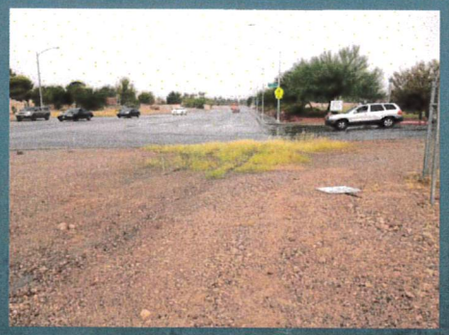
Draft Final Design Report
Gowan Outfall | Alexander Road, Rancho Drive to Decatur Boulevard

January 2015

H#49867



PREPARED BY

Stanley Consultants INC.

A Stanley Group Company
Engineering, Environmental and Construction Services - Worldwide

5820 S. Eastern Ave, Suite 200
Las Vegas, Nevada 89119

PREPARED FOR

City of Las Vegas
Department of Public Works
333 N. Rancho Drive
Las Vegas, Nevada 89106

Draft Final Design Report

Gowan - Alexander Road, Rancho Drive to Decatur Boulevard

January 2015
H# 49867
SCI Project # 25450

Prepared for:
City of Las Vegas (Public Works)
333 N. Rancho Drive
Las Vegas, NV 89106
Phone: (702) 229-6276

Prepared By:
Stanley Consultants, Inc.
5820 South Eastern Avenue, Suite 200
Las Vegas, Nevada 89119

HYDROLOGIC CRITERIA AND DRAINAGE MANUAL

DRAINAGE STUDY INFORMATION FORM

Name of Development: Gowan - Alexander Road, Rancho Drive to Decatur Boulevard Date: 01/27/2015

Location of Development: a) Descriptive (Cross Streets) North/South: Rancho Drive to Decatur Boulevard

East/West: Alexander Road

b) Section: 1, 12 Township: 20 South Range: 60 East

c) APN : See attached

Name of Owner: City of Las Vegas / Dennis Moyer

Telephone No.: (702) 229-6018 Fax No.: 702-369-9793 E-Mail Address: dmoyer@lasvegasnevada.gov

Address: 333 N. Rancho Drive, Las Vegas, NV 89106

Contact Person-Name: Lant Leavitt **Telephone No.:** 702-369-9396

* **E-Mail Address:** LeavittLant@stanleygroup.com **Fax No.:** 702-369-9793

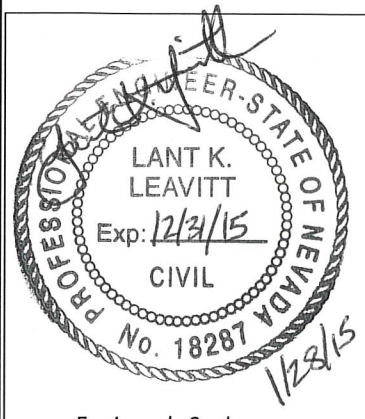
Firm: Stanley Consultants

Address: 5820 S. Eastern Ave, Suite 200, LV 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	CCRFCD facility	

1. Total Owned Land Area: At Site: right-of-way Being Developed/Disturbed: entire roadway
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.): CCRFCD Flood Control Facilities
5. Approximate upstream land area which drains to the subject site:
6. Has the site drainage been evaluated in the past? ☒ **YES** ☐ **NO** If yes, please identify documentation: Refer to Preliminary Design Report Section 3 for a complete list of referenced studies.
7. If known, please briefly identify the proposed discharge point(s) of runoff from the site: Alexander Road / Decatur Boulevard
8. Briefly describe your proposed schedule for the subject project: Construction schedule to be determined as project is not yet funded.



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:	Gowan-Alexander Road	Map ID:	See form 1 supplemental
Firm Name:	Stanley Consultants	Engineer:	Lant Leavitt, P.E.
Address:	5820 S. Eastern Ave., Suite 200		
City:	Las Vegas	State: NV	Zip: 89119
Phone Number:	(702)369-9396	Fax Number:	(702) 369-9793
Property Owner:	City of Las Vegas		
Address:	333 N. Rancho Drive		
City:	Las Vegas	State: NV	Zip: 89119

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	
X		Design manual **Standard Form 1** with the engineer's seal and signature.
X		Design manual Standard Form 4.
X		2 copies of the 24" x 36" Drainage Plan.
n/a		A notarized letter from the adjacent property owner(s) allowing off-site grading or discharge.

II. MAPS AND EXHIBITS

YES	NO	
X		A copy of a current Flood Insurance Rate Map (FIRM) with the site delineated.
X		A copy of the current CCRFCD Master Plan Update Figure, (F-x), for Flood Control Facilities and Environmental areas with the site delineated.

REFERENCE:	STANDARD FORM 2

DRAINAGE SUBMITTAL CHECKLIST

II. MAPS AND EXHIBITS (Continued)

Yes	No	
X	____	Off-site drainage basin maps for existing, interim and future conditions showing the existing topography, basin boundaries, concentration points, and flows in cfs.
n/a	____	On-site drainage basin maps for existing and proposed conditions showing the existing topography, basin boundaries, concentration points, and on-site and off-site flows in cfs.
X	____	Vicinity Map with local and major cross streets identified and a north arrow.

III. DRAINAGE PLAN

Yes	No	
X	____	Sheet size: 24" x 36" sealed by a registered engineer in the State of Nevada.
X	____	Minimum scale: 1" = 60'.
X	____	Project name.
X	____	Vicinity Map with local and major cross streets.
X	____	Revision box.
X	____	North arrow and bar scale.
X	____	Engineer's/consultant's address and phone number.
X	____	Elevation datum and benchmark.
X	____	Legend for symbols and abbreviations.
n/a	____	Cut/fill scarps, where applicable.
X	____	Street names, grades widths.
n/a	____	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.
n/a	____	Existing contours encompassing the site and 100 feet beyond with spot elevations for important locations, where appropriate.
n/a	____	Minimum finish floor elevations with top-of-curb elevations at upstream end of lot.
n/a	____	Proposed typical street sections.

REFERENCE:	STANDARD FORM 2

DRAINAGE SUBMITTAL CHECKLIST

III. DRAINAGE PLAN (Continued)

Yes	No	
n/a		Streets with off-set crowns.
X		Proposed contours or spot elevations in sufficient detail to exhibit intended drainage patterns and slopes.
X		Property lines.
X		Right-of-way lines and widths, existing and proposed.
X		Existing improvements and their elevations.
n/a	X	Delineation of proposed on-site drainage basins indicating area and 10-year and 100-year storm peak flows at basin concentration points.
n/a		Concentration points and drainage flow direction with Q_{100} and V_{100} and D_{100} in streets.
X		Cumulative flows, velocity, and direction of flow at upstream and downstream ends of site for the 10-year and 100-year flows.
X		Location and cross-section of street capacity calculations.
X		Cross-sectional detail for channels, including cutoff wall locations.
X		Existing and proposed drainage facilities, appurtenances, and connections (i.e., sidewalk, ditches, swales, storm drain systems, unimproved and improved channels, and culverts, etc.) stating size, material, shape, and slope with plan and profile and HGL calculations.
X		Existing and proposed drainage easements and widths shown with sufficient detail. A cross sectional detail must be provided that shows appropriate lining and reinforcement.
n/a		Location and detail of existing, proposed, and future block wall openings. Minimum size is 16" x 48". Wrought iron gate is required for flows > 10 cfs.
n/a		Location and detail of flood walls illustrating depth of flow, proposed grouting height, etc.
n/a		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.
n/a		Building and/or lot numbers.
X		Alignment of all existing, proposed, or future Regional Facilities adjacent to the site.
X		Limits of existing floodplain based on current FIRM or best available information; limits of proposed floodplains based on best available information.

REFERENCE:	**STANDARD FORM 2**

DRAINAGE SUBMITTAL CHECKLIST

III. DRAINAGE PLAN (Continued)

Yes	No	
n/a	____	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.
n/a	____	Appropriately elevated "humps" 6 inches above the 100 year water surface elevation at site accesses where the intent is to protect the site from the Q100 flows.
n/a	____	Street slopes for perimeter and interior streets. The minimum slope is 0.4 percent.
n/a	____	Location and detail of best management practice (BMP) for parking lots and low impact development (LID) (if required).

IV. HYDROLOGIC ANALYSIS

Yes	No	
X	____	Appropriate soil information and Soils Map for existing and future conditions with subbasins and property delineated.
X	____	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.
X	____	Input and output information for future conditions from computer models (HEC-1 or TR-55). The flow routing diagram must be provided with HEC-1 models.
X	____	Use of correct precipitation values in and around the McCarran Airport rainfall area.
X	____	A discussion in the text of the hydrologic analysis justifying subbasin boundaries and cutoffs, supporting assumptions, and calculations.
X	____	A summary table of stormwater flows showing basin area, Q10 and Q100 for both individual basins and combined basin flows, where applicable.
X	____	Copies of supporting technical information referenced from a previously approved study and a statement accepting these results.
n/a	____	On-site facilities must perpetuate flows through or around the site without significantly impacting adjacent property owners in accordance with current Nevada Drainage Law.
n/a	____	Calculation for impervious area for parking lots and LIDs (if required).

REFERENCE:	STANDARD FORM 2

DRAINAGE SUBMITTAL CHECKLIST

V. HYDRAULIC ANALYSIS

Yes	No	
n/a	____	Flow split calculations and supporting documentation or reference for the method of flow split calculations used.
n/a	____	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 $\leq$ 8. Q_{10} d x v $\leq$ 6 and 12 foot dry lane for rights-of-way $\geq$ 80 feet. Calculations must be labeled by street name as indicated on the Grading Plan.
n/a	____	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.
n/a	____	Appropriate hydraulic calculations for block wall openings assuming a 50 percent vertical clogging factor. (Assume the lower half of the opening is plugged.)
n/a	____	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.
n/a	____	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. Buildings adjacent to drainage easements must always be provided with 18 inches of freeboard above the Q100 weir height or flow depth, whichever is greater.
X	____	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.

X	____	Provide a 50 percent clogging factor in the capacity calculation for drop inlets.
X	____	Hydraulic calculations for culverts and storm drains. D-Load calculations must be provided for storm drain pipes in public rights-of-way, including headwater pool inundation.
n/a	____	The mitigation of nuisance water, both during construction and in the fully developed condition, must be addressed.
n/a	____	Provide BMP type, size and supporting calculations for parking lots and LIDs (if required).

REFERENCE:	**STANDARD FORM 2**

Standard Form 1-supplemental sheet with project APN's for Gowan-Alexander Road Facilities

138-12-199-003
138-12-199-004
138-01-499-016
138-12-199-007
138-01-499-017
138-01-499-002
138-01-499-003
138-01-499-019
138-01-499-007
138-01-899-001
138-01-899-017
138-12-599-010
138-01-899-012
138-12-599-001
138-01-899-003
138-12-599-015
138-01-899-018
138-01-899-013
138-12-599-003
138-01-899-014

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EXECUTIVE SUMMARY

This Draft Final Design Report presents hydrologic and hydraulic analyses performed for the Gowan - Alexander Road, Rancho Drive to Decatur Boulevard Project for the 70% Design Phase Submittal. It describes the drainage facilities recommended for construction with the project, including the Clark County Regional Flood Control District (CCRFCD) Las Vegas Valley Master Plan Update (MPU) flood control facility. The recommended alignment for the Gowan - Alexander Road, Rancho Drive to Decatur Boulevard Project and recommended sizes and locations of associated collection facilities are included in this report.

Gowan - Alexander Road, Rancho Drive to Decatur Boulevard Project receives stormwater runoff from two sources: planned upstream MPU facilities and the local offsite watershed south of Alexander Road. The majority of the flow comes from upstream MPU facilities in Rancho Drive and other upstream tributaries. The flow from these upstream MPU facilities is 1461 cfs at Rancho Drive and Alexander Road during the 100-year event. Local offsite flows from the roads crossing Alexander Road on the south side between Rancho Drive and Decatur Boulevard vary, but don't exceed 50 cfs in the 100-year event.

Analyses and design for the flood control facilities proposed as part of the project improvements meet criteria set forth by the City of Las Vegas (CLV), Regional Transportation Commission (RTC), and CCRFCD. Storm drain and drop inlets are sized to capture 100-year storm event flow rates. The analysis and design of this MPU facility extends from Rancho Drive east in Alexander Road to the intersection of Alexander Road and Decatur Boulevard.

The specific MPU facilities that are recommended for inclusion in this project are the following: 1864 lf of 14' x 6' RCB in Alexander Road east of Rancho Drive (GOAL 0000) and 3021 lf of 19' x 6' RCB continuing east in Alexander Road toward Decatur Boulevard (GOAL 0000). Recommended facilities also include collection facilities at cross streets with Alexander Road between Rancho Drive and Decatur Boulevard. These are proposed to capture all of the offsite 100-year flow to take full advantage of the reinforced concrete boxes being constructed along Alexander Road.

The MPU facility in Alexander Road changes size once between Rancho Drive and Decatur Boulevard. The facility starts out near Rancho Drive as a 14' x 6' RCB. Downstream of where the project starts, the existing roadway profile flattens, and the proposed MPU facility slope flattens as well, from a peak of 1.82% to as low as 0.5%. This flatter slope, combined with incoming local offsite flows from cross streets, necessitates a change in facility size to a 19' x 6' RCB. At the intersection of Alexander Road and Decatur Boulevard, a future connection to existing facilities is planned. The Rancho to Decatur facility

will join with the existing 96-inch RCP in Decatur Boulevard (Gowan Outfall Facility GOOF 0427) and continue east in Alexander Road. However, this connection is not being designed at this time.

Construction costs for the Gowan Outfall - Alexander Branch, Rancho to Decatur Project are estimated at approximately $10.5 million.

1. INTRODUCTION

On June 10, 2014, Stanley Consultants, Inc. received a Notice-to-Proceed from the City of Las Vegas to begin preliminary design services for the Gowan - Alexander Road, Rancho Drive to Decatur Boulevard Project. Analysis and recommendations from the 70% design phase are included in this Draft Final Design Report.

The purpose of this report is to present analysis and recommendations for the project, present the hydrologic and hydraulic analyses, and recommend drainage facilities necessary to meet criteria set forth by the CLV, RTC, and CCRFCD. The report includes hydrologic and hydraulic descriptions and calculations for the existing roadway conditions and recommended drainage facilities as well as a summary of costs, utility conflicts, and geotechnical considerations.

The design for the project will be completed and bid at such a time as construction funds become available.

2. PROJECT DESCRIPTION

2.1. Project Scope

The project includes the design of Clark County Regional Flood Control District (CCRFCD) Las Vegas Valley Master Plan Update (MPU) flood control facilities in Alexander Road from Rancho Drive to Decatur Boulevard. The facilities vary in size from a 14' X 6' RCB to a 19' X 6' RCB. These all work to convey the 100-year flow. The project also includes associated storm drain collection facilities at intersecting cross streets to collect local offsite flow and discharge to the proposed facility.

This report describes the hydrologic and hydraulic analyses performed for the site, as well as recommended drainage facilities. The storm drain facility is a MPU facility that will convey flow from the intersection of Rancho Drive and Alexander Road east to the intersection of Alexander Road and Decatur Boulevard. Plans for the project are included in Appendix G.

The design for the project begins in Alexander Road approximately 100 feet east of Rancho Drive and extends to approximately 100 feet west of Decatur Boulevard. The general location and alignment of the proposed flood control facilities are shown in Figure 1.

2.2. Project Location

The location of the project is the one mile reach of Alexander Road between the intersection with Rancho Drive and the intersection with Decatur Boulevard, in the City of Las Vegas, Nevada (Figure 1). Specifically, the project area is identified by the Assessor's Parcel Numbers (APNs) 138-12-199-003, 138-12-199-004, 138-01-499-016, 138-12-199-007, 138-01-499-017, 138-01-499-002, 138-01-499-003, 138-01-499-019, 138-01-499-007, 138-01-899-001, 138-01-899-017, 138-12-599-010, 138-01-899-012, 138-12-599-001, 138-01-899-003, 138-12-599-015, 138-01-899-018, 138-01-899-013, 138-12-599-003, and 138-01-899-014.

3. PROJECT BACKGROUND INFORMATION

3.1. Referenced Drainage Studies

As part of the engineering services, Stanley Consultants obtained and reviewed hydrologic and hydraulic reports and studies performed for areas surrounding, tributary to, and adjacent to the project site. The following studies were reviewed in the preparation of this report:

- *2008 Las Vegas Valley Flood Control Master Plan Update* (*MPU*), prepared for Clark County Regional Flood Control District, prepared by PBS&J, September 2008.
- *Rancho Drive/US 95 LOMR (Rancho LOMR*), prepared for City of Las Vegas, prepared by The Louis Berger Group, Inc., November 2006.
- *Final Design Report for Gowan Outfall Lone Mountain Branch Rancho to Decatur* (Gowan Outfall), prepared for City of Las Vegas, prepared by G.C. Wallace, Inc., January 2009.
- *Technical Drainage Report for the Rancho Drive Capacity Improvements - Rainbow Boulevard to Decatur Boulevard, and Gowan Outfall - Alexander Road Facilities*, prepared for City of Las Vegas, prepared by Stanley Consultants, April 2014.

3.2. FEMA Floodplain Information

The project site is located on Flood Insurance Rate Maps (FIRM) panel 2155F (Map Number 32003C2155F, revised November 16, 2011). The majority of the project site is outside of existing flood zones. The easternmost approximately 500 feet of the project is located within flood zone X.

A FIRM panel showing the limits of the project is included in this study in FEMA FIRM in Appendix A. Flood zones are defined by FEMA as follows:

- Zone X is a Moderate, Minimal Hazard Area subject to flooding from severe storm activity or local drainage problems.

3.3. Clark County Regional Flood Control District Facilities

The CCRFCD facilities analyzed in this preliminary design report are the Gowan Outfall – Alexander Road Facilities in Alexander Road from Rancho Drive to Decatur Boulevard (GOAL 0000). Other CCRFCD facilities within or adjacent to this project include the existing Gowan Outfall Facilities in Decatur Boulevard from Gowan Road to Alexander Road (GOOF 0427), the proposed Gowan Outfall Facilities downstream of the project in Alexander Road (GOOF 0375), and the proposed facilities upstream of the project including the Gowan Outfall Alexander Road Facilities in Rancho Drive (GOAL 0100 and GOAL 0111), the Gowan Outfall – Alexander Branch Facilities in West Alexander Road (GOA2 0000), the Gowan Outfall Alexander Road Facilities in Craig Road (GOAL 0168), and the Gowan Outfall Alexander Road Facilities along US 95 (GOAL 0247).

A map of the project facilities with respect to other MPU facilities in the area is included in the CCRFCD Facilities Map in Appendix A. This figure is reproduced from Figure F-19 of the CCRFCD MPU. An annotated facility inventory is also included in this study in CCRFCD Facilities Table in Appendix A.

The facilities in the project area and those being constructed with the project, their corresponding identification number (ID), and types and sizes are listed in Table 1. Due to the detailed hydrologic and hydraulic analysis performed for this report, the approximate sizes listed in the MPU have been reviewed and revised as necessary to convey project design flows. For comparison purposes, the table includes both MPU and recommended sizes.

Table 1 – CCRFCD Facilities

FACILITY	ID	Size and Type: Recommended	Size and Type: MPU	Location and construction status
Gowan – Alexander Road, Rancho Drive to Decatur Boulevard	GOAL 0000	14′ x 6′ RCB	10’ x 9’ RCB	Alexander Rd from start of project site to approximately 240 feet east of Helen Ave.
		19’ x 6’ RCB	10′ x 9′ RCB	Alexander Rd from approximately 240 feet east of Helen Ave to end of project.

The sizes and approximate lengths of facilities recommended to be constructed in Alexander Road are the following:

- 1864 lf of 14’ x 6’ RCB from near Rancho Drive to the east

- 3021 lf of 19' x 6' RCB from just east of Helen to end of project site

Near the location where the proposed facility changes from 14' x 6' RCB to 19' x 6' RCB, the existing roadway profile flattens. To maintain a cost-effective facility depth, the facility slope is reduced as well, to 0.50%. This reduction in slope, combined with incoming local offsite flows from cross streets, necessitates the increase in facility size.

At the intersection of Alexander Road and Decatur Boulevard, a connection to existing facilities is planned to be constructed with future downstream improvements. The Rancho to Decatur facility will join with the existing 96-inch RCP in Decatur Boulevard (Gowan Outfall Facility GOOF 0427) and continue east in Alexander Road. This connection is not being designed at this time. Facilities proposed with this project are designed to a point approximately 100 feet west of Decatur Boulevard.

4. SURVEY AND EASEMENT INFORMATION

4.1. Survey Summary

Aerial mapping and topographic information at a contour interval of 1 foot was acquired for Alexander Road from Rancho Drive to Decatur Blvd. An extensive ground survey was also completed to gather horizontal and vertical data at key locations along the project corridor and in order to acquire invert elevations of existing storm drain and sanitary sewer facilities and to locate other utilities. Existing public land corners, street centerline monuments, and reference monuments have been located to provide for Horizontal Control Plans, alignment ties, and a Record of Survey.

4.2. Rights-of-Way and Easements

Right-of-way plans are not required for the project at this time. The proposed connection to the existing 36-inch CMP culvert crossing Rancho Drive near Alexander Road will be located in an existing drainage easement. No additional right-of-way or easements are currently anticipated for the project.

5. GEOTECHNICAL CONDITIONS AND RECOMMENDATIONS

The subsurface conditions for the storm drain facilities were evaluated by GeoTek during design of the Rancho Drive Capacity Improvement Project. That same report is being used for design of this project. The report is titled *Pavement and Geotechnical Evaluation Report, Rancho Drive – Pavement Rehabilitation, Storm Drain, and Sewer Line, Decatur Boulevard to Rainbow Boulevard, Alexander Road – Storm Drain, Rancho Drive to Decatur Boulevard,* prepared for City of Las Vegas, May 31, 2013. The report describes subsurface conditions that include hard to very hard soil in some areas as well as loose

and soft soils. The hard to very hard soils may require the contractor to utilize special construction methods for the handling and removal of the material. The loose and soft soils may prove to be unstable during trenching operations for the deep drainage facilities excavation and, thus, require the contractor to utilize shoring. Thin layers of caliche can be found on Alexander Road, but do not appear to be a major cause for concern due to their depth and lack of substantial thickness. Medium dense to dense and stiff soils would provide suitable support of the pipeline. Over-excavation is recommended for loose and firm soils. No groundwater was encountered in the borings performed by GeoTek. Depth was typically 16.5 feet deep along Alexander Road with the exception of the intersection of Rancho and Alexander which had a depth of 21.5 feet. Geotechnical issues affecting construction of project improvements will be addressed in the project specifications.

The thickness of the existing pavement surface on Alexander Road was found to be 5 inches of asphalt pavement over 10 inches of aggregate base west of Leon Avenue. East of Leon Avenue, the existing pavement surface was found to be 3 inches of asphalt pavement over 6 inches of aggregate base. Where existing pavement is being removed to accommodate the proposed storm drain improvements, the improvement plans will require the existing pavement section to be replaced to match existing.

6. UTILITY IMPACTS

The facilities proposed with the project affect existing utilities in the area. Affected utilities include sanitary sewer conflicts, water conflicts, and dry utility conflicts. To document utility conflicts and proposed resolutions, a Utility Conflict Matrix has been prepared for the construction documents (Appendix D). The matrix lists the existing utility, the proposed feature that is in conflict and whether the existing utility can be protected-in-place, or concrete encased, or if it requires relocation.

To assist in defining conflicts and determining clearances between proposed facilities and existing utilities, potholing has been performed. The information obtained has been included in the design plans, and the testhole data sheets are included in Appendix D.

A CNLV utility conflict permit is required for this project. Details about the utility conflict permit as well as other permits for this project are included in Appendix E.

6.1. Drop Inlets:

The majority of existing utilities in the Alexander Road alignment are within or near the sidewalk area. To minimize conflicts and relocations of these existing utilities, the proposed drop inlets for the areas of

the project with existing curb and gutter are Clark County Type DM2 (Std Dwg 412.1) of the Uniform Standard Drawings Clark County Area (USDCCA). Type DM2 drop inlets feature a narrower width than other inlets to allow greater room for utilities beneath the sidewalk. For field areas, NDOT Type 2B inlets (Std Dwg R-4.2.2) with concrete apron (Std Dwg R-4.2.7) are proposed.

6.2. Water Conflicts:

Conflicts with water utilities are resolved in conformance with the Las Vegas Valley Water District Uniform Design and Construction Standards for Potable Water Systems, 3rd Edition 2010 (UDACS). The proposed improvement plans show a minimum of 10 feet of horizontal clearance between proposed storm drain facilities and adjacent parallel water facilities, which meets the requirements of UDACS Section 2.19. Asbestos concrete pipe (ACP) waterlines crossing trenches greater than 4 feet in width during construction are proposed to be replaced with ductile iron pipe (DIP) across the spanning section. Special instructions for the removal and disposal of ACP will be provided in the project special provisions. In most locations of the proposed vertical alignment of the storm drain facility, a minimum of 1.5 feet of clearance is maintained with existing waterlines. Concrete encasements will be provided per Design and Construction Standards for Wastewater Collection Systems (DCSWCS) Standard Drawing SD-11 for locations that do not meet the minimum vertical clearance requirements.

In general, existing water lines west of Bradley Avenue are owned by LVVWD. Existing water lines east of Thom Boulevard are generally owned by City of North Las Vegas (CNLV.) Ownership has been denoted in plans utility linework. During coordination of existing 8-inch water line in Alexander Road, west of Decatur Boulevard, CNLV requested that this water line be relocated if it conflicted with the proposed storm drain improvements. Based on results of testholes performed for the project, this water line stops short of currently proposed improvements. This line, along with an existing 16-inch water in Decatur Boulevard, will require relocation with downstream MPU storm drain improvements.

Major water-storm drain conflicts include the following (conflict number corresponds to the conflict listed in the Utility Conflict Matrix):

- CONFLICT NO. 001 (Station 48+50): Existing 8-inch PVC water line crosses above proposed RCB. It is proposed that it be protected in place.

- CONFLICT NO. 003 (Station 50+00 LT 60'): Existing 12-inch ACP water line parallel with drop inlet. It is proposed that it be protected in place.

- CONFLICT NO. 004 (Station 51+90): Existing 8-inch PVC water line crosses above proposed RCB. It is proposed that it be protected in place.

- CONFLICT NO. 005 (Station 53+40): Existing 6-inch PVC water line crosses above proposed RCB. It is proposed that it be protected in place.

- CONFLICT NO. 007 (Station 55+50 LT 55'): Existing 12-inch ACP water line parallel with drop inlet. It is proposed that it be protected in place.

- CONFLICT NO. 010 (Station 56+30): Existing 8-inch PVC water line crosses above proposed RCB. It is proposed that it be protected in place.

- CONFLICT NO. 013 (Station 62+00 LT 55'): Existing 6-inch ACP water line parallel to drop inlet. It is proposed that it be protected in place.

- CONFLICT NO. 014 (Station 62+40): Existing 6-inch ACP water line is in conflict with proposed RCB. It is proposed that it be replaced in the same location.

- CONFLICT NO. 015 (Station 62+70 RT 20'): Existing 6-inch ACP water line is in conflict with proposed RCP between south inlet and RCB. It is proposed that it be replaced in the same location.

- CONFLICT NO. 016 (Station 68+90 RT 20'): Existing 8-inch PVC water line is parallel to drop inlet. It is proposed that it be protected in place.

- CONFLICT NO. 018 (Station 69+15 RT 20'): Existing 8-inch PVC water line crosses above RCP between south inlet and RCB. It is proposed that it be protected in place.

- CONFLICT NO. 024 (Station 72+35): Existing 8-inch PVC water line crosses above proposed RCB. It is proposed that it be protected in place.

- CONFLICT NO. 036 (Station 82+10 RT 10'): Existing 8-inch PVC water line crosses over proposed RCP between south inlet and RCB. It is proposed that it be protected in place.

- CONFLICT NO. 039 (Station 82+45): Existing 8-inch PVC water line crosses above proposed RCB as well as above RCP to RCB at roughly RT 70'. It is proposed that it be protected in place.

- CONFLICT NO. 041 (Station 88+75): Existing 8-inch PVC water line is in conflict with proposed RCB. It is proposed to relocate to minimum clearance from RCB.

6.3. Sanitary Sewer Conflicts:

Conflicts with sanitary sewer facilities are resolved in conformance with the Clark County Water Reclamation District Design and Construction Standards for Wastewater Collection Systems, 3rd Edition 2009 (DCSWCS). In most locations, the proposed storm drain meets the minimum required one foot vertical clearance with existing sanitary sewer lines. In locations that don't meet the minimum vertical clearance requirements, concrete encasement has been provided (DCSWCS SD-11). Major sanitary sewer-storm drain conflicts include the following:

- CONFLICT NO. 020 (Station 69+25): Conflict with 36-inch HDPE sewer line and RCB. It is proposed that it be protected in place.

- CONFLICT NO. 028 (Station 75+20 RT 10'): Conflict with 18-inch PVC sewer line and RCB. It is proposed that sanitary sewer stub be removed and manhole be grouted.

- CONFLICT NO. 031 (Station 80+70): Conflict with 18-inch PVC sewer line and RCB. It is proposed that sewer main be abandoned.

- CONFLICT NO. 035 (Station 82+10): Conflict with 10-inch PVC sewer line and RCB as well as RCP between south inlet and RCB. It is proposed that sewer main be abandoned.

- CONFLICT NO. 044 (Station 89+55): Conflict with 8-inch PVC sewer line and RCB. It is proposed that sanitary sewer stub be removed and manhole be grouted.

- CONFLICT NO. 045 (Station 93+20): Conflict with 8-inch PVC sewer line and RCB. It is proposed that sanitary sewer stub be removed and manhole be grouted.

- CONFLICT NO. 046 (Station 93+75): Conflict with 27-inch PVC sewer line and RCB. It is proposed that it be protected in place.

In addition to the existing sanitary sewer facilities in the project area, a future 30 inch sanitary sewer pipe is planned to cross Alexander Road at Thom Boulevard. This facility is part of the collection system master plan, but no funding is available at this time. CLV Sanitary Sewer Planning believes the future facility will be deeper than the MPU storm drain facilities being constructed with this project, and no future vertical conflict is anticipated.

6.4. Dry Utility Conflicts:

Design adjustments were made to avoid conflicts with gas, power, telephone, cable and other dry utilities. Because the existing dry utilities are located either within the existing sidewalk or outside the existing roadway, most of the dry utility conflicts with proposed drainage facilities occur near the proposed curb line:

- CONFLICT NO. 002 (Station 49+80 RT 35'): Existing street light conduit parallel to drop inlet. It is proposed that it be protected in place.
- CONFLICT NO. 006 (Station 53+70 RT 45'): Existing street light conduit parallel to drop inlet. It is proposed that it be protected in place.
- CONFLICT NO. 008 (Station 55+50 RT 45'): Existing street light conduit parallel to drop inlet. It is proposed that it be protected in place.
- CONFLICT NO. 009 (Station 56+00 RT 90'): Existing street light conduit parallel to drop inlet. It is proposed that it be protected in place.
- CONFLICT NO. 011 (Station 58+20): Existing underground telephone line and power line cross above RCB. It is proposed that they be protected in place.
- CONFLICT NO. 012 (Station 61+20): Existing underground cable TV line crosses above RCB. It is proposed that it be protected in place.
- CONFLICT NO. 017 (Station 69+00 RT 70'): Existing 2-inch and 4-inch Telephone lines parallel to drop inlet. It is proposed that they be protected in place.
- CONFLICT NO. 019 (Station 69+20 RT 30'): Existing underground power line and cable TV line cross above pipe between inlet and RCB. It is proposed that they be protected in place.
- CONFLICT NO. 021 (Station 69+35): Existing underground power line and cable TV line cross above RCB. It is proposed that they be relocated by owners.
- CONFLICT NO. 022 (Station 69+35 RT 45'): Existing street light conduit parallel to drop inlet. It is proposed that it be protected in place.
- CONFLICT NO. 023 (Station 72+25): Existing underground telephone line crosses above RCB. It is proposed that it be protected in place.

- CONFLICT NO. 025 (Station 74+70 RT 50'): Existing underground cable TV, telephone line, and power line parallel to drop inlet. It is proposed that they be protected in place.

- CONFLICT NO. 026 (Station 74+70 LT 25'): Existing 2-inch gas line crosses above RCP from inlet to RCB. It is proposed that it be protected in place.

- CONFLICT NO. 027 (Station 74+70 LT 40'): Existing street light conduit parallel to drop inlet. It is proposed that it be protected in place.

- CONFLICT NO. 029 (Station 75+95): Conflict with existing 2-inch gas line and RCB. It is proposed that it be relocated by owner.

- CONFLICT NO. 030 (Station 79+05): Existing 2-inch gas line crosses above RCB. It is proposed that it be protected in place.

- CONFLICT NO. 032 (Station 81+40 RT 65'): Existing street light conduit, underground cable TV, underground telephone line, and underground power parallel to drop inlet. It is proposed that they be protected in place.

- CONFLICT NO. 033 (Station 81+65 LT 55'): Existing street light conduit parallel to drop inlet. It is proposed that it be protected in place.

- CONFLICT NO. 034 (Station 81+85 RT 120'): Existing underground cable TV and power parallel to drop inlet. It is proposed that they be protected in place.

- CONFLICT NO. 037 (Station 82+10 RT 15'): Existing underground telephone line and power parallel to drop inlet. It is proposed that they be protected in place.

- CONFLICT NO. 038 (Station 82+45): Existing 2'-4" underground telephone line crosses RCB and it is parallel to drop inlet at RT 70'. It is proposed that it be protected in place.

- CONFLICT NO. 040 (Station 82+45 RT 70'): Existing street light conduit parallel to drop inlet. It is proposed that it be protected in place.

- CONFLICT NO. 042 (Station 88+95 LT 60'): Existing street light conduit parallel to drop inlet. It is proposed that it be protected in place.

- CONFLICT NO. 047 (Station 94+75): Conflict with existing 2-inch gas line and RCB. It is proposed that it be relocated by owner.

7. HYDROLOGY

The Gowan Outfall – Alexander Road Facilities is a CCRFCD Master Plan facility and was designed to convey the 100-year storm event (developed condition flows). The offsite hydrology models for the project are based on the MPU Gowan Watershed hydrology models, with the exception of MPU subbasins PT5A2-C and PT5B6-C. PT5B6-C is adjacent to the site and was subdivided into seven smaller subbasins to determine design flows at cross streets with Alexander Road. PT5A2-C was subdivided into two smaller subbasins to account for flow entering the site from a 6' x 2' culvert under Rancho Drive. Flow from each of these smaller local offsite subbasins was then combined with major offsite flows in the proposed MPU facility in Alexander Road.

7.1. Criteria and Modeling

The offsite flows impacting the project were determined in accordance with CCRFCD's *Hydrologic Criteria and Drainage Design Manual* (HCDDM). The *HEC-1 Flood Hydrograph Computer Model* was used to estimate runoff. This program was developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center in the late 1970's and adopted in 1988 by the CCRFCD's HCDDM for rainfall and runoff predictions. The model is used to simulate the surface runoff response of a watershed to a design rainfall event by representing the watershed as an interconnected system of hydrologic and hydraulic components. Each component models an aspect of the rainfall-runoff process within a portion of the whole watershed. This basin portion is referred to as a subbasin. The runoff hydrographs of each subbasin are then combined and a final discharge hydrograph is obtained.

HEC-1 parameters are those drainage shed attributes that are input into the HEC-1 model in order to estimate peak runoff values. The parameters include the design storm, subbasin delineation, hydrologic abstractions lag time and flow routing. These parameters were either based on the referenced studies or determined as described below.

Subbasin Delineations: Subbasin areas were either referenced from the *2008 MPU* or from subbasins created using AutoCAD and ArcMap. These created offsite subbasins are included in the Offsite Subbasin Map in Appendix A.

Design Storm: The design storm event for the project is the 6-hour, 100-year frequency rainfall event. The rainfall pattern is based on Table 503 of HCDDM, 6-hour Design Storm Distributions. For

convenience, the analysis performed for this study is combined in a single HEC-1 model. In the developed condition, the area conveyed to the Alexander Road site is less than 8 square miles, therefore SDN3 distribution was used. The design storm events used for the analysis meet the criteria specified in the HCDDM.

The depth-duration-frequency data for the 100-year storm event were referenced from the MPU models.

Depth-area reduction factors (DARF; Table 502 of HCDDM) were applied to the point rainfall depths based on the tributary area of the concentration point as specified in HCDDM. The DARFs for the 100-year event were referenced from the MPU.

Curve Number: Hydrologic Abstraction is the reduction of total rainfall to effective rainfall through runoff interception, infiltration, surface storage, evaporation, and/or evapotranspiration. These factors are influenced by surface cover and soil characteristics and input into the model as a "Curve Number" as defined in the *HCDDM*. Most of the curve numbers were referenced from the MPU. With the aid of data from the MPU and soil type shapefiles that were imported into a map of the project site in ArcMap, curve numbers were found for each of the smaller subbasins created for the project area. A curve number calculation matrix is included in Appendix A.

Lag Time: Lag time is described as the time between the center of mass of rainfall excess and the time of peak discharge from a basin. The time of concentration is defined as the time required for runoff to flow from the most hydraulically distant point of the subbasin to the outlet of the subbasin. Lag times for project subbasins have been calculated using HCDDM Standard Form 4, included in Appendix A.

Flow Routing: The majority of flow routing used in the HEC-1 model is referenced from the MPU. New routing lengths and parameters were determined using AutoCAD.

Storm Centering: the applicability of storm centering to the project area was analyzed. Without tributary area from upstream of the Gowan Detention Basin, the watershed area of the project is approximately 5 square miles. Adding additional area upstream of the Gowan Detention Basin was investigated, however flow above the capacity of the Gowan outfall pipe continues east in Gowan Road and doesn't flow north to the project area. Therefore, modeling additional watershed area upstream of the basin doesn't increase the peak flow at Alexander Road/Decatur Boulevard; instead the peak flow is reduced due to the increasing Depth Area Reduction Factor (DARF) and/or changing storm distribution (SDN3 to SDN4 or SDN5).

7.2. Offsite Ultimate Conditions

Developed condition analysis assumes full build-out of all CCRFCD facilities and properties located upstream of the site are fully developed in accordance with current zoning requirements. Developed conditions are based on the MPU. The ultimate condition HEC-1 models are included in Appendix A.

The MPU includes a subbasin, PT5B6-C, adjacent to the project alignment. This subbasin is roughly bounded by Alexander Road, Rancho Drive, Gowan Road, and Decatur Boulevard. Further analysis of this subbasin reveals that a portion of the area drains to Decatur Boulevard, while another portion drains to Alexander Road. In order to determine design flows in Alexander Road, the subbasin has been divided into seven smaller subbasins. One subbasin (5B6-CG) defines the area tributary to Decatur Boulevard, the other six subbasins are subdivided to determine design flows at cross streets with Alexander Road.

The MPU subbasin PT5A2-C was also divided, to account for flow entering Alexander Road from a 6' x 2' culvert in Rancho Drive. In the existing condition, flow from this culvert passes through the VA Primary Care Clinic site and discharges to Alexander Road west of Leon Avenue. Although the MPU combines this flow at This flow is not accounted for in the MPUThis MPU subbasin was divided into two smaller subbasins; 5A2-CA, which accounts for flows conveyed by the 6' x 2' culvert, and PT5A2-C, which includes the remainder of the original MPU subbasin PT5A2-C. A summary of peak 100-year flows for each subbasin is included in Table 2, below. Combined flow rates with the MPU facility in Alexander Road are shown in Table 3. It should be noted that the difference of 10 cfs between the MPU analysis and Stanley Consultants analysis for combination point CPT5A2-C is due to the routing of the flows through the 6' x 2' Rancho Drive culvert. Although project design on the downstream end is stopping short of Decatur Boulevard, a comparison of flows at the intersection of Alexander Road/Decatur Boulevard is also included. The MPU flow is slightly higher and should be used for future design of the confluence at this intersection.

Table 2 – Local Offsite Subbasin Flow Summary

HEC-1 SUBBASIN	AREA, mi^2	Q100, CFS
PT5A2-C	0.323	205
5A2-CA	0.014	20
5B6-CA	0.022	27
5B6-CB	0.042	45
5B6-CC	0.044	37
5B6-CD	0.030	21
5B6-CE	0.029	20
5B6-CF	0.030	23
5B6-CG	0.180	161

Table 3 – MPU Facility Flow Summary

LOCATION	HEC-1 NODE	AREA, mi^2	2008 MPU Q100, CFS	2014 STANLEY CONSULTANTS Q100, CFS
ALEXANDER/RANCHO	CPT5A2-C	3.21	1461	1451
ALEXANDER/LEON	C5B6-CA	3.25	n/a	1476
ALEXANDER/HELEN	C5B6-CB	3.29	n/a	1502
ALEXANDER/BRADLEY	C5B6-CC	3.33	n/a	1525
ALEXANDER/THOM	CR5B6-CE	3.39	n/a	1551
ALEXANDER/TUFFER	C5B6-CF	3.42	n/a	1564
ALEXANDER/DECATUR	CCPT5B6C / CPT5B6-C	4.98	2277	2280

Local areas on the east and west sides of the streets crossing Alexander Road are discussed in the storm drain collection section of this study. Drop inlets along Alexander Road were sized for the offsite flow rates shown in the above tables and are described in Section 8, Storm Drain Collection Facility Design.

8. STORM DRAIN COLLECTION FACILITY DESIGN

Drop inlets were designed for flow from subbasins 5B6-CA through 5B6-CF as well as subbasin 5A2-CA (See Table 2). These subbasins drain to Alexander Road. Subbasin 5B6-CG drains to Decatur Boulevard. Existing facilities in this reach of Decatur Boulevard are part of the MPU GOOF 0427 facility and were not studied as part of this project.

8.1. Determining Surface Runoff

In general, local offsite flows drain to the project from the south side of Alexander Road. To determine how the incoming flows are distributed in the street cross section, flow rates approaching Alexander Road at major cross streets were determined from Table 2 and a normal depth analysis of the roadway section was performed using Bentley Flowmaster V8i. This analysis was used to determine flow rates on either side of the cross street. The analysis consisted of analyzing the runoff height to determine if it exceeds the roadway crest height. When the runoff exceeds the crest height, surface runoff divides itself between both sides of the road. When the crest height exceeds the height of the runoff, flow was assumed to be greater on the side of the road where the runoff started. The Flowmaster inputs and results from these runs are included in the Road Sections Table in Appendix B. Two additional columns created to give crest height and which side of the street has more of the runoff were added to this spreadsheet as well. Cross sections of the road segments are included in the road profiles of Appendix B with the sections going from left to right either South to North or West to East. Roadway surface flow spread calculations used a Manning's "n" value of 0.016 for the asphalt, 0.015 for the concrete of the curbs and sidewalks, and 0.025 for the sections of earth.

8.2. Inlet and Pipe Location and Design

Inlet capture for inlets and normal depth calculation for swales were performed using FlowMaster. Inlet interception in FlowMaster is based on FHWA HEC-22. From the information obtained from the road section runoff, it was possible to determine the required inlet size. Where a percentage of the flow bypasses the inlet, the design of the downstream inlet added that runoff flow to its calculation. The proposed drop inlets for the project are Clark County Type DM2 (Std Dwg 412.1) of the Uniform Standard Drawings Clark County Area (USDCCA). Type DM2 drop inlets feature a narrower width than other inlets to allow greater room for utilities beneath the sidewalk. For field areas, NDOT Type 2B inlets (Std Dwg R-4.2.2) with concrete apron (Std Dwg R-4.2.7) are proposed. A table of inlet types and locations are included in Table 4.

Table 4 - Inlet Types and Locations

Subbasin Contributing Flow	Location	Inlet Type	Uniform Standard Drawing
Ex. Rancho 36" CMP	Rancho south of Alexander	36" RCP	n/a
5B6-CA	North Alexander near Rancho	Ditch Inlet In Sag	NDOT Type 2B with concrete apron
5B6-CA	South Alexander near Rancho	Combination Inlet On Grade	Type "C-D" Modified Drop Inlet
5A2-CA, 5B6-CA	South Alexander near Leon West	Combination Inlet On Grade	Type "C-D" Modified Drop Inlet
5B6-CA	North Alexander near Leon	Ditch Inlet In Sag	NDOT Type 2B with concrete apron
5B6-CA	South Alexander near Leon East	Combination Inlet On Grade	Type "C-D" Modified Drop Inlet
5B6-CA	West Leon near Alexander	Combination Inlet On Grade	Type "C-D" Modified Drop Inlet
5B6-CA	East Leon near Alexander	Ditch Inlet In Sag	NDOT Type 2B with concrete apron
5B6-CB	North Alexander near Helen	Ditch Inlet In Sag	NDOT Type 2B with concrete apron
5B6-CB	West Helen near Alexander	Ditch Inlet In Sag	NDOT Type 2B with concrete apron
5B6-CB	East Helen near Alexander	Ditch Inlet In Sag	Modified NDOT Type 2B with concrete apron
5B6-CC	North Alexander near Bradley	Ditch Inlet In Sag	NDOT Type 2B with concrete apron
5B6-CC	South Alexander near Bradley	Ditch Inlet In Sag	NDOT Type 2B with concrete apron
5B6-CC	West Bradley near Alexander	Ditch Inlet In Sag	NDOT Type 2B with concrete apron
5B6-CC	East Bradley near Alexander	Combination Inlet On Grade	Type "C-D" Modified Drop Inlet
5B6-CC	North Alexander west of Thom	Combination Inlet On Grade	Type "C-D" Modified Drop Inlet
5B6-CC	South Alexander west of Thom	Combination Inlet On Grade	Type "C-D" Modified Drop Inlet
5B6-CD	South Alexander near Thom	Combination Inlet On Grade	Type "C-D" Modified Drop Inlet

5B6-CD	North Alexander near Thom	Combination Inlet On Grade	Type "C-D" Modified Drop Inlet
5B6-CE	West Thom near Alexander	Combination Inlet On Grade	Type "C-D" Modified Drop Inlet
5B6-CE	East Thom near Alexander	Combination Inlet On Grade	Type "C-D" Modified Drop Inlet
5B6-CF	North Alexander near Tuffer	Combination Inlet On Grade	Type "C-D" Modified Drop Inlet
5B6-CF	South Alexander near Tuffer	Combination Inlet On Grade	Type "C-D" Modified Drop Inlet
Bypass and Nuisance	North Alexander near Decatur	Curb Inlet On Grade	Existing Drop Inlet Type "A"
Bypass and Nuisance	South Alexander near Decatur	Curb Inlet On Grade	Existing Drop Inlet Type "A"

The design of inlets in Flowmaster was performed by selecting either a combination inlet on grade or ditch inlet in sag. The type was determined by curb and gutter availability. Along Alexander, there are many locations without curb and gutter. This condition made it necessary to use ditch inlets in sags (NDOT Type 2B). When a ditch inlet in sag was used in the design, a side slope of 6:1 was used to provide roadside safety. Where curb and gutter exist, combination inlets on grade (Clark County Type DM2) are used to collect flow. Both the ditch inlets and combination inlets are sized with a 50 percent clogging factor to provide a factor of safety against clogging. Calculations were also performed for the two existing inlets in Alexander Road near Decatur Boulevard. A summary of the inputs and outputs is included in the Inlets Table in Appendix B. This table also includes notes and a column detailing selected apron size for the ditch inlets on sag. There is also an exhibit of inlet capture and street flow included in Appendix B.

Hydraulic calculations for drop inlets and lateral pipes are designed for peak flow at the associated design point. Due to losses associated with combining of hydrographs with different times to peak, increase to the design flow of the RCB at each of these points will be less than simple addition of the lateral flow to the RCB flow.

Flow collected by the drop inlets will be discharged to the proposed MPU facility in Alexander Road by RCP laterals. These pipes were preliminarily sized in FlowMaster using the intercepted flow from the corresponding drop inlet. A summary of pipe size and placement location is included in the Pipe Table in Appendix B. In addition to the preliminary sizing in FlowMaster, a Standard Form 6 analysis has been prepared. This analysis is used to calculate hydraulic grade lines (HGL's) for the pipes. These are included in the storm drain lateral section of the plans. Storm drain laterals intended to collection only nuisance flow were not included in this analysis. Standard Form 6 analysis is included in Appendix B.

8.3. Street Flow Criteria

Street flow analyses were performed for half streets along Alexander Road using Flowmaster to verify that the street meets county street flow criteria, including DxV and dry lane criteria. The road sections used for these calculations were taken close to the intersections along Alexander Road. Intersections are where the majority of flow impacts Alexander Road, and therefore the most efficient location for proposed drop inlets. Performing street flow criteria calculations at these locations ensures that the proposed facilities are resulting in compliance with the criteria. A 12-foot dry lane with an additional 7-feet for the center lane was used as the dry lane criteria for each half street. It is assumed 19-feet of dry pavement surface needs to be available on each side of the road crest. A table with DxV calculations and Dry Lane criteria is included in Appendix B. For Alexander and Helen, sections for the ultimate roadway cross section were used due to the current road only being paved for a single lane in each direction. Cross sections of each of the half streets are included in Appendix B.

9. STORM DRAIN CONVEYANCE FACILITY DESIGN

9.1. Storm Drain Criteria and Methods

The project facilities were designed to accommodate the major storm event (100-year design storm). They were designed in accordance with criteria listed in CCRFCD's HCDDM. These criteria include the following:

- Maintain the hydraulic grade line (HGL) at 1 ft below the final grade above the storm drain at all locations; utilize a locking manhole lid for HGL less than 1.5 ft below the final grade.
- Limit the maximum velocity in the system to 25 ft/sec and the minimum velocity in the system to 3 ft/sec at half or full conduit flow conditions (minimum 0.3 percent slope of the storm drain).
- Increase conduit cross section area in the downstream direction.
- Locate manholes a maximum of 400 ft apart otherwise and outside of the normal vehicle wheel path where possible.
- Provide minimum 18-inch diameter RCP for new storm drain laterals.
- Manning's roughness used for design is 0.015.

The Water Surface Pressure Gradient Hydraulic Model (WSPG) 2010 software, updated by XP Software, was used to estimate hydraulic losses, including friction, expansion, construction, bend, and junction losses, and to calculate the energy grade line (EGL) and hydraulic grade line (HGL) for the storm drain

systems. An exhibit showing hydraulic results at key locations from the WSPG analysis is provided in Appendix C.

9.2. Facility Design Summary

The Gowan Outfall - Alexander Road Facilities were analyzed from roughly 100 feet east of the southern intersection of Alexander Road and Rancho Drive to roughly 100 feet west of the intersection of Alexander Road and Decatur Boulevard. The flow rates calculated by this study for the developed condition were used to design the project facilities due to the additional flow combination points provided and the higher level of detail associated with the hydrology.

The Rancho Drive Capacity Improvements Project, Stanley Consultants, April 2014, recommended a 12' x 8' RCB facility in Alexander Road from Rancho Drive to Decatur Boulevard with dual 9' x 6' RCB at the downstream sewer crossing. The original analysis assumed one design flow from Rancho Drive to Decatur Boulevard without flow increases, or junctions. Based on the refined hydrology presented in Section 7 of this report, flows are being increased in the facility at each cross street. The inclusion of these elements into the WSPG model results in a slightly larger facility required to convey the 100-year storm and maintain the criteria listed in Section 9.1. The proposed facility includes 1864 lf of 14' x 6' RCB going east from near Rancho Drive to a 20 lf transition to a 19' x 6' RCB. The 19' x 6' RCB then continues east for approximately 3021 lf to the end of the project at Decatur Boulevard. WSPG input and output summary tables are included in Appendix C.

10. ESTIMATED PROJECT CONSTRUCTION COSTS

Costs for the project were estimated to be approximately $10.5 million. The 70% Construction Cost Estimate is included in Appendix F.

11. CONCLUSIONS AND RECOMMENDATIONS

1. Methodology in this report is in compliance with Clark County Regional Flood Control District (CCRFCD) criteria.

2. The project site has an area within FEMA Flood Zone X. Zone X is a moderate, minimal hazard area subject to flooding from severe storm activity or local drainage problems.

3. The proposed alignment and function of the Gowan – Alexander Road, Rancho Drive to Decatur Boulevard Facilities are in conformance with the CCRFCD Las Vegas Flood Control Master Plan as outlined in the 2008 MPU.

4. The proposed improvements will intercept flows currently impacting Alexander Drive with proposed Clark County Type DM2 drop inlets where curb and gutter exists, and NDOT Type 2B drop inlets with concrete aprons in other locations. Construction of the proposed facility will reduce surface flows in Alexander Road so that CCRFCD street flow criteria will be met as required in the HCDDM.

5. The recommended facilities for the Gowan – Alexander Road, Rancho Drive to Decatur Boulevard Facilities consist of 1864 lf of 14' X 6' RCB going east until a 20 lf transition to a 19' X 6' RCB. The 19' X 6' RCB then continues east for roughly 3021 lf until the end of the project.

6. Conflicts between the proposed storm drain systems and existing utilities are identified; several were potholed to identify vertical conflicts and to incorporate into design to minimize conflicts. Additional potholes will be required as the design progresses.

12. REFERENCES

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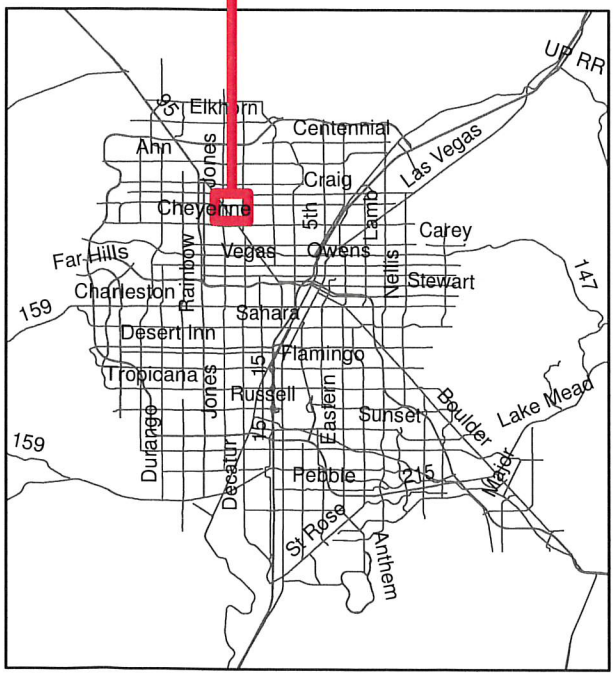

Gowan - Alexander Road, Rancho Drive to Decatur Boulevard Regional Flood Control Facility

Figure 1 - Vicinity Map

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