TECHNICAL MEMORANDUM

Date: May 10, 2022

BKF No.: 20201331

Deliver To: Bruce Dorfman
Mallard Pointe 1915, LLC

From: Christopher Mills
BKF Engineers

Subject: **Mallard Pointe Preliminary Drainage Strategy**

I. BACKGROUND INFORMATION

The existing Mallard Pointe project site is located at 1-22 Mallard Road, in Belvedere Tiburon. The property is located on 3 separate parcels which contain 22 existing units. The site is bounded by the Belvedere Lagoon on the north and east sides, Community Road on the west side, and residential units on the south side. The total site area is approximately 2.75-acres (120,079-SF), with 2.63-acres of that area being developable (0.12-acres are portions of the Lagoon). Within this developable area, roughly 78% is impervious area with 22% pervious area. The redevelopment improvement of this area includes the construction of 42 proposed units, 3 ADUs, parking, roadway and utilities to support the new developments.

Record information was used as a basis of design and was supplemented with survey conducted by BKF (March 2022) where gaps in information occured. The existing storm drain system is composed of 2 outfalls that run through the project site. According to existing record maps depicted in the 2007 Matterson & Associates study[3] and Marin County GIS, Outfall #1 is 15-inches and is located in the center of the site at existing 9 Mallard Road. Outfall #2 is 15-inches and is located at the southeast corner of the project site, adjacent to 500 San Rafael Avenue. An approximate total of 19.3-acres is routed to these 2 outfalls. Roughly 16.6-acres is generated by offsite drainage sheds that are upstream of the project site and 2.8-acres is contributed from the project site itself.

Prior to offsite drainage reaching the project site outfalls, it is routed to an existing diversion structure that is located on the Belvedere City Hall property, facing Community Road. This diversion structure sends approximately 6.5-cfs to Outfall #1 and 4.0-cfs to Outfall #2. Ponding occurs in the existing condition in Community Road, at the curb inlets just in front of the project site. Based on the 2006 Matterson & Associates study[2], residents have described historical flooding problems that occur about once a year, with ponding that exceeds 6-inches.

II. DRAINAGE STRATEGY

The proposed storm drain pipes are designed with assumptions consistent with available studies[2,3,4]. Pipes serving the site convey a 10-year design flow, with hydraulic grade lines 6-inches below the rim or gutter flow line. Factors that affect hydraulic grade line include pipe size and head losses (which include friction losses, entrance, bend and exit losses), and tail water elevation. Bentley StormCAD program was used to solve Manning's equation and head losses in the pipe.

In the proposed condition, all existing storm drain lines within the site will be removed. There are no proposed improvements to existing Outfalls #1 and #2. A new series of treated and untreated storm drain lines will be installed in its place to accommodate onsite and offsite drainage. The new storm drain network will reconnect to existing 15-inch Outfall #1, while Outfall #2 will remain unchanged. Per preliminary BKF modeling using XPSWMM of the existing storm drain system, a ponding of about 3-inches occurs at the existing curb inlets along Community Road. The project's proposed pipes have been sized to reduce the existing flooding within Community Road to a minimum of 6-inches below the gutter flow line. See Attachment 2 for the StormCAD analysis results.

The site is divided into 14 drainage sheds. Sheds 1 through 12 represent each lot's roof area, these sheds will be treated within the respective lot's bioretention area(s). Shed 13 represents the project sites roadways, walkways and lot driveways/frontage area that naturally drain towards the proposed roadways. Shed 13 drainage is captured via curb inlets within Mallard Road and be routed through an untreated storm drain line and pumped to a series of 4 bioretention areas located between lots 3, 4, 6 and 7. Finally, shed 14 represents the landscaped areas that surface flow into the lagoon and will be considered a Self-Treating area. Treated drainage from sheds 1 through 13 will be collected and conveyed to a 24-inch storm drain line located between lots 8 and 7. The 24-inch storm drain line ultimately connects back to the existing 15-inch storm drain Outfall #1 and outfalls into the Belvedere Lagoon.

III. DRAINAGE CRITERIA

- For drainage analysis, a runoff coefficient of 0.80 was utilized for all roadway and roof sheds.
- A Winter Water Surface elevation[4] of 2.43-feet was used as the tail water elevation.
- A time of concentration 5 minutes was assumed for all roadway and roof sheds.
- Pipes will be HDPE, with a roughness coefficient of 0.013.
- Each pipe size is designed with a minimum slope to achieve a minimum velocity of 2-feet per second when flowing half full.
- Proposed drainage system designed to prevent increased flooding to the existing condition within Community Road.

Table 1. Minimum Pipe Slope Table

Pipe Size (in)	Area (ft^2)	Wetted Perimeter (ft)	Manning's n	Minimum Slope (ft/ft)
4	0.09	1.04	0.013	0.0100
6	0.10	0.79	0.013	0.0050
8	0.18	1.05	0.013	0.0032
10	0.54	2.61	0.013	0.0024
12	0.79	3.14	0.013	0.0020
15	0.61	1.96	0.013	0.0015
18	0.88	2.36	0.013	0.0012
24	1.57	3.14	0.013	0.0008

IV. CONCLUSION

Based on the StormCAD calculations provided in attachments, the proposed onsite storm drain system will be able to capture and convey the 10-year event. BKF conducted a preliminary analysis of the existing storm drain system using XPSWMM hydraulic modeling software. Results of the existing conditions analysis depict flooding that occurs at the low points within Community Road. The StormCAD proposed modeling show the 10-year storm event contained within manholes 31 and 32 at Community Road, refer to Attachment 2. This result indicates a reduction in flooding due to the proposed infrastructure. The supplemental BKF study will be refined and provided at a later date for reference.

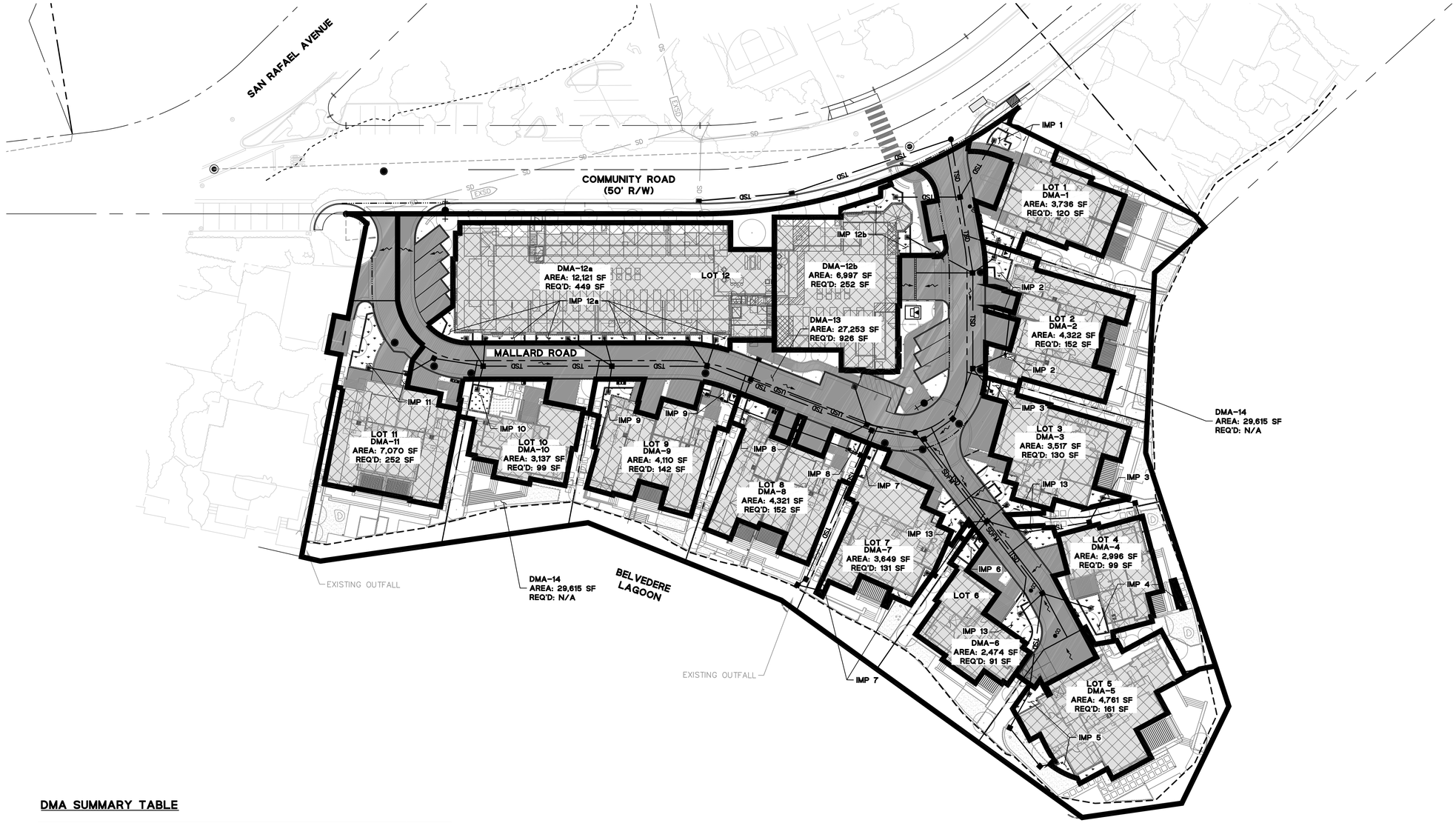
V. ATTACHMENTS

1. Preliminary Stormwater Concept
2. StormCAD Model Results

VI. REFERENCES

1. "Section VI. Drainage Facilities, Subsection 24.0.520 – Hydrologic and Hydraulic Design," By Marin County, CA Municode.
2. "Belvedere Community Road Drainage Improvements," By Mattern & Associates. Dated November 14, 2006.
3. "Belvedere Community Road Drainage Improvements," By Mattern & Associates. Dated April 27, 2007.
4. "Overview of Lagoon Water," Stetson Engineer Inc., Dated 2014.

ATTACHMENT 1:
PRELIMINARY
STORMWATER CONCEPT



DMA SUMMARY TABLE

BOUNDARY	CONVENTIONAL SURFACE (SF)			DRAINS TO	LID OR BMP (SF)	TOTAL (SF)	TOTAL (ACRE)
WATERSHED	ROOF	HARDSCAPE	LSP				
DMA-1	2,572	244	710	IMP 1	210	3,736	0.09
DMA-2	3,476	199	452	IMP 2	195	4,322	0.10
DMA-3	3,228	-	115	IMP 3	174	3,517	0.08
DMA-4	2,253	154	315	IMP 4	274	2,996	0.07
DMA-5	3,873	-	599	IMP 5	289	4,761	0.11
DMA-6	2,252	-	99	IMP 6	123	2,474	0.06
DMA-7	3,227	-	201	IMP 7	221	3,649	0.08
DMA-8	3,474	211	425	IMP 8	211	4,321	0.10
DMA-9	3,220	208	474	IMP 9	208	4,110	0.09
DMA-10	2,070	220	693	IMP 10	154	3,137	0.07
DMA-11	4,025	2,121	588	IMP 11	336	7,070	0.16
DMA-12a	11,097	-	462	IMP 12a	562	12,121	0.28
DMA-12b	5,917	259	507	IMP 12b	314	6,997	0.16
DMA-13	-	22,129	4,096	IMP 13	1,028	27,253	0.63
DMA-14	-	-	29,615	SELF-TREATING	-	29,615	0.68
OVERALL TOTAL	50,684	25,745	39,351	-		120,079	2.76

LEGEND

- EXISTING PROPERTY LINE
- PROPOSED PROJECT BOUNDARY
- PROPOSED PROPERTY LINE
- BUILDING SETBACK
- BULKHEAD LIMITS
- 100 YEAR BASE FLOOD ELEVATION
- ROAD CENTERLINE
- DRAINAGE MANAGEMENT AREA
- ROOF AREA
- IMPERVIOUS AREA
- LANDSCAPE AREA
- BIORETENTION AREA

NOTES

1. PROPOSED BUILDINGS ARE SHOWN FOR REFERENCE ONLY, REFER TO ARCHITECTURAL DRAWINGS FOR ADDITIONAL INFORMATION.

ABBREVIATIONS

DMA	DRAINAGE MANAGEMENT AREA
REQ'D	REQUIRED
SF	SQUARE FEET

STORMWATER CONTROL PLAN

May 10, 2022

Graphic Scale

1"=30'

30' 15' 0 30' 60'

MALLARD POINTE

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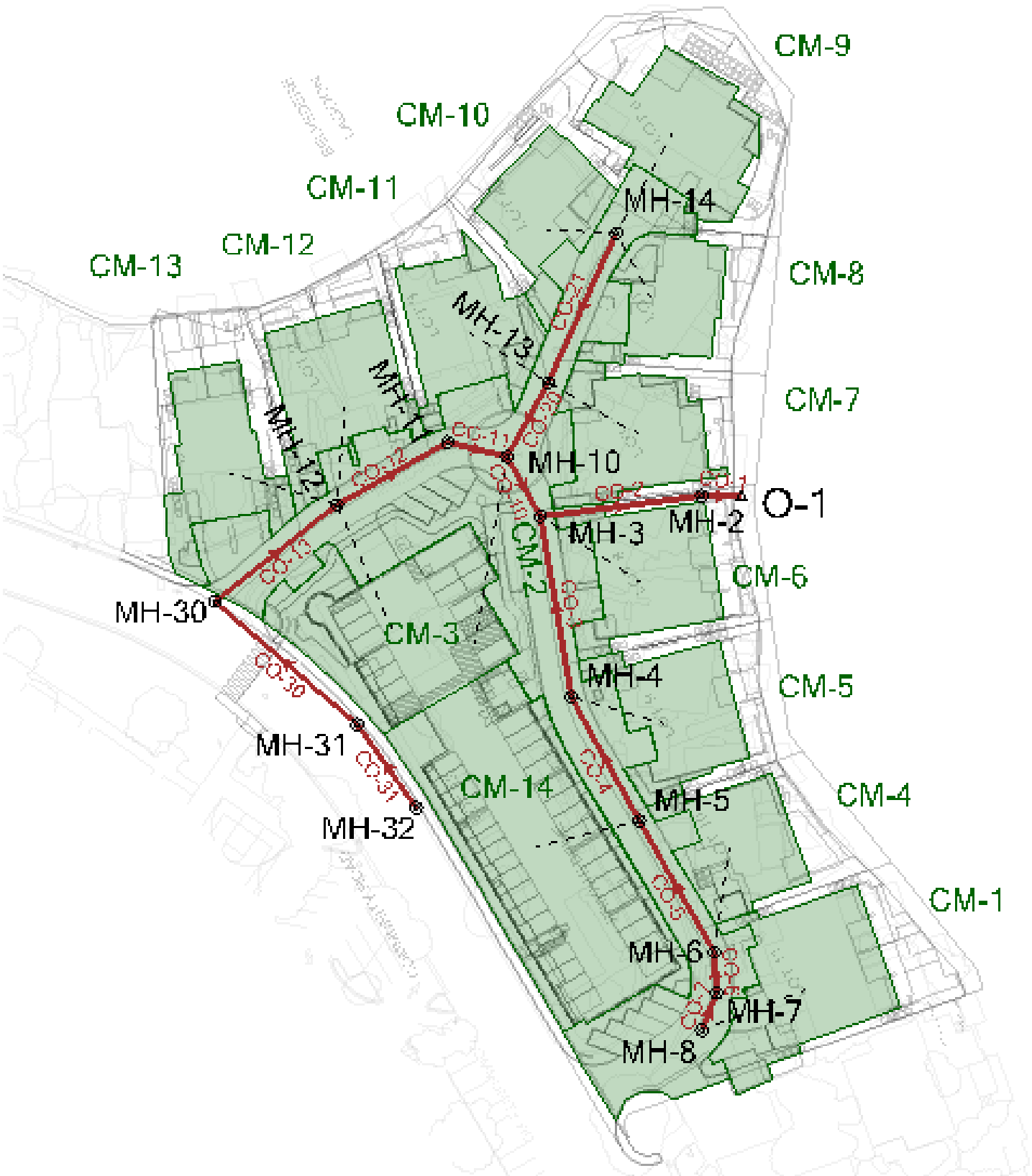
TM-6

ATTACHMENT 2:
STORMCAD MODEL RESULTS

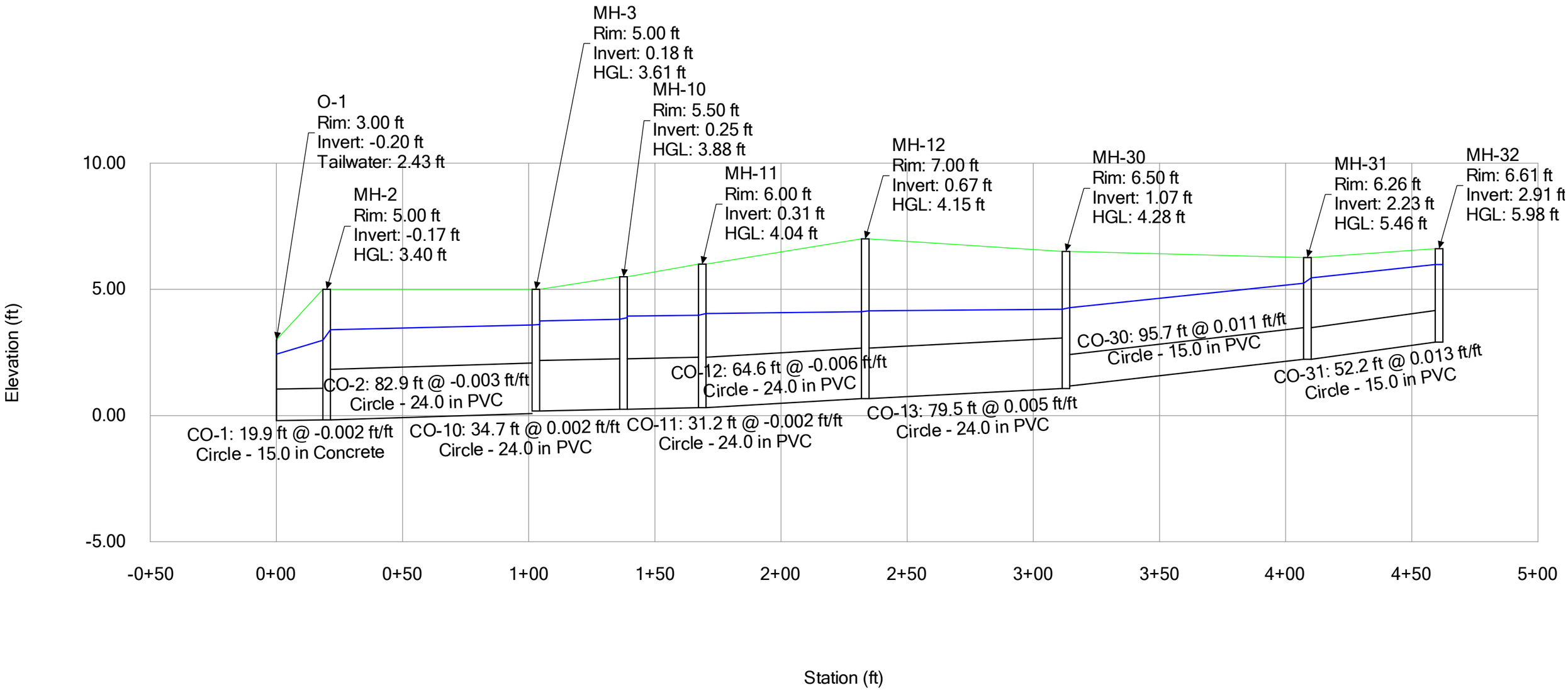
OVERALL STORMCAD MODEL



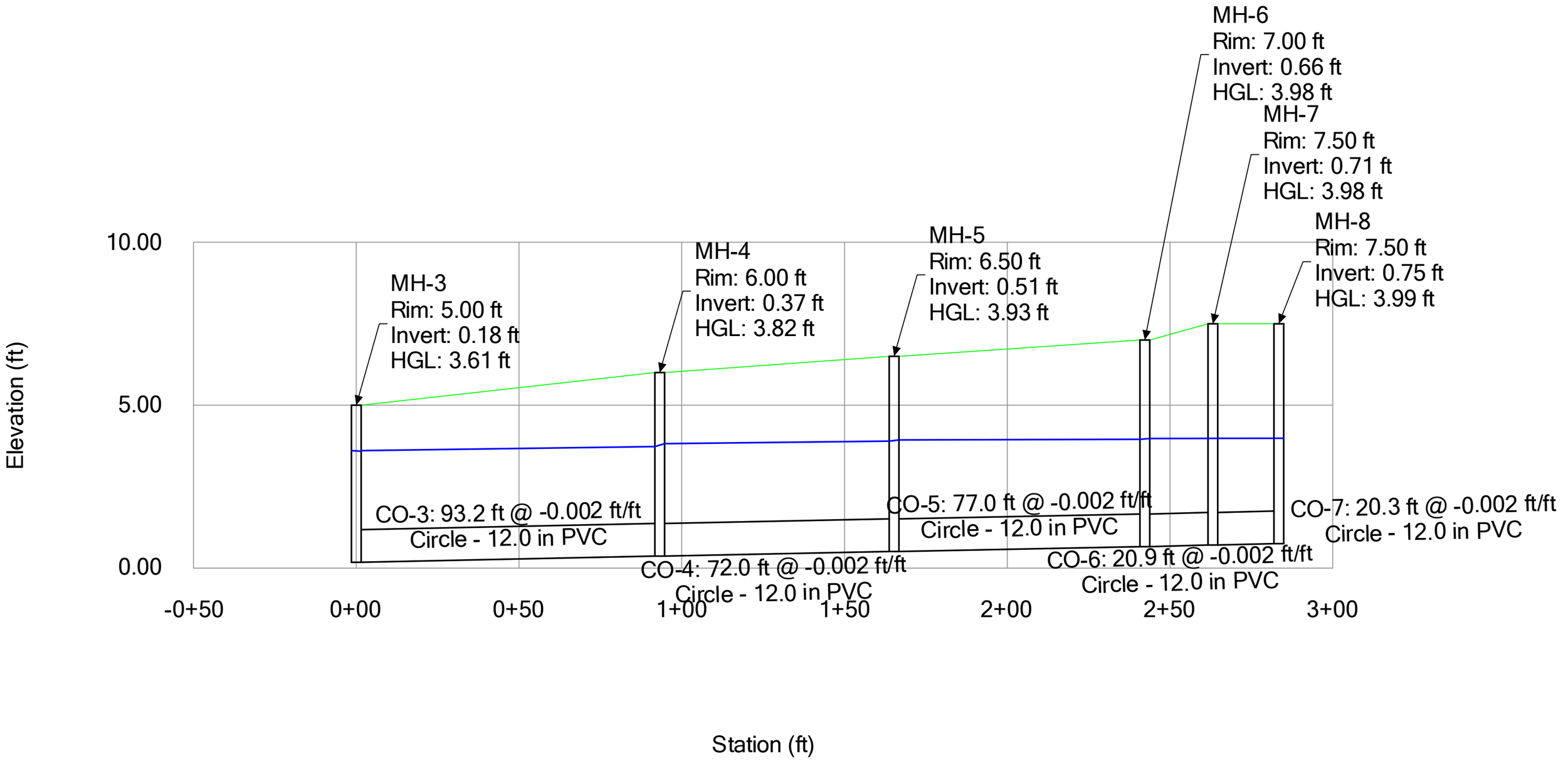
FlexTable: Conduit Table

Label	Start Node	Stop Node	Flow (cfs)	Capacity (Design) (cfs)	Diameter (in)	Length (Unified) (ft)	Slope (Calculated) (ft/ft)	Manning's n	Invert (Start) (ft)	Invert (Stop) (ft)	Velocity (ft/s)
CO-1	O-1	MH-2	10.74	2.51	15.0	19.9	-0.002	0.013	-0.20	-0.17	8.76
CO-2	MH-2	MH-3	10.81	12.42	24.0	82.9	-0.003	0.013	-0.17	0.08	3.44
CO-3	MH-3	MH-4	1.30	1.61	12.0	93.2	-0.002	0.013	0.18	0.37	1.66
CO-4	MH-4	MH-5	1.18	1.57	12.0	72.0	-0.002	0.013	0.37	0.51	1.50
CO-5	MH-5	MH-6	0.54	1.57	12.0	77.0	-0.002	0.013	0.51	0.66	0.68
CO-6	MH-6	MH-7	0.35	1.74	12.0	20.9	-0.002	0.013	0.66	0.71	0.44
CO-7	MH-7	MH-8	0.36	1.58	12.0	20.3	-0.002	0.013	0.71	0.75	0.46
CO-11	MH-10	MH-11	7.51	9.92	24.0	31.2	-0.002	0.013	0.25	0.31	2.39
CO-20	MH-10	MH-13	1.15	1.63	12.0	43.2	-0.002	0.013	0.35	0.44	1.46
CO-10	MH-10	MH-3	10.10	10.15	24.0	34.7	0.002	0.013	0.25	0.18	3.21
CO-12	MH-11	MH-12	7.54	16.89	24.0	64.6	-0.006	0.013	0.31	0.67	2.40
CO-21	MH-13	MH-14	0.71	1.60	12.0	83.8	-0.002	0.013	0.44	0.61	0.91
CO-31	MH-32	MH-31	6.48	7.37	15.0	52.2	0.013	0.013	2.91	2.23	5.28
CO-30	MH-31	MH-30	6.48	6.80	15.0	95.7	0.011	0.013	2.23	1.17	5.28
CO-13	MH-30	MH-12	6.48	16.04	24.0	79.5	0.005	0.013	1.07	0.67	2.06

Profile Report
Engineering Profile - O1-MH32 (MPPR_SDMODEL.stsw)



Profile Report
Engineering Profile - MH3-MH8 (MPPR_SDMODEL.stsw)



Profile Report
Engineering Profile - MH10-MH14 (MPPR_SDMODEL.stsw)