UPDATE#1 TO THE TECHNICAL DRAINAGE STUDY FOR GILMORE 2.14

CITY OF LAS VEGAS

TCE# 273-2005
DS05544

Prepared for:
Signature Homes
801 South Rancho Drive Suite E-4
Las Vegas, NV 89106

Prepared by:
TCE
7080 La Cienega, Suite 200
Las Vegas, Nevada 89119
(702) 932-6125
FAX (702) 932-6129

January 2023

John McAvoy
Digitally signed by John McAvoy
Date: 2023.01.12 12:37:15-08'00'

THOMASON CONSULTING ENGINEERS

REGISTERED PROFESSIONAL ENGINEER-STATE OF NEVADA
JOHN B. McAVOY
EXP. 12-31-23
CIVIL
No. 22439
01/12/2023

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

DRAINAGE STUDY INFORMATION FORM

Name of Development: Gilmore 2.14 DATE: January 11, 2023

Location of development: a) Descriptive (Cross Streets) North/South Fort Apache Rd East/West Gilmore Ave

b) Sect. 8 Twn. 20S Rng 60E

Name of Owner: Signature Homes Assessors Parcel No.: 138-08-101-030

Telephone No.: (702) 671-6062 Facsimile No.:

Address: 801 South Rancho Drive Suite E-4

Las Vegas, Nevada 89106

Contact Person-Name: John McAvoy Telephone No: 702-932-6125

Email: jmcavoy@tce-lv.com

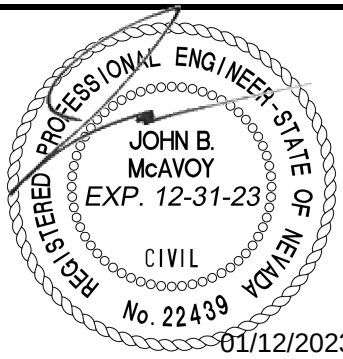
Firm: TCE

Address: 7080 La Cienega Street, Suite 200 Las Vegas, Nevada 89119

Type of Land Development/Land Disturbance Process:

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

1. Total Owned Land Area: At Site: 2.14 Acres Being Developed/Disturbed 2.14 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.)? Single Family Residential
5. Approximate upstream land area, which drains to the subject site? None
6. Has the site drainage been evaluated in the past? YES ☒ NO ☐ If yes, please documentation: Seton Academy (DS2677)
7. If known, please briefly identify the proposed discharge point(s) of runoff from the site: Gilmore Ave and Garehime Heights park
8. Briefly describe your proposed schedule for the subject project: ASAP



01/12/2023

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.

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

Local Entity File No.

Revision	Date

REFERENCE: **STANDARD FORM 1**

CITY OF LAS VEGAS

MINIMUM DRAINAGE STUDY CRITERIA
STANDARD FORM 2 CHECKLIST SUPPLEMENT

(Revised 5/18/11)

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

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

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

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

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

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

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

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

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

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

January 11, 2023

Albert Sung, P.E.
City of Las Vegas
333 North Rancho Drive
Las Vegas, NV 89106

Re: Update#1 to the Technical Drainage Study for Gilmore 2.14
DS05544, TCE#273-21005

Mr. Sung:

TCE has reviewed the City Conditional Approval letter for the above referenced study dated June 27, 2022. The comments in the subject memorandum have been reproduced in **bold** with accompanying responses as follows:

1. **The grading plan indicates offsite grading onto CLV land, Garehime Heights Park. Secure a letter of permission from the City of Las Vegas Parks & Recreation allowing the grading and access. This letter is required prior to the final acceptance of the improvement plans.**

2. **The grading plan indicates offsite grading onto Seton Academy. Secure a notarized letter of permission from the property owner allowing the construction. This letter is required prior to the final acceptance of the improvement plans.**

   Noted, the owners are still working on final approval of the permission letters and easements from CLV Parks and Rec. Department and Seton Academy.

Due to talks with the new owners of Seton Academy, we have realigned the storm drain to directly drain into the existing "L" curb within the parking lot. Please see the Appendix for the calculations. Please note, the storm drain will still contain the entire flow from our site, and we have better detailed the overflow path for DI#2 on the planset.

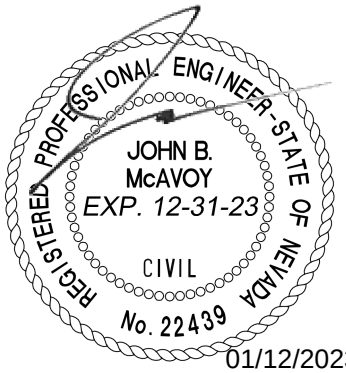
FIGURES

Figure 7 Updated Hydraulic Figure

LIST OF APPENDICES

Appendix A: Updated Storm Drain Analysis
Appendix B: Reference from Approved Study

Sincerely,
Thomason Consulting Engineers



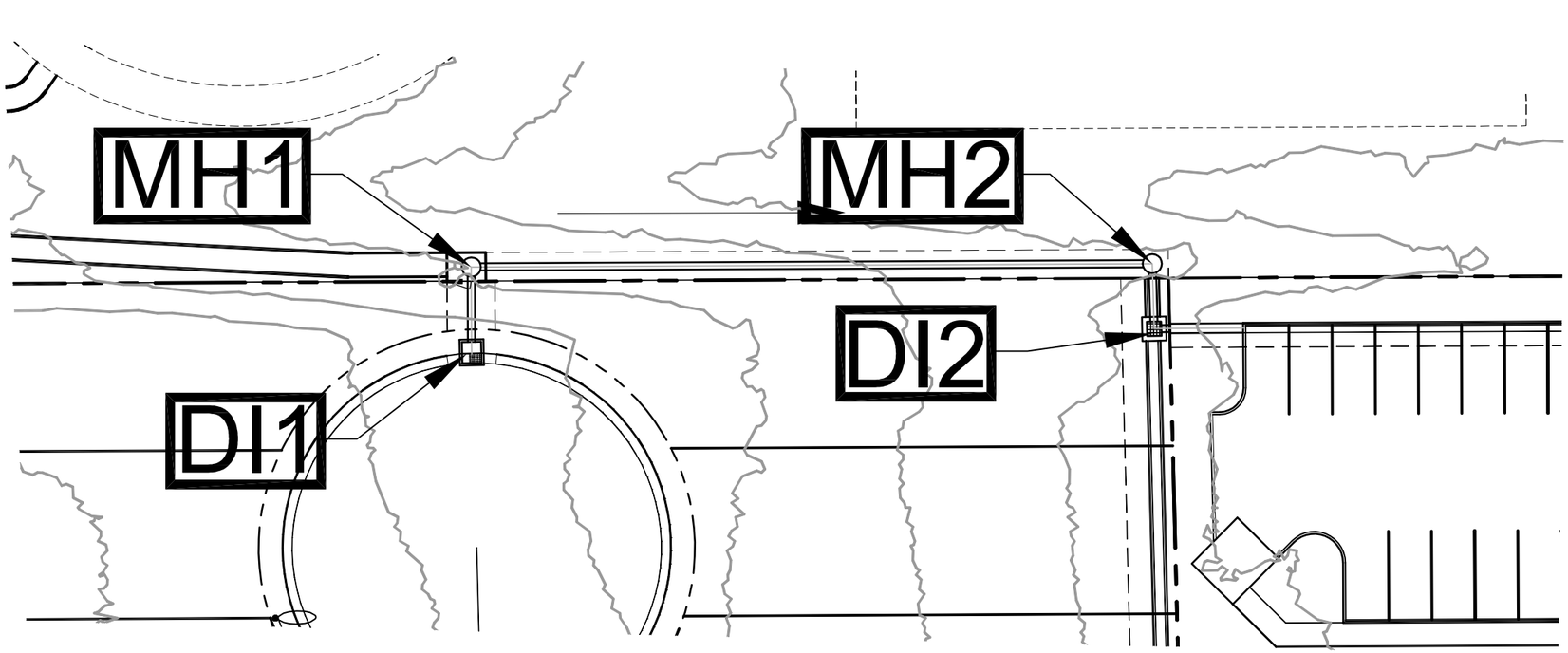
John McAvoy, P.E.

THOMASON
CONSULTING
ENGINEERS

7080 La Cienega Street #200
Las Vegas, Nevada 89119

FIGURES

INLET/MANHOLE	Q100 (CFS)	CONTROLING HGL	GRATE/TMH	HGL COVER
DI1	4	6.94	9.08	2.14
MH1	4	6.19	9.42	3.23
MH2	4	3.98	6.20	2.22
DI2	4	3.39	6.00	2.61



NORTH

30 0 15 30 60

1" = 30'

THOMASON CONSULTING ENGINEERS
7080 LA CIENEGA STREET, SUITE 200
LAS VEGAS, NEVADA 89119
702-932-6125 FAX: 702-932-6129

SIGNATURE HOMES
LEBARON EDMOND

UPDATED HYDRAULIC FIGURE
FIGURE 7

7

APPENDIX A

Updated Storm Drain Analysis

THOMASON
CONSULTING
ENGINEERS

Worksheet for DI1 - Type C Inlet

Project Description

Solve For	Spread

Input Data

Discharge		4.00	ft³/s
Gutter Width		1.50	ft
Gutter Cross Slope		0.09	ft/ft
Road Cross Slope		0.02	ft/ft
Local Depression		0.00	in
Local Depression Width		0.00	ft
Grate Width		1.50	ft
Grate Length		2.50	ft
Grate Type	P-50 mm (P-1-7/8")		
Clogging		50.00	%
Curb Opening Length		2.00	ft
Opening Height		6.00	in
Curb Throat Type	Horizontal		
Throat Incline Angle		90.00	degrees

Options

Calculation Option	Use Both

Results

Spread	22.77	ft
Depth	0.50	ft
Gutter Depression	0.10	ft
Total Depression	0.10	ft
Open Grate Area	1.69	ft²
Active Grate Weir Length	4.00	ft

Messages

Notes

Length of curb opening halved to account for 50% clogging

Cross Section for DI1 - Type C Inlet

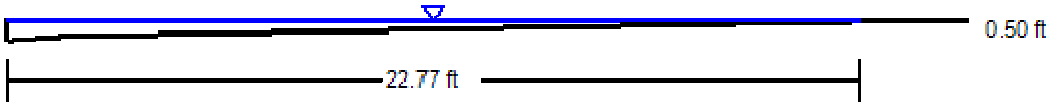
Project Description

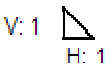
Solve For	Spread

Input Data

Discharge		4.00	ft³/s
Spread		22.77	ft
Gutter Width		1.50	ft
Gutter Cross Slope		0.09	ft/ft
Road Cross Slope		0.02	ft/ft
Local Depression		0.00	in
Local Depression Width		0.00	ft
Grate Width		1.50	ft
Grate Length		2.50	ft
Grate Type	P-50 mm (P-1-7/8")		
Clogging		50.00	%
Curb Opening Length		2.00	ft
Opening Height		6.00	in
Curb Throat Type	Horizontal		
Throat Incline Angle		90.00	degrees

Cross Section Image





Worksheet for DI2 - Type 2 Drop Inlet

Project Description

Solve For	Spread

Input Data

Discharge		1.00	ft³/s
Left Side Slope		2.00	%
Right Side Slope		2.00	%
Bottom Width		2.00	ft
Grate Width		2.00	ft
Grate Length		2.00	ft
Local Depression		0.00	in
Local Depression Width		0.00	ft
Grate Type	P-50 mm (P-1-7/8")		
Clogging		50.00	%

Results

Spread	16.56	ft
Depth	0.15	ft
Wetted Perimeter	16.56	ft
Top Width	16.56	ft
Open Grate Area	1.80	ft²
Active Grate Weir Length	6.00	ft

Cross Section for DI2 - Type 2 Drop Inlet

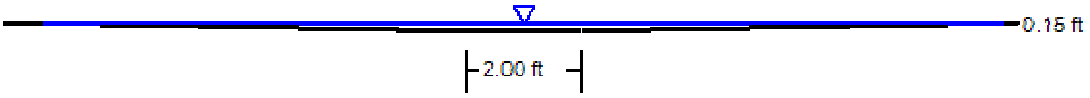
Project Description

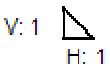
Solve For	Spread

Input Data

Discharge		1.00	ft³/s
Spread		16.56	ft
Left Side Slope		2.00	%
Right Side Slope		2.00	%
Bottom Width		2.00	ft
Grate Width		2.00	ft
Grate Length		2.00	ft
Local Depression		0.00	in
Local Depression Width		0.00	ft
Grate Type	P-50 mm (P-1-7/8")		
Clogging		50.00	%

Cross Section Image





Worksheet for Orifice Existing DI#2

Project Description

Solve For	Headwater Elevation

Input Data

Discharge	4.00	ft³/s
Centroid Elevation	0.75	ft
Tailwater Elevation	0.48	ft
Discharge Coefficient	3.00	
Diameter	1.50	ft

Results

Headwater Elevation	0.76	ft
Headwater Height Above Centroid	0.01	ft
Tailwater Height Above Centroid	-0.27	ft
Flow Area	1.77	ft²
Velocity	2.26	ft/s

Cross Section for Orifice Existing DI#2

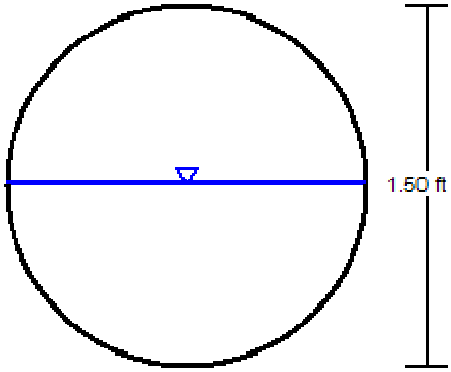
Project Description

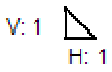
Solve For	Headwater Elevation

Input Data

Discharge	4.00	ft³/s
Headwater Elevation	0.76	ft
Centroid Elevation	0.75	ft
Tailwater Elevation	0.48	ft
Discharge Coefficient	3.00	
Diameter	1.50	ft

Cross Section Image





Worksheet for 3FT FLUME ON SCHOOL

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.60000	%
Bottom Width	2.00	ft
Discharge	4.00	ft³/s

Results

Normal Depth	0.48	ft
Flow Area	0.96	ft²
Wetted Perimeter	2.96	ft
Hydraulic Radius	0.32	ft
Top Width	2.00	ft
Critical Depth	0.50	ft
Critical Slope	0.00533	ft/ft
Velocity	4.18	ft/s
Velocity Head	0.27	ft
Specific Energy	0.75	ft
Froude Number	1.06	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.48	ft
Critical Depth	0.50	ft
Channel Slope	0.60000	%
Critical Slope	0.00533	ft/ft

Cross Section for 3FT FLUME ON SCHOOL

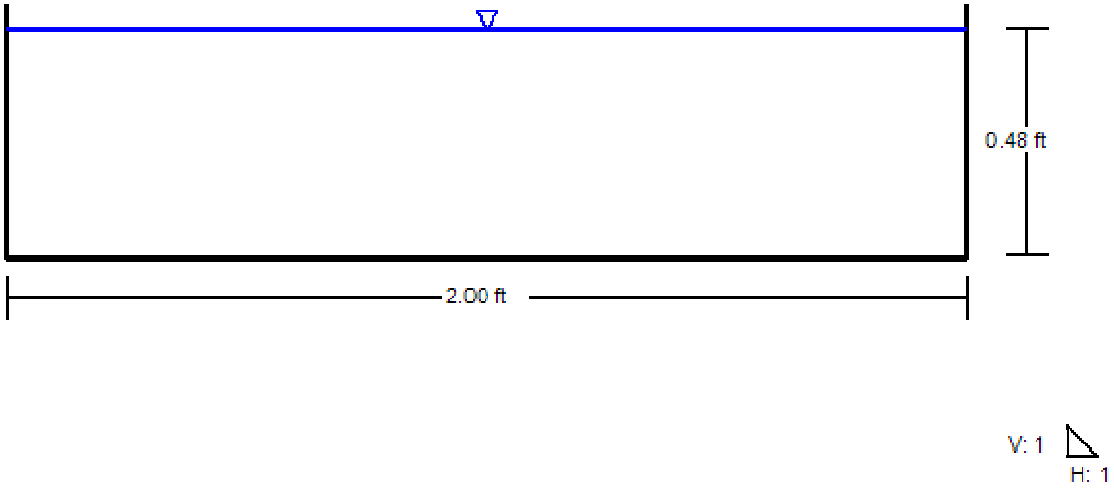
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.60000	%
Normal Depth	0.48	ft
Bottom Width	2.00	ft
Discharge	4.00	ft³/s

Cross Section Image



Dorrell Crossing Storm Drain Lateral Calcultations

Lateral Location	Diam (D) (ft)	Lateral Length (L) (ft)	D/S Invert	U/S Invert	Lateral Slope	Q (cfs)	Mannings n	TC/FG	Mainline D/S HGL	Critical Depth Yc	Normal Depth Yn	Mainline Depth above D/S lat Inv.	D/S Controling HGL	D/S HGL	Pressure Flow Y or N	Area Sqft	Wetted Perimeter Pw (ft)	Hydraulic Radius Rh (ft)	V ft/s	Hv ft	Sf ft/ft	Hf ft	Bend Angle	Bend Loss ft	Inlet loss Hi ft	U/S EGL ft	U/S HGL ft	Full Flow area	Inlet Control Check H	U/S HGL final	HGL Cover ft
DI#1-MH#1	1.5	18.1	5.45	6	0.0304	4	0.013	9.58	6.19	0.77	0.476	0.74	Maine	6.19	N	0.87	2.34	0.37	4.61	0.33	0.0061	0.11			0.16	6.79	6.46	1.77	6.94	6.94	2.14
MH#1-MH#2	1.5	142	1.7	5.25	0.0250	4	0.013	9.42	3.98	0.77	0.501	2.28	Maine	3.98	Y	1.77	4.71	0.38	2.26	0.08	0.0015	0.21	90	0.5	0.04	4.81	4.73	1.77	6.19	6.19	3.23
MH#2-DI#2	1.5	32.75	1.23	1.5	0.0082	4	0.013	6.2	3.39	0.77	0.677	2.16	Maine	3.39	Y	1.77	4.71	0.38	2.26	0.08	0.0015	0.05	90	0.5	0.04	4.06	3.98	1.77	2.44	3.98	2.22
DI#2-outlet	1.5	1	1.01	1.03	0.0200	4	0.013	6	2.85	0.77	0.531	1.84	Maine	2.85	Y	1.77	4.71	0.38	2.26	0.08	0.0015	0.00	90	0.5	0.04	3.47	3.39	1.77	1.97	3.39	2.61

Calculations
V=Q/A
Hv=v^2/(2g)
D/s EGL=D/S HGL+Hv
Sf=(Vn/(1.49R^2/3))^2
Hf=SfL
U/S EGL=D/S HGL+Hv+Hf+Hi
U/S HGL=U/S EGL-Hv
Hi=.5(v^2/(2g))
R=D/2
Pw=Rθ
Rh= A/Pw

Friction Loss (Hf)
Inlet Loss (Hi)

Phi=(2gn^2)/2.21
$Q=0.65A\sqrt{2gh}$

Bend Loss = Kb(V^2/2g) Eq 807
INLET CONTROL HGL=$(Q/.65A)^2$/2g+D/2+U/S INV

Critical Depth circular pipe & Area of partially full pipe

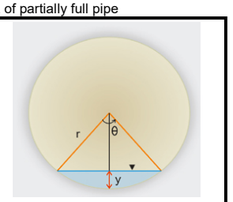
$\theta = 2\cos^{-1}[1 - 2(y/D)]$

$A = (D^2/8)(\theta - \sin\theta)$

$T = D\sin(\theta/2)$

$V = Q/A$

$(Q^2T)/(gA^3) = 1$



Manning Equation:

$$Q = VA \qquad V = \frac{k}{n}\left(\frac{A}{P}\right)^{2/3} S^{1/2}$$

k is a unit conversion factor: k=1.49 for English units (feet and seconds).
A=Flow area of the pipe, culvert, or channel.
P=Wetted perimeter which is the portion of the circumference that is in contact with water.
Q=Discharge (flow rate).
S=Downward (longitudinal) slope of the culvert.
V=Average velocity in the pipe, culvert, or channel.

Sharp Radius Bend (Table 803)

Angle	Kb
30	0.25
45	0.35
60	0.43
90	0.5

APPENDIX B

Referenced approved Calculations

THOMASON
CONSULTING
ENGINEERS

CITY OF LAS VEGAS INTER-OFFICE MEMORANDUM			DATE: August 23, 2022
TO: **Land Development Services** Department of Building & Safety			FROM: Albert Sung, P.E. Flood Control Project Engineer Department of Public Works
SUBJECT:	Drainage Study for:		**COPIES TO:**
	Gilmore 2.14		TCE
Cross Streets:	NW Gilmore Ave & Campbell Road		Signature Homes
File Number:	F:\Depot\DSMemos\DS5544C.doc		Bart Anderson, P.E., DevCo
Parcel Number:	138-08-101-030		
Zoning Action:	SDR-21-0671		
FEMA Flood Zone	YES	NO X	
Proposed Storm Drain	YES X	NO	

HISTORY	DATE RECEIVED	DATE REVIEWED	COMMENTS	REVIEW FEES	FEES PAID Payment Trn #
1st Submittal	2/03/2022	2/22/2022	Not Approved	$400	4637329: $400
2nd Submittal	5/31/2022	6/27/2022	Not Approved	$400	4809776: $400
3rd Submittal	8/10/2022	8/23/2022	Conditionally Approved	$400	4905523: $400
			TOTAL FEES (LDDRS):	**$1200**	**----**

REMARKS:

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

	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.
X	is conditionally approved subject to the following conditions:

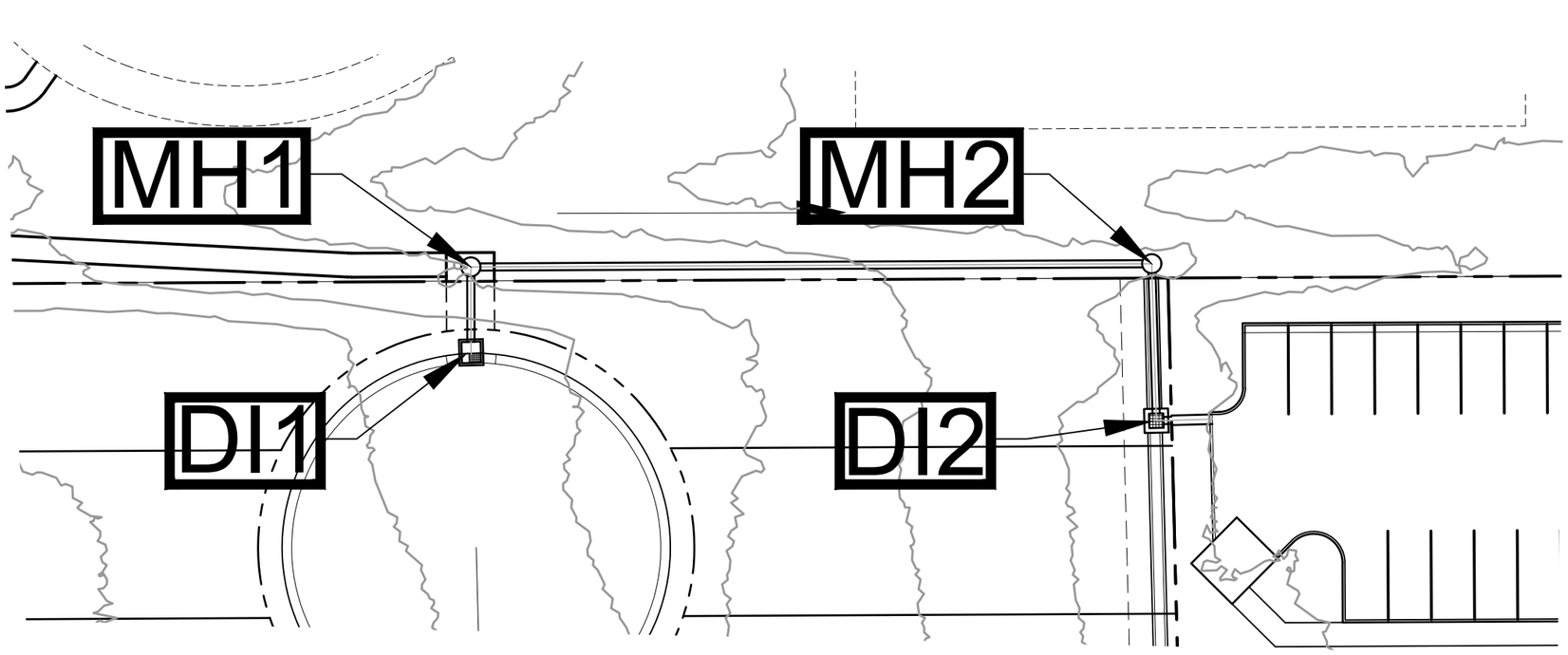
1. The grading plan indicates offsite grading onto CLV land, Garehime Heights Park. Secure a letter of permission from the City of Las Vegas Parks & Recreation allowing the grading and access. This letter is required prior to final acceptance of the improvement plans.
2. The grading plan indicates offsite grading onto Seton Academy. Secure a notarized letter of permission from the property owner allowing the construction. This letter is required prior to final acceptance of the improvement plans.

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) 687-942

END OF REMARKS
HDR/OSK/CAA

T/R/S: T20S/R60E/S08
AREA L-08

INLET/MANHOLE	Q100 (CFS)	CONTROLING HGL	GRATE/TMH	HGL COVER
DI1	4	7.49	9.08	1.59
MH1	4	6.38	9.42	3.04
MH2	4	3.44	6.20	2.76
DI2	4	3.23	8.30	5.07



FROM ADD2

NORTH

30 0 15 30 60

1" = 30'

THOMASON CONSULTING ENGINEERS
7080 LA CIENEGA STREET, SUITE 200
LAS VEGAS, NEVADA 89119
702-932-6125 FAX: 702-932-6129

SIGNATURE HOMES
LEBARON EDMONDS

HYDRAULIC FIGURE
FIGURE 7

7

FROM ADD2

Dorrell Crossing Storm Drain Lateral Calcultations

Lateral Location	Diam (D) (ft)	Lateral Length (L) (ft)	D/S Invert	U/S Invert	Lateral Slope	Q (cfs)	Mannings n	TC/FG	Mainline D/S HGL	Critical Depth Yc	Normal Depth Yn	Mainline Depth above D/S lat Inv.	D/S Controling HGL	D/S HGL	Pressure Flow Y or N	Area Sqft	Wetted Perimeter Pw (ft)	Hydraulic Radius Rh (ft)	V ft/s	Hv ft	Sf ft/ft	Hf ft	Bend Angle	Bend Loss ft	Inlet loss Hi ft	U/S EGL ft	U/S HGL ft	Full Flow area	Inlet Control Check H	U/S HGL final	HGL Cover ft
DI#1-MH#1	1.5	18.1	5.64	6.55	0.0503	4	0.013	9.58	6.38	0.77	0.418	0.74	Maine	6.38	N	0.87	2.34	0.37	4.61	0.33	0.0061	0.11			0.16	6.98	6.65	1.77	7.49	7.49	1.59
MH#1-MH#2	1.5	142	2.7	5.44	0.0193	4	0.013	9.42	4.11	0.77	0.536	1.41	Maine	4.11	N	1.72	3.97	0.43	2.32	0.08	0.0013	0.18	90	0.5	0.04	4.91	4.83	1.77	6.38	6.38	3.04
MH#2-DI#2	1.5	32.75	2.29	2.5	0.0064	4	0.013	6.2	3.51	0.77	0.727	1.22	Maine	3.51	N	1.54	3.37	0.46	2.60	0.10	0.0015	0.05	90	0.5	0.05	4.22	4.11	1.77	3.44	4.11	2.09
DI#2-outlet	1.5	2	2.09	2.29	0.1000	4	0.013	8.3	2.85	0.77	0.351	0.76	Maine	2.85	N	0.90	2.38	0.38	4.45	0.31	0.0056	0.01	90	0.5	0.15	3.82	3.51	1.77	3.23	3.51	4.79

Calculations
V=Q/A
Hv=v^2/(2g)
D/s EGL=D/S HGL+Hv
Sf=(Vn/(1.49R^2/3))^2
Hf=SfL
U/S EGL=D/S HGL+Hv+Hf+Hi
U/S HGL=U/S EGL-Hv
Hi=.5(v^2/(2g))
R=D/2
Pw=Rθ
Rh= A/Pw

Friction Loss (Hf)
Inlet Loss (Hi)

Phi=(2gn^2)/2.21
$Q=0.65A\sqrt{2gh}$

Bend Loss = Kb(V^2/2g) Eq 807
INLET CONTROL HGL=$(Q/.65A)^2$/2g+D/2+U/S INV

Critical Depth circular pipe & Area of partially full pipe

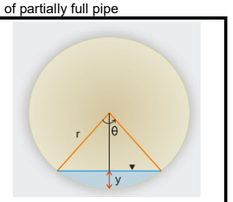
$\theta = 2\cos^{-1}[1 - 2(y/D)]$

$A = (D^2/8)(\theta - \sin\theta)$

$T = D\sin(\theta/2)$

$V = Q/A$

$(Q^2T)/(gA^3) = 1$



Manning Equation:

$$Q = VA \qquad V = \frac{k}{n}\left(\frac{A}{P}\right)^{2/3} S^{1/2}$$

k is a unit conversion factor: k=1.49 for English units (feet and seconds).
A=Flow area of the pipe, culvert, or channel.
P=Wetted perimeter which is the portion of the circumference that is in contact with water.
Q=Discharge (flow rate).
S=Downward (longitudinal) slope of the culvert.
V=Average velocity in the pipe, culvert, or channel.

Sharp Radius Bend (Table 803)

Angle	Kb
30	0.25
45	0.35
60	0.43
90	0.5