Technical Drainage Study

for

SAGE COLLEGIATE PHASE II

Date Prepared:
September 2023

Prepared for:
Red Hook Sage LLC C/O Red Hook Capital Partners IV LLC
2120 E Grand Ave STE 135
El Segundo, CA 90245

Prepared by:
Kimley-Horn and Associates, Inc.
6671 Las Vegas Boulevard South, Suite 320
Las Vegas, NV 89119
702.862.3600

Kimley»Horn

Kimley»Horn

September 7, 2023

Mr. Albert Sung, P.E.
City of Las Vegas Flood Control
333 Rancho Drive
Las Vegas, NV 89106

RE: ***Technical Drainage Study for Sage Collegiate Phase II***

Dear Mr. Sung,

This letter certifies that all items provided on the Technical Drainage Study for Sage Collegiate Phase II electronic submittal matches the paper version bound into the study.

With Kimley-Horn, you should expect more and will experience better. Please contact me at (702) 637-9664 or david.harvey@kimley-horn.com should you have any questions or concerns.

Sincerely,

David Harvey, P.E.

HYDROLOGIC CRITERIA AND DRAINAGE MANUAL

DRAINAGE STUDY INFORMATION FORM

Name of Development: Sage Collegiate Phase II Date: September 2023

Location of Development: a) Descriptive (Cross Streets) North/South: W Charleston Blvd/Fulton Pl

East/West: Hinson St/Bedford Rd

b) Section: 31 Township: 20 Range: 61

c) APN : 139-31-801-007 and 139-31-801-017

Name of Owner: Red Hook Sage LLC C/O Red Hook Capital Partners IV LLC

Telephone No.: N/A Fax No.: N/A E-Mail Address:

Address: 2120 E Grand Ave STE 135, El Segundo, CA 90245

Contact Person-Name: David Harvey, P.E. **Telephone No.:** 702.637.9664

* **E-Mail Address:** david.harvey@kimley-horn.com **Fax No.:** N/A

Firm: KIMLEY-HORN

Address: 6671 Las Vegas Boulevard South, Suite 320 Las Vegas, NV 89119

Type of Land Development/Land Disturbance Process:

☐	Rezoning	☐	Subdivision Map	☐	Clearing and Grading Only
☐	Parcel Map	☒	Planned Unit Development	☒	Other (Please specify below)
☐	Large Parcel Map	☐	Building Permit	GRADING PERMIT	

1. Total Owned Land Area: At Site: +/- 0.95 acres Being Developed/Disturbed: +/- 1.18 acres
2. Is a portion or all of the subject property located in a designated FEMA Flood Hazard Area? ☐ **Yes**** ☒ **No**
3. Is the property bordered or crossed by an existing or proposed Clark County Regional Flood Control District Master Planned Facility? ☒ **Yes**** ☐ **No**
4. Proposed type of development (Residential, Commercial, Etc.): Commercial
5. Approximate upstream land area which drains to the subject site: +/- 0.53 acres
6. Has the site drainage been evaluated in the past? ☒ **YES** ☐ **NO** If yes, please identify documentation: 1. Fire Station Study
7. If known, please briefly identify the proposed discharge point(s) of runoff from the site: 1. Surface drain to Hinson Street
8. Briefly describe your proposed schedule for the subject project: ASAP

Engineer's Seal

Submit this form as part of the required drainage study to the local entity which has jurisdiction over the subject property. This form may provide sufficient information to serve as the Conceptual Drainage Study.

*New Required Field

**Review and concurrence of the Clark County Regional Flood Control District is required.

Local Entity File No.

Revision	Date

REFERENCE:

STANDARD FORM 1

Updated 05/01/2008

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

DRAINAGE SUBMITTAL CHECKLIST

Project Name:	**Sage Collegiate Phase II**	Map ID:	
Firm Name:	**Kimley-Horn**	Engineer:	**David Harvey, P.E.**
Address:	**6671 Las Vegas Boulevard South, Suite 320**		
City:	**Las Vegas** State: **Nevada**	Zip:	**89119**
Phone No.:	**(702) 637 9664**	Fax No.	
Property Owner:	**Red Hook Sage LLC C/O Red Hook Capital Partners IV LLC**		
Address:	**2120 E Grand Ave STE 135**		
City:	**El Segundo** State: **CA**	Zip:	**90245**

Reviewed By:	**Date Received:**	**Date Accepted for Review:**

The following checklist is intended as a guide for the engineer preparing a Technical Drainage Study to submit to the local entity and Clark County Regional Flood Control District (if necessary). The listed items are the minimum information required prior to the entity performing a review. The engineer will remain responsible to ensure the Technical Drainage Study is prepared within the guidelines as set forth in the Clark County Regional Flood Control District (CCRFCD) Hydrologic Criteria and Drainage Design Manual (MANUAL).

This document is intended as an aid in preparing Technical Drainage Studies. Each study submitted is reviewed for compliance with local and regional criteria. This form is not intended to be all-inclusive and does not limit the extent of the information, calculations, or exhibits, which may be necessary to properly evaluate the intended land use.

If items are not applicable for the subject site, provide N/A.

I. GENERAL REQUIREMENT

YES	NO	N/A	
☒	☐	☐	Design Manual **Standard Form 1** with the Engineer's seal and signature.
☒	☐	☐	Design Manual **Standard Form 4.**
☒	☐	☐	2 copies of the 24" x 36" **Drainage Plan.**
☐	☐	☒	A notarized letter from the adjacent property owner(s) allowing off-site grading or discharge.

II. MAPS AND EXHIBITS

YES	NO	N/A	
☒	☐	☐	A copy of a current Flood Insurance Rate Map (FIRM) with the site delineated.
☒	☐	☐	A copy of the current CCRCD Master Plan Update Figure, (F-x), for Flood Control Facilities and Environmental areas with the site delineated.
☒	☐	☐	Off-site drainage basin maps for existing, interim, and future conditions showing the existing topography, basin boundaries, concentration points, and flows in cfs.

II. MAPS AND EXHIBITS (CONTINUED)

☒	☐	☐	Vicinity Map with local and major cross streets identified and a north arrow.

III. DRAINAGE PLAN

YES	NO	N/A	
☒	☐	☐	Sheet size: 24"x36" sealed by a registered engineer in the State of Nevada.
☒	☐	☐	Minimum scale: 1"=60'
☒	☐	☐	Project name.
☒	☐	☐	Vicinity Map with local and major cross streets.
☒	☐	☐	Revision box.
☒	☐	☐	North arrow and bar scale.
☒	☐	☐	Engineer's/consultant's address and phone number.
☒	☐	☐	Elevation datum and benchmark.
☒	☐	☐	Legend for symbols and abbreviations.
☒	☐	☐	Cut/Fill scarps, where applicable.
☒	☐	☐	Street names, grades, widths.
☒	☐	☐	Proposed future and existing spot grades for top of curbs and street crowns at lot lines, grade breaks, and along curb returns on both sides of the street.
☒	☐	☐	Existing contours encompassing the site and 100-feet beyond with spot elevations for important locations, where appropriate.
☒	☐	☐	Minimum finish floor elevations with top-of-curb elevations at upstream end of lot.
☒	☐	☐	Proposed typical street sections.
☐	☐	☒	Streets with offset crowns.
☒	☐	☐	Proposed contours or spot elevations in sufficient detail to exhibit intended drainage patterns and slopes.
☒	☐	☐	Property lines.
☒	☐	☐	Right-of-way lines and widths, existing and proposed.
☒	☐	☐	Existing improvements and their elevations.
☒	☐	☐	Delineation of proposed on-site drainage basins indicating area and 10-year and 100-year peak flows at basin concentration points.
☒	☐	☐	Concentration points and drainage flow directions with Q_{100} and V_{100} and D_{100} in streets.
☒	☐	☐	Cumulative flows, velocity, and direction of flow at upstream and downstream ends of site for the 10-year and 100-year flows.
☒	☐	☐	Location and cross-section of street capacity calculations.
☒	☐	☐	Cross-sectional detail for channels, including cutoff wall locations.

III. DRAINAGE PLAN (CONTINUED)

YES	NO	N/A	
☒	☐	☐	Existing and proposed drainage facilities, appurtenances, and connections (i.e., sidewalk ditches, swales, storm drain systems, unimproved channels, and culverts, etc.) stating size, material shape, and slope with plan and profile and HGL calculations.
☐	☐	☒	Existing and proposed drainage easements and widths shown with sufficient detail. A cross-sectional detail must be provided that shows appropriate lining and reinforcement.
☐	☐	☒	Location and detail of existing, proposed, and future block wall openings. Minimum size is 16"x48". Wrought iron gate is required for flows > 10 cfs.
☐	☐	☒	Location and detail of flood-wall(s) illustrating depth of flow, proposed grouting height, etc.
☐	☐	☒	Perimeter retaining wall locations. All existing and proposed walls (retaining screen and flood) must be shown with adjacent ground elevations. Flood walls with 8-inch concrete masonry unit.
☒	☐	☐	Building and/or lot numbers.
☒	☐	☐	Alignment of all existing, proposed, or future Regional Facilities adjacent to the site.
☐	☐	☒	Limits of existing floodplain based on current FIRM or best available information; limits of proposed floodplains based on best available information.
☐	☐	☒	For areas in Zone A, AE, AH, and AO, base flood elevations (BFEs) must be shown for each lot; BFEs may be listed on each lot, or in a table. Finish floor elevations must be a minimum of 18 inches above BFE.
☐	☐	☒	Appropriately elevated "humps" 6 inches above the 100-year water surface elevation at the accesses where the intent is to protect the site from the Q_{100} flows.
☒	☐	☐	Street slopes for perimeter and interior streets. The minimum slope is 0.4 percent.
☒	☐	☐	Location and detail of best management practice (BMP) for parking lots and low impact development (LID) (if required)

IV. HYDROLOGIC ANALYSIS

YES	NO	N/A	
☒	☐	☐	Appropriate soil information and Soils Map for existing and future conditions with sub-basins and property delineated.
☒	☐	☐	Input and Output information for existing conditions from computer models (HEC-1 or TR-55). The flow routing diagram must be provided with HEC-1 models.
☒	☐	☐	Input and Output information for proposed conditions from computer models (HEC-1 or TR-55). The flow routing diagram must be provided with HEC-1 models.
☒	☐	☐	Use of correct precipitation values in and around the McCarran Airport rainfall area.
☒	☐	☐	A discussion in the text of the hydrologic analysis justifying sub-basin boundaries and cutoffs, supporting assumptions, and calculations.
☒	☐	☐	A summary table of stormwater flows showing basin area Q_{10} and Q_{100} for both individual basins and combined basin flows, where applicable.

IV. HYDROLOGIC ANALYSIS (CONTINUED)

☒	☐	☐	Copies of supporting technical information referenced from a previously approved study and a statement accepting these results.
☒	☐	☐	On-site facilities must perpetuate flows through or around the site without significantly impacting adjacent property owners in accordance with current Nevada Drainage Law.
☒	☐	☐	Calculation for impervious area for parking lots and LIDs (if required)

V. HYDRAULIC ANALYSIS

YES	NO	N/A	
☐	☐	☒	Flow split calculations and supporting documentation or reference for the method of flow calculation used.
☒	☐	☐	Normal depth street flow calculations and cross-section diagrams for all interior and perimeter streets. Provide "d x v" products for the Q_{100} and Q_{10} flows representing the worst case for interior and all perimeter streets. Q_{100} d x v ≤ 8. Q_{10} d x v ≤ 6 and 12 foot dry lane for rights-of-way ≥ 80 feet. Calculations must be labeled by street name as indicated on the **Grading Plan**.
☒	☐	☐	A summary table of interior and exterior street capacity calculations showing the street name, Q_{100} flow, slope, depth of flow, velocity and depth times velocity product and streets needing to meet 12 foot dry lane criteria.
☐	☐	☒	Appropriate hydraulic calculations for block wall openings assuming a 50 percent vertical clogging factor. (Assume the lower half of the opening is plugged.)
☐	☐	☒	Appropriate hydraulic calculations at drainage easement entrance and discharge locations to set finish floor elevations. Hydraulic calculations must include submerged weir, superelevation and tee intersection losses, where appropriate.
☒	☐	☐	Provide necessary freeboard requirements to set the finished floor elevations of all proposed buildings, 2 x depth of flow or depth of flow plus 18 inches of freeboard, whichever is less. The minimum requirement is 6 inches above adjacent upstream top of curb. Building adjacent to drainage easements must always be provided with 18 inches of freeboard above the Q_{100} weir height or flow depth, whichever is greater.
☐	☐	☒	A complete water surface profile analysis (HEC-2, HEC-RAS, etc.) for channel flows and FEMA Zone A flood zones. • Field survey data. • Input and output information. • Plotted cross-sections based on survey with proper encroachments. • A map showing the location of the cross-sections. • Analysis of both sub and super-critical flow segments. • A summary table and a discussion of the results in the text of the report.
☐	☐	☒	Provide a 50 percent clogging factor in the capacity calculation for drop inlets.
☐	☐	☒	Hydraulic calculations for culverts and storm drains. D-Load calculations must be provided for storm drainpipes in public rights-of-way, including headwater pool inundation.
☒	☐	☐	The mitigation of nuisance water, both during construction and in the fully developed condition must be addressed.
☒	☐	☐	Provide BMP type, size and supporting calculations for parking lots and LIDs (if required)

CITY OF LAS VEGAS

MINIMUM DRAINAGE STUDY CRITERIA
STANDARD FORM 2 CHECKLIST SUPPLEMENT

(Revised 5/18/11)

The following checklist is intended as a supplemental guide for the engineer preparing a Technical Drainage Study submittal to the City of Las Vegas. This supplement focuses on requirements specific to the City of Las Vegas. The requirements presented are in addition to the Clark County Regional Flood Control District (CCRFCD) Manual Standard Form 2. The listed items are the minimum information required prior to the City performing a review. The engineer will remain responsible to ensure the Technical Drainage Study is prepared within the guidelines as set forth in the CCRFCD Hydrologic Criteria and Drainage Design Manual (Design Manual).

An appointment must be made to preview this checklist in conjunction with CCRFCD Standard Form 2 prior to the City accepting a new drainage study for review. The engineer must contact the Flood Control Section at (702) 229-6541 to schedule a submittal appointment.

If items are not applicable for the subject site, provide N/A.

I. GENERAL REQUIREMENT		
Yes	No	
	N/A	A notarized letter from the adjacent property owner(s) allowing off-site grading. (A copy of the letter must be received prior to final acceptance of the drainage study.)
X		Copies of all conditions of approval for development related to this property. (e.g. zoning, use permit, tentative map, etc.) Verify compliance with conditions.
X		An electronic copy of the complete submittal is required to be submitted with one original hard copy of the study. Electronic documents should be on a universal computer-readable digital output device replicating your submittal. An Indexed Portable Document Format (PDF) or Print Ready CAD file formats with a minimum of 300dpi are the desired formats. If figures are in color, they must be scanned in color and saved as a separate file. *DH* by initial here, the engineer on record acknowledges that the electronic copy is an identical replicate of the original hard copy submitted to the City of Las Vegas.

II. GRADING PLAN INFORMATION		
Yes	No	
X		(1) 24" X 36" copy of the Grading Plan, (including all Detail Sheets) sealed by the engineer.
X		Proposed future and existing spot grades for top of curbs and street crowns at lot lines, grade breaks, and along curb returns on both sides of the street. Note: Proposed top of curb elevations must be provided for both sides of roadways even if only half street construction is required.
X		Label existing topography at a minimum 5 foot elevation interval including adjacent developments, finished floor elevations of existing buildings and top of existing curbs extending 100 feet* around the perimeter of the site. (*Measured from the centerline of the adjacent roadway.)

II. GRADING PLAN INFORMATION		
Yes	No	
	N/A	Proposed on-site and off-site storm drains and other flood control facilities with plan and profile sheets for public storm drains showing the class of pipe, (Class III, IV, V, etc.), design hydraulic grade line, (HGL) and 100 year storm flow. A public drainage easement must be provided over on-site storm drains conveying off-site flows. An overflow path must be provided over all storm drains.
	N/A	All existing and "to be constructed" walls with cross-sections showing wall type, (e.g. block wall, retaining wall, flood wall, etc.), with limits clearly defined, adjacent ground elevations. Wall heights must meet current ordinances and in no case exceed 14 feet above the adjacent property.
X		Street slopes for both interior and perimeter streets. Note: The minimum slope for a roadway is 0.4 percent, a minimum 18-inch storm drain must be provided where minimum slopes cannot be met.
	N/A	Back of lot elevations and lot drainage pattern for all lots including common lots.
X		Sites with a grade difference two feet above or below existing ground are required to have approval from City of Las Vegas Current Planning. Current Planning approval is required prior to final approval of the drainage study.
X		On-site facilities must perpetuate flows through or around the site without significantly impacting adjacent property owners. (The project must pass flows through the site every 600 feet where the project is blocking flow paths.)
	N/A	This project uses a solid grouted stem wall (or approved alternate) at the back of sidewalk to provide erosion protection for landscaped areas where the depth of flow in the roadway exceeds the back of walk elevation. A corresponding cross-section detail is included.
X		Commercial and Common Lot Landscape areas are not allowed to drain over the sidewalk. The grading plans show flow lines with grades and sidewalk under drains for all landscape areas draining to the public ROW.

III. Local Entity Criteria - City of Las Vegas – Manual Section 1600		
Yes	No	
	N/A	Concrete valley gutters are required in parking lots with slopes less than 1 percent. Slopes through cul-de-sac must be at a 1 percent minimum where flow is drained through the cul-de-sac.
	N/A	Ten-foot wide public drainage easements to be privately maintained are allowed for flow less than 20 cfs. The depth of flow entering the easement must be checked using the submerged weir calculation.
	N/A	The limits of the flood zones and the base flood elevations (BFE) must be shown on all grading plans for all developments within a Special Flood Hazard Zone A, AO, AE, etc.
X		Minimum finish floor elevation is 6 inches above highest adjacent top of curb. Finish floor calculations must include allowances for super elevations on curves and velocity head for tee intersections.
	N/A	Finished floor elevations for buildings adjacent to public drainage easements must be a minimum of 18 inches above the Q100 weir of submerged weir elevation, whichever is greater.

III. Local Entity Criteria - City of Las Vegas – Manual Section 1600		
Yes	No	
	N/A	Lots with "B and C Type Drainage" that drain from one lot to another through a drainage easement shall be required to install an underground nuisance drainage system or a 2-foot valley gutter. 16" x 24" minimum block wall openings are required for both options.
	N/A	Bubblers are required across 80 foot and greater ROW streets. When flows exceed 10 cfs, bubblers larger than 18 inches will be required up to a maximum of 36". Inlets must be sized to match the pipe size provided.

- Contact the Flood Control Section regarding the drainage study review fee. These fees are payable at the time of submittal.
- The Drainage Study must be conditionally approved prior to submitting improvement plans to the Civil and Planning Development of the Department of Building and Safety for review.

This document is intended as an **aid** in preparing Technical Drainage Studies for the City of Las Vegas. Each study submitted is reviewed for compliance with local and regional criteria. This form is not intended to be all-inclusive and does not limit the extent of the information, calculations or exhibits which may be necessary to properly evaluate the intended land use.

Kimley»Horn

Technical Drainage Study

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SAGE COLLEGIATE PHASE II

Date Prepared:
September 2023

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Prepared by:
Kimley-Horn and Associates, Inc.
6671 Las Vegas Boulevard South, Suite 320
Las Vegas, NV 89119
702.862.3600

September 2023
KH Project #092815003

Kimley»Horn

Table of Contents

INTRODUCTION

The Red Hook Sage LLC and Red Hook Capital Partners IV LLC is proposing to expand the Sage Collegiate Charter School by developing ±0.95 acres north of the existing school building. The existing building lies at the northwest corner of West Charleston Boulevard and Hinson Street. The purpose of this report is to accompany the grading plans and to provide detailed hydrologic and hydraulic analyses for the proposed commercial site. The following tasks were performed in the preparation of this report:

1. Identify previous drainage studies for the project site and surrounding areas.
2. Identify the FEMA floodplain designation for the project site.
3. Identify existing and proposed regional drainage facilities adjacent to the site.
4. Estimate runoff generated for the peak 100-year and 10-year return period storms for existing and proposed conditions.
5. Verify proposed finished floor elevations meet CLV Criteria.
6. Recommend drainage features to protect the project from storm runoff.

LOCATION AND DEVELOPMENT DESCRIPTION

Sage Collegiate Phase II is located within Section 31, Township 20 South, Range 61 East, in Clark County, Nevada. The proposed project will consist of **commercial/school** within **±0.95 acres** of **APN 139-31-801-007 and 139-31-801-017.** A copy of the *Assessor's Parcel Map* is included in **Appendix A**. Please refer to **Figure 1 – Vicinity Map** for the location of the project.

Sage Collegiate Phase II is bordered by a residential development to the west, an existing school to the south, a fire department and park to the north, and Hinson Street to the east. The existing site is undeveloped and generally slopes from west to the east with flow being conveyed via sheet flow to east to Hinson Street. Drainage improvements will include curb and gutter, swales and valley gutters to convey onsite storm runoff to Hinson Street. Offsite flow will follow existing drainage patterns.

LAND USE CONDITIONS

Currently, the project site is undeveloped and zoned under limited commercial industrial (C-1) and civic (C-V). Planning condition documents for the project site are **23-0255** (ZON1 and SDR1) and will be voted on for approval at a Board meeting on October 18th.

VICINITY MAP
SAGE COLLEGIATE PHASE II

Figure 1

Kimley»Horn

PREVIOUS DRAINAGE STUDIES

Previous hydrology studies that were utilized in the preparation of this report:

1. *Technical Drainage Study for City of Las Vegas Fire Station No. 5 (Fire Station Study, February 2003)*

    a. The Fire Station Study notes that the 100-year flow in Charleston Boulevard does not overtop the high point along Hinson Street. Therefore, the only flow impacting Hinson Street adjacent to the project site is flow generated from the project site, the parcel south of the project site, and the half street basin for Hinson Street.

    b. The Fire Station Study notes that the developed condition for the project site (former Elk's Lodge RV site) will drain through the 30-foot driveway access to Hinson Street. The proposed improvements are consistent with this drainage pattern.

    c. The Fire Station Study analyzed the flow in Hinson Street. This street section was referenced to analyze the impacts of the proposed site improvements. The street geometry was referenced from the Fire Station Study; however, the section was updated to be a half street section since the tributary flows from the west did not overtop the street's crown.

Kimley-Horn has reviewed the reference studies listed and agrees with the information included therein. The information referenced is for determining the existing and proposed flow rates adjacent to the proposed project site. Pertinent reference material is included in **Appendix E**.

CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT (CCRFCD) MASTER PLAN FACILITIES

"*The Las Vegas Valley Flood Control Master Plan Update*", **Figure F-29**, dated December 2018, as prepared by the Clark County Regional Flood Control District (CCRFCD) illustrates the existing and proposed master planned facilities in the area (**See Appendix A**). As shown on the exhibit, the project site **is** located adjacent to existing regional facility **MEOK0048 (18' x 9' RCB)**.

FEMA FLOOD HAZARD DESIGNATION

The Special Flood Hazard Areas (SFHA) for both the unincorporated and the incorporated portions of Clark County, Nevada, are outlined in the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps. This subject site is located on FEMA Flood Insurance Rate Map (FIRM) Community Panel No. **32003C 2165D**, September 2002. As shown on the FEMA FIRM Exhibit (see **Appendix A**), the subject site is located within a FEMA-designated **Zone X**. Therefore, this project is not currently located in a FEMA-designated SFHA. Areas described as Zone X are areas determined to be outside the 0.2% annual chance (500-year) floodplain.

HYDROLOGIC METHODOLOGY

The hydrologic model and design of this site development are in compliance with local requirements, including Clark County (CC), the CCRFCD's "*Hydrologic Criteria and Drainage Design Manual*", and the CCRFCD's "*Flood Control Master Plan Update*".

MODEL DESCRIPTION

The hydrologic model utilized in this study is the **HEC-1** Flood Hydrograph Package developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center. **HEC-1** is a rainfall runoff event simulation model utilizing an interconnected system of hydrologic and hydraulic components to simulate the surface runoff response of a drainage area to precipitation. The calculations of this study were performed using the SCS Unit Hydrograph of the **HEC-1** Flood Hydrograph Model. The detailed explanation of the theory and background is presented in Section 4 of the SCS National Engineering Handbook and the **HEC-1** User Manual. Since the drainage area for the overall watershed is less than 8 square miles, and **SDN3** design storm was selected for the use in the HEC-1 computer model.

PRECIPITATION

According to Figure **513** of the Manual, the project is located within the **McCarran Airport Rainfall Area**; therefore, point rainfall values for the 10-year and 100-year, six-hour storm duration are **1.58** and **2.77** inches, respectively (see **Appendix B**).

CURVE NUMBER

The soils information for the project watershed was referenced from the Soil Survey of Las Vegas Area, Nevada, Part of Clark County" prepared by the United States Department of Agriculture Natural Resources Conservation Services (USDA NRCS). A *Custom Soil Resource Report* for the project site is included in **Appendix D**. The report indicates that the project area consists of Soil Types 300 (Las Vegas gravelly fine sandy loam) which is classified as Hydrologic Soil Group "**D**". HSG "**D**" is characterized as having a low infiltration rate when thoroughly wet.

The land uses / Land covers for the project site consist of: MPU Land Use 1 and 12, "**Undeveloped Land, Open Desert"** and **"School"** for undeveloped and developed areas, respectively. The offsite basin consists of MPU land use 9 **"Commercial"**.

For the given soil, CN values were determined from appropriate land use according to the Master Plan Update (MPU) matrix. Curve numbers ranging from **88.0** to **96.0** were determined for the existing and proposed conditions subbasins.

A copy of "*The Las Vegas Valley Flood Control Master Plan Update"*, Figure **W-5**, dated December 2018, as prepared by CCRFCD is included in **Appendix A** to illustrate Regional's hydrologic subareas, land use and soils in the area.

DRAINAGE AREAS AND FLOW PATTERNS

The subbasins and flow patterns used for the hydrologic modeling were determined from elevations established for the project site in a master grading digital file. Aerial topography with 2-foot contour intervals and survey data has been used for subbasin delineations.

LAG TIME

The time between a brief, heavy rain and maximum runoff rate is called Lag Time. Lag Time can be estimated from historical hydrographs, or it can be estimated from specific watershed characteristics such as watershed length, slope, and flow impedance. Based on studies of many storm events for a range of watershed conditions, the following empirical relationship between Lag Time (T) and Time of Concentration (T_c) was derived:

$$T = 0.6T_c$$

The Time of Concentration (T_c) is defined as the time required for runoff to the flow from the most remote part of the drainage basin to the outlet or to a combination point. The procedure for calculating the T_c is outlined in **Section 602** of CCRFCD's "*Hydrologic Criteria and Drainage Design Manual"*. Lag time calculations for this site are included in **Appendix B** as shown on **Standard Form 4**.

HYDROLOGY

Existing and Proposed Conditions hydrology have been analyzed for the impacts to the project site. Proposed Conditions hydrology has been prepared to address the proposed improvements. Existing condition subbasins have been included on **Figure EX** and depict the drainage patterns used in the hydrologic analysis for the project. Proposed condition hydrology has been prepared to analyze the impacts of onsite flow through the site. Proposed condition subbasins have been included on **Figure PRO** and depict the drainage patterns used in the proposed condition for the project. Copies of the figures are included in **Appendix A**. HEC-1 Models for Existing and Proposed Conditions subbasins have been included in **Appendix B**. Tables summarizing the results of the HEC-1 models have been included on the figures in **Appendix A**.

EXISTING CONDITIONS

Existing conditions assume the site is rough graded, the adjacent parcels and Hinson Street to the east are fully developed. The site's historical drainage patterns dictated that approximately 1 cfs drained at the northeast corner into an existing drainage easement on the City of Las Vegas Fire Station No. 5 property. Sometime after the construction of the fire station, the easement was blocked off, resulting in ponding at the northeast corner before flow eventually drains to Hinson Street through the site's access path. Currently, the entire project site drains east to Hinson Street, similar to the historical existing condition, where runoff is collected in several drop inlets that convey the flow to the existing 18' x 9' RCB Regional Facility **MEOK0048**.

The project-specific existing conditions hydrology consists of one (1) offsite subbasins (**OFF1**), one (1) onsite subbasin (**EON1**), and one (1) street basins (**HS1**). **Figure EX – Existing Conditions Basin Map** depicts the depicts the existing condition subbasins. **Table 1** summarizes the flows for existing conditions. A unit flowrate (cfs/acre) for subbasin **OFF1** was calculated by dividing the total flowrate of

the subbasin by the overall subbasin area. The total flowrate generated by areas shown on **Figure EX** is approximated by multiplying the calculated unit flow rate (cfs/acre) by the delineated portion of the tributary area (acres). Prorate calculations for the offsite subbasins have been included on **Figure EX**. **Table 1** summarizes the HEC-1 results for existing conditions and **Table 2** summarizes the prorated existing conditions flowrates. Hydrologic calculations have been included in **Appendix B**.

Table 1: Existing Condition Flow Summary

BASIN ID/ COMB. PT.	BASIN AREA	100-YR FLOW	10-YR FLOW
	(ac)	(cfs)	(cfs)
EON1	0.95	2	1
OFF1	2.81	10	6
OFF1-A	-	4	2
OFF1-B	-	6	4
HS1	0.29	1	1
CP1	-	7	3

Table 2: Existing Condition Prorated Flow Summary

Existing Offsite					
SUBBASIN	Q_{100} (cfs)	Q_{10} (cfs)	AREA (ac)	CFS_{100}/ACRE	CFS_{10}/ACRE
OFF1	10	6	2.81	3.56	2.14
Existing Offsite Prorated Basins					
SUBBASIN	Q_{100} (cfs)	Q_{10} (cfs)	AREA (ac)	CFS_{100}/ACRE	CFS_{10}/ACRE
OFF1-A	4	2	1.06	3.56	2.14
OFF1-B	6	4	1.75	3.56	2.14
TOTAL	**10**	**6**	**2.81**	**NA**	**NA**

PROPOSED CONDITIONS

The proposed condition drainage patterns assume the project site as fully developed, and the offsite basins as developed as in existing conditions. The proposed onsite flow patterns are similar to existing conditions. See **Figure PRO** in **Appendix A**. The project site (APNs 139-31-801-007 and 139-31-801-017), and adjacent parcel to the south (APN 139-31-801-009) will be updated to be one singular parcel. Therefore, no offsite flow is being conveyed through the site, and permission to grade will not be required for the proposed improvements.

The project-specific proposed conditions hydrology consists of one (1) onsite subbasin (**DON1). Figure PRO - Proposed Condition Basin Map** depicts the subbasins and is located in **Appendix A.** Subbasins **DON1** and **OFF1** were prorated to determine flowrates impacting the proposed improvements. A unit flowrate (cfs/acre) for the subbasins was calculated by dividing the total flowrate of the subbasin by the overall subbasin area. The total flowrate generated by areas shown on **Figure PRO** is approximated by multiplying the calculated unit flow rate (cfs/acre) by the delineated portion of the tributary area (acres). Prorate calculations for the onsite subbasin have been included on **Figure**

PRO. **Table 3** summarizes the HEC-1 results for proposed conditions and **Table 4** summarizes the prorated proposed conditions flowrates. Hydrologic calculations have been included in **Appendix B**.

Table 3: Proposed Condition Flow Summary

BASIN ID/ COMB. PT.	BASIN AREA (ac)	100-YR FLOW (cfs)	10-YR FLOW (cfs)
DON1	0.95	3	1
OFF1	2.81	10	6
OFF1-A-C	-	4	2
OFF1-D	-	6	4
HS1	0.29	1	1
CP1	-	8	4

Table 4: Proposed Condition Prorated Flow Summary

Proposed Onsite and Offsite					
SUBBASIN	**Q_{100} (cfs)**	**Q_{10} (cfs)**	**AREA (ac)**	**CFS_{100}/ACRE**	**CFS_{10}/ACRE**
DON1	3	1	0.95	3.16	1.05
OFF1	10	6	2.81	3.56	2.14
Proposed Onsite and Offsite Prorated Basins					
SUBBASIN	**Q_{100} (cfs)**	**Q_{10} (cfs)**	**AREA (ac)**	**CFS_{100}/ACRE**	**CFS_{10}/ACRE**
DON1-A	3	1	0.87	3.16	1.05
DON1-B	<1	<1	0.08	3.16	1.05
TOTAL	**3**	**1**	**0.95**	**NA**	**NA**
OFF1-A	1	1	0.35	3.56	2.14
OFF1-B	1	<1	0.18	3.56	2.14
OFF1-C	2	1	0.53	3.56	2.14
OFF1-D	6	4	1.75	3.56	2.14
TOTAL	**10**	**6**	**2.81**	**NA**	**NA**

Onsite flow from subbasin **DON1** is prorated in order to check the finished floor elevation of the proposed building. The proposed high point along the west side of the site splits flow around the building with DON1-A going north and DON1-B flowing south around the proposed building. Both subbasins drain into a proposed swale at the east end of the property prior to discharging into Hinson Street through a sidewalk drain. Offsite subbasin **OFF1** is prorated to determine the quantity of flow discharging north towards the project site. Subbasins **OFF1-A** and **OFF1-B** drain north onto the project site where the flow is collected and conveyed east through the swale at the eastern edge of the site. Subbasin **OFF1-C** drains east to Hinson Street where it combines with **DON1, OFF1-A** and **OFF1-B** at **CP1**. Prorate basin **OFF1-D** surface drains to Charleston Boulevard, where the runoff is intercepted by an existing drop inlet. See **Figure PRO** in **Appendix A**.

Once flows enter Hinson Street at **CP1**, they will be collected and conveyed by downstream facilities, discharging into CCRFCD facility **MEOK0048** (18' x 9' RCB). These downstream facilities have been

sized to convey the proposed condition flows from the project site, so the development of the site will not adversely affect downstream facilities or property.

HYDRAULIC CALCULATIONS

STREETS

The resulting street flow data based on the flows generated during proposed conditions has been presented in **Table 5**. **Figure PRO** in **Appendix A** show the locations of the cross sections corresponding to the calculations included in **Table 5**. Hydraulic calculations have been included in **Appendix C**. The onsite normal depth sections and flow rates have been calculated from their respective tributary subbasins.

Table 5: Proposed Roadway Hydraulic Sections

STREET SECTION	TRIBUTARY BASINS	SLOPE	Q_{100}	FLOW DEPTH	VELOCITY	D*V	Q_{10}	FLOW DEPTH	VELOCITY	D*V	DRY LANE
		%	(cfs)	(ft)	(ft/s)	ft^2/s	(cfs)	(ft)	(ft/s)	ft^2/s	
HS - 1	CP1	1.50	8.0	0.44	3.29	1.45	4.0	0.37	2.79	1.03	20.5

Based on the calculated flow characteristics, the Manual criteria for depth (D) and velocity times depth (V*D) during the 100-year storm event will be met.

The Manual criteria for a major roadway requires a 12-foot wide dry lane in addition to a dry center turn lane in each direction for streets with a ROW greater than 80 feet during a 10-year storm event. The calculated 10-year maximum depth for Hinson Street is 0.40 feet to provide for a 12-foot wide dry lane. Therefore, the 10-year criteria for Hinson Street has been met.

STORM DRAIN FACILITIES AND PROTECTION

The proposed flood control facilities for the site include concrete gutters, swales and trench drains. All existing and proposed flood control facilities have been shown on **Figure PRO** and the plans included in **Appendix F**. All proposed facilities have been sized to convey the proposed condition flowrates. Hydraulic calculations have been included in **Appendix C.**

In order to achieve ADA compliance, the proposed building's finished floor was not able to be elevated above the adjacent high top of curb (TC). In order to protect the building, a 12-inch wide trench drain will be installed along the low point just west of the proposed building. This trench drain will collect flows from the turf area just west of the building and discharge these flows north into the driveway.

PROPOSED DRAINAGE SWALES

Proposed onsite swales have been provided to direct flows away from the proposed project site and ultimately into the adjacent streets. Facility names for the proposed swales in the calculations correspond with the tributary subbasin/Cross Section Identifier. Information for the swales has been included on **Figures PRO** and summarized in **Table 6**. Normal depth calculations have been included in **Appendix C**.

Table 6: Drainage Swale Calculations

SECTION	TRIBUTARY BASINS	SLOPE (%)	Q_{100} (cfs)	FLOW DEPTH (ft)	VELOCITY (ft/s)	D*V	TYPE	SIDE SLOPES		Req'd d_{50} (in)
SW-1	DON1 + OFF1-A+ OFF1-B	1.00	5.0	0.76	2.18	1.66	V	4:1	4:1	6"
CH-1	DON1 + OFF1-A+ OFF1-B	1.00	5.0	0.29	3.82	1.11	RECTANGULAR	0:1	0:1	N/A

FINISHED FLOOR ELEVATION

The Clark County Regional Flood Control District requirement for the finish floor elevation (FF) is that it must be 18 inches above the centerline grade of the adjacent street or be elevated to twice the depth of flow up to 18 inches above the water surface elevation (WSE). Additional criteria requires the finished floor elevation to be a minimum 6 inches above the adjacent upstream top of curb. As noted above, the building finished floor is not elevated 6 inches above the adjacent upstream top of curb in order to meet ADA requirements. A 12-inch wide trench drain will be installed along the low point west of the proposed building in order to protect the building. The trench drain will collect flows from the turf area west of the proposed building and discharge these flows north into the drive aisle. The proposed finished floor elevation has been elevated at or above at least twice the depth of flow in the adjacent drive aisles. **Table 7** summarizes the proposed FFE for the proposed building and verifies that the minimum criteria is met. The onsite hydraulic summary table on **Figure PRO** in **Appendix A** shows the proposed finished floor elevation in relation to the proposed flow depths. Hydraulic calculations have been included in **Appendix C**.

Table 7: Building FFE Check Summary

ONSITE SECTION	TRIBUTARY BASINS	CHANNEL SLOPE %	Q_{100} (cfs)	FLOW DEPTH (ft)	*FLOW LINE (ft)	*FLOW LINE + 2D (ft)	*FFE BLDG (ft)	BLDG PROTECTED ?
DON1-A	1/3*DON1	0.50	1.0	0.28	68.17	68.73	71.00	YES
DON1-B	1/2*DON1	0.50	1.5	0.36	69.03	69.75	71.00	YES
DON1-C	DON1-B + OFF1-A	0.50	1.0	0.30	70.36	70.96	71.00	YES

*ADD 2100 FT

The site will be accessible from the existing site to the south. As a result, no new driveways are being constructed as part of these improvements. Please refer to the grading plans included in **Appendix E**.

PARKING LOT LOW IMPACT DEVELOPMENT (LID)

Per Section 1502.2 of the CCRFCD "Hydrologic Criteria and Drainage Design Manual", this project is categorized as a **Medium Parking Lot** since the size of the on-site parking lot is approximately +/-0.39 acres.

For the medium parking lot category, BMPs are required to disconnect impervious areas for at least 75 percent of the parking lot from the onsite drainage network. Treatment BMPs will be installed on site as a conservative measure. BMPs are sized for the 85th Percentile Rainfall. Please refer to **Appendix D** for all LID calculations and for **Figure LID – LID Basin Map**.

The BMP incorporated into the project design is a landscaped swale, located southeast of the proposed building, along northern border with the CLV fire station. Due to site design and grading constraints, the project site was delineated into one (1) sub-area; Drainage Management Area1 (DMA) 1.

DMA 1, will be treated by **landscaped swales**. The swales are designed with a minimum length of 40 feet long and a slope of 1.00%. The proposed swales are rock-lined (d50=6-inches; thickness=12-inches) and treat more than 75 percent of the parking lot area. Based on hydraulic analysis, these swales will convey, contain and treat the peak BMP discharge (QBMP) as well as facilitate the 100-year peak flow rate; these calculations are included in **Appendix D**.

The proposed **LID Basin Map** is included in **Appendix D**. The proposed BMPs are shown on the grading plan included in **Appendix F**.

CONCLUSIONS AND RECOMMENDATIONS

The proposed Sage Collegiate Phase 2 development will not adversely impact the surrounding areas in the 100-year and 10-year storm events. The development of this project site is in compliance with the *CCRFCD Hydrologic Criteria and Design Manual* and City of Las Vegas criteria.

1. This project is in compliance with the applicable drainage laws recognized by the State of Nevada.

2. This project is in compliance with the CCRFCD's "*Master Plan Update*" and will **not** conflict with any Master Planned Facilities.

3. This project is in compliance with the CCRFCD's "*Hydrologic Criteria and Drainage Design Manual*", with the exceptions noted in the study.

4. This project lies within FEMA-designated **Flood Zone X**. Therefore, the project is not currently located in a FEMA-designated Special Flood Hazard Area.

5. Buildings to be constructed with this project will have adequate freeboard protection from flows conveyed in the adjacent streets.

6. Runoff generated from, or conveyed by, the project will not adversely impact any downstream properties or facilities.

REFERENCES

1. Clark County Regional Flood Control District, "*Hydrologic Criteria and Drainage Design Manual*," August 1999, Revise September 2013.

2. Clark County Regional Flood Control District, "*2018 Las Vegas Valley Flood Control Master Plan Update*," November 2018.

3. U. S. Department of Agriculture Soil Conservation Service, *Soil Survey of Las Vegas Valley Area, Nevada, Part of Clark County*, September 2022, Version 18.

4. U.S. Army Corps of Engineers. HEC-1 Flood Hydrograph Package. Revised June 1998.

5. Technical Drainage Study for City of Las Vegas Fire Station No. 5 (Fire Station Study, February 2003)

LIST OF APPENDICES

Appendix A – Documents & Figures

- EX Existing Condition Basin Map
- PRO Proposed Condition Basin Map
- Assessor's Parcel Maps
- FIRMette Exhibit
- Figure F-29 Flood Control Facilities
- Figure W5 Hydrologic Subareas, Land Use & Soils

Appendix B – Hydrologic Parameters & HEC-1 Analyses

- Figure 513 McCarran Airport Rainfall Area
- Table 503 Six-hour Storm Distributions
- Table 505 Depth-Duration-Frequency Values
- USDA NRCS Custom Soils Resource Report for Las Vegas Valley
- Curve Number Calculations
- Existing Condition Standard Form 4
- Existing Condition HEC-1 Output
- Proposed Condition Standard Form 4
- Proposed Condition HEC-1 Output

Appendix C – Hydraulic Calculations

- Normal Depth Calculations – Streets
- Normal Depth Calculations – Onsite
- Normal Depth Calculations – Swale
- Trench Drain Calculation

Appendix D – Parking Lot LID Calculations

- LID Parking Lot LID Map & Calculations

Appendix E – Reference Materials

- Technical Drainage Study for City of Las Vegas Fire Station No. 5 (Fire Station Study, February 2003)

Appendix F – Improvement Plans

Appendix G – Data CD