downstream properties at non-erosive velocities and depths of flow.

All outfalls must address energy dissipation as necessary. A project proponent who believes that energy dissipation should not be required for a new outfall must provide justification in the project's conceptual or technical drainage study.

Where no conveyance system exists at the adjacent down-gradient property line, and the discharge was previously unconcentrated flow or significantly lower concentrated flow, then measure must be taken to prevent down-gradient impacts. Drainage easements or right-of-way from downstream property owners may be needed and should be obtained prior to approval of engineering plans.

1.4 Diversion of Drainage

Development can alter the historic or natural drainage paths. When these alterations result in a local on-site drainage system that discharges back into the natural drainage-way or wash at or near the historic location, then the alterations (inter-basin transfer) are generally acceptable. However, when flows from the local on-site drainage system do not return to the historic drainage-way or wash, then inter-basin transfer may result. These inter-basin transfers are generally not acceptable. Planning and design of drainage systems shall not be based on the premise that stormwater can be transferred from one basin to another unless part of an adopted City Regional Drainage System Plan.

The flow of storm runoff shall be maintained within its natural drainage course unless reasonable use is demonstrated otherwise. When stormwater is discharged into an existing drainage course, the peak discharge into the water course shall not adversely affect or cause damage to property along the drainage course now or in the future based on existing zoning and the Carson City Master Plan build-out conditions. Erosion impacts due to concentration of flows and increased flow durations shall be evaluated and mitigated.

1.5 Water Quality

Storm drainage improvements shall incorporate water quality, erosion control, BMPs, and LID measures in accordance with the Nevada "Handbook of Best Management Practices," Title 18 Appendix, Division 13, this Manual, and accepted engineering practice. Storm drainage leaving a development during the construction phase or post-construction may not be of a quality that shall adversely affect downstream uses. Flow based post-construction water quality controls shall be designed to capture and treat the flow rate for the 2-year runoff event from the drainage area connected to the BMP. Volume based post-construction water quality controls shall be designed to provide adequate storage to capture and treat 90 percent of the average annual stormwater runoff events.

Water quality controls to minimize stormwater pollution shall be provided for all development where the total of new and/or replaced impervious surface coverage equals or exceeds 10,000 square feet or causes disturbance equal to or greater than one (1) acre, except for the development of one (1) single-family residence that causes less than one (1) acre of land disturbance. Also, standard maintenance practices are exempt if the site remains similar to the existing flow patterns as determined by the City Engineer. In addition, commercial and industrial projects must include source control BMPs to the maximum extent practicable.

Direct discharge of untreated stormwater from pollution generating impervious surfaces is prohibited. The purpose of runoff treatment is to reduce pollutant loads and concentrations in stormwater runoff using physical, biological, and chemical removal mechanisms so that beneficial uses of receiving waters are maintained, and where possible, restored. The water quality parameters of concern in the Carson River basin include, but are not limited to, total suspended solids, total phosphorus, and turbidity. Water quality

treatment facilities should be chosen, designed, and maintained to minimize total phosphorus, turbidity and total suspended solids discharged into receiving waters.

Non-pollution generating impervious surfaces (NPGIS) are considered to be insignificant or low sources of pollutants in stormwater runoff. If the runoff from NPGIS is separated from the runoff from pollution generating impervious surfaces (PGIS), the NPGIS runoff does not need to be treated. However, if NPGIS and PGIS are combined, the entire amount of runoff must be treated.

NPGIS include the following:

1. Roofs that are subject only to atmospheric deposition or normal heating, ventilation and air conditions vents;
2. Paved bicycle pathways and pedestrian sidewalks that are separated from and not subject to drainage from roads for motor vehicles;
3. Fenced fire lanes; and
4. Infrequently used maintenance access roads.

Sidewalks that are regularly treated with salt or other de-icing chemicals are not considered NPGIS.

PGIS are considered to be significant sources of pollutants in stormwater runoff. Such surfaces include:

1. Surfaces subject to vehicular use;
2. Surfaces subject to industrial activities or subject to storage of erodible or leachable materials that receive direct rainfall or run-on or blow-in of rainfall;
3. Metal roofs unless coated with an inert, non-leachable material;
4. Roofs subject to the venting of manufacturing, commercial or other indoor pollutants;
5. Any surface, whether paved or not, that is regularly used by motor vehicles, including roads, unvegetated road shoulders, bike lanes within the traveled lane of a roadway, driveways, parking lots, unfenced fire lanes, vehicular equipment storage yards, and airport runways.

High-use sites generate high concentrations of oil due to high traffic turnover or the frequent transfer of oil and/or other petroleum products. High-use sites are land uses where sufficient quantities of free oil are likely to be present such that they can be effectively removed with special treatment. A high-use site is any one of the following:

1. A road intersection with expected average daily trips (ADT) of 25,000 vehicles or more on the main roadway and 15,000 vehicles or more on any intersecting roadway, excluding projects proposing primarily pedestrian or bicycle use improvements;
2. A commercial or industrial site with an expected trip end count equal to or greater than 100 vehicles per 1,000 square feet of gross building area;
3. A customer or visitor parking lot with an expected trip end count equal to or greater than 300 vehicles;
4. Commercial on-street parking areas on streets with an expected total ADT count equal to or greater than 7,500;
5. Fueling stations and facilities;
6. A commercial or industrial site subject to petroleum storage and transfer in excess of 1,500 gallons per year, not including locations where heating fuel is routinely delivered to end-users (heating fuel handling and storage facilities are subject to this definition);
7. A commercial or industrial site subject to use, storage, or maintenance of a fleet of 25 or more diesel vehicles that are over 10 tons gross weight;
8. Maintenance and repair facilities for vehicles, aircraft, construction equipment, railroad equipment or industrial machinery and equipment; or
9. Outdoor areas where hydraulic equipment is stored.

Exemptions

NPGIS areas are exempt from basic treatment requirements *unless* the runoff from these areas is not separated from the runoff generated from PGIS areas. All runoff treatment facilities must be sized for the entire flow that is directed to them.

1.6 Treatment Requirements

Runoff treatment is required for all projects unless it can be demonstrated to the satisfaction of the City Engineer that runoff treatment is not feasible due to specific site limitations (e.g., wellhead protection areas, high groundwater conditions that preclude LID practices, and areas of vector control concern). The basic treatment requirements include removal of 80 percent of total suspended solids for influent concentrations that are greater than 100 mg/l, but less than 200 mg/l. For influent concentrations less than 100 mg/l, the facilities should achieve an effluent goal of 20 mg/l total suspended solids. Additionally, the basic treatment requirements are intended to achieve a goal of 50 percent total phosphorus removal for a range of influent concentrations of 0.1 – 0.5 mg/l total phosphorus. The performance goals apply to either the water quality design storm volume or flow rate as appropriate.

High-use sites must provide facilities adequate to meet the basic treatment goals as well as oil control goals. The oil control facilities must achieve the goal of no ongoing or recurring visible sheen and to have a 24-hour average Total Petroleum Hydrocarbon (TPH) concentration no greater than 10 mg/l, and a maximum of 15 mg/l for a discrete sample (grab sample).

1.7 Drainage Improvements

Drainage improvements consist of curb and gutter, inlets and storm drains, culverts, bridges, swales, ditches, channels, detention areas, water quality facilities, and other drainage facilities required to convey and treat design storm runoff to the point of discharge. Drainage improvements are further defined as on-site (private) facilities that serve a specific development and are privately owned and maintained or off-site (public) facilities. Public and private drainage facilities shall be constructed in accordance with the requirements of this Manual, Title 18 Appendix, Division 13, and accepted engineering practice.

1.8 Floodplain Management

Floodplain management shall provide the guidance, condition, and restriction for development in floodplain areas while protecting the public's health, safety, welfare, and property from danger and damage. Development within the Federal Emergency Management Agency (FEMA) designated Special Flood Hazard Areas shall comply with CCMC and requirements of the National Flood Insurance Program (NFIP).

1.9 Storm Runoff Detention

Detention is considered a viable method to reduce storm runoff from developed properties. Temporarily detaining storm runoff can significantly reduce downstream flood hazards, pipe and channel requirements, and downstream erosion and sedimentation. Storage also provides for sediment and debris collection, which reduces maintenance requirements for downstream channels and streams.

Detention used in conjunction with other BMPs and LID measures can be particularly effective. The City requires the use of BMPs and LID measures unless it can be demonstrated that they are not suitable for the site.

Local detention storage for land development, which includes subdividing land, shall be required when the development increases flow and downstream conveyance capacities of the drainage system are not capable of handling non-detained flows, and the developer elects not to upgrade the existing storm drainage system. Onsite detention storage shall be sized to detain sufficient runoff to limit post-development flows from a 10-year storm (Q10) to the flows under the predevelopment condition. Volume credit will be granted for water quality features on a one-for-one basis.

The capacity of downstream conveyance systems shall be analyzed in accordance with this Manual and shall be based on runoff from the development as fully improved. Local detention can also be required when designated in flood or drainage master plans to reduce the peak rate in regional facilities.

The City may grant exemptions to the detention policy for the following:

1. Developments which discharge directly to a regional flood control facility, provided the facility is completed per the adopted plan and designed for the contributing flows.

2. Locations where a local detention facility is designed and constructed to serve several developments and the contributing flows.

3. Downstream facilities are upgraded to accommodate the increased flow.

4. Where the downstream facilities are adequate to carry up to 100-year flows.

All exemptions are subject to approval by the City.

1.10 Lower Watershed Design

In certain circumstances, i.e., close to the drainage system's point of discharge, it may be desirable not to detain stormwater runoff. The option to directly discharge shall be at the sole option of the City and after review of a flood route analysis. Water quality treatment will be required even if the stormwater runoff is directly discharged.

1.11 Storm Runoff Retention and Infiltration

Storm runoff retention and infiltration have been used to eliminate the need for constructing outlet structures and for ease of construction. However, problems with retention basins and infiltration facilities receiving runoff from pollution generating surfaces include perpetual maintenance requirements, soil expansion, siltation, decreasing infiltration capacity, and insect abatement. Retention basins and infiltration facilities receiving runoff from pollution generating surfaces also pose a hazard to City groundwater resources through possible contamination. The use of infiltration facilities is encouraged for runoff from non-pollution generating surfaces such as roofs. Percolation tests shall be conducted to verify that on-site soils are adequate for infiltration. Retention basins used to mitigate the increase of runoff from development must meet the requirements of detention basins and are only allowed on a case by case basis.

1.12 Drainage Facilities Maintenance

An important part of all storm drainage facilities is the continued maintenance of the facilities to ensure they function as designed. Maintenance of detention facilities involves the removal of debris and sediment. Such tasks are necessary to preclude the facility from becoming unhealthy and to retain the effectiveness of the detention basin. Sediment and debris must also be periodically removed from channels and storm drains. Trash racks and street inlets must be regularly cleared of debris to maintain system capacity. Channel bank erosion, damage to drop structures, crushing of pipe inlets and outlets, and deterioration to the facilities must be repaired to avoid reduced conveyance capability, unsightliness, and ultimate failure.

All drainage facilities shall be designed to minimize facility maintenance as well as to provide ease of maintenance and include maintenance access to the drainage facility. The owner of the drainage facilities shall be responsible for mosquito control, and the method of control shall comply with the Carson City Environmental Health Department.

The property owner or developer shall be responsible for the maintenance of all privately owned on-site drainage facilities, including but not limited to, inlets, pipes, channels, and detention basins unless otherwise required or modified by a separate agreement. An operation and maintenance schedule shall be provided for all proposed stormwater facilities and BMPs, and the party (or parties) responsible for maintenance and operations shall be identified. Prior to issuance of any permit for any regulated activity covered under this section, the City shall require the applicant and owner to execute an inspection and maintenance agreement

binding on all subsequent owners of land served by the private storm drainage system. If the property owner or developer fails to maintain said facilities adequately, Carson City shall have the right to enter the said property, upon proper notice, for the purposes of maintenance. All such maintenance costs shall be assessed against the owner(s).

An operation and maintenance schedule shall be developed for any storm drainage system. The schedule shall state the required maintenance to be performed, the equipment and skill level necessary to perform the maintenance, and the required frequency of maintenance. The operation and maintenance schedule shall either be printed on the stormwater management agreement or submitted under a separate cover.

1.13 Drainage Easements and Right-of-Way

Easements or Rights-of-Way shall be provided where necessary for access and maintenance of storm drain systems. Simple Fee Title of land is preferred.

1.14 Storm Runoff Water Quality Treatment

All development and redevelopment projects, except for the development of one (1) single-family residence that causes less than one-quarter (1/4) acre of land disturbance, must control the quality of stormwater leaving the site to the maximum extent practicable. Title 18 Appendix, Division 13, contains the Best Management Practices (BMPs) that must be included in an Erosion and Sediment Control Plan to control the water quality of stormwater runoff generated on construction sites. This Manual contains BMPs that must be included in site drainage plans to permanently control the quality of runoff from a developed or redeveloped site.

2. Technical Criteria

2.1 Design Storm Events

Drainage facilities shall be designed to convey the runoff from the 24-hour duration storm with a recurrence interval for a minor storm event (10-year) and a major storm event (100-year).

Water quality facilities will be designed to treat either the peak flow rate produced by the 2-year storm event if the treatment facility is flow-based or the volume of runoff produced by the 2-year, 24-hour storm event if the treatment facility is volume-based.

2.1.1 Storm Runoff Determination

Storm runoff (rates and volumes) shall be determined in accordance with the following methods (other methods may be used if approved by Development Engineering):

2.1.1.1 Conveyance Design

Contributing Basin Area (A)	Computation Procedure
A ≤ 100 Acres	Rational formula, SCS TR-55, or HEC-1, (SCS Unit Hydrograph or Kinematic Wave)
10 S.M > A ≥ 100 Acres	SCS TR-55 or HEC-1 (SCS Unit Hydrograph or Kinematic Wave)
A > 10 S.M.	HEC-1 (SCS Unit Hydrograph or Kinematic Wave)

2.1.1.2 Flow-Based Water Quality Control Design

Flow-based design standards apply to those structural treatment controls whose primary method of pollutant removal is based on the flow and filtration of runoff through the BMP. The water quality flow rate (WQF) for flow-based stormwater treatment controls should be determined by using the following methods to estimate the peak discharge produced by the 2-year storm event in the drainage area of the BMP.

Contributing Basin Area (A)	Computation Procedure
A ≤ 100 Acres	Rational formula, SCS TR-55, or HEC-1, (SCS Unit Hydrograph or Kinematic Wave)
A ≥ 100 Acres	SCS TR-55 or HEC-1 (SCS Unit Hydrograph or Kinematic Wave)

2.1.1.3 Volume-Based Water Quality Control Design

Volume-based BMP design standards apply to those stormwater treatment controls whose primary method of pollutant removal is based on the facilities' ability to capture and detain, retain and/or infiltrate a specific water quality volume. Volume-based stormwater treatment controls should be designed to capture and treat the volume of stormwater runoff determined based on the following formulas:

$$WQ_V = [(P)(R_V)(A)]/12$$
$$R_V = 0.05 + 0.009I$$

Where: WQ_V = water quality volume (ft3)
P = the 90^{th} percentile precipitation depth
I = percent of basin impervious area
A = drainage area (ft2)

(For P, use 1.5 inches for areas west of Carson Street and 0.5 inches for areas east of Carson Street unless otherwise directed by the City.)

2.1.2 Rainfall

Rainfall data tables and storm design information shall be derived from the NOAA Atlas, latest edition, or other City approval.

2.1.3 Streets

The use of streets to convey runoff, although naturally occurring, interferes with the primary function of the street for transportation purposes. Streets are, however, an important component in the storm drainage system due to their large storm carrying capacity obtained for little or no drainage costs. In order to balance these two (2) competing street uses, limits on the street carrying capacity are required based on the street classification related to emergency usage during storm and flood events. All development shall provide clear emergency flow paths for the onsite/offsite 100-year peak storm.

The allowable street capacity for different roadway functional classification shall be determined in accordance with Table 1 and Table 2. To ensure cleaning velocities at low flows, gutters shall have a minimum slope of 0.40 percent.

2.1.4 Culverts, Bridges, Valley Gutter, and Dip Sections

Culverts and bridges shall be installed where natural or manmade drainage channels are crossed by streets. Valley gutters, or “dip” sections, shall be permitted on local streets. The amount of channel flow that crosses over the street shall be minimized (not more than 0.5 feet) to protect the street embankment and pavement from erosion damage as well as to protect vehicles and pedestrians from dangerous flow depths and velocities. Bridges and culvert crossings under streets shall be sized for the required design storm capacity in accordance with Table 1.

Table 1 – Design Storm Events for Crossings

Design Storm Criteria	Design Storm Event (see Notes)
1. Local Streets	25-year return period, 24-hour duration
2. Arterial and Collector Streets	100-year return period, 24-hour duration
3. Developments (commercial, industrial, residential)	10-year return period, 24-hour duration

Notes:

1. All development shall provide emergency flow paths for a 100-year peak storm in accordance with Table 2.
2. Refer to Section 8.1 for additional situations where the drainage system shall be designed for not less than a 100-year return period, 24-hour duration.
3. Refer to Section 1.8 for additional requirements for projects located within a floodplain.

3. Submittal and Review Process

The purpose of the submittal and review process is to determine whether or not the drainage plan and improvements for a given project meet Carson City drainage requirements. These requirements include overall facility planning to assure an integrated and coordinated design as well as design standards to ensure consistent design and analysis. Drainage study submittal requirements for all land development in Carson City are presented in the following section and summarized in Table 2. The submittal requirements are intended to provide the necessary information for each development and minimize review time. The submittal and review process does not relieve the design engineer of the responsibility to provide a correct and safe drainage design or the developer to construct the designed drainage facilities properly.

By reviewing and approving drainage designs for given developments, Carson City shall not assume liability for improper drainage design, nor guarantee that the final drainage design review shall absolve the developer or designer of future liability for improper design or construction.

Table 2 – Drainage Study Submittal Requirements

Land Development and/or Land Action Process	Required Drainage Submittals (5)
Parcel Map:	Conceptual Study
Improvement Plans	Technical Study
Subdivision (including planned unit developments):	
Conceptual Plan	Conceptual Study
Tentative map	Conceptual Study
Improvements Plans	Technical Study
Building Permit	Technical Study
Clearing, Grading, Filling and/or Excavation	Conceptual Study
Other:	
MPR/CLU	Conceptual Study
Special Use Permit	Conceptual Study
Development Master Drainage Plans	Technical Study
Transportation Studies	Technical Study
Floodplain Modification Study	
Conditional Letter of Map Revision, Letter of Map Amendment, Letter of Map Revision, etc.	Technical Study

Notes:

1. Development Engineering may require a Technical Drainage Study in lieu of or in addition to a Conceptual Drainage Study.
2. If the City does not perceive a flooding hazard with the proposed development, the City may approve the development subject to review and approval of the Drainage Study and acceptance of conditions of approval by the owner.
3. All Floodplain Modification Studies shall be prepared in accordance with FEMA requirements and the CCMC.
4. Development Engineering may waive this requirement.
5. Carson City reserves the right to request additional information of the developer/design engineer after a drainage study has been submitted.

Drainage studies shall be submitted for all development and redevelopment, except for the development of one (1) single-family residence that causes less than one-quarter (1/4) acre of land disturbance. Additionally, Development Engineering may require drainage studies where a proposal may endanger the life, safety, and welfare of the public. Two (2) copies of the required drainage studies and attachments shall be submitted to Development Engineering for review with the required applications or improvement plans. Additional copies, as necessary, shall be submitted as requested by Development Engineering. All submitted reports shall be clearly and cleanly reproduced. Copies of charts, tables, nomographs, calculations, or other referenced material shall be legible. In addition, final approved reports and attachments shall be submitted in Adobe pdf format.

4. Drainage Study Information Page

A Drainage Study Information Form Page shall be included with all drainage study submittals. The Drainage Study Information Page shall provide basic information regarding the proposed development. A form will be provided at the request of the Project Engineer.

The Drainage Study shall contain the seal and signature of the professional engineer licensed in Nevada who is responsible for the drainage study.

5. Conceptual Drainage Study

A Conceptual Drainage Study is a descriptive report that addresses existing and proposed drainage conditions. The Conceptual Drainage Study documents the existing drainage conditions of the project site

and presents the details of the proposed drainage system. Additionally, it includes sufficient data to evaluate storm flows and proposed mitigation.

The conceptual drainage study shall contain sufficient information in order for Development Engineering to make a recommendation to the appropriate Carson City hearing body.

5.1 Conceptual Drainage Study Outline

The Conceptual Drainage Study shall contain a brief narrative letter, a calculation appendix (if required), and a drainage plan in accordance with the following outline:

I. Introduction
   - A. Drainage Study, Information page
   - B. Project Name, Type of Study, Study Date
   - C. Preparer's Name, Seal and Signature
   - D. Description of Project, including land use, site development plan, lot coverage, and amount of new and replaced impervious surface
   - E. Existing Site Conditions, including topography, existing ground cover, wetlands, sensitive areas, and stormwater and irrigation systems
   - F. General Location May (8 ½ x 11 is suggested)

II. Existing and Proposed Hydrology
   - A. Discuss existing and proposed drainage basin boundaries
   - B. Provide design storm and 100-year return period, 24-hour duration storm flow calculations for both on- and off-site flows
   - C. Discuss existing drainage problems (if applicable)
   - D. Discuss on-site and downstream drainage, identify downstream conveyance deficiencies, and identify areas with high potential for erosion and sediment deposition
   - E. Discuss Floodplain (if applicable)
   - F. Existing Irrigation
   - G. Discuss locations of sensitive and critical areas (e.g., vegetative buffers, wetlands, steep slopes, streams, etc.)
   - H. Tributary Exhibit

III. Erosion and Sediment Control Measures
   - A. Discuss how the requirements of Section 13 will be met.
   - B. Discuss erosion and sediment control measures implementation and maintenance.

IV. Proposed Drainage Facilities (on-site and off-site)
   - A. Discuss routing of flow in and/or around the site, downstream, and location of drainage facilities. Downstream analysis should extend downstream for the entire flow path from the project site to the receiving water or up to one (1) mile or to a point where the impact to receiving waters is minimal or nonexistent as determined by the City Engineer. The downstream analysis should assess the potential off-site water quality, erosion, slope stability, and drainage impacts associated with the project
   - B. Discuss stormwater quantity and water quality mitigation measures, including operation and maintenance procedures and responsibility
   - C. Discuss floodplain modifications (if applicable)
   - D. Provide Exhibit.

V. Conclusions
   - A. Compliance with the CCMC and the Carson City Development Standards
   - B. Compliance with FEMA (if applicable)
   - C. Discuss the effect of development on off-site flow rates and properties
   - D. Implementation measures necessary for project completion

VI. Exhibits
- A. Drainage Plan
- B. FEMA Floodplain Map (show on drainage plan also)

VII. Calculation Appendix (if required)
- A. Runoff calculations including hydrology computations
- B. Street and drainage facility capacity calculations, including inlet capacities, culvert and pipe system capacities, and outlet velocities, ditch capacities and velocities (if applicable)
- C. Stormwater quantity and water quality control facility calculations (if applicable)

5.2 Conceptual Drainage Plan

An 8 ½ ” x 11” or larger legible drainage plan which covers the development area shall be submitted and bound with the Conceptual Drainage Study. The plan shall contain as a minimum the following:

1. Locate and label the development boundary
2. Locate and label adjacent streets
3. Locate and label known 100-year floodplains
4. Locate and label existing and/or planned local flood control facilities
5. Show flow paths
6. Identify design inflow points and design outflow points and corresponding design storm and 100-year return period, 24-hour duration storm flow rates
7. Show existing and proposed topography
8. Show the time of concentration path for developed and existing conditions

6. Technical Drainage Study

The Technical Drainage Study shall discuss, at a detailed level, the existing site hydrologic conditions, erosion and sediment control during construction, and the proposed drainage plan to accommodate or modify site drainage conditions in the final development plan for the site. The Technical Drainage Study shall address both on-site and off-site drainage analysis and improvements necessary to mitigate the impact of the proposed development on downstream properties.

6.1 Technical Drainage Study Contents

The Technical Drainage Study shall be in accordance with the following outline and contain as a minimum the information listed:

I. Title Page
- A. Project Name, Type of Study, Date of Preparation, and Revisions
- B. Preparer’s Name, Seal and Signature
- C. Drainage Study Information Page

II. General Location and Development Description
- A. Location of Property
  1. Street Location and Assessor’s Parcel Number(s) adjacent to the development
  2. Township, range, section, ¼ section
  3. Drainage basin(s) encompassing the development, watershed name
  4. Location of the development in relation to existing drainage facilities
  5. Names of surrounding developments
  6. General location map (8 ½ x 11 is suggested)

- B. Description of Property
  1. Area in acres
  2. Existing site conditions (land use, buildings, drainage structures, floodplains, and other site conditions that may impact the project)
  3. General site topography, ground cover, and soil maps

4. Existing irrigation facilities such as ditches and canals
5. Adjacent and downstream developments, drainages and infrastructure

C. Project Description
1. Purpose and nature of land-disturbing activity; include the estimated amount of grading
2. Type and size of proposed new or replaced impervious surfaces
3. Critical areas on the site which have the potential for serious erosion and/or sedimentation, or other drainage problems

III. Drainage Basin Description
A. Off-Site drainage description
1. Discuss historical drainage patterns (overland flow, channelized flow, points of discharge) for off-site flows that enter the project site.
2. Discuss off-site flows that enter the project site.
3. Provide a map of drainage basins.
4. Discuss drainage basin characteristics (topography, area, land use, coverage, soil types, locations of critical areas, areas with high potential for erosion and sediment deposition, etc.).
5. Identify the design storm and 100-year return period, 24-hour duration storm flows for each drainage basin and sub-basin impacting or impacted by the project site.
6. Discuss downstream flow paths, rates, and conveyance capacity. Downstream analysis should extend downstream for the entire flow path from the project site to the receiving water or up to one (1) mile or to a point where the impacts to receiving waters are minimal or nonexistent as determined by the City Engineer. The downstream analysis should assess the potential off-site water quality, erosion, slope stability, and drainage impacts associated with the project.

B. On-site drainage description
1. Discuss historical on-site drainage patterns and capacity of the property (flow directions through the site and at property lines).
2. Discuss historical drainage patterns of upstream runoff through the property.
3. Provide a map of drainage basins.
4. Discuss historical drainage basin characteristics (topography, area, land use, coverage, soil types, locations of critical areas, areas with high potential for erosion and sedimentation, etc.).

C. Floodplain Information
1. Identify all FEMA regulated floodplains which impact the subject site. Locate the same on the drainage plan.
2. Note the lowest floor and other pertinent elevations(s).
3. Floodplain/Floodway calculations where pertinent.

D. Previous Drainage Studies
1. Identify previous drainage studies for the site and provide a copy if required by Carson City.
2. Identify previous drainage studies or previously approved projects which affect the site and provide copies of the studies if required by Carson City.

IV. Proposed Drainage Facilities
A. General Description
1. Discuss criteria and methodology.
2. Discuss the proposed construction erosion and sediment control and stormwater pollution prevention methodology. A Stormwater Pollution Prevention Plan prepared per the requirements of Title 18 Appendix, Division 13, may be submitted in compliance with this requirement.

3. Discuss the proposed permanent on-site water quantity control, water quality control, and drainage system plan and layout.
4. Discuss the proposed off-site drainage system plan and mitigation measures.

B. Compliance with Regulations and Adopted Plans
   1. Discuss compliance with FEMA floodplain regulations and CCMC, and all proposed modifications to or verifications of the FEMA regulated floodplain through the subject site.
   2. Discuss compliance with previously approved drainage studies for the subject site.
   3. Identify all requests for variances from the requirements of the drainage criteria individually.

C. Hydrologic Criteria
   1. Discuss design rainfall computations.
   2. Discuss design runoff computations, including peak flow rate for stormwater quantity control facilities and either peak flow rate or volume for water quality treatment facilities as appropriate.
   3. Discuss peak flow rates from off-site areas and facilities.
   4. Discuss off-site limiting conditions and constraints (see Section 14.1.3 Increase in Rate of Flow).
   5. Provide schematic of pre- and post-development time of concentration paths and calculations.

D. Facility Design Calculations
   1. Discuss design calculations for the on-site drainage system (design storm and 100-year storm flow).
      a. Street and ditch flow calculations
      b. Storm drains, inlets, and ditch flow calculations
      c. Channel and culvert flow calculations
      d. Other hydraulic structure flow calculations (trash rack, grates, etc.)
      e. Detention storage and outlet design calculations and flows
      f. Provide detail of control structure device
      g. Erosion and sediment deposition and mitigation measures during construction
      h. Permanent stabilization description of how the site shall be stabilized after construction is complete
      i. Water quality design calculations
   2. Discuss design calculations for the off-site drainage system that is accepting post-development runoff and impacts from the same.
      a. Street flow calculations
      b. Storm drain, inlets, and ditch flow calculations, including velocities
      c. Channel and culvert flow calculations
      d. Other hydraulic structure flow calculations
      e. Alluvial fan analysis and calculations (when required)
   3. Discuss Floodplain/Floodway calculations as related to FEMA requirements and compliance with CCMC.
   4. Discuss maintenance access, potential maintenance requirements, and maintenance responsibilities.
   5. Discuss easement requirements for the proposed drainage facilities.
   6. Discuss phasing of all drainage facilities.
   7. Energy and hydraulic grade lines.

V. Conclusions
   A. Compliance with Drainage Laws
   B. Compliance with the CCMC
   C. Compliance with FEMA requirements

D. Compliance with Development Standards
E. Effectiveness of proposed drainage facilities to control storm runoff
F. Impact of the proposed development on off-site property and facilities
G. Mitigation of impacts and implementation schedule

VI. Appendices as required by the report.

6.2 Technical Drainage Study Plan

A detailed drainage plan(s) for the subject site shall be submitted with the Technical Drainage Study. The plan(s) shall be on a 24" x 36" drawing at an appropriate scale (a scale of 1" = 20' to 1" = 200' is recommended). The following information shall be shown on this drawing, except that the off-site drainage basin boundaries may be shown at an appropriate legible scale on an exhibit:

1. Property lines and streets (roads) including right-of-way widths within 100 feet of the development.

2. Street names, grades, and widths.

3. Existing contours and proposed elevations sufficient to analyze drainage patterns extending a minimum of 100 feet past property lines of the project limits. If required by Development Engineering, more extensive off-site topography shall be required.

4. Existing drainage facilities and structures, including ditches, storm drains, channels, street flow direction, and culverts. All pertinent information such as material, size, shape, slope, and location shall also be included.

5. Limits of existing floodplains based on flood insurance rate maps (FIRM) and best available information. Provide tie to FEMA datum if all or a portion of the site is within a FEMA regulated floodplain and base flood elevation information when available. Establish base flood elevations if not determined on FIRMs.

6. Proposed on-site drainage basin boundaries. Include off-site drainage basins if the same runoff enters the project.

7. Proposed future on-site and off-site flow directions and paths for design storm and 100-year storm flows at pertinent locations.

8. Proposed street and ditch flow paths and slopes. Trace peak flows leaving the project site to the nearest drainage facility; identify capacity and improvements, if needed.

9. Proposed storm drain locations, type, size, capacities, depth of flow, and slope. Include inlet types, sizes and locations, and manhole locations. Correlate to drainage calculations.

10. Proposed channel alignment with a typical cross-section. Provide street cross-sections showing design storm and 100-year return period, 24-hour duration storm depth of flow.

11. Proposed culvert locations, type, size, and slope.

12. Proposed construction erosion and sediment control measures and BMPs.

13. Proposed detention facilities, type, size, and outlet characteristics.

14. Proposed water quality treatment facilities, type, and size.

15. Miscellaneous proposed drainage facilities (i.e., hydraulic structures, etc.)

16. Easements/right-of-way widths and boundaries (existing and proposed).

17. Ditch and channel sections with lining, if required.

18. Construction details, including control structures and identify construction materials.

19. Legend for all symbols used on drawing.

20. Scale, Bar Scale, North Arrow, Date, Bench Mark based on Carson City's Control Network, Title Block, Professional Engineers Signature, Seal.

21. Energy grade lines (EGL's) and hydraulic grade lines (HGL's) for storm drain and channel storm runoff.

22. Show clear emergency flow paths for 100-year peak storm.

7. Improvement Plans

Where drainage improvements are to be constructed, the improvement plans (on 24" x 36" sheets) and specifications shall be submitted to Development Engineering. Approval of the final improvement plans by Development Engineering shall be obtained prior to issuing construction permits, building permits, or grading permits. Plans for the drainage improvements shall include the following as a minimum:

1. Storm drains, inlets, outlets, and manholes with stationing, elevations, dimensions, type, and horizontal control indicated.

2. Culverts, end sections, and inlet/outlet protection with dimensions, type, elevations, and horizontal control indicated.

3. Channels, ditches, and swales (including side/rear yard swales) with lengths, widths, cross-sections, grades, and erosion control (i.e., rip-rap, concrete, grout) indicated.

4. Checks, channel drops, erosion, and sediment control facilities and measures.

5. Detention facility size, type, grading, low flow channels, outlets, landscaping, fencing, and maintenance access.

6. Water quality facility size, type, landscaping, and maintenance access.

7. Other drainage related structures and facilities (including underdrains and sump pump lines).

8. Maintenance access considerations.

9. Drainage easements and right-of-way with horizontal distance to improvements.

10. Plan and profile sheets showing all improvements.

11. Details for drainage structures, facilities, and improvements, including detention basin outlet control structures.

12. Erosion and sediment control plan. See Division 13, Carson City Development Standards for erosion and sediment control plan requirements.

The information required for the plans shall be in accordance with sound engineering principles, Division 13 of the Title 18 Appendix, this Manual, the Standard Details, and the "Standards Specifications for Public Works Construction." Construction documents shall include geometric, dimensional, structural, foundation, bedding, hydraulic, landscaping, specifications, and other details as needed to construct the drainage improvements. Improvement plans shall be signed and sealed by a professional engineer licensed in Nevada and be in accordance with the approved drainage report/drawings.

8. Storm Drain System

8.1 Introduction

The design storm peak flows generally govern the size of the storm drain system flows, as shown in Table 2. There are conditions, however, when the storm drain system design shall be governed by the 100-year return period, 24-hour duration storm flows. Storm drain systems shall be designed for not less than a 100-year peak storm for the following situations:

Locations where the street flow is collected in a sump with no allowable overflow capacity.

Locations where the desired 100-year return period, 24-hour duration storm flow direction is not reflected by the street flow direction during a 100-year return period, 24-hour duration storm (i.e., flow splits at intersections).

If a storm drain is to be designed to convey 100-year return period, 24-hour duration storm flows, then the inlets to the storm drain shall be designed accordingly.

Table 3 – Design Storm Street Capacity Limitations

Roadway Functional Classification	Maximum Limits of Street Inundation (See Notes)
1) Arterial	**Q10 Storm:** Flow contained in R/W. No curb overtopping. A minimum 48-foot wide dry lane centered shall be maintained and in each direction 24 feet. Runoff in excess of street capacity shall be piped. **Q100 Storm:** Flow contained to not inundate structures. Maximum depth at gutter flow line shall be 1 foot. A minimum 12-foot wide dry lane shall be maintained in each direction or 24 feet centered.
2) Collector	**Q10 Storm:** Flow contained in R/W. No curb overtopping. A minimum 18-foot wipe dry lane centered shall be maintained. Runoff in excess of street capacity shall be piped. **Q100 Storm:** Flow contained to not inundate structures. Maximum depth at gutter flow line shall be 1 foot. A minimum 12-foot wide dry lane shall be maintained centered.
3) Local or Industrial Street	**Q10 Storm:** Flow contained in R/W. No curb overtopping. A minimum 12-foot wide dry lane centered shall be maintained. Runoff in excess of street capacity shall be piped. **Q100 Storm**: Flow contained to not inundate structures. Maximum depth at gutter flow line shall be 1 foot. Street flooded.

Notes:

1. Where no curb exists, encroachment onto adjacent property shall be allowed but must be contained to not inundate structures.
2. Other criteria, such as the Federal Housing Administration regulations, may impose standards more restrictive than cited.

8.2 Design Criteria

8.2.1 Allowable Storm Drain Capacity

The storm drain capacity calculations shall begin at the storm drain outlet and proceed upstream, accounting for all energy losses. The Energy Grade Line (EGL) and Hydraulic Grade Line (HGL) shall be calculated to include all hydraulic losses, including friction, expansion, constriction, bend, and junction losses. The available energy at all junctions and transitions shall be checked to determine whether or not the flow in the storm drain shall be pressurized due to backwater effects even if the design flow is less than the full flow capacity of the storm drain.

If any section of the storm drain is pressurized due to backwater effects, then the storm drain system shall be designed to convey the design storm under surcharged or pressure flow conditions. The storm drain shall be considered surcharged when the depth of flow (HGL) in the storm drain is greater than 80 percent of full flow depth. The maximum level of surcharging for the capacity analysis shall be limited to maintaining the HGL to one foot (1') below the final grade above the storm drain at all locations. Special site conditions that warrant additional surcharging shall require locking type manhole covers or grated covers and shall be reviewed on a case-by-case basis by the City.

8.2.2 Allowable Storm Drain Velocity

The maximum allowable storm drain velocity is dependent on many factors, including the type of pipe, the acceptable wear level during the pipe design life, proposed flow conditions (open channel versus pressure flows), and the type and quality of construction of joints, manholes, and junctions. In consideration of the above factors, the maximum velocity in all storm drains and culverts shall not exceed the erosion resisting capabilities of the conduit and storm drain system. However, in no case shall the maximum velocity exceed 15 feet per second (fps).

All storm drains, culverts, and low flow outlets shall be designed to maintain a minimum velocity of three (3) fps at half or full conduit conditions, but in no case shall the storm drain slope be less than 0.25 percent.

8.2.3 Manning's Roughness Coefficient

All storm drain system hydraulic calculations shall be performed using Manning's Formula. A Manning's roughness factor, or "n," shall be as defined by the specific pipe manufacturer provided that the coefficient is within the range of accepted engineering standards.

8.2.4 Pipe Size

The minimum pipe size of storm inlet laterals and storm drain mains shall be 15 inches in diameter for round pipe or an equivalent flow area for other pipe shapes. Systems in all parking lots shall conform to the minimum standards.

8.2.5 Minimum and Maximum Cover

The required cover over a storm drainpipe is dependent on many factors, including the design pipe strength, pipe size, and cover material. For practical purposes, the storm drain shall be protected from potential surface disturbances and displacements. The minimum and maximum cover are dependent upon the design pipe strength.

8.2.6 Manhole and Junction Spacing

A manhole, catch basin, or junction box shall be located at all changes in pipe size, direction, elevation, and grade for all pipes with a diameter (or rise dimension) of less than 36 inches, and at the end of all public storm drain lines (unless the storm drain daylights at the end of the line). Maximum spacing between manholes or junction boxes shall be 350 feet. For pipes with a diameter (or rise dimension) of 36 inches and greater, the designer shall consult with Development Engineering for the location of manholes and junctions based on hydraulic and maintenance considerations.

8.2.7 Horizontal Alignment

The horizontal alignment of storm drains shall generally be straight between manholes and/or junctions. All storm drains shall be placed within the right-of-way dedicated for public streets unless Development Engineering approves the use of easements.

When storm drains are to be installed in existing streets, factors such as curbs, gutters, drainage ditches, sidewalks, traffic conditions, pavement conditions, future street improvement plans, and existing utilities shall be considered by the design engineer when selecting the storm drain location and alignment.

8.2.8 Utility Clearances

Storm drains and culverts shall be located to minimize potential contamination and disturbance of water supply and sanitary sewer mains. The local utility companies, or the Nevada Division of Health, may impose additional requirements. Where requirements differ, the more stringent shall apply.

8.2.9 Storm Inlet and Catch Basin Types, Locations, and Capacity Factors

Standard storm inlet and catch basin details are included in the Standard Details. The allowable use of these storm inlet and catch basin types is presented in Table 4. Allowable inlet capacity factors for each of the standard inlets and catch basins are also presented in Table 4. These capacity factors shall be applied to the theoretical capacity of the inlets and catch basins to account for conditions that decrease the capacity of the standard inlets. These conditions include plugging from debris and sediment, pavement overlaying, variations in design assumptions, and the general deterioration of the inlet and catch basin conditions over time. All catch basins may have sumps (12 inches minimum, 24 inches maximum) as determined by Development Engineering.

Catch basins or inlets shall be installed at low points of vertical curves, at all street intersections, and at sufficient intervals to intake the design storm peak flow such that flows shall not interfere with traffic or flood adjoining property in accordance with the requirements of Table 3. Catch basins and inlets at street intersections shall be located on the upstream side of the intersection and upstream of crosswalk locations.

When storm drainpipes are connected to a catch basin, inlet, or manhole with concrete/grout, both the inside and outside of the catch basin, manhole, or inlet shall be grouted at the pipe connection.

8.3 Materials

8.3.1 Pipe Material and Shape

The material and shape of the storm drain shall be in accordance with the “Standard Specifications for Public Works Construction”. Round, square, or rectangular reinforced concrete pipe (RCP) in accordance with ASTM C-789 or C-850 is preferred for use under roadways, driveways, and other traffic areas. Reinforced concrete pipe shall be at a minimum Class III, or the appropriate class when the design requires a greater pipe support strength. Other pipe materials, as approved by the City for storm drain use, except for corrugated metal (permitted for residential driveway culverts), are permitted.

8.3.2 Manholes

Precast manhole tees are not allowed where there is a change in storm drain slope or alignment or where there are intersecting storm drain mains or laterals. Pipes may be directly cast into the manhole base. Gasketed joints, locking type manhole covers, and/or grated manhole covers for pressure flow conditions may be required.

8.3.3 Storm Drain Outlet Protection

Storm drain outlets shall be designed to prevent the receiving channel from scour erosion or sediment deposition and shall be constructed with outlet protection for discharges to channels with unlined bottoms in accordance with the following:

Outlet Velocity (fps)	Minimum Outlet Protection
Less than 5	Rip-rap Protection
Between 5 and 15	Rip-rap Protection or Energy Dissipater
Greater than 15	Energy Dissipater

For channels with unlined bottoms, the outlet discharge velocity shall not exceed the maximum allowable channel velocity without an energy dissipation structure. Specifications for the outlet protection shall be submitted with the improvement plans.

8.4 Storm Drain Hydraulic Analysis

A hydraulic analysis of all storm drains shall be performed and submitted to Development Engineering as part of the Technical Drainage Report. Storm drain hydraulic and capacity analysis shall account for changes in flow conditions (open channel versus pressure flow) in the HGL and EGL calculations. Both the HGL and EGL for the design flow shall be included on storm drain improvement plans as part of the drainage report.

Table 4 – Allowable Storm Inlet Types and Capacity Factors

Inlet or Catch Basin Type	Permitted Use	Permitted Location Condition	Capacity Factor
Catch Basin Type - 1	Private Use Only	Sump	0.65
Catch Basin Type 1A	Street with Curb and Gutter	Continuous Grade **or** Sump	0.70 (Grate), 0.80 (Curb Opening) 0.65
Catch Basin Type 3	Landscaped or Unimproved Areas	Sump	0.50
Catch Basin Type 4	Street with Curb and Gutter	Continuous Grade **or** Sump	0.70 (Grate), 0.80 (Curb Opening) 0.65
Notes: 1. Capacity factor is applied to the theoretical inlet capacity to obtain the allowable inlet capacity to account for factors that reduce actual inlet capacity.			

8.5 Design Standards for Culverts

Culverts shall be designed and constructed using the following standards. The analysis and design shall consider design flow, culvert size and material, entrance structure layout, outlet structure layout, and erosion protection.

8.5.1 Culvert Sizing Criteria

8.5.1.1 Design Frequency

As indicated in Section 2.1.4 (Culverts), all culverts shall be designed to pass the flow from the design storm, including an overflow section where permitted.

8.5.1.2 Minimum Size

The minimum culvert size shall be 18 inches diameter for round pipe or an equivalent flow area for other pipe shapes.

8.5.2 Culvert Materials

Culverts shall be RCP in accordance with the Standard Details under roadways and other traffic areas. For rural residential driveways, CMP is allowed. The use of dip sections rather than culverts is encouraged for rural residential driveway crossings.

8.5.3 Outlet Protection

Outlet Velocity (fps)	Minimum Outlet Protection
Less than 5	Rip-rap Protection
Between 5 and 15	Rip-rap Protection or Energy Dissipater
Greater than 15	Energy Dissipater

Specifications for the outlet protection shall be submitted with the improvement plans.

8.5.4 Headwater Criteria

The maximum headwater for the design storm for culverts greater than 36 inches diameter or a culvert rise of 36 inches shall be 1.5 times the culvert height. The maximum headwater for culverts with a height of 36 inches or less shall be five feet (5') if adjacent properties are not adversely affected.

8.5.5 Alignment

Whenever possible, culverts shall be aligned with the natural channel to reduce inlet and outlet transition problems.

8.5.6 Temporary Crossing

Temporary crossings are defined as dip road sections with a culvert sized to pass nuisance flows or a culvert system that does not meet the criteria presented in this manual. Temporary crossings shall be reviewed on a case-by-case basis. Consideration shall be given to the following items:

1. Drainage area contributing to the crossing.
2. Level of roadway traffic.
3. Vertical and horizontal roadway alignment (sight distance).
4. Alternate access routes.
5. Time frame for temporary crossing (time to construction of permanent crossing).
6. Current and projected development density.
7. 25-year and 100-year storm flows.

8.5.7 Multiple Barrel Culverts

Multiple culverts may be used if available fill height limits the size of the culvert needed to convey the flood flow and the amount of debris is limited.

8.5.8 Inlet and Outlet Configurations

Culverts shall be designed with protection at the inlet and outlet areas. The culvert inlet shall include a headwall with wingwalls or a flared end-section.

The outlet area shall also include a headwall with wingwalls or a flared end-section. Where outlet velocities exceed the limitation set forth in Section 3.5.3 (Outlet Protection), an energy dissipater shall be required.

8.5.9 Structural Design

All culverts shall be designed to withstand, as a minimum, an H-20 loading in accordance with the design procedures of AASHTO "Standard Specifications for Highway Bridges" and with the pipe manufacturer's recommendations.

8.6 Drainage Channels

When open drainage channels are permitted, the potential for erosion and scour shall be determined and submitted as part of the drainage report. Recommended mitigation measures to prevent erosion and sediment deposition shall be identified and incorporated into the design of the drainage channels. Flow velocities in drainage shall not exceed the maximum permissible flow velocities for the design storm as recommended in the American Society of Civil Engineers (ASCE) Manuals and Reports of Engineering Practice No. 77, "Design and Construction of Urban Stormwater Management Systems."

Side slopes of unlined channels shall be 3:1 (horizontal to vertical) or flatter. Side slopes for lined channels shall be 2:1 (horizontal to vertical) or flatter. The use of rip rap as a channel lining is discouraged due to maintenance requirements.

All drainage channels that are not located within public rights-of-way shall be located in easements or lands dedicated to the City or the appropriate entity, and shall be provided with a permanent maintenance access road in accordance with Development Standard Division 12.11.14 (Improved Maintenance Access) to provide access for maintenance.

9. Stormwater Runoff Reduction BMPs

9.1 Introduction

The principal of runoff reduction starts by recognizing that developing or redeveloping land within a watershed inherently increases the imperviousness of the areas and, therefore, the volume and rate of runoff and the associated pollutant load.

Best management practices (BMPs) for reducing runoff include passive systems such as minimization of directly connected impervious areas and low impact development techniques and structural controls such as detention or infiltration facilities.

The main purpose of detention BMPs is to temporarily store runoff and reduce peak discharge by allowing flow to be discharged at a controlled rate. This controlled discharge rate shall be determined so that post-development runoff shall not exceed pre-development runoff leaving the site and that the appropriate LID feature is being used. The controlled release of storm drainage minimizes impact on downstream properties and also minimizes the potential for downstream erosion that may occur as a result of increased flow velocity. There are three (3) primary types of detention facilities: detention ponds, tanks, and vaults.

9.2 Minimize Directly Connected Impervious Areas (DCIA)

Impervious areas directly connected to the storm drain system are the greatest contributor to non-point source pollution. The first effort in site planning and design for stormwater quality protection is to minimize the directly connected impervious area (DCIA) as shown in Table 5.

Any impervious surface that drains into a catch basin, area drain, or other conveyance structure is a DCIA. As stormwater runoff flows across parking lots, roadways, and paved areas, the oils, sediments, metals, and other pollutants are collected and concentrated. If this runoff is collected by a drainage system and carried directly along impervious gutters or in closed underground pipes, it has no opportunity for filtering by plant material or infiltration into the soil. It also increases in speed and volume, which may cause higher peak flows downstream and may require a larger capacity storm drain system, increasing flood and erosion potential.

Minimizing directly connected impervious areas can be achieved in two (2) ways:

1. Limiting overall impervious land coverage.
2. Directing runoff from impervious areas to pervious areas for infiltration, retention/detention, or filtration.

9.3 Low-Impact Development Techniques

The low-impact development (LID) approach combines a hydrologically functional site design with pollution prevention measures to compensate for land development impacts on hydrology and water quality. The primary goal of LID methods is to mimic the predevelopment site hydrology by using site design techniques that store, infiltrate, evaporate, and detain runoff. The use of these techniques helps to reduce off-site runoff and ensure adequate groundwater recharge. Since every aspect of site development affects the hydrologic response of the site, LID control techniques focus mainly on-site hydrology. Specific LID controls can reduce runoff by integrating stormwater control throughout the site in many small, discrete units. LID controls are distributed in a small portion of each lot, near the source of impact, and may eliminate the need for a centralized BMP facility such as a stormwater management pond.

The Regional Water Planning Commission for the Truckee Meadows has developed the Truckee Meadows Structural Controls Design and Low Impact Development Manual, which may be used as a reference. Information on LID control techniques can also be found in the publication “Low-Impact Development Design Strategies, An Integrated Design Approach, 2,000”, Prince George’s County, Maryland, Department of Environmental Resources, Programs and Planning Division and at the Low Impact Development Center website http://www.lowimpactdevelopment.org.

LID control techniques include the following broad categories of stormwater control:

1. Zero Discharge Areas
2. Self-Treatment Areas
3. Runoff Reduction Areas

Site planning strategies and techniques provide the means to achieve stormwater management goals and objectives; facilitate the development of site plans that are adapted to natural topographic constraints; maintain lot yield; maintain site hydrologic functions; and provide for aesthetically pleasing, and perhaps, less expensive stormwater management controls.

Table 5 presents a list of site design and landscaping techniques and indicates whether they are applicable for use in Zero Discharge Areas, Self-Treating Areas, and Runoff Reduction Areas. Several techniques may be implemented within the same design philosophy. Some techniques may be used to implement more than one design philosophy. Where feasible, combinations of multiple techniques may be incorporated into new development and redevelopment projects to minimize the amount of treatment required.

Engineering Handbook, Section 4 (SCS, 1985). The antecedent moisture condition of the watershed is explained as follows:

> The amount of rainfall in a period of 5 to 30 days preceding a particular storm is referred to as antecedent rainfall, and the resulting condition of the watershed in regard to potential runoff is referred to as an antecedent moisture condition. In general, the heavier the antecedent rainfall, the greater the direct runoff that occurs from a given storm. The effects of infiltration and evapotranspiration during the antecedent period are also important, as they may increase or lessen the effect of antecedent rainfall. Because of the difficulties of determining antecedent storm conditions from data normally available, the conditions are reduced to three cases, AMC-I, AMC-II and AMC-III.

For the Washoe County area, an AMC-II condition shall be used for determining storm runoff.

Having determined the soil group, land use and treatment class and the antecedent moisture condition, CN values can be determined from Table 702.

There will be areas to which the values in Table 702 do not apply. The percentage of impervious area for the various types of residential areas or the land use condition for the pervious portions may vary from the conditions assumed in Table 702. A curve for each pervious CN can be developed to determine the composite CN for any density of impervious area. Figure 702 has been developed assuming a CN of 98 for the impervious area. The curves in Figure 702 can help in estimating the increase in runoff as more land within a given area is covered with impervious material.

There are a number of methods available for computing the percentage of impervious area in a watershed. Some methods include using U.S. Geological Survey topographic maps, land use maps, aerial photographs, and field reconnaissance. Care must be exercised when using methods based on such parameters as population density, street density, and age of the development as a means of determining the percentage of impervious area. The available data on runoff from urban areas are not yet sufficient to validate widespread use of these methods. Therefore, the CN to be used in the Washoe County area shall be based on Table 702 or Figure 702 in this Manual. A CN computation example is included in Section 711.

704 RATIONAL FORMULA METHOD

For drainage basins that are not complex and have small drainage areas, the design storm runoff may be analyzed using the Rational Formula Method in accordance with Section 304.3. This method was introduced in 1889 and is still being used in many engineering offices in the United States. Even though this method has frequently come under academic criticism for its simplicity, no other practical drainage design method has evolved to such a level of general acceptance by practicing engineers. The Rational Formula Method, when properly understood and applied, can produce satisfactory results for determining peak discharge.

704.1 METHODOLOGY

The Rational Formula Method is based on the formula:

$$Q = CIA \qquad (708)$$

Q is defined as the maximum rate of runoff in cubic feet per second (actually, Q has units of acre inches per hour, which is approximately equal to the units of cubic feet per second). C is a runoff coefficient and represents the runoff-producing conditions of the subject land area (see Section 704.5).

I is the average intensity of rainfall in inches per hour for a duration equal to the time of concentration.
A is the contributing basin area in acres.

704.2 ASSUMPTIONS

The basic assumptions made when applying the Rational Formula Method are as follows:

1. The computed maximum rate of runoff to the design point is a function of the average rainfall rate during the time of concentration to that point.
2. The maximum rate of rainfall occurs during the time of concentration, and the design rainfall depth during the time of concentration is converted to the average rainfall intensity for the time of concentration.
3. The maximum runoff rate occurs when the entire area is contributing flow. However, this assumption has been modified from time to time when local rainfall/runoff data was used to improve calculated results.

704.3 LIMITATIONS ON METHODOLOGY

The Rational Formula Method adequately approximates the peak rate of runoff from a rainstorm in a given basin. The critics of the method usually are unsatisfied with the fact that the answers are only approximations. A shortcoming of the Rational Formula Method is that only one point on the runoff hydrograph is computed (the peak runoff rate).

Another disadvantage of the Rational Formula Method is that with typical design procedures one normally assumes that all of the design flow is collected at the design point and that there is no "carry over water" running overland to the next design point. However, this is not the fault of the Rational Formula Method, but of the design procedure. The problem becomes one of routing the surface and subsurface hydrographs which have been separated by the storm sewer system. In general, this sophistication is not warranted and a conservative assumption is made wherein the entire routing occurs through the storm sewer system when this system is present.

704.4 RAINFALL INTENSITY

The rainfall intensity, I, is the average rainfall rate in inches per hour for the period of maximum rainfall of a given frequency having a duration equal to the time of concentration. After the design storm frequency has been selected, a graph should be prepared showing rainfall intensity versus time. Information on local rainfall data is presented in Section 600 of this Manual.

704.5 RUNOFF COEFFICIENT

The runoff coefficient, C, represents the integrated effects of infiltration, evaporation, retention, flow routing, and interception, all which affect the time distribution and peak rate of runoff. Determination of the coefficient requires judgment and understanding on the part of the engineer. Table 701 presents the recommended values of C for the various recurrence frequency storms. The values are presented for different surface characteristics as well as for different aggregate land uses. Variations to these values are subject to the approval of the Jurisdictional Entity.

A composite runoff coefficient is computed on the basis of the percentage of different types of surfaces in the drainage area. For homogeneous developed areas, this procedure is often applied to a typical "sample" area as a guide to selection of reasonable values of the coefficient for an entire area. Suggested coefficients with respect to surface type are also given in Table 701 under the column

labeled "Percent Impervious". Where land use features are mixed, a composite C analysis will result in more accurate results. The runoff coefficients in Table 701 also vary with recurrence frequency.

704.6 APPLICATION OF THE RATIONAL FORMULA METHOD

The first step in applying the Rational Formula Method is to obtain a topographic map and define the boundaries of all the relevant drainage basins. Basins to be defined include all basins tributary to the area of study and sub-basins within the study area. A field check and possibly field surveys should be made for each basin. At this stage of planning, the possibility for the diversion of transbasin waters should be identified.

The major storm drainage basin does not always coincide with the minor storm drainage basin. This is often the case in urban areas where a low flow will stay next to a curb and follow the lowest grade, but when a large flow occurs the water will be deep enough so that part of the water will overflow street crowns and flow into a new sub-basin. An example of how to apply the Rational Formula Method is presented in Section 711.

704.7 MAJOR STORM ANALYSIS

When analyzing the major runoff occurring within an area that has a storm sewer system sized for the minor storm, care must be used when applying the Rational Formula Method. Normal application of the Rational Method assumes that all of the runoff is collected by the storm sewer. For the minor storm design, the time of concentration is dependent upon the flow time in the sewer. However, during the major storm runoff, the sewers will probably be at capacity and would not carry the additional water flowing to the inlets. This additional water then flows overland past the inlets, generally at a lower velocity than the flow in the storm sewers.

If a separate time of concentration analysis is made for the pipe flow and surface flow, a time lag between the surface flow peak and the pipe flow peak will occur. This lag, in effect, will allow the pipe to carry a larger portion of the major storm runoff than would be predicted using the minor storm time of concentration. The basis for this increased benefit is that the excess water from one inlet will flow to the next inlet downhill, using the overland route. If that inlet is also at capacity, the water will often continue on until capacity is available in the storm sewer. The analysis of this aspect of the interaction between the storm sewer system and the major storm runoff is complex. The simplified approach of using the minor storm time of concentration for all frequency analysis is acceptable for use in Washoe County.

705 SCS UNIT HYDROGRAPH METHOD

The SCS Unit Hydrograph method was developed for the SCS by Mr. Victor Mockus. The SCS Unit Hydrograph was derived from a large number of natural unit hydrographs from watersheds varying widely in size and geographic location. The SCS Unit Hydrograph has been in use for many years and has produced satisfactory results for many applications. This method may be used for drainage areas within the Washoe County area in accordance with Section 304.3.

705.1 METHODOLOGY

The SCS Unit Hydrograph method uses the unit hydrograph theory as a basis for runoff computations. The unit hydrograph theory computes rainfall excess hydrographs for a unit amount of rainfall excess applied uniformly over a sub-basin for a given unit of time (or unit duration). The rainfall excess hydrographs are then transformed to a sub-basin hydrograph by superimposing each excess hydrograph lagged by the unit duration.

The shape of the SCS Unit Hydrograph is based on studies of various natural unit hydrographs. The basic governing parameters of this curvilinear hydrograph are as follows:

1. The time-to-peak, T_p, of the unit hydrograph approximately equals 0.2 times the time-of-base, T_b.
2. The point of inflection of the falling leg of the unit hydrograph approximately equals 1.7 times T_p.

For ease of calculation, an equivalent triangular unit hydrograph was derived from the natural curvilinear unit hydrograph. From the triangular unit hydrograph, equations for the peak discharge, Q_p, time-to-peak, T_p, and the time of concentration, t_c were developed based on a single lag factor (TLAG). The discharge hydrograph is then determined for the SCS Unit Hydrograph method based on the storm excess precipitation applied to the unit hydrograph whose parameters are determined by TLAG. TLAG is defined and discussed in Section 705.3.

705.2 ASSUMPTIONS

The basic assumptions made when applying the SCS Unit Hydrograph method (and all other unit hydrograph methods) are as follows:

1. The effects of all physical characteristics of a given drainage basin are reflected in the shape of the storm runoff hydrograph for that basin.
2. At a given point on a stream, discharge ordinates of different unit graphs of the same unit time of rainfall excess are mutually proportional to respective volumes.
3. A hydrograph of storm discharge that would result from a series of bursts of excess rain or from continuous excess rain of variable intensity may be constructed from a series of overlapping unit graphs each resulting from a single increment of excess rain of unit duration.

705.3 LAG TIME

Input data for the Soil Conservation Service dimensionless unit hydrograph method (SCS, 1985) consists of a single parameter, TLAG, which is equal to the lag (in hours) between the center of mass of rainfall excess and the peak of the unit hydrograph. For small drainage basins (less than one square mile) and basin slopes less than ten percent the lag time may be related to the time of concentration, t_c, by the following empirical relationship:

$$TLAG = 0.6\ t_c \qquad (709)$$

The t_c is computed as presented in Section 702.

For larger drainage basins (greater than one square mile) and basins with a basin slope equal to or greater than ten percent, the lag time (and t_c) is generally governed mostly by the concentrated flow travel time, not the initial overland flow time. In addition, as the basin gets increasingly larger, the average flow velocity (and associated travel time) becomes more difficult to estimate. Therefore, for these basins, the following lag equation is recommended for use in computing TLAG:

$$TLAG = 22.1\ K_n\ (L\ L_c/S^{0.5})^{0.33} \qquad (710)$$

where K_n = Roughness factor for the basin channels
L = Length of longest watercourse (miles)

RATIONAL FORMULA METHOD
RUNOFF COEFFICIENTS

Land Use or Surface Characteristics	Aver. % Impervious Area	Runoff Coefficients 5-Year (C_5)	Runoff Coefficients 100-Year (C_{100})
Business/Commercial:			
Downtown Areas	85	.82	.85
Neighborhood Areas	70	.65	.80
Residential:			
(Average Lot Size)			
⅛ Acre or Less (Multi-Unit)	65	.60	.78
¼ Acre	38	.50	.65
⅛ Acre	30	.45	.60
½ Acre	25	.40	.55
1 Acre	20	.35	.50
Industrial:	72	.68	.82
Open Space:			
(Lawns, Parks, Golf Courses)	5	.05	.30
Undeveloped Areas:			
Range	0	.20	.50
Forest	0	.05	.30
Streets/Roads:			
Paved	100	.88	.93
Gravel	20	.25	.50
Drives/Walks:	95	.87	.90
Roof:	90	.85	.87

Notes:

1. Composite runoff coefficients shown for Residential, Industrial, and Business/Commercial Areas assume irrigated grass landscaping for all pervious areas. For development with landscaping other than irrigated grass, the designer must develop project specific composite runoff coefficients from the surface characteristics presented in this table.

Where, the capital "D" refers to the filter grain size and the lower case "d" to the base grain size. The subscripts refer to the percent by weight which is finer than the grain size denoted by either "D" or "d". For example, 15 percent of the filter material is finer than $D_{15\ (filter)}$ and 85 percent of the base material is finer than $d_{85\ (base)}$.

When the T-V method is used, the thickness of the resulting layer of granular bedding may be reduced to six inches. However, if a gradation analysis of the existing soils shows that more than 50 percent of the soil is smaller than the No. 40 sieve size (> 50 percent passing No. 40 sieve by weight), then a two-layer granular bedding shall be used. The design of the bedding layer closest to the existing soils shall be based on the existing soil gradation. The design of the upper bedding layer shall be based on the gradation of the lower bedding layer. The thickness of each of the two layers shall be at least 4 inches.

805.5.4.2 Filter Fabrics

Filter fabric shall be designed in accordance with manufacturer's specifications. Filter fabric is not a complete substitute for granular bedding. Filter fabric provides filtering action only perpendicular to the fabric and has only a single equivalent pore opening between the channel bed and the riprap. Filter fabric has a relatively smooth surface which provides less resistance to stone movement. As a result, it is recommended that the use of filter fabric in place of granular bedding be restricted to slopes no steeper than 2.5 H:1V. A 6-inch layer of fine aggregate (Standard Specifications for Public Works Construction 200.01.03) may be placed on top of the filter fabric to act as a cushion when placing the riprap.

Tears in the fabric greatly reduce its effectiveness so that direct dumping of riprap on the filter fabric is not allowed and due care must be exercised during construction. Nonetheless, filter fabric has proven to be an adequate replacement for granular bedding in many instances. Filter fabric provides adequate bedding for channel linings along uniform mild sloping channels where leaching forces are primarily perpendicular to the fabric.

At drop structures and sloped channel drops, where seepage forces may run parallel with the fabric and cause piping along the bottom surface of the fabric, special care is required in the use of filter fabric. Seepage parallel with the fabric may be reduced by folding the edge of the fabric vertically downward about 2 feet (similar to a cutoff wall) at 12 foot intervals along the installation, particularly at the entrance and exit of the channel reach. Filter fabric has to be lapped a minimum of 12 inches at roll edges with upstream fabric being placed on top of downstream fabric at the lap.

Fine silt and clay have been found to clog the openings in filter fabric. This prevents free drainage which increases failure potential due to uplift. For this reason, a granular bedding is often more appropriate for fine silt and clay channel beds.

805.5.5 ROCK SIZING

Riprap lining requirements for a stable channel lining are based on the following relationship which resulted from model studies by Smith and Murray (Smith, 1965) and application to design criteria (Stevens, 1981):

$$V = 3(d_{50})^{0.5} S_S - 1) / S^{0.17} \qquad (842)$$

where,

V = Mean channel velocity, in ft/sec (10 ft/sec maximum for riprap-lined channel)
S = Longitudinal channel slope, in ft/ft

S_s = Specific gravity of rock (Minimum S_s = 2.50)
d_{50} = Rock size, in ft, for which 50 percent of the riprap by weight is finer.

Equation (842) was developed using laboratory data. Other procedures for design of riprap have been developed by a number of agencies, such as Federal Highway Administration (Searcy, 1967; Normann, 1975), USACE (1970), USBR (Peterka, 1958), California Department of Transportation (1970), American Society of Civil Engineers (Vanoni, 1975), (Simons and Sentruk, 1992). Blodgett (1986) evaluated these procedures and presented a tentative design relationship based on field data:

$$D_{50} = 0.010V^{2.44} \quad (843)$$

Where,
V = Mean Channel Velocity, in ft/sec
d_{50} = Rock size, in ft, for which 50 percent of the riprap by weight is finer.

Equation (843) is helpful for estimating the size of riprap needed and generally yields sizes larger than those determined by using Equation (842). However, use of a design method based on tractive stress considering bank slope is preferred for final design.

The basic premise underlying riprap design method based on tractive force is that the flow-induced tractive force should not exceed the permissible or critical shear stress of the riprap. Assuming a specific gravity of 2.50, the following equation can be used to determine d_{50} of the riprap by the tractive stress method:

$$d_{50} = 14.2F_S Y_{mas} \frac{S_e}{K_1} \quad (844)$$

Where,
F_s = Stability factor:
= 1.0 - 1.2, for straight or mildly curving reach
= 1.2 - 1.4, for moderate bend curvature with minor impact from floating debris
= 1.4 - 1.6, for sharp bend with significant impact from floating debris and waves
= 1.6 - 2.0, for rapidly varying flow with significant uncertainty in design
Y_{max} = maximum channel depth, in ft
Se = average energy slope, in ft/ft
K_1 = bank angle modification factor
$= [1 - (\text{Sin}^2 \Phi / \text{S in}^2 \theta)]^{0.5}$
Φ = bank angle with horizontal
θ = riprap material angle of repose (see Figure 818A)

805.5.6 LINING DIMENSIONS

Rock lined side slopes steeper than 2H:1V are considered unacceptable because of stability, safety, and maintenance considerations. Proper bedding is required both along the side slopes and the channel bottom for a stable lining. The riprap blanket thickness should adhere to the following rules:

1. The thickness should be at least two times d_{50}.
2. The thickness should not be less than the diameter of the upper limit d_{100} stone.
3. The thickness determined by either (1) or (2) above should be increased by 50 percent in all sections when the riprap is placed under water in water deeper than 3 feet to provide for uncertainties associated with this type of placement.

$$F_b = 1.0 + 0.025V(d)^{1/3} \quad (856)$$

where,

F_b = Freeboard height (ft);
V = Velocity (ft/sec);
d = Depth of flow (ft).

Freeboard shall be in addition to superelevation, standing waves, and/or other water surface disturbances.

The channel lining side slopes shall be extended, as a minimum, to the freeboard elevation.

806.2.5 SLUG FLOW

Slug flow is a series of shallow-water shock waves which occur in steep supercritical channels. The resulting wave heights may easily overtop channel linings using the typical freeboard requirements presented in this Manual or damage the channel lining. Therefore, all channels in the Washoe County area shall be designed to avoid the occurrence of slug flow. To avoid slug flow when the Froude number is greater than 2.0, the channel slope shall be as follows:

$$S \le (12/R_e) \quad (857)$$

where,

S = Channel slope (ft/ft) (858)
R_e = VR/ν = Reynolds Number
V = Mean design velocity (ft/sec)
R = Hydraulic radius (ft)
ν = Kinematic viscosity of water (ft^2/sec).

Theoretically, slug flow will not occur with Fr < 2.0.

807 CHANNEL APPURTENANCES

Presented in this section are the design standards for appurtenances to improved channels. All channels in the Washoe County area shall be designed to include these appurtenances.

807.1 MAINTENANCE ACCESS ROAD

A maintenance access road shall be provided along the entire length of all improved channels with a minimum passage width of 12 feet. For channels less than 30 feet in top width, one maintenance access shall be provided as part of the channel improvements. For channels greater than 30 feet in top width, the maintenance road shall be located at the bottom of the channel or on both sides at the channel top. Deviations from this are subject to approval by the appropriate jurisdictional entity.

807.2 SAFETY REQUIREMENTS

The following safety requirements are required for concrete-lined channels. Similar safety requirements may be required for all other channels:

a. Unless otherwise approved by the Jurisdictional Entity, a six-foot high galvanized coated chain link or comparable fence shall be installed to prevent unauthorized access. The fence shall be

located at the edge of the ROW or on the top of the channel lining. Gates, with top latch, shall be placed at major access points or 1,320 foot intervals, whichever is less.

b. Ladder-type steps shall be installed not more than 1,200 feet apart and shall be staggered on alternating sides of the channel to provide a ladder every 600 feet. The bottom rung shall be placed approximately 12 inches vertically above the channel invert.

807.3 CULVERT OUTLET PROTECTION

If the flow velocity at a culvert or storm sewer outlet exceeds the maximum permissible velocity for the local soil or channel lining, channel protection is required. This protection usually consists of an erosion resistant reach, such as riprap, to provide a stable reach at the outlet in which the exit velocity is reduced to a velocity allowable in the downstream channel.

807.3.1 BASIN CONFIGURATION

The length of the outlet protection (L_a) is determined using the following empirical relationships that were developed for the U.S Environmental Protection Agency (1976):

$$L_a = \left(1.8Q/D_o^{3/2}\right) + 7D_{05} \text{ for } TW < D_o/2 \quad (859)$$

and

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(860)

where,

D_o = Maximum inside culvert width (ft) or diameter;
Q = Pipe discharge (cfs);
TW = Tailwater depth (ft).

Where there is no well defined channel downstream of the apron, the width, W, of the outlet and of the apron (as shown in Figure 829) should be as follows:

$$W = 3D_o + 0.4L_a \text{ for } TW \geq D_o/2 \quad (861)$$

and

$$W = 3D_o + L_a \text{ for } TW < D_o/2 \quad (862)$$

The width of the apron at the culvert outlet should be at least 3 times the culvert width.

Where there is a well-defined channel downstream of the apron, the bottom width of the apron should be at least equal to the bottom width of the channel and the lining should extend at least one foot above the tailwater elevation and at least two-thirds of the vertical conduit dimension above the invert.

The side slopes should be 2:1 or flatter, and the bottom grade should be level.

807.3.2 ROCK SIZE

The median stone diameter, d_{50} is determined from the following equation (ASCE, 1975):

APPENDIX B

EXISTING HYDROLOGIC ANALYSIS

Project Description

File Name ..... BLACKSTONE PH2-A & B EXIST 10YR.SPF
Description .....
BLACKSTONE RANCH PH2

MASTER TECHNICAL DRAINAGE ANALYSIS

EXISTING CONDITIONS

10-YEAR PEAK FLOW EVENT

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... Rational
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Kinematic Wave
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins.....	1
Nodes.....	1
Junctions	0
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	0
Links.....	0
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period..... 10 year(s)

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	X-01	24.54	0.2000	0.45	0.09	2.21	5.59	0 00:23:45

Project Description

File Name	BLACKSTONE PH2-A & B EXIST 100YR.SPF
Description	
	BLACKSTONE RANCH PH2
	MASTER TECHNICAL DRAINAGE ANALYSIS
	100-YEAR PEAK FLOW EVENT

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	1
Nodes	1
Junctions	0
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	0
Links	0
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	100 year(s)

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	X-01	24.54	0.5000	0.89	0.44	10.87	27.34	0 00:23:45

APPENDIX C

PROPOSED HYDROLOGIC ANALYSIS

Project Description

File Name ..... BLACKSTONE PH2-A & B PROP 2YR.SPF
Description .....
BLACKSTONE RANCH PHASES 2-A AND 2-B
MASTER TECHNICAL DRAINAGE ANALYSIS
2-YEAR PROPOSED PEAK FLOW EVENT FOR
LOW IMPACT DEVELOPMENT DESIGN

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... Rational
Time of Concentration (TOC) Method ..... User-Defined
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins.....	49
Nodes.....	85
Junctions	36
Outfalls	9
Flow Diversions	0
Inlets	39
Storage Nodes	1
Links.....	97
Channels	22
Pipes	74
Pumps	0
Orifices	0
Weirs	1
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period..... 2 year(s)

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	2A-01	0.43	0.6000	0.18	0.11	0.05	0.28	0 00:10:00
2	2A-02	0.17	0.6000	0.18	0.11	0.02	0.11	0 00:10:00
3	2A-03	0.81	0.6000	0.18	0.11	0.09	0.53	0 00:10:00
4	2A-04	1.84	0.6000	0.18	0.11	0.20	1.19	0 00:10:00
5	2A-05	0.43	0.6000	0.18	0.11	0.05	0.28	0 00:10:00
6	2A-06	0.79	0.6000	0.18	0.11	0.09	0.51	0 00:10:00
7	2A-07	0.83	0.6000	0.18	0.11	0.09	0.54	0 00:10:00
8	2A-08	0.47	0.6000	0.18	0.11	0.05	0.31	0 00:10:00
9	2A-09	0.69	0.6000	0.18	0.11	0.07	0.45	0 00:10:00
10	2A-10	0.58	0.6000	0.18	0.11	0.06	0.38	0 00:10:00
11	2A-11	0.93	0.6000	0.18	0.11	0.10	0.60	0 00:10:00
12	2A-12	0.77	0.6000	0.18	0.11	0.08	0.50	0 00:10:00
13	2A-13	1.65	0.6000	0.18	0.11	0.18	1.07	0 00:10:00
14	2A-14	0.95	0.6000	0.18	0.11	0.10	0.62	0 00:10:00
15	2A-15	2.44	0.6000	0.18	0.11	0.26	1.58	0 00:10:00
16	2A-16	0.54	0.6000	0.18	0.11	0.06	0.35	0 00:10:00
17	2A-OFF-01	0.66	0.6000	0.18	0.11	0.07	0.43	0 00:10:00
18	2A-OFF-02	1.09	0.6000	0.18	0.11	0.12	0.71	0 00:10:00
19	2B-01	0.56	0.6000	0.18	0.11	0.06	0.36	0 00:10:00
20	2B-02	0.57	0.6000	0.18	0.11	0.06	0.37	0 00:10:00
21	2B-03	1.12	0.6000	0.18	0.11	0.12	0.73	0 00:10:00
22	2B-04	0.82	0.6000	0.18	0.11	0.09	0.53	0 00:10:00
23	2B-05	0.34	0.6000	0.18	0.11	0.04	0.22	0 00:10:00
24	2B-06	0.47	0.6000	0.18	0.11	0.05	0.31	0 00:10:00
25	2B-07	0.62	0.6000	0.18	0.11	0.07	0.40	0 00:10:00
26	2B-08	1.41	0.6000	0.18	0.11	0.15	0.91	0 00:10:00
27	2B-09	1.85	0.6000	0.18	0.11	0.20	1.20	0 00:10:00
28	2B-10	0.26	0.4100	0.18	0.07	0.02	0.12	0 00:10:00
29	2B-OFF-01	0.21	0.2000	0.18	0.04	0.01	0.05	0 00:10:00
30	2B-OFF-02	0.24	0.6000	0.18	0.11	0.03	0.16	0 00:10:00
31	AREA_R-05	0.24	0.6000	0.18	0.11	0.03	0.16	0 00:10:00
32	AREA_R-06	0.35	0.4900	0.18	0.09	0.03	0.19	0 00:10:00
33	AREA_R-07	0.41	0.6000	0.18	0.11	0.04	0.27	0 00:10:00
34	AREA_R-08	0.33	0.4900	0.18	0.09	0.03	0.18	0 00:10:00
35	AREA_R-09A	0.49	0.6000	0.18	0.11	0.05	0.32	0 00:10:00
36	AREA_R-09B	0.65	0.6000	0.18	0.11	0.07	0.42	0 00:10:00
37	AREA_R-10A	0.31	0.4900	0.18	0.09	0.03	0.16	0 00:10:00
38	AREA_R-10B	0.39	0.4900	0.18	0.09	0.03	0.21	0 00:10:00
39	AREA_R-11	0.24	0.5900	0.18	0.11	0.03	0.15	0 00:10:00
40	AREA_R-12	0.13	0.8800	0.18	0.16	0.02	0.12	0 00:10:00
41	AREA_R-13	1.36	0.6000	0.18	0.11	0.15	0.88	0 00:10:00
42	AREA_R-14A	0.14	0.8800	0.18	0.16	0.02	0.13	0 00:10:00
43	AREA_R-14B	0.41	0.4900	0.18	0.09	0.04	0.22	0 00:10:00
44	AREA_R-15	0.53	0.6000	0.18	0.11	0.06	0.34	0 00:10:00
45	AREA_R-16	0.50	0.4900	0.18	0.09	0.04	0.27	0 00:10:00
46	AREA_R-17	0.13	0.8800	0.18	0.16	0.02	0.12	0 00:10:00
47	AREA_R-18	0.54	0.8800	0.18	0.16	0.09	0.51	0 00:10:00
48	AREA_R-19	0.61	0.4900	0.18	0.09	0.05	0.32	0 00:10:00
49	OFF-01	0.27	0.2000	0.18	0.04	0.01	0.06	0 00:10:00

Project Description

File Name	BLACKSTONE PH2-A & B PROP 10YR.SPF
Description	BLACKSTONE RANCH PHASES 2-A AND 2-B MASTER TECHNICAL DRAINAGE ANALYSIS 10-YEAR PROPOSED PEAK FLOW EVENT

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	49
Nodes	85
Junctions	36
Outfalls	9
Flow Diversions	0
Inlets	39
Storage Nodes	1
Links	97
Channels	22
Pipes	74
Pumps	0
Orifices	0
Weirs	1
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	10 year(s)

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	2A-01	0.43	0.6000	0.30	0.18	0.08	0.46	0 00:10:00
2	2A-02	0.17	0.6000	0.30	0.18	0.03	0.18	0 00:10:00
3	2A-03	0.81	0.6000	0.30	0.18	0.14	0.87	0 00:10:00
4	2A-04	1.84	0.6000	0.30	0.18	0.33	1.98	0 00:10:00
5	2A-05	0.43	0.6000	0.30	0.18	0.08	0.46	0 00:10:00
6	2A-06	0.79	0.6000	0.30	0.18	0.14	0.85	0 00:10:00
7	2A-07	0.83	0.6000	0.30	0.18	0.15	0.89	0 00:10:00
8	2A-08	0.47	0.6000	0.30	0.18	0.08	0.51	0 00:10:00
9	2A-09	0.69	0.6000	0.30	0.18	0.12	0.74	0 00:10:00
10	2A-10	0.58	0.6000	0.30	0.18	0.10	0.62	0 00:10:00
11	2A-11	0.93	0.6000	0.30	0.18	0.17	1.00	0 00:10:00
12	2A-12	0.77	0.6000	0.30	0.18	0.14	0.83	0 00:10:00
13	2A-13	1.65	0.6000	0.30	0.18	0.30	1.77	0 00:10:00
14	2A-14	0.95	0.6000	0.30	0.18	0.17	1.02	0 00:10:00
15	2A-15	2.44	0.6000	0.30	0.18	0.44	2.62	0 00:10:00
16	2A-16	0.54	0.6000	0.30	0.18	0.10	0.58	0 00:10:00
17	2A-OFF-01	0.66	0.6000	0.30	0.18	0.12	0.71	0 00:10:00
18	2A-OFF-02	1.09	0.6000	0.30	0.18	0.20	1.17	0 00:10:00
19	2B-01	0.56	0.6000	0.30	0.18	0.10	0.60	0 00:10:00
20	2B-02	0.57	0.6000	0.30	0.18	0.10	0.61	0 00:10:00
21	2B-03	1.12	0.6000	0.30	0.18	0.20	1.20	0 00:10:00
22	2B-04	0.82	0.6000	0.30	0.18	0.15	0.88	0 00:10:00
23	2B-05	0.34	0.6000	0.30	0.18	0.06	0.37	0 00:10:00
24	2B-06	0.47	0.6000	0.30	0.18	0.08	0.51	0 00:10:00
25	2B-07	0.62	0.6000	0.30	0.18	0.11	0.67	0 00:10:00
26	2B-08	1.41	0.6000	0.30	0.18	0.25	1.51	0 00:10:00
27	2B-09	1.85	0.6000	0.30	0.18	0.33	1.99	0 00:10:00
28	2B-10	0.26	0.4100	0.30	0.12	0.03	0.19	0 00:10:00
29	2B-OFF-01	0.21	0.2000	0.30	0.06	0.01	0.08	0 00:10:00
30	2B-OFF-02	0.24	0.6000	0.30	0.18	0.04	0.26	0 00:10:00
31	AREA_R-05	0.24	0.6000	0.30	0.18	0.04	0.26	0 00:10:00
32	AREA_R-06	0.35	0.4900	0.30	0.15	0.05	0.31	0 00:10:00
33	AREA_R-07	0.41	0.6000	0.30	0.18	0.07	0.44	0 00:10:00
34	AREA_R-08	0.33	0.4900	0.30	0.15	0.05	0.29	0 00:10:00
35	AREA_R-09A	0.49	0.6000	0.30	0.18	0.09	0.53	0 00:10:00
36	AREA_R-09B	0.65	0.6000	0.30	0.18	0.12	0.70	0 00:10:00
37	AREA_R-10A	0.31	0.4900	0.30	0.15	0.05	0.27	0 00:10:00
38	AREA_R-10B	0.39	0.4900	0.30	0.15	0.06	0.34	0 00:10:00
39	AREA_R-11	0.24	0.5900	0.30	0.18	0.04	0.25	0 00:10:00
40	AREA_R-12	0.13	0.8800	0.30	0.26	0.03	0.21	0 00:10:00
41	AREA_R-13	1.36	0.6000	0.30	0.18	0.24	1.46	0 00:10:00
42	AREA_R-14A	0.14	0.8800	0.30	0.26	0.04	0.22	0 00:10:00
43	AREA_R-14B	0.41	0.4900	0.30	0.15	0.06	0.36	0 00:10:00
44	AREA_R-15	0.53	0.6000	0.30	0.18	0.09	0.57	0 00:10:00
45	AREA_R-16	0.50	0.4900	0.30	0.15	0.07	0.44	0 00:10:00
46	AREA_R-17	0.13	0.8800	0.30	0.26	0.03	0.21	0 00:10:00
47	AREA_R-18	0.54	0.8800	0.30	0.26	0.14	0.85	0 00:10:00
48	AREA_R-19	0.61	0.4900	0.30	0.15	0.09	0.54	0 00:10:00
49	OFF-01	0.27	0.2000	0.30	0.06	0.02	0.10	0 00:10:00

Project Description

File Name	BLACKSTONE PH2-A & B PROP 100YR NORMAL.SPF
Description	
	BLACKSTONE RANCH PH2
	MASTER TECHNICAL DRAINAGE ANALYSIS
	100-YEAR PROPOSED PEAK FLOW EVENT WITH
	PEAK FLOWS WITHIN CHANNELS

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	49
Nodes	85
Junctions	36
Outfalls	9
Flow Diversions	0
Inlets	39
Storage Nodes	1
Links	97
Channels	22
Pipes	74
Pumps	0
Orifices	0
Weirs	1
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	100 year(s)

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	2A-01	0.43	0.7800	0.59	0.46	0.20	1.18	0 00:10:00
2	2A-02	0.17	0.7800	0.59	0.46	0.08	0.47	0 00:10:00
3	2A-03	0.81	0.7800	0.59	0.46	0.37	2.22	0 00:10:00
4	2A-04	1.84	0.7800	0.59	0.46	0.84	5.04	0 00:10:00
5	2A-05	0.43	0.7800	0.59	0.46	0.20	1.18	0 00:10:00
6	2A-06	0.79	0.7800	0.59	0.46	0.36	2.16	0 00:10:00
7	2A-07	0.83	0.7800	0.59	0.46	0.38	2.27	0 00:10:00
8	2A-08	0.47	0.7800	0.59	0.46	0.21	1.29	0 00:10:00
9	2A-09	0.69	0.7800	0.59	0.46	0.31	1.89	0 00:10:00
10	2A-10	0.58	0.7800	0.59	0.46	0.26	1.59	0 00:10:00
11	2A-11	0.93	0.7800	0.59	0.46	0.42	2.55	0 00:10:00
12	2A-12	0.77	0.7800	0.59	0.46	0.35	2.11	0 00:10:00
13	2A-13	1.65	0.7800	0.59	0.46	0.75	4.52	0 00:10:00
14	2A-14	0.95	0.7800	0.59	0.46	0.43	2.60	0 00:10:00
15	2A-15	2.44	0.7800	0.59	0.46	1.11	6.68	0 00:10:00
16	2A-16	0.54	0.7800	0.59	0.46	0.25	1.48	0 00:10:00
17	2A-OFF-01	0.66	0.7800	0.59	0.46	0.30	1.81	0 00:10:00
18	2A-OFF-02	1.09	0.7800	0.59	0.46	0.50	2.98	0 00:10:00
19	2B-01	0.56	0.7800	0.59	0.46	0.26	1.53	0 00:10:00
20	2B-02	0.57	0.7800	0.59	0.46	0.26	1.56	0 00:10:00
21	2B-03	1.12	0.7800	0.59	0.46	0.51	3.07	0 00:10:00
22	2B-04	0.82	0.7800	0.59	0.46	0.37	2.25	0 00:10:00
23	2B-05	0.34	0.7800	0.59	0.46	0.16	0.93	0 00:10:00
24	2B-06	0.47	0.7800	0.59	0.46	0.21	1.29	0 00:10:00
25	2B-07	0.62	0.7800	0.59	0.46	0.28	1.70	0 00:10:00
26	2B-08	1.41	0.7800	0.59	0.46	0.64	3.86	0 00:10:00
27	2B-09	1.85	0.7800	0.59	0.46	0.84	5.07	0 00:10:00
28	2B-10	0.26	0.6300	0.59	0.37	0.10	0.58	0 00:10:00
29	2B-OFF-01	0.21	0.5000	0.59	0.29	0.06	0.37	0 00:10:00
30	2B-OFF-02	0.24	0.7800	0.59	0.46	0.11	0.66	0 00:10:00
31	AREA_R-05	0.24	0.7800	0.59	0.46	0.11	0.66	0 00:10:00
32	AREA_R-06	0.35	0.6300	0.59	0.37	0.13	0.77	0 00:10:00
33	AREA_R-07	0.41	0.7800	0.59	0.46	0.19	1.12	0 00:10:00
34	AREA_R-08	0.33	0.6300	0.59	0.37	0.12	0.73	0 00:10:00
35	AREA_R-09A	0.49	0.7800	0.59	0.46	0.22	1.34	0 00:10:00
36	AREA_R-09B	0.65	0.7800	0.59	0.46	0.30	1.78	0 00:10:00
37	AREA_R-10A	0.31	0.6300	0.59	0.37	0.11	0.69	0 00:10:00
38	AREA_R-11	0.24	0.7500	0.59	0.44	0.11	0.63	0 00:10:00
39	AREA_R-12	0.13	0.9300	0.59	0.54	0.07	0.42	0 00:10:00
40	AREA_R-13	1.36	0.7800	0.59	0.46	0.62	3.72	0 00:10:00
41	AREA_R-14A	0.14	0.9300	0.59	0.54	0.08	0.46	0 00:10:00
42	AREA_R-14B	0.41	0.6300	0.59	0.37	0.15	0.91	0 00:10:00
43	AREA_R-15	0.53	0.7800	0.59	0.46	0.24	1.45	0 00:10:00
44	AREA_R-16	0.50	0.6300	0.59	0.37	0.18	1.11	0 00:10:00
45	AREA_R-17	0.13	0.9300	0.59	0.54	0.07	0.42	0 00:10:00
46	AREA_R-18	0.54	0.9300	0.59	0.54	0.29	1.76	0 00:10:00
47	AREA_R-19	0.61	0.6300	0.59	0.37	0.23	1.35	0 00:10:00
48	OFF-01	0.27	0.5000	0.59	0.29	0.08	0.47	0 00:10:00
49	R-10B	0.39	0.6300	0.59	0.37	0.14	0.86	0 00:10:00

Project Description

File Name	BLACKSTONE PH2-A & B PROP 100YR.SPF
Description	BLACKSTONE RANCH PHASES 2-A AND 2-B MASTER TECHNICAL DRAINAGE ANALYSIS 100-YEAR PROPOSED PEAK FLOW EVENT WITH PEAK FLOWS WITHIN CHANNELS

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	49
Nodes	85
Junctions	36
Outfalls	9
Flow Diversions	0
Inlets	39
Storage Nodes	1
Links	97
Channels	22
Pipes	74
Pumps	0
Orifices	0
Weirs	1
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	100 year(s)

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	2A-01	0.43	0.7800	0.59	0.46	0.20	1.18	0 00:10:00
2	2A-02	0.17	0.7800	0.59	0.46	0.08	0.47	0 00:10:00
3	2A-03	0.81	0.7800	0.59	0.46	0.37	2.22	0 00:10:00
4	2A-04	1.84	0.7800	0.59	0.46	0.84	5.04	0 00:10:00
5	2A-05	0.43	0.7800	0.59	0.46	0.20	1.18	0 00:10:00
6	2A-06	0.79	0.7800	0.59	0.46	0.36	2.16	0 00:10:00
7	2A-07	0.83	0.7800	0.59	0.46	0.38	2.27	0 00:10:00
8	2A-08	0.47	0.7800	0.59	0.46	0.21	1.29	0 00:10:00
9	2A-09	0.69	0.7800	0.59	0.46	0.31	1.89	0 00:10:00
10	2A-10	0.58	0.7800	0.59	0.46	0.26	1.59	0 00:10:00
11	2A-11	0.93	0.7800	0.59	0.46	0.42	2.55	0 00:10:00
12	2A-12	0.77	0.7800	0.59	0.46	0.35	2.11	0 00:10:00
13	2A-13	1.65	0.7800	0.59	0.46	0.75	4.52	0 00:10:00
14	2A-14	0.95	0.7800	0.59	0.46	0.43	2.60	0 00:10:00
15	2A-15	2.44	0.7800	0.59	0.46	1.11	6.68	0 00:10:00
16	2A-16	0.54	0.7800	0.59	0.46	0.25	1.48	0 00:10:00
17	2A-OFF-01	0.66	0.7800	0.59	0.46	0.30	1.81	0 00:10:00
18	2A-OFF-02	1.09	0.7800	0.59	0.46	0.50	2.98	0 00:10:00
19	2B-01	0.56	0.7800	0.59	0.46	0.26	1.53	0 00:10:00
20	2B-02	0.57	0.7800	0.59	0.46	0.26	1.56	0 00:10:00
21	2B-03	1.12	0.7800	0.59	0.46	0.51	3.07	0 00:10:00
22	2B-04	0.82	0.7800	0.59	0.46	0.37	2.25	0 00:10:00
23	2B-05	0.34	0.7800	0.59	0.46	0.16	0.93	0 00:10:00
24	2B-06	0.47	0.7800	0.59	0.46	0.21	1.29	0 00:10:00
25	2B-07	0.62	0.7800	0.59	0.46	0.28	1.70	0 00:10:00
26	2B-08	1.41	0.7800	0.59	0.46	0.64	3.86	0 00:10:00
27	2B-09	1.85	0.7800	0.59	0.46	0.84	5.07	0 00:10:00
28	2B-10	0.26	0.6300	0.59	0.37	0.10	0.58	0 00:10:00
29	2B-OFF-01	0.21	0.5000	0.59	0.29	0.06	0.37	0 00:10:00
30	2B-OFF-02	0.24	0.7800	0.59	0.46	0.11	0.66	0 00:10:00
31	AREA_R-05	0.24	0.7800	0.59	0.46	0.11	0.66	0 00:10:00
32	AREA_R-06	0.35	0.6300	0.59	0.37	0.13	0.77	0 00:10:00
33	AREA_R-07	0.41	0.7800	0.59	0.46	0.19	1.12	0 00:10:00
34	AREA_R-08	0.33	0.6300	0.59	0.37	0.12	0.73	0 00:10:00
35	AREA_R-09A	0.49	0.7800	0.59	0.46	0.22	1.34	0 00:10:00
36	AREA_R-09B	0.65	0.7800	0.59	0.46	0.30	1.78	0 00:10:00
37	AREA_R-10A	0.31	0.6300	0.59	0.37	0.11	0.69	0 00:10:00
38	AREA_R-10B	0.39	0.6300	0.59	0.37	0.14	0.86	0 00:10:00
39	AREA_R-11	0.24	0.7500	0.59	0.44	0.11	0.63	0 00:10:00
40	AREA_R-12	0.13	0.9300	0.59	0.54	0.07	0.42	0 00:10:00
41	AREA_R-13	1.36	0.7800	0.59	0.46	0.62	3.72	0 00:10:00
42	AREA_R-14A	0.14	0.9300	0.59	0.54	0.08	0.46	0 00:10:00
43	AREA_R-14B	0.41	0.6300	0.59	0.37	0.15	0.91	0 00:10:00
44	AREA_R-15	0.53	0.7800	0.59	0.46	0.24	1.45	0 00:10:00
45	AREA_R-16	0.50	0.6300	0.59	0.37	0.18	1.11	0 00:10:00
46	AREA_R-17	0.13	0.9300	0.59	0.54	0.07	0.42	0 00:10:00
47	AREA_R-18	0.54	0.9300	0.59	0.54	0.29	1.76	0 00:10:00
48	AREA_R-19	0.61	0.6300	0.59	0.37	0.23	1.35	0 00:10:00
49	OFF-01	0.27	0.5000	0.59	0.29	0.08	0.47	0 00:10:00

APPENDIX D

STORM DRAIN HYDRAULIC ANALYSIS

Project Description

File Name ..... BLACKSTONE PH2-A & B PROP 2YR.SPF
Description .....
BLACKSTONE RANCH PHASES 2-A AND 2-B
MASTER TECHNICAL DRAINAGE ANALYSIS
2-YEAR PROPOSED PEAK FLOW EVENT FOR
LOW IMPACT DEVELOPMENT DESIGN

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... Rational
Time of Concentration (TOC) Method ..... User-Defined
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins.....	49
Nodes.....	85
Junctions	36
Outfalls	9
Flow Diversions	0
Inlets	39
Storage Nodes	1
Links.....	97
Channels	22
Pipes	74
Pumps	0
Orifices	0
Weirs	1
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period..... 2 year(s)

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	FES-03	Junction	4626.10	4630.06	4626.10	4629.10	22520.00	8.47	4627.84	0.00	4.26	0 00:00	0.00	0.00
2	Jun-39	Junction	4624.74	4630.74	4624.74	4628.32	65.00	8.69	4625.83	0.00	4.91	0 00:00	0.00	0.00
3	SDMH_2A-01	Junction	4632.50	4637.50	4632.50	4636.50	12.60	1.46	4633.04	0.00	4.46	0 00:00	0.00	0.00
4	SDMH_2A-02	Junction	4632.25	4637.57	4632.25	4636.57	12.60	1.82	4632.77	0.00	4.80	0 00:00	0.00	0.00
5	SDMH_2A-03	Junction	4629.20	4634.20	4629.20	4633.20	12.60	0.92	4629.56	0.00	4.64	0 00:00	0.00	0.00
6	SDMH_2A-04	Junction	4627.95	4632.94	4627.95	4631.94	12.60	0.85	4628.29	0.00	4.65	0 00:00	0.00	0.00
7	SDMH_2A-05	Junction	4627.20	4632.66	4627.20	4631.66	12.60	6.53	4628.29	0.00	4.37	0 00:00	0.00	0.00
8	SDMH_2A-06	Junction	4627.35	4632.62	4627.35	4631.62	19.60	5.00	4628.42	0.00	4.20	0 00:00	0.00	0.00
9	SDMH_2A-07	Junction	4627.80	4632.96	4627.80	4631.96	19.60	4.47	4628.61	0.00	4.35	0 00:00	0.00	0.00
10	SDMH_2A-08	Junction	4628.90	4633.92	4628.90	4632.92	19.60	4.47	4629.60	0.00	4.32	0 00:00	0.00	0.00
11	SDMH_2A-09	Junction	4633.00	4638.03	4633.00	4637.03	12.60	0.74	4633.30	0.00	4.73	0 00:00	0.00	0.00
12	SDMH_2A-10	Junction	4631.35	4636.35	4631.35	4635.35	19.60	1.44	4631.75	0.00	4.60	0 00:00	0.00	0.00
13	SDMH_2A-11	Junction	4630.05	4635.05	4630.05	4634.05	19.60	2.31	4630.64	0.00	4.41	0 00:00	0.00	0.00
14	SDMH_2A-12	Junction	4629.60	4634.62	4629.60	4633.62	19.60	2.23	4630.23	0.00	4.39	0 00:00	0.00	0.00
15	SDMH_2A-13	Junction	4629.25	4634.24	4629.25	4633.24	19.60	3.70	4630.05	0.00	4.19	0 00:00	0.00	0.00
16	SDMH_2A-14	Junction	4631.90	4636.90	4631.90	4635.90	19.60	0.74	4632.23	0.00	4.67	0 00:00	0.00	0.00
17	SDMH_2A-15	Junction	4630.55	4635.46	4630.55	4634.46	19.60	0.96	4630.89	0.00	4.57	0 00:00	0.00	0.00
18	SDMH_2B-01	Junction	4629.60	4634.61	4629.60	4633.61	12.60	0.86	4629.95	0.00	4.66	0 00:00	0.00	0.00
19	SDMH_2B-02	Junction	4631.80	4636.83	4631.80	4635.83	12.60	0.97	4632.18	0.00	4.65	0 00:00	0.00	0.00
20	SDMH_2B-03	Junction	4630.60	4635.58	4630.60	4634.58	19.60	1.75	4631.09	0.00	4.49	0 00:00	0.00	0.00
21	SDMH_2B-04	Junction	4629.95	4635.08	4629.95	4634.08	19.60	1.69	4630.42	0.00	4.66	0 00:00	0.00	0.00
22	SDMH_2B-05	Junction	4629.00	4633.72	4629.00	4632.72	19.60	2.42	4629.63	0.00	4.09	0 00:00	0.00	0.00
23	SDMH-03	Junction	4629.70	4634.69	4629.70	4633.75	12.60	0.32	4629.90	0.00	4.79	0 00:00	0.00	0.00
24	SDMH-04	Junction	4628.30	4633.28	4628.30	4632.28	12.60	0.68	4628.58	0.00	4.70	0 00:00	0.00	0.00
25	SDMH-05	Junction	4627.10	4632.21	4626.85	4631.21	12.60	0.69	4627.93	0.00	4.28	0 00:00	0.00	0.00
26	SDMH-06	Junction	4626.60	4631.51	4626.60	4630.51	12.60	0.89	4627.93	0.00	3.58	0 00:00	0.00	0.00
27	SDMH-07	Junction	4626.65	4632.02	4626.60	4631.02	19.60	6.92	4628.01	0.00	4.01	0 00:00	0.00	0.00
28	SDMH-08	Junction	4626.25	4631.80	4626.25	4630.80	28.30	8.49	4627.91	0.00	3.89	0 00:00	0.00	0.00
29	SDMH-09	Junction	4626.70	4632.16	4626.70	4631.16	19.60	1.43	4627.92	0.00	4.24	0 00:00	0.00	0.00
30	SDMH-10	Junction	4628.00	4633.02	4628.00	4632.02	19.60	1.02	4628.42	0.00	4.60	0 00:00	0.00	0.00
31	SDMH-11	Junction	4627.70	4633.36	4627.70	4632.36	19.60	1.47	4628.12	0.00	5.24	0 00:00	0.00	0.00
32	SDMH-12	Junction	4628.70	4633.51	4628.70	4632.51	12.60	0.67	4628.96	0.00	4.55	0 00:00	0.00	0.00
33	SDMH-13	Junction	4626.30	4631.94	4626.30	4630.94	19.60	1.42	4626.75	0.00	5.19	0 00:00	0.00	0.00
34	SDMH-14	Junction	4625.80	4633.18	4625.80	4632.18	19.60	1.42	4626.36	0.00	6.82	0 00:00	0.00	0.00
35	SIDEWALK_CROSS_DRAIN	Junction	4633.46	4633.88	4633.46	4632.88	10.00	1.26	4634.06	0.00	0.82	0 00:00	0.00	0.00
36	STUB-01	Junction	4626.79	4632.17	4626.79	4631.17	7.06	6.44	4628.12	0.00	4.05	0 00:00	0.00	0.00
37	FES-04	Outfall	4625.27					1.39	4625.67					
38	Jun-94	Outfall	4631.78					1.80	4632.26					
39	Out-05	Outfall	4624.56					8.40	4625.47					
40	Out-12	Outfall	4627.75					3.40	4628.22					
41	Out-13	Outfall	4632.00					0.00	4632.00					
42	PH2A-OFF-01	Outfall	4636.36					0.43	4636.36					
43	PH2A-OFF-02	Outfall	4633.64					0.71	4633.64					
44	PH2B-OFF-01	Outfall	4633.02					0.05	4633.02					
45	PH2B-OFF-02	Outfall	4632.19					0.16	4632.19					
46	DET-B101	Storage Node	4628.80	4633.50	4628.80		5500.00	3.54	4629.33				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	CULV-01	Pipe	Jun-39	Out-05	56.00	4624.74	4624.56	0.3200	42.000	0.0130	8.40	57.04	0.15	3.72	1.00	0.28	0.00	Calculated
2	LAT_2A-01	Pipe	CB2A-01	SDMH_2A-02	64.37	4634.23	4632.35	2.9200	15.000	0.0130	0.27	11.04	0.02	2.23	0.28	0.22	0.00	Calculated
3	LAT_2A-02	Pipe	CB2A-02	SDMH_2A-02	28.37	4634.23	4632.35	6.6300	15.000	0.0130	0.11	16.63	0.01	2.22	0.25	0.20	0.00	Calculated
4	LAT_2A-03	Pipe	CB2A-03	SDMH_2A-03	44.57	4631.64	4629.30	5.2500	15.000	0.0130	0.46	14.80	0.03	4.25	0.21	0.16	0.00	Calculated
5	LAT_2A-04	Pipe	CB2A-04	SDMH_2A-01	58.37	4634.20	4632.60	2.7400	15.000	0.0130	1.19	10.70	0.11	4.01	0.36	0.29	0.00	Calculated
6	LAT_2A-05	Pipe	CB2A-05	SDMH_2A-01	22.37	4634.20	4632.60	7.1500	15.000	0.0130	0.27	17.28	0.02	2.80	0.28	0.22	0.00	Calculated
7	LAT_2A-06	Pipe	CB2A-06	SDMH_2A-03	30.98	4631.46	4629.30	6.9700	15.000	0.0130	0.45	17.06	0.03	4.57	0.20	0.16	0.00	Calculated
8	LAT_2A-07	Pipe	CB2A-07	SDMH_2A-09	59.89	4635.18	4633.10	3.4700	15.000	0.0130	0.47	12.04	0.04	4.30	0.19	0.15	0.00	Calculated
9	LAT_2A-08	Pipe	CB2A-08	SDMH_2A-09	29.41	4635.58	4633.10	8.4300	15.000	0.0130	0.27	18.76	0.01	4.29	0.15	0.12	0.00	Calculated
10	LAT_2A-09	Pipe	CB2A-09	SDMH_2A-14	28.49	4634.10	4632.00	7.3700	15.000	0.0130	0.40	17.54	0.02	4.23	0.18	0.14	0.00	Calculated
11	LAT_2A-10	Pipe	CB2A-10	SDMH_2A-14	51.02	4634.41	4632.00	4.7200	15.000	0.0130	0.34	14.04	0.02	3.47	0.18	0.14	0.00	Calculated
12	LAT_2A-11	Pipe	CB2A-11	SDMH_2A-15	28.49	4632.65	4630.65	7.0200	15.000	0.0130	0.51	17.12	0.03	4.44	0.19	0.15	0.00	Calculated
13	LAT_2A-12	Pipe	CB2A-12	SDMH_2A-15	51.03	4632.92	4630.65	4.4500	15.000	0.0130	0.44	13.62	0.03	3.64	0.20	0.16	0.00	Calculated
14	LAT_2A-13	Pipe	CB2A-13	SDMH_2A-05	29.99	4629.83	4627.30	8.4400	15.000	0.0130	0.80	18.76	0.04	4.51	0.58	0.47	0.00	Calculated
15	LAT_2A-14	Pipe	CB2A-14	SDMH_2A-06	5.23	4628.83	4627.95	16.8300	15.000	0.0130	0.59	26.50	0.02	6.46	0.30	0.24	0.00	Calculated
16	LAT_2A-15	Pipe	CB2A-15	SDMH_2A-13	22.14	4631.42	4629.35	9.3500	15.000	0.0130	1.31	19.75	0.07	5.78	0.45	0.36	0.00	Calculated
17	LAT_2A-16	Pipe	CB2A-16	SDMH_2A-13	12.83	4631.33	4629.35	15.4300	15.000	0.0130	0.39	25.38	0.02	3.79	0.40	0.32	0.00	Calculated
18	LAT_2B-01	Pipe	CB2B-01	SDMH_2B-02	29.90	4634.06	4631.90	7.2200	15.000	0.0130	0.39	17.36	0.02	4.24	0.20	0.16	0.00	Calculated
19	LAT_2B-02	Pipe	CB2B-02	SDMH_2B-02	48.16	4633.54	4631.90	3.4100	15.000	0.0130	0.36	11.92	0.03	3.34	0.21	0.17	0.00	Calculated
20	LAT_2B-03	Pipe	CB2B-03	SDMH_2B-01	29.49	4631.84	4629.70	7.2600	15.000	0.0130	0.59	17.40	0.03	4.94	0.20	0.16	0.00	Calculated
21	LAT_2B-04	Pipe	CB2B-04	SDMH_2B-03	28.86	4632.78	4630.70	7.2100	15.000	0.0130	0.49	17.34	0.03	4.32	0.26	0.21	0.00	Calculated
22	LAT_2B-05	Pipe	CB2B-05	SDMH_2B-02	29.41	4633.54	4631.90	5.5800	15.000	0.0130	0.22	15.25	0.01	3.18	0.19	0.15	0.00	Calculated
23	LAT_2B-06	Pipe	CB2B-06	SDMH_2B-01	89.05	4632.29	4629.70	2.9100	15.000	0.0130	0.27	11.02	0.02	2.59	0.19	0.16	0.00	Calculated
24	LAT_2B-07	Pipe	CB2B-07	SDMH_2B-03	7.63	4631.79	4630.70	14.2900	15.000	0.0130	0.36	24.42	0.01	4.54	0.24	0.19	0.00	Calculated
25	LAT_2B-08	Pipe	CB2B-08	SDMH_2B-05	7.56	4629.88	4629.10	10.3200	15.000	0.0130	0.73	20.75	0.04	4.95	0.35	0.28	0.00	Calculated
26	LAT-05	Pipe	CB-05	SDMH-03	42.90	4631.96	4629.80	5.0300	15.000	0.0130	0.15	14.49	0.01	3.61	0.09	0.07	0.00	Calculated
27	LAT-06	Pipe	CB-06	SDMH-03	33.92	4632.16	4629.80	6.9600	15.000	0.0130	0.17	17.04	0.01	4.26	0.09	0.07	0.00	Calculated
28	LAT-07	Pipe	CB-07	SDMH-04	42.90	4630.35	4628.40	4.5500	15.000	0.0130	0.25	13.77	0.02	3.56	0.15	0.12	0.00	Calculated
29	LAT-08	Pipe	CB-08	SDMH-04	4.90	4629.05	4628.40	13.2700	15.000	0.0130	0.17	23.53	0.01	3.93	0.13	0.10	0.00	Calculated
30	LAT-09	Pipe	CB-09	SDMH-07	10.80	4627.78	4626.65	10.4600	15.000	0.0130	0.70	20.90	0.03	4.16	0.74	0.59	0.00	Calculated
31	LAT-10	Pipe	CB-10	SDMH-06	4.90	4627.28	4626.70	11.8400	15.000	0.0130	0.44	22.22	0.02	4.37	0.93	0.75	0.00	Calculated
32	LAT-11	Pipe	CB-11	SDMH-10	30.92	4629.33	4628.10	3.9800	15.000	0.0130	0.15	12.88	0.01	2.02	0.21	0.17	0.00	Calculated
33	LAT-12	Pipe	CB-13	SDMH-10	58.80	4629.33	4628.10	2.0900	15.000	0.0130	0.87	9.34	0.09	3.95	0.29	0.24	0.00	Calculated
34	LAT-13	Pipe	CB-12	SDMH-11	45.01	4628.83	4627.80	2.2900	15.000	0.0130	0.12	9.77	0.01	1.85	0.21	0.17	0.00	Calculated
35	LAT-14	Pipe	CB-14	SDMH-11	66.57	4629.33	4627.80	2.3000	15.000	0.0130	0.34	9.79	0.04	2.74	0.24	0.19	0.00	Calculated
36	LAT-15	Pipe	CB-16	SDMH-12	66.21	4629.45	4629.05	0.6000	15.000	0.0130	0.26	5.02	0.05	2.08	0.20	0.16	0.00	Calculated
37	LAT-16	Pipe	CB-15	SDMH-12	74.17	4630.78	4629.05	2.3300	15.000	0.0130	0.30	9.87	0.03	3.54	0.15	0.12	0.00	Calculated
38	LAT-17	Pipe	CB-17	SDMH-12	43.42	4629.45	4629.05	0.9200	15.000	0.0150	0.12	5.37	0.02	1.73	0.13	0.11	0.00	Calculated
39	LAT-18	Pipe	CB-18	SDMH-13	36.89	4629.09	4626.90	5.9400	15.000	0.0130	0.50	15.74	0.03	5.55	0.16	0.13	0.00	Calculated
40	LAT-19	Pipe	CB-19	SDMH-13	10.90	4628.09	4626.90	10.9200	15.000	0.0130	0.32	21.34	0.01	5.68	0.11	0.09	0.00	Calculated
41	PIPE-03	Pipe	SDMH-03	SDMH-04	235.00	4629.70	4628.40	0.5500	18.000	0.0130	0.29	7.81	0.04	2.08	0.20	0.13	0.00	Calculated
42	PIPE-04	Pipe	SDMH-04	SDMH-05	143.18	4628.30	4627.20	0.7700	18.000	0.0130	0.69	9.21	0.07	2.82	0.48	0.32	0.00	Calculated
43	PIPE-05	Pipe	SDMH-05	SDMH-06	92.49	4627.10	4626.70	0.4300	18.000	0.0130	0.54	6.91	0.08	1.81	1.02	0.68	0.00	Calculated
44	PIPE-06	Pipe	SDMH-06	SDMH-08	58.22	4626.60	4626.35	0.4300	18.000	0.0130	0.79	6.88	0.12	1.46	1.41	0.94	0.00	Calculated
45	PIPE-07	Pipe	STUB-01	SDMH-07	10.00	4626.79	4626.75	0.4000	30.000	0.0130	6.34	25.94	0.24	2.84	1.29	0.52	0.00	Calculated
46	PIPE-08	Pipe	SDMH-07	SDMH-08	68.63	4626.65	4626.35	0.4400	30.000	0.0130	6.85	27.12	0.25	2.71	1.46	0.58	0.00	Calculated
47	PIPE-09	Pipe	SDMH-10	SDMH-11	38.50	4628.00	4627.80	0.5200	18.000	0.0130	1.01	7.57	0.13	2.71	0.39	0.26	0.00	Calculated
48	PIPE-10	Pipe	SDMH-11	SDMH-09	214.29	4627.70	4626.80	0.4200	24.000	0.0130	1.43	14.66	0.10	2.48	0.74	0.37	0.00	Calculated
49	PIPE-12	Pipe	SDMH-09	SDMH-08	69.87	4626.70	4626.35	0.5000	24.000	0.0130	1.03	16.01	0.06	1.43	1.39	0.70	0.00	Calculated

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
50	PIPE-13	Pipe	SDMH-08	FES-03	44.05	4626.25	4626.10	0.3400	36.000	0.0130	8.44	38.92	0.22	2.04	1.70	0.57	0.00	Calculated
51	PIPE-14	Pipe	SDMH-12	SDMH-13	270.27	4628.70	4626.90	0.6700	24.000	0.0130	0.63	18.46	0.03	2.70	0.26	0.13	0.00	Calculated
52	PIPE-15	Pipe	SDMH-13	SDMH-14	88.43	4626.30	4625.90	0.4500	24.000	0.0130	1.42	15.21	0.09	2.70	0.45	0.23	0.00	Calculated
53	PIPE-16	Pipe	SDMH-14	FES-04	107.76	4625.80	4625.27	0.4900	24.000	0.0130	1.39	15.87	0.09	2.40	0.48	0.24	0.00	Calculated
54	PIPE-2A-01	Pipe	SDMH_2A-01	SDMH_2A-02	37.50	4632.50	4632.35	0.4000	18.000	0.0130	1.44	6.64	0.22	2.82	0.50	0.33	0.00	Calculated
55	PIPE-2A-02	Pipe	SDMH_2A-02	Jun-94	117.25	4632.25	4631.78	0.4000	24.000	0.0130	1.80	14.32	0.13	2.95	0.50	0.25	0.00	Calculated
56	PIPE-2A-03	Pipe	SDMH_2A-03	SDMH_2A-04	252.27	4629.20	4628.05	0.4600	18.000	0.0130	0.85	7.09	0.12	2.69	0.35	0.24	0.00	Calculated
57	PIPE-2A-04	Pipe	SDMH_2A-04	SDMH_2A-05	52.87	4627.95	4627.30	1.2300	18.000	0.0130	0.85	11.65	0.07	1.45	0.66	0.44	0.00	Calculated
58	PIPE-2A-05	Pipe	SDMH_2A-06	SDMH_2A-05	11.57	4627.35	4627.30	0.4300	30.000	0.0130	4.96	26.96	0.18	2.70	1.03	0.41	0.00	Calculated
59	PIPE-2A-06	Pipe	SDMH_2A-07	SDMH_2A-06	65.14	4627.80	4627.45	0.5400	30.000	0.0130	4.42	30.07	0.15	2.91	0.89	0.36	0.00	Calculated
60	PIPE-2A-07	Pipe	SDMH_2A-08	SDMH_2A-07	191.56	4628.90	4627.90	0.5200	30.000	0.0130	4.47	29.64	0.15	4.02	0.70	0.28	0.00	Calculated
61	PIPE-2A-08	Pipe	SDMH_2A-13	SDMH_2A-08	64.05	4629.25	4629.00	0.3900	24.000	0.0130	3.68	14.13	0.26	3.50	0.74	0.37	0.00	Calculated
62	PIPE-2A-09	Pipe	SDMH_2A-12	SDMH_2A-13	60.96	4629.60	4629.35	0.4100	24.000	0.0130	2.23	14.49	0.15	2.45	0.67	0.33	0.00	Calculated
63	PIPE-2A-10	Pipe	SDMH_2A-11	SDMH_2A-12	85.72	4630.05	4629.70	0.4100	24.000	0.0130	2.23	14.46	0.15	3.10	0.56	0.28	0.00	Calculated
64	PIPE-2A-11	Pipe	SDMH_2A-15	SDMH_2A-11	80.00	4630.55	4630.15	0.5000	24.000	0.0130	0.96	16.00	0.06	2.25	0.40	0.20	0.00	Calculated
65	PIPE-2A-12	Pipe	SDMH_2A-10	SDMH_2A-11	250.00	4631.35	4630.15	0.4800	24.000	0.0130	1.40	15.67	0.09	2.69	0.45	0.22	0.00	Calculated
66	PIPE-2A-13	Pipe	SDMH_2A-14	SDMH_2A-10	80.00	4631.90	4631.45	0.5600	18.000	0.0130	0.73	7.88	0.09	2.66	0.32	0.21	0.00	Calculated
67	PIPE-2A-14	Pipe	SDMH_2A-09	SDMH_2A-10	242.25	4633.00	4631.45	0.6400	18.000	0.0130	0.72	8.40	0.09	2.84	0.30	0.20	0.00	Calculated
68	PIPE-2A-CONNECTION	Pipe	SDMH_2A-05	STUB-01	109.14	4627.20	4626.79	0.3800	30.000	0.0130	6.44	25.14	0.26	2.94	1.21	0.48	0.00	Calculated
69	PIPE-2B-01	Pipe	SDMH_2B-01	SDMH_2A-08	138.44	4629.60	4629.00	0.4300	18.000	0.0130	0.84	6.92	0.12	2.05	0.48	0.32	0.00	Calculated
70	PIPE-2B-02	Pipe	SDMH_2B-02	SDMH_2B-03	248.25	4631.80	4630.70	0.4400	18.000	0.0130	0.94	6.99	0.13	2.65	0.38	0.25	0.00	Calculated
71	PIPE-2B-03	Pipe	SDMH_2B-03	SDMH_2B-04	124.95	4630.60	4630.05	0.4400	24.000	0.0130	1.69	15.01	0.11	3.03	0.47	0.23	0.00	Calculated
72	PIPE-2B-04	Pipe	SDMH_2B-04	SDMH_2B-05	207.84	4629.95	4629.10	0.4100	24.000	0.0130	1.69	14.47	0.12	2.76	0.50	0.25	0.00	Calculated
73	PIPE-2B-05	Pipe	SDMH_2B-05	DET-B101	49.25	4629.00	4628.80	0.4100	24.000	0.0130	2.39	14.42	0.17	3.15	0.58	0.29	0.00	Calculated
74	PIPE-2B-06	Pipe	DET-B101	Out-12	66.39	4628.00	4627.60	0.6000	24.000	0.0130	3.40	28.45	0.12	5.52	0.50	0.25	0.00	Calculated
75	BYPASS_16_17	Channel	CB-15	CB-18	337.95	4633.78	4632.09	0.5000	8.640	0.0320	0.03	18.05	0.00	1.16	0.15	0.20	0.00	
76	BYPASS-03-04	Channel	CB2A-03	CB2A-14	375.28	4634.64	4632.83	0.4800	6.120	0.0320	0.06	9.54	0.01	1.10	0.14	0.28	0.00	
77	BYPASS-05-07	Channel	CB-05	CB-07	235.00	4634.96	4633.35	0.6900	8.640	0.0320	0.01	21.12	0.00	0.45	0.08	0.11	0.00	
78	BYPASS-06-08	Channel	CB-06	CB-08	267.99	4635.16	4633.55	0.6000	8.640	0.0320	0.01	19.79	0.00	0.61	0.07	0.10	0.00	
79	BYPASS-06-13	Channel	CB2A-06	CB2A-13	306.42	4634.46	4632.83	0.5300	6.120	0.0320	0.05	10.04	0.01	0.60	0.17	0.33	0.00	
80	BYPASS-07-09	Channel	CB-07	CB-09	226.71	4633.35	4631.78	0.6900	8.640	0.0320	0.02	21.24	0.00	1.10	0.18	0.25	0.00	
81	BYPASS-07-18	Channel	CB2A-07	CB2B-01	232.00	4638.18	4637.06	0.4800	6.120	0.0320	0.06	9.56	0.01	1.39	0.10	0.19	0.00	
82	BYPASS-08-10	Channel	CB-08	CB-10	238.38	4633.55	4631.78	0.7400	8.640	0.0320	0.02	22.00	0.00	1.06	0.11	0.15	0.00	
83	BYPASS-08-19	Channel	CB2A-08	CB2A-15	647.42	4638.58	4634.42	0.6400	6.120	0.0320	0.03	11.01	0.00	0.51	0.14	0.28	0.00	
84	BYPASS-09-15	Channel	CB2A-09	CB2A-15	495.00	4637.10	4634.42	0.5400	6.120	0.0320	0.04	10.13	0.00	0.60	0.15	0.29	0.00	
85	BYPASS-10-15	Channel	CB2A-10	CB2A-15	512.00	4637.41	4634.42	0.5800	6.120	0.0320	0.03	10.50	0.00	0.57	0.15	0.29	0.00	
86	BYPASS-11-15	Channel	CB2A-11	CB2A-15	242.29	4635.65	4634.42	0.5100	6.120	0.0320	0.08	9.81	0.01	0.76	0.16	0.32	0.00	
87	BYPASS-12-16	Channel	CB2A-12	CB2A-16	275.17	4635.92	4634.33	0.5800	6.120	0.0320	0.05	10.44	0.00	1.55	0.08	0.16	0.00	
88	BYPASS-15-13	Channel	CB2A-15	CB2A-13	332.45	4634.42	4632.83	0.4800	6.120	0.0320	0.46	9.52	0.05	1.56	0.21	0.42	0.00	
89	BYPASS-16-13	Channel	CB2A-16	CB2A-13	275.96	4634.33	4632.83	0.5400	6.120	0.0320	0.01	10.15	0.00	0.26	0.15	0.29	0.00	
90	BYPASS-18-21	Channel	CB2B-01	CB2B-04	248.00	4637.06	4635.78	0.5200	6.120	0.0320	0.03	9.89	0.00	5.93	0.07	0.14	0.00	
91	BYPASS-20-13	Channel	CB2B-03	CB2A-13	393.54	4634.84	4632.83	0.5100	6.120	0.0320	0.13	9.84	0.01	0.82	0.18	0.35	0.00	
92	BYPASS-21-XDRAIN	Channel	CB2B-04	SIDEWALK_CROSS_DRAIN	369.46	4635.78	4633.88	0.5100	6.120	0.0320	0.06	9.87	0.01	7.56	0.14	0.28	0.00	
93	BYPASS-23-13	Channel	CB2B-06	CB2A-13	483.60	4635.29	4632.83	0.5100	6.120	0.0320	0.03	9.82	0.00	0.42	0.16	0.31	0.00	
94	BYPASS-25-26	Channel	CB2B-07	CB2B-08	330.35	4635.79	4633.88	0.5800	6.120	0.0320	0.04	10.45	0.00	0.91	0.18	0.35	0.00	
95	CHANNEL-01	Channel	FES-03	Jun-39	410.00	4626.10	4624.74	0.3300	72.000	0.0320	8.69	371.84	0.02	2.24	1.39	0.23	0.00	
96	Link-117	Channel	SIDEWALK_CROSS_DRAIN	DET-B101	38.99	4633.88	4628.80	13.0300	12.000	0.0320	1.20	14.29	0.08	2.45	0.34	0.34	0.00	
97	Weir-01	Weir	DET-B101	Out-13		4628.80	4632.00				0.00							

Inlet Summary

SN	Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Initial Water Elevation (ft)	Ponded Area (ft^2)	Peak Flow (cfs)	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Allowable Spread (ft)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)
1	CB-05	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.96	4634.96	4631.96	N/A	0.16	0.16	0.00	100.00	7.00	1.77	4635.07
2	CB-06	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.16	4635.16	4632.16	N/A	0.19	0.19	0.00	100.00	7.00	1.90	4635.28
3	CB-07	FHWA HEC-22 GENERIC	N/A	On Grade	1	4630.35	4633.35	0.00	N/A	0.27	0.01	0.26	5.07	7.00	2.41	4633.40
4	CB-08	FHWA HEC-22 GENERIC	N/A	On Grade	1	4629.05	4633.55	4629.05	N/A	0.18	0.01	0.17	5.98	7.00	2.08	4633.59
5	CB-09	FHWA HEC-22 GENERIC	N/A	On Sag	1	4627.78	4631.78	4627.78	40.00	0.76	N/A	N/A	N/A	7.00	2.77	4631.94
6	CB-10	FHWA HEC-22 GENERIC	N/A	On Sag	1	4627.28	4631.78	4627.28	40.00	0.39	N/A	N/A	N/A	7.00	2.12	4631.93
7	CB-11	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.33	4632.83	4629.33	40.00	0.15	N/A	N/A	N/A	7.00	1.60	4632.97
8	CB-12	FHWA HEC-22 GENERIC	N/A	On Sag	1	4628.83	4632.83	4628.83	40.00	0.12	N/A	N/A	N/A	7.00	1.52	4632.97
9	CB-13	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.33	4632.83	4629.33	40.00	0.88	N/A	N/A	N/A	7.00	2.94	4632.99
10	CB-14	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.33	4632.83	4629.33	40.00	0.35	N/A	N/A	N/A	7.00	2.05	4632.98
11	CB-15	FHWA HEC-22 GENERIC	N/A	On Grade	1	4630.78	4633.78	4630.78	N/A	0.34	0.33	0.02	95.14	7.00	4.06	4633.95
12	CB-16	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.45	4632.45	4629.45	40.00	0.26	N/A	N/A	N/A	7.00	1.87	4632.59
13	CB-17	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.45	4632.45	4629.45	40.00	0.12	N/A	N/A	N/A	7.00	1.52	4632.59
14	CB-18	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.09	4632.09	4629.09	40.00	0.54	N/A	N/A	N/A	7.00	2.40	4632.24
15	CB-19	FHWA HEC-22 GENERIC	N/A	On Sag	1	4628.09	4632.09	4628.09	40.00	0.32	N/A	N/A	N/A	7.00	2.00	4632.24
16	CB2A-01	FHWA HEC-22 GENERIC	N/A	On Sag	1	4634.23	4637.23	4634.23	40.00	0.28	N/A	N/A	N/A	7.00	1.90	4637.37
17	CB2A-02	FHWA HEC-22 GENERIC	N/A	On Sag	1	4634.23	4637.23	4634.23	40.00	0.11	N/A	N/A	N/A	7.00	1.49	4637.37
18	CB2A-03	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.64	4634.64	4631.64	N/A	0.52	0.47	0.06	88.94	7.00	5.23	4634.83
19	CB2A-04	FHWA HEC-22 GENERIC	N/A	On Sag	1	4634.20	4637.20	4634.20	40.00	1.19	N/A	N/A	N/A	7.00	6.28	4637.43
20	CB2A-05	FHWA HEC-22 GENERIC	N/A	On Sag	1	4634.20	4637.20	4634.20	40.00	0.28	N/A	N/A	N/A	7.00	1.90	4637.34
21	CB2A-06	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.46	4634.46	4631.46	N/A	0.51	0.46	0.06	89.22	7.00	5.19	4634.65
22	CB2A-07	FHWA HEC-22 GENERIC	N/A	On Grade	1	4635.18	4638.18	4635.18	N/A	0.54	0.48	0.06	88.42	7.00	5.33	4638.37
23	CB2A-08	FHWA HEC-22 GENERIC	N/A	On Grade	1	4635.58	4638.58	4635.58	N/A	0.30	0.29	0.01	96.48	7.00	3.75	4638.74
24	CB2A-09	FHWA HEC-22 GENERIC	N/A	On Grade	1	4634.10	4637.10	4634.10	N/A	0.45	0.41	0.03	92.30	7.00	4.56	4637.28
25	CB2A-10	FHWA HEC-22 GENERIC	N/A	On Grade	1	4634.41	4637.41	4634.41	N/A	0.38	0.36	0.02	94.89	7.00	4.05	4637.58
26	CB2A-11	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.65	4635.65	4632.65	N/A	0.60	0.52	0.08	86.56	7.00	5.65	4635.85
27	CB2A-12	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.92	4635.92	4632.92	N/A	0.50	0.45	0.05	89.74	7.00	5.09	4636.11
28	CB2A-13	FHWA HEC-22 GENERIC	N/A	On Sag	2	4629.83	4632.83	4629.83	40.00	1.74	N/A	N/A	N/A	7.00	6.39	4633.06
29	CB2A-14	FHWA HEC-22 GENERIC	N/A	On Sag	2	4628.83	4632.83	4628.83	40.00	0.67	N/A	N/A	N/A	7.00	2.28	4632.98
30	CB2A-15	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.42	4634.42	4631.12	N/A	1.77	1.22	0.55	68.89	7.00	8.52	4634.64
31	CB2A-16	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.33	4634.33	4631.33	N/A	0.40	0.01	0.39	2.17	7.00	2.28	4634.38
32	CB2B-01	FHWA HEC-22 GENERIC	N/A	On Grade	1	4634.06	4637.06	4634.06	N/A	0.42	0.40	0.02	96.22	7.00	3.67	4637.22
33	CB2B-02	FHWA HEC-22 GENERIC	N/A	On Sag	1	4633.54	4636.54	4633.54	40.00	0.37	N/A	N/A	N/A	7.00	2.09	4636.69
34	CB2B-03	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.84	4634.84	4631.84	N/A	0.73	0.60	0.12	83.15	7.00	6.26	4635.05
35	CB2B-04	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.78	4635.78	4632.78	N/A	0.53	0.47	0.06	88.56	7.00	5.32	4635.97
36	CB2B-05	FHWA HEC-22 GENERIC	N/A	On Sag	1	4633.54	4636.54	4633.54	40.00	0.22	N/A	N/A	N/A	7.00	1.77	4636.68
37	CB2B-06	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.29	4635.29	4632.29	N/A	0.30	0.01	0.29	4.82	7.00	2.51	4635.34
38	CB2B-07	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.79	4635.79	4631.79	N/A	0.40	0.37	0.03	93.04	7.00	4.48	4635.96
39	CB2B-08	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.88	4633.88	4629.88	40.00	0.95	N/A	N/A	N/A	7.00	5.26	4634.09

Project Description

File Name	BLACKSTONE PH2-A & B PROP 10YR.SPF
Description	BLACKSTONE RANCH PHASES 2-A AND 2-B MASTER TECHNICAL DRAINAGE ANALYSIS 10-YEAR PROPOSED PEAK FLOW EVENT

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	49
Nodes	85
Junctions	36
Outfalls	9
Flow Diversions	0
Inlets	39
Storage Nodes	1
Links	97
Channels	22
Pipes	74
Pumps	0
Orifices	0
Weirs	1
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	10 year(s)

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	FES-03	Junction	4626.10	4630.06	4626.10	4629.10	22520.00	13.57	4628.10	0.00	4.00	0 00:00	0.00	0.00
2	Jun-39	Junction	4624.74	4630.74	4624.74	4628.32	65.00	14.16	4626.17	0.00	4.57	0 00:00	0.00	0.00
3	SDMH_2A-01	Junction	4632.50	4637.50	4632.50	4636.50	12.60	2.42	4633.23	0.00	4.27	0 00:00	0.00	0.00
4	SDMH_2A-02	Junction	4632.25	4637.57	4632.25	4636.57	12.60	3.02	4632.94	0.00	4.63	0 00:00	0.00	0.00
5	SDMH_2A-03	Junction	4629.20	4634.20	4629.20	4633.20	12.60	1.36	4629.65	0.00	4.55	0 00:00	0.00	0.00
6	SDMH_2A-04	Junction	4627.95	4632.94	4627.95	4631.94	12.60	1.35	4628.74	0.00	4.20	0 00:00	0.00	0.00
7	SDMH_2A-05	Junction	4627.20	4632.66	4627.20	4631.66	12.60	9.74	4628.73	0.00	3.93	0 00:00	0.00	0.00
8	SDMH_2A-06	Junction	4627.35	4632.62	4627.35	4631.62	19.60	7.75	4628.85	0.00	3.77	0 00:00	0.00	0.00
9	SDMH_2A-07	Junction	4627.80	4632.96	4627.80	4631.96	19.60	7.13	4628.97	0.00	3.99	0 00:00	0.00	0.00
10	SDMH_2A-08	Junction	4628.90	4633.92	4628.90	4632.92	19.60	7.10	4629.81	0.00	4.11	0 00:00	0.00	0.00
11	SDMH_2A-09	Junction	4633.00	4638.03	4633.00	4637.03	12.60	1.15	4633.38	0.00	4.65	0 00:00	0.00	0.00
12	SDMH_2A-10	Junction	4631.35	4636.35	4631.35	4635.35	19.60	2.25	4631.85	0.00	4.50	0 00:00	0.00	0.00
13	SDMH_2A-11	Junction	4630.05	4635.05	4630.05	4634.05	19.60	3.55	4630.82	0.00	4.23	0 00:00	0.00	0.00
14	SDMH_2A-12	Junction	4629.60	4634.62	4629.60	4633.62	19.60	3.45	4630.46	0.00	4.16	0 00:00	0.00	0.00
15	SDMH_2A-13	Junction	4629.25	4634.24	4629.25	4633.24	19.60	5.86	4630.30	0.00	3.94	0 00:00	0.00	0.00
16	SDMH_2A-14	Junction	4631.90	4636.90	4631.90	4635.90	19.60	1.14	4632.32	0.00	4.58	0 00:00	0.00	0.00
17	SDMH_2A-15	Junction	4630.55	4635.46	4630.55	4634.46	19.60	1.43	4630.96	0.00	4.50	0 00:00	0.00	0.00
18	SDMH_2B-01	Junction	4629.60	4634.61	4629.60	4633.61	12.60	1.33	4630.04	0.00	4.57	0 00:00	0.00	0.00
19	SDMH_2B-02	Junction	4631.80	4636.83	4631.80	4635.83	12.60	1.67	4632.31	0.00	4.52	0 00:00	0.00	0.00
20	SDMH_2B-03	Junction	4630.60	4635.58	4630.60	4634.58	19.60	2.93	4631.25	0.00	4.33	0 00:00	0.00	0.00
21	SDMH_2B-04	Junction	4629.95	4635.08	4629.95	4634.08	19.60	2.84	4630.57	0.00	4.51	0 00:00	0.00	0.00
22	SDMH_2B-05	Junction	4629.00	4633.72	4629.00	4632.72	19.60	3.91	4629.84	0.00	3.88	0 00:00	0.00	0.00
23	SDMH-03	Junction	4629.70	4634.69	4629.70	4633.75	12.60	0.53	4629.96	0.00	4.73	0 00:00	0.00	0.00
24	SDMH-04	Junction	4628.30	4633.28	4628.30	4632.28	12.60	1.16	4628.66	0.00	4.62	0 00:00	0.00	0.00
25	SDMH-05	Junction	4627.10	4632.21	4626.85	4631.21	12.60	1.14	4628.27	0.00	3.94	0 00:00	0.00	0.00
26	SDMH-06	Junction	4626.60	4631.51	4626.60	4630.51	12.60	1.45	4628.26	0.00	3.25	0 00:00	0.00	0.00
27	SDMH-07	Junction	4626.65	4632.02	4626.60	4631.02	19.60	10.66	4628.40	0.00	3.62	0 00:00	0.00	0.00
28	SDMH-08	Junction	4626.25	4631.80	4626.25	4630.80	28.30	13.46	4628.24	0.00	3.56	0 00:00	0.00	0.00
29	SDMH-09	Junction	4626.70	4632.16	4626.70	4631.16	19.60	2.39	4628.25	0.00	3.91	0 00:00	0.00	0.00
30	SDMH-10	Junction	4628.00	4633.02	4628.00	4632.02	19.60	1.70	4628.56	0.00	4.46	0 00:00	0.00	0.00
31	SDMH-11	Junction	4627.70	4633.36	4627.70	4632.36	19.60	2.46	4628.28	0.00	5.08	0 00:00	0.00	0.00
32	SDMH-12	Junction	4628.70	4633.51	4628.70	4632.51	12.60	1.11	4629.03	0.00	4.48	0 00:00	0.00	0.00
33	SDMH-13	Junction	4626.30	4631.94	4626.30	4630.94	19.60	2.32	4626.89	0.00	5.05	0 00:00	0.00	0.00
34	SDMH-14	Junction	4625.80	4633.18	4625.80	4632.18	19.60	2.32	4626.54	0.00	6.64	0 00:00	0.00	0.00
35	SIDEWALK_CROSS_DRAIN	Junction	4633.46	4633.88	4633.46	4632.88	10.00	2.17	4634.12	0.00	0.76	0 00:00	0.00	0.00
36	STUB-01	Junction	4626.79	4632.17	4626.79	4631.17	7.06	9.69	4628.54	0.00	3.63	0 00:00	0.00	0.00
37	FES-04	Outfall	4625.27					2.29	4625.78					
38	Jun-94	Outfall	4631.78					2.99	4632.40					
39	Out-05	Outfall	4624.56					13.73	4625.73					
40	Out-12	Outfall	4627.75					5.58	4628.35					
41	Out-13	Outfall	4632.00					0.00	4632.00					
42	PH2A-OFF-01	Outfall	4636.36					0.71	4636.36					
43	PH2A-OFF-02	Outfall	4633.64					1.17	4633.64					
44	PH2B-OFF-01	Outfall	4633.02					0.08	4633.02					
45	PH2B-OFF-02	Outfall	4632.19					0.26	4632.19					
46	DET-B101	Storage Node	4628.80	4633.50	4628.80		5500.00	5.83	4629.51				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	CULV-01	Pipe	Jun-39	Out-05	56.00	4624.74	4624.56	0.3200	42.000	0.0130	13.73	57.04	0.24	4.22	1.30	0.37	0.00	Calculated
2	LAT_2A-01	Pipe	CB2A-01	SDMH_2A-02	64.37	4634.23	4632.35	2.9200	15.000	0.0130	0.45	11.04	0.04	2.41	0.38	0.30	0.00	Calculated
3	LAT_2A-02	Pipe	CB2A-02	SDMH_2A-02	28.37	4634.23	4632.35	6.6300	15.000	0.0130	0.18	16.63	0.01	2.42	0.34	0.27	0.00	Calculated
4	LAT_2A-03	Pipe	CB2A-03	SDMH_2A-03	44.57	4631.64	4629.30	5.2500	15.000	0.0130	0.69	14.80	0.05	4.53	0.26	0.21	0.00	Calculated
5	LAT_2A-04	Pipe	CB2A-04	SDMH_2A-01	58.37	4634.20	4632.60	2.7400	15.000	0.0130	1.97	10.70	0.18	4.27	0.50	0.40	0.00	Calculated
6	LAT_2A-05	Pipe	CB2A-05	SDMH_2A-01	22.37	4634.20	4632.60	7.1500	15.000	0.0130	0.45	17.28	0.03	3.01	0.38	0.31	0.00	Calculated
7	LAT_2A-06	Pipe	CB2A-06	SDMH_2A-03	30.98	4631.46	4629.30	6.9700	15.000	0.0130	0.67	17.06	0.04	4.89	0.26	0.21	0.00	Calculated
8	LAT_2A-07	Pipe	CB2A-07	SDMH_2A-09	59.89	4635.18	4633.10	3.4700	15.000	0.0130	0.70	12.04	0.06	4.49	0.24	0.19	0.00	Calculated
9	LAT_2A-08	Pipe	CB2A-08	SDMH_2A-09	29.41	4635.58	4633.10	8.4300	15.000	0.0130	0.45	18.76	0.02	4.58	0.21	0.16	0.00	Calculated
10	LAT_2A-09	Pipe	CB2A-09	SDMH_2A-14	28.49	4634.10	4632.00	7.3700	15.000	0.0130	0.61	17.54	0.03	4.43	0.24	0.19	0.00	Calculated
11	LAT_2A-10	Pipe	CB2A-10	SDMH_2A-14	51.02	4634.41	4632.00	4.7200	15.000	0.0130	0.53	14.04	0.04	3.63	0.24	0.19	0.00	Calculated
12	LAT_2A-11	Pipe	CB2A-11	SDMH_2A-15	28.49	4632.65	4630.65	7.0200	15.000	0.0130	0.77	17.12	0.04	4.66	0.24	0.20	0.00	Calculated
13	LAT_2A-12	Pipe	CB2A-12	SDMH_2A-15	51.03	4632.92	4630.65	4.4500	15.000	0.0130	0.66	13.62	0.05	3.82	0.25	0.20	0.00	Calculated
14	LAT_2A-13	Pipe	CB2A-13	SDMH_2A-05	29.99	4629.83	4627.30	8.4400	15.000	0.0130	1.25	18.76	0.07	5.70	0.73	0.59	0.00	Calculated
15	LAT_2A-14	Pipe	CB2A-14	SDMH_2A-06	5.23	4628.83	4627.95	16.8300	15.000	0.0130	0.88	26.50	0.03	6.60	0.53	0.42	0.00	Calculated
16	LAT_2A-15	Pipe	CB2A-15	SDMH_2A-13	22.14	4631.42	4629.35	9.3500	15.000	0.0130	2.04	19.75	0.10	6.09	0.61	0.49	0.00	Calculated
17	LAT_2A-16	Pipe	CB2A-16	SDMH_2A-13	12.83	4631.33	4629.35	15.4300	15.000	0.0130	0.70	25.38	0.03	4.04	0.54	0.44	0.00	Calculated
18	LAT_2B-01	Pipe	CB2B-01	SDMH_2B-02	29.90	4634.06	4631.90	7.2200	15.000	0.0130	0.71	17.36	0.04	4.58	0.29	0.23	0.00	Calculated
19	LAT_2B-02	Pipe	CB2B-02	SDMH_2B-02	48.16	4633.54	4631.90	3.4100	15.000	0.0130	0.60	11.92	0.05	3.56	0.30	0.24	0.00	Calculated
20	LAT_2B-03	Pipe	CB2B-03	SDMH_2B-01	29.49	4631.84	4629.70	7.2600	15.000	0.0130	0.88	17.40	0.05	5.25	0.26	0.21	0.00	Calculated
21	LAT_2B-04	Pipe	CB2B-04	SDMH_2B-03	28.86	4632.78	4630.70	7.2100	15.000	0.0130	0.81	17.34	0.05	4.69	0.36	0.29	0.00	Calculated
22	LAT_2B-05	Pipe	CB2B-05	SDMH_2B-02	29.41	4633.54	4631.90	5.5800	15.000	0.0130	0.36	15.25	0.02	3.44	0.27	0.21	0.00	Calculated
23	LAT_2B-06	Pipe	CB2B-06	SDMH_2B-01	89.05	4632.29	4629.70	2.9100	15.000	0.0130	0.45	11.02	0.04	2.75	0.26	0.21	0.00	Calculated
24	LAT_2B-07	Pipe	CB2B-07	SDMH_2B-03	7.63	4631.79	4630.70	14.2900	15.000	0.0130	0.55	24.42	0.02	4.86	0.33	0.27	0.00	Calculated
25	LAT_2B-08	Pipe	CB2B-08	SDMH_2B-05	7.56	4629.88	4629.10	10.3200	15.000	0.0130	1.09	20.75	0.05	5.09	0.47	0.37	0.00	Calculated
26	LAT-05	Pipe	CB-05	SDMH-03	42.90	4631.96	4629.80	5.0300	15.000	0.0130	0.24	14.49	0.02	3.79	0.14	0.11	0.00	Calculated
27	LAT-06	Pipe	CB-06	SDMH-03	33.92	4632.16	4629.80	6.9600	15.000	0.0130	0.29	17.04	0.02	4.47	0.14	0.11	0.00	Calculated
28	LAT-07	Pipe	CB-07	SDMH-04	42.90	4630.35	4628.40	4.5500	15.000	0.0130	0.41	13.77	0.03	3.80	0.20	0.16	0.00	Calculated
29	LAT-08	Pipe	CB-08	SDMH-04	4.90	4629.05	4628.40	13.2700	15.000	0.0130	0.28	23.53	0.01	4.14	0.18	0.14	0.00	Calculated
30	LAT-09	Pipe	CB-09	SDMH-07	10.80	4627.78	4626.65	10.4600	15.000	0.0130	1.06	20.90	0.05	4.57	0.94	0.75	0.00	Calculated
31	LAT-10	Pipe	CB-10	SDMH-06	4.90	4627.28	4626.70	11.8400	15.000	0.0130	0.63	22.22	0.03	4.57	1.12	0.89	0.00	Calculated
32	LAT-11	Pipe	CB-11	SDMH-10	30.92	4629.33	4628.10	3.9800	15.000	0.0130	0.25	12.88	0.02	2.14	0.29	0.23	0.00	Calculated
33	LAT-12	Pipe	CB-13	SDMH-10	58.80	4629.33	4628.10	2.0900	15.000	0.0130	1.46	9.34	0.16	4.18	0.41	0.33	0.00	Calculated
34	LAT-13	Pipe	CB-12	SDMH-11	45.01	4628.83	4627.80	2.2900	15.000	0.0130	0.20	9.77	0.02	2.01	0.29	0.23	0.00	Calculated
35	LAT-14	Pipe	CB-14	SDMH-11	66.57	4629.33	4627.80	2.3000	15.000	0.0130	0.57	9.79	0.06	2.96	0.32	0.26	0.00	Calculated
36	LAT-15	Pipe	CB-16	SDMH-12	66.21	4629.45	4629.05	0.6000	15.000	0.0130	0.43	5.02	0.08	2.39	0.25	0.20	0.00	Calculated
37	LAT-16	Pipe	CB-15	SDMH-12	74.17	4630.78	4629.05	2.3300	15.000	0.0130	0.49	9.87	0.05	4.05	0.19	0.15	0.00	Calculated
38	LAT-17	Pipe	CB-17	SDMH-12	43.42	4629.45	4629.05	0.9200	15.000	0.0150	0.20	5.37	0.04	2.02	0.17	0.13	0.00	Calculated
39	LAT-18	Pipe	CB-18	SDMH-13	36.89	4629.09	4626.90	5.9400	15.000	0.0130	0.78	15.74	0.05	6.26	0.20	0.16	0.00	Calculated
40	LAT-19	Pipe	CB-19	SDMH-13	10.90	4628.09	4626.90	10.9200	15.000	0.0130	0.53	21.34	0.02	6.25	0.15	0.12	0.00	Calculated
41	PIPE-03	Pipe	SDMH-03	SDMH-04	235.00	4629.70	4628.40	0.5500	18.000	0.0130	0.50	7.81	0.06	2.43	0.26	0.17	0.00	Calculated
42	PIPE-04	Pipe	SDMH-04	SDMH-05	143.18	4628.30	4627.20	0.7700	18.000	0.0130	1.14	9.21	0.12	3.08	0.70	0.47	0.00	Calculated
43	PIPE-05	Pipe	SDMH-05	SDMH-06	92.49	4627.10	4626.70	0.4300	18.000	0.0130	0.93	6.91	0.14	1.91	1.33	0.89	0.00	Calculated
44	PIPE-06	Pipe	SDMH-06	SDMH-08	58.22	4626.60	4626.35	0.4300	18.000	0.0130	1.43	6.88	0.21	1.57	1.50	1.00	6.00	SURCHARGED
45	PIPE-07	Pipe	STUB-01	SDMH-07	10.00	4626.79	4626.75	0.4000	30.000	0.0130	9.70	25.94	0.37	2.92	1.70	0.68	0.00	Calculated
46	PIPE-08	Pipe	SDMH-07	SDMH-08	68.63	4626.65	4626.35	0.4400	30.000	0.0130	10.67	27.12	0.39	2.89	1.82	0.73	0.00	Calculated
47	PIPE-09	Pipe	SDMH-10	SDMH-11	38.50	4628.00	4627.80	0.5200	18.000	0.0130	1.69	7.57	0.22	3.09	0.52	0.35	0.00	Calculated
48	PIPE-10	Pipe	SDMH-11	SDMH-09	214.29	4627.70	4626.80	0.4200	24.000	0.0130	2.39	14.66	0.16	2.68	1.02	0.51	0.00	Calculated
49	PIPE-12	Pipe	SDMH-09	SDMH-08	69.87	4626.70	4626.35	0.5000	24.000	0.0130	1.90	16.01	0.12	1.51	1.72	0.86	0.00	Calculated

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
50	PIPE-13	Pipe	SDMH-08	FES-03	44.05	4626.25	4626.10	0.3400	36.000	0.0130	13.51	38.92	0.35	2.72	2.00	0.67	0.00	Calculated
51	PIPE-14	Pipe	SDMH-12	SDMH-13	270.27	4628.70	4626.90	0.6700	24.000	0.0130	1.06	18.46	0.06	3.13	0.33	0.16	0.00	Calculated
52	PIPE-15	Pipe	SDMH-13	SDMH-14	88.43	4626.30	4625.90	0.4500	24.000	0.0130	2.32	15.21	0.15	2.88	0.61	0.31	0.00	Calculated
53	PIPE-16	Pipe	SDMH-14	FES-04	107.76	4625.80	4625.27	0.4900	24.000	0.0130	2.29	15.87	0.14	2.72	0.63	0.31	0.00	Calculated
54	PIPE-2A-01	Pipe	SDMH_2A-01	SDMH_2A-02	37.50	4632.50	4632.35	0.4000	18.000	0.0130	2.39	6.64	0.36	3.22	0.66	0.44	0.00	Calculated
55	PIPE-2A-02	Pipe	SDMH_2A-02	Jun-94	117.25	4632.25	4631.78	0.4000	24.000	0.0130	2.99	14.32	0.21	3.36	0.65	0.33	0.00	Calculated
56	PIPE-2A-03	Pipe	SDMH_2A-03	SDMH_2A-04	252.27	4629.20	4628.05	0.4600	18.000	0.0130	1.35	7.09	0.19	2.95	0.54	0.36	0.00	Calculated
57	PIPE-2A-04	Pipe	SDMH_2A-04	SDMH_2A-05	52.87	4627.95	4627.30	1.2300	18.000	0.0130	1.11	11.65	0.10	1.60	1.11	0.74	0.00	Calculated
58	PIPE-2A-05	Pipe	SDMH_2A-06	SDMH_2A-05	11.57	4627.35	4627.30	0.4300	30.000	0.0130	7.64	26.96	0.28	2.82	1.47	0.59	0.00	Calculated
59	PIPE-2A-06	Pipe	SDMH_2A-07	SDMH_2A-06	65.14	4627.80	4627.45	0.5400	30.000	0.0130	6.88	30.07	0.23	2.98	1.28	0.51	0.00	Calculated
60	PIPE-2A-07	Pipe	SDMH_2A-08	SDMH_2A-07	191.56	4628.90	4627.90	0.5200	30.000	0.0130	7.13	29.64	0.24	4.16	0.97	0.39	0.00	Calculated
61	PIPE-2A-08	Pipe	SDMH_2A-13	SDMH_2A-08	64.05	4629.25	4629.00	0.3900	24.000	0.0130	5.85	14.13	0.41	3.96	0.95	0.48	0.00	Calculated
62	PIPE-2A-09	Pipe	SDMH_2A-12	SDMH_2A-13	60.96	4629.60	4629.35	0.4100	24.000	0.0130	3.46	14.49	0.24	2.57	0.91	0.45	0.00	Calculated
63	PIPE-2A-10	Pipe	SDMH_2A-11	SDMH_2A-12	85.72	4630.05	4629.70	0.4100	24.000	0.0130	3.45	14.46	0.24	3.15	0.76	0.38	0.00	Calculated
64	PIPE-2A-11	Pipe	SDMH_2A-15	SDMH_2A-11	80.00	4630.55	4630.15	0.5000	24.000	0.0130	1.42	16.00	0.09	2.44	0.53	0.26	0.00	Calculated
65	PIPE-2A-12	Pipe	SDMH_2A-10	SDMH_2A-11	250.00	4631.35	4630.15	0.4800	24.000	0.0130	2.18	15.67	0.14	2.86	0.59	0.29	0.00	Calculated
66	PIPE-2A-13	Pipe	SDMH_2A-14	SDMH_2A-10	80.00	4631.90	4631.45	0.5600	18.000	0.0130	1.13	7.88	0.14	2.92	0.41	0.27	0.00	Calculated
67	PIPE-2A-14	Pipe	SDMH_2A-09	SDMH_2A-10	242.25	4633.00	4631.45	0.6400	18.000	0.0130	1.12	8.40	0.13	3.09	0.39	0.26	0.00	Calculated
68	PIPE-2A-CONNECTION	Pipe	SDMH_2A-05	STUB-01	109.14	4627.20	4626.79	0.3800	30.000	0.0130	9.69	25.14	0.39	3.06	1.64	0.66	0.00	Calculated
69	PIPE-2B-01	Pipe	SDMH_2B-01	SDMH_2A-08	138.44	4629.60	4629.00	0.4300	18.000	0.0130	1.30	6.92	0.19	2.22	0.62	0.42	0.00	Calculated
70	PIPE-2B-02	Pipe	SDMH_2B-02	SDMH_2B-03	248.25	4631.80	4630.70	0.4400	18.000	0.0130	1.63	6.99	0.23	2.97	0.52	0.35	0.00	Calculated
71	PIPE-2B-03	Pipe	SDMH_2B-03	SDMH_2B-04	124.95	4630.60	4630.05	0.4400	24.000	0.0130	2.84	15.01	0.19	3.46	0.62	0.31	0.00	Calculated
72	PIPE-2B-04	Pipe	SDMH_2B-04	SDMH_2B-05	207.84	4629.95	4629.10	0.4100	24.000	0.0130	2.86	14.47	0.20	3.08	0.67	0.34	0.00	Calculated
73	PIPE-2B-05	Pipe	SDMH_2B-05	DET-B101	49.25	4629.00	4628.80	0.4100	24.000	0.0130	3.86	14.42	0.27	3.45	0.77	0.39	0.00	Calculated
74	PIPE-2B-06	Pipe	DET-B101	Out-12	66.39	4628.00	4627.60	0.6000	24.000	0.0130	5.58	28.45	0.20	6.23	0.66	0.33	0.00	Calculated
75	BYPASS_16_17	Channel	CB-15	CB-18	337.95	4633.78	4632.09	0.5000	8.640	0.0320	0.06	18.05	0.00	1.18	0.22	0.30	0.00	
76	BYPASS-03-04	Channel	CB2A-03	CB2A-14	375.28	4634.64	4632.83	0.4800	6.120	0.0320	0.18	9.54	0.02	1.02	0.21	0.41	0.00	
77	BYPASS-05-07	Channel	CB-05	CB-07	235.00	4634.96	4633.35	0.6900	8.640	0.0320	0.01	21.12	0.00	0.53	0.10	0.13	0.00	
78	BYPASS-06-08	Channel	CB-06	CB-08	267.99	4635.16	4633.55	0.6000	8.640	0.0320	0.02	19.79	0.00	0.70	0.09	0.13	0.00	
79	BYPASS-06-13	Channel	CB2A-06	CB2A-13	306.42	4634.46	4632.83	0.5300	6.120	0.0320	0.17	10.04	0.02	0.60	0.23	0.45	0.00	
80	BYPASS-07-09	Channel	CB-07	CB-09	226.71	4633.35	4631.78	0.6900	8.640	0.0320	0.04	21.24	0.00	1.09	0.25	0.34	0.00	
81	BYPASS-07-18	Channel	CB2A-07	CB2B-01	232.00	4638.18	4637.06	0.4800	6.120	0.0320	0.19	9.56	0.02	2.56	0.12	0.24	0.00	
82	BYPASS-08-10	Channel	CB-08	CB-10	238.38	4633.55	4631.78	0.7400	8.640	0.0320	0.03	22.00	0.00	1.09	0.16	0.22	0.00	
83	BYPASS-08-19	Channel	CB2A-08	CB2A-15	647.42	4638.58	4634.42	0.6400	6.120	0.0320	0.05	11.01	0.00	0.51	0.18	0.35	0.00	
84	BYPASS-09-15	Channel	CB2A-09	CB2A-15	495.00	4637.10	4634.42	0.5400	6.120	0.0320	0.13	10.13	0.01	0.59	0.20	0.40	0.00	
85	BYPASS-10-15	Channel	CB2A-10	CB2A-15	512.00	4637.41	4634.42	0.5800	6.120	0.0320	0.08	10.50	0.01	0.59	0.19	0.37	0.00	
86	BYPASS-11-15	Channel	CB2A-11	CB2A-15	242.29	4635.65	4634.42	0.5100	6.120	0.0320	0.23	9.81	0.02	0.74	0.22	0.42	0.00	
87	BYPASS-12-16	Channel	CB2A-12	CB2A-16	275.17	4635.92	4634.33	0.5800	6.120	0.0320	0.17	10.44	0.02	2.11	0.13	0.25	0.00	
88	BYPASS-15-13	Channel	CB2A-15	CB2A-13	332.45	4634.42	4632.83	0.4800	6.120	0.0320	1.06	9.52	0.11	1.84	0.28	0.55	0.00	
89	BYPASS-16-13	Channel	CB2A-16	CB2A-13	275.96	4634.33	4632.83	0.5400	6.120	0.0320	0.04	10.15	0.00	0.17	0.20	0.39	0.00	
90	BYPASS-18-21	Channel	CB2B-01	CB2B-04	248.00	4637.06	4635.78	0.5200	6.120	0.0320	0.12	9.89	0.01	6.86	0.08	0.16	0.00	
91	BYPASS-20-13	Channel	CB2B-03	CB2A-13	393.54	4634.84	4632.83	0.5100	6.120	0.0320	0.32	9.84	0.03	0.90	0.24	0.48	0.00	
92	BYPASS-21-XDRAIN	Channel	CB2B-04	SIDEWALK_CROSS_DRAIN	369.46	4635.78	4633.88	0.5100	6.120	0.0320	0.19	9.87	0.02	8.36	0.20	0.39	0.00	
93	BYPASS-23-13	Channel	CB2B-06	CB2A-13	483.60	4635.29	4632.83	0.5100	6.120	0.0320	0.04	9.82	0.00	0.25	0.21	0.41	0.00	
94	BYPASS-25-26	Channel	CB2B-07	CB2B-08	330.35	4635.79	4633.88	0.5800	6.120	0.0320	0.11	10.45	0.01	0.67	0.24	0.48	0.00	
95	CHANNEL-01	Channel	FES-03	Jun-39	410.00	4626.10	4624.74	0.3300	72.000	0.0320	14.16	371.84	0.04	2.50	1.69	0.28	0.00	
96	Link-117	Channel	SIDEWALK_CROSS_DRAIN	DET-B101	38.99	4633.88	4628.80	13.0300	12.000	0.0320	1.98	14.29	0.14	3.00	0.47	0.47	0.00	
97	Weir-01	Weir	DET-B101	Out-13		4628.80	4632.00				0.00							

Inlet Summary

SN	Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Initial Water Elevation (ft)	Ponded Area (ft^2)	Peak Flow (cfs)	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Allowable Spread (ft)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)
1	CB-05	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.96	4634.96	4631.96	N/A	0.26	0.01	0.25	3.67	7.00	2.14	4635.00
2	CB-06	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.16	4635.16	4632.16	N/A	0.31	0.01	0.30	3.44	7.00	2.29	4635.21
3	CB-07	FHWA HEC-22 GENERIC	N/A	On Grade	1	4630.35	4633.35	0.00	N/A	0.45	0.42	0.04	92.15	7.00	4.58	4633.53
4	CB-08	FHWA HEC-22 GENERIC	N/A	On Grade	1	4629.05	4633.55	4629.05	N/A	0.31	0.01	0.29	4.79	7.00	2.52	4633.60
5	CB-09	FHWA HEC-22 GENERIC	N/A	On Sag	1	4627.78	4631.78	4627.78	40.00	1.26	N/A	N/A	N/A	7.00	6.57	4632.02
6	CB-10	FHWA HEC-22 GENERIC	N/A	On Sag	1	4627.28	4631.78	4627.28	40.00	0.64	N/A	N/A	N/A	7.00	2.57	4631.94
7	CB-11	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.33	4632.83	4629.33	40.00	0.25	N/A	N/A	N/A	7.00	1.85	4632.97
8	CB-12	FHWA HEC-22 GENERIC	N/A	On Sag	1	4628.83	4632.83	4628.83	40.00	0.20	N/A	N/A	N/A	7.00	1.73	4632.97
9	CB-13	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.33	4632.83	4629.33	40.00	1.46	N/A	N/A	N/A	7.00	7.34	4633.08
10	CB-14	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.33	4632.83	4629.33	40.00	0.58	N/A	N/A	N/A	7.00	2.47	4632.98
11	CB-15	FHWA HEC-22 GENERIC	N/A	On Grade	1	4630.78	4633.78	4630.78	N/A	0.57	0.50	0.07	87.50	7.00	5.49	4633.97
12	CB-16	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.45	4632.45	4629.45	40.00	0.44	N/A	N/A	N/A	7.00	2.22	4632.60
13	CB-17	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.45	4632.45	4629.45	40.00	0.20	N/A	N/A	N/A	7.00	1.73	4632.59
14	CB-18	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.09	4632.09	4629.09	40.00	0.91	N/A	N/A	N/A	7.00	2.98	4632.25
15	CB-19	FHWA HEC-22 GENERIC	N/A	On Sag	1	4628.09	4632.09	4628.09	40.00	0.53	N/A	N/A	N/A	7.00	2.39	4632.24
16	CB2A-01	FHWA HEC-22 GENERIC	N/A	On Sag	1	4634.23	4637.23	4634.23	40.00	0.46	N/A	N/A	N/A	7.00	2.26	4637.38
17	CB2A-02	FHWA HEC-22 GENERIC	N/A	On Sag	1	4634.23	4637.23	4634.23	40.00	0.18	N/A	N/A	N/A	7.00	1.68	4637.37
18	CB2A-03	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.64	4634.64	4631.64	N/A	0.87	0.69	0.18	79.86	7.00	6.83	4634.86
19	CB2A-04	FHWA HEC-22 GENERIC	N/A	On Sag	1	4634.20	4637.20	4634.20	40.00	1.97	N/A	N/A	N/A	7.00	9.23	4637.49
20	CB2A-05	FHWA HEC-22 GENERIC	N/A	On Sag	1	4634.20	4637.20	4634.20	40.00	0.46	N/A	N/A	N/A	7.00	2.26	4637.35
21	CB2A-06	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.46	4634.46	4631.46	N/A	0.85	0.68	0.17	80.34	7.00	6.74	4634.68
22	CB2A-07	FHWA HEC-22 GENERIC	N/A	On Grade	1	4635.18	4638.18	4635.18	N/A	0.89	0.71	0.18	79.48	7.00	6.88	4638.40
23	CB2A-08	FHWA HEC-22 GENERIC	N/A	On Grade	1	4635.58	4638.58	4635.58	N/A	0.50	0.45	0.05	89.49	7.00	5.14	4638.77
24	CB2A-09	FHWA HEC-22 GENERIC	N/A	On Grade	1	4634.10	4637.10	4634.10	N/A	0.74	0.62	0.12	83.75	7.00	6.02	4637.30
25	CB2A-10	FHWA HEC-22 GENERIC	N/A	On Grade	1	4634.41	4637.41	4634.41	N/A	0.62	0.54	0.08	86.92	7.00	5.49	4637.60
26	CB2A-11	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.65	4635.65	4632.65	N/A	1.00	0.77	0.23	77.31	7.00	7.28	4635.88
27	CB2A-12	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.92	4635.92	4632.92	N/A	0.83	0.67	0.16	80.83	7.00	6.65	4636.14
28	CB2A-13	FHWA HEC-22 GENERIC	N/A	On Sag	2	4629.83	4632.83	4629.83	40.00	3.39	N/A	N/A	N/A	7.00	10.59	4633.15
29	CB2A-14	FHWA HEC-22 GENERIC	N/A	On Sag	2	4628.83	4632.83	4628.83	40.00	1.20	N/A	N/A	N/A	7.00	2.88	4632.99
30	CB2A-15	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.42	4634.42	4631.12	N/A	3.10	1.76	1.34	56.67	7.00	11.05	4634.68
31	CB2A-16	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.33	4634.33	4631.33	N/A	0.74	0.68	0.07	91.13	7.00	4.49	4634.50
32	CB2B-01	FHWA HEC-22 GENERIC	N/A	On Grade	1	4634.06	4637.06	4634.06	N/A	0.78	0.67	0.11	85.97	7.00	5.42	4637.25
33	CB2B-02	FHWA HEC-22 GENERIC	N/A	On Sag	1	4633.54	4636.54	4633.54	40.00	0.61	N/A	N/A	N/A	7.00	2.53	4636.70
34	CB2B-03	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.84	4634.84	4631.84	N/A	1.20	0.89	0.32	73.75	7.00	7.96	4635.08
35	CB2B-04	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.78	4635.78	4632.78	N/A	0.88	0.70	0.18	79.67	7.00	6.86	4636.00
36	CB2B-05	FHWA HEC-22 GENERIC	N/A	On Sag	1	4633.54	4636.54	4633.54	40.00	0.36	N/A	N/A	N/A	7.00	2.08	4636.69
37	CB2B-06	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.29	4635.29	4632.29	N/A	0.50	0.46	0.05	90.62	7.00	4.85	4635.47
38	CB2B-07	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.79	4635.79	4631.79	N/A	0.67	0.56	0.10	84.79	7.00	5.96	4635.99
39	CB2B-08	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.88	4633.88	4629.88	40.00	1.62	N/A	N/A	N/A	7.00	7.95	4634.14

Project Description

File Name	BLACKSTONE PH2-A & B PROP 100YR NORMAL.SPF
Description	
	BLACKSTONE RANCH PH2
	MASTER TECHNICAL DRAINAGE ANALYSIS
	100-YEAR PROPOSED PEAK FLOW EVENT WITH
	PEAK FLOWS WITHIN CHANNELS

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	49
Nodes	85
Junctions	36
Outfalls	9
Flow Diversions	0
Inlets	39
Storage Nodes	1
Links	97
Channels	22
Pipes	74
Pumps	0
Orifices	0
Weirs	1
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	100 year(s)

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	FES-03	Junction	4626.10	4630.06	4626.10	4629.10	22520.00	31.98	4628.65	0.00	3.45	0 00:00	0.00	0.00
2	Jun-39	Junction	4624.74	4630.74	4624.74	4628.32	65.00	33.05	4627.08	0.00	3.66	0 00:00	0.00	0.00
3	SDMH_2A-01	Junction	4632.50	4637.50	4632.50	4636.50	12.60	6.16	4633.90	0.00	3.60	0 00:00	0.00	0.00
4	SDMH_2A-02	Junction	4632.25	4637.57	4632.25	4636.57	12.60	7.74	4633.47	0.00	4.10	0 00:00	0.00	0.00
5	SDMH_2A-03	Junction	4629.20	4634.20	4629.20	4633.20	12.60	2.73	4630.84	0.00	3.36	0 00:00	0.00	0.00
6	SDMH_2A-04	Junction	4627.95	4632.94	4627.95	4631.94	12.60	2.52	4630.65	0.00	2.29	0 00:00	0.00	0.00
7	SDMH_2A-05	Junction	4627.20	4632.66	4627.20	4631.66	12.60	20.95	4630.59	0.00	2.07	0 00:00	0.00	0.00
8	SDMH_2A-06	Junction	4627.35	4632.62	4627.35	4631.62	19.60	14.72	4630.75	0.00	1.87	0 00:00	0.00	0.00
9	SDMH_2A-07	Junction	4627.80	4632.96	4627.80	4631.96	19.60	13.87	4630.90	0.00	2.06	0 00:00	0.00	0.00
10	SDMH_2A-08	Junction	4628.90	4633.92	4628.90	4632.92	19.60	14.86	4631.13	0.00	2.79	0 00:00	0.00	0.00
11	SDMH_2A-09	Junction	4633.00	4638.03	4633.00	4637.03	12.60	2.32	4633.55	0.00	4.48	0 00:00	0.00	0.00
12	SDMH_2A-10	Junction	4631.35	4636.35	4631.35	4635.35	19.60	4.60	4632.08	0.00	4.27	0 00:00	0.00	0.00
13	SDMH_2A-11	Junction	4630.05	4635.05	4630.05	4634.05	19.60	7.01	4631.61	0.00	3.44	0 00:00	0.00	0.00
14	SDMH_2A-12	Junction	4629.60	4634.62	4629.60	4633.62	19.60	6.46	4631.51	0.00	3.11	0 00:00	0.00	0.00
15	SDMH_2A-13	Junction	4629.25	4634.24	4629.25	4633.24	19.60	12.69	4631.42	0.00	2.82	0 00:00	0.00	0.00
16	SDMH_2A-14	Junction	4631.90	4636.90	4631.90	4635.90	19.60	2.33	4632.53	0.00	4.37	0 00:00	0.00	0.00
17	SDMH_2A-15	Junction	4630.55	4635.46	4630.55	4634.46	19.60	2.85	4631.63	0.00	3.83	0 00:00	0.00	0.00
18	SDMH_2B-01	Junction	4629.60	4634.61	4629.60	4633.61	12.60	2.66	4631.34	0.00	3.27	0 00:00	0.00	0.00
19	SDMH_2B-02	Junction	4631.80	4636.83	4631.80	4635.83	12.60	4.29	4632.67	0.00	4.16	0 00:00	0.00	0.00
20	SDMH_2B-03	Junction	4630.60	4635.58	4630.60	4634.58	19.60	7.50	4631.74	0.00	3.84	0 00:00	0.00	0.00
21	SDMH_2B-04	Junction	4629.95	4635.08	4629.95	4634.08	19.60	7.33	4631.04	0.00	4.04	0 00:00	0.00	0.00
22	SDMH_2B-05	Junction	4629.00	4633.72	4629.00	4632.72	19.60	10.60	4630.59	0.00	3.13	0 00:00	0.00	0.00
23	SDMH-03	Junction	4629.70	4634.69	4629.70	4633.75	12.60	1.23	4630.10	0.00	4.59	0 00:00	0.00	0.00
24	SDMH-04	Junction	4628.30	4633.28	4628.30	4632.28	12.60	2.80	4629.42	0.00	3.86	0 00:00	0.00	0.00
25	SDMH-05	Junction	4627.10	4632.21	4626.85	4631.21	12.60	2.30	4629.49	0.00	2.72	0 00:00	0.00	0.00
26	SDMH-06	Junction	4626.60	4631.51	4626.60	4630.51	12.60	3.51	4629.27	0.00	2.24	0 00:00	0.00	0.00
27	SDMH-07	Junction	4626.65	4632.02	4626.60	4631.02	19.60	23.54	4629.73	0.00	2.29	0 00:00	0.00	0.00
28	SDMH-08	Junction	4626.25	4631.80	4626.25	4630.80	28.30	31.62	4629.14	0.00	2.66	0 00:00	0.00	0.00
29	SDMH-09	Junction	4626.70	4632.16	4626.70	4631.16	19.60	5.27	4629.20	0.00	2.96	0 00:00	0.00	0.00
30	SDMH-10	Junction	4628.00	4633.02	4628.00	4632.02	19.60	4.40	4629.41	0.00	3.61	0 00:00	0.00	0.00
31	SDMH-11	Junction	4627.70	4633.36	4627.70	4632.36	19.60	5.72	4629.31	0.00	4.05	0 00:00	0.00	0.00
32	SDMH-12	Junction	4628.70	4633.51	4628.70	4632.51	12.60	2.50	4629.21	0.00	4.30	0 00:00	0.00	0.00
33	SDMH-13	Junction	4626.30	4631.94	4626.30	4630.94	19.60	5.40	4627.30	0.00	4.64	0 00:00	0.00	0.00
34	SDMH-14	Junction	4625.80	4633.18	4625.80	4632.18	19.60	5.38	4626.98	0.00	6.20	0 00:00	0.00	0.00
35	SIDEWALK_CROSS_DRAIN	Junction	4633.46	4633.88	4633.46	4632.88	10.00	5.91	4634.33	0.00	0.55	0 00:00	0.00	0.00
36	STUB-01	Junction	4626.79	4632.17	4626.79	4631.17	7.06	20.97	4630.03	0.00	2.14	0 00:00	0.00	0.00
37	FES-04	Outfall	4625.27					5.34	4626.07					
38	Jun-94	Outfall	4631.78					7.67	4632.82					
39	Out-05	Outfall	4624.56					31.62	4626.42					
40	Out-12	Outfall	4627.75					14.62	4628.77					
41	Out-13	Outfall	4632.00					0.00	4632.00					
42	PH2A-OFF-01	Outfall	4636.36					1.81	4636.36					
43	PH2A-OFF-02	Outfall	4633.64					2.98	4633.64					
44	PH2B-OFF-01	Outfall	4633.02					0.37	4633.02					
45	PH2B-OFF-02	Outfall	4632.19					0.66	4632.19					
46	DET-B101	Storage Node	4628.80	4633.50	4628.80		5500.00	15.76	4630.12				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	CULV-01	Pipe	Jun-39	Out-05	56.00	4624.74	4624.56	0.3200	42.000	0.0130	31.62	57.04	0.55	5.24	2.10	0.60	0.00	Calculated
2	LAT_2A-01	Pipe	CB2A-01	SDMH_2A-02	64.37	4634.23	4632.35	2.9200	15.000	0.0130	1.17	11.04	0.11	2.81	0.69	0.56	0.00	Calculated
3	LAT_2A-02	Pipe	CB2A-02	SDMH_2A-02	28.37	4634.23	4632.35	6.6300	15.000	0.0130	0.46	16.63	0.03	2.84	0.63	0.50	0.00	Calculated
4	LAT_2A-03	Pipe	CB2A-03	SDMH_2A-03	44.57	4631.64	4629.30	5.2500	15.000	0.0130	1.38	14.80	0.09	5.23	0.75	0.60	0.00	Calculated
5	LAT_2A-04	Pipe	CB2A-04	SDMH_2A-01	58.37	4634.20	4632.60	2.7400	15.000	0.0130	4.99	10.70	0.47	4.88	0.97	0.78	0.00	Calculated
6	LAT_2A-05	Pipe	CB2A-05	SDMH_2A-01	22.37	4634.20	4632.60	7.1500	15.000	0.0130	1.17	17.28	0.07	3.41	0.74	0.59	0.00	Calculated
7	LAT_2A-06	Pipe	CB2A-06	SDMH_2A-03	30.98	4631.46	4629.30	6.9700	15.000	0.0130	1.35	17.06	0.08	5.63	0.74	0.59	0.00	Calculated
8	LAT_2A-07	Pipe	CB2A-07	SDMH_2A-09	59.89	4635.18	4633.10	3.4700	15.000	0.0130	1.40	12.04	0.12	4.89	0.37	0.30	0.00	Calculated
9	LAT_2A-08	Pipe	CB2A-08	SDMH_2A-09	29.41	4635.58	4633.10	8.4300	15.000	0.0130	0.93	18.76	0.05	5.26	0.32	0.26	0.00	Calculated
10	LAT_2A-09	Pipe	CB2A-09	SDMH_2A-14	28.49	4634.10	4632.00	7.3700	15.000	0.0130	1.24	17.54	0.07	4.98	0.38	0.30	0.00	Calculated
11	LAT_2A-10	Pipe	CB2A-10	SDMH_2A-14	51.02	4634.41	4632.00	4.7200	15.000	0.0130	1.09	14.04	0.08	4.02	0.38	0.31	0.00	Calculated
12	LAT_2A-11	Pipe	CB2A-11	SDMH_2A-15	28.49	4632.65	4630.65	7.0200	15.000	0.0130	1.52	17.12	0.09	5.19	0.60	0.48	0.00	Calculated
13	LAT_2A-12	Pipe	CB2A-12	SDMH_2A-15	51.03	4632.92	4630.65	4.4500	15.000	0.0130	1.33	13.62	0.10	4.18	0.60	0.48	0.00	Calculated
14	LAT_2A-13	Pipe	CB2A-13	SDMH_2A-05	29.99	4629.83	4627.30	8.4400	15.000	0.0130	4.39	18.76	0.23	6.66	1.13	0.90	0.00	Calculated
15	LAT_2A-14	Pipe	CB2A-14	SDMH_2A-06	5.23	4628.83	4627.95	16.8300	15.000	0.0130	2.61	26.50	0.10	6.85	1.25	1.00	8.00	SURCHARGED
16	LAT_2A-15	Pipe	CB2A-15	SDMH_2A-13	22.14	4631.42	4629.35	9.3500	15.000	0.0130	5.06	19.75	0.26	6.78	0.93	0.75	0.00	Calculated
17	LAT_2A-16	Pipe	CB2A-16	SDMH_2A-13	12.83	4631.33	4629.35	15.4300	15.000	0.0130	1.82	25.38	0.07	4.55	0.74	0.59	0.00	Calculated
18	LAT_2B-01	Pipe	CB2B-01	SDMH_2B-02	29.90	4634.06	4631.90	7.2200	15.000	0.0130	1.85	17.36	0.11	5.16	0.53	0.42	0.00	Calculated
19	LAT_2B-02	Pipe	CB2B-02	SDMH_2B-02	48.16	4633.54	4631.90	3.4100	15.000	0.0130	1.55	11.92	0.13	3.99	0.54	0.43	0.00	Calculated
20	LAT_2B-03	Pipe	CB2B-03	SDMH_2B-01	29.49	4631.84	4629.70	7.2600	15.000	0.0130	1.73	17.40	0.10	5.96	0.75	0.60	0.00	Calculated
21	LAT_2B-04	Pipe	CB2B-04	SDMH_2B-03	28.86	4632.78	4630.70	7.2100	15.000	0.0130	2.27	17.34	0.13	5.35	0.66	0.53	0.00	Calculated
22	LAT_2B-05	Pipe	CB2B-05	SDMH_2B-02	29.41	4633.54	4631.90	5.5800	15.000	0.0130	0.92	15.25	0.06	3.87	0.49	0.39	0.00	Calculated
23	LAT_2B-06	Pipe	CB2B-06	SDMH_2B-01	89.05	4632.29	4629.70	2.9100	15.000	0.0130	0.93	11.02	0.08	3.12	0.74	0.59	0.00	Calculated
24	LAT_2B-07	Pipe	CB2B-07	SDMH_2B-03	7.63	4631.79	4630.70	14.2900	15.000	0.0130	1.14	24.42	0.05	5.50	0.61	0.49	0.00	Calculated
25	LAT_2B-08	Pipe	CB2B-08	SDMH_2B-05	7.56	4629.88	4629.10	10.3200	15.000	0.0130	3.42	20.75	0.16	5.51	1.02	0.82	0.00	Calculated
26	LAT-05	Pipe	CB-05	SDMH-03	42.90	4631.96	4629.80	5.0300	15.000	0.0130	0.57	14.49	0.04	4.22	0.23	0.19	0.00	Calculated
27	LAT-06	Pipe	CB-06	SDMH-03	33.92	4632.16	4629.80	6.9600	15.000	0.0130	0.65	17.04	0.04	4.95	0.23	0.19	0.00	Calculated
28	LAT-07	Pipe	CB-07	SDMH-04	42.90	4630.35	4628.40	4.5500	15.000	0.0130	0.91	13.77	0.07	4.27	0.60	0.48	0.00	Calculated
29	LAT-08	Pipe	CB-08	SDMH-04	4.90	4629.05	4628.40	13.2700	15.000	0.0130	0.72	23.53	0.03	4.63	0.70	0.56	0.00	Calculated
30	LAT-09	Pipe	CB-09	SDMH-07	10.80	4627.78	4626.65	10.4600	15.000	0.0130	3.01	20.90	0.14	5.28	1.25	1.00	10.00	SURCHARGED
31	LAT-10	Pipe	CB-10	SDMH-06	4.90	4627.28	4626.70	11.8400	15.000	0.0130	1.51	22.22	0.07	5.03	1.25	1.00	12.00	SURCHARGED
32	LAT-11	Pipe	CB-11	SDMH-10	30.92	4629.33	4628.10	3.9800	15.000	0.0130	0.62	12.88	0.05	2.37	0.72	0.57	0.00	Calculated
33	LAT-12	Pipe	CB-13	SDMH-10	58.80	4629.33	4628.10	2.0900	15.000	0.0130	3.78	9.34	0.40	4.58	0.89	0.71	0.00	Calculated
34	LAT-13	Pipe	CB-12	SDMH-11	45.01	4628.83	4627.80	2.2900	15.000	0.0130	0.46	9.77	0.05	2.19	0.87	0.70	0.00	Calculated
35	LAT-14	Pipe	CB-14	SDMH-11	66.57	4629.33	4627.80	2.3000	15.000	0.0130	1.35	9.79	0.14	3.41	0.78	0.63	0.00	Calculated
36	LAT-15	Pipe	CB-16	SDMH-12	66.21	4629.45	4629.05	0.6000	15.000	0.0130	1.09	5.02	0.22	3.06	0.41	0.33	0.00	Calculated
37	LAT-16	Pipe	CB-15	SDMH-12	74.17	4630.78	4629.05	2.3300	15.000	0.0130	1.01	9.87	0.10	4.93	0.28	0.22	0.00	Calculated
38	LAT-17	Pipe	CB-17	SDMH-12	43.42	4629.45	4629.05	0.9200	15.000	0.0150	0.41	5.37	0.08	2.48	0.24	0.19	0.00	Calculated
39	LAT-18	Pipe	CB-18	SDMH-13	36.89	4629.09	4626.90	5.9400	15.000	0.0130	1.79	15.74	0.11	7.44	0.35	0.28	0.00	Calculated
40	LAT-19	Pipe	CB-19	SDMH-13	10.90	4628.09	4626.90	10.9200	15.000	0.0130	1.35	21.34	0.06	7.45	0.32	0.26	0.00	Calculated
41	PIPE-03	Pipe	SDMH-03	SDMH-04	235.00	4629.70	4628.40	0.5500	18.000	0.0130	1.20	7.81	0.15	2.82	0.69	0.46	0.00	Calculated
42	PIPE-04	Pipe	SDMH-04	SDMH-05	143.18	4628.30	4627.20	0.7700	18.000	0.0130	2.30	9.21	0.25	3.51	1.31	0.87	0.00	Calculated
43	PIPE-05	Pipe	SDMH-05	SDMH-06	92.49	4627.10	4626.70	0.4300	18.000	0.0130	2.30	6.91	0.33	2.25	1.50	1.00	11.00	SURCHARGED
44	PIPE-06	Pipe	SDMH-06	SDMH-08	58.22	4626.60	4626.35	0.4300	18.000	0.0130	3.51	6.88	0.51	1.99	1.50	1.00	16.00	SURCHARGED
45	PIPE-07	Pipe	STUB-01	SDMH-07	10.00	4626.79	4626.75	0.4000	30.000	0.0130	20.97	25.94	0.81	4.27	2.50	1.00	8.00	SURCHARGED
46	PIPE-08	Pipe	SDMH-07	SDMH-08	68.63	4626.65	4626.35	0.4400	30.000	0.0130	23.55	27.12	0.87	4.80	2.50	1.00	7.00	SURCHARGED
47	PIPE-09	Pipe	SDMH-10	SDMH-11	38.50	4628.00	4627.80	0.5200	18.000	0.0130	4.13	7.57	0.55	3.65	1.46	0.97	0.00	Calculated
48	PIPE-10	Pipe	SDMH-11	SDMH-09	214.29	4627.70	4626.80	0.4200	24.000	0.0130	5.27	14.66	0.36	3.12	1.80	0.90	0.00	Calculated
49	PIPE-12	Pipe	SDMH-09	SDMH-08	69.87	4626.70	4626.35	0.5000	24.000	0.0130	5.27	16.01	0.33	1.80	2.00	1.00	10.00	SURCHARGED

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
50	PIPE-13	Pipe	SDMH-08	FES-03	44.05	4626.25	4626.10	0.3400	36.000	0.0130	31.64	38.92	0.81	4.70	2.72	0.91	0.00	Calculated
51	PIPE-14	Pipe	SDMH-12	SDMH-13	270.27	4628.70	4626.90	0.6700	24.000	0.0130	2.41	18.46	0.13	3.95	0.50	0.25	0.00	Calculated
52	PIPE-15	Pipe	SDMH-13	SDMH-14	88.43	4626.30	4625.90	0.4500	24.000	0.0130	5.38	15.21	0.35	3.30	1.04	0.52	0.00	Calculated
53	PIPE-16	Pipe	SDMH-14	FES-04	107.76	4625.80	4625.27	0.4900	24.000	0.0130	5.34	15.87	0.34	3.44	0.99	0.50	0.00	Calculated
54	PIPE-2A-01	Pipe	SDMH_2A-01	SDMH_2A-02	37.50	4632.50	4632.35	0.4000	18.000	0.0130	6.12	6.64	0.92	3.88	1.26	0.84	0.00	Calculated
55	PIPE-2A-02	Pipe	SDMH_2A-02	Jun-94	117.25	4632.25	4631.78	0.4000	24.000	0.0130	7.67	14.32	0.54	4.20	1.13	0.56	0.00	Calculated
56	PIPE-2A-03	Pipe	SDMH_2A-03	SDMH_2A-04	252.27	4629.20	4628.05	0.4600	18.000	0.0130	2.52	7.09	0.36	3.18	1.50	1.00	2.00	SURCHARGED
57	PIPE-2A-04	Pipe	SDMH_2A-04	SDMH_2A-05	52.87	4627.95	4627.30	1.2300	18.000	0.0130	2.61	11.65	0.22	1.98	1.50	1.00	11.00	SURCHARGED
58	PIPE-2A-05	Pipe	SDMH_2A-06	SDMH_2A-05	11.57	4627.35	4627.30	0.4300	30.000	0.0130	14.72	26.96	0.55	3.12	2.50	1.00	9.00	SURCHARGED
59	PIPE-2A-06	Pipe	SDMH_2A-07	SDMH_2A-06	65.14	4627.80	4627.45	0.5400	30.000	0.0130	12.38	30.07	0.41	3.13	2.50	1.00	7.00	SURCHARGED
60	PIPE-2A-07	Pipe	SDMH_2A-08	SDMH_2A-07	191.56	4628.90	4627.90	0.5200	30.000	0.0130	13.87	29.64	0.47	4.42	2.37	0.95	0.00	Calculated
61	PIPE-2A-08	Pipe	SDMH_2A-13	SDMH_2A-08	64.05	4629.25	4629.00	0.3900	24.000	0.0130	12.51	14.13	0.88	4.78	2.00	1.00	3.00	SURCHARGED
62	PIPE-2A-09	Pipe	SDMH_2A-12	SDMH_2A-13	60.96	4629.60	4629.35	0.4100	24.000	0.0130	6.40	14.49	0.44	2.88	1.95	0.98	0.00	Calculated
63	PIPE-2A-10	Pipe	SDMH_2A-11	SDMH_2A-12	85.72	4630.05	4629.70	0.4100	24.000	0.0130	6.46	14.46	0.45	3.12	1.68	0.84	0.00	Calculated
64	PIPE-2A-11	Pipe	SDMH_2A-15	SDMH_2A-11	80.00	4630.55	4630.15	0.5000	24.000	0.0130	2.62	16.00	0.16	2.77	1.27	0.64	0.00	Calculated
65	PIPE-2A-12	Pipe	SDMH_2A-10	SDMH_2A-11	250.00	4631.35	4630.15	0.4800	24.000	0.0130	4.48	15.67	0.29	3.10	1.07	0.53	0.00	Calculated
66	PIPE-2A-13	Pipe	SDMH_2A-14	SDMH_2A-10	80.00	4631.90	4631.45	0.5600	18.000	0.0130	2.31	7.88	0.29	3.30	0.63	0.42	0.00	Calculated
67	PIPE-2A-14	Pipe	SDMH_2A-09	SDMH_2A-10	242.25	4633.00	4631.45	0.6400	18.000	0.0130	2.30	8.40	0.27	3.58	0.59	0.39	0.00	Calculated
68	PIPE-2A-CONNECTION	Pipe	SDMH_2A-05	STUB-01	109.14	4627.20	4626.79	0.3800	30.000	0.0130	20.97	25.14	0.83	4.27	2.50	1.00	9.00	SURCHARGED
69	PIPE-2B-01	Pipe	SDMH_2B-01	SDMH_2A-08	138.44	4629.60	4629.00	0.4300	18.000	0.0130	2.37	6.92	0.34	2.52	1.50	1.00	2.00	SURCHARGED
70	PIPE-2B-02	Pipe	SDMH_2B-02	SDMH_2B-03	248.25	4631.80	4630.70	0.4400	18.000	0.0130	4.19	6.99	0.60	3.54	0.95	0.64	0.00	Calculated
71	PIPE-2B-03	Pipe	SDMH_2B-03	SDMH_2B-04	124.95	4630.60	4630.05	0.4400	24.000	0.0130	7.33	15.01	0.49	4.35	1.06	0.53	0.00	Calculated
72	PIPE-2B-04	Pipe	SDMH_2B-04	SDMH_2B-05	207.84	4629.95	4629.10	0.4100	24.000	0.0130	7.23	14.47	0.50	3.47	1.28	0.64	0.00	Calculated
73	PIPE-2B-05	Pipe	SDMH_2B-05	DET-B101	49.25	4629.00	4628.80	0.4100	24.000	0.0130	10.43	14.42	0.72	4.42	1.44	0.72	0.00	Calculated
74	PIPE-2B-06	Pipe	DET-B101	Out-12	66.39	4628.00	4627.60	0.6000	24.000	0.0130	14.62	28.45	0.51	7.68	1.17	0.58	0.00	Calculated
75	BYPASS_16_17	Channel	CB-15	CB-18	337.95	4633.78	4632.09	0.5000	8.640	0.0320	0.42	18.05	0.02	1.10	0.37	0.51	0.00	
76	BYPASS-03-04	Channel	CB2A-03	CB2A-14	375.28	4634.64	4632.83	0.4800	6.120	0.0320	0.83	9.54	0.09	0.91	0.34	0.67	0.00	
77	BYPASS-05-07	Channel	CB-05	CB-07	235.00	4634.96	4633.35	0.6900	8.640	0.0320	0.07	21.12	0.00	0.69	0.19	0.26	0.00	
78	BYPASS-06-08	Channel	CB-06	CB-08	267.99	4635.16	4633.55	0.6000	8.640	0.0320	0.11	19.79	0.01	1.22	0.17	0.24	0.00	
79	BYPASS-06-13	Channel	CB2A-06	CB2A-13	306.42	4634.46	4632.83	0.5300	6.120	0.0320	0.80	10.04	0.08	0.90	0.37	0.72	0.00	
80	BYPASS-07-09	Channel	CB-07	CB-09	226.71	4633.35	4631.78	0.6900	8.640	0.0320	0.28	21.24	0.01	1.03	0.38	0.53	0.00	
81	BYPASS-07-18	Channel	CB2A-07	CB2B-01	232.00	4638.18	4637.06	0.4800	6.120	0.0320	0.97	9.56	0.10	4.36	0.19	0.39	0.00	
82	BYPASS-08-10	Channel	CB-08	CB-10	238.38	4633.55	4631.78	0.7400	8.640	0.0320	0.13	22.00	0.01	1.10	0.29	0.41	0.00	
83	BYPASS-08-19	Channel	CB2A-08	CB2A-15	647.42	4638.58	4634.42	0.6400	6.120	0.0320	0.36	11.01	0.03	0.51	0.29	0.57	0.00	
84	BYPASS-09-15	Channel	CB2A-09	CB2A-15	495.00	4637.10	4634.42	0.5400	6.120	0.0320	0.65	10.13	0.06	0.63	0.31	0.61	0.00	
85	BYPASS-10-15	Channel	CB2A-10	CB2A-15	512.00	4637.41	4634.42	0.5800	6.120	0.0320	0.49	10.50	0.05	0.59	0.30	0.59	0.00	
86	BYPASS-11-15	Channel	CB2A-11	CB2A-15	242.29	4635.65	4634.42	0.5100	6.120	0.0320	1.02	9.81	0.10	0.85	0.33	0.64	0.00	
87	BYPASS-12-16	Channel	CB2A-12	CB2A-16	275.17	4635.92	4634.33	0.5800	6.120	0.0320	0.78	10.44	0.07	2.19	0.22	0.44	0.00	
88	BYPASS-15-13	Channel	CB2A-15	CB2A-13	332.45	4634.42	4632.83	0.4800	6.120	0.0320	4.11	9.52	0.43	2.38	0.44	0.86	0.00	
89	BYPASS-16-13	Channel	CB2A-16	CB2A-13	275.96	4634.33	4632.83	0.5400	6.120	0.0320	0.42	10.15	0.04	0.37	0.34	0.68	0.00	
90	BYPASS-18-21	Channel	CB2B-01	CB2B-04	248.00	4637.06	4635.78	0.5200	6.120	0.0320	0.90	9.89	0.09	18.91	0.15	0.30	0.00	
91	BYPASS-20-13	Channel	CB2B-03	CB2A-13	393.54	4634.84	4632.83	0.5100	6.120	0.0320	1.33	9.84	0.14	1.38	0.39	0.76	0.00	
92	BYPASS-21-XDRAIN	Channel	CB2B-04	SIDEWALK_CROSS_DRAIN	369.46	4635.78	4633.88	0.5100	6.120	0.0320	0.85	9.87	0.09	11.07	0.34	0.67	0.00	
93	BYPASS-23-13	Channel	CB2B-06	CB2A-13	483.60	4635.29	4632.83	0.5100	6.120	0.0320	0.34	9.82	0.04	0.36	0.34	0.67	0.00	
94	BYPASS-25-26	Channel	CB2B-07	CB2B-08	330.35	4635.79	4633.88	0.5800	6.120	0.0320	0.56	10.45	0.05	0.46	0.36	0.71	0.00	
95	CHANNEL-01	Channel	FES-03	Jun-39	410.00	4626.10	4624.74	0.3300	72.000	0.0320	33.05	371.84	0.09	2.97	2.40	0.40	0.00	
96	Link-117	Channel	SIDEWALK_CROSS_DRAIN	DET-B101	38.99	4633.88	4628.80	13.0300	12.000	0.0320	4.89	14.29	0.34	4.49	0.73	0.73	0.00	
97	Weir-01	Weir	DET-B101	Out-13		4628.80	4632.00				0.00							

Inlet Summary

SN	Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Initial Water Elevation (ft)	Ponded Area (ft^2)	Peak Flow (cfs)	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Allowable Spread (ft)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)
1	CB-05	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.96	4634.96	4631.96	N/A	0.66	0.59	0.07	89.16	7.00	4.92	4635.14
2	CB-06	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.16	4635.16	4632.16	N/A	0.77	0.67	0.11	86.30	7.00	5.36	4635.35
3	CB-07	FHWA HEC-22 GENERIC	N/A	On Grade	1	4630.35	4633.35	0.00	N/A	1.19	0.89	0.30	74.63	7.00	7.60	4633.59
4	CB-08	FHWA HEC-22 GENERIC	N/A	On Grade	1	4629.05	4633.55	4629.05	N/A	0.84	0.68	0.16	81.34	7.00	6.43	4633.76
5	CB-09	FHWA HEC-22 GENERIC	N/A	On Sag	1	4627.78	4631.78	4627.78	40.00	3.39	N/A	N/A	N/A	7.00	13.72	4632.16
6	CB-10	FHWA HEC-22 GENERIC	N/A	On Sag	1	4627.28	4631.78	4627.28	40.00	1.68	N/A	N/A	N/A	7.00	8.17	4632.05
7	CB-11	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.33	4632.83	4629.33	40.00	0.63	N/A	N/A	N/A	7.00	2.56	4632.99
8	CB-12	FHWA HEC-22 GENERIC	N/A	On Sag	1	4628.83	4632.83	4628.83	40.00	0.42	N/A	N/A	N/A	7.00	2.19	4632.98
9	CB-13	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.33	4632.83	4629.33	40.00	3.72	N/A	N/A	N/A	7.00	14.66	4633.23
10	CB-14	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.33	4632.83	4629.33	40.00	1.36	N/A	N/A	N/A	7.00	6.97	4633.07
11	CB-15	FHWA HEC-22 GENERIC	N/A	On Grade	1	4630.78	4633.78	4630.78	N/A	1.45	1.02	0.43	70.15	7.00	8.70	4634.04
12	CB-16	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.45	4632.45	4629.45	40.00	1.10	N/A	N/A	N/A	7.00	5.91	4632.67
13	CB-17	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.45	4632.45	4629.45	40.00	0.42	N/A	N/A	N/A	7.00	2.19	4632.60
14	CB-18	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.09	4632.09	4629.09	40.00	2.18	N/A	N/A	N/A	7.00	9.92	4632.39
15	CB-19	FHWA HEC-22 GENERIC	N/A	On Sag	1	4628.09	4632.09	4628.09	40.00	1.35	N/A	N/A	N/A	7.00	6.91	4632.33
16	CB2A-01	FHWA HEC-22 GENERIC	N/A	On Sag	1	4634.23	4637.23	4634.23	40.00	1.18	N/A	N/A	N/A	7.00	6.21	4637.46
17	CB2A-02	FHWA HEC-22 GENERIC	N/A	On Sag	1	4634.23	4637.23	4634.23	40.00	0.47	N/A	N/A	N/A	7.00	2.27	4637.38
18	CB2A-03	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.64	4634.64	4631.64	N/A	2.22	1.38	0.84	62.29	7.00	10.45	4634.93
19	CB2A-04	FHWA HEC-22 GENERIC	N/A	On Sag	1	4634.20	4637.20	4634.20	40.00	5.03	N/A	N/A	N/A	7.00	18.18	4637.67
20	CB2A-05	FHWA HEC-22 GENERIC	N/A	On Sag	1	4634.20	4637.20	4634.20	40.00	1.18	N/A	N/A	N/A	7.00	6.21	4637.43
21	CB2A-06	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.46	4634.46	4631.46	N/A	2.16	1.36	0.80	62.81	7.00	10.27	4634.75
22	CB2A-07	FHWA HEC-22 GENERIC	N/A	On Grade	1	4635.18	4638.18	4635.18	N/A	2.27	1.40	0.87	61.86	7.00	10.53	4638.47
23	CB2A-08	FHWA HEC-22 GENERIC	N/A	On Grade	1	4635.58	4638.58	4635.58	N/A	1.29	0.93	0.35	72.47	7.00	8.21	4638.83
24	CB2A-09	FHWA HEC-22 GENERIC	N/A	On Grade	1	4634.10	4637.10	4634.10	N/A	1.89	1.24	0.65	65.73	7.00	9.37	4637.37
25	CB2A-10	FHWA HEC-22 GENERIC	N/A	On Grade	1	4634.41	4637.41	4634.41	N/A	1.59	1.10	0.49	69.10	7.00	8.65	4637.67
26	CB2A-11	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.65	4635.65	4632.65	N/A	2.54	1.52	1.02	59.83	7.00	11.03	4635.95
27	CB2A-12	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.92	4635.92	4632.92	N/A	2.11	1.33	0.77	63.25	7.00	10.18	4636.21
28	CB2A-13	FHWA HEC-22 GENERIC	N/A	On Sag	2	4629.83	4632.83	4629.83	40.00	11.52	N/A	N/A	N/A	7.00	11.21	4633.16
29	CB2A-14	FHWA HEC-22 GENERIC	N/A	On Sag	2	4628.83	4632.83	4628.83	40.00	3.43	N/A	N/A	N/A	7.00	10.67	4633.15
30	CB2A-15	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.42	4634.42	4631.12	N/A	9.18	3.47	5.72	37.74	7.00	17.37	4634.77
31	CB2A-16	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.33	4634.33	4631.33	N/A	2.25	1.53	0.72	68.17	7.00	7.99	4634.57
32	CB2B-01	FHWA HEC-22 GENERIC	N/A	On Grade	1	4634.06	4637.06	4634.06	N/A	2.44	1.53	0.90	62.96	7.00	9.37	4637.33
33	CB2B-02	FHWA HEC-22 GENERIC	N/A	On Sag	1	4633.54	4636.54	4633.54	40.00	1.56	N/A	N/A	N/A	7.00	7.73	4636.80
34	CB2B-03	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.84	4634.84	4631.84	N/A	3.06	1.73	1.33	56.54	7.00	11.94	4635.16
35	CB2B-04	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.78	4635.78	4632.78	N/A	2.24	1.39	0.85	62.07	7.00	10.49	4636.07
36	CB2B-05	FHWA HEC-22 GENERIC	N/A	On Sag	1	4633.54	4636.54	4633.54	40.00	0.93	N/A	N/A	N/A	7.00	5.15	4636.75
37	CB2B-06	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.29	4635.29	4632.29	N/A	1.29	0.94	0.35	73.10	7.00	7.90	4635.53
38	CB2B-07	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.79	4635.79	4631.79	N/A	1.70	1.14	0.56	67.21	7.00	9.32	4636.06
39	CB2B-08	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.88	4633.88	4629.88	40.00	4.41	N/A	N/A	N/A	7.00	16.56	4634.32

Project Description

File Name	BLACKSTONE PH2-A & B PROP 100YR.SPF
Description	BLACKSTONE RANCH PHASES 2-A AND 2-B MASTER TECHNICAL DRAINAGE ANALYSIS 100-YEAR PROPOSED PEAK FLOW EVENT WITH PEAK FLOWS WITHIN CHANNELS

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	49
Nodes	85
Junctions	36
Outfalls	9
Flow Diversions	0
Inlets	39
Storage Nodes	1
Links	97
Channels	22
Pipes	74
Pumps	0
Orifices	0
Weirs	1
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	100 year(s)

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	FES-03	Junction	4626.10	4630.06	4626.10	4629.10	22520.00	34.20	4629.25	0.00	2.85	0 00:00	0.00	0.00
2	Jun-39	Junction	4624.74	4630.74	4624.74	4628.32	65.00	79.61	4629.14	0.00	1.60	0 00:00	0.00	0.00
3	SDMH_2A-01	Junction	4632.50	4637.50	4632.50	4636.50	12.60	10.59	4637.56	0.06	0.00	0 00:00	0.00	0.00
4	SDMH_2A-02	Junction	4632.25	4637.57	4632.25	4636.57	12.60	17.13	4637.57	0.00	0.00	0 00:00	0.00	0.00
5	SDMH_2A-03	Junction	4629.20	4634.20	4629.20	4633.20	12.60	3.04	4632.21	0.00	1.99	0 00:00	0.00	0.00
6	SDMH_2A-04	Junction	4627.95	4632.94	4627.95	4631.94	12.60	3.16	4632.94	0.00	0.00	0 00:06	0.00	0.00
7	SDMH_2A-05	Junction	4627.20	4632.66	4627.20	4631.66	12.60	21.44	4631.24	0.00	1.42	0 00:00	0.00	0.00
8	SDMH_2A-06	Junction	4627.35	4632.62	4627.35	4631.62	19.60	15.36	4631.41	0.00	1.21	0 00:00	0.00	0.00
9	SDMH_2A-07	Junction	4627.80	4632.96	4627.80	4631.96	19.60	12.54	4631.56	0.00	1.40	0 00:00	0.00	0.00
10	SDMH_2A-08	Junction	4628.90	4633.92	4628.90	4632.92	19.60	13.24	4631.86	0.00	2.06	0 00:00	0.00	0.00
11	SDMH_2A-09	Junction	4633.00	4638.03	4633.00	4637.03	12.60	2.32	4633.55	0.00	4.48	0 00:00	0.00	0.00
12	SDMH_2A-10	Junction	4631.35	4636.35	4631.35	4635.35	19.60	4.60	4632.34	0.00	4.01	0 00:00	0.00	0.00
13	SDMH_2A-11	Junction	4630.05	4635.05	4630.05	4634.05	19.60	6.72	4632.42	0.00	2.63	0 00:00	0.00	0.00
14	SDMH_2A-12	Junction	4629.60	4634.62	4629.60	4633.62	19.60	6.93	4632.28	0.00	2.34	0 00:00	0.00	0.00
15	SDMH_2A-13	Junction	4629.25	4634.24	4629.25	4633.24	19.60	11.35	4632.15	0.00	2.09	0 00:00	0.00	0.00
16	SDMH_2A-14	Junction	4631.90	4636.90	4631.90	4635.90	19.60	2.33	4632.53	0.00	4.37	0 00:00	0.00	0.00
17	SDMH_2A-15	Junction	4630.55	4635.46	4630.55	4634.46	19.60	2.85	4632.36	0.00	3.10	0 00:00	0.00	0.00
18	SDMH_2B-01	Junction	4629.60	4634.61	4629.60	4633.61	12.60	2.71	4632.48	0.00	2.13	0 00:00	0.00	0.00
19	SDMH_2B-02	Junction	4631.80	4636.83	4631.80	4635.83	12.60	4.15	4634.75	0.00	2.08	0 00:00	0.00	0.00
20	SDMH_2B-03	Junction	4630.60	4635.58	4630.60	4634.58	19.60	7.37	4633.63	0.00	1.95	0 00:00	0.00	0.00
21	SDMH_2B-04	Junction	4629.95	4635.08	4629.95	4634.08	19.60	7.35	4635.08	0.00	0.00	0 00:05	0.00	0.00
22	SDMH_2B-05	Junction	4629.00	4633.72	4629.00	4632.72	19.60	10.66	4633.12	0.00	0.60	0 00:00	0.00	0.00
23	SDMH-03	Junction	4629.70	4634.69	4629.70	4633.75	12.60	1.23	4630.11	0.00	4.58	0 00:00	0.00	0.00
24	SDMH-04	Junction	4628.30	4633.28	4628.30	4632.28	12.60	2.78	4630.20	0.00	3.08	0 00:00	0.00	0.00
25	SDMH-05	Junction	4627.10	4632.21	4626.85	4631.21	12.60	4.09	4632.21	0.00	0.00	0 00:04	0.00	0.00
26	SDMH-06	Junction	4626.60	4631.51	4626.60	4630.51	12.60	4.44	4630.72	0.00	0.79	0 00:00	0.00	0.00
27	SDMH-07	Junction	4626.65	4632.02	4626.60	4631.02	19.60	24.19	4630.34	0.00	1.68	0 00:00	0.00	0.00
28	SDMH-08	Junction	4626.25	4631.80	4626.25	4630.80	28.30	32.88	4629.70	0.00	2.10	0 00:00	0.00	0.00
29	SDMH-09	Junction	4626.70	4632.16	4626.70	4631.16	19.60	6.65	4630.27	0.00	1.89	0 00:00	0.00	0.00
30	SDMH-10	Junction	4628.00	4633.02	4628.00	4632.02	19.60	4.12	4630.11	0.00	2.91	0 00:00	0.00	0.00
31	SDMH-11	Junction	4627.70	4633.36	4627.70	4632.36	19.60	5.77	4629.92	0.00	3.44	0 00:00	0.00	0.00
32	SDMH-12	Junction	4628.70	4633.51	4628.70	4632.51	12.60	5.69	4630.53	0.00	2.98	0 00:00	0.00	0.00
33	SDMH-13	Junction	4626.30	4631.94	4626.30	4630.94	19.60	17.87	4631.96	0.02	0.00	0 00:01	0.00	0.00
34	SDMH-14	Junction	4625.80	4633.18	4625.80	4632.18	19.60	24.55	4633.33	0.15	0.00	0 00:00	0.01	0.00
35	SIDEWALK_CROSS_DRAIN	Junction	4633.46	4633.88	4633.46	4632.88	10.00	5.92	4634.37	0.00	0.51	0 00:00	0.00	0.00
36	STUB-01	Junction	4626.79	4632.17	4626.79	4631.17	7.06	21.30	4630.66	0.00	1.51	0 00:00	0.00	0.00
37	FES-04	Outfall	4625.27					24.55	4630.00					
38	Jun-94	Outfall	4631.78					17.13	4634.96					
39	Out-05	Outfall	4624.56					79.61	4628.90					
40	Out-12	Outfall	4627.75					26.11	4632.40					
41	Out-13	Outfall	4632.00					0.00	4632.40					
42	PH2A-OFF-01	Outfall	4636.36					1.81	4636.36					
43	PH2A-OFF-02	Outfall	4633.64					2.98	4633.64					
44	PH2B-OFF-01	Outfall	4633.02					0.37	4633.02					
45	PH2B-OFF-02	Outfall	4632.19					0.66	4632.19					
46	DET-B101	Storage Node	4628.80	4633.50	4628.80		5500.00	26.89	4632.87				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	CULV-01	Pipe	Jun-39	Out-05	56.00	4624.74	4624.56	0.3200	42.000	0.0130	79.61	57.04	1.40	9.77	3.50	1.00	1439.00	SURCHARGED
2	LAT_2A-01	Pipe	CB2A-01	SDMH_2A-02	64.37	4634.23	4632.35	2.9200	15.000	0.0130	3.11	11.04	0.28	2.90	1.25	1.00	0.00	SURCHARGED
3	LAT_2A-02	Pipe	CB2A-02	SDMH_2A-02	28.37	4634.23	4632.35	6.6300	15.000	0.0130	3.85	16.63	0.23	4.12	1.17	1.00	0.00	SURCHARGED
4	LAT_2A-03	Pipe	CB2A-03	SDMH_2A-03	44.57	4631.64	4629.30	5.2500	15.000	0.0130	1.44	14.80	0.10	5.23	0.75	0.61	0.00	Calculated
5	LAT_2A-04	Pipe	CB2A-04	SDMH_2A-01	58.37	4634.20	4632.60	2.7400	15.000	0.0130	5.03	10.70	0.47	4.10	1.25	1.00	7.00	SURCHARGED
6	LAT_2A-05	Pipe	CB2A-05	SDMH_2A-01	22.37	4634.20	4632.60	7.1500	15.000	0.0130	4.76	17.28	0.28	5.90	1.25	1.00	2.00	SURCHARGED
7	LAT_2A-06	Pipe	CB2A-06	SDMH_2A-03	30.98	4631.46	4629.30	6.9700	15.000	0.0130	1.66	17.06	0.10	5.62	0.76	0.61	0.00	Calculated
8	LAT_2A-07	Pipe	CB2A-07	SDMH_2A-09	59.89	4635.18	4633.10	3.4700	15.000	0.0130	1.40	12.04	0.12	4.89	0.37	0.30	0.00	Calculated
9	LAT_2A-08	Pipe	CB2A-08	SDMH_2A-09	29.41	4635.58	4633.10	8.4300	15.000	0.0130	0.93	18.76	0.05	5.26	0.32	0.26	0.00	Calculated
10	LAT_2A-09	Pipe	CB2A-09	SDMH_2A-14	28.49	4634.10	4632.00	7.3700	15.000	0.0130	1.24	17.54	0.07	4.98	0.38	0.30	0.00	Calculated
11	LAT_2A-10	Pipe	CB2A-10	SDMH_2A-14	51.02	4634.41	4632.00	4.7200	15.000	0.0130	1.09	14.04	0.08	4.03	0.38	0.31	0.00	Calculated
12	LAT_2A-11	Pipe	CB2A-11	SDMH_2A-15	28.49	4632.65	4630.65	7.0200	15.000	0.0130	1.52	17.12	0.09	5.19	0.74	0.60	0.00	Calculated
13	LAT_2A-12	Pipe	CB2A-12	SDMH_2A-15	51.03	4632.92	4630.65	4.4500	15.000	0.0130	1.33	13.62	0.10	4.18	0.75	0.60	0.00	Calculated
14	LAT_2A-13	Pipe	CB2A-13	SDMH_2A-05	29.99	4629.83	4627.30	8.4400	15.000	0.0130	4.37	18.76	0.23	5.11	1.25	1.00	5.00	SURCHARGED
15	LAT_2A-14	Pipe	CB2A-14	SDMH_2A-06	5.23	4628.83	4627.95	16.8300	15.000	0.0130	2.90	26.50	0.11	6.80	1.25	1.00	12.00	SURCHARGED
16	LAT_2A-15	Pipe	CB2A-15	SDMH_2A-13	22.14	4631.42	4629.35	9.3500	15.000	0.0130	5.04	19.75	0.25	6.79	1.08	0.86	0.00	Calculated
17	LAT_2A-16	Pipe	CB2A-16	SDMH_2A-13	12.83	4631.33	4629.35	15.4300	15.000	0.0130	1.82	25.38	0.07	4.58	1.03	0.83	0.00	Calculated
18	LAT_2B-01	Pipe	CB2B-01	SDMH_2B-02	29.90	4634.06	4631.90	7.2200	15.000	0.0130	2.33	17.36	0.13	5.16	0.78	0.62	0.00	Calculated
19	LAT_2B-02	Pipe	CB2B-02	SDMH_2B-02	48.16	4633.54	4631.90	3.4100	15.000	0.0130	1.61	11.92	0.13	3.90	0.89	0.71	0.00	Calculated
20	LAT_2B-03	Pipe	CB2B-03	SDMH_2B-01	29.49	4631.84	4629.70	7.2600	15.000	0.0130	1.78	17.40	0.10	5.96	0.76	0.61	0.00	Calculated
21	LAT_2B-04	Pipe	CB2B-04	SDMH_2B-03	28.86	4632.78	4630.70	7.2100	15.000	0.0130	2.22	17.34	0.13	5.35	1.06	0.86	0.00	Calculated
22	LAT_2B-05	Pipe	CB2B-05	SDMH_2B-02	29.41	4633.54	4631.90	5.5800	15.000	0.0130	1.15	15.25	0.08	3.86	0.88	0.71	0.00	Calculated
23	LAT_2B-06	Pipe	CB2B-06	SDMH_2B-01	89.05	4632.29	4629.70	2.9100	15.000	0.0130	0.93	11.02	0.08	3.12	0.75	0.60	0.00	Calculated
24	LAT_2B-07	Pipe	CB2B-07	SDMH_2B-03	7.63	4631.79	4630.70	14.2900	15.000	0.0130	1.55	24.42	0.06	5.51	1.25	1.00	8.00	SURCHARGED
25	LAT_2B-08	Pipe	CB2B-08	SDMH_2B-05	7.56	4629.88	4629.10	10.3200	15.000	0.0130	3.44	20.75	0.17	2.80	1.25	1.00	1437.00	SURCHARGED
26	LAT-05	Pipe	CB-05	SDMH-03	42.90	4631.96	4629.80	5.0300	15.000	0.0130	0.57	14.49	0.04	4.20	0.23	0.19	0.00	Calculated
27	LAT-06	Pipe	CB-06	SDMH-03	33.92	4632.16	4629.80	6.9600	15.000	0.0130	0.65	17.04	0.04	4.92	0.23	0.19	0.00	Calculated
28	LAT-07	Pipe	CB-07	SDMH-04	42.90	4630.35	4628.40	4.5500	15.000	0.0130	0.91	13.77	0.07	4.28	0.73	0.59	0.00	Calculated
29	LAT-08	Pipe	CB-08	SDMH-04	4.90	4629.05	4628.40	13.2700	15.000	0.0130	0.86	23.53	0.04	4.63	1.17	0.94	0.00	Calculated
30	LAT-09	Pipe	CB-09	SDMH-07	10.80	4627.78	4626.65	10.4600	15.000	0.0130	3.17	20.90	0.15	5.29	1.25	1.00	17.00	SURCHARGED
31	LAT-10	Pipe	CB-10	SDMH-06	4.90	4627.28	4626.70	11.8400	15.000	0.0130	1.52	22.22	0.07	4.96	1.25	1.00	1436.00	SURCHARGED
32	LAT-11	Pipe	CB-11	SDMH-10	30.92	4629.33	4628.10	3.9800	15.000	0.0130	0.68	12.88	0.05	2.38	0.98	0.79	0.00	Calculated
33	LAT-12	Pipe	CB-13	SDMH-10	58.80	4629.33	4628.10	2.0900	15.000	0.0130	3.54	9.34	0.38	4.30	1.10	0.88	0.00	Calculated
34	LAT-13	Pipe	CB-12	SDMH-11	45.01	4628.83	4627.80	2.2900	15.000	0.0130	0.65	9.77	0.07	2.20	1.16	0.93	0.00	Calculated
35	LAT-14	Pipe	CB-14	SDMH-11	66.57	4629.33	4627.80	2.3000	15.000	0.0130	1.28	9.79	0.13	3.35	0.92	0.74	0.00	Calculated
36	LAT-15	Pipe	CB-16	SDMH-12	66.21	4629.45	4629.05	0.6000	15.000	0.0130	1.14	5.02	0.23	1.29	1.22	0.99	0.00	Calculated
37	LAT-16	Pipe	CB-15	SDMH-12	74.17	4630.78	4629.05	2.3300	15.000	0.0130	1.01	9.87	0.10	2.71	0.74	0.59	0.00	Calculated
38	LAT-17	Pipe	CB-17	SDMH-12	43.42	4629.45	4629.05	0.9200	15.000	0.0150	0.81	5.37	0.15	1.20	1.20	0.97	0.00	Calculated
39	LAT-18	Pipe	CB-18	SDMH-13	36.89	4629.09	4626.90	5.9400	15.000	0.0130	5.29	15.74	0.34	4.98	1.25	1.00	0.00	SURCHARGED
40	LAT-19	Pipe	CB-19	SDMH-13	10.90	4628.09	4626.90	10.9200	15.000	0.0130	10.12	21.34	0.47	8.25	1.25	1.00	1439.00	SURCHARGED
41	PIPE-03	Pipe	SDMH-03	SDMH-04	235.00	4629.70	4628.40	0.5500	18.000	0.0130	1.22	7.81	0.16	2.19	0.95	0.64	0.00	Calculated
42	PIPE-04	Pipe	SDMH-04	SDMH-05	143.18	4628.30	4627.20	0.7700	18.000	0.0130	2.68	9.21	0.29	2.58	1.50	1.00	5.00	SURCHARGED
43	PIPE-05	Pipe	SDMH-05	SDMH-06	92.49	4627.10	4626.70	0.4300	18.000	0.0130	3.22	6.91	0.47	2.02	1.50	1.00	1436.00	SURCHARGED
44	PIPE-06	Pipe	SDMH-06	SDMH-08	58.22	4626.60	4626.35	0.4300	18.000	0.0130	4.19	6.88	0.61	2.37	1.50	1.00	1436.00	SURCHARGED
45	PIPE-07	Pipe	STUB-01	SDMH-07	10.00	4626.79	4626.75	0.4000	30.000	0.0130	21.41	25.94	0.83	4.36	2.50	1.00	15.00	SURCHARGED
46	PIPE-08	Pipe	SDMH-07	SDMH-08	68.63	4626.65	4626.35	0.4400	30.000	0.0130	24.14	27.12	0.89	4.92	2.50	1.00	17.00	SURCHARGED
47	PIPE-09	Pipe	SDMH-10	SDMH-11	38.50	4628.00	4627.80	0.5200	18.000	0.0130	4.13	7.57	0.55	3.02	1.50	1.00	11.00	SURCHARGED
48	PIPE-10	Pipe	SDMH-11	SDMH-09	214.29	4627.70	4626.80	0.4200	24.000	0.0130	5.74	14.66	0.39	1.85	2.00	1.00	5.00	SURCHARGED
49	PIPE-12	Pipe	SDMH-09	SDMH-08	69.87	4626.70	4626.35	0.5000	24.000	0.0130	5.74	16.01	0.36	2.13	2.00	1.00	1435.00	SURCHARGED

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
50	PIPE-13	Pipe	SDMH-08	FES-03	44.05	4626.25	4626.10	0.3400	36.000	0.0130	32.90	38.92	0.85	4.65	3.00	1.00	12.00	SURCHARGED
51	PIPE-14	Pipe	SDMH-12	SDMH-13	270.27	4628.70	4626.90	0.6700	24.000	0.0130	5.40	18.46	0.29	2.63	1.91	0.96	0.00	Calculated
52	PIPE-15	Pipe	SDMH-13	SDMH-14	88.43	4626.30	4625.90	0.4500	24.000	0.0130	17.86	15.21	1.17	8.05	2.00	1.00	1439.00	SURCHARGED
53	PIPE-16	Pipe	SDMH-14	FES-04	107.76	4625.80	4625.27	0.4900	24.000	0.0130	24.55	15.87	1.55	7.91	2.00	1.00	1440.00	SURCHARGED
54	PIPE-2A-01	Pipe	SDMH_2A-01	SDMH_2A-02	37.50	4632.50	4632.35	0.4000	18.000	0.0130	10.53	6.64	1.59	7.45	1.50	1.00	1439.00	SURCHARGED
55	PIPE-2A-02	Pipe	SDMH_2A-02	Jun-94	117.25	4632.25	4631.78	0.4000	24.000	0.0130	17.13	14.32	1.20	5.66	2.00	1.00	1439.00	SURCHARGED
56	PIPE-2A-03	Pipe	SDMH_2A-03	SDMH_2A-04	252.27	4629.20	4628.05	0.4600	18.000	0.0130	3.05	7.09	0.43	2.74	1.50	1.00	7.00	SURCHARGED
57	PIPE-2A-04	Pipe	SDMH_2A-04	SDMH_2A-05	52.87	4627.95	4627.30	1.2300	18.000	0.0130	3.06	11.65	0.26	2.13	1.50	1.00	16.00	SURCHARGED
58	PIPE-2A-05	Pipe	SDMH_2A-06	SDMH_2A-05	11.57	4627.35	4627.30	0.4300	30.000	0.0130	15.34	26.96	0.57	3.13	2.50	1.00	13.00	SURCHARGED
59	PIPE-2A-06	Pipe	SDMH_2A-07	SDMH_2A-06	65.14	4627.80	4627.45	0.5400	30.000	0.0130	12.55	30.07	0.42	2.71	2.50	1.00	11.00	SURCHARGED
60	PIPE-2A-07	Pipe	SDMH_2A-08	SDMH_2A-07	191.56	4628.90	4627.90	0.5200	30.000	0.0130	12.54	29.64	0.42	3.68	2.50	1.00	5.00	SURCHARGED
61	PIPE-2A-08	Pipe	SDMH_2A-13	SDMH_2A-08	64.05	4629.25	4629.00	0.3900	24.000	0.0130	10.80	14.13	0.76	4.37	2.00	1.00	7.00	SURCHARGED
62	PIPE-2A-09	Pipe	SDMH_2A-12	SDMH_2A-13	60.96	4629.60	4629.35	0.4100	24.000	0.0130	7.25	14.49	0.50	2.61	2.00	1.00	6.00	SURCHARGED
63	PIPE-2A-10	Pipe	SDMH_2A-11	SDMH_2A-12	85.72	4630.05	4629.70	0.4100	24.000	0.0130	6.93	14.46	0.48	3.13	2.00	1.00	4.00	SURCHARGED
64	PIPE-2A-11	Pipe	SDMH_2A-15	SDMH_2A-11	80.00	4630.55	4630.15	0.5000	24.000	0.0130	3.12	16.00	0.20	2.77	1.91	0.95	0.00	Calculated
65	PIPE-2A-12	Pipe	SDMH_2A-10	SDMH_2A-11	250.00	4631.35	4630.15	0.4800	24.000	0.0130	4.48	15.67	0.29	3.10	1.49	0.74	0.00	Calculated
66	PIPE-2A-13	Pipe	SDMH_2A-14	SDMH_2A-10	80.00	4631.90	4631.45	0.5600	18.000	0.0130	2.31	7.88	0.29	3.30	0.71	0.47	0.00	Calculated
67	PIPE-2A-14	Pipe	SDMH_2A-09	SDMH_2A-10	242.25	4633.00	4631.45	0.6400	18.000	0.0130	2.30	8.40	0.27	3.58	0.68	0.46	0.00	Calculated
68	PIPE-2A-CONNECTION	Pipe	SDMH_2A-05	STUB-01	109.14	4627.20	4626.79	0.3800	30.000	0.0130	21.30	25.14	0.85	4.34	2.50	1.00	14.00	SURCHARGED
69	PIPE-2B-01	Pipe	SDMH_2B-01	SDMH_2A-08	138.44	4629.60	4629.00	0.4300	18.000	0.0130	2.79	6.92	0.40	2.52	1.50	1.00	7.00	SURCHARGED
70	PIPE-2B-02	Pipe	SDMH_2B-02	SDMH_2B-03	248.25	4631.80	4630.70	0.4400	18.000	0.0130	4.15	6.99	0.59	2.52	1.50	1.00	6.00	SURCHARGED
71	PIPE-2B-03	Pipe	SDMH_2B-03	SDMH_2B-04	124.95	4630.60	4630.05	0.4400	24.000	0.0130	7.35	15.01	0.49	2.34	2.00	1.00	13.00	SURCHARGED
72	PIPE-2B-04	Pipe	SDMH_2B-04	SDMH_2B-05	207.84	4629.95	4629.10	0.4100	24.000	0.0130	7.35	14.47	0.51	2.34	2.00	1.00	1435.00	SURCHARGED
73	PIPE-2B-05	Pipe	SDMH_2B-05	DET-B101	49.25	4629.00	4628.80	0.4100	24.000	0.0130	10.66	14.42	0.74	3.39	2.00	1.00	1437.00	SURCHARGED
74	PIPE-2B-06	Pipe	DET-B101	Out-12	66.39	4628.00	4627.60	0.6000	24.000	0.0130	26.11	28.45	0.92	9.35	2.00	1.00	1437.00	SURCHARGED
75	BYPASS_16_17	Channel	CB-15	CB-18	337.95	4633.78	4632.09	0.5000	8.640	0.0320	0.43	18.05	0.02	1.09	0.37	0.51	0.00	
76	BYPASS-03-04	Channel	CB2A-03	CB2A-14	375.28	4634.64	4632.83	0.4800	6.120	0.0320	0.83	9.54	0.09	0.91	0.34	0.67	0.00	
77	BYPASS-05-07	Channel	CB-05	CB-07	235.00	4634.96	4633.35	0.6900	8.640	0.0320	0.07	21.12	0.00	0.69	0.19	0.26	0.00	
78	BYPASS-06-08	Channel	CB-06	CB-08	267.99	4635.16	4633.55	0.6000	8.640	0.0320	0.11	19.79	0.01	1.22	0.17	0.24	0.00	
79	BYPASS-06-13	Channel	CB2A-06	CB2A-13	306.42	4634.46	4632.83	0.5300	6.120	0.0320	0.80	10.04	0.08	0.91	0.37	0.72	0.00	
80	BYPASS-07-09	Channel	CB-07	CB-09	226.71	4633.35	4631.78	0.6900	8.640	0.0320	0.27	21.24	0.01	1.10	0.38	0.53	0.00	
81	BYPASS-07-18	Channel	CB2A-07	CB2B-01	232.00	4638.18	4637.06	0.4800	6.120	0.0320	2.26	9.56	0.24	7.23	0.25	0.51	0.00	
82	BYPASS-08-10	Channel	CB-08	CB-10	238.38	4633.55	4631.78	0.7400	8.640	0.0320	0.13	22.00	0.01	1.17	0.29	0.41	0.00	
83	BYPASS-08-19	Channel	CB2A-08	CB2A-15	647.42	4638.58	4634.42	0.6400	6.120	0.0320	0.36	11.01	0.03	0.52	0.29	0.57	0.00	
84	BYPASS-09-15	Channel	CB2A-09	CB2A-15	495.00	4637.10	4634.42	0.5400	6.120	0.0320	0.65	10.13	0.06	0.63	0.31	0.61	0.00	
85	BYPASS-10-15	Channel	CB2A-10	CB2A-15	512.00	4637.41	4634.42	0.5800	6.120	0.0320	0.49	10.50	0.05	0.59	0.30	0.59	0.00	
86	BYPASS-11-15	Channel	CB2A-11	CB2A-15	242.29	4635.65	4634.42	0.5100	6.120	0.0320	1.02	9.81	0.10	0.85	0.33	0.64	0.00	
87	BYPASS-12-16	Channel	CB2A-12	CB2A-16	275.17	4635.92	4634.33	0.5800	6.120	0.0320	0.78	10.44	0.07	2.20	0.22	0.44	0.00	
88	BYPASS-15-13	Channel	CB2A-15	CB2A-13	332.45	4634.42	4632.83	0.4800	6.120	0.0320	4.11	9.52	0.43	2.38	0.44	0.86	0.00	
89	BYPASS-16-13	Channel	CB2A-16	CB2A-13	275.96	4634.33	4632.83	0.5400	6.120	0.0320	0.42	10.15	0.04	0.37	0.34	0.68	0.00	
90	BYPASS-18-21	Channel	CB2B-01	CB2B-04	248.00	4637.06	4635.78	0.5200	6.120	0.0320	2.02	9.89	0.20	50.00	0.11	0.24	0.00	
91	BYPASS-20-13	Channel	CB2B-03	CB2A-13	393.54	4634.84	4632.83	0.5100	6.120	0.0320	1.33	9.84	0.14	1.38	0.39	0.76	0.00	
92	BYPASS-21-XDRAIN	Channel	CB2B-04	SIDEWALK_CROSS_DRAIN	369.46	4635.78	4633.88	0.5100	6.120	0.0320	0.85	9.87	0.09	23.02	0.36	0.70	0.00	
93	BYPASS-23-13	Channel	CB2B-06	CB2A-13	483.60	4635.29	4632.83	0.5100	6.120	0.0320	0.34	9.82	0.04	0.36	0.34	0.67	0.00	
94	BYPASS-25-26	Channel	CB2B-07	CB2B-08	330.35	4635.79	4633.88	0.5800	6.120	0.0320	0.56	10.45	0.05	0.73	0.36	0.71	0.00	
95	CHANNEL-01	Channel	FES-03	Jun-39	410.00	4626.10	4624.74	0.3300	72.000	0.0320	34.07	371.84	0.09	2.39	3.77	0.63	0.00	
96	Link-117	Channel	SIDEWALK_CROSS_DRAIN	DET-B101	38.99	4633.88	4628.80	13.0300	12.000	0.0320	4.23	14.29	0.30	3.78	0.75	0.75	0.00	
97	Weir-01	Weir	DET-B101	Out-13		4628.80	4632.00				0.00							

Inlet Summary

SN	Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Initial Water Elevation (ft)	Ponded Area (ft^2)	Peak Flow (cfs)	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Allowable Spread (ft)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)
1	CB-05	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.96	4634.96	4631.96	N/A	0.66	0.59	0.07	89.15	7.00	4.93	4635.14
2	CB-06	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.16	4635.16	4632.16	N/A	0.77	0.67	0.11	86.29	7.00	5.36	4635.35
3	CB-07	FHWA HEC-22 GENERIC	N/A	On Grade	1	4630.35	4633.35	0.00	N/A	1.19	0.89	0.30	74.52	7.00	7.64	4633.59
4	CB-08	FHWA HEC-22 GENERIC	N/A	On Grade	1	4629.05	4633.55	4629.05	N/A	0.84	0.68	0.16	81.33	7.00	6.44	4633.76
5	CB-09	FHWA HEC-22 GENERIC	N/A	On Sag	1	4627.78	4631.78	4627.78	40.00	3.39	N/A	N/A	N/A	7.00	13.72	4632.16
6	CB-10	FHWA HEC-22 GENERIC	N/A	On Sag	1	4627.28	4631.78	4627.28	40.00	1.68	N/A	N/A	N/A	7.00	8.17	4632.05
7	CB-11	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.33	4632.83	4629.33	40.00	0.63	N/A	N/A	N/A	7.00	2.56	4632.99
8	CB-12	FHWA HEC-22 GENERIC	N/A	On Sag	1	4628.83	4632.83	4628.83	40.00	0.42	N/A	N/A	N/A	7.00	2.20	4632.98
9	CB-13	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.33	4632.83	4629.33	40.00	3.72	N/A	N/A	N/A	7.00	14.67	4633.23
10	CB-14	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.33	4632.83	4629.33	40.00	1.36	N/A	N/A	N/A	7.00	6.97	4633.07
11	CB-15	FHWA HEC-22 GENERIC	N/A	On Grade	1	4630.78	4633.78	4630.78	N/A	1.45	1.02	0.43	70.13	7.00	8.70	4634.04
12	CB-16	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.45	4632.45	4629.45	40.00	1.11	N/A	N/A	N/A	7.00	5.92	4632.67
13	CB-17	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.45	4632.45	4629.45	40.00	0.42	N/A	N/A	N/A	7.00	2.20	4632.60
14	CB-18	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.09	4632.09	4629.09	40.00	2.19	N/A	N/A	N/A	7.00	9.96	4632.39
15	CB-19	FHWA HEC-22 GENERIC	N/A	On Sag	1	4628.09	4632.09	4628.09	40.00	1.35	N/A	N/A	N/A	7.00	6.91	4632.33
16	CB2A-01	FHWA HEC-22 GENERIC	N/A	On Sag	1	4634.23	4637.23	4634.23	40.00	1.18	N/A	N/A	N/A	7.00	6.22	4637.46
17	CB2A-02	FHWA HEC-22 GENERIC	N/A	On Sag	1	4634.23	4637.23	4634.23	40.00	0.47	N/A	N/A	N/A	7.00	2.27	4637.38
18	CB2A-03	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.64	4634.64	4631.64	N/A	2.22	1.38	0.84	62.27	7.00	10.45	4634.93
19	CB2A-04	FHWA HEC-22 GENERIC	N/A	On Sag	1	4634.20	4637.20	4634.20	40.00	5.04	N/A	N/A	N/A	7.00	18.19	4637.67
20	CB2A-05	FHWA HEC-22 GENERIC	N/A	On Sag	1	4634.20	4637.20	4634.20	40.00	1.18	N/A	N/A	N/A	7.00	6.22	4637.43
21	CB2A-06	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.46	4634.46	4631.46	N/A	2.16	1.36	0.80	62.79	7.00	10.27	4634.75
22	CB2A-07	FHWA HEC-22 GENERIC	N/A	On Grade	1	4635.18	4638.18	4635.18	N/A	2.27	1.41	0.87	61.85	7.00	10.54	4638.47
23	CB2A-08	FHWA HEC-22 GENERIC	N/A	On Grade	1	4635.58	4638.58	4635.58	N/A	1.29	0.93	0.35	72.46	7.00	8.21	4638.83
24	CB2A-09	FHWA HEC-22 GENERIC	N/A	On Grade	1	4634.10	4637.10	4634.10	N/A	1.89	1.24	0.65	65.72	7.00	9.37	4637.37
25	CB2A-10	FHWA HEC-22 GENERIC	N/A	On Grade	1	4634.41	4637.41	4634.41	N/A	1.59	1.10	0.49	69.01	7.00	8.70	4637.67
26	CB2A-11	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.65	4635.65	4632.65	N/A	2.55	1.52	1.02	59.81	7.00	11.03	4635.95
27	CB2A-12	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.92	4635.92	4632.92	N/A	2.11	1.33	0.77	63.24	7.00	10.19	4636.21
28	CB2A-13	FHWA HEC-22 GENERIC	N/A	On Sag	2	4629.83	4632.83	4629.83	40.00	11.52	N/A	N/A	N/A	7.00	11.22	4633.16
29	CB2A-14	FHWA HEC-22 GENERIC	N/A	On Sag	2	4628.83	4632.83	4628.83	40.00	3.43	N/A	N/A	N/A	7.00	10.68	4633.15
30	CB2A-15	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.42	4634.42	4631.12	N/A	9.19	3.47	5.72	37.74	7.00	17.38	4634.77
31	CB2A-16	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.33	4634.33	4631.33	N/A	2.25	1.53	0.72	68.17	7.00	7.99	4634.57
32	CB2B-01	FHWA HEC-22 GENERIC	N/A	On Grade	1	4634.06	4637.06	4634.06	N/A	3.71	2.04	1.66	55.12	7.00	11.14	4637.37
33	CB2B-02	FHWA HEC-22 GENERIC	N/A	On Sag	1	4633.54	4636.54	4633.54	40.00	1.56	N/A	N/A	N/A	7.00	7.73	4636.80
34	CB2B-03	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.84	4634.84	4631.84	N/A	3.07	1.73	1.33	56.52	7.00	11.94	4635.16
35	CB2B-04	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.78	4635.78	4632.78	N/A	2.24	1.39	0.85	62.06	7.00	10.50	4636.07
36	CB2B-05	FHWA HEC-22 GENERIC	N/A	On Sag	1	4633.54	4636.54	4633.54	40.00	0.93	N/A	N/A	N/A	7.00	5.16	4636.75
37	CB2B-06	FHWA HEC-22 GENERIC	N/A	On Grade	1	4632.29	4635.29	4632.29	N/A	1.29	0.94	0.35	73.09	7.00	7.90	4635.53
38	CB2B-07	FHWA HEC-22 GENERIC	N/A	On Grade	1	4631.79	4635.79	4631.79	N/A	1.70	1.14	0.56	67.19	7.00	9.33	4636.06
39	CB2B-08	FHWA HEC-22 GENERIC	N/A	On Sag	1	4629.88	4633.88	4629.88	40.00	4.42	N/A	N/A	N/A	7.00	16.57	4634.32

APPENDIX E

OUTLET HYDRAULIC ANALYSIS

CULVERT OUTLET PROTECTION

$$For\ TW < \frac{Do}{2}$$

$$La = \frac{(1.8\,Q)}{Do^{3/2}} + 7\,Do$$

$$W = 3\,Do + La$$

$$For\ TW \geq \frac{Do}{2}$$

$$La = \frac{(3\,Q)}{Do^{3/2}} + 7\,Do$$

$$W = 3\,Do + 0.4\,La$$

$$d_{50} = 0.02\frac{(Q)^{4/3}}{TW\,(Do)}$$

F.E.S. 2B-01

Q= 26.90
Do= 2
TW= 2

APRON SIZE		ROCK SIZE			
La=	42.53	d_{50}=	0.32	Design d_{50}=	0.5
W=	23.01	Use Class		150	Rock Riprap

F.E.S. 2B-03

Q= 26.10
Do= 2
TW= 1.17

APRON SIZE		ROCK SIZE			
La=	41.68	d_{50}=	0.52	Design d_{50}=	0.75
W=	22.67	Use Class		300	Rock Riprap

TECHNICAL DRAINAGE STUDY

FOR

BLACKSTONE RANCH PHASE 2C
(APN 010-041-40)

Prepared for

RD Lompa, LLC
985 Damonte Ranch Parkway, Suite 140
Reno, NV 89521

Prepared by

JK Architecture Engineering Incorporated
1311 McCarran Blvd, Suite 103
Sparks, Nevada 89431
(775) 507-7009

May 2022
Updated July 2022

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I. Overview

A. DRAINAGE STUDY INFORMATION FORM

Name of Development: Blackstone Ranch Phase 2-C Development

Location of Development: The Blackstone Ranch Phase 2-C development is located west of I-580, north of E. 5th Street, east of N. Saliman Road, and south of E. Robinson Street (Figure #1 – Vicinity Map) within the Carson City Limits.

Name of Owner: RD Lompa, LLC

Contact Person: Steve Thomsen **Telephone No.:** 775-823-3788

Firm: Ryder Homes
Address: 985 Damonte Ranch Parkway, Suite 140, Reno, NV 89521

Type of Development: Residential

Total Site Acreage: 15.46 acres (*)
*Area excludes portion of previously studied roadway infrastructure drainage analysis

Total Proposed Units: 74 Residential Units

Approximate offsite area that drains to site: 0 acres

Existing Conditions On-site Peak Flows:
10-year: 3.40 cfs
100-year: 16.67 cfs

Proposed Conditions On-site Peak Flows
2-year: 9.87 cfs
10-year: 15.46 cfs
100-year: 41.98 cfs

Proposed Detention Conditions (East Basin):
2-year peak inflow: 1.83 cfs
10-year peak inflow: 3.12 cfs

100-year peak inflow: 8.31 cfs (Assumes normal condition model)
100-year peak inflow: 26.92 cfs (Assumes Existing Channel at Peak Flow)
2-year peak outflow: 1.78 cfs
10-year peak outflow: 3.03 cfs (4.5' of free-board at spillway)
100-year peak outflow: 7.85 cfs (Under normal condition model)
100-year peak outflow: 31.14 cfs (1.1' of free-board at spillway under Existing Channel Peak Flow)

Proposed Detention Conditions (South Basin):
2-year peak inflow: 3.42 cfs
10-year peak inflow: 5.51 cfs
100-year peak inflow: 14.05 cfs (Assumes normal condition model)
100-year peak inflow: 25.65 cfs (Assumes Existing Channel at Peak Flow)
2-year peak outflow: 3.38 cfs
10-year peak outflow: 5.44 cfs (3.9' of free-board at spillway)
100-year peak outflow: 12.89 cfs (Under normal condition model)
100-year peak outflow: 26.53 cfs (1' of free-board at spillway under Existing Channel Peak Flow)

Proposed Construction Schedule for the Subject Property:

1. On-Site Grading Activities: Late Summer-Early Fall 2022
2. Backbone Improvements (On-Site Roads): Fall 2022-Spring 2023
3. Start Construction of Initial Model Lots: Spring 2023
4. Start production Lots: Summer 2024

B. PROJECT NAME, TYPE OF STUDY, DATE OF PREPARATION, AND REVISIONS

Project Name: Blackstone Ranch Phase 2-C
Type of Study: Technical Drainage Study
Date of Preparation: May 3, 2022
Revisions: N/A

C. PREPARER'S NAME, SEAL AND SIGNATURE

Preparers Name: Kenneth Anderson, P.E.

02.09.2023

II. GENERAL LOCATION AND DEVELOPMENT DESCRIPTION

A. Location of Property

The Blackstone Ranch Phase 2-C Project (BRPH2C Project) which is located west of I-580, north of E. 5th Street, east of S. Saliman Road, and south of E. Robinson Street (APN #010-041-40) within the Carson City Limits. The BRPH2C Project will consist of a proposed 74-unit single family residential development and is located within Section 16, Township 15 North, and Range 20 East M.D.M., lying within Carson City, State of Nevada.

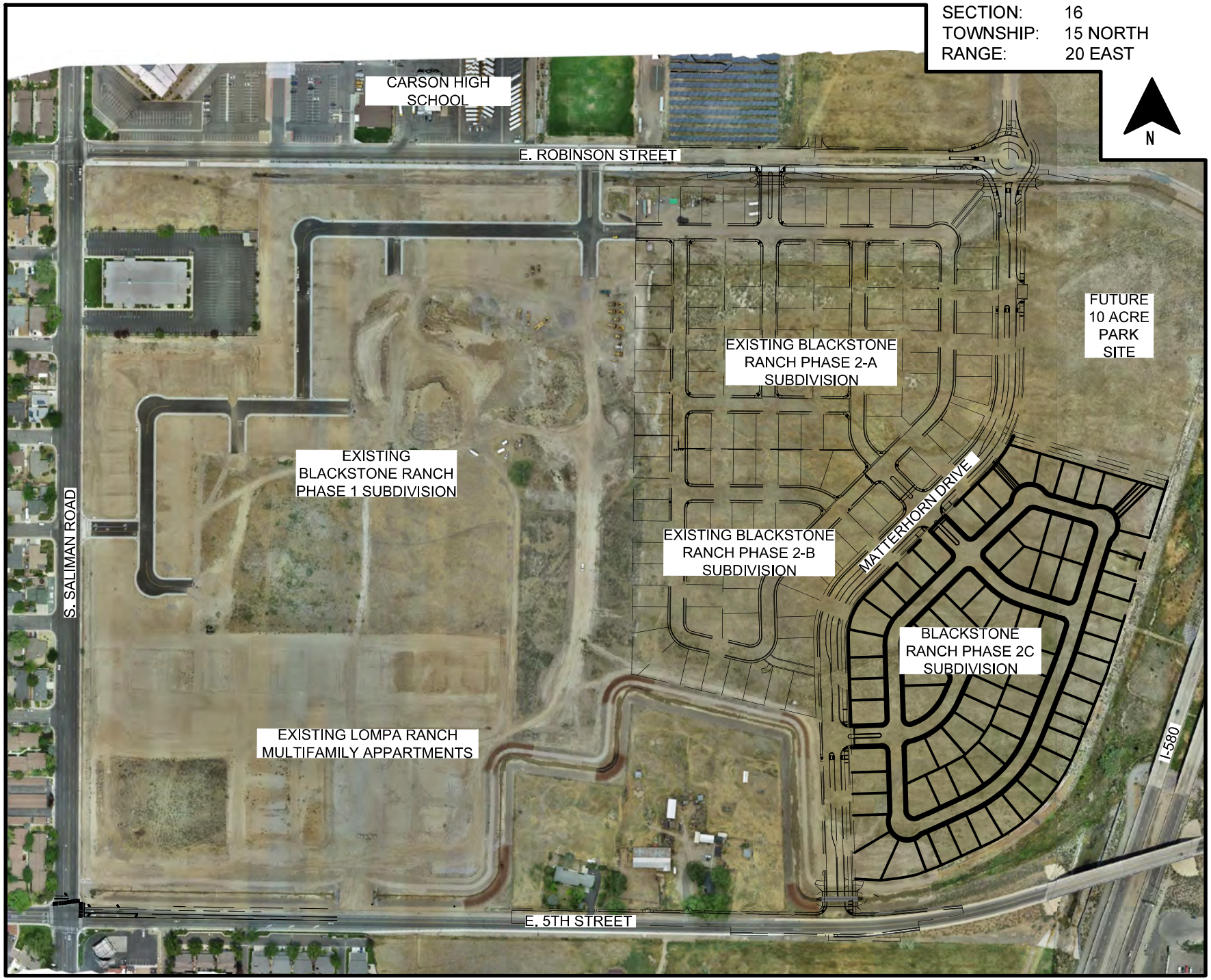
The project site consists of undeveloped open space that generally drains from the west to the east. According to the previously approved "Drainage Master Plan" prepared by Kimley-Horn & Associates (Kimley-Horn Report), historically Ash Canyon Creek (ACC), Kings Canyon Creek (KCC), and Tributary H & I, as well as the local, unnamed ditches that contribute to the Kings Creek drainage system historically discharged onto the proposed site. There are existing drainage facilities adjacent to the site, such as the civil improvements in S. Saliman Road and the triple barrel concrete box culvert that runs under I-580. With the construction of the previously approved ACC and KCC channels, the proposed site will no longer receive any of the upstream flows from either the Ash Canyon or Kings Canyon watersheds.

B. Description of Property

The 16.05-acre site is currently undeveloped and consists of native vegetation. Site topography slopes generally to the northeast and southeast with slopes ranging from 0% to 0.5%. Rainfall runoff from the developed portion of the site flows in an east-northeasterly direction towards existing culverts that cross under U.S. Highway 395 (Hwy 395). Currently, there are existing drainage facilities adjacent to the proposed site, which include the ACC and KCC engineered channels and the triple barrel concrete box culvert that runs under I-580. The proposed site is located directly east of the proposed Matterhorn Drive and Blackstone Ranch Phases 2-A 2-B (Refer to Figure 1, Vicinity Map).

C. Project Description

The BRPH2C Project will consist of the proposed 74-unit single family residential project. Phase 2-C and will have an estimated net import of approximately 46,500 cubic yards.



VICINITY MAP

N.T.S.

III. DRAINAGE BASIN DESCRIPTION

A. Off-Site drainage description

The project site consists of undeveloped open space that generally drains from the west to the east. According to the previously approved Kimley-Horn Report, ACC, KCC, Tributaries H & I, as well as the local, unnamed ditches that contribute to the Kings Creek drainage system historically discharged upstream flows onto the proposed site. However, with the construction of the ACC and KCC channels, the offsite flows will no longer enter the proposed site. Reference Figure 3 of the Kimley-Horn Report for off-site basins in Appendix F.

B. On-site drainage description

The existing hydrologic analysis was based on the native vegetation and the existing hydrologic sub-basins were delineated based on the property boundaries. The project site has been used as a working ranch for several decades. For the existing catchments, a time of concentration (T_C) and Rational Method coefficient were selected based on the Rational Method (Appendix A), taking into consideration the catchment characteristics, which include catchment area, slope and length of the longest channel, watershed boundaries, urbanization, and land cover. Table 1 and Figure 2 summarize the characteristics of the existing on-site catchment areas in the study area. Reference Appendix B for the complete existing conditions Rational Method analysis. Reference Figure 2 (Existing Hydrology Display) for the existing hydrology drainage map and the associated hydrologic sub-area.

Table 1 – Existing Conditions Rational Method Model Summary for BRPH2C Project, Carson City, NV.

Sub-Basin	Area (Ac.)	Rational Method Coefficient (C_{10}/C_{100})	Time of Concentration (min)	Rainfall Intensity (I_5/I_{100}) (in/hr.)	10-Year Peak Flows (cfs)	100-Year Peak Flows (cfs)
X-01	16.04	0.20/0.50	26.85	1.06/2.08	3.40	16.67
TOTAL	**16.04**	**-----**	**-----**	**-----**	**3.40**	**16.67**

C. Floodplain Information

The site is located in the floodways of Ash Canyon Creek and Kings Canyon Creek as portrayed on the effective FEMA Firmette which is map number 3200010111G dated December 22, 2016 (Appendix A). BRPH2C will be designed so that the finished floor elevation of each residential lot is a minimum two-feet higher than the 100-year water surface elevation determined in the previously approved Kimley–Horn Report.

D. Previous Drainage Studies

The Kimley-Horn Report was the main reference for this study. The following studies were in the Kimley-Horn Report:

1) Kimley-Horn and Associates; *Lompa Ranch FEMA Conditional Letter of Map Amendment*, submitted to FEMA January 2017
2) Resource Concepts Inc; *Preliminary Geotechnical Investigation, Lompa Ranch Project,* October 2016

3) Rubicon Design Group LLC; *Lompa Ranch North - Specific Plan*, Adopted March 17, 2016
4) HDR, *Draft Hydrologic Analyses and Results for Carson City Flood Insurance Study*, June 2010
5) HDR; *Draft Hydraulic Analyses and Results for the Carson City Flood Insurance Study*, July 2010
6) Kimley-Horn and Associates; *Southwest Carson City Flood Study*, February 2014
7) Manhard Consulting, LTD; SW Carson City Regional Hydrologic Analysis Final Report, March 2010
8) Northwest Hydraulic Consultants; *Summary Findings for Vicee Canyon Channel HEC-RAS Analysis Preliminary FIS/FIRM Review Support Carson City, NV*, September 2001

IV. PROPOSED DRAINAGE FACILITIES

A. General Description

Hydrologic analyses were performed based on the Carson City Drainage Manual (CCDM) (dated effective July 1, 2021) to determine the peak discharge for the 10-year and 100-year peak flow events. *AutoDesk Storm and Sanitary Analysis (SSA)* was used to perform a *Rational Method* analysis to model the hydrologic basins that contribute in the BRPH2C Project single family development existing and proposed conditions. The Rational Method was utilized in accordance with the CCDM to analyze the existing and proposed conditions. The proposed storm drain system was designed to convey the 10-year storm event in a "gravity flow" condition with the pipes below full flow capacity and in a "surcharged" or pressurized condition in the 100-year event. According to the approved Kimley-Horn Report, the ACC and KCC flood control channel were “sized to convey the 100-year storm with a minimum freeboard of at least 1-foot to the top of the channel banks and 18-inches to the top of the roadway crossings. Bottomless concrete culverts are proposed for all flood control channel crossings”. However, the Saliman Channel analyzed in the Kimley-Horn Report is not designed to convey the 100-year peak flow event. Flows will overtop the channel and will eventually be routed to the KCC channel.

Riprap or other approved erosion resistant channel bank lining will be provided at each culvert transition. A smooth channel bank lining will be installed along the outside bank of all bends in the flood control channels to prevent erosion of the channel bank and minimize the decrease in channel velocities due to the change of flow direction”. Additionally, the previously approved Kimley-Horn Report determined that the proposed BRPH2C Project will not adversely affect downstream properties and is not required to provide detention on-site.

A minimum time of concentration of 10- minutes was used for all sub-basins. The rainfall characteristics were modeled using the NOAA database (http://dipper.nws.noaa.gov/hdsc/pfds/sa/nv_pfds.html) to determine site specific depth of precipitation (Appendix A).

Rational Formula: ***Q=CiA***

Q=Peak Discharge (cfs)
C=Runoff Coefficient (dimensionless)
i=Precipitation Intensity (in/hr.)

A=Watershed Area (Acres)

B. Compliance with Regulations and Adopted Plans

The proposed BRPH2C Project is compliant with FEMA floodplain regulations and the Carson City Drainage Manual (CCDM).

C. Hydrologic Criteria

Parameters for peak storm flow and runoff volume estimates presented herein were determined using the data and methodologies presented in the CCDM. In instances where the CCDM was lacking information or specificity, the Truckee Meadows Regional Drainage Design Manual (TMRDM) and/or the other appropriate sources and software user manuals were referenced. The Rational Method was utilized in accordance with the CCDM to analyze the existing and proposed conditions. A minimum time of concentration of 10 minutes was used for all sub-basins. The rainfall characteristics were modeled using the NOAA database (http://dipper.nws.noaa.gov/hdsc/pfds/sa/nv_pfds.html) to determine site specific depth of precipitation (Appendix A).

The sub-areas accounted for the proposed on-site flows that affect the site. The associated calculated 10-year and 100-year peak flows can be found in Table 2 and Figure 3 (Appendix C). Both pipe sizes and catch basins have been sized to accommodate the proposed flows. Reference Figure 3 in the map pocket for the associated hydrologic sub-areas and the proposed catch basins. All drainage for the basins will be contained in swales and the roadway and will travel to the catch basins. A portion of the discharge of the proposed sub-basins (Table 2) are directed through the storm drain system to the existing engineered channel adjacent to the project to north, or to the sedimentation/detention facilities located at the eastern portion of the project with the remaining sub-basins discharging directly into the engineered channels adjacent to the project site. The outlets of the detention ponds will discharge to the existing engineered channel at eastern portion of the site. Refer to Table 2 and Appendix C, Proposed Conditions Hydrologic Analysis for all data and supporting calculations using the Rational Method.

Table 2 – Proposed Rational Method Model Summary for BRPH2C Project, Carson City, NV.

Sub-Basin	Area (Ac.)	Rational Method Coefficient (C_2-C_{10}/C_{100})	Time of Concentration (min)	Rainfall Intensity (I_2/I_{10}/I_{100}) (in/hr.)	2-Year Peak Flows (cfs)	10-Year Peak Flows (cfs)	100-Year Peak Flows (cfs)
2C-01	0.58	0.60/0.78	10.00	1.08/1.79/3.51	0.38	0.62	1.59
2C-02	0.59	0.60/0.78	10.00	1.08/1.79/3.51	0.38	0.63	1.62
2C-03	0.81	0.60/0.78	10.00	1.08/1.79/3.51	0.53	0.87	2.22
2C-04	0.49	0.60/0.78	10.00	1.08/1.79/3.51	0.32	0.53	1.34
2C-05	0.65	0.60/0.78	10.00	1.08/1.79/3.51	0.42	0.70	1.78
2C-06	0.76	0.60/0.78	10.00	1.08/1.79/3.51	0.49	0.82	2.08
2C-07	0.64	0.60/0.78	10.00	1.08/1.79/3.51	0.42	0.69	1.75
2C-08	0.83	0.60/0.78	10.00	1.08/1.79/3.51	0.54	0.89	2.27
2C-09	1.17	0.60/0.78	10.00	1.08/1.79/3.51	0.76	1.26	3.20
2C-10	0.97	0.60/0.78	10.00	1.08/1.79/3.51	0.63	1.04	2.66
2C-11	0.95	0.60/0.78	10.00	1.08/1.79/3.51	0.62	1.02	2.60
2C-12	1.36	0.60/0.78	10.00	1.08/1.79/3.51	0.88	1.46	3.72
2C-13	0.95	0.60/0.78	10.00	1.08/1.79/3.51	0.62	1.02	2.60
2C-14	1.53	0.60/0.78	10.00	1.08/1.79/3.51	0.99	1.64	4.19
2C-15	0.46	0.60/0.78	10.00	1.08/1.79/3.51	0.30	0.49	1.26
2C-OFF-1	0.46	0.60/0.78	10.00	1.08/1.79/3.51	0.30	0.49	1.26
2C-OFF-2	1.10	0.60/0.78	10.00	1.08/1.79/3.51	0.71	1.18	3.01
2C-OFF-3	0.20	0.20/0.50	10.00	1.08/1.79/3.51	0.04	0.07	0.35
2C-OFF-4	0.81	0.60/0.78	10.00	1.08/1.79/3.51	0.53	0.87	2.22
2C-OFF-5	0.15	0.20/0.50	10.00	1.08/1.79/3.51	0.03	0.05	0.26
**2C-R1	0.03	0.20/0.50	10.00	1.08/1.79/3.51	0.01	0.01	0.05
**2C-R2	0.13	0.60/0.78	10.00	1.08/1.79/3.51	0.08	0.14	0.36
**2C-R3	0.14	0.60/0.78	10.00	1.08/1.79/3.51	0.09	0.15	0.38
**2C-R4	0.14	0.60/0.78	10.00	1.08/1.79/3.51	0.09	0.15	0.38
**2C-R5	0.14	0.60/0.78	10.00	1.08/1.79/3.51	0.09	0.15	0.38
TOTAL	**16.04**	-----	-----	-----	**10.23**	**16.95**	**43.54**

*Total subbasin area does not match total acreage of the site due to some lots adjacent to the Matterhorn Drive draining to existing roadway drainage areas.

**Area from PH2 Roadway infrastructure hydrology report.

Additionally, the Lompa Ranch North Specific Plan Area (SPA) and the Kimley-Horn Report determined that the proposed BRPH2C Project will not adversely affect downstream properties and is not required to provide detention on-site due to the single-family residential development and the associated civil improvements. As stated in the previously approved Kimley-Horn Report, "Although post-construction stormwater detention is required by the Specific Plan in the commercial and multi-family residential developments, it should not be required in the single-family residential developments. Due to the location of the project within the lower portions of the KCC, ACC, and VCC watersheds, providing detention may actually increase peak flows and water surface elevations downstream of the proposed development" (Kimley-Horn Report, page 10). Once the single-family developments are designed, a portion of the 2-year event will be routed to the existing drainage channel constructed as part of the Phase 2 Roadway Infrastructure plans and the two proposed sedimentation/detention facilities located within the project. The proposed facilities will have a low-flow channel that will act as a LID.

D. Facility Design Calculation

The hydraulic model utilized routing of the peak flows through proposed storm drain to the engineered channels. Runoff will be collected in catch basins, storm drain, and the LID facilities, which are routed toward the ACC and KCC channels designed by Kimley-Horn. All drainage from the sub-basins will be contained in the swales and roadway and will travel to the catch basins, engineered channels, sedimentation/detention basins, and the KCC channel. Additionally, the proposed storm drain system was designed to convey the 10-year storm event in a "gravity flow" condition with the pipes below full flow capacity and in a "surcharged" or pressurized condition in the 100-year event. Each of the proposed inlet capacities were designed based on Table 4 of CCDM. Additionally, JK Architecture Engineering used the 100-year water surface elevations in the KCC channel from the Kimley-Horn study to analyze the back-water effects on the proposed storm drain system, which is a conservative approach, due to the fact that the peak flows from BRPH2C would be significantly downstream of the peak flows analyzed by the previously approved Kimley-Horn Report.

As part of the hydrologic and hydraulic analysis of the proposed residential infrastructure, two sedimentation/detention ponds were added on the east side of the subdivision that ultimately discharge into the existing drainage channel paralleling the highway. A portion of the subdivision drains to the storm drain system constructed with the roadway infrastructure which leads to a drainage facility located directly north of the project. A portion of the proposed storm drain system will discharge into the channel which was designed to convey the 100-year peak flow event with two-feet of free-board.

The proposed outlet hydraulics were analyzed using TMRDM equations 842, 843, 859, 861, and 862 (Appendix A). The calculated flows for the proposed from the 100-year peak discharges at locations where the proposed storm drain discharges into the existing engineered channels, or where the newly proposed sedimentation/detention ponds discharge into the existing channel are summarized below. Riprap aprons will be designed at outlets that produces exit velocities greater than 5.0 ft/sec. The outlets were analyzed using the

previously mentioned equations for outlet protection. Table 3 summarizes the channel and outlet hydraulic (Appendix E).

Table 3 – Proposed Outlet Protection Summary for BRPH2C Project, Carson City, NV.

Outlet ID	Q_{100} Peak Flow (cfs)	Velocity (ft./sec)	Outlet Diameter (ft.)	Tailwater Depth (ft.)	Length (ft.)	Width (ft.)	Rock Diameter (D_{50})
OUTFALL-01	8.92	3.41	2.0	2.22	24	16	0.07
POND2C-01	7.80	4.54	2.0	0.85	19	25	0.14
POND2C-02	12.88	5.14	2.0	1.30	28	18	0.18

Channel stabilization methods were employed to mitigate the erosive properties of flood events. Riprap was designed and provided at each outlet to minimize erosion of the native soils.

According to the Kimley-Horn Report, the offsite flows will be conveyed in the proposed ACC and KCC channels. Reference Kimley-Horn Report for the associated calculations. FEMA floodplain/floodway calculations were also determined in the Kimley-Horn Report.

The proposed storm drain system was analyzed during the 100-year peak flow event. Catch basins were located for the 100-year storm to not inundate structures. Refer to Appendix D for the associated cross-sectional analyses. The proposed storm drain system will be maintained by the Carson City.

The Energy and Hydraulic Grade Lines (HGL) can be viewed in the civil improvement plans. All of the HGL's are a minimum of one foot below the proposed rim with the exceptions of SDMH-C12 & SDMH-C13. SDMH-C12 is approximately 0.96' below the proposed rim grade and SDMH-C13 is approximately 0.99' below the rim grade. Due to the conservative nature of the modeling, it is not recommended to use bolt down lids for these two manholes.

According to Table 3 in the Carson City Drainage Manual, a local roadway shall contain flow to not inundate structures during the 100-year peak flow event. The maximum depth at gutter flow line shall be 1 foot. Table 4 summarizes the 100-year peak flow inlet hydraulics for all local roads from right of way to right of way (ROW) within the subdivision for Phase 2-A and 2-B (Appendix D).

Table 4 – Proposed 100-year Dry Lane Summary for BRPH2C Project, Carson City, NV.

Outlet ID	Inlet Condition	10-Year Peak Flow (cfs)	100-Year Peak Flow (cfs)	Peak Flow Intercepted Q_{10}/Q_{100} (cfs)	Peak Flow Bypassing Q_{10}/Q_{100} (cfs)	Max Gutter Spread Q_{10}/Q_{100} (ft.)
CB-C01	On Sag	0.62	1.59	0.62/	N/A	2.15/3.14
CB-C02	On Sag	0.63	1.61	0.63	N/A	2.16/3.17
CB-C03	On Grade	0.87	2.22	0.76/	0.11/0.73	5.94/9.86
CB-C04	On Grade	0.53	1.34	0.45/	0.08/0.30	2.65/7.64
CB-C05	On Sag	0.72	2.08	0.72	N/A	2.26/7.99
CB-C06	On Sag	0.94	2.81	0.94	N/A	2.51/13.11
CB-C07	On Sag	0.69	1.75	0.69	N/A	2.23/6.83
CB-C08	On Sag	0.89	2.27	0.89	N/A	2.46/8.64
CB-C09	On Sag	1.26	3.20	1.26	N/A	2.83/11.56
CB-C10	On Sag	1.04	2.65	1.04	N/A	2.62/9.88
CB-C11	On Sag	1.02	2.60	1.02	N/A	2.60/9.71
CB-C12	On Grade	1.46	3.72	1.33/	0.13/1.20	4.82/8.55
CB-C13	On Sag	1.16	3.80	1.16	N/A	2.73/13.29
CB-C14	On Sag	1.64	4.19	1.64	N/A	6.44/14.35

The sedimentation/detention basins within the subdivision were modeled with no backwater effect. The anticipated flow was based on the Kimley-Horn attenuated flow and the 100-year WSE in the channel. Even with the 100-year WSE in the channel, the adjacent lots have approximately 1.3' of freeboard before the water reached the lowest lot line elevation. Spillways are also provided in each of the ponds as a secondary measure to prevent the potential for flooding in the event of a clogged pipe. The spillway elevation has been set to 1.0' above the 100-year water surface elevation in the channel as determined in the Kimley-Horn study.

Water quality control measures have been incorporated into the project in an attempt to prevent storm drainage leaving the site from adversely affecting downstream uses. Three water quality control measures are utilized on this site. The first portion of the project (4.64 acres) will discharge into the engineered linear channel constructed as a part of the Phase 2 Roadway Infrastructure plans, the second portion (3.3 acres) will discharge into the proposed detention basin located at the eastern portion of the site with the last portion (5.91 acres) discharging into the proposed detention basin located at the southern portion of the site. These items have been designed to capture stormwater and allow for infiltration during the storm event.

The calculations listed below for the Volume-Based Water Quality Control Design were obtained from section 2.1.1.3 in the CCDM and the are listed in Table 5 below:

Water Quality Volume Calculation: **$WQ_v=[(P)(R_v)(A)]/12$**
$R_v=0.05 + 0.009I$
WQ_v=Water quality volume (ft^3)
P=the 90^{th} percentile precipitation depth (in.)
I=percent of basin impervious area
A=drainage area (ft^2)

Table 5 – Water Quality Volume Calculation for BRPH2 Project, Carson City, NV.

	P (inches)	I (%)	A (ft^2)	R_v	WQ_v (ft^3) (Required)	WQ_v (ft^3) (Provided)
Linear Channel	0.5	0	202,118	0.05	421	1,640 @ 2' depth
E. Detention Pond	0.5	0	143,748	0.05	299	510 @1' depth
S. Detention Pond	0.5	0	257,440	0.05	536	703 @ 1.5' depth

All underground storm drain facilities shall be owned and maintained by Carson City while maintenance of all common areas including all stormwater treatment facilities shall be the responsibility of a homeowner's maintenance association.

V. CONCLUSIONS

A. Compliance with drainage laws

This Technical Drainage Study is compliant with all local and federal requirements and specifications. The proposed on-site civil improvements meet or exceed the minimum design standards set forth by Carson City and FEMA.

B. Compliance with the CCMC

JK Architecture Engineering Inc., has coordinated with Carson City engineering and planners during the planning and design phases of the BRPH2C project.

C. Compliance with FEMA requirements

This analysis is based on the Kimley-Horn Report which is in compliance with FEMA requirements. All design recommendations have been based on the ACC, KCC, and tributaries H and I channel designs.

D. Compliance with development standards

The BRPH2C Project is in complete compliance with the Carson City developmental standards.

E. Effectiveness of proposed drainage facilities to control storm runoff

All drainage from the sub-basins will be contained in the lot swales and roadways and will travel to the catch basins, the sedimentation/detention basins, and the approved KCC channel. Additionally, the proposed storm drain system was be designed to convey the 10-year storm event in a "gravity flow" condition with the pipes below full flow capacity and in a "surcharged" or pressurized condition in the 100-year. Each of the proposed inlet capacities were designed based on Table 4 (Allowable Storm Inlet Types and Capacity Factors) in the CCDM (Appendix D). Additionally, JK Architecture Engineering used the 100-year water surface elevations in the proposed KCC channel from the previously approved Kimley-Horn study to analyze the back-water effects on the proposed storm drain system, which is a conservative approach due to the fact that the peak flows from the BRPH2C would be significantly downstream of the peak flows from the upstream basins analyzed by Kimley-Horn study. Additionally, the proposed catch basins in the local roads within the subdivision were spaced so flow contained will not inundate the structures during the 100-year peak flow event.

F. Impact of proposed development on off-site property and facilities

There will be no impact to the off-site property and facilities due to the proposed BRPH2C Project. The proposed peak flows will be significantly downstream of the peak flows in the proposed channels analyzed in the Kimley-Horn Report and will have no impact downstream.

G. Mitigation of impacts and implementation schedule

The proposed BRPH2C Project development will be constructed in one phase. In an attempt to control the potential sedimentation due to precipitation runoff, Best Management Practices will be employed to reduce the associated environmental impacts. The 2-year peak flow event was calculated as part of the Low Impact Development (LID) analysis (Appendix C). Water quality measures have been designed to collect and treat the calculated flows.

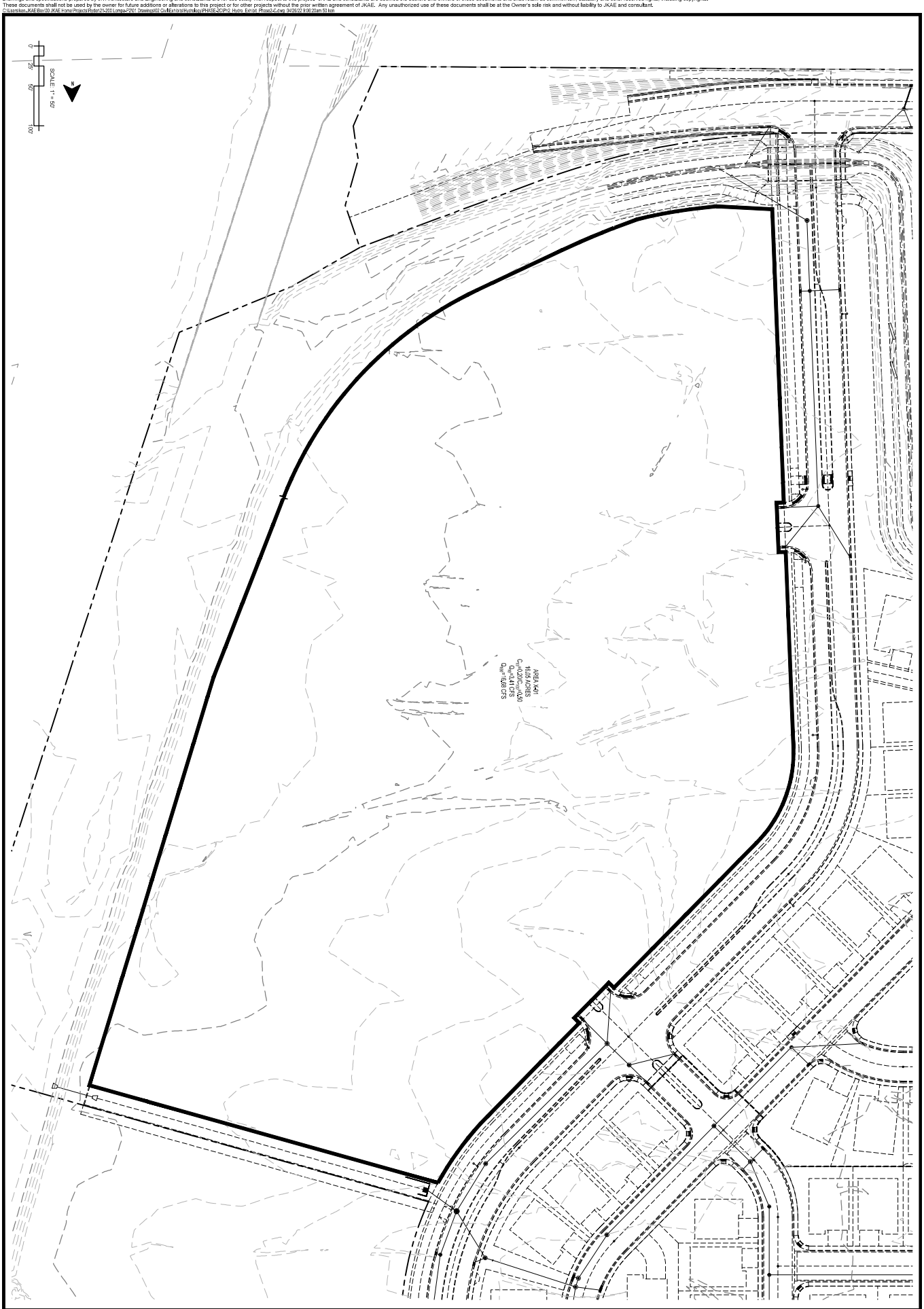


Fig. 2
OF
3

Project
CIVIL IMPROVEMENT PLANS

BLACKSTONE RANCH PHASE 2
PHASE 2-C SUBDIVISION
CARSON CITY, NEVADA

Drawing Title
EXISTING HYDROLOGY DISPLAY

Seal

NO.	DATE	ISSUE

Date: MAY 2022
Project No.: 21-100
Checked By: KA
Drawn By: KA

JK ARCHITECTURE ENGINEERING
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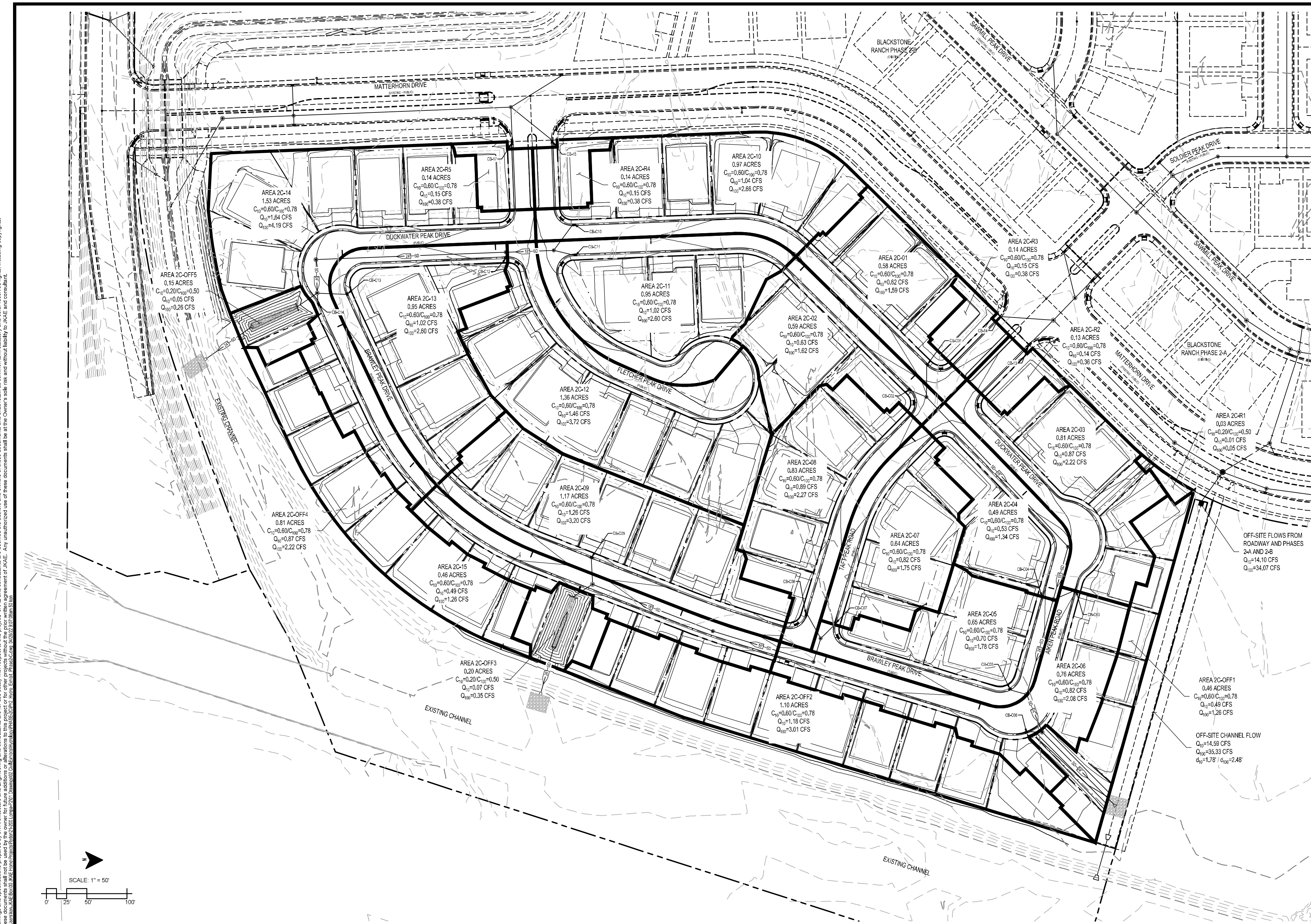
MATTERHORN DRIVE
BLACKSTONE RANCH PHASE 2-B
SAWMILL PEAK DRIVE
SOLDIER PEAK DRIVE
BLACKSTONE RANCH PHASE 2-A
MATTERHORN DRIVE
DUCKWATER PEAK DRIVE
FLETCHER PEAK DRIVE
BRAWLEY PEAK DRIVE
TAFT PEAK ROAD
AIKEN PEAK ROAD
EXISTING CHANNEL
AREA 2C-14
1.53 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=1.64 CFS
Q_{100}=4.19 CFS
AREA 2C-R5
0.14 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=0.15 CFS
Q_{100}=0.38 CFS
AREA 2C-R4
0.14 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=0.15 CFS
Q_{100}=0.38 CFS
AREA 2C-10
0.97 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=1.04 CFS
Q_{100}=2.66 CFS
AREA 2C-OFF5
0.15 ACRES
C_{10}=0.20/C_{100}=0.50
Q_{10}=0.05 CFS
Q_{100}=0.26 CFS
AREA 2C-13
0.95 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=1.02 CFS
Q_{100}=2.60 CFS
AREA 2C-11
0.95 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=1.02 CFS
Q_{100}=2.60 CFS
AREA 2C-01
0.58 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=0.62 CFS
Q_{100}=1.59 CFS
AREA 2C-R3
0.14 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=0.15 CFS
Q_{100}=0.38 CFS
AREA 2C-02
0.59 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=0.63 CFS
Q_{100}=1.62 CFS
AREA 2C-R2
0.13 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=0.14 CFS
Q_{100}=0.36 CFS
AREA 2C-12
1.36 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=1.46 CFS
Q_{100}=3.72 CFS
AREA 2C-R1
0.03 ACRES
C_{10}=0.20/C_{100}=0.50
Q_{10}=0.01 CFS
Q_{100}=0.05 CFS
AREA 2C-03
0.81 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=0.87 CFS
Q_{100}=2.22 CFS
AREA 2C-08
0.83 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=0.89 CFS
Q_{100}=2.27 CFS
AREA 2C-09
1.17 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=1.26 CFS
Q_{100}=3.20 CFS
AREA 2C-OFF4
0.81 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=0.87 CFS
Q_{100}=2.22 CFS
AREA 2C-04
0.49 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=0.53 CFS
Q_{100}=1.34 CFS
AREA 2C-07
0.64 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=0.82 CFS
Q_{100}=1.75 CFS
OFF-SITE FLOWS FROM
ROADWAY AND PHASES
2-A AND 2-B
Q_{10}=14.10 CFS
Q_{100}=34.07 CFS
AREA 2C-15
0.46 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=0.49 CFS
Q_{100}=1.26 CFS
AREA 2C-05
0.65 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=0.70 CFS
Q_{100}=1.78 CFS
AREA 2C-OFF3
0.20 ACRES
C_{10}=0.20/C_{100}=0.50
Q_{10}=0.07 CFS
Q_{100}=0.35 CFS
AREA 2C-06
0.76 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=0.82 CFS
Q_{100}=2.08 CFS
AREA 2C-OFF1
0.46 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=0.49 CFS
Q_{100}=1.26 CFS
AREA 2C-OFF2
1.10 ACRES
C_{10}=0.60/C_{100}=0.78
Q_{10}=1.18 CFS
Q_{100}=3.01 CFS
OFF-SITE CHANNEL FLOW
Q_{10}=14.59 CFS
Q_{100}=35.33 CFS
d_{10}=1.78' / d_{100}=2.48'
EXISTING CHANNEL
EXISTING CHANNEL
SCALE: 1" = 50'
0' 25' 50' 100'

JK ARCHITECTURE ENGINEERING
AUBURN | TAHOE CITY | RENO | SAN JOSE
www.jkaedesign.com

Drawn By: KA
Checked By: KA
Project No.: 21-100
Date: MAY 2022

NO.	DATE	ISSUE

Seal

Drawing Title
PROPOSED HYDROLOGY DISPLAY

Project
CIVIL IMPROVEMENT PLANS
BLACKSTONE RANCH PHASE 2
PHASE 2-C SUBDIVISION
CARSON CITY, NEVADA

Fig. 3 OF 3

APPENDIX A

SUPPORTING DATA

National Flood Hazard Layer FIRMette

FEMA

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance / Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 11/16/2021 at 7:20 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

NOAA Atlas 14, Volume 1, Version 5
Location name: Carson City, Nevada, USA*
Latitude: 39.1647°, Longitude: -119.7452°
Elevation: 4636.4 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	1.14 (0.984-1.34)	1.42 (1.22-1.68)	1.90 (1.62-2.26)	2.35 (2.00-2.80)	3.11 (2.56-3.68)	3.79 (3.02-4.54)	4.61 (3.56-5.57)	5.59 (4.14-6.86)	7.15 (5.00-8.96)	8.56 (5.70-10.9)
10-min	0.864 (0.744-1.02)	1.08 (0.930-1.28)	1.44 (1.24-1.71)	1.79 (1.52-2.12)	2.36 (1.94-2.81)	2.89 (2.30-3.45)	3.51 (2.71-4.24)	4.26 (3.16-5.23)	5.44 (3.80-6.82)	6.51 (4.34-8.30)
15-min	0.716 (0.616-0.844)	0.892 (0.772-1.06)	1.19 (1.02-1.42)	1.48 (1.26-1.76)	1.95 (1.61-2.32)	2.38 (1.90-2.85)	2.90 (2.24-3.50)	3.52 (2.61-4.32)	4.50 (3.14-5.64)	5.38 (3.58-6.86)
30-min	0.482 (0.414-0.568)	0.600 (0.520-0.712)	0.802 (0.688-0.952)	0.996 (0.848-1.18)	1.31 (1.08-1.56)	1.61 (1.28-1.92)	1.95 (1.51-2.36)	2.37 (1.76-2.91)	3.03 (2.12-3.80)	3.62 (2.41-4.62)
60-min	0.298 (0.257-0.352)	0.371 (0.321-0.440)	0.497 (0.426-0.590)	0.616 (0.524-0.732)	0.813 (0.670-0.967)	0.994 (0.794-1.19)	1.21 (0.933-1.46)	1.47 (1.09-1.80)	1.87 (1.31-2.35)	2.24 (1.49-2.86)
2-hr	0.202 (0.180-0.232)	0.250 (0.223-0.288)	0.320 (0.282-0.366)	0.382 (0.333-0.436)	0.474 (0.403-0.545)	0.557 (0.462-0.646)	0.650 (0.526-0.764)	0.764 (0.597-0.910)	0.958 (0.716-1.19)	1.14 (0.822-1.44)
3-hr	0.161 (0.144-0.181)	0.200 (0.180-0.227)	0.252 (0.224-0.284)	0.294 (0.260-0.331)	0.354 (0.308-0.401)	0.405 (0.346-0.463)	0.462 (0.387-0.533)	0.535 (0.438-0.628)	0.655 (0.519-0.798)	0.769 (0.594-0.972)
6-hr	0.111 (0.100-0.124)	0.139 (0.125-0.156)	0.173 (0.154-0.193)	0.200 (0.177-0.224)	0.236 (0.207-0.266)	0.265 (0.229-0.300)	0.294 (0.249-0.336)	0.327 (0.272-0.380)	0.377 (0.305-0.444)	0.421 (0.333-0.504)
12-hr	0.073 (0.065-0.082)	0.091 (0.082-0.103)	0.115 (0.102-0.130)	0.134 (0.118-0.150)	0.159 (0.139-0.180)	0.178 (0.154-0.203)	0.198 (0.168-0.228)	0.218 (0.182-0.254)	0.245 (0.199-0.292)	0.267 (0.212-0.322)
24-hr	0.048 (0.043-0.053)	0.060 (0.054-0.066)	0.075 (0.069-0.083)	0.088 (0.080-0.097)	0.105 (0.095-0.116)	0.119 (0.107-0.131)	0.134 (0.119-0.148)	0.148 (0.131-0.165)	0.169 (0.146-0.189)	0.185 (0.158-0.209)
2-day	0.028 (0.026-0.032)	0.036 (0.032-0.040)	0.045 (0.041-0.051)	0.053 (0.048-0.059)	0.064 (0.057-0.072)	0.073 (0.064-0.082)	0.082 (0.072-0.092)	0.091 (0.079-0.104)	0.104 (0.089-0.120)	0.115 (0.097-0.133)
3-day	0.021 (0.019-0.023)	0.026 (0.023-0.029)	0.033 (0.030-0.038)	0.039 (0.035-0.044)	0.048 (0.042-0.054)	0.054 (0.048-0.061)	0.061 (0.053-0.070)	0.069 (0.059-0.079)	0.079 (0.067-0.091)	0.087 (0.073-0.102)
4-day	0.017 (0.015-0.019)	0.021 (0.019-0.024)	0.028 (0.024-0.031)	0.032 (0.029-0.037)	0.040 (0.035-0.045)	0.045 (0.039-0.051)	0.051 (0.044-0.058)	0.057 (0.049-0.066)	0.066 (0.056-0.077)	0.074 (0.061-0.086)
7-day	0.011 (0.010-0.013)	0.014 (0.013-0.016)	0.018 (0.016-0.021)	0.022 (0.019-0.024)	0.026 (0.023-0.030)	0.030 (0.026-0.034)	0.034 (0.029-0.039)	0.038 (0.033-0.043)	0.043 (0.037-0.050)	0.048 (0.040-0.056)
10-day	0.009 (0.008-0.010)	0.011 (0.010-0.012)	0.014 (0.013-0.016)	0.017 (0.015-0.019)	0.020 (0.018-0.023)	0.023 (0.020-0.026)	0.026 (0.022-0.029)	0.029 (0.025-0.032)	0.032 (0.028-0.037)	0.035 (0.030-0.041)
20-day	0.005 (0.005-0.006)	0.007 (0.006-0.007)	0.009 (0.008-0.010)	0.010 (0.009-0.011)	0.012 (0.011-0.013)	0.014 (0.012-0.015)	0.015 (0.013-0.017)	0.016 (0.014-0.019)	0.018 (0.016-0.021)	0.020 (0.017-0.023)
30-day	0.004 (0.004-0.004)	0.005 (0.005-0.006)	0.006 (0.006-0.007)	0.008 (0.007-0.008)	0.009 (0.008-0.010)	0.010 (0.009-0.011)	0.011 (0.010-0.012)	0.012 (0.011-0.014)	0.014 (0.012-0.015)	0.015 (0.013-0.017)
45-day	0.003 (0.003-0.003)	0.004 (0.004-0.004)	0.005 (0.005-0.006)	0.006 (0.005-0.006)	0.007 (0.006-0.008)	0.008 (0.007-0.008)	0.008 (0.007-0.009)	0.009 (0.008-0.010)	0.010 (0.009-0.011)	0.011 (0.009-0.012)
60-day	0.003 (0.002-0.003)	0.003 (0.003-0.004)	0.004 (0.004-0.005)	0.005 (0.005-0.006)	0.006 (0.005-0.006)	0.006 (0.006-0.007)	0.007 (0.006-0.008)	0.008 (0.007-0.008)	0.008 (0.007-0.009)	0.009 (0.008-0.010)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical

I. Introduction

Stormwater runoff and the drainage systems that convey the runoff through the community, both naturally occurring and manmade, are integral elements of the watershed and the developed environment. While stormwater runoff is part of a natural hydrologic process, development and other human activities can change natural drainage patterns and add pollutants to streams, rivers, and lakes. Carson City's efforts to control stormwater discharge focus on both the quantity and quality of the stormwater. This Manual is an effort to improve stormwater management by improving stormwater quality and reducing the quantity of stormwater conveyed through the City's stormwater drainage system.

This Carson City Drainage Manual (Manual) includes and promotes the use of Low Impact Development (LID) practices. LID is a stormwater management approach to land development and redevelopment that works to manage stormwater close to its source. Design principles are used that minimize disturbance, maintain or create perviousness, and use on-site stormwater treatment techniques. LID practices can be effective in reducing runoff quantity, enhancing groundwater recharge, preserving flood plain storage, and removing pollutants by filtration and biological processes before entering the City's storm drainage system.

The Manual supersedes and has been created from the former Stormwater Division 14 of the City's Development Standards. The Manual is an update of the previous stormwater criteria for Carson City and incorporates LID practices and requirements for new and redeveloped properties in the City. The new Manual's formatting has been adjusted to include LID Best Management Practices (BMPs) that are most likely to be used in Carson City.

I.1 Purpose

The Manual's purpose is to reduce pollutants and control drainage by providing guidance on the selection, design, implementation, and management of stormwater source control and structural treatment control BMPs and LID measures for Carson City. The Manual provides information and potential references to aid in making informed selections of BMPs and LID practices.

I.2 NPDES Stormwater Permit and Legal Authority

Carson City is required to implement and enforce a Stormwater Management Program (SWMP) to reduce the pollutants in its stormwater and discharge through its Municipal Separate Storm Sewer System (MS4). Also required is the development of policies and procedures to implement and enforce the operation and maintenance of source controls and structural treatment controls for new development and redevelopment within the City. The requirements for the SWMP and a permit to discharge pollutants into waters of the United States from a MS4 are contained in Section 402 of the Federal Clean Water Act (CWA).

In 2021, Carson City amended and updated the provisions pertaining to drainage, stormwater, LID, and related topics in Titles 12 and 18 of its Municipal Code. As part of this update, Division 14, Storm Drainage, of the Title18 Appendix was removed from the Code and replaced by this Manual.

I.3 Relationship to Other Standards and References

Users of this Manual should be aware of other City standards that may be applicable to the development or redevelopment of property within Carson City. Users may also consult references cited in this Manual for more information and alternative practices. Pertinent Carson City and regional standards include, but are not limited to, those listed below.

- Carson City Municipal Code, Title 18 Appendix, Development Standards.
- Standard Specifications for Public Works Construction (SSPWC) (The "Orange Book") (2012 or the most current edition) provides general provisions, material specifications, and construction

methods for typical public works installations, including storm drainage infrastructure and landscaping.
- Truckee Meadows Structural Controls Design and Low Impact Development Manual.
- Truckee Meadows Structural Controls Design Manual, together with all addenda.
- Truckee Meadows Construction Site Best Management Practices Handbook, together with all addenda.
- Truckee Meadows Industrial Commercial Best Management Practices Handbook, together with all addenda.
- Chapter 4 of the Tahoe Regional Planning Agency Best Management Practices Handbook, together with all referenced addenda.

The standards, criteria, and requirements in this Manual are minimum standards that may not necessarily be adequate to address the highly variable conditions that must be covered by effective low impact development measures.

I.4 Updates and Revisions

Innovation and improvement continue to advance BMPs, LID practices, and the science and technology related to stormwater management and stormwater quality. The City Engineer may make technical engineering and clerical revisions to this manual at any time. For revisions that may have minor cost implications to the development community to comply with the specifications in this manual, the City Engineer must provide an opportunity for public input and update the Board of Supervisors prior to making the revisions. For major revisions that may have significant cost implications to the development community, the City Engineer must provide an opportunity for public input and obtain Board of Supervisor approval prior to making the major revision. Any revisions must be posted to the Carson City website where this manual is available for a period of 30 days before the revisions become effective.

1. Drainage Policy Introduction and Basic Principles

Adequate drainage systems shall be provided in order to preserve and promote the general health, welfare, and economic well-being of the region. Drainage is a regional feature that affects all of Carson City. Drainage plans shall be consistent with and integrated with BMPs, LID measures, and the Carson City Drainage Master Plan upon adoption. This characteristic of drainage requires coordination and cooperation from both the public and private sectors.

Stormwater drainage systems are an integral part of the development process. The planning of drainage facilities, BMPs, and LID measures shall be integrated into the development process and in preparation of improvement plans. Onsite stormwater drainage systems shall include BMPs and LID measures to reduce runoff and improve stormwater quality unless it is demonstrated to the satisfaction of the City Engineer that the site is not suitable.

Drainage systems require space to accommodate conveyance, storage, and treatment functions. When the space requirements are considered, the provision for adequate drainage becomes a competing use for space along with other land uses.

Storm drainage planning for all development and redevelopment shall include the allocation of space for drainage facility construction and maintenance, which may entail the dedication of right-of-way and/or easements. The provision of multi-use facilities such as combining with parks, open space, and recreation needs is strongly encouraged.

New development. New development is the conversion of previously undeveloped or pervious surfaces to impervious surfaces and managed landscape areas.

Redevelopment. Redevelopment is the replacement of impervious surfaces on a developed site. All new impervious surfaces added during redevelopment are considered new development.

The long-term goal of the redevelopment standard is to reduce stormwater pollution from existing developed sites, especially when the site is being upgraded to a use with a greater potential to contribute pollution to the receiving waters.

1.1 Water Rights

All drainage systems shall be planned and constructed with consideration given to the existing water rights and applicable water laws.

1.2 Reasonable Use of Drainage

Downstream properties shall not be unreasonably burdened with increased flow rates, negative impacts, or unreasonable changes in the manner of flow from upstream properties. Drainage problems shall not be transferred from one location to another. However, downstream properties cannot block natural or existing runoff through their site and shall accept runoff from upstream properties.

“Reasonable Use of Drainage” is defined for planning purposes, as providing an economic and hydraulically efficient drainage system which is demonstrated not to adversely and unreasonably impact downstream properties within reason. This “Reasonable Use of Drainage” therefore allows development to occur while preserving the rights of adjacent property owners.

1.3 Change in Manner of Flow

Development shall tend to concentrate existing natural sheet flow into point flows at property lines. These point flows are generally associated with outlets from gutter flow, storm drains, and detention facilities. Downstream properties may experience a longer duration of storm flows, and greater flows in general due to a shortened time of concentration. Discharge of point flows on downstream property can cause

increased erosion at the discharge point and further downstream. The manner by which runoff is discharged from the project site must not cause a significant adverse impact to downstream receiving waters and down-gradient properties. Therefore, downstream facilities shall be evaluated for runoff capacity during the design and review process. Mitigation of these point flows can be accomplished through energy dissipaters or flow spreaders. Point flows shall be discharged to downstream properties at non-erosive velocities and depths of flow.

All outfalls must address energy dissipation as necessary. A project proponent who believes that energy dissipation should not be required for a new outfall must provide justification in the project's conceptual or technical drainage study.

Where no conveyance system exists at the adjacent down-gradient property line, and the discharge was previously unconcentrated flow or significantly lower concentrated flow, then measure must be taken to prevent down-gradient impacts. Drainage easements or right-of-way from downstream property owners may be needed and should be obtained prior to approval of engineering plans.

1.4 Diversion of Drainage

Development can alter the historic or natural drainage paths. When these alterations result in a local on-site drainage system that discharges back into the natural drainage-way or wash at or near the historic location, then the alterations (inter-basin transfer) are generally acceptable. However, when flows from the local on-site drainage system do not return to the historic drainage-way or wash, then inter-basin transfer may result. These inter-basin transfers are generally not acceptable. Planning and design of drainage systems shall not be based on the premise that stormwater can be transferred from one basin to another unless part of an adopted City Regional Drainage System Plan.

The flow of storm runoff shall be maintained within its natural drainage course unless reasonable use is demonstrated otherwise. When stormwater is discharged into an existing drainage course, the peak discharge into the water course shall not adversely affect or cause damage to property along the drainage course now or in the future based on existing zoning and the Carson City Master Plan build-out conditions. Erosion impacts due to concentration of flows and increased flow durations shall be evaluated and mitigated.

1.5 Water Quality

Storm drainage improvements shall incorporate water quality, erosion control, BMPs, and LID measures in accordance with the Nevada "Handbook of Best Management Practices," Title 18 Appendix, Division 13, this Manual, and accepted engineering practice. Storm drainage leaving a development during the construction phase or post-construction may not be of a quality that shall adversely affect downstream uses. Flow based post-construction water quality controls shall be designed to capture and treat the flow rate for the 2-year runoff event from the drainage area connected to the BMP. Volume based post-construction water quality controls shall be designed to provide adequate storage to capture and treat 90 percent of the average annual stormwater runoff events.

Water quality controls to minimize stormwater pollution shall be provided for all development where the total of new and/or replaced impervious surface coverage equals or exceeds 10,000 square feet or causes disturbance equal to or greater than one (1) acre, except for the development of one (1) single-family residence that causes less than one (1) acre of land disturbance. Also, standard maintenance practices are exempt if the site remains similar to the existing flow patterns as determined by the City Engineer. In addition, commercial and industrial projects must include source control BMPs to the maximum extent practicable.

Direct discharge of untreated stormwater from pollution generating impervious surfaces is prohibited. The purpose of runoff treatment is to reduce pollutant loads and concentrations in stormwater runoff using physical, biological, and chemical removal mechanisms so that beneficial uses of receiving waters are maintained, and where possible, restored. The water quality parameters of concern in the Carson River basin include, but are not limited to, total suspended solids, total phosphorus, and turbidity. Water quality

treatment facilities should be chosen, designed, and maintained to minimize total phosphorus, turbidity and total suspended solids discharged into receiving waters.

Non-pollution generating impervious surfaces (NPGIS) are considered to be insignificant or low sources of pollutants in stormwater runoff. If the runoff from NPGIS is separated from the runoff from pollution generating impervious surfaces (PGIS), the NPGIS runoff does not need to be treated. However, if NPGIS and PGIS are combined, the entire amount of runoff must be treated.

NPGIS include the following:

1. Roofs that are subject only to atmospheric deposition or normal heating, ventilation and air conditions vents;
2. Paved bicycle pathways and pedestrian sidewalks that are separated from and not subject to drainage from roads for motor vehicles;
3. Fenced fire lanes; and
4. Infrequently used maintenance access roads.

Sidewalks that are regularly treated with salt or other de-icing chemicals are not considered NPGIS.

PGIS are considered to be significant sources of pollutants in stormwater runoff. Such surfaces include:

1. Surfaces subject to vehicular use;
2. Surfaces subject to industrial activities or subject to storage of erodible or leachable materials that receive direct rainfall or run-on or blow-in of rainfall;
3. Metal roofs unless coated with an inert, non-leachable material;
4. Roofs subject to the venting of manufacturing, commercial or other indoor pollutants;
5. Any surface, whether paved or not, that is regularly used by motor vehicles, including roads, unvegetated road shoulders, bike lanes within the traveled lane of a roadway, driveways, parking lots, unfenced fire lanes, vehicular equipment storage yards, and airport runways.

High-use sites generate high concentrations of oil due to high traffic turnover or the frequent transfer of oil and/or other petroleum products. High-use sites are land uses where sufficient quantities of free oil are likely to be present such that they can be effectively removed with special treatment. A high-use site is any one of the following:

1. A road intersection with expected average daily trips (ADT) of 25,000 vehicles or more on the main roadway and 15,000 vehicles or more on any intersecting roadway, excluding projects proposing primarily pedestrian or bicycle use improvements;
2. A commercial or industrial site with an expected trip end count equal to or greater than 100 vehicles per 1,000 square feet of gross building area;
3. A customer or visitor parking lot with an expected trip end count equal to or greater than 300 vehicles;
4. Commercial on-street parking areas on streets with an expected total ADT count equal to or greater than 7,500;
5. Fueling stations and facilities;
6. A commercial or industrial site subject to petroleum storage and transfer in excess of 1,500 gallons per year, not including locations where heating fuel is routinely delivered to end-users (heating fuel handling and storage facilities are subject to this definition);
7. A commercial or industrial site subject to use, storage, or maintenance of a fleet of 25 or more diesel vehicles that are over 10 tons gross weight;
8. Maintenance and repair facilities for vehicles, aircraft, construction equipment, railroad equipment or industrial machinery and equipment; or
9. Outdoor areas where hydraulic equipment is stored.

Exemptions

NPGIS areas are exempt from basic treatment requirements *unless* the runoff from these areas is not separated from the runoff generated from PGIS areas. All runoff treatment facilities must be sized for the entire flow that is directed to them.

1.6 Treatment Requirements

Runoff treatment is required for all projects unless it can be demonstrated to the satisfaction of the City Engineer that runoff treatment is not feasible due to specific site limitations (e.g., wellhead protection areas, high groundwater conditions that preclude LID practices, and areas of vector control concern). The basic treatment requirements include removal of 80 percent of total suspended solids for influent concentrations that are greater than 100 mg/l, but less than 200 mg/l. For influent concentrations less than 100 mg/l, the facilities should achieve an effluent goal of 20 mg/l total suspended solids. Additionally, the basic treatment requirements are intended to achieve a goal of 50 percent total phosphorus removal for a range of influent concentrations of 0.1 – 0.5 mg/l total phosphorus. The performance goals apply to either the water quality design storm volume or flow rate as appropriate.

High-use sites must provide facilities adequate to meet the basic treatment goals as well as oil control goals. The oil control facilities must achieve the goal of no ongoing or recurring visible sheen and to have a 24-hour average Total Petroleum Hydrocarbon (TPH) concentration no greater than 10 mg/l, and a maximum of 15 mg/l for a discrete sample (grab sample).

1.7 Drainage Improvements

Drainage improvements consist of curb and gutter, inlets and storm drains, culverts, bridges, swales, ditches, channels, detention areas, water quality facilities, and other drainage facilities required to convey and treat design storm runoff to the point of discharge. Drainage improvements are further defined as on-site (private) facilities that serve a specific development and are privately owned and maintained or off-site (public) facilities. Public and private drainage facilities shall be constructed in accordance with the requirements of this Manual, Title 18 Appendix, Division 13, and accepted engineering practice.

1.8 Floodplain Management

Floodplain management shall provide the guidance, condition, and restriction for development in floodplain areas while protecting the public's health, safety, welfare, and property from danger and damage. Development within the Federal Emergency Management Agency (FEMA) designated Special Flood Hazard Areas shall comply with CCMC and requirements of the National Flood Insurance Program (NFIP).

1.9 Storm Runoff Detention

Detention is considered a viable method to reduce storm runoff from developed properties. Temporarily detaining storm runoff can significantly reduce downstream flood hazards, pipe and channel requirements, and downstream erosion and sedimentation. Storage also provides for sediment and debris collection, which reduces maintenance requirements for downstream channels and streams.

Detention used in conjunction with other BMPs and LID measures can be particularly effective. The City requires the use of BMPs and LID measures unless it can be demonstrated that they are not suitable for the site.

Local detention storage for land development, which includes subdividing land, shall be required when the development increases flow and downstream conveyance capacities of the drainage system are not capable of handling non-detained flows, and the developer elects not to upgrade the existing storm drainage system. Onsite detention storage shall be sized to detain sufficient runoff to limit post-development flows from a 10-year storm (Q10) to the flows under the predevelopment condition. Volume credit will be granted for water quality features on a one-for-one basis.

The capacity of downstream conveyance systems shall be analyzed in accordance with this Manual and shall be based on runoff from the development as fully improved. Local detention can also be required when designated in flood or drainage master plans to reduce the peak rate in regional facilities.

The City may grant exemptions to the detention policy for the following:

1. Developments which discharge directly to a regional flood control facility, provided the facility is completed per the adopted plan and designed for the contributing flows.

2. Locations where a local detention facility is designed and constructed to serve several developments and the contributing flows.

3. Downstream facilities are upgraded to accommodate the increased flow.

4. Where the downstream facilities are adequate to carry up to 100-year flows.

All exemptions are subject to approval by the City.

1.10 Lower Watershed Design

In certain circumstances, i.e., close to the drainage system's point of discharge, it may be desirable not to detain stormwater runoff. The option to directly discharge shall be at the sole option of the City and after review of a flood route analysis. Water quality treatment will be required even if the stormwater runoff is directly discharged.

1.11 Storm Runoff Retention and Infiltration

Storm runoff retention and infiltration have been used to eliminate the need for constructing outlet structures and for ease of construction. However, problems with retention basins and infiltration facilities receiving runoff from pollution generating surfaces include perpetual maintenance requirements, soil expansion, siltation, decreasing infiltration capacity, and insect abatement. Retention basins and infiltration facilities receiving runoff from pollution generating surfaces also pose a hazard to City groundwater resources through possible contamination. The use of infiltration facilities is encouraged for runoff from non-pollution generating surfaces such as roofs. Percolation tests shall be conducted to verify that on-site soils are adequate for infiltration. Retention basins used to mitigate the increase of runoff from development must meet the requirements of detention basins and are only allowed on a case by case basis.

1.12 Drainage Facilities Maintenance

An important part of all storm drainage facilities is the continued maintenance of the facilities to ensure they function as designed. Maintenance of detention facilities involves the removal of debris and sediment. Such tasks are necessary to preclude the facility from becoming unhealthy and to retain the effectiveness of the detention basin. Sediment and debris must also be periodically removed from channels and storm drains. Trash racks and street inlets must be regularly cleared of debris to maintain system capacity. Channel bank erosion, damage to drop structures, crushing of pipe inlets and outlets, and deterioration to the facilities must be repaired to avoid reduced conveyance capability, unsightliness, and ultimate failure.

All drainage facilities shall be designed to minimize facility maintenance as well as to provide ease of maintenance and include maintenance access to the drainage facility. The owner of the drainage facilities shall be responsible for mosquito control, and the method of control shall comply with the Carson City Environmental Health Department.

The property owner or developer shall be responsible for the maintenance of all privately owned on-site drainage facilities, including but not limited to, inlets, pipes, channels, and detention basins unless otherwise required or modified by a separate agreement. An operation and maintenance schedule shall be provided for all proposed stormwater facilities and BMPs, and the party (or parties) responsible for maintenance and operations shall be identified. Prior to issuance of any permit for any regulated activity covered under this section, the City shall require the applicant and owner to execute an inspection and maintenance agreement

binding on all subsequent owners of land served by the private storm drainage system. If the property owner or developer fails to maintain said facilities adequately, Carson City shall have the right to enter the said property, upon proper notice, for the purposes of maintenance. All such maintenance costs shall be assessed against the owner(s).

An operation and maintenance schedule shall be developed for any storm drainage system. The schedule shall state the required maintenance to be performed, the equipment and skill level necessary to perform the maintenance, and the required frequency of maintenance. The operation and maintenance schedule shall either be printed on the stormwater management agreement or submitted under a separate cover.

1.13 Drainage Easements and Right-of-Way

Easements or Rights-of-Way shall be provided where necessary for access and maintenance of storm drain systems. Simple Fee Title of land is preferred.

1.14 Storm Runoff Water Quality Treatment

All development and redevelopment projects, except for the development of one (1) single-family residence that causes less than one-quarter (1/4) acre of land disturbance, must control the quality of stormwater leaving the site to the maximum extent practicable. Title 18 Appendix, Division 13, contains the Best Management Practices (BMPs) that must be included in an Erosion and Sediment Control Plan to control the water quality of stormwater runoff generated on construction sites. This Manual contains BMPs that must be included in site drainage plans to permanently control the quality of runoff from a developed or redeveloped site.

2. Technical Criteria

2.1 Design Storm Events

Drainage facilities shall be designed to convey the runoff from the 24-hour duration storm with a recurrence interval for a minor storm event (10-year) and a major storm event (100-year).

Water quality facilities will be designed to treat either the peak flow rate produced by the 2-year storm event if the treatment facility is flow-based or the volume of runoff produced by the 2-year, 24-hour storm event if the treatment facility is volume-based.

2.1.1 Storm Runoff Determination

Storm runoff (rates and volumes) shall be determined in accordance with the following methods (other methods may be used if approved by Development Engineering):

2.1.1.1 Conveyance Design

Contributing Basin Area (A)	Computation Procedure
A ≤ 100 Acres	Rational formula, SCS TR-55, or HEC-1, (SCS Unit Hydrograph or Kinematic Wave)
10 S.M > A ≥ 100 Acres	SCS TR-55 or HEC-1 (SCS Unit Hydrograph or Kinematic Wave)
A > 10 S.M.	HEC-1 (SCS Unit Hydrograph or Kinematic Wave)

2.1.1.2 Flow-Based Water Quality Control Design

Flow-based design standards apply to those structural treatment controls whose primary method of pollutant removal is based on the flow and filtration of runoff through the BMP. The water quality flow rate (WQF) for flow-based stormwater treatment controls should be determined by using the following methods to estimate the peak discharge produced by the 2-year storm event in the drainage area of the BMP.

Contributing Basin Area (A)	Computation Procedure
A ≤ 100 Acres	Rational formula, SCS TR-55, or HEC-1, (SCS Unit Hydrograph or Kinematic Wave)
A ≥ 100 Acres	SCS TR-55 or HEC-1 (SCS Unit Hydrograph or Kinematic Wave)

2.1.1.3 Volume-Based Water Quality Control Design

Volume-based BMP design standards apply to those stormwater treatment controls whose primary method of pollutant removal is based on the facilities' ability to capture and detain, retain and/or infiltrate a specific water quality volume. Volume-based stormwater treatment controls should be designed to capture and treat the volume of stormwater runoff determined based on the following formulas:

$$WQ_V = [(P)(R_V)(A)]/12$$
$$R_V = 0.05 + 0.009I$$

Where: WQ_V = water quality volume (ft3)
P = the 90^{th} percentile precipitation depth
I = percent of basin impervious area
A = drainage area (ft2)

(For P, use 1.5 inches for areas west of Carson Street and 0.5 inches for areas east of Carson Street unless otherwise directed by the City.)

2.1.2 Rainfall

Rainfall data tables and storm design information shall be derived from the NOAA Atlas, latest edition, or other City approval.

2.1.3 Streets

The use of streets to convey runoff, although naturally occurring, interferes with the primary function of the street for transportation purposes. Streets are, however, an important component in the storm drainage system due to their large storm carrying capacity obtained for little or no drainage costs. In order to balance these two (2) competing street uses, limits on the street carrying capacity are required based on the street classification related to emergency usage during storm and flood events. All development shall provide clear emergency flow paths for the onsite/offsite 100-year peak storm.

The allowable street capacity for different roadway functional classification shall be determined in accordance with Table 1 and Table 2. To ensure cleaning velocities at low flows, gutters shall have a minimum slope of 0.40 percent.

2.1.4 Culverts, Bridges, Valley Gutter, and Dip Sections

Culverts and bridges shall be installed where natural or manmade drainage channels are crossed by streets. Valley gutters, or “dip” sections, shall be permitted on local streets. The amount of channel flow that crosses over the street shall be minimized (not more than 0.5 feet) to protect the street embankment and pavement from erosion damage as well as to protect vehicles and pedestrians from dangerous flow depths and velocities. Bridges and culvert crossings under streets shall be sized for the required design storm capacity in accordance with Table 1.

Table 1 – Design Storm Events for Crossings

Design Storm Criteria	Design Storm Event (see Notes)
1. Local Streets	25-year return period, 24-hour duration
2. Arterial and Collector Streets	100-year return period, 24-hour duration
3. Developments (commercial, industrial, residential)	10-year return period, 24-hour duration

Notes:

1. All development shall provide emergency flow paths for a 100-year peak storm in accordance with Table 2.
2. Refer to Section 8.1 for additional situations where the drainage system shall be designed for not less than a 100-year return period, 24-hour duration.
3. Refer to Section 1.8 for additional requirements for projects located within a floodplain.

3. Submittal and Review Process

The purpose of the submittal and review process is to determine whether or not the drainage plan and improvements for a given project meet Carson City drainage requirements. These requirements include overall facility planning to assure an integrated and coordinated design as well as design standards to ensure consistent design and analysis. Drainage study submittal requirements for all land development in Carson City are presented in the following section and summarized in Table 2. The submittal requirements are intended to provide the necessary information for each development and minimize review time. The submittal and review process does not relieve the design engineer of the responsibility to provide a correct and safe drainage design or the developer to construct the designed drainage facilities properly.

By reviewing and approving drainage designs for given developments, Carson City shall not assume liability for improper drainage design, nor guarantee that the final drainage design review shall absolve the developer or designer of future liability for improper design or construction.

Table 2 – Drainage Study Submittal Requirements

Land Development and/or Land Action Process	Required Drainage Submittals (5)
Parcel Map:	Conceptual Study
Improvement Plans	Technical Study
Subdivision (including planned unit developments):	
Conceptual Plan	Conceptual Study
Tentative map	Conceptual Study
Improvements Plans	Technical Study
Building Permit	Technical Study
Clearing, Grading, Filling and/or Excavation	Conceptual Study
Other:	
MPR/CLU	Conceptual Study
Special Use Permit	Conceptual Study
Development Master Drainage Plans	Technical Study
Transportation Studies	Technical Study
Floodplain Modification Study	
Conditional Letter of Map Revision, Letter of Map Amendment, Letter of Map Revision, etc.	Technical Study

Notes:

1. Development Engineering may require a Technical Drainage Study in lieu of or in addition to a Conceptual Drainage Study.
2. If the City does not perceive a flooding hazard with the proposed development, the City may approve the development subject to review and approval of the Drainage Study and acceptance of conditions of approval by the owner.
3. All Floodplain Modification Studies shall be prepared in accordance with FEMA requirements and the CCMC.
4. Development Engineering may waive this requirement.
5. Carson City reserves the right to request additional information of the developer/design engineer after a drainage study has been submitted.

Drainage studies shall be submitted for all development and redevelopment, except for the development of one (1) single-family residence that causes less than one-quarter (1/4) acre of land disturbance. Additionally, Development Engineering may require drainage studies where a proposal may endanger the life, safety, and welfare of the public. Two (2) copies of the required drainage studies and attachments shall be submitted to Development Engineering for review with the required applications or improvement plans. Additional copies, as necessary, shall be submitted as requested by Development Engineering. All submitted reports shall be clearly and cleanly reproduced. Copies of charts, tables, nomographs, calculations, or other referenced material shall be legible. In addition, final approved reports and attachments shall be submitted in Adobe pdf format.

4. Drainage Study Information Page

A Drainage Study Information Form Page shall be included with all drainage study submittals. The Drainage Study Information Page shall provide basic information regarding the proposed development. A form will be provided at the request of the Project Engineer.

The Drainage Study shall contain the seal and signature of the professional engineer licensed in Nevada who is responsible for the drainage study.

5. Conceptual Drainage Study

A Conceptual Drainage Study is a descriptive report that addresses existing and proposed drainage conditions. The Conceptual Drainage Study documents the existing drainage conditions of the project site

and presents the details of the proposed drainage system. Additionally, it includes sufficient data to evaluate storm flows and proposed mitigation.

The conceptual drainage study shall contain sufficient information in order for Development Engineering to make a recommendation to the appropriate Carson City hearing body.

5.1 Conceptual Drainage Study Outline

The Conceptual Drainage Study shall contain a brief narrative letter, a calculation appendix (if required), and a drainage plan in accordance with the following outline:

I. Introduction
   - A. Drainage Study, Information page
   - B. Project Name, Type of Study, Study Date
   - C. Preparer's Name, Seal and Signature
   - D. Description of Project, including land use, site development plan, lot coverage, and amount of new and replaced impervious surface
   - E. Existing Site Conditions, including topography, existing ground cover, wetlands, sensitive areas, and stormwater and irrigation systems
   - F. General Location May (8 ½ x 11 is suggested)

II. Existing and Proposed Hydrology
   - A. Discuss existing and proposed drainage basin boundaries
   - B. Provide design storm and 100-year return period, 24-hour duration storm flow calculations for both on- and off-site flows
   - C. Discuss existing drainage problems (if applicable)
   - D. Discuss on-site and downstream drainage, identify downstream conveyance deficiencies, and identify areas with high potential for erosion and sediment deposition
   - E. Discuss Floodplain (if applicable)
   - F. Existing Irrigation
   - G. Discuss locations of sensitive and critical areas (e.g., vegetative buffers, wetlands, steep slopes, streams, etc.)
   - H. Tributary Exhibit

III. Erosion and Sediment Control Measures
   - A. Discuss how the requirements of Section 13 will be met.
   - B. Discuss erosion and sediment control measures implementation and maintenance.

IV. Proposed Drainage Facilities (on-site and off-site)
   - A. Discuss routing of flow in and/or around the site, downstream, and location of drainage facilities. Downstream analysis should extend downstream for the entire flow path from the project site to the receiving water or up to one (1) mile or to a point where the impact to receiving waters is minimal or nonexistent as determined by the City Engineer. The downstream analysis should assess the potential off-site water quality, erosion, slope stability, and drainage impacts associated with the project
   - B. Discuss stormwater quantity and water quality mitigation measures, including operation and maintenance procedures and responsibility
   - C. Discuss floodplain modifications (if applicable)
   - D. Provide Exhibit.

V. Conclusions
   - A. Compliance with the CCMC and the Carson City Development Standards
   - B. Compliance with FEMA (if applicable)
   - C. Discuss the effect of development on off-site flow rates and properties
   - D. Implementation measures necessary for project completion

VI. Exhibits
- A. Drainage Plan
- B. FEMA Floodplain Map (show on drainage plan also)

VII. Calculation Appendix (if required)
- A. Runoff calculations including hydrology computations
- B. Street and drainage facility capacity calculations, including inlet capacities, culvert and pipe system capacities, and outlet velocities, ditch capacities and velocities (if applicable)
- C. Stormwater quantity and water quality control facility calculations (if applicable)

5.2 Conceptual Drainage Plan

An 8 ½ ” x 11” or larger legible drainage plan which covers the development area shall be submitted and bound with the Conceptual Drainage Study. The plan shall contain as a minimum the following:

1. Locate and label the development boundary
2. Locate and label adjacent streets
3. Locate and label known 100-year floodplains
4. Locate and label existing and/or planned local flood control facilities
5. Show flow paths
6. Identify design inflow points and design outflow points and corresponding design storm and 100-year return period, 24-hour duration storm flow rates
7. Show existing and proposed topography
8. Show the time of concentration path for developed and existing conditions

6. Technical Drainage Study

The Technical Drainage Study shall discuss, at a detailed level, the existing site hydrologic conditions, erosion and sediment control during construction, and the proposed drainage plan to accommodate or modify site drainage conditions in the final development plan for the site. The Technical Drainage Study shall address both on-site and off-site drainage analysis and improvements necessary to mitigate the impact of the proposed development on downstream properties.

6.1 Technical Drainage Study Contents

The Technical Drainage Study shall be in accordance with the following outline and contain as a minimum the information listed:

I. Title Page
- A. Project Name, Type of Study, Date of Preparation, and Revisions
- B. Preparer’s Name, Seal and Signature
- C. Drainage Study Information Page

II. General Location and Development Description
- A. Location of Property
  1. Street Location and Assessor’s Parcel Number(s) adjacent to the development
  2. Township, range, section, ¼ section
  3. Drainage basin(s) encompassing the development, watershed name
  4. Location of the development in relation to existing drainage facilities
  5. Names of surrounding developments
  6. General location map (8 ½ x 11 is suggested)

- B. Description of Property
  1. Area in acres
  2. Existing site conditions (land use, buildings, drainage structures, floodplains, and other site conditions that may impact the project)
  3. General site topography, ground cover, and soil maps

4. Existing irrigation facilities such as ditches and canals
5. Adjacent and downstream developments, drainages and infrastructure

C. Project Description
1. Purpose and nature of land-disturbing activity; include the estimated amount of grading
2. Type and size of proposed new or replaced impervious surfaces
3. Critical areas on the site which have the potential for serious erosion and/or sedimentation, or other drainage problems

III. Drainage Basin Description
A. Off-Site drainage description
1. Discuss historical drainage patterns (overland flow, channelized flow, points of discharge) for off-site flows that enter the project site.
2. Discuss off-site flows that enter the project site.
3. Provide a map of drainage basins.
4. Discuss drainage basin characteristics (topography, area, land use, coverage, soil types, locations of critical areas, areas with high potential for erosion and sediment deposition, etc.).
5. Identify the design storm and 100-year return period, 24-hour duration storm flows for each drainage basin and sub-basin impacting or impacted by the project site.
6. Discuss downstream flow paths, rates, and conveyance capacity. Downstream analysis should extend downstream for the entire flow path from the project site to the receiving water or up to one (1) mile or to a point where the impacts to receiving waters are minimal or nonexistent as determined by the City Engineer. The downstream analysis should assess the potential off-site water quality, erosion, slope stability, and drainage impacts associated with the project.

B. On-site drainage description
1. Discuss historical on-site drainage patterns and capacity of the property (flow directions through the site and at property lines).
2. Discuss historical drainage patterns of upstream runoff through the property.
3. Provide a map of drainage basins.
4. Discuss historical drainage basin characteristics (topography, area, land use, coverage, soil types, locations of critical areas, areas with high potential for erosion and sedimentation, etc.).

C. Floodplain Information
1. Identify all FEMA regulated floodplains which impact the subject site. Locate the same on the drainage plan.
2. Note the lowest floor and other pertinent elevations(s).
3. Floodplain/Floodway calculations where pertinent.

D. Previous Drainage Studies
1. Identify previous drainage studies for the site and provide a copy if required by Carson City.
2. Identify previous drainage studies or previously approved projects which affect the site and provide copies of the studies if required by Carson City.

IV. Proposed Drainage Facilities
A. General Description
1. Discuss criteria and methodology.
2. Discuss the proposed construction erosion and sediment control and stormwater pollution prevention methodology. A Stormwater Pollution Prevention Plan prepared per the requirements of Title 18 Appendix, Division 13, may be submitted in compliance with this requirement.

3. Discuss the proposed permanent on-site water quantity control, water quality control, and drainage system plan and layout.
4. Discuss the proposed off-site drainage system plan and mitigation measures.

B. Compliance with Regulations and Adopted Plans
   1. Discuss compliance with FEMA floodplain regulations and CCMC, and all proposed modifications to or verifications of the FEMA regulated floodplain through the subject site.
   2. Discuss compliance with previously approved drainage studies for the subject site.
   3. Identify all requests for variances from the requirements of the drainage criteria individually.

C. Hydrologic Criteria
   1. Discuss design rainfall computations.
   2. Discuss design runoff computations, including peak flow rate for stormwater quantity control facilities and either peak flow rate or volume for water quality treatment facilities as appropriate.
   3. Discuss peak flow rates from off-site areas and facilities.
   4. Discuss off-site limiting conditions and constraints (see Section 14.1.3 Increase in Rate of Flow).
   5. Provide schematic of pre- and post-development time of concentration paths and calculations.

D. Facility Design Calculations
   1. Discuss design calculations for the on-site drainage system (design storm and 100-year storm flow).
      a. Street and ditch flow calculations
      b. Storm drains, inlets, and ditch flow calculations
      c. Channel and culvert flow calculations
      d. Other hydraulic structure flow calculations (trash rack, grates, etc.)
      e. Detention storage and outlet design calculations and flows
      f. Provide detail of control structure device
      g. Erosion and sediment deposition and mitigation measures during construction
      h. Permanent stabilization description of how the site shall be stabilized after construction is complete
      i. Water quality design calculations
   2. Discuss design calculations for the off-site drainage system that is accepting post-development runoff and impacts from the same.
      a. Street flow calculations
      b. Storm drain, inlets, and ditch flow calculations, including velocities
      c. Channel and culvert flow calculations
      d. Other hydraulic structure flow calculations
      e. Alluvial fan analysis and calculations (when required)
   3. Discuss Floodplain/Floodway calculations as related to FEMA requirements and compliance with CCMC.
   4. Discuss maintenance access, potential maintenance requirements, and maintenance responsibilities.
   5. Discuss easement requirements for the proposed drainage facilities.
   6. Discuss phasing of all drainage facilities.
   7. Energy and hydraulic grade lines.

V. Conclusions
   A. Compliance with Drainage Laws
   B. Compliance with the CCMC
   C. Compliance with FEMA requirements

D. Compliance with Development Standards
E. Effectiveness of proposed drainage facilities to control storm runoff
F. Impact of the proposed development on off-site property and facilities
G. Mitigation of impacts and implementation schedule

VI. Appendices as required by the report.

6.2 Technical Drainage Study Plan

A detailed drainage plan(s) for the subject site shall be submitted with the Technical Drainage Study. The plan(s) shall be on a 24" x 36" drawing at an appropriate scale (a scale of 1" = 20' to 1" = 200' is recommended). The following information shall be shown on this drawing, except that the off-site drainage basin boundaries may be shown at an appropriate legible scale on an exhibit:

1. Property lines and streets (roads) including right-of-way widths within 100 feet of the development.

2. Street names, grades, and widths.

3. Existing contours and proposed elevations sufficient to analyze drainage patterns extending a minimum of 100 feet past property lines of the project limits. If required by Development Engineering, more extensive off-site topography shall be required.

4. Existing drainage facilities and structures, including ditches, storm drains, channels, street flow direction, and culverts. All pertinent information such as material, size, shape, slope, and location shall also be included.

5. Limits of existing floodplains based on flood insurance rate maps (FIRM) and best available information. Provide tie to FEMA datum if all or a portion of the site is within a FEMA regulated floodplain and base flood elevation information when available. Establish base flood elevations if not determined on FIRMs.

6. Proposed on-site drainage basin boundaries. Include off-site drainage basins if the same runoff enters the project.

7. Proposed future on-site and off-site flow directions and paths for design storm and 100-year storm flows at pertinent locations.

8. Proposed street and ditch flow paths and slopes. Trace peak flows leaving the project site to the nearest drainage facility; identify capacity and improvements, if needed.

9. Proposed storm drain locations, type, size, capacities, depth of flow, and slope. Include inlet types, sizes and locations, and manhole locations. Correlate to drainage calculations.

10. Proposed channel alignment with a typical cross-section. Provide street cross-sections showing design storm and 100-year return period, 24-hour duration storm depth of flow.

11. Proposed culvert locations, type, size, and slope.

12. Proposed construction erosion and sediment control measures and BMPs.

13. Proposed detention facilities, type, size, and outlet characteristics.

14. Proposed water quality treatment facilities, type, and size.

15. Miscellaneous proposed drainage facilities (i.e., hydraulic structures, etc.)

16. Easements/right-of-way widths and boundaries (existing and proposed).

17. Ditch and channel sections with lining, if required.

18. Construction details, including control structures and identify construction materials.

19. Legend for all symbols used on drawing.

20. Scale, Bar Scale, North Arrow, Date, Bench Mark based on Carson City's Control Network, Title Block, Professional Engineers Signature, Seal.

21. Energy grade lines (EGL's) and hydraulic grade lines (HGL's) for storm drain and channel storm runoff.

22. Show clear emergency flow paths for 100-year peak storm.

7. Improvement Plans

Where drainage improvements are to be constructed, the improvement plans (on 24" x 36" sheets) and specifications shall be submitted to Development Engineering. Approval of the final improvement plans by Development Engineering shall be obtained prior to issuing construction permits, building permits, or grading permits. Plans for the drainage improvements shall include the following as a minimum:

1. Storm drains, inlets, outlets, and manholes with stationing, elevations, dimensions, type, and horizontal control indicated.

2. Culverts, end sections, and inlet/outlet protection with dimensions, type, elevations, and horizontal control indicated.

3. Channels, ditches, and swales (including side/rear yard swales) with lengths, widths, cross-sections, grades, and erosion control (i.e., rip-rap, concrete, grout) indicated.

4. Checks, channel drops, erosion, and sediment control facilities and measures.

5. Detention facility size, type, grading, low flow channels, outlets, landscaping, fencing, and maintenance access.

6. Water quality facility size, type, landscaping, and maintenance access.

7. Other drainage related structures and facilities (including underdrains and sump pump lines).

8. Maintenance access considerations.

9. Drainage easements and right-of-way with horizontal distance to improvements.

10. Plan and profile sheets showing all improvements.

11. Details for drainage structures, facilities, and improvements, including detention basin outlet control structures.

12. Erosion and sediment control plan. See Division 13, Carson City Development Standards for erosion and sediment control plan requirements.

The information required for the plans shall be in accordance with sound engineering principles, Division 13 of the Title 18 Appendix, this Manual, the Standard Details, and the "Standards Specifications for Public Works Construction." Construction documents shall include geometric, dimensional, structural, foundation, bedding, hydraulic, landscaping, specifications, and other details as needed to construct the drainage improvements. Improvement plans shall be signed and sealed by a professional engineer licensed in Nevada and be in accordance with the approved drainage report/drawings.

8. Storm Drain System

8.1 Introduction

The design storm peak flows generally govern the size of the storm drain system flows, as shown in Table 2. There are conditions, however, when the storm drain system design shall be governed by the 100-year return period, 24-hour duration storm flows. Storm drain systems shall be designed for not less than a 100-year peak storm for the following situations:

Locations where the street flow is collected in a sump with no allowable overflow capacity.

Locations where the desired 100-year return period, 24-hour duration storm flow direction is not reflected by the street flow direction during a 100-year return period, 24-hour duration storm (i.e., flow splits at intersections).

If a storm drain is to be designed to convey 100-year return period, 24-hour duration storm flows, then the inlets to the storm drain shall be designed accordingly.

Table 3 – Design Storm Street Capacity Limitations

Roadway Functional Classification	Maximum Limits of Street Inundation (See Notes)
1) Arterial	**Q10 Storm:** Flow contained in R/W. No curb overtopping. A minimum 48-foot wide dry lane centered shall be maintained and in each direction 24 feet. Runoff in excess of street capacity shall be piped. **Q100 Storm:** Flow contained to not inundate structures. Maximum depth at gutter flow line shall be 1 foot. A minimum 12-foot wide dry lane shall be maintained in each direction or 24 feet centered.
2) Collector	**Q10 Storm:** Flow contained in R/W. No curb overtopping. A minimum 18-foot wipe dry lane centered shall be maintained. Runoff in excess of street capacity shall be piped. **Q100 Storm:** Flow contained to not inundate structures. Maximum depth at gutter flow line shall be 1 foot. A minimum 12-foot wide dry lane shall be maintained centered.
3) Local or Industrial Street	**Q10 Storm:** Flow contained in R/W. No curb overtopping. A minimum 12-foot wide dry lane centered shall be maintained. Runoff in excess of street capacity shall be piped. **Q100 Storm**: Flow contained to not inundate structures. Maximum depth at gutter flow line shall be 1 foot. Street flooded.

Notes:

1. Where no curb exists, encroachment onto adjacent property shall be allowed but must be contained to not inundate structures.
2. Other criteria, such as the Federal Housing Administration regulations, may impose standards more restrictive than cited.

8.2 Design Criteria

8.2.1 Allowable Storm Drain Capacity

The storm drain capacity calculations shall begin at the storm drain outlet and proceed upstream, accounting for all energy losses. The Energy Grade Line (EGL) and Hydraulic Grade Line (HGL) shall be calculated to include all hydraulic losses, including friction, expansion, constriction, bend, and junction losses. The available energy at all junctions and transitions shall be checked to determine whether or not the flow in the storm drain shall be pressurized due to backwater effects even if the design flow is less than the full flow capacity of the storm drain.

If any section of the storm drain is pressurized due to backwater effects, then the storm drain system shall be designed to convey the design storm under surcharged or pressure flow conditions. The storm drain shall be considered surcharged when the depth of flow (HGL) in the storm drain is greater than 80 percent of full flow depth. The maximum level of surcharging for the capacity analysis shall be limited to maintaining the HGL to one foot (1') below the final grade above the storm drain at all locations. Special site conditions that warrant additional surcharging shall require locking type manhole covers or grated covers and shall be reviewed on a case-by-case basis by the City.

8.2.2 Allowable Storm Drain Velocity

The maximum allowable storm drain velocity is dependent on many factors, including the type of pipe, the acceptable wear level during the pipe design life, proposed flow conditions (open channel versus pressure flows), and the type and quality of construction of joints, manholes, and junctions. In consideration of the above factors, the maximum velocity in all storm drains and culverts shall not exceed the erosion resisting capabilities of the conduit and storm drain system. However, in no case shall the maximum velocity exceed 15 feet per second (fps).

All storm drains, culverts, and low flow outlets shall be designed to maintain a minimum velocity of three (3) fps at half or full conduit conditions, but in no case shall the storm drain slope be less than 0.25 percent.

8.2.3 Manning's Roughness Coefficient

All storm drain system hydraulic calculations shall be performed using Manning's Formula. A Manning's roughness factor, or "n," shall be as defined by the specific pipe manufacturer provided that the coefficient is within the range of accepted engineering standards.

8.2.4 Pipe Size

The minimum pipe size of storm inlet laterals and storm drain mains shall be 15 inches in diameter for round pipe or an equivalent flow area for other pipe shapes. Systems in all parking lots shall conform to the minimum standards.

8.2.5 Minimum and Maximum Cover

The required cover over a storm drainpipe is dependent on many factors, including the design pipe strength, pipe size, and cover material. For practical purposes, the storm drain shall be protected from potential surface disturbances and displacements. The minimum and maximum cover are dependent upon the design pipe strength.

8.2.6 Manhole and Junction Spacing

A manhole, catch basin, or junction box shall be located at all changes in pipe size, direction, elevation, and grade for all pipes with a diameter (or rise dimension) of less than 36 inches, and at the end of all public storm drain lines (unless the storm drain daylights at the end of the line). Maximum spacing between manholes or junction boxes shall be 350 feet. For pipes with a diameter (or rise dimension) of 36 inches and greater, the designer shall consult with Development Engineering for the location of manholes and junctions based on hydraulic and maintenance considerations.

8.2.7 Horizontal Alignment

The horizontal alignment of storm drains shall generally be straight between manholes and/or junctions. All storm drains shall be placed within the right-of-way dedicated for public streets unless Development Engineering approves the use of easements.

When storm drains are to be installed in existing streets, factors such as curbs, gutters, drainage ditches, sidewalks, traffic conditions, pavement conditions, future street improvement plans, and existing utilities shall be considered by the design engineer when selecting the storm drain location and alignment.

8.2.8 Utility Clearances

Storm drains and culverts shall be located to minimize potential contamination and disturbance of water supply and sanitary sewer mains. The local utility companies, or the Nevada Division of Health, may impose additional requirements. Where requirements differ, the more stringent shall apply.

8.2.9 Storm Inlet and Catch Basin Types, Locations, and Capacity Factors

Standard storm inlet and catch basin details are included in the Standard Details. The allowable use of these storm inlet and catch basin types is presented in Table 4. Allowable inlet capacity factors for each of the standard inlets and catch basins are also presented in Table 4. These capacity factors shall be applied to the theoretical capacity of the inlets and catch basins to account for conditions that decrease the capacity of the standard inlets. These conditions include plugging from debris and sediment, pavement overlaying, variations in design assumptions, and the general deterioration of the inlet and catch basin conditions over time. All catch basins may have sumps (12 inches minimum, 24 inches maximum) as determined by Development Engineering.

Catch basins or inlets shall be installed at low points of vertical curves, at all street intersections, and at sufficient intervals to intake the design storm peak flow such that flows shall not interfere with traffic or flood adjoining property in accordance with the requirements of Table 3. Catch basins and inlets at street intersections shall be located on the upstream side of the intersection and upstream of crosswalk locations.

When storm drainpipes are connected to a catch basin, inlet, or manhole with concrete/grout, both the inside and outside of the catch basin, manhole, or inlet shall be grouted at the pipe connection.

8.3 Materials

8.3.1 Pipe Material and Shape

The material and shape of the storm drain shall be in accordance with the “Standard Specifications for Public Works Construction”. Round, square, or rectangular reinforced concrete pipe (RCP) in accordance with ASTM C-789 or C-850 is preferred for use under roadways, driveways, and other traffic areas. Reinforced concrete pipe shall be at a minimum Class III, or the appropriate class when the design requires a greater pipe support strength. Other pipe materials, as approved by the City for storm drain use, except for corrugated metal (permitted for residential driveway culverts), are permitted.

8.3.2 Manholes

Precast manhole tees are not allowed where there is a change in storm drain slope or alignment or where there are intersecting storm drain mains or laterals. Pipes may be directly cast into the manhole base. Gasketed joints, locking type manhole covers, and/or grated manhole covers for pressure flow conditions may be required.

8.3.3 Storm Drain Outlet Protection

Storm drain outlets shall be designed to prevent the receiving channel from scour erosion or sediment deposition and shall be constructed with outlet protection for discharges to channels with unlined bottoms in accordance with the following:

Outlet Velocity (fps)	Minimum Outlet Protection
Less than 5	Rip-rap Protection
Between 5 and 15	Rip-rap Protection or Energy Dissipater
Greater than 15	Energy Dissipater

For channels with unlined bottoms, the outlet discharge velocity shall not exceed the maximum allowable channel velocity without an energy dissipation structure. Specifications for the outlet protection shall be submitted with the improvement plans.

8.4 Storm Drain Hydraulic Analysis

A hydraulic analysis of all storm drains shall be performed and submitted to Development Engineering as part of the Technical Drainage Report. Storm drain hydraulic and capacity analysis shall account for changes in flow conditions (open channel versus pressure flow) in the HGL and EGL calculations. Both the HGL and EGL for the design flow shall be included on storm drain improvement plans as part of the drainage report.

Table 4 – Allowable Storm Inlet Types and Capacity Factors

Inlet or Catch Basin Type	Permitted Use	Permitted Location Condition	Capacity Factor
Catch Basin Type - 1	Private Use Only	Sump	0.65
Catch Basin Type 1A	Street with Curb and Gutter	Continuous Grade **or** Sump	0.70 (Grate), 0.80 (Curb Opening) 0.65
Catch Basin Type 3	Landscaped or Unimproved Areas	Sump	0.50
Catch Basin Type 4	Street with Curb and Gutter	Continuous Grade **or** Sump	0.70 (Grate), 0.80 (Curb Opening) 0.65
Notes: 1. Capacity factor is applied to the theoretical inlet capacity to obtain the allowable inlet capacity to account for factors that reduce actual inlet capacity.			

8.5 Design Standards for Culverts

Culverts shall be designed and constructed using the following standards. The analysis and design shall consider design flow, culvert size and material, entrance structure layout, outlet structure layout, and erosion protection.

8.5.1 Culvert Sizing Criteria

8.5.1.1 Design Frequency

As indicated in Section 2.1.4 (Culverts), all culverts shall be designed to pass the flow from the design storm, including an overflow section where permitted.

8.5.1.2 Minimum Size

The minimum culvert size shall be 18 inches diameter for round pipe or an equivalent flow area for other pipe shapes.

8.5.2 Culvert Materials

Culverts shall be RCP in accordance with the Standard Details under roadways and other traffic areas. For rural residential driveways, CMP is allowed. The use of dip sections rather than culverts is encouraged for rural residential driveway crossings.

8.5.3 Outlet Protection

Outlet Velocity (fps)	Minimum Outlet Protection
Less than 5	Rip-rap Protection
Between 5 and 15	Rip-rap Protection or Energy Dissipater
Greater than 15	Energy Dissipater

Specifications for the outlet protection shall be submitted with the improvement plans.

8.5.4 Headwater Criteria

The maximum headwater for the design storm for culverts greater than 36 inches diameter or a culvert rise of 36 inches shall be 1.5 times the culvert height. The maximum headwater for culverts with a height of 36 inches or less shall be five feet (5') if adjacent properties are not adversely affected.

8.5.5 Alignment

Whenever possible, culverts shall be aligned with the natural channel to reduce inlet and outlet transition problems.

8.5.6 Temporary Crossing

Temporary crossings are defined as dip road sections with a culvert sized to pass nuisance flows or a culvert system that does not meet the criteria presented in this manual. Temporary crossings shall be reviewed on a case-by-case basis. Consideration shall be given to the following items:

1. Drainage area contributing to the crossing.
2. Level of roadway traffic.
3. Vertical and horizontal roadway alignment (sight distance).
4. Alternate access routes.
5. Time frame for temporary crossing (time to construction of permanent crossing).
6. Current and projected development density.
7. 25-year and 100-year storm flows.

8.5.7 Multiple Barrel Culverts

Multiple culverts may be used if available fill height limits the size of the culvert needed to convey the flood flow and the amount of debris is limited.

8.5.8 Inlet and Outlet Configurations

Culverts shall be designed with protection at the inlet and outlet areas. The culvert inlet shall include a headwall with wingwalls or a flared end-section.

The outlet area shall also include a headwall with wingwalls or a flared end-section. Where outlet velocities exceed the limitation set forth in Section 3.5.3 (Outlet Protection), an energy dissipater shall be required.

8.5.9 Structural Design

All culverts shall be designed to withstand, as a minimum, an H-20 loading in accordance with the design procedures of AASHTO "Standard Specifications for Highway Bridges" and with the pipe manufacturer's recommendations.

8.6 Drainage Channels

When open drainage channels are permitted, the potential for erosion and scour shall be determined and submitted as part of the drainage report. Recommended mitigation measures to prevent erosion and sediment deposition shall be identified and incorporated into the design of the drainage channels. Flow velocities in drainage shall not exceed the maximum permissible flow velocities for the design storm as recommended in the American Society of Civil Engineers (ASCE) Manuals and Reports of Engineering Practice No. 77, "Design and Construction of Urban Stormwater Management Systems."

Side slopes of unlined channels shall be 3:1 (horizontal to vertical) or flatter. Side slopes for lined channels shall be 2:1 (horizontal to vertical) or flatter. The use of rip rap as a channel lining is discouraged due to maintenance requirements.

All drainage channels that are not located within public rights-of-way shall be located in easements or lands dedicated to the City or the appropriate entity, and shall be provided with a permanent maintenance access road in accordance with Development Standard Division 12.11.14 (Improved Maintenance Access) to provide access for maintenance.

9. Stormwater Runoff Reduction BMPs

9.1 Introduction

The principal of runoff reduction starts by recognizing that developing or redeveloping land within a watershed inherently increases the imperviousness of the areas and, therefore, the volume and rate of runoff and the associated pollutant load.

Best management practices (BMPs) for reducing runoff include passive systems such as minimization of directly connected impervious areas and low impact development techniques and structural controls such as detention or infiltration facilities.

The main purpose of detention BMPs is to temporarily store runoff and reduce peak discharge by allowing flow to be discharged at a controlled rate. This controlled discharge rate shall be determined so that post-development runoff shall not exceed pre-development runoff leaving the site and that the appropriate LID feature is being used. The controlled release of storm drainage minimizes impact on downstream properties and also minimizes the potential for downstream erosion that may occur as a result of increased flow velocity. There are three (3) primary types of detention facilities: detention ponds, tanks, and vaults.

9.2 Minimize Directly Connected Impervious Areas (DCIA)

Impervious areas directly connected to the storm drain system are the greatest contributor to non-point source pollution. The first effort in site planning and design for stormwater quality protection is to minimize the directly connected impervious area (DCIA) as shown in Table 5.

Any impervious surface that drains into a catch basin, area drain, or other conveyance structure is a DCIA. As stormwater runoff flows across parking lots, roadways, and paved areas, the oils, sediments, metals, and other pollutants are collected and concentrated. If this runoff is collected by a drainage system and carried directly along impervious gutters or in closed underground pipes, it has no opportunity for filtering by plant material or infiltration into the soil. It also increases in speed and volume, which may cause higher peak flows downstream and may require a larger capacity storm drain system, increasing flood and erosion potential.

Minimizing directly connected impervious areas can be achieved in two (2) ways:

1. Limiting overall impervious land coverage.
2. Directing runoff from impervious areas to pervious areas for infiltration, retention/detention, or filtration.

9.3 Low-Impact Development Techniques

The low-impact development (LID) approach combines a hydrologically functional site design with pollution prevention measures to compensate for land development impacts on hydrology and water quality. The primary goal of LID methods is to mimic the predevelopment site hydrology by using site design techniques that store, infiltrate, evaporate, and detain runoff. The use of these techniques helps to reduce off-site runoff and ensure adequate groundwater recharge. Since every aspect of site development affects the hydrologic response of the site, LID control techniques focus mainly on-site hydrology. Specific LID controls can reduce runoff by integrating stormwater control throughout the site in many small, discrete units. LID controls are distributed in a small portion of each lot, near the source of impact, and may eliminate the need for a centralized BMP facility such as a stormwater management pond.

The Regional Water Planning Commission for the Truckee Meadows has developed the Truckee Meadows Structural Controls Design and Low Impact Development Manual, which may be used as a reference. Information on LID control techniques can also be found in the publication “Low-Impact Development Design Strategies, An Integrated Design Approach, 2,000”, Prince George’s County, Maryland, Department of Environmental Resources, Programs and Planning Division and at the Low Impact Development Center website http://www.lowimpactdevelopment.org.

LID control techniques include the following broad categories of stormwater control:

1. Zero Discharge Areas
2. Self-Treatment Areas
3. Runoff Reduction Areas

Site planning strategies and techniques provide the means to achieve stormwater management goals and objectives; facilitate the development of site plans that are adapted to natural topographic constraints; maintain lot yield; maintain site hydrologic functions; and provide for aesthetically pleasing, and perhaps, less expensive stormwater management controls.

Table 5 presents a list of site design and landscaping techniques and indicates whether they are applicable for use in Zero Discharge Areas, Self-Treating Areas, and Runoff Reduction Areas. Several techniques may be implemented within the same design philosophy. Some techniques may be used to implement more than one design philosophy. Where feasible, combinations of multiple techniques may be incorporated into new development and redevelopment projects to minimize the amount of treatment required.

Engineering Handbook, Section 4 (SCS, 1985). The antecedent moisture condition of the watershed is explained as follows:

> The amount of rainfall in a period of 5 to 30 days preceding a particular storm is referred to as antecedent rainfall, and the resulting condition of the watershed in regard to potential runoff is referred to as an antecedent moisture condition. In general, the heavier the antecedent rainfall, the greater the direct runoff that occurs from a given storm. The effects of infiltration and evapotranspiration during the antecedent period are also important, as they may increase or lessen the effect of antecedent rainfall. Because of the difficulties of determining antecedent storm conditions from data normally available, the conditions are reduced to three cases, AMC-I, AMC-II and AMC-III.

For the Washoe County area, an AMC-II condition shall be used for determining storm runoff.

Having determined the soil group, land use and treatment class and the antecedent moisture condition, CN values can be determined from Table 702.

There will be areas to which the values in Table 702 do not apply. The percentage of impervious area for the various types of residential areas or the land use condition for the pervious portions may vary from the conditions assumed in Table 702. A curve for each pervious CN can be developed to determine the composite CN for any density of impervious area. Figure 702 has been developed assuming a CN of 98 for the impervious area. The curves in Figure 702 can help in estimating the increase in runoff as more land within a given area is covered with impervious material.

There are a number of methods available for computing the percentage of impervious area in a watershed. Some methods include using U.S. Geological Survey topographic maps, land use maps, aerial photographs, and field reconnaissance. Care must be exercised when using methods based on such parameters as population density, street density, and age of the development as a means of determining the percentage of impervious area. The available data on runoff from urban areas are not yet sufficient to validate widespread use of these methods. Therefore, the CN to be used in the Washoe County area shall be based on Table 702 or Figure 702 in this Manual. A CN computation example is included in Section 711.

704 RATIONAL FORMULA METHOD

For drainage basins that are not complex and have small drainage areas, the design storm runoff may be analyzed using the Rational Formula Method in accordance with Section 304.3. This method was introduced in 1889 and is still being used in many engineering offices in the United States. Even though this method has frequently come under academic criticism for its simplicity, no other practical drainage design method has evolved to such a level of general acceptance by practicing engineers. The Rational Formula Method, when properly understood and applied, can produce satisfactory results for determining peak discharge.

704.1 METHODOLOGY

The Rational Formula Method is based on the formula:

$$Q = CIA \qquad (708)$$

Q is defined as the maximum rate of runoff in cubic feet per second (actually, Q has units of acre inches per hour, which is approximately equal to the units of cubic feet per second). C is a runoff coefficient and represents the runoff-producing conditions of the subject land area (see Section 704.5).

I is the average intensity of rainfall in inches per hour for a duration equal to the time of concentration.
A is the contributing basin area in acres.

704.2 ASSUMPTIONS

The basic assumptions made when applying the Rational Formula Method are as follows:

1. The computed maximum rate of runoff to the design point is a function of the average rainfall rate during the time of concentration to that point.
2. The maximum rate of rainfall occurs during the time of concentration, and the design rainfall depth during the time of concentration is converted to the average rainfall intensity for the time of concentration.
3. The maximum runoff rate occurs when the entire area is contributing flow. However, this assumption has been modified from time to time when local rainfall/runoff data was used to improve calculated results.

704.3 LIMITATIONS ON METHODOLOGY

The Rational Formula Method adequately approximates the peak rate of runoff from a rainstorm in a given basin. The critics of the method usually are unsatisfied with the fact that the answers are only approximations. A shortcoming of the Rational Formula Method is that only one point on the runoff hydrograph is computed (the peak runoff rate).

Another disadvantage of the Rational Formula Method is that with typical design procedures one normally assumes that all of the design flow is collected at the design point and that there is no "carry over water" running overland to the next design point. However, this is not the fault of the Rational Formula Method, but of the design procedure. The problem becomes one of routing the surface and subsurface hydrographs which have been separated by the storm sewer system. In general, this sophistication is not warranted and a conservative assumption is made wherein the entire routing occurs through the storm sewer system when this system is present.

704.4 RAINFALL INTENSITY

The rainfall intensity, I, is the average rainfall rate in inches per hour for the period of maximum rainfall of a given frequency having a duration equal to the time of concentration. After the design storm frequency has been selected, a graph should be prepared showing rainfall intensity versus time. Information on local rainfall data is presented in Section 600 of this Manual.

704.5 RUNOFF COEFFICIENT

The runoff coefficient, C, represents the integrated effects of infiltration, evaporation, retention, flow routing, and interception, all which affect the time distribution and peak rate of runoff. Determination of the coefficient requires judgment and understanding on the part of the engineer. Table 701 presents the recommended values of C for the various recurrence frequency storms. The values are presented for different surface characteristics as well as for different aggregate land uses. Variations to these values are subject to the approval of the Jurisdictional Entity.

A composite runoff coefficient is computed on the basis of the percentage of different types of surfaces in the drainage area. For homogeneous developed areas, this procedure is often applied to a typical "sample" area as a guide to selection of reasonable values of the coefficient for an entire area. Suggested coefficients with respect to surface type are also given in Table 701 under the column

labeled "Percent Impervious". Where land use features are mixed, a composite C analysis will result in more accurate results. The runoff coefficients in Table 701 also vary with recurrence frequency.

704.6 APPLICATION OF THE RATIONAL FORMULA METHOD

The first step in applying the Rational Formula Method is to obtain a topographic map and define the boundaries of all the relevant drainage basins. Basins to be defined include all basins tributary to the area of study and sub-basins within the study area. A field check and possibly field surveys should be made for each basin. At this stage of planning, the possibility for the diversion of transbasin waters should be identified.

The major storm drainage basin does not always coincide with the minor storm drainage basin. This is often the case in urban areas where a low flow will stay next to a curb and follow the lowest grade, but when a large flow occurs the water will be deep enough so that part of the water will overflow street crowns and flow into a new sub-basin. An example of how to apply the Rational Formula Method is presented in Section 711.

704.7 MAJOR STORM ANALYSIS

When analyzing the major runoff occurring within an area that has a storm sewer system sized for the minor storm, care must be used when applying the Rational Formula Method. Normal application of the Rational Method assumes that all of the runoff is collected by the storm sewer. For the minor storm design, the time of concentration is dependent upon the flow time in the sewer. However, during the major storm runoff, the sewers will probably be at capacity and would not carry the additional water flowing to the inlets. This additional water then flows overland past the inlets, generally at a lower velocity than the flow in the storm sewers.

If a separate time of concentration analysis is made for the pipe flow and surface flow, a time lag between the surface flow peak and the pipe flow peak will occur. This lag, in effect, will allow the pipe to carry a larger portion of the major storm runoff than would be predicted using the minor storm time of concentration. The basis for this increased benefit is that the excess water from one inlet will flow to the next inlet downhill, using the overland route. If that inlet is also at capacity, the water will often continue on until capacity is available in the storm sewer. The analysis of this aspect of the interaction between the storm sewer system and the major storm runoff is complex. The simplified approach of using the minor storm time of concentration for all frequency analysis is acceptable for use in Washoe County.

705 SCS UNIT HYDROGRAPH METHOD

The SCS Unit Hydrograph method was developed for the SCS by Mr. Victor Mockus. The SCS Unit Hydrograph was derived from a large number of natural unit hydrographs from watersheds varying widely in size and geographic location. The SCS Unit Hydrograph has been in use for many years and has produced satisfactory results for many applications. This method may be used for drainage areas within the Washoe County area in accordance with Section 304.3.

705.1 METHODOLOGY

The SCS Unit Hydrograph method uses the unit hydrograph theory as a basis for runoff computations. The unit hydrograph theory computes rainfall excess hydrographs for a unit amount of rainfall excess applied uniformly over a sub-basin for a given unit of time (or unit duration). The rainfall excess hydrographs are then transformed to a sub-basin hydrograph by superimposing each excess hydrograph lagged by the unit duration.

The shape of the SCS Unit Hydrograph is based on studies of various natural unit hydrographs. The basic governing parameters of this curvilinear hydrograph are as follows:

1. The time-to-peak, T_p, of the unit hydrograph approximately equals 0.2 times the time-of-base, T_b.
2. The point of inflection of the falling leg of the unit hydrograph approximately equals 1.7 times T_p.

For ease of calculation, an equivalent triangular unit hydrograph was derived from the natural curvilinear unit hydrograph. From the triangular unit hydrograph, equations for the peak discharge, Q_p, time-to-peak, T_p, and the time of concentration, t_c were developed based on a single lag factor (TLAG). The discharge hydrograph is then determined for the SCS Unit Hydrograph method based on the storm excess precipitation applied to the unit hydrograph whose parameters are determined by TLAG. TLAG is defined and discussed in Section 705.3.

705.2 ASSUMPTIONS

The basic assumptions made when applying the SCS Unit Hydrograph method (and all other unit hydrograph methods) are as follows:

1. The effects of all physical characteristics of a given drainage basin are reflected in the shape of the storm runoff hydrograph for that basin.
2. At a given point on a stream, discharge ordinates of different unit graphs of the same unit time of rainfall excess are mutually proportional to respective volumes.
3. A hydrograph of storm discharge that would result from a series of bursts of excess rain or from continuous excess rain of variable intensity may be constructed from a series of overlapping unit graphs each resulting from a single increment of excess rain of unit duration.

705.3 LAG TIME

Input data for the Soil Conservation Service dimensionless unit hydrograph method (SCS, 1985) consists of a single parameter, TLAG, which is equal to the lag (in hours) between the center of mass of rainfall excess and the peak of the unit hydrograph. For small drainage basins (less than one square mile) and basin slopes less than ten percent the lag time may be related to the time of concentration, t_c, by the following empirical relationship:

$$TLAG = 0.6\ t_c \qquad (709)$$

The t_c is computed as presented in Section 702.

For larger drainage basins (greater than one square mile) and basins with a basin slope equal to or greater than ten percent, the lag time (and t_c) is generally governed mostly by the concentrated flow travel time, not the initial overland flow time. In addition, as the basin gets increasingly larger, the average flow velocity (and associated travel time) becomes more difficult to estimate. Therefore, for these basins, the following lag equation is recommended for use in computing TLAG:

$$TLAG = 22.1\ K_n\ (L\ L_c/S^{0.5})^{0.33} \qquad (710)$$

where K_n = Roughness factor for the basin channels
L = Length of longest watercourse (miles)

RATIONAL FORMULA METHOD
RUNOFF COEFFICIENTS

Land Use or Surface Characteristics	Aver. % Impervious Area	Runoff Coefficients 5-Year (C_5)	Runoff Coefficients 100-Year (C_{100})
Business/Commercial:			
Downtown Areas	85	.82	.85
Neighborhood Areas	70	.65	.80
Residential:			
(Average Lot Size)			
⅛ Acre or Less (Multi-Unit)	65	.60	.78
¼ Acre	38	.50	.65
⅛ Acre	30	.45	.60
½ Acre	25	.40	.55
1 Acre	20	.35	.50
Industrial:	72	.68	.82
Open Space:			
(Lawns, Parks, Golf Courses)	5	.05	.30
Undeveloped Areas:			
Range	0	.20	.50
Forest	0	.05	.30
Streets/Roads:			
Paved	100	.88	.93
Gravel	20	.25	.50
Drives/Walks:	95	.87	.90
Roof:	90	.85	.87

Notes:

1. Composite runoff coefficients shown for Residential, Industrial, and Business/Commercial Areas assume irrigated grass landscaping for all pervious areas. For development with landscaping other than irrigated grass, the designer must develop project specific composite runoff coefficients from the surface characteristics presented in this table.

Where, the capital "D" refers to the filter grain size and the lower case "d" to the base grain size. The subscripts refer to the percent by weight which is finer than the grain size denoted by either "D" or "d". For example, 15 percent of the filter material is finer than $D_{15\ (filter)}$ and 85 percent of the base material is finer than $d_{85\ (base)}$.

When the T-V method is used, the thickness of the resulting layer of granular bedding may be reduced to six inches. However, if a gradation analysis of the existing soils shows that more than 50 percent of the soil is smaller than the No. 40 sieve size (> 50 percent passing No. 40 sieve by weight), then a two-layer granular bedding shall be used. The design of the bedding layer closest to the existing soils shall be based on the existing soil gradation. The design of the upper bedding layer shall be based on the gradation of the lower bedding layer. The thickness of each of the two layers shall be at least 4 inches.

805.5.4.2 Filter Fabrics

Filter fabric shall be designed in accordance with manufacturer's specifications. Filter fabric is not a complete substitute for granular bedding. Filter fabric provides filtering action only perpendicular to the fabric and has only a single equivalent pore opening between the channel bed and the riprap. Filter fabric has a relatively smooth surface which provides less resistance to stone movement. As a result, it is recommended that the use of filter fabric in place of granular bedding be restricted to slopes no steeper than 2.5 H:1V. A 6-inch layer of fine aggregate (Standard Specifications for Public Works Construction 200.01.03) may be placed on top of the filter fabric to act as a cushion when placing the riprap.

Tears in the fabric greatly reduce its effectiveness so that direct dumping of riprap on the filter fabric is not allowed and due care must be exercised during construction. Nonetheless, filter fabric has proven to be an adequate replacement for granular bedding in many instances. Filter fabric provides adequate bedding for channel linings along uniform mild sloping channels where leaching forces are primarily perpendicular to the fabric.

At drop structures and sloped channel drops, where seepage forces may run parallel with the fabric and cause piping along the bottom surface of the fabric, special care is required in the use of filter fabric. Seepage parallel with the fabric may be reduced by folding the edge of the fabric vertically downward about 2 feet (similar to a cutoff wall) at 12 foot intervals along the installation, particularly at the entrance and exit of the channel reach. Filter fabric has to be lapped a minimum of 12 inches at roll edges with upstream fabric being placed on top of downstream fabric at the lap.

Fine silt and clay have been found to clog the openings in filter fabric. This prevents free drainage which increases failure potential due to uplift. For this reason, a granular bedding is often more appropriate for fine silt and clay channel beds.

805.5.5 ROCK SIZING

Riprap lining requirements for a stable channel lining are based on the following relationship which resulted from model studies by Smith and Murray (Smith, 1965) and application to design criteria (Stevens, 1981):

$$V = 3(d_{50})^{0.5} S_S - 1) / S^{0.17} \qquad (842)$$

where,

V = Mean channel velocity, in ft/sec (10 ft/sec maximum for riprap-lined channel)
S = Longitudinal channel slope, in ft/ft

S_s = Specific gravity of rock (Minimum S_s = 2.50)
d_{50} = Rock size, in ft, for which 50 percent of the riprap by weight is finer.

Equation (842) was developed using laboratory data. Other procedures for design of riprap have been developed by a number of agencies, such as Federal Highway Administration (Searcy, 1967; Normann, 1975), USACE (1970), USBR (Peterka, 1958), California Department of Transportation (1970), American Society of Civil Engineers (Vanoni, 1975), (Simons and Sentruk, 1992). Blodgett (1986) evaluated these procedures and presented a tentative design relationship based on field data:

$$D_{50} = 0.010V^{2.44} \quad (843)$$

Where,
V = Mean Channel Velocity, in ft/sec
d_{50} = Rock size, in ft, for which 50 percent of the riprap by weight is finer.

Equation (843) is helpful for estimating the size of riprap needed and generally yields sizes larger than those determined by using Equation (842). However, use of a design method based on tractive stress considering bank slope is preferred for final design.

The basic premise underlying riprap design method based on tractive force is that the flow-induced tractive force should not exceed the permissible or critical shear stress of the riprap. Assuming a specific gravity of 2.50, the following equation can be used to determine d_{50} of the riprap by the tractive stress method:

$$d_{50} = 14.2F_S Y_{mas} \frac{S_e}{K_1} \quad (844)$$

Where,
F_s = Stability factor:
= 1.0 - 1.2, for straight or mildly curving reach
= 1.2 - 1.4, for moderate bend curvature with minor impact from floating debris
= 1.4 - 1.6, for sharp bend with significant impact from floating debris and waves
= 1.6 - 2.0, for rapidly varying flow with significant uncertainty in design
Y_{max} = maximum channel depth, in ft
Se = average energy slope, in ft/ft
K_1 = bank angle modification factor
$= [1 - (\text{Sin}^2 \Phi / \text{S in}^2 \theta)]^{0.5}$
Φ = bank angle with horizontal
θ = riprap material angle of repose (see Figure 818A)

805.5.6 LINING DIMENSIONS

Rock lined side slopes steeper than 2H:1V are considered unacceptable because of stability, safety, and maintenance considerations. Proper bedding is required both along the side slopes and the channel bottom for a stable lining. The riprap blanket thickness should adhere to the following rules:

1. The thickness should be at least two times d_{50}.
2. The thickness should not be less than the diameter of the upper limit d_{100} stone.
3. The thickness determined by either (1) or (2) above should be increased by 50 percent in all sections when the riprap is placed under water in water deeper than 3 feet to provide for uncertainties associated with this type of placement.

$$F_b = 1.0 + 0.025V(d)^{1/3} \quad (856)$$

where,

F_b = Freeboard height (ft);
V = Velocity (ft/sec);
d = Depth of flow (ft).

Freeboard shall be in addition to superelevation, standing waves, and/or other water surface disturbances.

The channel lining side slopes shall be extended, as a minimum, to the freeboard elevation.

806.2.5 SLUG FLOW

Slug flow is a series of shallow-water shock waves which occur in steep supercritical channels. The resulting wave heights may easily overtop channel linings using the typical freeboard requirements presented in this Manual or damage the channel lining. Therefore, all channels in the Washoe County area shall be designed to avoid the occurrence of slug flow. To avoid slug flow when the Froude number is greater than 2.0, the channel slope shall be as follows:

$$S \le (12/R_e) \quad (857)$$

where,

S = Channel slope (ft/ft) (858)
R_e = VR/ν = Reynolds Number
V = Mean design velocity (ft/sec)
R = Hydraulic radius (ft)
ν = Kinematic viscosity of water (ft^2/sec).

Theoretically, slug flow will not occur with Fr < 2.0.

807 CHANNEL APPURTENANCES

Presented in this section are the design standards for appurtenances to improved channels. All channels in the Washoe County area shall be designed to include these appurtenances.

807.1 MAINTENANCE ACCESS ROAD

A maintenance access road shall be provided along the entire length of all improved channels with a minimum passage width of 12 feet. For channels less than 30 feet in top width, one maintenance access shall be provided as part of the channel improvements. For channels greater than 30 feet in top width, the maintenance road shall be located at the bottom of the channel or on both sides at the channel top. Deviations from this are subject to approval by the appropriate jurisdictional entity.

807.2 SAFETY REQUIREMENTS

The following safety requirements are required for concrete-lined channels. Similar safety requirements may be required for all other channels:

a. Unless otherwise approved by the Jurisdictional Entity, a six-foot high galvanized coated chain link or comparable fence shall be installed to prevent unauthorized access. The fence shall be

located at the edge of the ROW or on the top of the channel lining. Gates, with top latch, shall be placed at major access points or 1,320 foot intervals, whichever is less.

b. Ladder-type steps shall be installed not more than 1,200 feet apart and shall be staggered on alternating sides of the channel to provide a ladder every 600 feet. The bottom rung shall be placed approximately 12 inches vertically above the channel invert.

807.3 CULVERT OUTLET PROTECTION

If the flow velocity at a culvert or storm sewer outlet exceeds the maximum permissible velocity for the local soil or channel lining, channel protection is required. This protection usually consists of an erosion resistant reach, such as riprap, to provide a stable reach at the outlet in which the exit velocity is reduced to a velocity allowable in the downstream channel.

807.3.1 BASIN CONFIGURATION

The length of the outlet protection (L_a) is determined using the following empirical relationships that were developed for the U.S Environmental Protection Agency (1976):

$$L_a = \left(1.8Q/D_o^{3/2}\right) + 7D_{05} \text{ for } TW < D_o/2 \quad (859)$$

and

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(860)

where,

D_o = Maximum inside culvert width (ft) or diameter;
Q = Pipe discharge (cfs);
TW = Tailwater depth (ft).

Where there is no well defined channel downstream of the apron, the width, W, of the outlet and of the apron (as shown in Figure 829) should be as follows:

$$W = 3D_o + 0.4L_a \text{ for } TW \geq D_o/2 \quad (861)$$

and

$$W = 3D_o + L_a \text{ for } TW < D_o/2 \quad (862)$$

The width of the apron at the culvert outlet should be at least 3 times the culvert width.

Where there is a well-defined channel downstream of the apron, the bottom width of the apron should be at least equal to the bottom width of the channel and the lining should extend at least one foot above the tailwater elevation and at least two-thirds of the vertical conduit dimension above the invert.

The side slopes should be 2:1 or flatter, and the bottom grade should be level.

807.3.2 ROCK SIZE

The median stone diameter, d_{50} is determined from the following equation (ASCE, 1975):

APPENDIX B

EXISTING HYDROLOGIC ANALYSIS

Project Description

File Name	PH2-C EXIST 10YR.SPF
Description	BLACKSTONE RANCH PH2 MASTER TECHNICAL DRAINAGE ANALYSIS 10-YEAR PEAK FLOW EVENT

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	1
Nodes	1
Junctions	0
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	0
Links	0
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	10 year(s)

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	X-01	16.04	0.2000	0.48	0.10	1.52	3.40	0 00:26:51

Project Description

File Name	PH2-C EXIST 100YR.SPF
Description	BLACKSTONE RANCH PH2 MASTER TECHNICAL DRAINAGE ANALYSIS 100-YEAR PEAK FLOW EVENT

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	1
Nodes	1
Junctions	0
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	0
Links	0
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	100 year(s)

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	X-01	16.04	0.5000	0.93	0.47	7.46	16.67	0 00:26:51

APPENDIX C

PROPOSED HYDROLOGIC ANALYSIS

Project Description

File Name	PH2-C PROP 2YR.SPF
Description	BLACKSTONE RANCH PHASE 2-C 2-YEAR STORM EVENT

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	Apr 13, 2022	00:00:00
End Analysis On	Apr 14, 2022	00:00:00
Start Reporting On	Apr 13, 2022	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	25
Nodes	42
Junctions	15
Outfalls	11
Flow Diversions	0
Inlets	14
Storage Nodes	2
Links	34
Channels	5
Pipes	29
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	2 year(s)

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	2C-01	0.58	0.6000	0.18	0.11	0.06	0.38	0 00:10:00
2	2C-02	0.59	0.6000	0.18	0.11	0.06	0.38	0 00:10:00
3	2C-03	0.81	0.6000	0.18	0.11	0.09	0.53	0 00:10:00
4	2C-04	0.49	0.6000	0.18	0.11	0.05	0.32	0 00:10:00
5	2C-05	0.65	0.6000	0.18	0.11	0.07	0.42	0 00:10:00
6	2C-06	0.76	0.6000	0.18	0.11	0.08	0.49	0 00:10:00
7	2C-07	0.64	0.6000	0.18	0.11	0.07	0.42	0 00:10:00
8	2C-08	0.83	0.6000	0.18	0.11	0.09	0.54	0 00:10:00
9	2C-09	1.17	0.6000	0.18	0.11	0.13	0.76	0 00:10:00
10	2C-10	0.97	0.6000	0.18	0.11	0.10	0.63	0 00:10:00
11	2C-11	0.95	0.6000	0.18	0.11	0.10	0.62	0 00:10:00
12	2C-12	1.36	0.6000	0.18	0.11	0.15	0.88	0 00:10:00
13	2C-13	0.95	0.6000	0.18	0.11	0.10	0.62	0 00:10:00
14	2C-14	1.53	0.6000	0.18	0.11	0.17	0.99	0 00:10:00
15	2C-15	0.46	0.6000	0.18	0.11	0.05	0.30	0 00:10:00
16	2C-OFF1	0.46	0.6000	0.18	0.11	0.05	0.30	0 00:10:00
17	2C-OFF2	1.10	0.6000	0.18	0.11	0.12	0.71	0 00:10:00
18	2C-OFF3	0.20	0.2000	0.18	0.04	0.01	0.04	0 00:10:00
19	2C-OFF4	0.81	0.6000	0.18	0.11	0.09	0.53	0 00:10:00
20	2C-OFF5	0.15	0.2000	0.18	0.04	0.01	0.03	0 00:10:00
21	2C-R1	0.03	0.2000	0.18	0.04	0.00	0.01	0 00:10:00
22	2C-R2	0.13	0.6000	0.18	0.11	0.01	0.08	0 00:10:00
23	2C-R3	0.14	0.6000	0.18	0.11	0.02	0.09	0 00:10:00
24	2C-R4	0.14	0.6000	0.18	0.11	0.02	0.09	0 00:10:00
25	2C-R5	0.14	0.6000	0.18	0.11	0.02	0.09	0 00:10:00

Project Description

File Name	PH2-C PROP 10YR.SPF
Description	BLACKSTONE RANCH PHASE 2-C 10-YEAR STORM EVENT

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	Apr 13, 2022	00:00:00
End Analysis On	Apr 14, 2022	00:00:00
Start Reporting On	Apr 13, 2022	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	25
Nodes	42
Junctions	15
Outfalls	11
Flow Diversions	0
Inlets	14
Storage Nodes	2
Links	34
Channels	5
Pipes	29
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	10 year(s)

Project Description

File Name	PH2-C PROP 100YR.SPF
Description	BLACKSTONE RANCH PHASE 2-C 100-YEAR STORM EVENT

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	Apr 13, 2022	00:00:00
End Analysis On	Apr 14, 2022	00:00:00
Start Reporting On	Apr 13, 2022	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	25
Nodes	42
Junctions	15
Outfalls	11
Flow Diversions	0
Inlets	14
Storage Nodes	2
Links	34
Channels	5
Pipes	29
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	100 year(s)

Project Description

File Name	PH2-C PROP 100YR NORMAL.SPF
Description	BLACKSTONE RANCH PHASE 2-C 100-YEAR NORMAL STORM EVENT

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	Apr 13, 2022	00:00:00
End Analysis On	Apr 14, 2022	00:00:00
Start Reporting On	Apr 13, 2022	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	25
Nodes	42
Junctions	15
Outfalls	11
Flow Diversions	0
Inlets	14
Storage Nodes	2
Links	34
Channels	5
Pipes	29
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	100 year(s)

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	2C-01	0.58	0.7800	0.59	0.46	0.26	1.59	0 00:10:00
2	2C-02	0.59	0.7800	0.59	0.46	0.27	1.62	0 00:10:00
3	2C-03	0.81	0.7800	0.59	0.46	0.37	2.22	0 00:10:00
4	2C-04	0.49	0.7800	0.59	0.46	0.22	1.34	0 00:10:00
5	2C-05	0.65	0.7800	0.59	0.46	0.30	1.78	0 00:10:00
6	2C-06	0.76	0.7800	0.59	0.46	0.35	2.08	0 00:10:00
7	2C-07	0.64	0.7800	0.59	0.46	0.29	1.75	0 00:10:00
8	2C-08	0.83	0.7800	0.59	0.46	0.38	2.27	0 00:10:00
9	2C-09	1.17	0.7800	0.59	0.46	0.53	3.20	0 00:10:00
10	2C-10	0.97	0.7800	0.59	0.46	0.44	2.66	0 00:10:00
11	2C-11	0.95	0.7800	0.59	0.46	0.43	2.60	0 00:10:00
12	2C-12	1.36	0.7800	0.59	0.46	0.62	3.72	0 00:10:00
13	2C-13	0.95	0.7800	0.59	0.46	0.43	2.60	0 00:10:00
14	2C-14	1.53	0.7800	0.59	0.46	0.70	4.19	0 00:10:00
15	2C-15	0.46	0.7800	0.59	0.46	0.21	1.26	0 00:10:00
16	2C-OFF1	0.46	0.7800	0.59	0.46	0.21	1.26	0 00:10:00
17	2C-OFF2	1.10	0.7800	0.59	0.46	0.50	3.01	0 00:10:00
18	2C-OFF3	0.20	0.5000	0.59	0.29	0.06	0.35	0 00:10:00
19	2C-OFF4	0.81	0.7800	0.59	0.46	0.37	2.22	0 00:10:00
20	2C-OFF5	0.15	0.5000	0.59	0.29	0.04	0.26	0 00:10:00
21	2C-R1	0.03	0.5000	0.59	0.29	0.01	0.05	0 00:10:00
22	2C-R2	0.13	0.7800	0.59	0.46	0.06	0.36	0 00:10:00
23	2C-R3	0.14	0.7800	0.59	0.46	0.06	0.38	0 00:10:00
24	2C-R4	0.14	0.7800	0.59	0.46	0.06	0.38	0 00:10:00
25	2C-R5	0.14	0.7800	0.59	0.46	0.06	0.38	0 00:10:00

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	2C-01	0.58	0.7800	0.59	0.46	0.26	1.59	0 00:10:00
2	2C-02	0.59	0.7800	0.59	0.46	0.27	1.62	0 00:10:00
3	2C-03	0.81	0.7800	0.59	0.46	0.37	2.22	0 00:10:00
4	2C-04	0.49	0.7800	0.59	0.46	0.22	1.34	0 00:10:00
5	2C-05	0.65	0.7800	0.59	0.46	0.30	1.78	0 00:10:00
6	2C-06	0.76	0.7800	0.59	0.46	0.35	2.08	0 00:10:00
7	2C-07	0.64	0.7800	0.59	0.46	0.29	1.75	0 00:10:00
8	2C-08	0.83	0.7800	0.59	0.46	0.38	2.27	0 00:10:00
9	2C-09	1.17	0.7800	0.59	0.46	0.53	3.20	0 00:10:00
10	2C-10	0.97	0.7800	0.59	0.46	0.44	2.66	0 00:10:00
11	2C-11	0.95	0.7800	0.59	0.46	0.43	2.60	0 00:10:00
12	2C-12	1.36	0.7800	0.59	0.46	0.62	3.72	0 00:10:00
13	2C-13	0.95	0.7800	0.59	0.46	0.43	2.60	0 00:10:00
14	2C-14	1.53	0.7800	0.59	0.46	0.70	4.19	0 00:10:00
15	2C-15	0.46	0.7800	0.59	0.46	0.21	1.26	0 00:10:00
16	2C-OFF1	0.46	0.7800	0.59	0.46	0.21	1.26	0 00:10:00
17	2C-OFF2	1.10	0.7800	0.59	0.46	0.50	3.01	0 00:10:00
18	2C-OFF3	0.20	0.5000	0.59	0.29	0.06	0.35	0 00:10:00
19	2C-OFF4	0.81	0.7800	0.59	0.46	0.37	2.22	0 00:10:00
20	2C-OFF5	0.15	0.5000	0.59	0.29	0.04	0.26	0 00:10:00
21	2C-R1	0.03	0.5000	0.59	0.29	0.01	0.05	0 00:10:00
22	2C-R2	0.13	0.7800	0.59	0.46	0.06	0.36	0 00:10:00
23	2C-R3	0.14	0.7800	0.59	0.46	0.06	0.38	0 00:10:00
24	2C-R4	0.14	0.7800	0.59	0.46	0.06	0.38	0 00:10:00
25	2C-R5	0.14	0.7800	0.59	0.46	0.06	0.38	0 00:10:00

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	2C-01	0.58	0.6000	0.30	0.18	0.10	0.62	0 00:10:00
2	2C-02	0.59	0.6000	0.30	0.18	0.11	0.63	0 00:10:00
3	2C-03	0.81	0.6000	0.30	0.18	0.14	0.87	0 00:10:00
4	2C-04	0.49	0.6000	0.30	0.18	0.09	0.53	0 00:10:00
5	2C-05	0.65	0.6000	0.30	0.18	0.12	0.70	0 00:10:00
6	2C-06	0.76	0.6000	0.30	0.18	0.14	0.82	0 00:10:00
7	2C-07	0.64	0.6000	0.30	0.18	0.11	0.69	0 00:10:00
8	2C-08	0.83	0.6000	0.30	0.18	0.15	0.89	0 00:10:00
9	2C-09	1.17	0.6000	0.30	0.18	0.21	1.26	0 00:10:00
10	2C-10	0.97	0.6000	0.30	0.18	0.17	1.04	0 00:10:00
11	2C-11	0.95	0.6000	0.30	0.18	0.17	1.02	0 00:10:00
12	2C-12	1.36	0.6000	0.30	0.18	0.24	1.46	0 00:10:00
13	2C-13	0.95	0.6000	0.30	0.18	0.17	1.02	0 00:10:00
14	2C-14	1.53	0.6000	0.30	0.18	0.27	1.64	0 00:10:00
15	2C-15	0.46	0.6000	0.30	0.18	0.08	0.49	0 00:10:00
16	2C-OFF1	0.46	0.6000	0.30	0.18	0.08	0.49	0 00:10:00
17	2C-OFF2	1.10	0.6000	0.30	0.18	0.20	1.18	0 00:10:00
18	2C-OFF3	0.20	0.2000	0.30	0.06	0.01	0.07	0 00:10:00
19	2C-OFF4	0.81	0.6000	0.30	0.18	0.14	0.87	0 00:10:00
20	2C-OFF5	0.15	0.2000	0.30	0.06	0.01	0.05	0 00:10:00
21	2C-R1	0.03	0.2000	0.30	0.06	0.00	0.01	0 00:10:00
22	2C-R2	0.13	0.6000	0.30	0.18	0.02	0.14	0 00:10:00
23	2C-R3	0.14	0.6000	0.30	0.18	0.03	0.15	0 00:10:00
24	2C-R4	0.14	0.6000	0.30	0.18	0.03	0.15	0 00:10:00
25	2C-R5	0.14	0.6000	0.30	0.18	0.03	0.15	0 00:10:00

APPENDIX D

STORM DRAIN HYDRAULIC ANALYSIS

Project Description

File Name	PH2-C PROP 2YR.SPF
Description	BLACKSTONE RANCH PHASE 2-C 2-YEAR STORM EVENT

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	Apr 13, 2022	00:00:00
End Analysis On	Apr 14, 2022	00:00:00
Start Reporting On	Apr 13, 2022	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	25
Nodes	42
Junctions	15
Outfalls	11
Flow Diversions	0
Inlets	14
Storage Nodes	2
Links	34
Channels	5
Pipes	29
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	2 year(s)

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Min Freeboard Attained (ft)
1	FES_POND-01	Junction	4624.55	4630.10	4624.55	4630.10	3240.00	1.80	4625.05	6.60
2	FES_POND-02	Junction	4625.35	4630.40	4625.35	4630.40	2700.00	3.40	4626.06	6.39
3	SDMH-C01	Junction	4628.50	4633.03	4628.50	4632.03	10.00	0.74	4628.83	4.20
4	SDMH-C02	Junction	4627.30	4631.83	4627.30	4630.83	10.00	0.69	4627.58	4.25
5	SDMH-C03	Junction	4626.70	4631.20	4626.70	4630.20	10.00	1.43	4627.20	4.00
6	SDMH-C04	Junction	4626.10	4630.68	4626.10	4629.68	10.00	1.80	4626.60	4.08
7	SDMH-C05	Junction	4625.70	4630.53	4625.70	4629.53	10.00	2.24	4626.43	4.10
8	SDMH-C06	Junction	4626.90	4631.51	4626.90	4630.51	10.00	0.94	4627.35	4.16
9	SDMH-C07	Junction	4626.70	4631.67	4626.70	4630.67	10.00	0.93	4627.12	4.55
10	SDMH-C08	Junction	4626.15	4631.48	4626.15	4630.48	10.00	0.91	4626.56	4.92
11	SDMH-C09	Junction	4625.50	4630.69	4625.50	4629.69	10.00	1.53	4625.91	4.78
12	SDMH-C10	Junction	4628.20	4632.78	4628.20	4631.78	10.00	1.22	4628.68	4.10
13	SDMH-C11	Junction	4627.85	4632.36	4627.85	4631.36	10.00	2.03	4628.34	4.02
14	SDMH-C12	Junction	4626.50	4630.99	4626.50	4629.99	10.00	1.98	4627.02	3.97
15	SDMH-C13	Junction	4626.10	4630.64	4626.10	4629.64	10.00	3.39	4626.74	3.90
16	OUT2C-OFF1	Outfall	4630.56					0.30	4630.56	
17	OUT2C-OFF2	Outfall	4630.10					0.71	4630.10	
18	OUT2C-OFF4	Outfall	4630.40					0.52	4630.40	
19	OUT2C-R1	Outfall	4632.72					0.01	4632.72	
20	OUT2C-R2	Outfall	4632.90					0.08	4632.90	
21	OUT2C-R3	Outfall	4632.94					0.09	4632.94	
22	OUT2C-R4	Outfall	4632.56					0.09	4632.56	
23	OUT2C-R5	Outfall	4632.56					0.09	4632.56	
24	OUTFALL-01	Outfall	4625.10					2.27	4626.31	
25	OUTPOND_2C-01	Outfall	4624.25					1.78	4624.69	
26	OUTPOND_2C-02	Outfall	4625.00					3.38	4625.62	
27	DET_2C-01	Storage Node	4624.55	4630.10	4624.55		3240.00	1.83	4625.50	
28	DET_2C-02	Storage Node	4625.95	4630.40	4625.35		2700.00	3.42	4626.35	

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)	
1	Pipe - (120)	Pipe	CB-C04	SDMH-C03	12.86	4628.28	4627.05	9.5600	15.000	0.0130	0.31	19.98	0.02	5.31	0.13	0.10
2	Pipe - (121)	Pipe	CB-C03	SDMH-C03	29.11	4628.37	4627.05	4.5300	15.000	0.0130	0.50	13.76	0.04	4.97	0.17	0.14
3	Pipe - (122)	Pipe	SDMH-C03	SDMH-C04	122.33	4626.70	4626.20	0.4100	18.000	0.0130	1.40	6.72	0.21	2.95	0.47	0.32
4	Pipe - (123)	Pipe	SDMH-C04	SDMH-C05	50.56	4626.10	4625.80	0.5900	24.000	0.0130	1.80	17.43	0.10	2.68	0.53	0.27
5	Pipe - (124)	Pipe	SDMH-C05	OUTFALL-01	126.51	4625.70	4625.10	0.4700	24.000	0.0130	2.27	15.58	0.15	1.62	0.97	0.49
6	Pipe - (125)	Pipe	CB-C05	SDMH-C04	21.41	4627.59	4626.95	2.9900	15.000	0.0130	0.40	11.17	0.04	3.94	0.17	0.14
7	Pipe - (126)	Pipe	CB-C06	SDMH-C05	18.09	4627.32	4626.55	4.2600	15.000	0.0130	0.44	13.33	0.03	4.55	0.17	0.13
8	Pipe - (139)	Pipe	SDMH-C01	SDMH-C02	256.12	4628.50	4627.40	0.4300	18.000	0.0130	0.69	6.88	0.10	2.51	0.32	0.21
9	Pipe - (140)	Pipe	SDMH-C02	SDMH-C03	68.24	4627.30	4626.80	0.7300	18.000	0.0130	0.69	8.99	0.08	2.29	0.34	0.23
10	Pipe - (143)	Pipe	SDMH-C06	SDMH-C07	30.50	4626.90	4626.80	0.3300	18.000	0.0130	0.93	6.01	0.15	2.43	0.40	0.27
11	Pipe - (144)	Pipe	SDMH-C07	SDMH-C08	130.73	4626.70	4626.25	0.3400	18.000	0.0130	0.91	6.16	0.15	2.53	0.39	0.26
12	Pipe - (145)	Pipe	SDMH-C08	SDMH-C09	160.50	4626.15	4625.60	0.3400	18.000	0.0130	0.88	6.15	0.14	2.52	0.38	0.25
13	Pipe - (146)	Pipe	CB-C09	SDMH-C09	32.75	4627.84	4625.85	6.0800	15.000	0.0130	0.75	15.92	0.05	6.20	0.19	0.15
14	Pipe - (147)	Pipe	CB-C07	SDMH-C06	25.90	4628.35	4627.25	4.2500	15.000	0.0130	0.41	13.31	0.03	4.58	0.16	0.13
15	Pipe - (148)	Pipe	CB-C08	SDMH-C06	34.24	4628.35	4627.25	3.2100	15.000	0.0130	0.53	11.58	0.05	4.50	0.19	0.15
16	Pipe - (149)	Pipe	SDMH-C09	DET_2C-01	28.45	4625.50	4625.20	1.0500	24.000	0.0130	1.53	23.23	0.07	3.68	0.38	0.19
17	Pipe - (150)	Pipe	CB-C01	SDMH-C01	40.00	4630.00	4628.85	2.8700	15.000	0.0130	0.37	10.95	0.03	3.95	0.16	0.13
18	Pipe - (151)	Pipe	CB-C02	SDMH-C01	21.53	4629.97	4628.85	5.2000	15.000	0.0130	0.38	14.73	0.03	4.62	0.15	0.12
19	Pipe - (152)	Pipe	SDMH-C10	SDMH-C11	59.76	4628.20	4627.95	0.4200	18.000	0.0130	1.21	6.79	0.18	2.77	0.44	0.30
20	Pipe - (153)	Pipe	SDMH-C11	SDMH-C12	236.10	4627.85	4626.60	0.5300	24.000	0.0130	1.98	16.46	0.12	3.43	0.48	0.24
21	Pipe - (154)	Pipe	SDMH-C12	SDMH-C13	41.53	4626.50	4626.20	0.7200	24.000	0.0130	1.98	19.23	0.10	2.96	0.53	0.27
22	Pipe - (155)	Pipe	SDMH-C13	DET_2C-02	30.00	4626.10	4625.95	0.5000	30.000	0.0130	3.39	29.00	0.12	4.55	0.52	0.21
23	Pipe - (156)	Pipe	CB-C13	SDMH-C13	36.43	4627.79	4626.20	4.3600	15.000	0.0130	0.52	13.50	0.04	2.75	0.36	0.28
24	Pipe - (157)	Pipe	CB-C14	SDMH-C13	12.53	4627.80	4626.20	12.7700	15.000	0.0130	0.98	23.08	0.04	4.93	0.36	0.29
25	Pipe - (158)	Pipe	CB-C12	SDMH-C11	5.90	4628.59	4628.20	6.6100	15.000	0.0130	0.86	16.61	0.05	5.32	0.24	0.19
26	Pipe - (159)	Pipe	CB-C11	SDMH-C10	25.88	4629.47	4628.55	3.5500	15.000	0.0130	0.61	12.18	0.05	4.74	0.20	0.16
27	Pipe - (160)	Pipe	CB-C10	SDMH-C10	40.10	4629.47	4628.55	2.2900	15.000	0.0130	0.62	9.78	0.06	4.16	0.22	0.18
28	Pipe - (161)	Pipe	FES_POND-02	OUTPOND_2C-02	66.77	4625.35	4625.00	0.5200	24.000	0.0130	3.38	16.38	0.21	3.73	0.66	0.33
29	Pipe - (162)	Pipe	FES_POND-01	OUTPOND_2C-01	55.56	4624.55	4624.25	0.5400	24.000	0.0130	1.78	16.62	0.11	3.17	0.47	0.23
30	CB-C03_BYPASS	Channel	CB-C03	CB-C06	195.30	4630.95	4629.91	0.5300	6.000	0.0320	0.02	12.54	0.00	0.77	0.11	0.22
31	CB-C04_BYPASS	Channel	CB-C04	CB-C05	122.64	4630.86	4630.17	0.5600	6.000	0.0320	0.01	12.81	0.00	0.70	0.09	0.19
32	CB-C12_BYPASS	Channel	CB-C12	CB-C13	225.58	4632.59	4630.79	0.8000	6.000	0.0320	0.02	15.27	0.00	0.27	0.12	0.24
33	CHANNEL-01	Channel	DET_2C-01	FES_POND-01	67.90	4625.20	4624.55	0.9600	85.200	0.0320	1.80	1912.60	0.00	1.43	0.40	0.06
34	CHANNEL-02	Channel	DET_2C-02	FES_POND-02	59.63	4625.95	4625.35	1.0100	85.200	0.0320	3.40	1960.86	0.00	1.29	0.55	0.08

Inlet Summary

SN	Element ID	Inlet Manufacturer	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Initial Water Elevation (ft)	Ponded Area (ft²)	Peak Flow (cfs)	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Allowable Spread (ft)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)
1	CB-C01	FHWA HEC-22 GENERIC	On Sag	1	4630.00	4633.00	4630.00	40.00	0.38	N/A	N/A	N/A	7.00	1.82	4633.17
2	CB-C02	FHWA HEC-22 GENERIC	On Sag	1	4629.97	4632.97	4629.97	40.00	0.38	N/A	N/A	N/A	7.00	1.83	4633.14
3	CB-C03	FHWA HEC-22 GENERIC	On Grade	1	4628.37	4631.37	4628.37	N/A	0.52	0.50	0.02	96.08	7.00	4.05	4631.59
4	CB-C04	FHWA HEC-22 GENERIC	On Grade	1	4628.28	4631.28	4628.28	N/A	0.32	0.32	0.00	99.97	7.00	2.29	4631.46
5	CB-C05	FHWA HEC-22 GENERIC	On Sag	1	4627.59	4630.59	4627.59	40.00	0.43	N/A	N/A	N/A	7.00	1.90	4630.76
6	CB-C06	FHWA HEC-22 GENERIC	On Sag	1	4627.32	4630.32	4627.32	40.00	0.51	N/A	N/A	N/A	7.00	2.00	4630.49
7	CB-C07	FHWA HEC-22 GENERIC	On Sag	1	4628.35	4631.35	4628.35	40.00	0.41	N/A	N/A	N/A	7.00	1.88	4631.52
8	CB-C08	FHWA HEC-22 GENERIC	On Sag	1	4628.35	4631.35	4628.35	40.00	0.54	N/A	N/A	N/A	7.00	2.04	4631.52
9	CB-C09	FHWA HEC-22 GENERIC	On Sag	1	4627.84	4630.84	4627.84	40.00	0.76	N/A	N/A	N/A	7.00	2.31	4631.02
10	CB-C10	FHWA HEC-22 GENERIC	On Sag	1	4629.47	4632.47	4629.47	40.00	0.63	N/A	N/A	N/A	7.00	2.16	4632.64
11	CB-C11	FHWA HEC-22 GENERIC	On Sag	1	4629.47	4632.47	4629.47	40.00	0.62	N/A	N/A	N/A	7.00	2.14	4632.64
12	CB-C12	FHWA HEC-22 GENERIC	On Grade	1	4628.59	4632.59	4628.59	N/A	0.88	0.87	0.01	98.94	7.00	3.03	4632.79
13	CB-C13	FHWA HEC-22 GENERIC	On Sag	1	4627.79	4630.79	4627.79	40.00	0.63	N/A	N/A	N/A	7.00	2.16	4630.96
14	CB-C14	FHWA HEC-22 GENERIC	On Sag	1	4627.80	4630.80	4627.80	40.00	0.99	N/A	N/A	N/A	7.00	2.57	4630.98

Project Description

File Name	PH2-C PROP 10YR.SPF
Description	BLACKSTONE RANCH PHASE 2-C 10-YEAR STORM EVENT

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	Apr 13, 2022	00:00:00
End Analysis On	Apr 14, 2022	00:00:00
Start Reporting On	Apr 13, 2022	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	25
Nodes	42
Junctions	15
Outfalls	11
Flow Diversions	0
Inlets	14
Storage Nodes	2
Links	34
Channels	5
Pipes	29
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	10 year(s)

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Min Freeboard Attained (ft)
1	FES_POND-01	Junction	4624.55	4630.10	4624.55	4630.10	3240.00	3.06	4625.22	6.43
2	FES_POND-02	Junction	4625.35	4630.40	4625.35	4630.40	2700.00	5.48	4626.29	6.16
3	SDMH-C01	Junction	4628.50	4633.03	4628.50	4632.03	10.00	1.23	4628.93	4.10
4	SDMH-C02	Junction	4627.30	4631.83	4627.30	4630.83	10.00	1.16	4627.67	4.16
5	SDMH-C03	Junction	4626.70	4631.20	4626.70	4630.20	10.00	2.30	4627.37	3.83
6	SDMH-C04	Junction	4626.10	4630.68	4626.10	4629.68	10.00	2.91	4626.83	3.85
7	SDMH-C05	Junction	4625.70	4630.53	4625.70	4629.53	10.00	3.74	4626.75	3.78
8	SDMH-C06	Junction	4626.90	4631.51	4626.90	4630.51	10.00	1.56	4627.49	4.02
9	SDMH-C07	Junction	4626.70	4631.67	4626.70	4630.67	10.00	1.54	4627.25	4.42
10	SDMH-C08	Junction	4626.15	4631.48	4626.15	4630.48	10.00	1.51	4626.69	4.79
11	SDMH-C09	Junction	4625.50	4630.69	4625.50	4629.69	10.00	2.61	4626.05	4.64
12	SDMH-C10	Junction	4628.20	4632.78	4628.20	4631.78	10.00	2.05	4628.84	3.94
13	SDMH-C11	Junction	4627.85	4632.36	4627.85	4631.36	10.00	3.28	4628.48	3.88
14	SDMH-C12	Junction	4626.50	4630.99	4626.50	4629.99	10.00	3.21	4627.20	3.79
15	SDMH-C13	Junction	4626.10	4630.64	4626.10	4629.64	10.00	5.46	4626.93	3.71
16	OUT2C-OFF1	Outfall	4630.56					0.49	4630.56	
17	OUT2C-OFF2	Outfall	4630.10					1.18	4630.10	
18	OUT2C-OFF4	Outfall	4630.40					0.87	4630.40	
19	OUT2C-R1	Outfall	4632.72					0.01	4632.72	
20	OUT2C-R2	Outfall	4632.90					0.14	4632.90	
21	OUT2C-R3	Outfall	4632.94					0.15	4632.94	
22	OUT2C-R4	Outfall	4632.56					0.15	4632.56	
23	OUT2C-R5	Outfall	4632.56					0.15	4632.56	
24	OUTFALL-01	Outfall	4625.10					3.74	4626.62	
25	OUTPOND_2C-01	Outfall	4624.25					3.03	4624.83	
26	OUTPOND_2C-02	Outfall	4625.00					5.44	4625.79	
27	DET_2C-01	Storage Node	4624.55	4630.10	4624.55		3240.00	3.12	4625.59	
28	DET_2C-02	Storage Node	4625.95	4630.40	4625.35		2700.00	5.51	4626.46	

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)	
1	Pipe - (120)	Pipe	CB-C04	SDMH-C03	12.86	4628.28	4627.05	9.5600	15.000	0.0130	0.50	19.98	0.03	5.46	0.22	0.18
2	Pipe - (121)	Pipe	CB-C03	SDMH-C03	29.11	4628.37	4627.05	4.5300	15.000	0.0130	0.75	13.76	0.05	5.17	0.26	0.21
3	Pipe - (122)	Pipe	SDMH-C03	SDMH-C04	122.33	4626.70	4626.20	0.4100	18.000	0.0130	2.29	6.72	0.34	3.19	0.64	0.43
4	Pipe - (123)	Pipe	SDMH-C04	SDMH-C05	50.56	4626.10	4625.80	0.5900	24.000	0.0130	2.91	17.43	0.17	2.48	0.81	0.40
5	Pipe - (124)	Pipe	SDMH-C05	OUTFALL-01	126.51	4625.70	4625.10	0.4700	24.000	0.0130	3.74	15.58	0.24	2.19	1.28	0.64
6	Pipe - (125)	Pipe	CB-C05	SDMH-C04	21.41	4627.59	4626.95	2.9900	15.000	0.0130	0.62	11.17	0.06	4.39	0.21	0.17
7	Pipe - (126)	Pipe	CB-C06	SDMH-C05	18.09	4627.32	4626.55	4.2600	15.000	0.0130	0.70	13.33	0.05	5.08	0.21	0.17
8	Pipe - (139)	Pipe	SDMH-C01	SDMH-C02	256.12	4628.50	4627.40	0.4300	18.000	0.0130	1.16	6.88	0.17	2.89	0.42	0.28
9	Pipe - (140)	Pipe	SDMH-C02	SDMH-C03	68.24	4627.30	4626.80	0.7300	18.000	0.0130	1.16	8.99	0.13	2.49	0.47	0.31
10	Pipe - (143)	Pipe	SDMH-C06	SDMH-C07	30.50	4626.90	4626.80	0.3300	18.000	0.0130	1.54	6.01	0.26	2.79	0.53	0.35
11	Pipe - (144)	Pipe	SDMH-C07	SDMH-C08	130.73	4626.70	4626.25	0.3400	18.000	0.0130	1.51	6.16	0.25	2.90	0.50	0.34
12	Pipe - (145)	Pipe	SDMH-C08	SDMH-C09	160.50	4626.15	4625.60	0.3400	18.000	0.0130	1.50	6.15	0.24	2.91	0.50	0.33
13	Pipe - (146)	Pipe	CB-C09	SDMH-C09	32.75	4627.84	4625.85	6.0800	15.000	0.0130	1.25	15.92	0.08	7.05	0.25	0.20
14	Pipe - (147)	Pipe	CB-C07	SDMH-C06	25.90	4628.35	4627.25	4.2500	15.000	0.0130	0.68	13.31	0.05	4.94	0.22	0.18
15	Pipe - (148)	Pipe	CB-C08	SDMH-C06	34.24	4628.35	4627.25	3.2100	15.000	0.0130	0.88	11.58	0.08	5.09	0.25	0.20
16	Pipe - (149)	Pipe	SDMH-C09	DET_2C-01	28.45	4625.50	4625.20	1.0500	24.000	0.0130	2.61	23.23	0.11	4.21	0.50	0.25
17	Pipe - (150)	Pipe	CB-C01	SDMH-C01	40.00	4630.00	4628.85	2.8700	15.000	0.0130	0.61	10.95	0.06	4.52	0.21	0.17
18	Pipe - (151)	Pipe	CB-C02	SDMH-C01	21.53	4629.97	4628.85	5.2000	15.000	0.0130	0.62	14.73	0.04	5.41	0.19	0.15
19	Pipe - (152)	Pipe	SDMH-C10	SDMH-C11	59.76	4628.20	4627.95	0.4200	18.000	0.0130	2.01	6.79	0.30	3.15	0.58	0.39
20	Pipe - (153)	Pipe	SDMH-C11	SDMH-C12	236.10	4627.85	4626.60	0.5300	24.000	0.0130	3.21	16.46	0.19	3.91	0.62	0.31
21	Pipe - (154)	Pipe	SDMH-C12	SDMH-C13	41.53	4626.50	4626.20	0.7200	24.000	0.0130	3.21	19.23	0.17	3.20	0.71	0.36
22	Pipe - (155)	Pipe	SDMH-C13	DET_2C-02	30.00	4626.10	4625.95	0.5000	30.000	0.0130	5.46	29.00	0.19	5.18	0.67	0.27
23	Pipe - (156)	Pipe	CB-C13	SDMH-C13	36.43	4627.79	4626.20	4.3600	15.000	0.0130	0.80	13.50	0.06	2.74	0.47	0.37
24	Pipe - (157)	Pipe	CB-C14	SDMH-C13	12.53	4627.80	4626.20	12.7700	15.000	0.0130	1.64	23.08	0.07	5.20	0.49	0.39
25	Pipe - (158)	Pipe	CB-C12	SDMH-C11	5.90	4628.59	4628.20	6.6100	15.000	0.0130	1.32	16.61	0.08	5.67	0.31	0.25
26	Pipe - (159)	Pipe	CB-C11	SDMH-C10	25.88	4629.47	4628.55	3.5500	15.000	0.0130	1.01	12.18	0.08	5.15	0.28	0.22
27	Pipe - (160)	Pipe	CB-C10	SDMH-C10	40.10	4629.47	4628.55	2.2900	15.000	0.0130	1.04	9.78	0.11	4.72	0.29	0.24
28	Pipe - (161)	Pipe	FES_POND-02	OUTPOND_2C-02	66.77	4625.35	4625.00	0.5200	24.000	0.0130	5.44	16.38	0.33	4.18	0.87	0.43
29	Pipe - (162)	Pipe	FES_POND-01	OUTPOND_2C-01	55.56	4624.55	4624.25	0.5400	24.000	0.0130	3.03	16.62	0.18	3.62	0.62	0.31
30	CB-C03_BYPASS	Channel	CB-C03	CB-C06	195.30	4630.95	4629.91	0.5300	6.000	0.0320	0.12	12.54	0.01	0.75	0.18	0.36
31	CB-C04_BYPASS	Channel	CB-C04	CB-C05	122.64	4630.86	4630.17	0.5600	6.000	0.0320	0.02	12.81	0.00	0.72	0.14	0.28
32	CB-C12_BYPASS	Channel	CB-C12	CB-C13	225.58	4632.59	4630.79	0.8000	6.000	0.0320	0.14	15.27	0.01	0.29	0.19	0.39
33	CHANNEL-01	Channel	DET_2C-01	FES_POND-01	67.90	4625.20	4624.55	0.9600	85.200	0.0320	3.06	1912.60	0.00	1.58	0.53	0.07
34	CHANNEL-02	Channel	DET_2C-02	FES_POND-02	59.63	4625.95	4625.35	1.0100	85.200	0.0320	5.48	1960.86	0.00	1.47	0.72	0.10

Inlet Summary

SN	Element ID	Inlet Manufacturer	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Initial Water Elevation (ft)	Ponded Area (ft²)	Peak Flow (cfs)	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Allowable Spread (ft)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)
1	CB-C01	FHWA HEC-22 GENERIC	On Sag	1	4630.00	4633.00	4630.00	40.00	0.62	N/A	N/A	N/A	7.00	2.15	4633.17
2	CB-C02	FHWA HEC-22 GENERIC	On Sag	1	4629.97	4632.97	4629.97	40.00	0.63	N/A	N/A	N/A	7.00	2.16	4633.14
3	CB-C03	FHWA HEC-22 GENERIC	On Grade	1	4628.37	4631.37	4628.37	N/A	0.87	0.76	0.11	86.94	7.00	5.91	4631.63
4	CB-C04	FHWA HEC-22 GENERIC	On Grade	1	4628.28	4631.28	4628.28	N/A	0.53	0.51	0.02	96.05	7.00	4.06	4631.50
5	CB-C05	FHWA HEC-22 GENERIC	On Sag	1	4627.59	4630.59	4627.59	40.00	0.72	N/A	N/A	N/A	7.00	2.26	4630.77
6	CB-C06	FHWA HEC-22 GENERIC	On Sag	1	4627.32	4630.32	4627.32	40.00	0.94	N/A	N/A	N/A	7.00	2.51	4630.50
7	CB-C07	FHWA HEC-22 GENERIC	On Sag	1	4628.35	4631.35	4628.35	40.00	0.69	N/A	N/A	N/A	7.00	2.23	4631.52
8	CB-C08	FHWA HEC-22 GENERIC	On Sag	1	4628.35	4631.35	4628.35	40.00	0.89	N/A	N/A	N/A	7.00	2.46	4631.53
9	CB-C09	FHWA HEC-22 GENERIC	On Sag	1	4627.84	4630.84	4627.84	40.00	1.26	N/A	N/A	N/A	7.00	2.83	4631.03
10	CB-C10	FHWA HEC-22 GENERIC	On Sag	1	4629.47	4632.47	4629.47	40.00	1.04	N/A	N/A	N/A	7.00	2.62	4632.65
11	CB-C11	FHWA HEC-22 GENERIC	On Sag	1	4629.47	4632.47	4629.47	40.00	1.02	N/A	N/A	N/A	7.00	2.60	4632.65
12	CB-C12	FHWA HEC-22 GENERIC	On Grade	1	4628.59	4632.59	4628.59	N/A	1.46	1.33	0.13	90.78	7.00	4.84	4632.82
13	CB-C13	FHWA HEC-22 GENERIC	On Sag	1	4627.79	4630.79	4627.79	40.00	1.16	N/A	N/A	N/A	7.00	2.73	4630.98
14	CB-C14	FHWA HEC-22 GENERIC	On Sag	1	4627.80	4630.80	4627.80	40.00	1.64	N/A	N/A	N/A	7.00	6.44	4631.06

Project Description

File Name	PH2-C PROP 100YR NORMAL.SPF
Description	BLACKSTONE RANCH PHASE 2-C 100-YEAR NORMAL STORM EVENT

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	Apr 13, 2022	00:00:00
End Analysis On	Apr 14, 2022	00:00:00
Start Reporting On	Apr 13, 2022	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	25
Nodes	42
Junctions	15
Outfalls	11
Flow Diversions	0
Inlets	14
Storage Nodes	2
Links	34
Channels	5
Pipes	29
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	100 year(s)

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Min Freeboard Attained (ft)
1	FES_POND-01	Junction	4624.55	4630.10	4624.55	4630.10	3240.00	7.93	4625.74	5.91
2	FES_POND-02	Junction	4625.35	4630.40	4625.35	4630.40	2700.00	13.02	4627.04	5.41
3	SDMH-C01	Junction	4628.50	4633.03	4628.50	4632.03	10.00	3.19	4629.26	3.77
4	SDMH-C02	Junction	4627.30	4631.83	4627.30	4630.83	10.00	3.14	4628.20	3.63
5	SDMH-C03	Junction	4626.70	4631.20	4626.70	4630.20	10.00	5.17	4628.12	3.08
6	SDMH-C04	Junction	4626.10	4630.68	4626.10	4629.68	10.00	6.83	4627.73	2.95
7	SDMH-C05	Junction	4625.70	4630.53	4625.70	4629.53	10.00	8.93	4627.62	2.91
8	SDMH-C06	Junction	4626.90	4631.51	4626.90	4630.51	10.00	4.02	4627.97	3.54
9	SDMH-C07	Junction	4626.70	4631.67	4626.70	4630.67	10.00	3.97	4627.69	3.98
10	SDMH-C08	Junction	4626.15	4631.48	4626.15	4630.48	10.00	3.93	4627.12	4.36
11	SDMH-C09	Junction	4625.50	4630.69	4625.50	4629.69	10.00	6.84	4626.47	4.22
12	SDMH-C10	Junction	4628.20	4632.78	4628.20	4631.78	10.00	5.25	4629.38	3.40
13	SDMH-C11	Junction	4627.85	4632.36	4627.85	4631.36	10.00	7.67	4628.89	3.47
14	SDMH-C12	Junction	4626.50	4630.99	4626.50	4629.99	10.00	7.66	4627.79	3.20
15	SDMH-C13	Junction	4626.10	4630.64	4626.10	4629.64	10.00	13.90	4627.58	3.06
16	OUT2C-OFF1	Outfall	4630.56					1.26	4630.56	
17	OUT2C-OFF2	Outfall	4630.10					3.01	4630.10	
18	OUT2C-OFF4	Outfall	4630.40					2.22	4630.40	
19	OUT2C-R1	Outfall	4632.72					0.05	4632.72	
20	OUT2C-R2	Outfall	4632.90					0.36	4632.90	
21	OUT2C-R3	Outfall	4632.94					0.38	4632.94	
22	OUT2C-R4	Outfall	4632.56					0.38	4632.56	
23	OUT2C-R5	Outfall	4632.56					0.38	4632.56	
24	OUTFALL-01	Outfall	4625.10					8.92	4627.32	
25	OUTPOND_2C-01	Outfall	4624.25					7.85	4625.22	
26	OUTPOND_2C-02	Outfall	4625.00					12.89	4626.29	
27	DET_2C-01	Storage Node	4624.55	4630.10	4624.55		3240.00	8.31	4625.85	
28	DET_2C-02	Storage Node	4625.95	4630.40	4625.35		2700.00	14.05	4627.08	

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)	
1	Pipe - (120)	Pipe	CB-C04	SDMH-C03	12.86	4628.28	4627.05	9.5600	15.000	0.0130	1.04	19.98	0.05	4.53	0.62	0.50
2	Pipe - (121)	Pipe	CB-C03	SDMH-C03	29.11	4628.37	4627.05	4.5300	15.000	0.0130	1.48	13.76	0.11	4.06	0.66	0.53
3	Pipe - (122)	Pipe	SDMH-C03	SDMH-C04	122.33	4626.70	4626.20	0.4100	18.000	0.0130	5.11	6.72	0.76	2.91	1.46	0.97
4	Pipe - (123)	Pipe	SDMH-C04	SDMH-C05	50.56	4626.10	4625.80	0.5900	24.000	0.0130	6.83	17.43	0.39	3.22	1.73	0.86
5	Pipe - (124)	Pipe	SDMH-C05	OUTFALL-01	126.51	4625.70	4625.10	0.4700	24.000	0.0130	8.92	15.58	0.57	3.41	1.96	0.98
6	Pipe - (125)	Pipe	CB-C05	SDMH-C04	21.41	4627.59	4626.95	2.9900	15.000	0.0130	1.73	11.17	0.15	3.09	0.58	0.47
7	Pipe - (126)	Pipe	CB-C06	SDMH-C05	18.09	4627.32	4626.55	4.2600	15.000	0.0130	2.06	13.33	0.15	2.89	0.72	0.57
8	Pipe - (139)	Pipe	SDMH-C01	SDMH-C02	256.12	4628.50	4627.40	0.4300	18.000	0.0130	3.14	6.88	0.46	3.60	0.76	0.50
9	Pipe - (140)	Pipe	SDMH-C02	SDMH-C03	68.24	4627.30	4626.80	0.7300	18.000	0.0130	2.91	8.99	0.32	2.31	1.11	0.74
10	Pipe - (143)	Pipe	SDMH-C06	SDMH-C07	30.50	4626.90	4626.80	0.3300	18.000	0.0130	3.97	6.01	0.66	3.27	0.98	0.65
11	Pipe - (144)	Pipe	SDMH-C07	SDMH-C08	130.73	4626.70	4626.25	0.3400	18.000	0.0130	3.93	6.16	0.64	3.45	0.93	0.62
12	Pipe - (145)	Pipe	SDMH-C08	SDMH-C09	160.50	4626.15	4625.60	0.3400	18.000	0.0130	3.89	6.15	0.63	3.46	0.92	0.61
13	Pipe - (146)	Pipe	CB-C09	SDMH-C09	32.75	4627.84	4625.85	6.0800	15.000	0.0130	3.20	15.92	0.20	7.66	0.52	0.42
14	Pipe - (147)	Pipe	CB-C07	SDMH-C06	25.90	4628.35	4627.25	4.2500	15.000	0.0130	1.75	13.31	0.13	4.98	0.53	0.43
15	Pipe - (148)	Pipe	CB-C08	SDMH-C06	34.24	4628.35	4627.25	3.2100	15.000	0.0130	2.26	11.58	0.20	5.11	0.58	0.46
16	Pipe - (149)	Pipe	SDMH-C09	DET_2C-01	28.45	4625.50	4625.20	1.0500	24.000	0.0130	6.83	23.23	0.29	5.33	0.85	0.43
17	Pipe - (150)	Pipe	CB-C01	SDMH-C01	40.00	4630.00	4628.85	2.8700	15.000	0.0130	1.58	10.95	0.14	5.46	0.38	0.30
18	Pipe - (151)	Pipe	CB-C02	SDMH-C01	21.53	4629.97	4628.85	5.2000	15.000	0.0130	1.61	14.73	0.11	6.29	0.36	0.29
19	Pipe - (152)	Pipe	SDMH-C10	SDMH-C11	59.76	4628.20	4627.95	0.4200	18.000	0.0130	5.20	6.79	0.77	3.90	1.06	0.71
20	Pipe - (153)	Pipe	SDMH-C11	SDMH-C12	236.10	4627.85	4626.60	0.5300	24.000	0.0130	7.66	16.46	0.47	4.32	1.10	0.55
21	Pipe - (154)	Pipe	SDMH-C12	SDMH-C13	41.53	4626.50	4626.20	0.7200	24.000	0.0130	7.48	19.23	0.39	3.41	1.33	0.67
22	Pipe - (155)	Pipe	SDMH-C13	DET_2C-02	30.00	4626.10	4625.95	0.5000	30.000	0.0130	13.81	29.00	0.48	5.84	1.31	0.52
23	Pipe - (156)	Pipe	CB-C13	SDMH-C13	36.43	4627.79	4626.20	4.3600	15.000	0.0130	2.78	13.50	0.21	4.63	0.82	0.65
24	Pipe - (157)	Pipe	CB-C14	SDMH-C13	12.53	4627.80	4626.20	12.7700	15.000	0.0130	4.15	23.08	0.18	5.95	0.87	0.69
25	Pipe - (158)	Pipe	CB-C12	SDMH-C11	5.90	4628.59	4628.20	6.6100	15.000	0.0130	2.51	16.61	0.15	5.86	0.64	0.51
26	Pipe - (159)	Pipe	CB-C11	SDMH-C10	25.88	4629.47	4628.55	3.5500	15.000	0.0130	2.60	12.18	0.21	5.22	0.66	0.53
27	Pipe - (160)	Pipe	CB-C10	SDMH-C10	40.10	4629.47	4628.55	2.2900	15.000	0.0130	2.65	9.78	0.27	4.77	0.68	0.54
28	Pipe - (161)	Pipe	FES_POND-02	OUTPOND_2C-02	66.77	4625.35	4625.00	0.5200	24.000	0.0130	12.89	16.38	0.79	5.14	1.49	0.74
29	Pipe - (162)	Pipe	FES_POND-01	OUTPOND_2C-01	55.56	4624.55	4624.25	0.5400	24.000	0.0130	7.85	16.62	0.47	4.55	1.08	0.54
30	CB-C03_BYPASS	Channel	CB-C03	CB-C06	195.30	4630.95	4629.91	0.5300	6.000	0.0320	0.73	12.54	0.06	0.44	0.34	0.67
31	CB-C04_BYPASS	Channel	CB-C04	CB-C05	122.64	4630.86	4630.17	0.5600	6.000	0.0320	0.30	12.81	0.02	0.60	0.30	0.60
32	CB-C12_BYPASS	Channel	CB-C12	CB-C13	225.58	4632.59	4630.79	0.8000	6.000	0.0320	1.20	15.27	0.08	0.50	0.36	0.72
33	CHANNEL-01	Channel	DET_2C-01	FES_POND-01	67.90	4625.20	4624.55	0.9600	85.200	0.0320	7.93	1912.60	0.00	1.82	0.92	0.13
34	CHANNEL-02	Channel	DET_2C-02	FES_POND-02	59.63	4625.95	4625.35	1.0100	85.200	0.0320	13.02	1960.86	0.01	1.77	1.41	0.20

Inlet Summary

SN	Element ID	Inlet Manufacturer	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Initial Water Elevation (ft)	Ponded Area (ft²)	Peak Flow (cfs)	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Allowable Spread (ft)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)
1	CB-C01	FHWA HEC-22 GENERIC	On Sag	1	4630.00	4633.00	4630.00	40.00	1.59	N/A	N/A	N/A	7.00	3.14	4633.19
2	CB-C02	FHWA HEC-22 GENERIC	On Sag	1	4629.97	4632.97	4629.97	40.00	1.61	N/A	N/A	N/A	7.00	3.17	4633.16
3	CB-C03	FHWA HEC-22 GENERIC	On Grade	1	4628.37	4631.37	4628.37	N/A	2.22	1.48	0.73	66.92	7.00	9.86	4631.70
4	CB-C04	FHWA HEC-22 GENERIC	On Grade	1	4628.28	4631.28	4628.28	N/A	1.34	1.04	0.30	77.69	7.00	7.62	4631.57
5	CB-C05	FHWA HEC-22 GENERIC	On Sag	1	4627.59	4630.59	4627.59	40.00	2.08	N/A	N/A	N/A	7.00	7.99	4630.88
6	CB-C06	FHWA HEC-22 GENERIC	On Sag	1	4627.32	4630.32	4627.32	40.00	2.81	N/A	N/A	N/A	7.00	13.11	4630.66
7	CB-C07	FHWA HEC-22 GENERIC	On Sag	1	4628.35	4631.35	4628.35	40.00	1.75	N/A	N/A	N/A	7.00	6.83	4631.62
8	CB-C08	FHWA HEC-22 GENERIC	On Sag	1	4628.35	4631.35	4628.35	40.00	2.27	N/A	N/A	N/A	7.00	8.64	4631.65
9	CB-C09	FHWA HEC-22 GENERIC	On Sag	1	4627.84	4630.84	4627.84	40.00	3.20	N/A	N/A	N/A	7.00	11.56	4631.20
10	CB-C10	FHWA HEC-22 GENERIC	On Sag	1	4629.47	4632.47	4629.47	40.00	2.65	N/A	N/A	N/A	7.00	9.88	4632.80
11	CB-C11	FHWA HEC-22 GENERIC	On Sag	1	4629.47	4632.47	4629.47	40.00	2.60	N/A	N/A	N/A	7.00	9.71	4632.79
12	CB-C12	FHWA HEC-22 GENERIC	On Grade	1	4628.59	4632.59	4628.59	N/A	3.72	2.51	1.21	67.55	7.00	8.58	4632.90
13	CB-C13	FHWA HEC-22 GENERIC	On Sag	1	4627.79	4630.79	4627.79	40.00	3.80	N/A	N/A	N/A	7.00	13.29	4631.19
14	CB-C14	FHWA HEC-22 GENERIC	On Sag	1	4627.80	4630.80	4627.80	40.00	4.19	N/A	N/A	N/A	7.00	14.35	4631.22

Project Description

File Name	PH2-C PROP 100YR.SPF
Description	BLACKSTONE RANCH PHASE 2-C 100-YEAR STORM EVENT

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	Apr 13, 2022	00:00:00
End Analysis On	Apr 14, 2022	00:00:00
Start Reporting On	Apr 13, 2022	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	25
Nodes	42
Junctions	15
Outfalls	11
Flow Diversions	0
Inlets	14
Storage Nodes	2
Links	34
Channels	5
Pipes	29
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	100 year(s)

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Min Freeboard Attained (ft)
1	FES_POND-01	Junction	4624.55	4630.10	4624.55	4630.10	3240.00	31.14	4628.99	2.66
2	FES_POND-02	Junction	4625.35	4630.40	4625.35	4630.40	2700.00	26.53	4629.52	2.93
3	SDMH-C01	Junction	4628.50	4633.03	4628.50	4632.03	10.00	3.19	4629.26	3.77
4	SDMH-C02	Junction	4627.30	4631.83	4627.30	4630.83	10.00	3.14	4628.20	3.63
5	SDMH-C03	Junction	4626.70	4631.20	4626.70	4630.20	10.00	5.18	4628.12	3.08
6	SDMH-C04	Junction	4626.10	4630.68	4626.10	4629.68	10.00	6.83	4627.73	2.95
7	SDMH-C05	Junction	4625.70	4630.53	4625.70	4629.53	10.00	8.94	4627.62	2.91
8	SDMH-C06	Junction	4626.90	4631.51	4626.90	4630.51	10.00	4.01	4629.83	1.68
9	SDMH-C07	Junction	4626.70	4631.67	4626.70	4630.67	10.00	4.02	4629.70	1.97
10	SDMH-C08	Junction	4626.15	4631.48	4626.15	4630.48	10.00	4.06	4630.01	1.47
11	SDMH-C09	Junction	4625.50	4630.69	4625.50	4629.69	10.00	7.21	4629.09	1.60
12	SDMH-C10	Junction	4628.20	4632.78	4628.20	4631.78	10.00	5.16	4630.40	2.38
13	SDMH-C11	Junction	4627.85	4632.36	4627.85	4631.36	10.00	7.63	4630.12	2.24
14	SDMH-C12	Junction	4626.50	4630.99	4626.50	4629.99	10.00	7.63	4630.18	0.81
15	SDMH-C13	Junction	4626.10	4630.64	4626.10	4629.64	10.00	14.13	4629.65	0.99
16	OUT2C-OFF1	Outfall	4630.56					1.26	4630.56	
17	OUT2C-OFF2	Outfall	4630.10					3.01	4630.10	
18	OUT2C-OFF4	Outfall	4630.40					2.22	4630.40	
19	OUT2C-R1	Outfall	4632.72					0.05	4632.72	
20	OUT2C-R2	Outfall	4632.90					0.36	4632.90	
21	OUT2C-R3	Outfall	4632.94					0.38	4632.94	
22	OUT2C-R4	Outfall	4632.56					0.38	4632.56	
23	OUT2C-R5	Outfall	4632.56					0.38	4632.56	
24	OUTFALL-01	Outfall	4625.10					8.93	4627.32	
25	OUTPOND_2C-01	Outfall	4624.25					31.14	4628.83	
26	OUTPOND_2C-02	Outfall	4625.00					26.53	4629.10	
27	DET_2C-01	Storage Node	4624.55	4630.10	4624.55		3240.00	26.92	4628.99	
28	DET_2C-02	Storage Node	4625.95	4630.40	4625.35		2700.00	25.65	4629.52	

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)	
1	Pipe - (120)	Pipe	CB-C04	SDMH-C03	12.86	4628.28	4627.05	9.5600	15.000	0.0130	1.04	19.98	0.05	4.52	0.62	0.50
2	Pipe - (121)	Pipe	CB-C03	SDMH-C03	29.11	4628.37	4627.05	4.5300	15.000	0.0130	1.48	13.76	0.11	4.05	0.66	0.53
3	Pipe - (122)	Pipe	SDMH-C03	SDMH-C04	122.33	4626.70	4626.20	0.4100	18.000	0.0130	5.11	6.72	0.76	2.91	1.46	0.97
4	Pipe - (123)	Pipe	SDMH-C04	SDMH-C05	50.56	4626.10	4625.80	0.5900	24.000	0.0130	6.83	17.43	0.39	3.23	1.73	0.86
5	Pipe - (124)	Pipe	SDMH-C05	OUTFALL-01	126.51	4625.70	4625.10	0.4700	24.000	0.0130	8.93	15.58	0.57	3.42	1.96	0.98
6	Pipe - (125)	Pipe	CB-C05	SDMH-C04	21.41	4627.59	4626.95	2.9900	15.000	0.0130	1.73	11.17	0.15	3.09	0.58	0.47
7	Pipe - (126)	Pipe	CB-C06	SDMH-C05	18.09	4627.32	4626.55	4.2600	15.000	0.0130	2.07	13.33	0.15	2.89	0.72	0.57
8	Pipe - (139)	Pipe	SDMH-C01	SDMH-C02	256.12	4628.50	4627.40	0.4300	18.000	0.0130	3.14	6.88	0.46	3.60	0.76	0.50
9	Pipe - (140)	Pipe	SDMH-C02	SDMH-C03	68.24	4627.30	4626.80	0.7300	18.000	0.0130	2.91	8.99	0.32	2.31	1.11	0.74
10	Pipe - (143)	Pipe	SDMH-C06	SDMH-C07	30.50	4626.90	4626.80	0.3300	18.000	0.0130	4.02	6.01	0.67	2.48	1.50	1.00
11	Pipe - (144)	Pipe	SDMH-C07	SDMH-C08	130.73	4626.70	4626.25	0.3400	18.000	0.0130	4.03	6.16	0.65	2.28	1.50	1.00
12	Pipe - (145)	Pipe	SDMH-C08	SDMH-C09	160.50	4626.15	4625.60	0.3400	18.000	0.0130	4.03	6.15	0.66	2.28	1.50	1.00
13	Pipe - (146)	Pipe	CB-C09	SDMH-C09	32.75	4627.84	4625.85	6.0800	15.000	0.0130	3.20	15.92	0.20	4.58	1.25	1.00
14	Pipe - (147)	Pipe	CB-C07	SDMH-C06	25.90	4628.35	4627.25	4.2500	15.000	0.0130	1.75	13.31	0.13	4.90	1.25	1.00
15	Pipe - (148)	Pipe	CB-C08	SDMH-C06	34.24	4628.35	4627.25	3.2100	15.000	0.0130	2.27	11.58	0.20	4.83	1.25	1.00
16	Pipe - (149)	Pipe	SDMH-C09	DET_2C-01	28.45	4625.50	4625.20	1.0500	24.000	0.0130	7.21	23.23	0.31	2.52	2.00	1.00
17	Pipe - (150)	Pipe	CB-C01	SDMH-C01	40.00	4630.00	4628.85	2.8700	15.000	0.0130	1.58	10.95	0.14	5.46	0.38	0.30
18	Pipe - (151)	Pipe	CB-C02	SDMH-C01	21.53	4629.97	4628.85	5.2000	15.000	0.0130	1.61	14.73	0.11	6.29	0.36	0.29
19	Pipe - (152)	Pipe	SDMH-C10	SDMH-C11	59.76	4628.20	4627.95	0.4200	18.000	0.0130	5.17	6.79	0.76	2.92	1.50	1.00
20	Pipe - (153)	Pipe	SDMH-C11	SDMH-C12	236.10	4627.85	4626.60	0.5300	24.000	0.0130	7.63	16.46	0.46	2.43	2.00	1.00
21	Pipe - (154)	Pipe	SDMH-C12	SDMH-C13	41.53	4626.50	4626.20	0.7200	24.000	0.0130	7.63	19.23	0.40	2.95	2.00	1.00
22	Pipe - (155)	Pipe	SDMH-C13	DET_2C-02	30.00	4626.10	4625.95	0.5000	30.000	0.0130	14.12	29.00	0.49	2.88	2.50	1.00
23	Pipe - (156)	Pipe	CB-C13	SDMH-C13	36.43	4627.79	4626.20	4.3600	15.000	0.0130	2.78	13.50	0.21	2.27	1.25	1.00
24	Pipe - (157)	Pipe	CB-C14	SDMH-C13	12.53	4627.80	4626.20	12.7700	15.000	0.0130	4.16	23.08	0.18	4.77	1.25	1.00
25	Pipe - (158)	Pipe	CB-C12	SDMH-C11	5.90	4628.59	4628.20	6.6100	15.000	0.0130	2.50	16.61	0.15	5.54	1.25	1.00
26	Pipe - (159)	Pipe	CB-C11	SDMH-C10	25.88	4629.47	4628.55	3.5500	15.000	0.0130	2.55	12.18	0.21	5.12	1.14	0.91
27	Pipe - (160)	Pipe	CB-C10	SDMH-C10	40.10	4629.47	4628.55	2.2900	15.000	0.0130	2.61	9.78	0.27	4.63	1.15	0.92
28	Pipe - (161)	Pipe	FES_POND-02	OUTPOND_2C-02	66.77	4625.35	4625.00	0.5200	24.000	0.0130	26.53	16.38	1.62	8.85	2.00	1.00
29	Pipe - (162)	Pipe	FES_POND-01	OUTPOND_2C-01	55.56	4624.55	4624.25	0.5400	24.000	0.0130	31.14	16.62	1.87	10.57	2.00	1.00
30	CB-C03_BYPASS	Channel	CB-C03	CB-C06	195.30	4630.95	4629.91	0.5300	6.000	0.0320	0.73	12.54	0.06	0.44	0.34	0.67
31	CB-C04_BYPASS	Channel	CB-C04	CB-C05	122.64	4630.86	4630.17	0.5600	6.000	0.0320	0.30	12.81	0.02	0.60	0.30	0.60
32	CB-C12_BYPASS	Channel	CB-C12	CB-C13	225.58	4632.59	4630.79	0.8000	6.000	0.0320	1.20	15.27	0.08	0.50	0.36	0.72
33	CHANNEL-01	Channel	DET_2C-01	FES_POND-01	67.90	4625.20	4624.55	0.9600	85.200	0.0320	26.71	1912.60	0.01	2.11	4.12	0.58
34	CHANNEL-02	Channel	DET_2C-02	FES_POND-02	59.63	4625.95	4625.35	1.0100	85.200	0.0320	25.63	1960.86	0.01	2.42	3.87	0.55

Inlet Summary

SN	Element ID	Inlet Manufacturer	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Initial Water Elevation (ft)	Ponded Area (ft²)	Peak Flow (cfs)	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Allowable Spread (ft)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)
1	CB-C01	FHWA HEC-22 GENERIC	On Sag	1	4630.00	4633.00	4630.00	40.00	1.59	N/A	N/A	N/A	7.00	3.14	4633.19
2	CB-C02	FHWA HEC-22 GENERIC	On Sag	1	4629.97	4632.97	4629.97	40.00	1.62	N/A	N/A	N/A	7.00	3.17	4633.16
3	CB-C03	FHWA HEC-22 GENERIC	On Grade	1	4628.37	4631.37	4628.37	N/A	2.22	1.48	0.73	66.91	7.00	9.86	4631.70
4	CB-C04	FHWA HEC-22 GENERIC	On Grade	1	4628.28	4631.28	4628.28	N/A	1.34	1.04	0.30	77.68	7.00	7.62	4631.57
5	CB-C05	FHWA HEC-22 GENERIC	On Sag	1	4627.59	4630.59	4627.59	40.00	2.08	N/A	N/A	N/A	7.00	8.00	4630.88
6	CB-C06	FHWA HEC-22 GENERIC	On Sag	1	4627.32	4630.32	4627.32	40.00	2.81	N/A	N/A	N/A	7.00	13.11	4630.66
7	CB-C07	FHWA HEC-22 GENERIC	On Sag	1	4628.35	4631.35	4628.35	40.00	1.75	N/A	N/A	N/A	7.00	6.84	4631.62
8	CB-C08	FHWA HEC-22 GENERIC	On Sag	1	4628.35	4631.35	4628.35	40.00	2.27	N/A	N/A	N/A	7.00	8.64	4631.65
9	CB-C09	FHWA HEC-22 GENERIC	On Sag	1	4627.84	4630.84	4627.84	40.00	3.20	N/A	N/A	N/A	7.00	11.56	4631.20
10	CB-C10	FHWA HEC-22 GENERIC	On Sag	1	4629.47	4632.47	4629.47	40.00	2.66	N/A	N/A	N/A	7.00	9.88	4632.80
11	CB-C11	FHWA HEC-22 GENERIC	On Sag	1	4629.47	4632.47	4629.47	40.00	2.60	N/A	N/A	N/A	7.00	9.71	4632.79
12	CB-C12	FHWA HEC-22 GENERIC	On Grade	1	4628.59	4632.59	4628.59	N/A	3.72	2.51	1.21	67.54	7.00	8.58	4632.90
13	CB-C13	FHWA HEC-22 GENERIC	On Sag	1	4627.79	4630.79	4627.79	40.00	3.80	N/A	N/A	N/A	7.00	13.30	4631.19
14	CB-C14	FHWA HEC-22 GENERIC	On Sag	1	4627.80	4630.80	4627.80	40.00	4.19	N/A	N/A	N/A	7.00	14.36	4631.22

APPENDIX E

OUTLET HYDRAULIC ANALYSIS

CULVERT OUTLET PROTECTION

$$For TW < \frac{Do}{2}$$

$$La = \frac{(1.8\,Q)}{Do^{3/2}} + 7\,Do$$

$$W = 3\,Do + La$$

$$For TW \geq \frac{Do}{2}$$

$$La = \frac{(3\,Q)}{Do^{3/2}} + 7\,Do$$

$$W = 3\,Do + 0.4\,La$$

$$d_{50} = 0.02\frac{(Q)^{4/3}}{TW\,(Do)}$$

F.E.S.-01

Q= 8.92
Do= 2
TW= 2.22

APRON SIZE		ROCK SIZE			
La=	23.46	d_{50}=	0.07	Design d_{50}=	0.25
W=	15.38	Use Class		150	Rock Riprap

F.E.S.-05

Q= 7.80
Do= 2
TW= 0.85

APRON SIZE		ROCK SIZE			
La=	18.96	d_{50}=	0.14	Design d_{50}=	0.25
W=	24.96	Use Class		150	Rock Riprap

F.E.S.-03

Q= 12.88
Do= 2
TW= 1.3

APRON SIZE		ROCK SIZE			
La=	27.66	d_{50}=	0.18	Design d_{50}=	0.25
W=	17.06	Use Class		150	Rock Riprap

CULVERT OUTLET PROTECTION

$$For TW < \frac{Do}{2}$$

$$La = \frac{(1.8\,Q)}{Do^{3/2}} + 7\,Do$$

$$W = 3\,Do + La$$

$$For TW \geq \frac{Do}{2}$$

$$La = \frac{(3\,Q)}{Do^{3/2}} + 7\,Do$$

$$W = 3\,Do + 0.4\,La$$

$$d_{50} = 0.02\,\frac{(Q)^{4/3}}{TW\,(Do)}$$

F.E.S.-04

Q= 4.82 V=4.07 ft/sec.
Do= 2
TW= 0.84

APRON SIZE	ROCK SIZE			
La= 17.07	d_{50}= 0.10	Design d_{50}=	0.25	
W= 23.07	Use Class	150	Rock Riprap	

F.E.S.-05

Q= 5.70 V=6.55 ft/sec.
Do= 1.5
TW= 0.92

APRON SIZE	ROCK SIZE			
La= 19.81	d_{50}= 0.15	Design d_{50}=	0.25	
W= 12.42	Use Class	150	Rock Riprap	

F.E.S.-06

Q= 3.29 V=5.12 ft/sec.
Do= 1.5
TW= 0.8

APRON SIZE	ROCK SIZE			
La= 15.87	d_{50}= 0.08	Design d_{50}=	0.25	
W= 10.85	Use Class	150	Rock Riprap	

CULVERT OUTLET PROTECTION

$$For TW < \frac{Do}{2}$$

$$La = \frac{(1.8\,Q)}{Do^{3/2}} + 7\,Do$$

$$W = 3\,Do + La$$

$$For TW \geq \frac{Do}{2}$$

$$La = \frac{(3\,Q)}{Do^{3/2}} + 7\,Do$$

$$W = 3\,Do + 0.4\,La$$

$$d_{50} = 0.02\,\frac{(Q)^{4/3}}{TW\,(Do)}$$

Culvert #7

Q= 8.00 V=3.20 ft/sec.
Do= 1
TW= 0.44

APRON SIZE	ROCK SIZE			
La= 21.40	d_{50}= 0.73	Design d_{50}=	0.75	
W= 24.40	Use Class	300	Rock Riprap	

Culvert #8

Q= 6.00 V=4.64 ft/sec.
Do= 1
TW= 0.68

APRON SIZE	ROCK SIZE			
La= 25.00	d_{50}= 0.32	Design d_{50}=	0.5	
W= 13.00	Use Class	150	Rock Riprap	

Culvert #9

Q= 15.00 V=11.58 ft/sec.
Do= 1.5
TW= 1.15

APRON SIZE	ROCK SIZE			
La= 34.99	d_{50}= 0.43	Design d_{50}=	0.5	
W= 18.50	Use Class	150	Rock Riprap	

CULVERT OUTLET PROTECTION

$$For TW < \frac{Do}{2}$$

$$La = \frac{(1.8\,Q)}{Do^{3/2}} + 7\,Do$$

$$W = 3\,Do + La$$

$$For TW \geq \frac{Do}{2}$$

$$La = \frac{(3\,Q)}{Do^{3/2}} + 7\,Do$$

$$W = 3\,Do + 0.4\,La$$

$$d_{50} = 0.02\,\frac{(Q)^{4/3}}{TW\,(Do)}$$

Culvert #10

Q= 27.00
Do= 1.5
TW= 1.49

APRON SIZE		ROCK SIZE			
La=	54.59	d_{50}=	0.72	Design d_{50}=	0.75
W=	26.34	Use Class		300	Rock Riprap

Culvert #11

Q= 30.00
Do= 2
TW= 1.37

APRON SIZE		ROCK SIZE			
La=	45.82	d_{50}=	0.68	Design d_{50}=	0.75
W=	24.33	Use Class		300	Rock Riprap

Culvert #12

Q= 42.00
Do= 2
TW= 1.28

APRON SIZE		ROCK SIZE			
La=	58.55	d_{50}=	1.14	Design d_{50}=	1.25
W=	29.42	Use Class		400	Rock Riprap

December 7, 2021
Project No. 3621001

Ms. Bobbie Merrigan
RYDER HOMES
985 Damonte Ranch Parkway, #140
Reno, NV 89521

RE: Geotechnical Update #1
Lompa Ranch – Phases B1 & B2
Carson City, Nevada

REF: Geotechnical Investigation
Lompa Ranch
Wood Rodgers' Project No. 3621001
April 11, 2018

ASCE Design Loads Manual 7-16
2018 International Residential Code (IRC)
2018 Northern Nevada International Code Council Amendments

Dear Ms. Merrigan:

Wood Rodgers is pleased to present this geotechnical update for the Lompa Ranch project. Our assessments and recommendations are based on our 2021 field exploration, the findings presented in the 2018 report prepared by Wood Rodgers, and the referenced codes and standards as they relate to geotechnical design considerations. This update has been developed to incorporate Phases B1 & B2 into the project's geotechnical report.

Except where specifically modified herein, the recommendations presented in the referenced 2018 Wood Rodgers' report should be considered valid as written and is presented in Appendix C for ease of reference.

PROJECT DESCRIPTION

Lompa Ranch Phases B1 & B2 consists of developing a single-family residential subdivision with associated streets. Structures will be one to two stories, wood-framed, with standard spread foundations and slab-on-grade flooring or a structural slab-on-grade foundation. Foundation loads are anticipated to be light.

Grading plans were not available at the time this letter was prepared; however, cuts and fills are anticipated to be negligible and on the order of five feet, or less, respectively. Once grading plans are

available, Wood Rodgers should be afforded the opportunity to review the plans to evaluate and revise recommendations, if necessary.

Street improvements are intended to be dedicated to Carson City. Underground utilities will be provided by a variety of public and private companies.

SITE CONDITIONS

The project area for Lompa Ranch Phases B1 & B2, located in Carson City, Nevada, encompasses an area of approximately 59 acres, and based on representative latitude and longitude, is located at 39.1645°N and -119.7425°E, respectively. The site is bordered by the initial phase(s) of Lompa Ranch to the west, undeveloped land to the north, Interstate 580 to the east, and East 5th Street to the south.

The site slopes downward to the southeast at less than one percent. Vegetation is light to moderate and typically consists of grasses and brush. Several dirt roads cross the property. Naturally eroded and man-made drainages are prevalent across the project area.

EXPLORATION

Phases B1 and B2 of the project were explored in November 2021, by excavating a series of 10 test pits using a Volvo ECR235 track mounted excavator and conducting a geophysical field study of shear wave velocity utilizing the Refraction Micro-tremor (ReMi) method. The approximate locations of the test pits and ReMi geophysical lines are shown on Plate A-1b – Site Map. Maximum depth of test pit advance extended to 10 feet below the existing ground surface. Bulk samples for index testing were collected from representative depths within the soil horizon. Plate A-1c presents an Improvement Map showing current project layout in relation to the site and exploration locations.

Wood Rodgers' personnel examined and classified soils in the field in general accordance with ASTM D2488 (Description and Identification of Soils). During exploration, representative bulk samples were placed in sealed plastic bags and subsequently returned to our Reno, Nevada laboratory for testing. Additional soil classifications, as well as verification of the field classifications, were performed in accordance with ASTM D2487 (Unified Soil Classification System [USCS]) upon completion of laboratory testing as described below in the Laboratory Testing section. Logs of the test xxx are presented as Plate A-2. A USCS explanatory chart of soil unit symbols and related descriptions has been included as Plate A-3 - Unified Soil Classification and Key to Soil Descriptions.

Shear wave velocity measurements have been relied upon for the development of geotechnical design characterization of soil stiffness. This information also aids in the determination of an appropriate Site Class (IBC, ASCE 7) and provides a screening tool for liquefaction potential. Plate A-5 presents the geophysical profile.

LABORATORY TESTING

Soil testing performed in the Wood Rodgers' laboratory was conducted in general accordance with the standards and methods described in Volume 4.08 (Soil and Rock; Dimension Stone; Geosynthetics) of the ASTM Standards. Samples of significant soil types were analyzed to determine in-situ moisture contents (ASTM D2216), grain size distributions (ASTM D6913), plasticity indices (ASTM D4318), and R-Value (ASTM D2844). Results of the testing is presented in Appendix A on Plates A-4a through A-4c. Table 1 also presents a summary of the test data. The test results were used to classify the soils according the USCS (ASTM D2487) and to verify the field logs which were then updated.

Chemical testing was performed to indicate the potential for corrosion to concrete and steel elements which is presented on Plate A-4d.

Table 1 - Summary of Test Data

Test Hole	Depth (Ft.)	Moisture (%)	%Gravel (+ #4)*	% Sand (#4-#200)	%Fines (-#200)	Liquid Limit	Plastic Index	R-Value	USCS
ASTM Standard		D2216	D6913			D4318		D2844	D2487
TP-1	0-1.5	16.2	0	58.6	41.3	27	13	---	SC
TP-2,5,8	0-4.5	13.3	0.1	54.5	45.4	32	15	46	SC
TP-6	0-1	23.9	0	62.5	37.5	44	16	---	SM
TP-9	1.5-2.5	15.6	0	46.7	53.3	32	12	---	CL

* Since ASTM D2487 is limited by a maximum particle size of 3", the gradation test data presented is based on a maximum particle size of 3".

SEISMIC HAZARDS

Surface Rupture

In 1998, the Nevada Earthquake Safety Council formulated guidelines for evaluating potential surface rupture due to faulting. The intent of the guidelines is to provide *a standardized minimum level of investigation for fault rupture in Nevada*; these guidelines have been adopted with the 2018 Northern Nevada Amendments of the IBC. Specifically, the guidelines state that investigation of sites for potential surface rupture or hazards shall be included in all geotechnical investigations. Further, if any Quaternary age surface rupture is mapped or otherwise interpreted to be present on the site, the feature is to be investigated further.

In addition to establishing the minimum level of investigation for fault rupture, the guidelines also offer recommendations for dealing with or mitigating identified hazards:

- Holocene active faults (evidence of movement within the past 10,000 years) shall be set-back a minimum distance of 50-feet for occupied structures.
- Late Quaternary (evidence of movement within the past 130,000 years) faults shall not be spanned by any critical facilities (hospitals, schools, fire stations, etc.). The facility under investigation does not meet the requisite requirements to be considered critical.

These guidelines allow for set-back distances to be adjusted by the competent professional. No additional constraints with regard to fault-structure location are presented in the guidelines.

The United States Geological Survey's (USGS) interactive fault map was accessed to determine the presence of any mapped features transecting the property. No faults have been mapped crossing, intersecting, or trending toward the property.

Liquefaction

Liquefaction is a loss of soil shear strength that can occur during a seismic event as excessive pore water pressure between the soil grains is induced by cyclic shear stresses. This phenomenon is limited to poorly consolidated (Standard Penetration Test less than 30, overburden stress corrected shear wave velocity less than 700 fps) clean to silty sand/sandy silt lying below the ground water table (typically less than 50 feet deep).

Based on our liquefaction screening involving a shear wave velocity survey, liquefaction potential on the site is considered low. A liquefaction study incorporating 50-foot boring(s) should be performed if a critical facility such as a hospital, school, or fire house become part of the overall project development.

Slope Instability

The site and surrounding low-lying topography are such that the potential for slope instability at the site due to gravitational or seismic activity is considered negligible.

DISCUSSION AND RECOMMENDATIONS

Soil Profile Type Amplification Factors

In accordance with ASCE 7-16 and the Northern Nevada Amendments of the 2018 IBC, Site Class D has been assigned to the project. Seismic design values were determined based on a representative latitude and longitude of 39.1645°N and -119.7425°E, respectively. Per ASCE 7-16, the site's modified Peak Ground Acceleration to be used for engineering analyses is equal to 0.78g. The ASCE 7 Hazards Report is attached to this letter in Appendix B.

Trenching and Excavations

Groundwater was encountered as shallow as 9-feet below the existing ground surface in the eastern area of the site in test pits TP-6 and TP-9. Excavations for the underground storage tanks or utility trenches that approach groundwater or that extend to within the zone of influence of groundwater will have a greater tendency to slough or cave and must be adequately considered and planned for by the contractor. Provisions for wet trench conditions should be included in construction planning and cost estimates.

Concrete

Sulfate testing on the native soils in the immediate area yielded results in the negligible range. No special concrete provisions are required to address sulfate resistance based on the materials tested. Type 1 or Type 2 cement is recommended for use on the site.

Pavement Sections

Table 2 presents the recommended minimum structural pavement sections for the development based on planned use. These sections have been developed with the expectation that the separation requirements presented in Table 3 from the referenced geotechnical report have been satisfied.

Table 2 - Structural Pavement Sections

Condition	Pavement Thickness (In.)	Pavement Type[1]	Type II Class B Base Course Thickness (In.)[2]
Local Street	4	2" Type 3 + Lime / 2" Type 2	6
Collector Street	4	2" Type 3 + Lime / 2" Type 2	8

[1] Per the Standard Specifications for Public Works Construction
[2] Base Course thickness is in addition to structural fill separation requirements

Asphalt Concrete Design Life

Maintenance is mandatory to ensure long-term pavement performance and to meet or exceed the assumed 20-year design life. Maintenance refers to any activity performed on the pavement that is intended to preserve its original service life or load-carrying capacity. Examples of maintenance activities include patching, crack or joint sealing, and seal coats. If these maintenance activities are ignored or deferred, premature failure of the pavement will occur.

Premature failure of asphaltic concrete frequently occurs adjacent to poorly graded ponding areas and/or landscape areas. Failures may occur due to excessive precipitation, irrigation and landscaping water infiltrating into the subgrade soils causing subgrade failure. As such, in areas where saturation of the subgrade soils beneath asphaltic pavement may occur, we strongly recommend the owner/project

manager include provisions by design for a subdrain system to eliminate the potential for saturation of subgrade soils. The subdrain system should discharge into a permanent drainage area that will not impede drainage flow to cause the system to back-up and/or clog. Appropriate maintenance procedures should be implemented to ensure the subdrain system does not plug and allow for proper drainage of surface and subsurface water beneath paved areas. Subdrain location and configuration should be evaluated once final grading and landscaping plans have been prepared. If the ultimate traffic exceeds the anticipated levels, it may be necessary to reevaluate and overlay the pavement at some time in the future.

LIMITATIONS

This report has been prepared in accordance with generally accepted local geotechnical practices. The analyses and recommendations submitted are based upon field exploration performed at the specific locations identified and the conditions encountered, as discussed in our report. No guarantee or warranty as to the continuity of soil conditions between exploration points is implied or intended. Therefore, this report does not reflect soil variations that may become evident during the construction period, at which time re-evaluation of the recommendations may be necessary. Final plans and specifications should be reviewed by the design engineer responsible for this geotechnical report to determine if they have been prepared in accordance with the recommendations contained in this report prior to submitting to the building department for review. It is the owner's/project manager responsibility to provide the plans and specifications to the engineer. We recommend our firm be retained to perform construction observation in all phases of the project related to geotechnical factors to document compliance with our recommendations. The owner/project manager is responsible for distribution of this geotechnical report to all designers and contractors whose work is related to geotechnical factors.

It is the contractor’s responsibility for the grading and construction of the designed improvements. This responsibility includes the means, methods, techniques, sequence, and procedures of construction and safety of construction at the site. All construction shall conform to the requirements of the most recently adopted version of the Standard Specifications for Public Works Construction and the requirements of Carson City. Failure to inspect the work shall not relieve the contractor from his obligation to perform sound and reliable work as described herein and as described in the Standard Specifications for Public Works Construction.

This report is issued with the understanding that it is the responsibility of the owner or their representative to ensure that the information and recommendations contained herein are brought to the attention of the design team for the project and incorporated into the plans and specifications, and that the necessary steps are taken to see that the contractor and subcontractors carry out such recommendations in the field.

This report was prepared by Wood Rodgers, Inc. for the benefit of Ryder Homes and their duly assigned agents or other responsible parties. The material in it reflects Wood Rodgers' best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Wood Rodgers accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made by third parties or actions based on this report without consultation with Wood Rodgers and written approval for such actions.

CONCLUSION

We appreciate the opportunity to prepare this geotechnical update for the Lompa Ranch – Phase B1 & B2 project. Please contact our office should you have any related questions or comments.

Sincerely,

WOOD RODGERS, INCORPORATED

Justin M. McDougal, PE
Associate
RE Number: 24474
Expires: 12/31/2023

James G. Smith, PE
Principal

APPENDICES

Appendix A – Geotechnical Plates
A-1a – Vicinity Map
A-1b – Site Map
A-2 – Logs of Test Pits
A-3 – Unified Soil Classification and Key to Soil Descriptions
A-4 – Laboratory Testing Results
A-5 – ReMi Results

Appendix B – ASCE 7 Hazards Report

Appendix C – Previous Report

APPENDIX A
GEOTECHNICAL PLATES

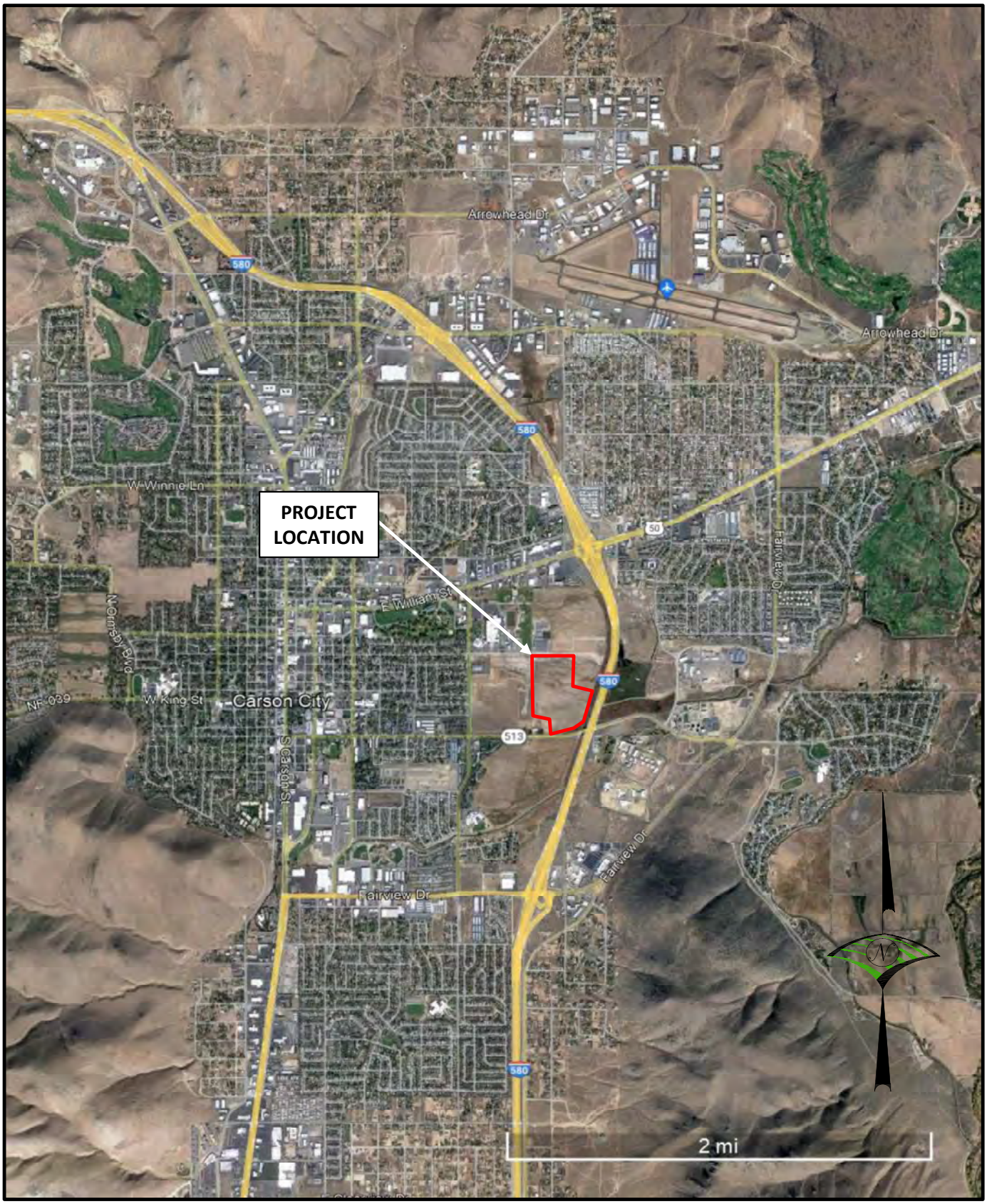

Image Reference: Google Earth, Imagery Date: 10/23/2020, Accessed 11/30/2021

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VICINITY MAP

Geotechnical Investigation
LOMPA RANCH - PHASES B1 & B2
RYDER HOMES
CARSON CITY, NV

Project No.: 36210001
Date: 11/30/21

PLATE A-1a