WEST YOST ASSOCIATES
Consulting Engineers

May 15, 2015

Project No.: 011-10-15-46
SENT VIA: EMAIL

Mr. Nicholas J. Ponticello
Ponticello Enterprises Consulting Engineers, Inc.
1216 Fortna Avenue
Woodland, CA 95776

SUBJECT: Innovation Center Flood Elevation and Inundation Area Increase Study

Dear Michael:

The purpose of this study was to help the City of Davis (City) evaluate the potential increases in the 10-year, 100-year and 200-year floodplain water surface elevations (WSEs) from the development of the Davis Innovation Center (DIC), the Mace Ranch Innovation Center (MRIC), and the Triangle Area Development (TAD). The steps in this process included:

- Develop an Elevation-Area-Storage Curve for the area west of the Yolo Bypass subject to potential flooding from runoff from the DIC, MRIC, and TAD.
- Identify specific predevelopment water surface elevations to be used in this evaluation.
- Determine the increase in the runoff volumes from the DIC, MRIC, and TAD that could contribute to the flooding west of the Yolo Bypass.
- Use the Elevation-Area-Storage Curves to determine the increases in flood WSEs and flood areas from the increased runoff volumes.

ELEVATION-AREA-STORAGE DATA

Elevation-Area-Storage data were developed from topographic mapping prepared by the State of California in 2008. The area represented by the Elevation-Area-Storage Curves is located west of the Yolo Bypass, north of the Railroad (just north of Interstate 80), south of the Willow Slough Bypass Channel, and as far west as Oceano Way. These curves are shown on Figure 1, and the data are presented in Table 1. As shown, if this area was flooded to an elevation of 20 feet, the volume of floodwater would be 1,721 acre-feet and the flooded area would be 894 acres. If this area was flooded to an elevation of 30 feet, the volume of floodwater would be 29,415 acre-feet and the flooded area would be 4,441 acres. The areas and storage volumes are not known to an accuracy of 0.1 acres or 0.1 acre-feet; however, to show small changes in these values, this level of accuracy is used throughout this report.

Table 1. Elevation-Area-Storage Curves		
Elevation, NAVD88	Area, acres	Storage Volume, ac-ft
13.00	0.5	0.0
17.00	119.2	239.4
18.00	352.2	475.1
20.00	894.1	1,721.5
22.00	1,583.1	4,198.7
24.00	2,394.8	8,176.6
26.00	3,301.4	13,872.9
28.00	3,887.8	21,062.2
29.00	4,189.0	25,100.6
30.00	4,440.7	29,415.4
31.00	4,707.6	33,989.6
32.00	4,970.4	38,828.6
33.00	5,153.9	43,890.8

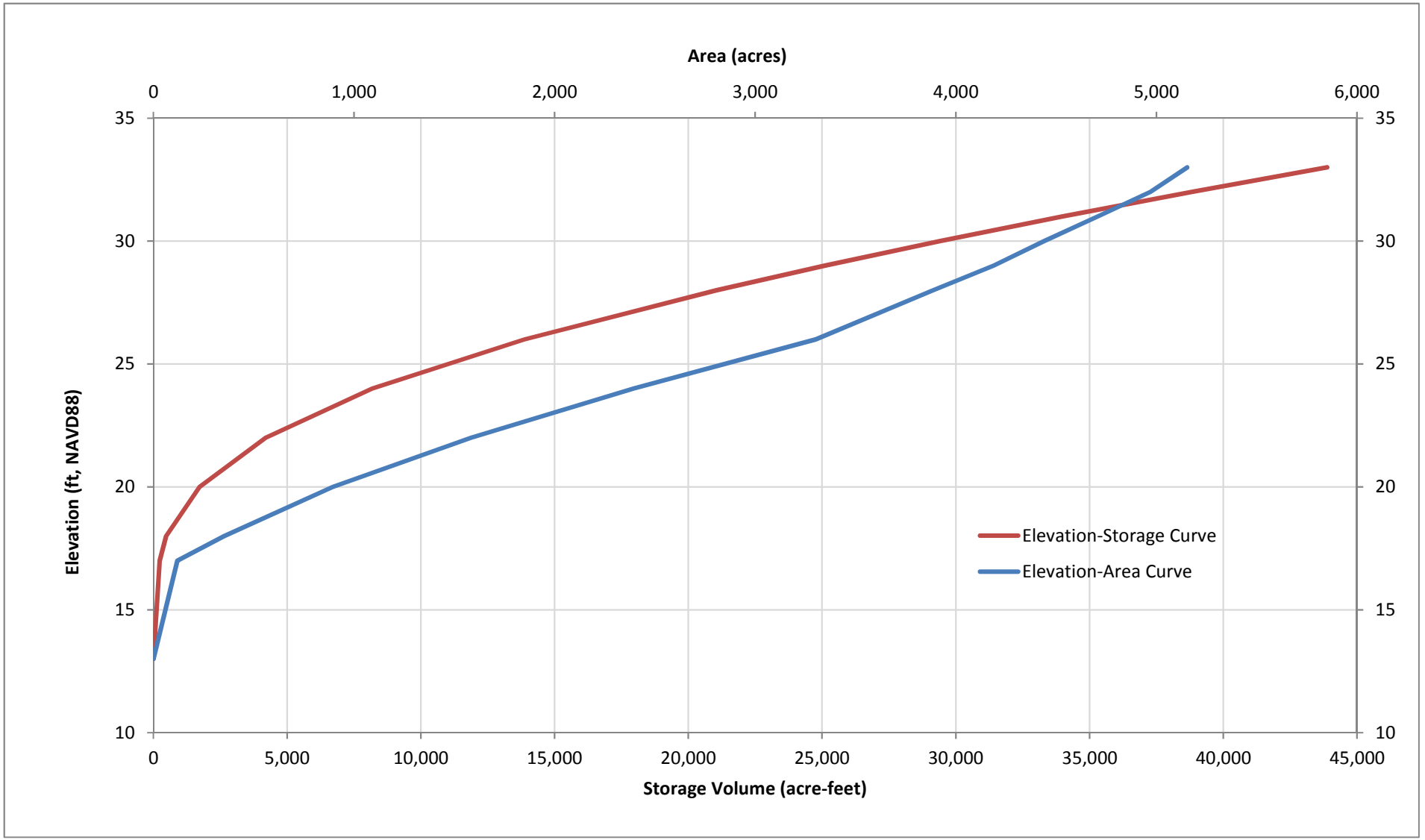

Figure 1

Elevation-Storage Curve

City of Davis
Innovation Center Flood Elevation and
Area Increase Study

PREDEVELOPMENT FLOOD WATER SURFACE ELEVATIONS

When the WSEs in the Yolo Bypass and Willow Slough Bypass Channel are high, the flow from the study area into the Yolo Bypass and Willow Slough Bypass Channel can be blocked, resulting in flooding on the land-side of the levees. To gain an understanding of the potential increases in flood WSEs and inundation areas due to the DIC, MRIC, and TAD developments, a range of predevelopment WSEs were evaluated, including:

- Lowest Flood Water Level – The lowest possible WSE that would likely block the flow into the Yolo Bypass and cause flooding in the study area is about 17 feet NAVD88. This lowest flood water level will have the smallest associated flooded area and consequently will have the largest potential increases in WSEs and flood inundation area due to the development of the Innovation Centers. This situation could occur if a routine storm event occurred over the majority of the local watershed, but an intense rain cell producing the 10-year, 24-hour or 100-year, 24-hour precipitation occurred over just the Davis area.
- Highest Flood Water Level Contained on City Owned Property – The City owns several parcels between the Yolo Bypass and the City. The highest elevation on which floodwater can pool and still be contained on the City owned parcels is about 19 feet NAVD88. This situation could occur if a routine storm event occurred over the majority of the local watershed, but an intense rain cell producing the 10-year, 24-hour or 100-year, 24-hour precipitation occurred over just the Davis area.
- 10-Year Water Level – The April 2, 2002 FEMA Flood Insurance Study for Yolo County provides a 10-year WSE in the Yolo Bypass at the upstream side of the railroad (where the Mace Ranch Drain enters the Yolo Bypass) of about 24.80 feet NGVD29. This is equivalent to 27.34 feet NAVD88.
- 100-Year Water Level – The FEMA Flood Insurance Rate Map Number 06113C0610G (June 18, 2010) for Yolo County provided a 100-year WSE in the Yolo Bypass at the upstream side of the railroad (where the Mace Ranch Drain enters the Yolo Bypass) between 29 and 30 feet NAVD88. For this study, a 100-year WSE of 29.50 feet NAVD88 was used.
- 200-Year Water Level – The California Department of Water Resources FloodSAFE Program published a 200-year flood map for the City (June 26, 2013), and indicated the 200-year WSE is 32.00 feet NAVD88. This is the highest WSE considered during this study. Consequently, it will have the smallest predicted increases in WSE and flood area. This water level would only occur in the study area if there was a Yolo Bypass levee failure.

None of the WSEs listed above are known to an accuracy of 0.01 foot. However, for this study, elevations are reported to an accuracy of 0.01 foot because the potential changes in the WSEs from the development of the Innovation Centers are very small, and it is the potential change in WSEs that are being evaluated.

INCREASES IN THE DIC, MRIC, AND TAD RUNOFF VOLUMES FOR THE LOCAL STORM

Development of the MRIC would result in construction of new impervious surfaces on the MRIC site, which would result in an increase in total volume of runoff from the site. Similarly, development of the DIC and TAD would result in increases in the runoff from the DIC and TAD sites. The drainage engineers for the MRIC and DIC have estimated the increase in runoff from each site for various storm events, as summarized in Table 2. The TAD runoff volume increases were estimated by the MRIC engineer.

The local storm event occurring over the City would not necessarily be the same magnitude of storm event that occurred over Northern California causing high water levels in the Yolo Bypass. Also, the duration of the high water levels in the Yolo Bypass would probably last much longer than the duration of flooding from the local storm. Thus, to develop a "worst case" evaluation, it was assumed that the water levels discussed above would block the flow into the Yolo Bypass for the full duration of the local storm events occurring over the City and Yolo County. This means that all of the increase in runoff from the DIC, MRIC, and TAD would contribute to increased flooding in the study area west of the Yolo Bypass.

Table 2. Increases in Runoff Volumes Resulting from Development of the MRIC, DIC, and TAD

Local Storm Event	MRIC Increase in Runoff Volume, ac-ft	DIC Increase in Runoff Volume, ac-ft	TAD Increase in Runoff Volume, ac-ft
10-Year, 24-Hour	20	20.8	2.0
100-Year 24-Hour	26	28.6	2.5
100-Year, 10-Day	63	53.1	6.7
200-Year, 10-Day	68	55.2	7.2

These increases in runoff volumes were verified as reasonable through a preliminary evaluation of the total design storm rainfall depths applied to the proposed impervious areas on the Innovation Centers.

DIC FLOOD IMPACTS

The DIC drains into the Covell Drain, which flows to the Willow Slough Bypass, which flows to the Yolo Bypass. For this evaluation, it is assumed that the flow into the Willow Slough Bypass and the Yolo Bypass are blocked by the high water levels described above. When the flow from the Covell Drain into the Willow Slough Bypass is blocked, the resulting floodwater flows into the Mace Ranch Drain Watershed. It is assumed that the Mace Ranch Drain flow would also be blocked from entering the Yolo Bypass. This combination of assumptions results in all of the flow from the DIC site contributing to the flooding in the Mace Ranch Drain Watershed on the land-side of the western Yolo Bypass levee.

As shown in Table 3, the development of the DIC results in a range of increases in WSEs and inundation areas:

- The largest estimated increase in flood WSE and inundation area are 0.12 feet and 28.3 acres.
- For 100-year and 200-year flood levels, the estimated increase in flood WSEs are about 0.01 feet and the increase in inundation areas are less than 3.1 acres.

MRIC FLOOD IMPACTS

The MRIC drains into the Mace Ranch Drain and Railroad Drain. For this evaluation, it was assumed that the Mace Ranch Drain-Railroad Drain flow is blocked from entering the Yolo Bypass. This assumption results in all of the flow from the MRIC site contributing to the flooding in the Mace Ranch Drain Watershed on the land-side of the western Yolo Bypass levee.

As shown in Table 4, the development of the MRIC results in a range of increases in WSEs and inundation areas:

- The largest estimated increase in flood WSE and inundation area are 0.11 feet and 25.7 acres.
- For 100-year and 200-year flood levels, the estimated increase in flood WSEs is about 0.01 feet and the increase in inundation area is less than 3.7 acres.

TAD FLOOD IMPACTS

The TAD drains into the Railroad Drain downstream of the Mace Ranch Drain. For this evaluation, it was assumed that the Railroad Drain flow is blocked from entering the Yolo Bypass. This assumption results in all of the flow from the TAD site contributing to the flooding in the Mace Ranch Drain Watershed on the land-side of the western Yolo Bypass levee.

As shown in Table 5, the development of the TAD results in a range of increases in WSEs and inundation areas:

- The largest estimated increase in flood WSE and inundation area are 0.01 feet and 2.5 acres.
- For 100-year and 200-year flood levels, the estimated increase in flood WSEs is less than 0.01 feet and the increase in inundation area is about 0.4 acres.

DIC, MRIC, AND TAD COMBINED FLOODPLAIN IMPACTS

As shown in Table 6, the combined development of the DIC, MRIC, and TAD results in a range of increases in WSEs and inundation areas:

- The largest estimated increase in flood WSE and inundation area are 0.24 feet and 56.5 acres.

For 100-year and 200-year flood levels, the estimated increase in flood WSEs is about 0.03 feet and the increase in inundation area is about 7.2 acres.

Table 3. Increases in Flood WSE and Inundation Areas West of the Yolo Bypass Due to Development of the Davis Innovation Center

Local Storm	Predevelopment WSE, ft,NAVD88	Predevelopment Flooded Area, acres	Predevelopment Flooded Volume, ac-ft	Increase in Volume of Runoff from Development (from Table 1), ac-ft	Post Development Flooded Volume, ac-ft	Post Development WSE, ft, NAVD88	Development Related Increase in WSE, ft, NAVD88	Post Development Flooded Area, acres	Development Related Increase in Flooded Area, acres
Lowest Flood Water Level (WSE = 17 feet NAVD88)									
10-Year, 24-Hour	17.00	119.2	239.4	20.8	260.2	17.09	0.09	139.7	20.6
100-Year 24-Hour	17.00	119.2	239.4	28.6	268.0	17.12	0.12	147.5	28.3
Highest Flood Water Level on City Owned Property (WSE = 19 feet NAVD88)									
10-Year, 24-Hour	19.00	623.2	1,098.3	20.8	1,119.1	19.03	0.03	632.2	9.0
100-Year 24-Hour	19.00	623.2	1,098.3	28.6	1,126.9	19.05	0.05	635.6	12.4
10-Year Water Level (WSE = 27.34 feet NAVD88)									
10-Year, 24-Hour	27.34	3,694.3	18,689.7	20.8	18,710.5	27.35	0.01	3,696.0	1.7
100-Year 24-Hour	27.34	3,694.3	18,689.7	28.6	18,718.3	27.35	0.01	3,696.7	2.3
100-Year Water Level (WSE = 29.5 feet NAVD88)									
10-Year, 24-Hour	29.50	4,314.8	27,258.0	20.8	27,278.8	29.50	0.00	4,316.1	1.2
100-Year 24-Hour	29.50	4,314.8	27,258.0	28.6	27,286.6	29.51	0.01	4,316.5	1.7
100-Year, 10-Day	29.50	4,314.8	27,258.0	53.5	27,311.5	29.51	0.01	4,318.0	3.1
200-Year Water Level (WSE = 32 feet NAVD88)									
10-Year, 24-Hour	32.00	4,970.4	38,828.6	20.8	38,849.4	32.00	0.00	4,971.2	0.8
100-Year 24-Hour	32.00	4,970.4	38,828.6	28.6	38,857.2	32.01	0.01	4,971.5	1.0
100-Year, 10-Day	32.00	4,970.4	38,828.6	53.5	38,882.1	32.01	0.01	4,972.4	1.9
200-Year, 10-Day	32.00	4,970.4	38,828.6	55.2	38,883.8	32.01	0.01	4,972.4	2.0

RECOMMENDED ACTIONS

The following actions are recommended to prevent the potential increases in water levels and flooded area.

DIC Recommended Action

The DIC development should design the proposed detention storage facilities to detain the 100-year, 10-day increase in runoff volume (53.5 acre-feet) when the flow from the Covell Drain into the Willow Slough Bypass channel is blocked by high water levels in the Willow Slough Bypass Channel. This could result in detaining 53.5 acre feet of water for an extended time period. During this time period, additional large storms could occur, so the proposed detention storage facilities must also be able manage (detain with a controlled release) the 100-year, 24-hour storm event.

MRIC Recommended Action

The MRIC development should design the proposed detention storage facilities to detain the 100-year, 10-day increase in runoff volume (63 acre-feet) when the flow from the Mace Ranch Drainage Channel into the Yolo Bypass is blocked by high water levels in the Yolo Bypass. This could result in detaining 63 acre-feet of water for an extended time period. During this time period, additional large storms could occur, so the proposed detention storage facilities must also be able manage (detain with a controlled release) the 100-year, 24-hour storm event.

TAD Recommended Action

The TAD should design the proposed detention storage facilities to detain the 100-year, 10-day increase in runoff volume (6.7 acre-feet) when the flow from the Mace Ranch Drainage Channel into the Yolo Bypass is blocked by high water levels in the Yolo Bypass. This could result in detaining 6.7 acre-feet of water for an extended time period. During this time period, additional large storms could occur, so the proposed detention storage facilities must also be able manage (detain with a controlled release) the 100-year, 24-hour storm event.

Please call or email if you have questions or comments.

Sincerely,

WEST YOST ASSOCIATES

Douglas T. Moore
Engineering Manager
R.C.E. #C058122

DTM:ap

Table 4. Increases in Flood WSE and Inundation Areas West of the Yolo Bypass Due to Development of the Mace Ranch Innovation Center

Local Storm	Predevelopment WSE, ft,NAVD88	Predevelopment Flooded Area, acres	Predevelopment Flooded Volume, ac-ft	Increase in Volume of Runoff from Development (from Table 1), ac-ft	Post Development Flooded Volume, ac-ft	Post Development WSE, ft, NAVD88	Development Related Increase in WSE, ft, NAVD88	Post Development Flooded Area, acres	Development Related Increase in Flooded Area, acres
Lowest Flood Water Level (WSE = 17 feet NAVD88)									
10-Year, 24-Hour	17.00	119.2	239.4	20.0	259.4	17.08	0.08	139.0	19.8
100-Year 24-Hour	17.00	119.2	239.4	26.0	265.4	17.11	0.11	144.9	25.7
Highest Flood Water Level on City Owned Property (WSE = 19 feet NAVD88)									
10-Year, 24-Hour	19.00	623.2	1,098.3	20.0	1,118.3	19.03	0.03	631.9	8.7
100-Year 24-Hour	19.00	623.2	1,098.3	26.0	1,124.3	19.04	0.04	634.5	11.3
10-Year Water Level (WSE = 27.34 feet NAVD88)									
10-Year, 24-Hour	27.34	3,694.3	18,689.7	20.0	18,709.7	27.35	0.01	3,696.0	1.6
100-Year 24-Hour	27.34	3,694.3	18,689.7	26.0	18,715.7	27.35	0.01	3,696.5	2.1
100-Year Water Level (WSE = 29.5 feet NAVD88)									
10-Year, 24-Hour	29.50	4,314.8	27,258.0	20.0	27,278.0	29.50	0.00	4,316.0	1.2
100-Year 24-Hour	29.50	4,314.8	27,258.0	26.0	27,284.0	29.51	0.01	4,316.4	1.5
100-Year, 10-Day	29.50	4,314.8	27,258.0	63.0	27,321.0	29.51	0.01	4,318.5	3.7
200-Year Water Level (WSE = 32 feet NAVD88)									
10-Year, 24-Hour	32.00	4,970.4	38,828.6	20.0	38,848.6	32.00	0.00	4,971.2	0.7
100-Year 24-Hour	32.00	4,970.4	38,828.6	26.0	38,854.6	32.01	0.01	4,971.4	0.9
100-Year, 10-Day	32.00	4,970.4	38,828.6	63.0	38,891.6	32.01	0.01	4,972.7	2.3
200-Year, 10-Day	32.00	4,970.4	38,828.6	68.0	38,896.6	32.01	0.01	4,972.9	2.5

Table 5. Increases in Flood WSE and Inundation Areas West of the Yolo Bypass Due to Development of the Triangle Area Development

Local Storm	Predevelopment WSE, ft,NAVD88	Predevelopment Flooded Area, acres	Predevelopment Flooded Volume, ac-ft	Increase in Volume of Runoff from Development (from Table 1), ac-ft	Post Development Flooded Volume, ac-ft	Post Development WSE, ft, NAVD88	Development Related Increase in WSE, ft, NAVD88	Post Development Flooded Area, acres	Development Related Increase in Flooded Area, acres
Lowest Flood Water Level (WSE = 17 feet NAVD88)									
10-Year, 24-Hour	17.00	119.2	239.4	2.0	241.4	17.01	0.01	121.2	2.0
100-Year 24-Hour	17.00	119.2	239.4	2.5	241.9	17.01	0.01	121.7	2.5
Highest Flood Water Level on City Owned Property (WSE = 19 feet NAVD88)									
10-Year, 24-Hour	19.00	623.2	1,098.3	2.0	1,100.3	19.00	0.00	624.1	0.9
100-Year 24-Hour	19.00	623.2	1,098.3	2.5	1,100.8	19.00	0.00	624.3	1.1
10-Year Water Level (WSE = 27.34 feet NAVD88)									
10-Year, 24-Hour	27.34	3,694.3	18,689.7	2.0	18,691.7	27.34	0.00	3,694.5	0.2
100-Year 24-Hour	27.34	3,694.3	18,689.7	2.5	18,692.2	27.34	0.00	3,694.5	0.2
100-Year Water Level (WSE = 29.5 feet NAVD88)									
10-Year, 24-Hour	29.50	4,314.8	27,258.0	2.0	27,260.0	29.50	0.00	4,315.0	0.1
100-Year 24-Hour	29.50	4,314.8	27,258.0	2.5	27,260.5	29.50	0.00	4,315.0	0.1
100-Year, 10-Day	29.50	4,314.8	27,258.0	6.7	27,264.7	29.50	0.00	4,315.2	0.4
200-Year Water Level (WSE = 32 feet NAVD88)									
10-Year, 24-Hour	32.00	4,970.4	38,828.6	2.0	38,830.6	32.00	0.00	4,970.5	0.1
100-Year 24-Hour	32.00	4,970.4	38,828.6	2.5	38,831.1	32.00	0.00	4,970.5	0.1
100-Year, 10-Day	32.00	4,970.4	38,828.6	6.7	38,835.3	32.00	0.00	4,970.7	0.2
200-Year, 10-Day	32.00	4,970.4	38,828.6	7.2	38,835.8	32.00	0.00	4,970.7	0.3

Table 6. Increases in Flood WSE and Inundation Areas West of the Yolo Bypass Due to Development of the Davis Innovation Center, Mace Ranch Innovation Center, and Triangle Area Development

Local Storm	Predevelopment WSE, ft,NAVD88	Predevelopment Flooded Area, acres	Predevelopment Flooded Volume, ac-ft	Increase in Volume of Runoff from Development (from Table 1), ac-ft	Post Development Flooded Volume, ac-ft	Post Development WSE, ft, NAVD88	Development Related Increase in WSE, ft, NAVD88	Post Development Flooded Area, acres	Development Related Increase in Flooded Area, acres
Lowest Flood Water Level (WSE = 17 feet NAVD88)									
10-Year, 24-Hour	17.00	119.2	239.4	42.8	282.2	17.18	0.18	161.5	42.3
100-Year 24-Hour	17.00	119.2	239.4	57.1	296.5	17.24	0.24	175.6	56.5
Highest Flood Water Level Contained on City Owned Property (WSE = 19 feet NAVD88)									
10-Year, 24-Hour	19.00	623.2	1,098.3	42.8	1,141.1	19.07	0.07	641.8	18.6
100-Year 24-Hour	19.00	623.2	1,098.3	57.1	1,155.4	19.09	0.09	648.0	24.8
10-Year Water Level (WSE = 27.34 feet NAVD88)									
10-Year, 24-Hour	27.34	3,694.3	18,689.7	42.8	18,732.5	27.35	0.01	3,697.8	3.5
100-Year 24-Hour	27.34	3,694.3	18,689.7	57.1	18,746.8	27.36	0.02	3,699.0	4.7
100-Year Water Level (WSE = 29.5 feet NAVD88)									
10-Year, 24-Hour	29.50	4,314.8	27,258.0	42.8	27,300.8	29.51	0.01	4,317.3	2.5
100-Year 24-Hour	29.50	4,314.8	27,258.0	57.1	27,315.1	29.51	0.01	4,318.2	3.3
100-Year, 10-Day	29.50	4,314.8	27,258.0	123.2	27,381.2	29.53	0.03	4,322.0	7.2
200-Year Water Level (WSE = 32 feet NAVD88)									
10-Year, 24-Hour	32.00	4,970.4	38,828.6	42.8	38,871.4	32.01	0.01	4,972.0	1.6
100-Year 24-Hour	32.00	4,970.4	38,828.6	57.1	38,885.7	32.01	0.01	4,972.5	2.1
100-Year, 10-Day	32.00	4,970.4	38,828.6	123.2	38,951.8	32.02	0.02	4,974.9	4.5
200-Year, 10-Day	32.00	4,970.4	38,828.6	130.4	38,959.0	32.03	0.03	4,975.2	4.7