APPENDIX G

DRAINAGE MASTER PLAN

Drainage Master Plan

STONE BEETLAND
SACRAMENTO, CALIFORNIA

NOVEMBER 2021

CARLSON, BARBEE & GIBSON, Inc.
CIVIL ENGINEERS • SURVEYORS • PLANNERS

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I. BACKGROUND

The Stone Beetland property ("Project") is located directly east of the Delta Shores master planned community. The Project is approximately 140 acres and is bound by Cosumnes River Boulevard to the south, Delta Shores and the future 24th Street extension to the west, US Government Job Corps property and the Detroit Boulevard Neighborhood to the north and the Sacramento Regional Transit Blue Line light rail line and station, and Morrison Creek to the east. See Figure 1 depicting the Project Location. The proposed Project includes the development of a mixed-use community with a range of residential densities that transition from singular housing types as the surrounding communities to higher densities surrounding the Light Rail station, promoting transit-oriented development. The current land uses within the Project include approximately 1,160 residential units, 6 acres of commercial uses and 28 acres of trails, open space and integrated drainage facilities. See Figure 2 depicting the proposed Project Land Use Plan.

The proposed Project was considered as a future development site within the Delta Shores Drainage Master Plan, dated August 2013. Accordingly, the infrastructure downstream of the Project and within the Sump 89 Watershed has been planned to provide capacity for the Project. Additionally, the existing storm drain pipelines and culverts crossing existing Cosumnes River Boulevard have been planned and constructed to convey the stormwater runoff from the Project site.

II. EXISTING CONDITIONS

The Project site existing conditions consist of undeveloped agricultural lands. The existing drainage pattern of the Project site is gently sloped from the north and west to the lower lying southeast corner. The existing ground elevations of the Project site range from elevation 12' to 13' along the northern boundary to elevation 5' in the southwest corner. The existing stormwater runoff within the site is conveyed by surface flows to small ditches that convey runoff to the southwest, where existing culverts convey runoff across Cosumnes River Blvd and to the downstream Sump 89 facilities and outfall to Morrison Creek.

The majority of the Project site is within FEMA Zone X (areas of outside of the 100-year floodplain) per FEMA's FIRM Panel 06067C0305H, dated August 16, 2012. The southeastern corner of portions of the Project site is within FEMA Zone AE (areas subject to the 100-year

floodplain). The portion of the Project within FEMA Zone X is protected from flood inundation by the certified levee along the west bank of Morrison Creek.

III. EXISTING STORM DRAIN FACILITIES

There are two existing storm drain pipelines that bisect the Project site. These pipelines convey runoff from the US Govt Job Corps property and Detroit Boulevard Neighborhood through the Project Site and to the downstream facilities. The existing storm drain pipeline bisecting the center of the Project was referred to as the "Z Line" in the 2013 Delta Shores Drainage Master Plan. The Z Line conveys runoff from the undeveloped US Govt Job Corps property and it ranges from 24" to 30" in diameter. The existing storm drain pipeline bisecting the eastern portions of the Project was referred to as the "Y Line" in the 2013 Master Plan. The Y Line conveys runoff from the Detroit Boulevard Neighborhood and it ranges from 27" – 42" in diameter.

There is also an existing drainage basin that treats and detains the runoff from the Light Rail station parking lot. This facility discharges into a ditch that then is collected and conveyed by a 42" culvert crossing Cosumnes River Blvd.

All of the existing storm drain facilities discussed above extend southerly and convey stormwater across the existing Cosumnes River Blvd. These pipelines then converge into larger diameter pipelines, ranging from 54" to 78" in diameter, which then connect to the existing Sump 89 discharge to Morrison Creek. The existing storm drain facilities within and downstream of the Project site are reflected on Figure 3.

IV. STORMWATER MODELING METHODOLOGY

Stormwater modeling has been conducted utilizing the xpStorm platform, starting with the regional modeling runs provided by the City of Sacramento (file name "Ult-10-16-13-100-yr"). This corresponds to the approved 2013 Delta Shores Drainage Master Plan. The design criteria established for the Stone Beetland drainage system is to provide storm drain infrastructure that does not increase the hydraulic grade line elevations downstream or upstream of the Project site for the 100-year design storm.

The stormwater model has maintained the same parameterization as that in the approved 2013 Delta Shores Drainage Master Plan. The only updates incorporated include the hydrologic inputs that more accurately represent the proposed drainage areas within the Project site and the hydraulic inputs that more accurately reflect the proposed pipeline relocations and basin locations within the Project site. The model assumed consistent slope, analogous width parameters and identical infiltration parameters as included in the approved original model. Also, the 100-year, 24-hour design storm, with a total rainfall of 4.28 inches, was utilized for the updated stormwater model.

V. PROPOSED DRAINAGE AREAS

The 2013 Delta Shores Drainage Master Plan represented the area encompassed by the proposed Project in five distinct sub-watersheds with a combined total area of 135.7 acres. All five of these sub-watersheds were routed to a single stormwater basin designated "BodDB". This aggregate area included the full Stone Beetland site plus the intervening properties (Light Rail and Regional Sanitation) to the east as far as the Morrison Creek levee.

For the purposes of preliminary drainage planning, the Project site was also divided into five drainage management areas (DMAs), with two additional off-site DMAs encompassing the remainder of the previous "Boswell" area. These DMAs are shown on the attached Figure 4 – Hydrology Workmap along with the pre-project storm drain system immediately downstream and upstream of the site. The calculated aggregate drainage area of 137.9 acres compares well with the value in the 2013 Delta Shores Drainage Master Plan.

The stormwater planning is to route the four eastern DMAs to a single stormwater basin as referred to herein as the East Basin. The West DMA will be routed separately to a single stormwater basin identified as the West Basin. The characteristics of the stormwater basins are discussed in the following section.

Hydrologic properties used in the updated modeling are summarized in Table 1 for the on-site DMAs and Table 2 for the off-site DMAs.

Table 1 – Hydrologic Parameters for On-Site DMA's

DMA	Area (acres)	Impervious (%)	Width (feet)	Connection Node
East	25.4	90	2,400	SE-50
North	22.1	70	2,200	SE-54
East Central	13.0	65	1,600	SE-60
West Central	15.7	60	1,800	SE-70
East Basin Subtotal	**76.2**	**74**	**----**	**----**
West	32.6	50	2,600	SW-50
West Basin Subtotal	**32.6**	**50**	**----**	**----**
Project Total	**108.8**	**67**	**----**	**----**

Table 2 – Hydrologic Parameters for the Off-Site DMAs

DMA	Area (acres)	Impervious (%)	Width (feet)	Connection Node
Light Rail	9.3	45	1,400	LR-B
Reg San	19.8	5	2,000	RS-40
Off-Site Subtotal	**29.1**	**18**	**----**	**----**
Project	108.8	67	----	----
Study Area Total	**137.9**	**57**	**----**	**----**

VI. PROJECT STORMWATER BASINS

As noted previously, Project plans currently call for two multi-function stormwater basins to provide runoff water-quality treatment and peak flow attenuation (detention). With respect to water-quality treatment, these facilities will be combination extended detention basins that have been sized using the design guidance in the Stormwater Quality Design Manual for the Sacramento Region (July 2018).

The East Basin will receive runoff from the four eastern Project DMAs as well as all runoff from the existing Detroit Avenue neighborhood and will have a total water quality treatment volume of 8.03 acre-feet and additional detention storage volume of 31.85 acre-feet (including freeboard to top of bank).

The West basin will receive runoff from the West DMA and was sized with a water quality treatment volume of 1.22 acre-feet and additional detention storage volume of 17.91 acre-feet.

Parameters used for sizing these basins are summarized in Table 3.

Table 3 – Stormwater Basin Sizing Parameters

Watershed	Area (acres)	Impervious (%)	East Basin	
On-Site	76.2	74	**Unit Storage**	0.365 inches
Detroit Avenue	135	39	**Water Quality Volume**	8.03 ac-ft
East Basin Subtotal	**211.2**	**52**	**Permanent Pool Volume**	4.02 ac-ft
			West Basin	
On-Site	32.6	50	**Unit Storage**	0.360 inches
West Basin Subtotal	**32.6**	**50**	**Water Quality Volume**	1.22 ac-ft
			Permanent Pool Volume	0.61 ac-ft

The West Basin is considerably larger than the East Basin on a unit drainage area basis. This difference is solely attributable to the required detention storage and not the water quality treatment volume. This reflect the fact that the 2013 Master Drainage Plan had all runoff from the Project area routed to the Y Line pipe infrastructure. However, the current Project plans propose to connect outflow from the West Basin to the Z Line pipe system, which conveys runoff from the large, undeveloped U.S. Govt Job Corps property to the north. This adds a considerable additional load on that system and requires "over detention" to avoid having any increase in HGL values along the Z Line system south of Cosumnes River Boulevard.

Runoff from the Light Rail DMA is currently routed to a stormwater basin on that property. This facility is proposed to be relocated further to the south to allow for additional development areas adjacent to the Light Rail station. The size and function of this basin will be replaced to the south. This will remain unchanged. Lastly, the Reg San DMA is presently routed to a ditch system that crosses under Consumnes River Boulevard and south from there. The east basin and Light Rail basin will be located within this Reg San DMA, but the flow routing of the ditch system will remain as under pre-project conditions. See Figure 5 depicting these facilities.

VII. SUMMARY OF HYDRAULIC MODELING

The Project parameters were loaded into the updated version of the hydrologic / hydraulic model and iterative model runs were carried out to identify the appropriate outlet configurations for the two stormwater basins and required pipe diameters that would fully contain runoff from the 100-year design storm without an overtopping. The latter criterion of no overtopping is not strictly a requirement as overland release for the 100-year event is allowed with proper design. However, this modeling approach is conservative and the only practical approach for this stage of the Project. Additionally, full containment of the 100-year event essentially assures that the runoff from the 10-year design storm can be accommodated with the required system freeboard. Modeled pipe sizes may well be reduced through the final design.

The resulting alignment and sizing of the proposed backbone pipe system and immediately adjacent existing infrastructure are depicted on the Figure 4 – Hydrology Workmap. Table 4 summarizes the pre- and post- project hydraulic modeling results in terms of modeled HGL as pertinent downstream and upstream existing system nodes.

Table 4 – Summary of Modeled Hydraulic Gradeline Values

Model Node	Pre-Project	100-ye HGL (feet) Post-Project	Difference
xPS	0.70	0.67	-0.03
X2 Jct Box	1.31	1.25	-0.06
Y2	1.99	1.88	-0.11
Y8	4.01	3.75	-0.26
Y10	5.19	4.75	-0.43
Y14	9.58	8.90	-0.68
Z2	5.61	5.61	-0.01
Z6	11.37	10.62	-0.75

VIII. CONCLUSION

Hydrologic and hydraulic modeling to update previously approved drainage master planning shows that the Stone Beetland Project can provide adequate stormwater quality treatment, peak flow controls, and conveyance infrastructure that would allow a mix of higher density land uses without adverse impact to the existing regional storm drain system. In fact, with allocation of an appropriate land area (just over 4 acres total) the proposed East Basin will provide full remedial water quality treatment for the existing Detroit Avenue subdivision.

FIGURES

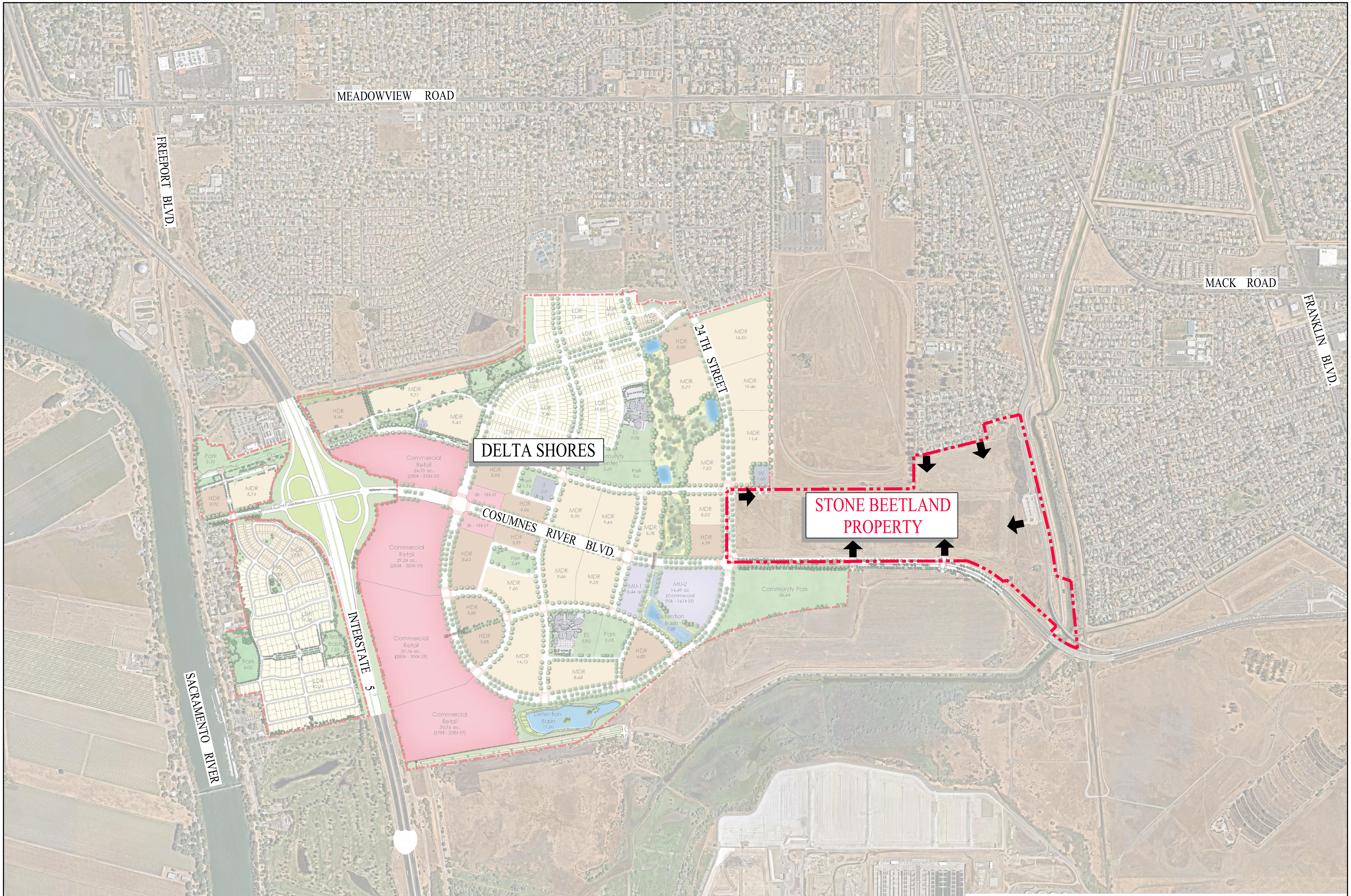

FIGURE 1
CONTEXTUAL REGIONAL MAP
STONE BEETLAND

CITY OF SACRAMENTO SACRAMENTO COUNTY CALIFORNIA

SCALE:1"=400' DATE: NOVEMBER, 2021

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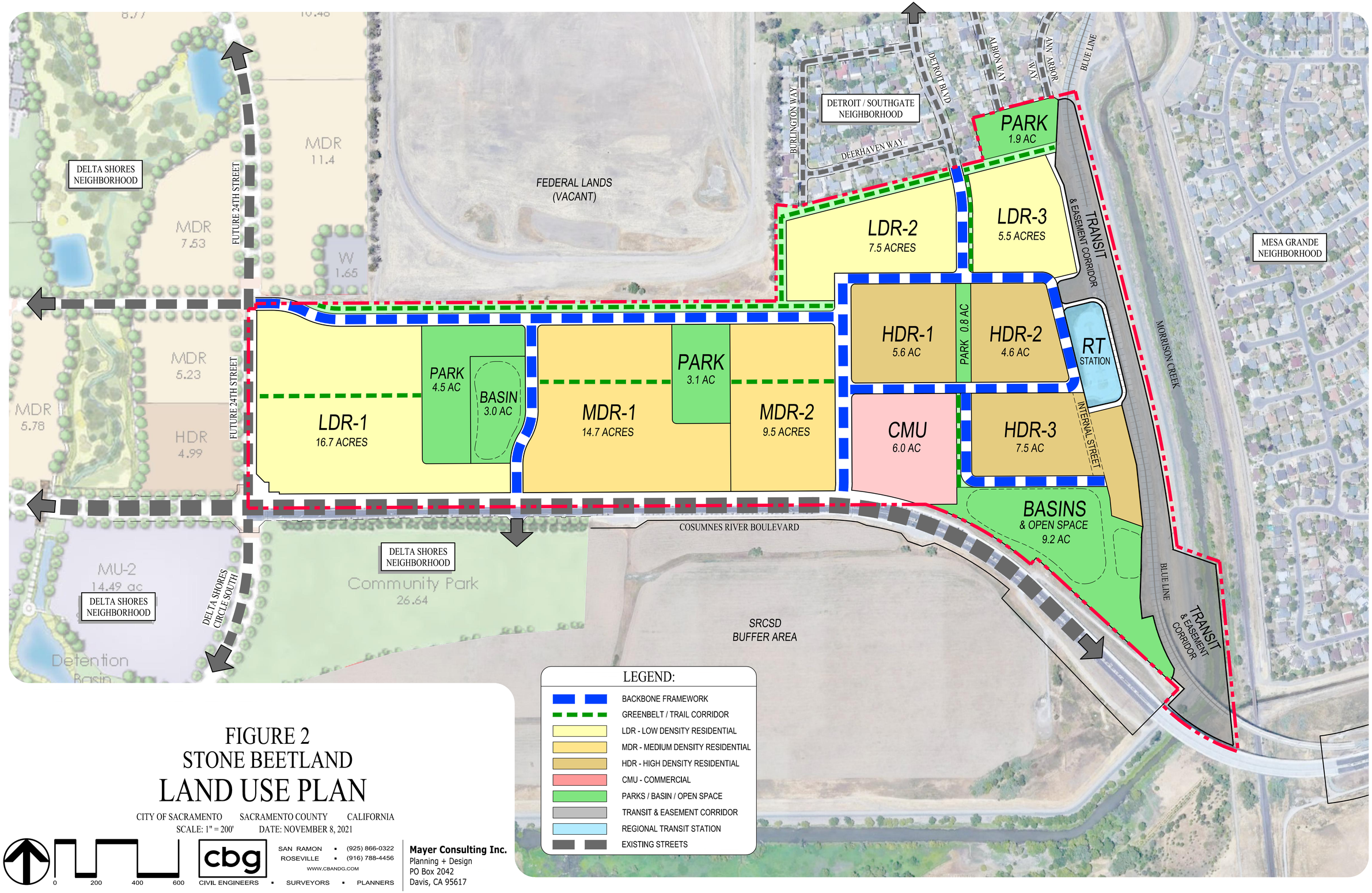

FIGURE 2
STONE BEETLAND
LAND USE PLAN

CITY OF SACRAMENTO SACRAMENTO COUNTY CALIFORNIA

SCALE: 1" = 200' DATE: NOVEMBER 8, 2021

0 200 400 600

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DETROIT / SOUTHGATE

DETROIT BOULEVARD

ALBION WAY

ANN ARBOR WAY

BURLINGTON WAY

DEERHAVEN WAY

FEDERAL LANDS

RT STATION

TRANSIT CORRIDOR

LEVEE

MORRISON CREEK

EX TREATMENT SWALE TO THE BASIN

DELTA SHORES

DELTA SHORES CIRCLE SOUTH

COSUMNES RIVER BOULEVARD

SRCSD
APN 119-0090-014

EX 42" CULVERT

FEMA FLOOD X
FEMA FLOOD ZONE AE

SUMP 89 & OUTFALL TO MORRISON CREEK

APN 119-0080-030

APN 119-0080-031

APN 119-0080-032

APN 119-0080-033

APN 119-0080-034

APN 119-0080-035

FIGURE 3
EXISTING STORM DRAIN FACILITIES
STONE BEETLAND

CITY OF SACRAMENTO SACRAMENTO COUNTY CALIFORNIA

SCALE: 1" = 150' DATE: NOVEMBER 8, 2021

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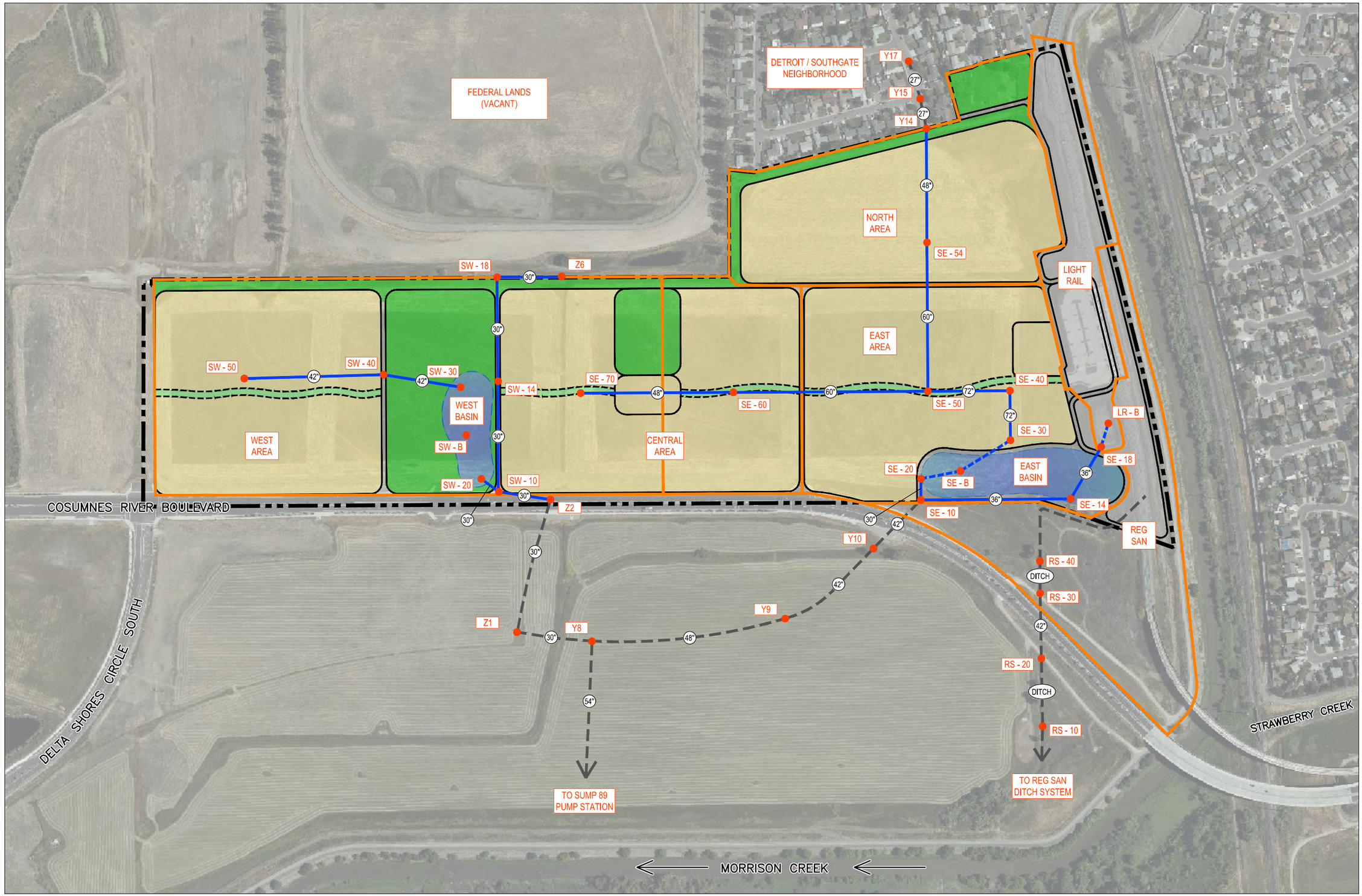
FIGURE 4



STORMWATER BIORETENTION AREA

DMA BOUNDARY

30" EXISTING STORMDRAIN PIPE (30" DIAMETER)

RS - 40 STORMDRAIN NODE

OPEN SPACE

42" STORMDRAIN PIPE (42" DIAMETER)

PROJECT BOUNDARY

CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

N

0' 100' 200' 400'

SCALE: 1" = 200'

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DATE	BY	SUBMITTALS / REVISIONS

DESIGNED BY	DRAWN BY	CHECKED BY	IN CHARGE	DATE

NOT FOR CONSTRUCTION

HYDROLOGY WORKMAP

STONE BEETLAND

CITY OF SACRAMENTO, SACTRAMENTO COUNTY, CALIFORNIA

PROJECT NUMBER 221044

SCALE (AT 22" X 34") AS NOTED

SHEET

LOT MDR-2

LOT HDR-1

LOT HDR-2

LOT PU-1

TRANSIT CORRIDOR

MORRISON CREEK

E STREET

C STREET

G STREET

LOT MDR-2

LOT CMU-1

LOT HDR-3

LOT HDR-3

G STREET

LOT B/OS-1

LOT OS-2

COSUMNES RIVER BOULEVARD

SRCSD
APN 119-0090-014

REMOVE EXISTING STORM DRAIN

REMOVE EXISTING STORM DRAIN

EX TRANSIT STORM DRAIN TO REMAIN

INTERCEPT EXISTING TRANSIT BIO SWALE

RELOCATE TRANSIT BASIN SOUTH

REMOVE EXISTING STORM DRAIN

CONNECT TO EX 42" STORM DRAIN

INLET STRUCTURE WITH ORIFICE OPENINGS

REROUTE TRANSIT DRAINAGE TO NEW BASIN LOCATION

INTERCEPT EXISTING DRAINAGE DITCH

REMOVE EX STORM DRAIN CULVERT

RELOCATED TRANSIT STOP BASIN

CONNECT TO EX 42" CULVERT

42" SD

54" SD

18" SD

30" SD

72" SD

36" SD

24" SD

EX 21" SD

FIGURE 5
RT STATION BASIN RELOCATION
STONE BEETLAND

CITY OF SACRAMENTO SACRAMENTO COUNTY CALIFORNIA

SCALE: 1" = 60' DATE: NOVEMBER 8, 2021

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0 60 120 180

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APPENDICES

APPENDIX A
MODEL OUTPUT

Table 1. Hydraulic Model Output for Pertinent System Nodes, Stone Beetland Project

Node Name	Node Elevations: Invert (feet)	Node Elevations: Ground (feet)	Watershed Area (acres)	Inflow (cfs)	Maximum WSE (feet)	Overflow Duration (sec)
LR-B	-0.02	8.50	9.3	24.4	6.41	0
RegSan	-3.00	8.00	151.0	126.0	5.12	0
RS-10	-0.15	6.00	0.0	0.0	5.13	0
RS-20	0.15	6.00	0.0	0.0	5.13	0
RS-30	0.35	6.00	0.0	0.0	5.13	0
RS-40	0.49	6.00	19.8	15.4	5.13	0
SE-10	-5.78	10.00	0.0	0.0	5.08	0
SE-14	-2.00	9.00	0.0	0.0	5.12	0
SE-18	-0.02	9.00	0.0	0.0	5.14	0
SE-20	-5.31	10.00	0.0	0.0	5.18	0
SE-30	-6.48	10.00	0.0	0.0	5.71	0
SE-40	-5.81	10.50	0.0	0.0	5.73	0
SE-50	-4.70	10.50	25.4	74.8	5.95	0
SE-54	-2.68	11.00	22.1	61.1	8.06	0
SE-60	-2.57	11.00	13.0	38.0	9.12	0
SE-70	-0.90	11.00	15.7	43.0	11.10	1
SE-B	-8.00	10.00	0.0	0.0	5.68	0
SW-10	-5.21	10.50	0.0	0.0	6.19	0
SW-14	-4.36	10.50	0.0	0.0	7.58	0
SW-18	-3.55	10.50	0.0	0.0	9.36	0
SW-20	-5.07	10.50	0.0	0.0	6.19	0
SW-30	-3.00	10.50	0.0	0.0	6.21	0
SW-40	-2.15	10.50	0.0	0.0	6.21	0
SW-50	-0.62	11.00	32.6	70.0	9.92	0
SW-B	-8.00	10.00	0.0	0.0	6.21	0
X1	-13.08	4.00	0.0	0.0	0.89	0
X2-JctBox	-12.69	4.00	0.0	0.0	1.25	0
xPS	-14.00	4.00	0.0	0.0	0.67	0
Y10	-6.22	7.50	0.0	0.0	4.75	0
Y14	-1.14	11.58	10.6	26.1	8.90	0
Y15	-0.42	12.18	5.1	12.5	12.20	1
Y16	2.83	11.18	18.2	39.6	13.36	317
Y17	1.68	13.28	7.6	18.5	14.09	60
Y2	-10.29	4.00	0.0	0.0	1.88	0
Y3	-10.17	4.00	0.0	0.0	1.99	0
Y4	-9.75	4.00	0.0	0.0	2.34	0
Y5	-9.42	4.00	0.0	0.0	2.63	0
Y6	-9.07	4.00	0.0	0.0	2.92	0
Y7	-8.61	4.00	0.0	0.0	3.31	0
Y8	-8.09	6.00	0.0	0.0	3.75	0
Y9	-6.99	6.00	0.0	0.0	4.21	0
Z1	-5.89	5.00	0.0	0.0	4.41	0
Z2	-5.56	10.50	0.0	0.0	5.61	0
Z6-USGov	-3.04	11.00	150.0	125.3	10.62	0

Table 2. Hydraulic Model Output for Pertinent System Links, Stone Beetland Project

Link Name	Bounding Nodes		Diameter	Length	Roughness	Shape	Invert Elevation		Maximum Water Surface		Maximum Flow	Maximum Velocity
	Upstream	Downstream	(feet)	(feet)			Upstream (feet)	Downstream (feet)	Upstream (feet)	Downstream (feet)	(cfs)	(ft/sec)
LR-B-Out	LR-B	SE-18							6.41	5.14	1.0	10.79
LFDrain	RegSan	Y2	2.0	400	0.015	Circular	-3.00	-5.00	5.12	1.88	22.9	7.21
RS-10 Overflow	RS-10	RegSan									14.1	0.00
RS-20-C	RS-20	RS-10	n.a.	297	0.070	Natural	0.15	-0.15	5.13	5.13	15.0	0.32
RS-30-P	RS-30	RS-20	3.5	285	0.015	Circular	0.35	0.15	5.13	5.13	15.5	1.74
RS-40-C	RS-40	RS-30	n.a	142	0.070	Natural	0.49	0.35	5.13	5.13	14.6	0.62
SB-10-P	SE-10	Y10	3.5	295	0.015	Circular	-5.78	-6.22	5.08	4.75	29.4	3.63
SE-14-P	SE-14	SE-10	3.0	656	0.015	Circular	-2.00	-5.28	5.12	5.08	-7.0	1.64
SE-18-P	SE-18	SE-14	3.0	264	0.015	Circular	-0.02	-2.00	5.14	5.12	-1.9	2.57
SE-20-P	SE-20	SE-10	3.5	93	0.015	Circular	-5.31	-5.78	5.18	5.08	28.8	4.12
EB-In	SE-30	SE-B									287.8	0.00
SE-40-P	SE-40	SE-30	6.0	216	0.015	Circular	-5.81	-6.48	5.73	5.71	288.5	10.18
SE-50-P	SE-50	SE-40	6.0	359	0.015	Circular	-4.70	-5.81	6.09	5.73	287.9	10.15
SE-54-P	SE-54	SE-50	5.0	651	0.015	Circular	-2.68	-4.70	8.14	6.09	121.9	6.18
SE-60-P	SE-60	SE-50	5.0	851	0.015	Circular	-2.57	-4.70	9.44	6.09	97.0	4.92
SE-70-P	SE-70	SE-60	4.0	668	0.015	Circular	-0.90	-2.57	11.10	9.44	68.4	5.38
EB-Out	SE-B	SE-20	Basin Oulet Orifice						5.68	5.18	6.9	12.48
EB-Out	SE-B	SE-20	Basin Outlet Weir						5.68	5.18	25.6	5.54
SW-10-P	SW-10	Z2	2.5	231	0.015	Circular	-5.21	-5.56	6.19	5.61	18.9	3.77
SW-14-P	SW-14	SW-10	2.5	483	0.015	Circular	-4.36	-5.21	7.58	6.19	26.4	5.30
SW-18-P	SW-18	SW-14	2.5	455	0.015	Circular	-3.55	-4.36	9.36	7.58	26.4	5.28
SW-20-P	SW-20	SW-10	2.5	95	0.015	Circular	-5.07	-5.21	6.19	6.19	17.2	3.50
WB-In	SW-30	SW-B									70.5	0.00
SW-40-P	SW-40	SW-30	3.5	341	0.015	Circular	-2.15	-3.00	6.21	6.21	70.6	7.29
SW-50-P	SW-50	SW-40	3.5	609	0.015	Circular	-0.62	-2.15	9.93	6.21	70.3	7.23
WB-Out	SW-B	SW-20	Basin Oulet Orifice						6.21	6.19	3.2	8.42
WB-Out	SW-B	SW-20	Basin Outlet Weir						6.21	6.19	14.2	9.25
x1p	X1	xPS	6.5	223	0.015	Circular	-13.08	-13.30	0.95	0.71	150.7	6.67
x2p	X2-JctBox	X1	6.5	387	0.015	Circular	-12.69	-13.08	1.26	0.95	147.9	6.02
y10p	Y10	Y9	3.5	500	0.015	Circular	-6.22	-6.99	4.75	4.21	29.4	3.36
Y-14-P	Y14	SE-54	4.0	498	0.015	Circular	-1.14	-2.68	9.07	8.14	60.0	4.74
y15p	Y15	Y14	2.3	305	0.015	Circular	-0.42	-1.14	12.20	9.07	40.0	9.92
y16p	Y16	Y15	1.3	280	0.015	Circular	2.83	0.83	13.36	12.20	7.1	5.58
y17p	Y17	Y15	2.3	320	0.015	Circular	1.68	-0.42	14.09	12.20	29.0	7.13
y2p	Y2	X2-JctBox	4.5	494	0.015	Circular	-10.29	-10.69	1.88	1.26	65.0	4.97
y3p	Y3	Y2	4.5	156	0.015	Circular	-10.17	-10.29	1.99	1.88	57.0	4.15
y4p	Y4	Y3	4.5	530	0.015	Circular	-9.75	-10.17	2.35	1.99	55.3	3.87
y5p	Y5	Y4	4.5	415	0.015	Circular	-9.42	-9.75	2.64	2.35	53.4	3.60
y6p	Y6	Y5	4.5	415	0.015	Circular	-9.07	-9.42	2.92	2.64	51.8	3.45
y7p	Y7	Y6	4.5	571	0.015	Circular	-8.61	-9.07	3.31	2.92	49.9	3.29
y8p	Y8	Y7	4.5	648	0.015	Circular	-8.09	-8.61	3.76	3.31	46.3	3.13
y9p	Y9	Y8	4.0	854	0.015	Circular	-6.99	-7.59	4.21	3.76	29.4	2.92
z1p	Z1	Y8	2.5	329	0.015	Circular	-5.89	-6.06	4.41	3.76	18.9	4.34
z2p	Z2	Z1	2.5	525	0.015	Circular	-5.56	-5.89	5.61	4.41	18.9	3.78
Z-6-P	Z6-USGov	SW-18	2.5	285	0.015	Circular	-3.04	-3.55	10.62	9.36	26.4	5.27