DS #: 4516

APN: 164-01-601-001

PROJECT: FAITH LUTHERAN HIGH SCHOOL ADDITION (PROJECT IN CLARK COUNTY FOR CLV CONC.)

SUBMITTAL: 1ST

SCANNED BY/DATE:

CHECKED BY/DATE:

CITY OF LAS VEGAS INTER-OFFICE MEMORANDUM				DATE: January 26, 2011
TO: **Land Development Services** Department of Public Works				FROM: Albert Sung, P.E. Flood Control Project Engineer Department of Public Works
SUBJECT:	Drainage Study for: **Faith Lutheran High School Addition** **(Project in Clark County for CLV Concurrence)**			COPIES TO: Lochsa Engineering
Cross Streets:	NWC of Hualapai Way & Homestretch Dr.			Faith Lutheran High School Board
File Number:	F:\Depot\DSMemos\DS4516A.doc			Bart Anderson, P.E., DevCo
Parcel Number:	164-01-601-001			CCPW
Zoning Action:	N/A			
FEMA Flood Zone	YES	NO	X	
Proposed Storm Drain	YES	NO	X	

HISTORY	DATE RECEIVED	DATE REVIEWED	COMMENTS	REVIEW FEES	FEES PAID Transaction #
1st Submittal	1/19/2011	1/26/2011	See Comments Below	$400.00	161113: $400
			TOTAL FEES (LDDRS):	**$400.00**	----

REMARKS:

The Drainage Study for the subject project has been reviewed and:

X	is approved subject to conformance to all City standards and the following conditions:
	must be resubmitted or supplemented including the following:
	is conditionally approved subject to Clark County Regional Flood Control District concurrence.
	is conditionally approved subject to Clark County Public Works Department concurrence.

***City of Las Vegas Flood Control* staff has reviewed the subject Technical Drainage Study, including Addendum #1 and Addendum #2. *City of Las Vegas* concurs with the acceptance of the drainage study by the *Clark County Public Works Department*. The review of this project was limited to issues of flood control significance to the *City of Las Vegas*.**

NOTE: Please be advised that all land surface area disturbances over 1 acre or any area adjacent to a water way must submit to the *Nevada Division of Environmental Protection* a "Notice of Intent" to discharge that certifies a stormwater pollution prevention plan has been developed and is maintained on site; for inclusion in the Stormwater General Permit No. NVR100000. A phased construction unit in a contiguous subdivision is considered under construction until all stripped or disturbed surface areas have been covered by paving, building construction or planting. For more information, including forms and applications see http://ndep.nv.gov/bwpc/storm01.htm or call (775) 687-9429.

NOTE: Any future changes to the proposed design (or design assumptions) as outlined in the approved drainage study and attached preliminary grading plan which affect drainage must be addressed in a Drainage Study Amendment and accepted by the *City of Las Vegas Flood Control Section*. Additionally, conditional acceptance of a drainage study is valid for a period of one (1) year. If the proposed construction has not been completed in that time period, the *City of Las Vegas* reserves the right to require additional conditions and/or submission and acceptance of a complete drainage study update prior to further construction of a project.

END OF REMARKS

ays

T/R/S: T59S/R21E/01
AREA P-01

Department of Public Works

500 S Grand Central Pky • Box 554000 • Las Vegas NV 89155-4000
(702) 455-6000 • Fax (702) 455-6040

Denis Cederburg, P.E., Director • E-Mail: dlc@ClarkCountyNV.gov

Drainage Study Approval Letter

Date: January 13, 2011
Firm: Lochsa Engineering
Engineer: Guy M. Morris, P.E.
Address: 6345 South Jones Boulevard, Suite 100, Las Vegas, NV 89118
Phone: (702) 365-9312
Fax: (702) 365-9317
E-mail:

Subject: Technical Drainage Study for Faith Lutheran High School Soccer Field
Location: NWC of Hualapai Way and Homestretch Drive
APN: 164-01-601-001; 164-01-501-001
Sec, Township, Range: S01, T21S, R59E
Flood Zone & Panel: Zone X, 2150E, Revised September 28, 2002
Application Tracking #: 10-31779

HTE10-31779

Submittals	Date Received	Date Returned	Reviewer	Miscellaneous
Technical	11/15/2010	12/03/2010	WG	
Addendum #1	12/29/2010	12/30/2010	WG	
Addendum #2	01/10/2011	01/13/2011	WG	

Concurrence Required: (Must be obtained prior to permit issuance)		Reason Concurrence is required
	City of Henderson	Adjacent to or Impacts Henderson
X	City of Las Vegas	Adjacent to or Impacts Las Vegas
	City of North Las Vegas	Adjacent to or Impacts North Las Vegas
	Nevada Department of Transportation	Impacts NDOT Facility
	Union Pacific Rail Road	Adjacent to or Impacts a UPRR Facility
	US Army Corp of Engineers	Impacts a USACE Facility
	Clark County Regional Flood Control District	Adjacent to or Impacts CCRFCD MPU Facility or in a SFHA

The referenced **Technical Drainage Study** has been reviewed and is accepted as complying with minimum improvement standards. As set forth in the subject drainage study, the following measures will be taken to mitigate flood hazards.

The site shall be graded with respect to drainage as shown on "Faith Lutheran High School Soccer Field", grading plan sheets C1.01, C1.02, C3.01, C3.02, C3.03, C3.03A, C5.01, signed and sealed by Guy M. Morris, P.E., on January 6, 2011.

Check appropriate conditions

	Retaining/screen wall combination may be in excess of current **Clark County Unified Development Code, Chapter 30.64.050.**
	A FEMA Elevation Certificate, completed by a licensed surveyor, must be submitted to and approved by CCPW Development Review Plan Check prior to the issuance of Certificates of Occupancy for those structures.
X	Mylars of the grading plan must be submitted to the CCPW Development Review Plan Check for approval signatures prior to map recordation (residential) or permit issuance (commercial).
	An administrative variance to allow the finished floor elevation(s) to be set below the current Clark County criteria must be approved. The finished floor variance must be submitted to CCPW Development Review front counter after drainage study approval and prior to offsite final review.
X	The grading plan will be reviewed by the Building Office Operations Division to ensure compliance with the ADA access requirements. Revisions to the grading plan may be required if the site accessibility design does not comply with the requirements set forth in the Accessibility Chapter of the Clark County Building Code.
	The plans show work is proposed outside of the project boundary. Notarized written permission must be obtained **prior to grading plan approval.**
X	Right-of-way dedication must be verified.
	Any previously approved drainage easements that are not being used must be vacated.
	Per *Regional Flood Control District policies and Procedures manual, Section VIII. D. 13. Uniform Regulations for the Control of Drainage*, the Engineer of Record shall provide As-Built plans or record drawings to the District after completion and final inspection of such privately installed flood control facilities that have regional flood control significance.
	Structural calculations are required. The structural calculations, plans, and details must be approved prior to "Offsite" submittal.
X	Plan revisions can be found on the red-lined plans and must be addressed.
X	Prepare drainage easement documents as shown on the grading plans.

Additional Conditions:

1. Per Addendum, Response #3, maintenance of the public underground drainage easements, storm drain systems, laterals and drop inlets will be privately maintained by the school.

2. Revise proposed PVC lateral to RCP as facility is within a public drainage easement, Sheet C3.01.

3. Separate private drainage easement limits from the public drainage easement, Sheet C3.03.

The County's review is solely based on the information submitted by the Engineer of Record. The County's review is strictly limited to compliance with minimum County Codes and Standards. The Engineer of Record is responsible for researching and addressing situations that may require designs above and beyond the minimum codes for issues of public safety and impacts to upstream, downstream and adjacent properties. The County assumes no liability for information data, designs or conclusions of the Engineer of Record.

By _____
W. Layne Weber, P.E., CFM
Principal Engineer
Clark County Public Works
Development Review

cc: Faith Lutheran High School

Rec'd: 1/19/11

Technical Drainage Study
for
Faith Lutheran High School Addition

DS 4516

P-01

(Project in County for CCV Concurrence)

JOB# 101081

November 2010

Prepared for:

Faith Lutheran High School
2015 South Hualapai Way
Las Vegas, Nevada 89117
(702) 804-4402

Prepared By:
LOCHSA ENGINEERING
6345 South Jones Boulevard
Suite 100
Las Vegas, Nevada 89118
(702) 365-9312

Technical Drainage Study
for
Faith Lutheran High School Addition

JOB# 101081

November 2010

Prepared for:

Faith Lutheran High School
2015 South Hualapai Way
Las Vegas, Nevada 89117
(702) 804-4402

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6345 South Jones Boulevard
Suite 100
Las Vegas, Nevada 89118
(702) 365-9312

2-365-9312 | F 702-365-9317
45 S Jones Blvd, Suite 100
Vegas, NV 89118

Lochsa engineering

November 10, 2010

Mr. Layne W. Weber, P.E., CFM
Clark County Public Works Department
500 South Grand Central Parkway
Las Vegas, Nevada 89155

Subject: **Technical Drainage Study for Faith Lutheran High School Addition**
Previous HTE #09-4903
Lochsa Job #101081

Dear Mr. Weber:

This letter is intended to serve the purpose of a "*Technical Drainage Study for Faith Lutheran High School Addition*". The formal technical drainage study (HTE #09-4903) was originally submitted to Clark County Development Services Department with initial review comments dated March 12, 2009. However, the project was put on hold indefinitely due to funding and budget related issues and as a result, the comments were never addressed and no formal approval was obtained. Consequently the application file on record with Clark County Public Works Department was closed. It is now the intent of the Faith Lutheran High School board of trustees to resume the school addition project, hence the subject submittal. No significant changes have been made to the plans for the proposed high school addition other than downsizing of the area for the proposed addition. In addition, all the future Phase 2 improvements as previously submitted are no longer shown on the proposed grading plans provided. These future improvements include the proposed Tennis Courts at the northeast corner of the site directly north of the existing Football Field, the proposed Concession Building at the southwest corner of the existing Football Field, the proposed driveway off of Indigo Drive and the Parking Stalls directly north of the proposed Soccer Field. These improvements will still be constructed in the future but will be addressed with separate plans at that time. The subject project will only address the proposed Soccer Field with the adjacent drive aisle and parking stalls located between the existing Football Field and the proposed Soccer Field.

The downsizing of the area for the proposed school addition does not warrant a revision to either the onsite or offsite hydrology and hydraulic analysis for the site as addressed in the previous submittal. Hence, no revised analysis is being provided as the former provided in the previous submittal already addressed the ultimate development of the site. Per our telephone conversation with Mr. Layne Weber, P.E. of the Clark County Public Works Department, the subject letter will address the comments from the previous submittal in continuation with the development application. However, the original technical drainage study and grading plans as previously submitted have been attached for your record and verification. The subject submittal is also accompanied by a new review fee, while a new application (HTE #) number will be obtained upon payment of the review fees to Clark County Public Works to reactivate this project.

The comments in the previous review memorandum have been restated below followed by our respective responses.

Comment 1: It appears that no Land Use Application has been obtained for this project. Please obtain Land Use and provide Notice of Final Action.

Response 1: A Land Use Application has been submitted to the zoning/planning department and is scheduled for hearing at the December 22, 2010 Board of County Commissioners meeting. Please note that the project is only a Soccer Field addition to an existing school. No zoning/planning conditions that will warrant any revisions to the site drainage parameters are anticipated.

Comment 2: Please provide a "public underground drainage easement to be privately maintained" for the 36" RCP and 66" RCP that traverses the site. Please note that the drainage easement width for the underground facility is based on adding 1-foot to each side of the proposed pipe, and then providing a 1:1 slope to daylight at the surface to define the required easement limits. Note the minimum width is 10-feet for smaller storm drains per Section 1604 of the CCRFCD Manual.

Response 2: Noted. The grading plans have been revised to call out a 44' wide and a 30' wide "Public Underground Drainage Easements to be Privately Maintained" over the existing 66" RCP and 36" RCP respectively traversing west to east across the site. Please refer to the revised grading plans provided in the appendix.

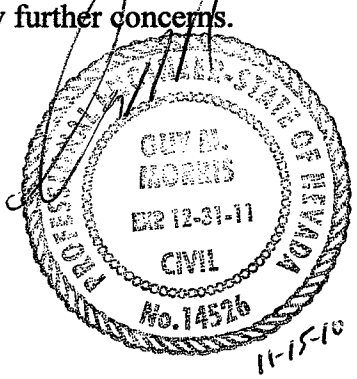
Comment 3: Please provide a "drainage easement to be privately maintained" for the 24" RCP that enters the subject site from the north. Please note that the minimum width of an underground drainage easement to be privately maintained is 5-feet, per section 1604 of the CCRFCD Manual.

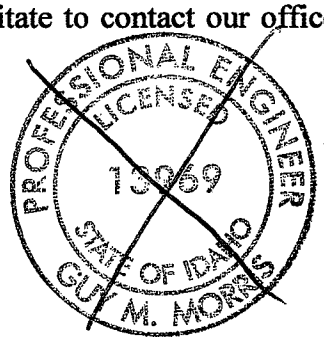
Response 3: The grading plans have also been revised to call out a 20' wide Private Underground Drainage Easement" over the existing 24" RCP traversing north to south along the eastern boundary of the site. Please refer to the revised grading plans provided with this submittal.

We believe that the above responses coupled with the revised plans have adequately addressed your concerns from the previous memorandum. Please do not hesitate to contact our office at your earliest convenience, if you have any further concerns.

Sincerely,
LOCHSA ENGINEERING

Stanley Okey Amadi
Civil Designer





HYDROLOGIC CRITERIA AND DRAINAGE MANUAL

DRAINAGE STUDY INFORMATION FORM

Name of Development: Faith Lutheran High School Addition Date: November 10, 2010

Location of Development: a) Descriptive (Cross Streets) North/South: Hualapai Way

East/West: Homestretch Drive

b) Section: 01 Township: 21 South Range: 59 East

c) APN : 164-01-501-001 and a portion of 164-01-601-001

Name of Owner: Faith Lutheran High School Board

Telephone No.: (702) 804-4402 Fax No.: (702) 804-4493 E-Mail Address:

Address: 2015 South Hualapai Way, Las Vegas, Nevada 89117

Contact Person-Name: Stanley Okey Amadi **Telephone No.:** (702) 365-9312

* **E-Mail Address:** stanley@lochsa.com **Fax No.:** (702) 365-9317

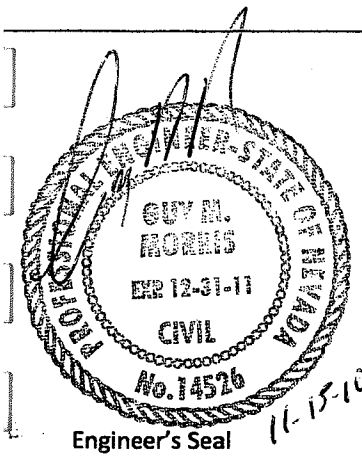
Firm: Lochsa Engineering

Address: 6345 South Jones Boulevard, Suite 100, Las Vegas, Nevada 89118

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		

1. Total Owned Land Area: At Site: 38.56 +/- Acres Being Developed/Disturbed: 8.11 +/- 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.): Public High School (Soccer Field Addition)
5. Approximate upstream land area which drains to the subject site: 70 +/- Acres
6. Has the site drainage been evaluated in the past? ☒ **YES** ☐ **NO** If yes, please identify documentation: Technical Drainage Study for Faith Lutheran Junior/Senior High School (HTE #97-7046)
7. If known, please briefly identify the proposed discharge point(s) of runoff from the site: To the east towards Hualapai Way
8. Briefly describe your proposed schedule for the subject project: ASAP



Engineer's Seal 11-15-10

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.**

Revision	Date

Local Entity File No.

REFERENCE:

STANDARD FORM 1

Updated 05/01/2008

Department of Development Services

500 S Grand Central Pky 1st Fl • Box 551799 • Las Vegas NV 89155-1799

(702) 455-4600 • Fax (702) 388-2550

Ronald L. Lynn, Director/Building Official

Dean Friedli
Assistant Director
Administrative Division

Greg Franklin
Assistant Director
Building Division

Robert Thompson
Assistant Director
Civil Engineering Division

Drainage Study Comment Letter

Date: March 12, 2009
Firm: Lochsa Engineering
Engineer: Ted T. Egerton, P.E.
Address: 6345 South Jones Boulevard, Suite 100, Las Vegas, NV 89118
Phone: (702) 365-9312
Fax: (702) 365-9317
E-mail:

Subject: Technical Drainage Study for Faith Lutheran High School Addition
Location: NWC of Hualapai Way and Homestretch Drive
APN: 164-01-501-001 & 164-01-601-001
Sec, Township, Range: S01, T21S, R59E
Flood Zone & Panel: Zone X, 2150, effective September 27, 2002
Application Tracking #: 09-4903

Submittals	Date Received	Date Returned	Clark Co. Reviewer	WILLDAN Reviewer	Misc.
Technical	3/5/2009	3/12/2009	KL		

Concurrence Required: (Must be obtained prior to permit issuance)		Reason Concurrence is required
	City of Henderson	Adjacent to or Impacts Henderson
X	City of Las Vegas	Adjacent to or Impacts Las Vegas
	City of North Las Vegas	Adjacent to or Impacts North Las Vegas
	Nevada Department of Transportation	Adjacent to or Impacts NDOT Facility
	Union Pacific Rail Road	Adjacent to or Impacts a UPRR Facility
	US Army Corp of Engineers	Impacts a USACOE Facility
	Clark County Regional Flood Control District	Adjacent to or Impacts CCRFCD MPU Facility or in a SFHA

The following comments must be fully addressed and response provided with the next submittal. Incomplete responses may result in further review and time delays to the drainage study approval. Any revisions/modifications to the original site design must have supporting hydrologic and/or hydraulic calculations. Clark County Development Services will not be held responsible for project delays due to incomplete responses.

Review Comments

1. It appears that no Land Use Application has been obtained for this project. Please obtain Land Use and provide Notice of Final Action.

2. Please provide a "public underground drainage easement to be privately maintained" for the 36" RCP and 66" RCP that traverses the site. Please note that the drainage easement width for the underground facility is based on adding 1-foot to each side of the proposed pipe, and then providing a 1:1 slope to daylight at the surface to define the required drainage easement limits. Note the minimum width is 10-feet for smaller storm drains, per Section 1604 of the *CCRFCD Manual.*

3. Please provide a "drainage easement to be privately maintained" for the 24" RCP that enters the subject site from the north. Please note that the minimum width of an underground drainage easement to be privately maintained is 5-feet, per Section 1604 of the *CCRFCD Manual.*

The drainage/grading plans have been redlined and require modifications prior to the next submittal.

The County's review is solely based on the information submitted by the Engineer of Record. The County's review is strictly limited to compliance with minimum County Codes and Standards. The Engineer of Record is responsible for researching and addressing situations that may require designs above and beyond the minimum codes for issues of public safety and impacts to upstream, downstream and adjacent properties. The County assumes no liability for information data, designs or conclusions of the Engineer of Record.

By 

Glenn S. Hale, P.E.
Senior Engineer
Department of Development Services
Civil Engineering Division

cc: Faith Lutheran High School Board

Technical Drainage Study
for
Faith Lutheran High School Addition

JOB# 081161

February 2008

Prepared for:

Faith Lutheran High School
2015 South Hualapai Way
Las Vegas, Nevada 89117
(702) 804-4402

Prepared By:
LOCHSA ENGINEERING
6345 South Jones Boulevard
Suite 100
Las Vegas, Nevada 89118
(702) 365-9312

HYDROLOGIC CRITERIA AND DRAINAGE MANUAL

DRAINAGE STUDY INFORMATION FORM

Name of Development: Faith Lutheran High School Addition Date: February 27, 2009

Location of Development: a) Descriptive (Cross Streets) North/South: Hualapai Way

East/West: Homestretch Drive

b) Section: 01 Township: 21 South Range: 59 East

c) APN : 164-01-501-001 & a portion of 164-01-601-001

Name of Owner: Faith Lutheran High School Board

Telephone No.: (702) 804-4402 Fax No.: (702) 804-4493 E-Mail Address:

Address: 2015 South Hualapai Way, Las Vegas, Nevada 89117

Contact Person-Name: Stanley Okey Amadi **Telephone No.:** (702) 365-9312

*** E-Mail Address:** stanley@lochsa.com **Fax No.:** (702) 365-9317

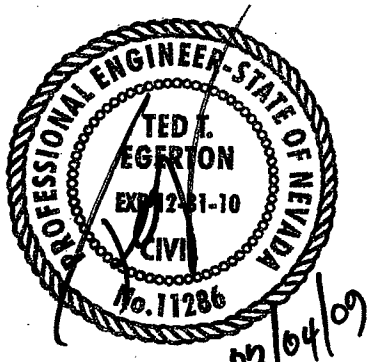
Firm: Lochsa Engineering

Address: 6345 South Jones Boulevard, Suite 100, Las Vegas, Nevada 89118

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		

1. Total Owned Land Area: At Site: 38.56 +/- Acres Being Developed/Disturbed: 8.11 +/- 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.): School Improvements
5. Approximate upstream land area which drains to the subject site: +/- 70 Acres
6. Has the site drainage been evaluated in the past? ☒ YES ☐ NO If yes, please identify documentation: Technical Drainage Study for Faith Lutheran Junior/Senior High School (HTE #97-7046)
7. If known, please briefly identify the proposed discharge point(s) of runoff from the site: To the east towards Hualapai Way
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.**

Revision	Date

Local Entity File No.

REFERENCE:

STANDARD FORM 1

Updated 05/01/2008

Technical Drainage Study
for
Faith Lutheran School Addition

TABLE OF CONTENTS

APPENDICES

1. GENERAL LOCATION AND DEVELOPMENT DESCRIPTION

1.1 Purpose

Lochsa Engineering has been retained by Faith Lutheran High School to provide a technical drainage study in support of the proposed school addition. The existing Faith Lutheran High School occupies the parcel located directly north of Home Stretch Drive between Hualapai Way and Sandstone Bluff Street. However, the area for the proposed addition is vacant parcel located directly north of the existing school.

This study is submitted to provide a detailed analysis of the existing hydrology of the site and the offsite watersheds impacting the site, and to substantiate the hydraulic design for the proposed school addition. The study will also investigate the hydraulics of the flows conveyed across the school site to ensure that the existing and proposed improvements will be adequately protected from the minor and major design storms. The Clark County Regional Flood Control District (CCRFCD) Hydrologic Criteria and Drainage Design Manual and CCRFCD 2008 Las Vegas Valley Flood Control Master Plan Update have been compiled and utilized. This report presents a summary of the existing condition hydrologic and hydraulic analyses, methodology, and results of the study.

1.2 Location of Property

The project site is located within the southwest quadrant of the intersection of Charleston Boulevard and Indigo Drive, approximately 280-feet south of Charleston Boulevard. The site for the school addition comprises of the vacant parcel located directly north of the existing base ball and foot ball fields. The existing Las Ventanas Retirement Center is located directly west of the site across Indigo Drive, while the adjacent parcel to the north of the site is the existing Charleston Auto Care Plaza. There is an existing mini storage located directly east of the site within the City of Las Vegas cooperate jurisdiction.

The subject site is located within a portion of Section 01 Township 21 South, Range 59 East of the M.D.M., in an unincorporated portion of Clark County, Nevada. The proposed addition will

be constructed over the parcel identified by Assessor's Parcel Number (APN) 164-01-501-001. Please refer to copies of the Assessors Parcel Map provided in the appendix. Figure 1 in the appendix shows the vicinity map of the site in relation to the surrounding streets.

1.3 Description of Property

The Faith Lutheran High School property spans over 30 acres, while the project parcel for the proposed expansion consists of approximately 5.0 acres of vacant desert land. However, the proposed improvements will extend south to encroach into portions of the existing school site for approximately 4.0 acres. Offsite flows generally impact the site from the west through a storm drain system that is connected to the outfall facility for the Summerlin Village 13 Detention Basin. The site generally slopes to the east towards Hualapai Way with slopes ranging roughly between 2.0% and 2.50%. The determination of the runoff generated through the project site in existing and developed conditions utilizes the Soil Conservation Service (SCS) curve number (CN) method recommended in the CCRFCD Drainage Design Manual (Reference 1). The SCS method divides the soils into four hydrological groups as A, B, C and D. Review of the 2008 Flood Control Master Plan Update's Figure H-30, (Reference 2), and both the 1995 SCS Soil Survey of Las Vegas Area, Nevada and Natural Resources Conservation Service (NRCS), "*2007 Web Soil Survey 2.0*" (Reference 3), indicates that the entire site generally falls within the hydrologic soil group D. Soil group D is defined as soils with "Low infiltration rate, and high runoff potential/rock outcrops" However, for the determination of the SCS curve numbers of the site and offsite basins, the SCS soil type map for the Las Vegas Valley is used. The curve numbers associated with the different land cover types also utilized Table 602 of the CCRFCD Drainage Design Manual.

2. DRAINAGE DESCRIPTION

In the 2008 Las Vegas Valley Flood Control Master Plan Update, the valley was hydrologically divided into ten watersheds and each watershed was further subdivided into subareas. The subject Faith Lutheran School site and its tributary areas fall within the Gowan Wash watershed. The site and its immediate offsite tributary areas are located within basin 13B-2 as analyzed in the 2008 CCRFCD Master Plan Update.

2.1 Existing Drainage Conditions

A. Offsite and Onsite Drainage

The majority of the offsite flows impacting the site are mostly generated by the areas directly west of the site, and are concentrated through the outfall facilities of the Summerlin Village 13 Park Detention Basin. There has been several drainage studies in the vicinity of the project site, prepared by G. C. Wallace Inc., that addressed the outflows from the subject detention basin. These studies include the "*Technical Drainage Study for Summerlin Village 13 Faith Lutheran Site Half-Street Improvements*" (1997), which initially constructed the detention basin. The study estimated the inflow and outflow discharges to and from the basin at the time to be approximately 472 cfs and 242 cfs respectively, with 90 cfs discharging through a 48" RCP spillway into the existing Faith Lutheran High School site. The "*Conceptual Drainage Study for Summerlin Village 13 East*" (1998) estimated an ultimate inflow to the detention basin to be approximately 548 cfs, with 99 cfs conveyed through the 48" RCP spillway. Since the ultimate inflow is slightly higher than designed for in the original study, recommendations for modification of the basin to increase capacity were made by the conceptual study. Furthermore, in 1999 the "*Technical Drainage Study for Summerlin Village 13 East Phase-I Improvements*" further refined the recommended modifications to the detention basin. The peak inflow and outflow from the detention basin was determined to be 555 cfs and 224 cfs respectively during the 100-year storm event. This study also determined that the 100-year peak stage elevation in the basin is at 45.70' which is approximately 0.40' below the spillway elevation at 46.10'. Therefore, no flows were estimated to impact the Faith Lutheran High

School site through the 48" RCP spillway.

The most recent study in the vicinity of the site that addressed the detention basin improvements is the "*Technical Drainage Study for Summerlin Village 13 East Detention basin*" (HTE #00-26582; Reference 5), also by G. C. Wallace, Inc. This study was prepared as an amendment to the aforementioned "*Technical Drainage Study for Summerlin Village 13 East Phase-I Improvements*", and addressed the refined finished grading of the detention basin to incorporate park facilities as originally intended. The hydrologic analysis presented in Reference 5 indicates that the peak 100-year outflow from the detention basin is approximately 231 cfs with a peak stage elevation of 46.05'. This indicates that the peak stage elevation is still slightly below the spillway elevation. Thus, the spillway will not convey any surface flows towards the Faith Lutheran High School site. The outfall facility for the detention basin is a 5'x4' RCB which is connected to a 66" RCP that traverses the Faith Lutheran High School site to discharge through a headwall onto the culvert crossing underneath Hualapai Way.

Additional offsite flows impact the school site from the existing Las Ventanas Retirement Home adjacent to the site across Indigo Drive. These flows were analyzed in the "*Technical Drainage Study for Las Ventanas at Summerlin*" (HTE #01-31361; Reference 6) by Pentacore/Stantec Consulting, Inc. A review of Reference 6 indicates that a 100-year flow of approximately 34 cfs impacts the Faith Lutheran High School site through an existing 36" RCP. This runoff is estimated at concentration point CN-C (17/34 cfs) of the Developed Condition HEC-1 model presented in Reference 6. Furthermore, the surface flows conveyed along Indigo Drive adjacent to the site were also estimated by the "*Technical Drainage Study for Summerlin Village 13 Town Center Drive Improvements*", (HTE #00-21026; Reference 7). Reference 7 indicates that the flows {basin CH2 (6/10 cfs)} conveyed within the southern half of Charleston Boulevard between Indigo Drive and Town Center Drive turns south into Indigo Drive. There is an existing low point in Indigo Drive near the 36" RCP crossing, thus, the flows generated by the portion of Indigo Drive south of the low point are analyzed as basin A32 (3/5 cfs), while those generated by the portion of

the street north of the low point were analyzed as basin A33 (2/5 cfs). These surface flows are captured by existing drop inlets at the low point and also routed in the 36" RCP to combine with other flows from the Las Ventanas Retirement Home. The combined flows algebraically sum up to be approximately 54 cfs during the 100-year storm, and discharges into the 66" RCP that traverses the Faith Lutheran High School site. 231+54 = 285 Offsite Q100 in 66" RCP

Additional offsite flows impact the site through the existing 24" RCP along the eastern boundary of the site from the Charleston Auto Care Plaza located directly north of the site. These storm drain flows have also been addressed by the "*Technical Drainage Study for Charleston Auto Care Plaza at Summerlin Village 13 East Phase I*" (HTE #00-10616; Reference 8). Review of Reference 8 indicates that the combined flows that impact the site were estimated to be approximately 9 cfs and 17 cfs during the 10-year and 100-year 6-hour storms respectively. Please refer to concentration point C1(9/17 cfs) of the HEC-1 analysis from Reference 8. Runoff conveyed within the 24" RCP discharges through the same headwall as the 66" RCP onto the culvert crossing underneath Hualapai Way.

Generally, the offsite flows impacting the Faith Lutheran High School site are conveyed below ground within existing storm drains that have been adequately sized. The WSPG hydraulic analysis for the 66" RCP was already addressed in the original "*Technical Drainage Study for Faith Lutheran Junior/Senior High School*" (HTE #97-7046; Reference 9). A review of the WSPG model indicates that the storm drain has adequate capacity to convey the design 100-year peak flows impacting the site from the outfall facility of the Summerlin Village 13 Park Detention Basin, and those from the existing 36" storm drain across Indigo Drive. The pertinent hydraulic and hydrologic models and Drainage Basin Maps from all the referenced studies have been provided in the appendix.

The existing Faith Lutheran High School site has been fully developed except the northern parcel for the proposed addition. The original "*Technical Drainage Study for Faith Lutheran Junior/Senior High School*" (HTE #97-7046; Reference 9) at the time, analyzed the subject northern

parcel as basin OFF-1 (9/22 cfs) and is conveyed east and eventually south to the culvert crossing in Hualapai Way. The same drainage pattern as analyzed in Reference 9 still exists over the northern parcel for the proposed addition. As previously stated, the proposed addition will encroach onto the already developed portions of the school. These areas of encroachment were also analyzed in Reference 9 as portions of basins ON-3 (5/12 cfs) and ON-4 (2/6 cfs). Runoff from basins ON-3 and ON-4 were stored and routed to the 66" RCP that traverses the site through area drains. Since both the parcel for the subject addition and the areas of encroachment have already been analyzed in the original study, and the drainage patterns within this areas have not changed, their existing condition hydrologic analysis will not be revisited in this report. Copies of the pertinent excerpts including the Drainage Basin Maps and the HEC-1 output files from the original study have been provided in the appendix.

2.2 Interim Drainage Condition

A. Offsite and Onsite Drainage

For the interim condition, the offsite watersheds contributing flows to the site will generally remain same as analyzed and adopted from the referenced studies described for the existing condition. Thus, no change or increase in offsite flows is anticipated to impact the site, and hence, no revised offsite analyses have been provided.

However, the area for the proposed addition including the encroachment onto the existing school site has been analyzed as three drainage basins labeled ND1 through ND3. Basin ND1 (6/15 cfs) consists of the northwestern majority of the site over which the proposed soccer complex will be constructed. Runoff from ND1 is designed to be captured by a the existing 66" RCP storm drain system through a grated manhole cover and existing 2'x2' Jensen Inlet. Basin ND2 (4/7 cfs) is the northeastern portion of the site for construction of the proposed tennis and basket ball courts. Runoff from ND2 will travel as surface flows to discharge near the outlet of the existing 66" RCP that traverses the site. Basin ND3 (2/3 cfs) is the remainder southern portion of the site that generally consists of paved parking and drive aisle. Runoff from ND3 will be captured by two existing inlets

(a Type 'A' DI and a 12"x12" Jensen Inlet) and one proposed 24"x24" Jensen Precast Inlet), and routed in the existing 18" storm drain to the 66" RCP. Please refer to the Proposed Condition Drainage Basin Map (Sheet DR2) provided in the appendix.

2.3 Future Drainage Condition

A. Onsite and Offsite Drainage

For the future, the upstream offsite watersheds as described in the existing condition are already fully developed. Therefore, no change in drainage pattern or increase in tributary runoff will be anticipated. Hence, a future condition hydrologic analysis will not be necessary and has not been provided. Similarly, no further improvements are expected within the site for the subject school addition. Thus, no increase in the flows generated onsite and/or change in drainage pattern are anticipated.

2.4 Master Planning Information

The "*2008 Las Vegas Valley Flood Control Master Plan Update*", dated September 2008, as prepared by Post Buckley Schuh and Jernigan, Inc. (PBS&J), in association with Louis Berger Group and Parsons Brinckerhoff, for the Clark County Regional Flood Control District (CCRFCD) (Reference 2) illustrates the existing/proposed regional master planned facilities around the site as shown on Figure F-30.

Review of the Master Plan Update (Reference 2), indicates that there are no existing or proposed Clark County Regional Flood Control District Master Plan facilities adjacent to, or crossing through the site.

2.5 Flood Plain Information

The project site is covered by Flood Insurance Rate Map (FIRM) for the Clark County, Nevada, and incorporated areas, Community Panel Numbers: 32003C 2150 E, Effective Date: September 27, 2002 (Reference 4).

Review of panel 3200C 2150 E indicates that the entire site for the Faith Lutheran High School is located within FEMA Flood Zone "X" (unshaded). Zone "X" (unshaded) is described by

the Federal Emergency Management Agency (FEMA) as:

"*Areas determined to be outside the 0.2% annual chance floodplain*".

Figure 2 in Appendix C illustrates the location of the site on a portion of the above referenced Flood Insurance Rate Map.

2.6 Previous Drainage Studies

As previously stated, the overall area is covered within the CCRFCD "*2008 Las Vegas Valley Flood Control Master Plan Update Volume I and II*" (Reference 2). Other previously approved drainage studies in the vicinity of the site includes the "*Technical Drainage Study for Summerlin Village 13 Faith Lutheran Site Half-Street Improvements*" (1997) and the "*Conceptual Drainage Study for Summerlin Village 13 East*" (1998). Other recent studies with relevance to the site include the "*Technical Drainage Study for Summerlin Village 13 East Detention basin*" (HTE #00-26582; Reference 5) which addressed the ultimate design and finished grade improvements for the Summerlin Village 13 Park Detention Basin. The analysis in the "*Technical Drainage Study for Las Ventanas at Summerlin*" (HTE #01-31361; Reference 6) addressed a portion of the offsite flows that impacts the site through the existing 36" RCP underneath Indigo Drive. The "*Technical Drainage Study for Summerlin Village 13 Town Center Drive Improvements*", (HTE #00-21026; Reference 7) estimated the offsite surface flows in Indigo Drive adjacent to the site, while the "*Technical Drainage Study for Charleston Auto Care Plaza at Summerlin Village 13 East Phase I*" (HTE #00-10616; Reference 8) analyzed the offsite flows impacting the site through the existing 24" RCP that traverses the site from the north. Furthermore, the original "*Technical Drainage Study for Faith Lutheran Junior/Senior High School*" (HTE #97-7046; Reference 9) provided the initial analysis of the site, while the street capacity calculations for Indigo Drive adjacent to the site are adopted from the "*Technical Drainage Study for Summerlin Village 13 East Phase-I Improvements*" (HTE #99-13810; Reference 10). Lochsa Engineering has reviewed and generally concurs with the referenced hydrologic and hydraulic analyses and results presented in the above mentioned studies.

3. PROPOSED DRAINAGE FACILITIES

3.1 General Description

This report is being submitted to address the proposed expansion improvements for the existing Faith Lutheran High School. The proposed improvements will generally consist of driveway access from Indigo Drive with parking lots and drive aisle. The improvements will also include the construction of a Soccer Complex and multiple Tennis and Basket Ball Courts. A portion of the site will also be rough graded for future improvements. Majority of the flows generated by the area of proposed addition will be captured by inlets and conveyed to the existing 66" RCP storm drain that traverses the site. Runoff from basin ND1 (6/15 cfs) is designed to be captured by a combination of the proposed grated manhole cover and the existing 24"x24" Jensen Precast Inlet. Inlet capacity calculations provided for both inlets indicate that the entire runoff from basin ND1 will be captured at a ponding depth of less than 1.50-feet.

A review of the hydraulic analysis presented in Reference 9 indicates that the onsite flows conveyed to the 66" storm drain were designed to be controlled by the drop inlets. Reference 9 expected to capture approximately 30 cfs from the onsite detention basin due to the overflows that was supposed to impact the site from the spillway of the Summerlin Village 13 Detention Basin. However, Reference 5 indicates that the overflows have been completely eliminated. Thus, the flows impacting the 66" storm drain from the onsite detention area will only consist of the runoff generated by onsite basin ON-1 (6/14 cfs) as analyzed in Reference 9. Furthermore, basin ND1 (6/15 cfs) as analyzed in the subject study includes portions of the existing Faith Lutheran High School analyzed in the original "*Technical Drainage Study for Faith Lutheran Junior/Senior High School*" (HTE #97-7046; Reference 9). However, the additional area from the subject expansion within basin ND1 is only 2.73 acres, and by ratio will contribute approximately 7.50 cfs, during a 100-year storm event. Therefore, it can be concluded that although, the area of the subject high school addition was not originally designed to be captured by the existing 66" storm drain system, it does not contribute any net increase in flow rate to the system. Thus, the storm drain system will still operate with adequate

capacity as originally designed. An exhibit (Sheet DR1) showing the onsite drainage basins analyzed in Reference 9 with an overlay of the proposed basins per the subject study for the high school addition is provided in the appendix to verify the additional area (≈2.73 acres) from basin ND1 contributing flows to the existing storm drain system.

There is a proposed driveway entrance to the site of off Indigo Drive. The street capacity calculation for Indigo Drive has been adopted from the "*Technical Drainage Study for Summerlin Village 13 East Phase-I Improvements*" (HTE #99-13810; Reference 10). A review of the analysis in Reference 10 indicates a 100-year surface flow of approximately 15 cfs in Indigo Drive, conveyed at a flow depth of 0.45-feet with a velocity of 2.93 fps. The proposed driveway is designed with a hump of more than 6" above the 100-year flow depth in Indigo Drive adjacent to the site.

3.2 Compliance with Regulations and Adopted Plans

The hydrologic and hydraulic analyses presented in this report is in compliance with all local requirements, including the Clark County Regional Flood Control District (CCRFCD) "*Hydrologic Criteria and Drainage Design Manual*" (HCDDM) (Reference 1), and the CCRFCD "*Flood Control Master Plan Update*" (Reference 2). The analysis is also in compliance with the Federal Emergency Management Agency (FEMA)(Reference 3).

3.3 Hydrologic Criteria

The onsite and offsite basins of this study area fall within the Gowan Wash Watershed. The hydrologic and hydraulic analyses of the project site is performed in accordance with the CCRFCD Hydrologic Criteria and Drainage Design Manual (HCDDM) (Reference 1). The rainfall values used for the hydrologic analysis of the site represent the 10-year and 100-year storm recurrence events, each with a six-hour duration. The site is outside the boundary for using the McCarran Airport Rainfall Data, therefore precipitation data was determined using Figures 503 and 506 of the HCDDM (Reference 1). The rainfall values obtained from Figure 503 and 506 are multiplied by the precipitation adjustment factors to obtain the adjusted point rainfall values. The adjusted point rainfall values for the 6-hour, 10- and 100-year storm events are determined to be approximately 1.74

and 3.15 inches, respectively. The rainfall losses due to infiltration, interception, etc. are represented using the SCS curve number (CN) method recommended in the CCRFCD's Manual (Reference 1). The SCS method divides the soils into four hydrologic groups as A, B, C and D. A review of the Natural Resources Conservation Service (NRCS) Web Soil Survey 2.0 and the 1995 SCS Soil Survey of Las Vegas Area (Reference 3), indicates that the site is located within hydrologic soil group D. Soil group D is defined as soils with "Slow infiltration rate, and High runoff potential". The Curve Numbers (CN) for the existing and developed conditions as analyzed have been determined from Table 602 of the CCRFCD HCDDM. The runoff hydrograph is determined from the design precipitation for each sub-basin using the Soil Conservation Service (SCS) unit hydrograph method.

Calculations used in the hydrologic analysis for the site and its tributary watersheds for existing and developed conditions are attached in Appendix A.

3.4 Facility Design Calculations

All drainage facilities within this project have been designed in accordance with the CCRFCD "*Hydrologic Criteria and Drainage Design Manual*" (Reference 1). The proposed drainage plan has been developed to closely resemble the existing/historic drainage patterns, and to produce minimal impact on the adjacent properties. No adverse impact will be caused on other adjacent offsite properties. The proposed addition will including buildings to be constructed with Phase 2, hence an interim grading plan set have been attached for the proposed construction prior to that phase. The finished floor elevations of the proposed buildings have been set at a minimum of 18-inches above the street centerline or the adjacent highest curb elevation in Hualapai Way adjacent to the site as required by the CCRFCD HCDDM. The finished floor elevations are also set or flood protected above the following criteria:

- Twice the depth of flow (100-year, 6-hour runoff) in the adjacent gutter flow line up to a maximum of 18-inches above the water surface elevation.
- A minimum of 6" above the highest adjacent top-of-curb elevation in the street.

4. CONCLUSIONS AND RECOMMENDATIONS

1. This project is in compliance with the applicable drainage laws as recognized by the State of Nevada.
2. This project is in compliance with the CCRFCD "*Master Plan Update*", and will not conflict with any Master Planned Facilities.
3. This project is in compliance with the CCRFCD "*Hydrologic Criteria and Drainage Design Manual*" (Reference 1).
4. The site is generally located within Federal Emergency Management Agency (FEMA) Flood Zone "X" (shaded).
5. The drainage facilities for this project have been designed to control and convey the onsite and offsite runoff from the 100-year storm safely through the site. In addition, they have been designed based on generally accepted engineering practices. The finished floor elevations for the proposed buildings have been designed to be adequately protected from runoff due to the 100-year, 6-hour storm event.

5. REFERENCES

1. Clark County Regional Flood Control District, "*Hydrologic Criteria and Drainage Design Manual,*" August 1999.
2. Post Buckley, Schuh & Jernigan (PBS&J), Inc., in association with, Louis Berger Group and Parsons Brinckerhoff, "*2008 Las Vegas Valley Flood Control Master Plan Update, Volume 1 and II*", September 2008.
3. Natural Resources Conservation Service (NRCS), "*1985 Soil Survey of the Las Vegas Valley* ", Issued July 1985.
4. Federal Emergency Management Agency, "*Flood Insurance Rate Map; Community Panel Number: 3200C 2150 E, Clark County, Nevada and Incorporated Areas,*" Effective Date: September 27, 2002.
5. G. C. Wallace, Inc., "*Technical Drainage Study for Summerlin Village 13 East Detention basin*", Approved on September 15, 2000.
6. Stantec Consulting, Inc., "*Technical Drainage Study for Las Ventanas at Summerlin*", Approved on August 29, 2002.
7. G. C. Wallace, Inc., "*Technical Drainage Study for Summerlin Village 13 Town Center Drive Improvements*", Approved on August 17, 2000.
8. G. C. Wallace, Inc., "*Technical Drainage Study for Charleston Auto Care Plaza at Summerlin Village 13 East Phase I*", Approved on May 19, 2000.
9. Lochsa Engineering, Inc., "*Technical Drainage Study for Faith Lutheran Junior/Senior High School*", Approved on May 09, 1997.
10. G. C. Wallace, Inc., "*Technical Drainage Study for Summerlin Village 13 East Phase-I Improvements*", Approved on July 28, 1999.

Peak Flow Summary
Proposed Condition

HEC-1 I.D.	Area (acres)	10-year Flow (cfs)	100-year Flow (cfs)
ND1	5.45	6	15
ND2	1.91	4	7
ND3	0.75	2	3

APPENDIX A

HYDROLOGIC ANALYSIS

NOTES

This map is for assessment use only and does NOT represent a survey.

No liability is assumed for the accuracy of the data delineated herein. Information on roads and other non-assessed parcels may be obtained from the Road Document Listing in the Assessor's Office.

This map is compiled from official records, including surveys and deeds, but only contains the information required for assessment. See the recorded documents for more detailed legal information.

USE THIS SCALE(FEET) WHEN MAP REDUCED FROM 11X17 ORIGINAL

0 50 100 200 400 600 800

MAP LEGEND

	PARCEL BOUNDARY	001 1.00	PARCEL NUMBER ACREAGE
	SUBD BOUNDARY	202	PARCEL SUB/SEQ NUMBER
	ROAD EASEMENT	PB 25-45	PLAT RECORDING NUMBER
	PM/LD BOUNDARY	5	BLOCK NUMBER
	NON-PARCEL LOT LINE	5	LOT NUMBER
	MATCH LINE / LEADER LINE	GL5	GOV. LOT NUMBER
001	ROAD ID NUMBER		

AVERAGE QA VALUE 22

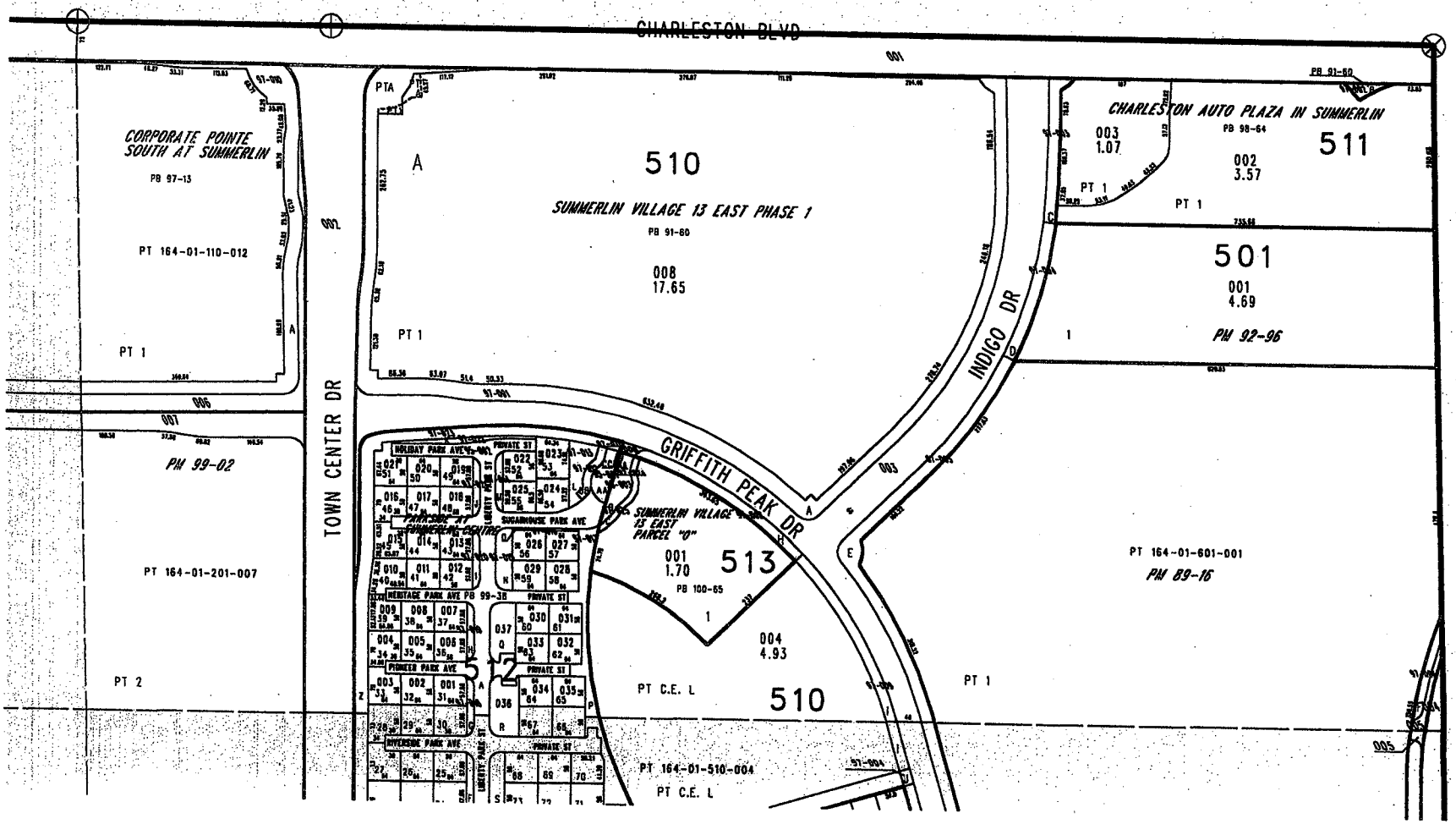
ASSESSOR'S PARCELS - CLARK CO., NV.
M. W. Schofield, Assessor

BOOK T21S R59E | SEC 01 | MAP N 2 NE 4 | 164-01-5

	R58E	R59E	R60E
T20S	136	137	138
T21S	165	164	163
T22S	174	175	176

6	5	4	3	2	1	
7	8	9	10	11	12	
18	17	16	15	14	13	
19	20	21	22	23	24	
30	29	28	27	26	25	
31	32	33	34	35	36	

Scale:1"=200' Rev:04/23/08



TAX DIST 420

NOTES

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USE THIS SCALE(FEET) WHEN MAP REDUCED FROM 11X17 ORIGINAL

0 50 100 200 400 600 800

MAP LEGEND

AVERAGE DA VALUE 22

ASSESSOR'S PARCELS - CLARK CO., NV.

M. W. Schofield, Assessor

PARCEL BOUNDARY		001	PARCEL NUMBER
SUBD BOUNDARY		1.00	ACREAGE
ROAD EASEMENT		202	PARCEL SUB/SEQ NUMBER
PM/LD BOUNDARY		PB 25-45	PLAT RECORDING NUMBER
NON-PARCEL LOT LINE		5	BLOCK NUMBER
MATCH LINE / LEADER LINE		5	LOT NUMBER
001 ROAD ID NUMBER		GL5	GOV. LOT NUMBER

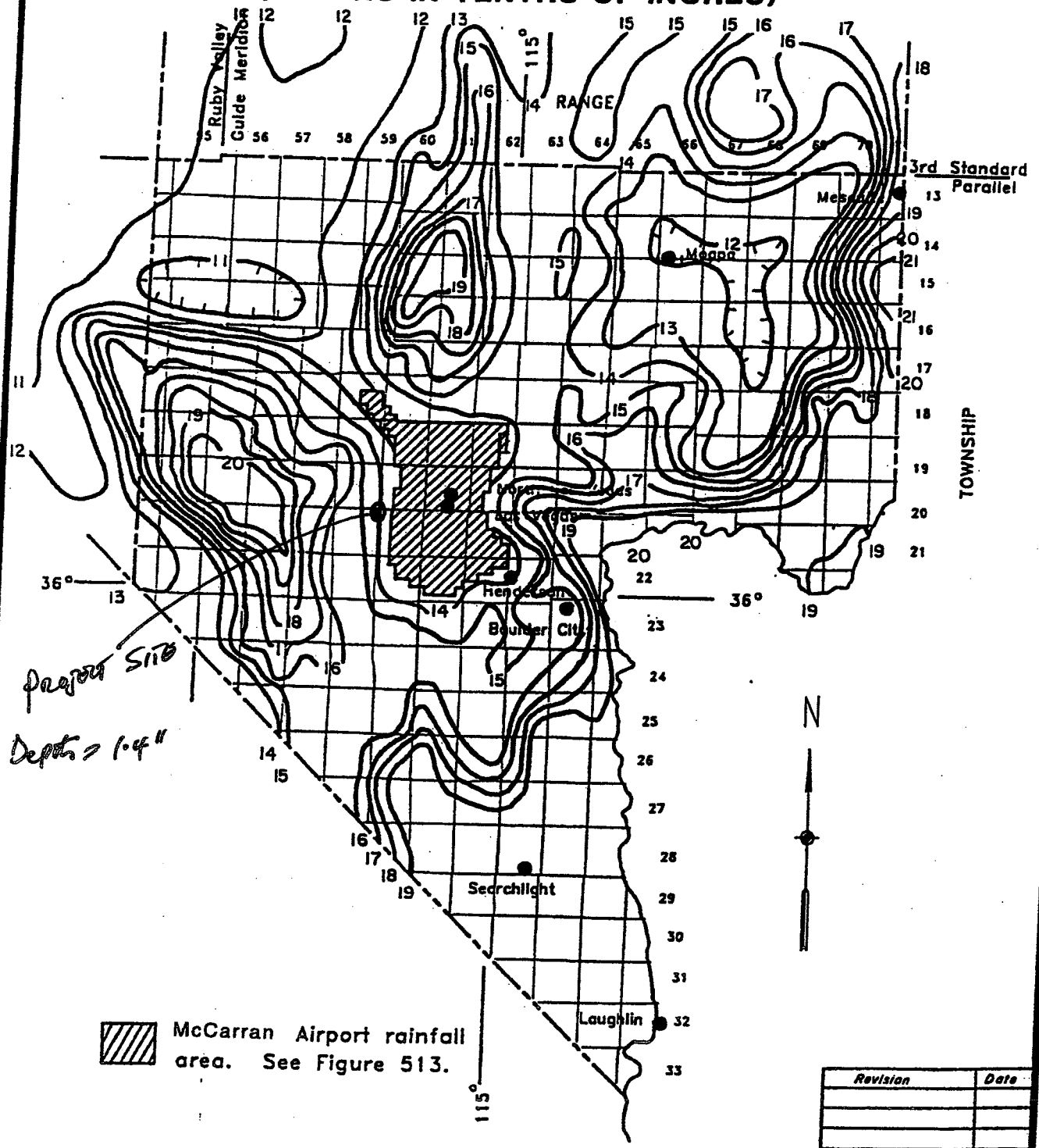
T21S R59E | SEC 01 | MAP S 2 NE 4 | 164-01-6

	R58E	R59E	R60E
T20S	136	137	138
T21S	165	164	163
T22S	174	175	176

Scale:1"=200' | Rev:05/13/03

TAX DIST 420

RAINFALL DEPTH-DURATION-FREQUENCY
10-YEAR, 6-HOUR
(DEPTHS IN TENTHS OF INCHES)



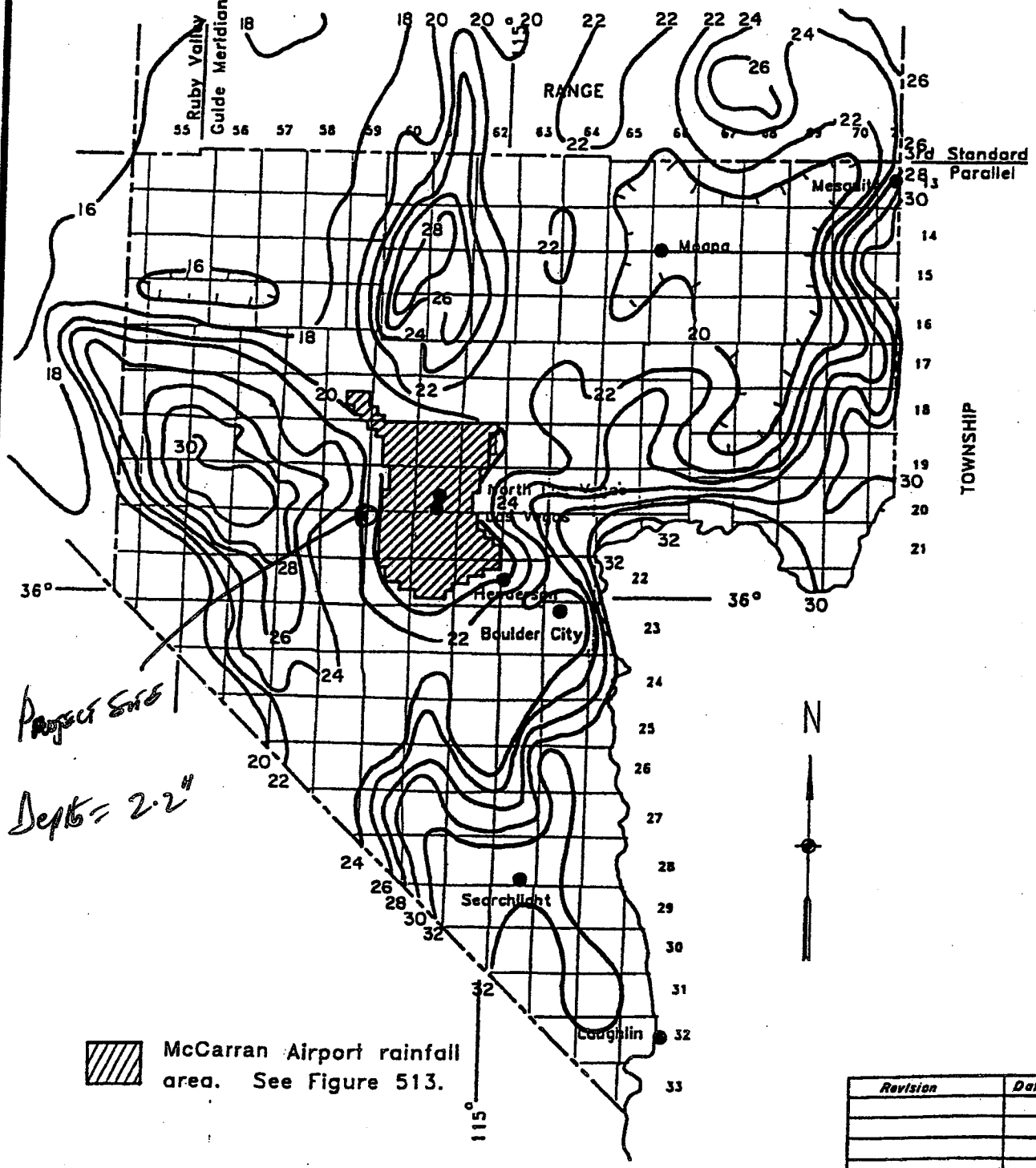
Revision	Date

WRC ENGINEERING

REFERENCE:
NOAA ATLAS 2, VOLUME VII NEVADA, 1973

FIGURE 503

RAINFALL DEPTH-DURATION-FREQUENCY
100-YEAR, 6-HOUR
(DEPTHS IN TENTHS OF INCHES)



Revision	Date

WRC ENGINEERING

REFERENCE:
NOAA ATLAS 2, VOLUME VII NEVADA, 1973

FIGURE 506

PRECIPITATION ADJUSTMENT RATIOS

Recurrence Interval	Ratio to NOAA Atlas 2
2-year	1.00
5-year	1.16
10-year	1.24
25-year	1.33
50-year	1.39
100-year	1.43

NOTE:
1. Multiply the values obtained from the NOAA Atlas 2 by the above ratios to obtain the adjusted precipitation values.
2. NOAA Atlas 2 values for use with TR-55 shall not be adjusted by the above ratios.
3. Tables 505 and 506 require no adjustments.

10-yr
Rainfall Depth = 1.4"
Adjusted Depth = 1.4 × 1.24 = 1.736
10-yr Ratio = 1.736/3.146 = 0.5518

100-yr
2.2"
2.2 × 1.43 = 3.146

Revision	Date

WRC ENGINEERING

REFERENCE:
USACE, Los Angeles District, 1988

TABLE 501

SIX-HOUR STORM DISTRIBUTIONS

Storm Time (In Minutes)	Percent of Total Storm Depth SDN3	SDN4	SDN5	Storm Time (In Minutes)	Percent of Total Storm Depth SDN3	SDN4	SDN5
0	0.0	0.0	0.0	185	32.2	37.6	43.0
5	2.0	2.0	2.0	190	35.2	41.5	47.7
10	5.7	5.8	5.9	195	40.9	46.2	51.4
15	7.0	7.5	8.0	200	49.9	53.0	56.1
20	8.7	9.9	11.0	205	59.0	61.0	63.0
25	10.8	12.6	14.4	210	71.0	71.0	71.0
30	12.4	13.7	15.0	215	74.4	73.2	72.0
35	13.0	14.5	16.0	220	78.1	75.6	73.1
40	13.0	14.9	16.8	225	81.2	78.2	75.2
45	13.0	15.1	17.1	230	81.9	79.9	77.9
50	13.0	15.5	18.0	235	83.5	81.3	79.0
55	13.0	15.6	18.2	240	85.1	82.3	79.5
60	13.0	15.9	18.7	245	85.6	83.0	80.4
65	13.3	16.2	19.0	250	86.0	83.5	81.0
70	14.0	16.9	19.7	255	86.8	84.4	82.0
75	14.2	17.2	20.2	260	87.6	85.1	82.6
80	14.8	17.9	21.0	265	88.8	86.4	84.0
85	15.8	18.9	22.0	270	91.0	88.5	85.9
90	17.2	20.1	23.0	275	92.6	90.8	88.9
95	18.1	21.1	24.1	280	93.7	92.4	91.0
100	19.0	22.0	25.0	285	95.0	94.4	93.8
105	19.7	22.8	25.9	290	97.0	96.8	96.6
110	19.9	23.2	26.5	295	97.6	97.3	97.0
115	20.0	24.0	28.0	300	98.2	97.8	97.4
120	20.1	24.6	29.0	305	98.5	98.2	97.9
125	20.4	25.2	30.0	310	98.7	98.4	98.1
130	21.4	26.0	30.5	315	98.9	98.6	98.3
135	22.9	26.9	30.9	320	99.0	98.8	98.5
140	24.1	27.6	31.0	325	99.3	99.1	98.9
145	24.9	28.3	31.7	330	99.3	99.2	99.0
150	25.1	28.6	32.1	335	99.4	99.3	99.2
155	25.6	29.2	32.7	340	99.5	99.4	99.3
160	27.0	30.2	33.3	345	99.8	99.7	99.6
165	27.8	31.2	34.6	350	99.8	99.8	99.7
170	28.1	32.1	36.1	355	99.9	99.9	99.9
175	28.3	33.2	38.1	360	100.0	100.0	100.0
180	29.5	35.2	40.8				

Notes:
1. For drainage areas less than 8 square miles in size, use SDN 3.
2. For drainage areas greater than or equal to 8 square miles and less than 12 square miles in size, use SDN 4.
3. For drainage areas greater than or equal to 12 square miles, use SDN 5.
4. A graphical representation of these values is presented on **Figure 515.**

Revision	Date

REFERENCE:

TABLE 503

RUNOFF CURVE NUMBERS
(URBAN AREAS[1])

Cover description		Curve numbers for hydrologic soil group—			
Cover type and hydrologic condition	Average percent impervious area[2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)[4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
See Table 602A					
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)[5]		77	86	91	94

1 Average runoff condition, and $I_a = 0.2S$.

2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system. Impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using Figure 603.

3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

4 Composite CN's for natural desert landscaping should be computed using Figure 603 based on the impervious area percentage (CN #98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using Figure 603 based on the degree of development impervious area percentage) and the CN's for the newly graded pervious areas.

Revision	Date