CITY OF COLUSA

DRAINAGE MASTER PLAN

ADOPTED BY CITY COUNCIL
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DEVELOPING INNOVATIVE DESIGN SOLUTIONS

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I. GENERAL

This section of the Drainage Master Plan provides several alternatives for drainage facilities that mitigate drainage impacts and patterns. Previous work in establishing the City of Colusa's (City) Design Criteria and Problem Identification Report, developed during this master planning effort, were used as the basis for determining the hydrology and flooding concerns affecting the City under developed conditions.

II. LOCAL WATERSHED SOLUTIONS

The City is subject to direct rainfall and the effects of runoff during less frequent (larger) storm events. Flooding, from sources outside the City, particularly along the Colusa Basin Drain, and through overtopping or failure of the western bank of the Sacramento River creates risks for the City.

The primary goal of watershed master planning is to determine the impacts of planned development on local storm runoff and to size drainage facilities to mitigate impacts within the General Plan area. This determination will help alleviate any adverse impacts to downstream properties while alleviating localized flooding within the General Plan area.

A. EXISTING CITY DRAINAGE CORRIDORS

There are three general drainage corridors within the City's General Plan boundary through which storm water runoff is directed out of the City. Depiction of the corridors can be found in more detail under Section II.C. The eastern portion of the City collects runoff from land along the Highway 20/45 corridor (eastbound leaving the City) and drains into the south side of the Colusa Industrial Park (CIP), exiting the City near the southern tip of the General Plan area. The central portion of the City discharges drainage near the southern end of Will S Green Avenue, through a pumped discharge (just south of the high school football field) and a small gravity culvert. The western portion of the City is primarily located to the west of an abandoned railroad alignment and north of the westbound Highway 20 alignment. This western area has a few developed properties located along portions of Lurline Avenue and Wilson Avenue, which are currently within the County.

1. Eastern Drainage Corridor

The Eastern Drainage Corridor, primarily east of 3rd Street, north of Louis Lane, including the future development area referred to as "River Bend," drains along the combined stretch of Highway 20/45, south of the highway intersection of Wescott Road. This drainage corridor is defined with many smaller drainage features.

Most land within the River Bend area is currently draining through a shared pond located south of Clay Street and north of Moon Bend Road. Other farmland

adjacent to the river holds some rainwater and a portion is infiltrated back into the soil when there is capacity, which helps to prevent overflow into the existing pond. The pond is located in a depressed area and will be considered for receiving future drainage.

Located between Sioc Street and Louis Lane is an abandoned irrigation ditch that is now disconnected from the Sacramento River (or any surface water source) and acts as a small linear detention basin. Hereinafter this ditch will be referred to as the Sioc-Louis Ditch. The drainage from the land just south of the Sioc-Louis Ditch and west of the highway (along Louis Lane) is pumped through an undersized pumping system into the ditch, where it is allowed to seep back into the ground or overflow southward on the west side of the highway. A small area just north of this ditch and east of the highway, which includes a small shopping center and new apartment complex, drains into a designed retention pond. While this retention pond will need to be monitored to ensure it is operating according to design, for purposes of this report it is assumed it will retain all of the runoff directed to it.

Land located south of Larson Lane and west of the highway is directed through small, undersized detention ponds and conveyed southward through the Colusa Golf and Country Club. A small pumped detention basin is located along the south side of Meadowview Drive. A second "surge" detention pond is located just south of the southern cul-de-sac at Tara Lane, which receives backflow from the storm drain system to fill the pond, and drains back out the same pipe system.

All areas within the upstream portions of the Eastern Drainage Corridor of the existing General Plan area drain southward through the CIP. Runoff leaving the Colusa Golf and Country Club crosses Sunrise Boulevard and commingles with drainage collected along Highway 20/45 to access a detention pond located within the CIP along the north side of Farinon Road. As described within the Problem Identification Report, this area floods during the 100-year event. Any facilities for alleviating flooding will consider utilizing and enlarging detention areas before proposing a new detention.

2. Central Drainage Corridor

The Central Drainage Corridor reaches from the Sacramento River west of the Bridge Street bridge and continues southward through the City to its outlets along the southern edge of the General Plan area near Will S. Green Avenue. The areas within the City that drain through this shed are generally east of the abandoned railroad alignment, which is coincident with the General Plan boundary south of Highway 20 from Williams. North of the intersection of Highway 20 and Will S. Green Avenue, the Central Drainage Corridor collects runoff from 14th Street eastward to 4th Street. A portion of the runoff is directed through a piping system to the Will S. Green Pump Station. However, a significant portion of runoff during a 100-year storm bypasses the pumping station and collects against the abandoned

railroad to the south, also known as the Brookins Ranch area. Ponding will occur and runoff will continue to drain through a small culvert.

3. Western Drainage Corridor

The Western Drainage Corridor is less defined than the eastern and central sheds due to the lack of development in the area. Currently the land within the shed drains west and southwestward toward Powell Slough and the Colusa Basin Drain channel. The terrain of this western shed is generally sloping away from the Sacramento River and collects and drains runoff through a series of roadside ditches. All land within the General Plan boundary to the west of the abandoned railroad alignment is considered to be within the western corridor for purposes of this report.

B. LAND USE

The General Plan land uses shown on Figure 1 were used to determine the levels of development runoff associated with the imperviousness created by each land use type. The parameters for calculating runoff are found in the Drainage Criteria portion of the Drainage Master Plan, and their specific application under existing conditions is described in the Problem Identification Report section of the Drainage Master Plan.

Areas shown as Urban Reserve in the General Plan, were considered as Low Density (1-2 dwelling units per acre) for purposes of future calculations. At the direction of the City, the Urban Reserve areas were considered independently from drainage and, wherever possible, dedicated storage facilities that connect into facilities downstream were sized to keep separate all other development identified in the General Plan.

C. DEVELOPED CONDITIONS HYDROLOGY

Consistent with hydrology conditions for the undeveloped condition, the developed conditions reflect the unique influence of the groundwater upon soil infiltration rate. In the Problem Identification Report, it was noted that groundwater levels, particularly under wet weather and high river conditions, substantially limit soil infiltration during storm events as water table levels rise to near surface conditions in between storms.

Areas within the City may have improved infiltrative capacity (during the storm event) due to improved blockage of river influences and/or localized dewatering activities associated with drainage detention volume preservation design considerations. Future activity and/or improvements along the Sacramento River are unknown at this time and will be discussed at a conceptual level later in this report. It is unknown whether any improvements will alleviate seepage or

significantly depress the groundwater table. Levee integrity calculations are only concerned with preventing movement of underlying levee foundation soils. Under post-improvement conditions, it is acceptable for seepage to continue saturating the ground adjacent to the river as long as "boils" do not develop. "Boils" are concentrated flows under the levee that can erode the levee structure. Localized dewatering of future detention basins may have limited impacts with subsurface conditions possibly returning to elevated/saturated groundwater conditions within the areas being serviced. Considerations of development impacts must identify the increment added by development to downstream runoff. The existing conditions reflect Hydrologic Soil Group D (low infiltration) and account for decreased infiltration due to groundwater. This soil infiltration may improve runoff without the construction of detention basins. While there may be a minor improvement due to lowered groundwater, it is not quantifiable and such considerations will mask the true impact of development. As defined under the storm drainage design criteria section of this Drainage Master Plan, all soil infiltrative capacities reflect limited infiltration under developed conditions with Hydrologic Soil Group D.

The entire developed conditions watersheds for the City are presented on Figure 2.

D. CONCEPTUAL ALTERNATIVES

Consistent with the modeling performed as part of the Problem Identification Report, XP-SWMM modeling software was utilized to determine conduit sizes, pumping alternatives, and detention storage operations for all alternatives considered. Modeling of the proposed alternatives is provided on the CD at the end of this report.

1. Eastern Corridor Alternatives

There are areas within the existing City, located in the northern and western portion of this Eastern Drainage Corridor system, that are already developed and have under 100-year flooding conditions. Locally generated runoff resulting from direct rainfall cannot be adequately drained from the existing City.

Improving the drainage systems within the developed lands of the Eastern Drainage Corridor will not significantly change the volume or flow characteristics of the overall shed. Therefore, such improvements can be made regardless of how downstream improvements are designed for use by new development over undeveloped lands within the General Plan area. The existing development is not changing; therefore, the existing runoff from this development is not changing. Runoff amounts from these areas either reach their respective outlet by means of overland street conveyance, or it can reach the same outlet using a new proposed pipe system. The pipe sizing and alignment determined to improve street flooding within existing areas are not governed by any off-site facilities considered as part of this Drainage Master Plan. Therefore, improvements can be made and can be

considered independent of development occurring downstream. The areas where existing development were considered for improvement within the eastern shed are shown on Figure 3.

The areas north of Sioc-Louis Ditch have insufficient underground pipe capacity which prevents the water from flowing into the street. To alleviate this localized condition, a large diameter pipe can be installed with drainage inlets at each street intersection (both corners), as shown on Figure 3, along the western side of Highway 20/45. Installing a 66-inch-diameter pipe connecting directly to the Sioc-Louis Ditch could alleviate 10-year flooding within this area. This pipe installation would cause runoff from the east-west streets to drain more efficiently without having to backup behind the road crown and elevated pavement configurations at intersections. Gutter flooding will be limited within the unpiped street network until it can reach the proposed storm drain along Highway 20/45; however, flooding should be greatly reduced to below "nuisance" levels.

As described within the Problem Identification Report, the existing developed area just south of the Sioc-Louis Ditch is served by a small pumping system, which lifts the runoff into the Sioc-Louis Ditch. Back-up power, such as a generator, could improve the reliability and redundancy in the pumping to prevent street flooding within this area of the system. Given that this is such a small area and only a small number of homes may be affected, it is unlikely that these improvements would be constructed due to the high cost that these homeowners could experience for these improvements. This area is somewhat protected from the watershed directly north by the elevated configuration of the Sioc-Louis Ditch blocking overland flow from the north. More detailed topography would be needed to identify the actual flooding occurring during storms. It is understood that to-date significant flooding has not been reported in this area.

There are two existing detention basins located within the existing development as described earlier. The first detention basin is located on the south side of Meadowview Drive. The detention water is pumped to the drainage ditch within the Colusa Golf and Country Club. During a 100-year event this fully functioning detention/pump system will overflow. It currently does not have a back-up generator and would not be considered reliable by the Federal Emergency Management Agency (FEMA). Improvements addressing local 100-year runoff would include deepening the detention pond and improving the pumping system to effectively pump the deepened volume.

The second detention basin currently acts as a "surge" basin, filling and draining by gravity through a single storm drain inlet/outlet. Only minor flooding occurs during the 100-year storm, and this pond could be improved to contain the 100-year storm by deepening the pond (adding storage volume) and adding a small pump to keep the deeper storage empty before each storm event. Only the pipe alternative draining the upstream-most portion of the shed to the north of the Sioc-Louis Ditch

was sized and estimated from a cost perspective under this report. The remaining facilities improvements would require more detailed topographic mapping and design analysis to properly estimate improvement costs. The opinion of probable cost for the pipe alternative is included as part of the alternatives evaluated below.

a. Alternative E1A

The layout for drainage improvements associated with this alternative is presented on Figure 4. New development within the River Bend (northeast) portion of the eastern corridor would create additional volume in the system. This volume would be stored in a detention pond (DB-E1-1) and pumped into the Sacramento River with a small residual overflow from the pond and allowed to drain toward Highway 20/45 below peak flows and peak volume levels. Under this alternative, the 100-year detention storage volume is approximately 72 acre-feet with a pumping rate of 10 cfs. The pumped discharge into the river is a new proposed discharge that requires addressing permitting and water quality. After speaking with the Sacramento River West Side Levee District, it was determined that there are no existing drains to the Sacramento River from lands within the City along the west side of the river. Water is being pumped from the river for irrigation purposes, but no existing discharge point currently exists, causing future discharge permitting to be difficult.

The drainage from the developed areas north of the Sioc-Louis Ditch could be piped to the ditch. The impact of this piping has little downstream effect, but does alleviate local street flooding north of the ditch. Located downstream of the Sioc-Louis Ditch, overland flooding conditions occur that may or may not be alleviated by new facilities. It is an existing condition that will not be exacerbated by new development. To alleviate this localized flooding, a new channel is proposed that would convey the flow southward along the east side of Highway 20/45 to the existing channel south of Moon Bend Road. An evaluation of the existing Caltrans conveyances along the highway north of Moon Bend Road indicates limited capacity as well as not being able to accommodate the 100-year flows from upstream, even with new development runoff being diverted to the Sacramento River.

Flooding within the CIP can be alleviated by expanding detention basins within the southern portion of the Eastern Drainage Corridor, as shown at approximate locations DB-E1-3 and DB-E1-4 on Figure 4. Additional volume required to alleviate existing flooding during the 100-year event and to address future levels of development within the CIP are 55.9 acre-feet within DB-E1-3 and 47.5 acre-feet within DB-E1-4. Recommended water quality treatment can be achieved with in-line flow units upstream of DB-E1-3, as upstream flows (developed and undeveloped runoff) commingle with development runoff and balloon the complexity of treating the entire runoff volume. The runoff volume entering DB-E1-4 is presumed isolated and can be treated by in-pond treatment storage

within a wet-pond configuration with 9.2 acre-feet of treatment storage required.

In order to drain water to DB-E1-4, several small channels need to be constructed to convey the runoff under developed conditions without flooding developed land in the surrounding basin area. The detention is necessary due to limited channel outfall capacity beyond the City's future boundary. Flooding in the vicinity of DB-E1-4 during the 100-year event cannot be directed uphill to DB-E1-3. Flooding also occurs under existing conditions and would be exacerbated by the industrial and low-density land uses presented on Figure 1. For this reason, the additional runoff from the Urban Reserve area to the west, located east of Wescott Road, was directed to DB-E1-4 rather than attempting to introduce an additional basin to the watershed. Regardless of the Urban Reserve land being developed or not, DB-E1-4 is necessary.

The isolated detention basin servicing the Urban Reserve area (DB-El-2), located east of Highway 20/45, requires 27.6 acre-feet of storage to mitigate the 100-year storm runoff under developed conditions and an estimated 7.0 acre-feet of wet-pond treatment volume. The existing runoff from this area is accounted for in downstream sizing of facilities within the CIP.

A fifth detention pond (DB-E1-5) is recommended to serve the very southern tip of the General Plan area. This area currently drains into a ditch that flows directly south and away from the CIP. Drainage from this area cannot gravity-drain northward to the proposed detention; therefore, a small pond with a footprint of one-quarter acre and a storage volume of 1.5 acre-feet is recommended to detain the flood runoff and provide water quality treatment options before being discharged downstream. Approximately 1.2 acre-feet of treatment storage is recommended. Table 1 provides a summary of the sizing and dimensions for detention ponds and channels for this alternative.

b. Alternative E1B

Alternative E1B has existing City drainage north of the Sioc-Louis Ditch that is directed to the detention basin (DB-E1-1) and diverted to the Sacramento River by means of increased pumping. The proposed facilities associated with this alternative are presented on Figure 5. The pumping rate is increased to 90 cfs and the detention basin volume is unchanged from Alternative E1A, except that water quality treatment volume increases due to commingling new development and existing development flows. The estimated wet-pond water quality volume is now 34.9 acre-feet.

This essentially helps to mitigate an existing flooding problem downstream of the Sioc-Louis Ditch. With this alternative the proposed channel along

Highway 20/45 north of Moon Bend Road is no longer necessary, since existing pipes are large enough to convey the 100-year flow along the highway.

The sizing of DB-E1-2 (detention and water quality treatment) is unchanged since it is sized to service only the Urban Reserve area before combining with any other drainage area.

Detention facilities within the CIP are improved with 10.7 acre-feet required for DB-E1-3 and 46.4 acre-feet required for DB-E1-4. This is due to the redirection of existing runoff out of the system via DB-E1-1 and more efficient drainage downstream with less flow. Water quality treatment facilities, located in the two southern basins, remain the same under this Alternative E1B and there is no shift in treatment recommendations from Alternative 1A. Table 2 provides a summary of the sizing and dimensions for detention ponds and channels for this alternative.

c. Alternative E2A

The facilities requirements for this alternative are presented on Figure 6. Alternative E2A detention volume in DB-E1-1 (referred to as DB-E2-1 under this alternative) is directed westward toward Highway 20/45 and flows through the existing interior system downstream. The existing conditions flow rate leaving the pond is approximately 8 cfs. Under developed conditions this detention basin must be pumped to preserve room for storm volume. Allowing this pond to drain by gravity to the Highway 20/45 facilities would significantly limit the elevation of the bottom of the basin. The pumping rate to deliver water westward was designated at 7 cfs.

The detention volume and water quality treatment recommendations for detention basins DB-E2-2, DB-E2-3, DB-E2-4 and DB-E2-5 are adjusted under Alternative E2A. Table 3 provides a summary of the sizing and dimensions for detention ponds and channels for this alternative.

d. Alternative E2B

Similar to Alternative E2A, Alternative E2B detention volume in DB-E2-1 is directed westward toward Highway 20/45 and has increased volume and water quality treatment recommendations. The detention and water quality treatment recommendations for the remaining detention basins (DB-E2-2, DB-E2-3, DB-E2-4 and DB-E2-5) are modified from Alternative E1B, as well as the channel sizing and locations for conveying water within the watershed. Under this alternative, the existing City north of the Sioc-Louis Ditch is directed to DB-E2-1. The proposed facilities layout for this alternative is presented on Figure 7. Table 4 provides a summary of the sizing and dimensions for detention ponds and channels for this alternative.

2. Central Corridor Alternatives

a. Alternative C1A-1

Under this alternative the drainage pathways remain the same as exists today, but the efficiency is improved. A new detention basin metered outfall pumping system is incorporated at the southern end of the drainage corridor with storm water being metered through pumps.

The existing development in the northern portions of the shed currently drains through an undersized piping system to the Will S. Green Pump Station. Evaluations for enlarging the upstream piping system to convey the 10-year flooding more efficiently to the pump station resulted in additional overflow carried overland toward the new detention basin. This is caused by improvement to the drainage efficiency upstream of the pump station, reducing street storage and storm water attenuation, which then overwhelms the current capacity of the Will S. Green Pump Station.

Full build-out of development under the General Plan requires storm water detention and water quality treatment to serve the central portions of the City as originally developed by the "Brookins Ranch" development. The storm water detention volume required for the 100-year storm is 181.7 acre-feet with 49.8 acre-feet of water quality treatment storage. The proposed detention pond cannot discharge at a higher rate than the existing conditions outflow rate. With this limitation, the most efficient storage configuration would be to construct the detention storage at the upstream side of the pump station and meter the discharge, which would reduce pumping costs. Representatives of this development have proposed a small inflow detention basin with a large pump station, lifting the flow to a second, separate detention pond. This does not reduce the overall footprint or storage volume of the pond, but it does significantly increase the size of the pump required; therefore, it was not evaluated as part of this Drainage Master Plan. Table 5 provides a summary of the sizing and dimensions for detention ponds and channels for this alternative. Refer to Figure 8 for this alternative layout.

b. Alternative C1A-2

The existing City development within the northern portion of the central corridor does not drain efficiently, as described above under Alternative C1A-1. However, similar to the eastern corridor, there can be alternatives considered to remedy this localized flooding within the existing City, while also determining the facilities required to serve proposed development within the remaining portion of the drainage corridor. With only pipe improvements, it was determined under Alternative C1A-1 that additional water volume would actually bypass the pumping system (Will S Green Pump Station) and would

increase the size of the single detention pond alternative at the southern end of the central corridor. To alleviate this proposed conditions impact as well as the existing impacts upstream, an alternative was developed with the City Engineer that provides drainage improvement to serve the existing City under a 10-year storm event.

This alternative (Alternative C1A-2) proposes pipe system improvements to replace a portion of the existing pipe system with larger pipes, large enough to convey the 10-year storm to the existing pump station, alleviating street flooding within the existing City during the 10-year storm. A separate detention pond would be constructed just upstream of the Will S Green Pump Station to provide the existing pump station with a sump volume to operate more efficiently, and to allow the 10-year storm volume from the existing City to be entirely pumped through the existing pump station, with no overflow leaving the sump. This separated detention/sump area is proposed with 1 foot of freeboard calculated using 10-year storm conditions with a 24-hour storm duration. Once the configuration of the pond/sump was defined (with 1 foot of freeboard), it was introduced into the 100-year design storm analysis and the subsequent sizing of downstream detention, to serve proposed development, was determined. The 100-year rainfall did overwhelm the upstream detention capacity and an estimated 23 cfs of overflow through the proposed development resulted.

The summary of proposed facilities (sizing and dimensions) serving both existing and future development is provided on Table 6. Figure 9 provides a schematic layout of facilities for Alternative C1A-2.

c. Alternative C1B

Alternative C1B reduces the overall contributing shed acreage by approximately 426 acres, diverting the acreage into and through the western corridor drainage. The sizing of the detention basin at the southern downstream end of the central corridor is 79.6 acre-feet with 26.8 acre-feet of water quality treatment volume. This water quality treatment volume assumes the worst-case conditions of improved upstream piping network and the associated 100-year overflow across the Brookins Ranch project area. Table 7 provides a summary of the sizing and dimensions for detention ponds and channels for this alternative. Refer to Figure 10 for this alternative layout.

3. Western Corridor Alternatives

The City owns property outside of the General Plan area just north of Highway 20, which could potentially be used for localized flood detention purposes. Even though this area is shown as inundated under the Colusa Basin Drain floodplain on the current FEMA maps, it is still a usable site for detention because the detention

pond would operate when local rainfall creates runoff within the City's western areas. The Colusa Basin Drain watershed is much larger than the City's contributing drainage area and is not considered coincident with the local runoff. Runoff from the City would arrive at the detention pond prior to runoff from the Colusa Basin Drain watershed. This allows the basin to attenuate and mitigate for impacts due to development within the western shed. The volume within the proposed basin would be below existing ground and would act as a holding facility for the development runoff until the Colusa Basin Drain flooding subsides downstream with the larger regional flooding flowing over the top of the stored basin volume. This would allow the development runoff to drain after the peak of the larger watershed passes.

In order to drain the development runoff to the proposed detention storage, a pipe system feeding into a channel conveyance system would be required.

The western shed is subject to flooding from the Colusa Basin Drain; therefore, to protect the area from external flooding a flood barrier would need to be constructed that prevents the edge of the floodplain from encroaching into the City. The height of such a levee would be approximately six feet, located to the north of Highway 20. Estimates of the proposed levee height are based upon flood depths associated with a projected 100,000 cfs being placed within the Colusa Basin Drain channel due to potential upstream levee failures on the Sacramento River. There should be more in-depth flood studies assessing this flooding by the California Department of Water Resources (DWR) in the next 1-2 years to verify these estimates. A detailed assessment of upstream influences from the Sacramento River is beyond the scope of this report. To prevent flooding in the City along the Highway 20 alignment, a flood barrier is proposed. It is assumed that Caltrans would allow a high water gap-filling structure, since Highway 20 would likely be closed due to flooding at this point. The closing of the highway should be in coordination with the appropriate floodwall procedures to prevent flooding into the City and traffic from entering the floodplain.

a. Alternative W1A

Alternative W1A proposes detention storage on City property outside of the General Plan area as the primary mitigation of development runoff from the western corridor. Figure 11 depicts the proposed drainage system layout as well as the tributary area. Downstream detention must be connected with existing channels to properly drain. The development within this area has the capacity of draining by gravity to the proposed detention basin during most storm conditions, with no adverse impacts upstream or downstream. However, the downstream potential for flooding cannot be ignored and local drainage from the City must have an outlet when the Colusa Basin Drain is flooded. It is not likely that the City would experience severe internal drainage when the Colusa Basin Drain is flooded. It is estimated that the peak flow from simultaneous

interior rainfall would not exceed the 10-year peak flow rate (202 cfs). Therefore, the peak flow rate is proposed to be pumped up into the exterior floodplain with an emergency pump station if simultaneous local rainfall does occur during the exterior flooding peak. Backflow prevention structures must be constructed to allow for gravity drainage when downstream capacity is available, and to prevent the Colusa Basin Drain flooding from backing up into the City through the storm drain system. Only under this condition would the pump station be activated.

This configuration requires interior drainage channels from north of the Western Drainage Corridor to the outlet just north of Highway 20. These channels will allow efficient movement of all drainage water and provide interior flood protection.

The proposed detention volume for basin DB-W1-1 is 56.3 acre-feet, which represents the increase in development runoff volume above existing conditions runoff. The western areas currently drain into this area and the increment of volume being added by development defines the impact. The proposed storm water quality treatment volume would be constructed below the bottom of the flood control storage within the footprint of the basin and is 40.6 acre-feet.

Conveying runoff from the Urban Reserve areas (Figure 1) can be accomplished with roadside ditches located to the west and southwest reaching the western edge of the plan area at Lurline Road. From this point southward, a channel is proposed to convey design 100-year flows to Highway 20 which then combines with the remaining development runoff and reach the proposed pump station and levee crossing before flowing westerly into the proposed detention basin. Table 8 provides a summary of the sizing and dimensions for detention ponds and channels for this alternative.

b. Alternative W1B

Alternative W1B is functionally the same as Alternative W1A, except additional drainage area is directed into the western corridor from the central corridor as presented on Figure 12. Additional channel is required to convey the excess runoff from the existing City to the proposed emergency pump station. With more runoff from the tributary area being conveyed out of the City, the size of the proposed pump station increases to 280 cfs. The size of the proposed channel is governed by gravity drainage conditions and does not require further expansion beyond Alternative W1A sizing. The required 100-year detention volume downstream increases to 65.5 acre-feet, with 40.6 acre-feet of water quality treatment storage. Table 9 provides a summary of the sizing and dimensions for detention ponds and channels for this alternative.

c. Alternative W2A

The Western Drainage Corridor must detain flows, but if it cannot utilize detention outside of the General Plan area, the detention storage must be provided inside of the General Plan boundary. The exterior flooding conditions discussed under Alternative W1A is still present. The interior drainage must be allowed to gravity-drain along Highway 20 westward to the same outfall channels that drain Alternatives W1A and W1B. The detention volume for mitigation downstream is the same as W1A; however, the configuration and discharge of the runoff volume must be adjusted to account for the storage inside of the General Plan area.

During flood stage, pumps to the Colusa Basin Drain from the interior basins must evacuate the simultaneously occurring inflowing runoff; however, the mitigation volume must be held back until after the flooding has subsided. With the pumps in operation, pumping must be limited to operate above a specific elevation in order to achieve the downstream mitigation and hold the volume until after the larger flood subsides. To achieve this, additional volume must be excavated to allow for the pumping system to operate effectively in the upper volume of the pond without creating internal flooding to the General Plan area. This increases the size of the detention basin and achieves the same effect as Alternative W1A. The required detention storage increases by 50% to accommodate this condition.

Figure 13 depicts the proposed facilities for Alternative W2A. Table 10 provides a summary of the sizing and dimensions for detention ponds and channels for this alternative.

d. Alternative W2B

Diversion of drainage area from the Central Drainage Corridor of existing City was not considered an alternative for W2B since detention volume would need to be stored upon developable land within the western shed. It may be considered by the individual property owners north of Highway 20, if development in the central corridor proves problematic with downstream detention phasing.

III. PREFERRED ALTERNATIVE

Given the three distinct drainage corridors, the preferred alternative for each of these areas was selected with input from City staff. Reasoning for the selected alternative is explained herein, but it should be noted that the reasoning is similar for the east watershed because all three watersheds are considered at the "headwaters" of their respective local watersheds and share similarities in the reasoning associated with each.

A. EASTERN CORRIDOR

The eastern corridor drains through the CIP and outside of the City before being discharged back into the Sacramento River near Knights Landing. Any additional volume being added to the system should be considered as impacts to downstream properties and require mitigation. The drainage flows across land immediately downstream of Davis Ranch City. In Davis Ranch the water flows slowly and ponds due to the limited ability to drain, and storm volume impacts must be considered in this area. Therefore, Alternative E1 (A or B) was selected as the preferred alternative; thus reducing overall volume flowing overland downstream through Davis Ranch and to other low-lying and flood-prone properties.

The runoff from the City would naturally reach the Sacramento River if it were allowed to flow through Davis Ranch; however, the runoff is currently attenuated behind levees before entering the Sacramento River. It is arguable that even a small amount of water being pumped to the river could create impacts downstream in the river. To avoid this condition we recommend pumping into the river should be avoided when the river is within the peak portion (within 0.5 feet) of flood stage, which will be defined by DWR in its upcoming hydraulic analysis of the Sacramento River.

The water level of the Sacramento River can be monitored at the downstream end of the constructed discharge pipeline and pumping can be curtailed during peak river periods. It should be clear that direct rainfall over the City is not directly concurrent with peak river stages, so it is extremely remote that a design storm would occur within the City at the same time as peak river stages. As such, there should be sufficient storage to address less intense rainfall, and perhaps a low-flow pumping rate could be established to spread the volume out within the river to sufficiently address the concerns of the agencies involved.

B. CENTRAL CORRIDOR

There is only one central corridor alternative, which is to collect, store, and discharge runoff through a downstream detention pond at the southernmost portion of the basin. Changing upstream pumping capacity has the potential of exacerbating downstream flooding outside of the General Plan boundary. Therefore, leaving the existing pumping capacity unchanged and adding detention

with its own limited/metered discharge is the only viable solution. The issue with the central corridor will be collecting or diverting a portion of the watershed to the west of Highway 20, and whether this area should be directed to the western corridor.

C. WESTERN CORRIDOR

The western corridor must drain water toward Powell Slough and the Colusa Basin Drain. Detention storage must be provided to attenuate storm volume and prevent downstream impacts. The location of such storage can be either within the General Plan area boundary, or located outside of the boundary. The preferred alternative for the western corridor is to utilize the City-owned property outside of the General Plan boundary to construct downstream detention storage, and to convey the local runoff from within the General Plan area to this storage. The use of the land within the General Plan area is maximized for development purposes. The local runoff from the City is also considered non-coincident with peak flows from the Colusa Basin Drain. This alternative does include constructing a barrier to prevent flooding from the Colusa Basin Drain watershed into the City. With flap gates preventing backflow, any residual drainage within the City would need to be pumped. Therefore, this alternative allows for back-up pumping of the 10-year flow rate under such conditions. Most of time the system should operate under gravity flow conditions, without pumping.

Regardless of the local improvements within the City, a barrier must be constructed around the perimeter to protect it from external flooding sources.

IV. REGIONAL FLOODING AND LEVEE IMPACTS

A. COLUSA BASIN DRAIN IMPACTS

The City's General Plan contributes to and is influenced by the Colusa Basin Drain and the floodplain associated with the watershed, which floods adjacent to the City along its western and southern boundary. The current FEMA Flood Insurance Rate Map (FIRM) clearly shows this large floodplain to the west of the City. Fortunately, the majority of the flow is along the main channel alignment with only the fringe of the floodplain encroaching upon the western edge of the City's future development areas.

Disregarding the impacts from the Sacramento River, there would be significant flooding from the adjacent Colusa Basin Drain to the west. The most effective way of blocking this flooding from the City would be to construct a barrier along the western and southern edges of the City's General Plan boundary. To the north of Highway 20 in this portion of the City, a stand-alone low-level levee embankment would need to be constructed to protect this portion of the City. To the south of Highway 20, there is a proposed roadway along the edge of the future development that could also serve as the barrier for protecting the City from Colusa Basin Drain flooding along much of the alignment with a short segment not connecting with a road just south of Highway 20.

The existing City to the south of Highway 20 is already elevated due to the abandoned railroad that once occupied this alignment. The existing raised portion is much narrower than the future roadway. It is assumed that the most cost-effective way of constructing the barrier would be to build a compacted earth levee. Reinforced concrete floodwalls may take up less space, but are generally more costly to construct and difficult to transition at intersections. To the south, the cost of raising the roadway is assumed attributable to drainage and is counted as a drainage cost; however, the construction of the roadway is not a drainage cost. Obtaining the right-of-way for the road would be required whether the road acted as a drainage barrier or not. Elevating the road may add a small amount to the width of the overall right-of-way so an estimate of the additional right-of-way would depend upon the final required height to protect the City. Assuming freeboard of three feet above the maximum water surface and 3H:1V side slopes, the additional width could be approximately 20 feet; however, local roadway right-of-way requirements may have additional width outside of the paved travel-way already accounted for, regardless of the slope. For purposes of this Drainage Master Plan, it is assumed that a roadway of 24 feet in width would need to be raised an average of four feet in height and require an additional 20 feet of right-of-way to protect the southwestern boundary of the General Plan.

B. SACRAMENTO RIVER IMPACTS

As identified in the Problem Identification Report section of the Drainage Master Plan, there is potential flood risk the City of Colusa faces from the Sacramento River and the Colusa Basin watersheds. Each of these larger flood sources, separately and together, has the potential of affecting the 100-year flood risk within the City's General Plan boundary.

For the Sacramento River, either the existing levees are sufficient and certifiable as they exist today or they are not. Up until recently, these levees have been assumed as providing protection by both FEMA and subsequently the local residents. Even if the levees physically exist today in a certifiable condition, they still need to be proven certifiable to regulatory/government agencies, including DWR and FEMA, in accordance with FEMA's Procedural Memorandum 34, before certification can have any meaningful impact with regards to flood insurance requirements.

It is not within the scope of this Drainage Master Plan to determine the certifiability of these levees; however, this plan can address the approximate facilities and cost impacts to the City under either condition, allowing the City to be fully informed in its future decisions. The drainage options regarding the levees as certified and providing protection are reflected in the previous alternatives described under the Local Solutions section of this Drainage Master Plan. Under the alternatives presented, it is assumed that no failure of the Sacramento River can occur, and only the drainage facilities necessary to address direct rainfall on the City and the Colusa Basin Drain watershed are provided. Such facilities are the absolute minimum necessary to help protect property within the City from flooding, but should not be considered as truly providing protection until the levees affecting the City can be tested and certified.

The levees along the Sacramento River affecting the City are considered part of the State/Federal Levee System as documented on mapping by DWR under the references section on their FloodSAFE Website:

http://www.water.ca.gov/floodsafe/

As stated under the Problem Identification Report, any levee must now be proven certifiable before FEMA will accredit its protection on their maps. In order to prove that the levee is certifiable in its current condition, a detailed study must be performed, relying heavily on geotechnical analyses (borings and seepage calculations) and interpretation, and on predicted hydrologic and hydraulic conditions within the river. The absolute minimum reach of existing levee that must be tested is the reach along the northern and eastern boundaries of the General Plan adjoining the Sacramento River, or approximately 3.83 miles of levee.

From previous work experience on other levee projects in the area, an opinion of probable cost for conducting preliminary and full-scale design geotechnical testing can be estimated; however, it would benefit the City to consult directly with geotechnical firms before budgeting for such work. Initially, borings can be spaced farther apart but it is highly recommended if it is determined early on that the levee core is not certifiable, borings and analyses should advance to a more detailed focus, allowing for design-level data to be obtained without delay. This information can be used to more accurately identify the problem as well as more accurately quantify solutions for obtaining funding. It is also generally more costly to commission two separate geotechnical studies (reconnaissance and design). Geotechnical investigations and reports are costly and can range from $250,000 to $500,000 per mile of tested levee in order to properly address current certification and design criteria. Therefore, as an estimate, the levees adjoining the City could be tested for approximately $1,000,000 to $2,000,000.

Extending the levee upstream and downstream, it remains to be seen whether it is more cost effective to test along the river away from the City, or to focus on protecting the City more directly. If the levees adjoining the City test poorly, it is not likely that levees upstream and downstream will do any better. However, if the levee adjoining the City is strong then additional testing upstream and downstream may be more cost efficient than assuming the construction costs of building new facilities around the perimeter of the City. Until such time as testing is performed, the potential repair cost for the levee is unknown.

It is known from recent levee improvement work in the Sacramento region that deep cut-off wall construction (one type of solution) can be completed for approximately $5,000,000 to $10,000,000 per mile of levee. Generally, the types of solutions available include deep cement slurry cutoff walls (placed with open trenches), deep soil (with cement) mixture (placed by auger), sheet pile walls, levee widening or seepage berming (to lengthen the seepage gradient), and dewatering wells (to prevent movement of underlying soil by drawing down the groundwater table below the landside elevation of the levee). Other solutions can be considered to either lower the water surface within the river through channel widening/deepening, or by diverting flood flow elsewhere before reaching the questionable levee. With the size of the Sacramento River system, it is unrealistic to consider channel improvements or diversions as feasible to protect the City. While the Sacramento River is already outfitted with diversions to the east at the Moulton Weir and the Colusa Weir, increased diversions may be considered an alternative; however, the scope of evaluating and mitigating the impacts to the bypass systems downstream of the existing weirs is too large to be considered for this master planning effort.

There has been some limited geotechnical analysis and slurry wall construction in the past along this reach of the Sacramento River, downstream of Bridge Street under the Sacramento River West Side Levee District. The previous analysis

performed some borings, which will likely need to be reassessed in light of recent underseepage requirements for levees. There are also new analyses planned, from a geotechnical and river hydraulics perspective, under current DWR contracts. The hydrology and hydraulics of the Sacramento River is planned for reevaluation within the next 2-3 years under DWR's rural levee assessment programs. There may be opportunity for the City to accelerate this process through negotiations with the state agencies involved. It is always prudent for the City to become aware of and involved in the assessments affecting the City's flood protection.

Solutions to protect the City from flooding due to levee failure will require a comprehensive analysis of the levees along the Sacramento River, as well as an analysis of the Colusa Basin Drain. It is important to note that the western levee of the Sacramento River is parallel and/or adjacent to the Colusa Basin Drain for a long distance upstream and downstream of the City. If this western levee breached, it would flow into and be conveyed by the Colusa Basin Drain, and eventually flooding the western and southern portions of the City. The flow in the Sacramento River upstream (100-year flows >150,000 cfs) is much larger than the natural watershed flow directly draining to the Colusa Basin Drain (100-year flow approximately 30,000 cfs). The true risk is essentially unknown at this time, but it is imperative that the City address this flooding condition.

There are two major options for accommodating such flooding. The first option is to perform analyses and provide improvements, as necessary, to obtain certification on all of the western Sacramento River levees upstream and downstream that may affect the City, which is not realistic. The second option is to account for upstream breaching of levees along the Sacramento River, and to construct a barrier large enough to prevent flooding from entering the City. A flood barrier will exacerbate flooding within the Colusa Basin Drain, since the flood water would normally have flowed through sections of the City. The resulting water surface elevations along the Colusa Basin Drain should not be increased as the result of a barrier. Therefore the second option must include constructing additional floodplain conveyance (channel) to carry the water around the City.

To begin estimating the size of such a barrier and conveyance channel, the worst-case flow conditions of flooding leaving the Sacramento River need to be identified. A detailed evaluation that could be considered as "design-level" was not possible within the scope of this document; however, some effort was directed toward identifying the potential risk and the magnitude of a solution. A two-dimensional flow model was constructed utilizing the USGS Quadrangle topography to represent the flow capacity of the Colusa Basin area (including within the City) adjacent to the Sacramento River from approximately five miles north of the City to approximately six miles south of the City. The grid element size represented 30-meter by 30-meter resolution, which is consistent with the digital elevation models used to develop the topography. In order to represent the hydraulics of breaching westward out of the Sacramento River, with its existing channel capacity and

constructed bypasses to the east, a steady-state condition was modeled within the channel based upon sustained peak flows that were obtained from the river profiles published by the Central Valley Flood Protection Board on their website. The necessary adjustments for vertical datum concurrence were taken into account. This published river profile establishes the channel invert elevations in profile as well as the maximum water surface elevations within the river during peak flow conditions. Trapezoidal cross sections were approximated to represent the conveyance capacity to match the hydraulic information documented on the profile. Since the two-dimensional model requires a time simulation of flow entering and leaving the grid, the maximum flow was simulated as occurring over time, to allow for the full flow to pass through the breach and to estimate the maximum impact to the City. The Sacramento River can flow in an elevated condition for several days at a time, so this method of estimating flooding was assumed reasonable.

1. Upstream Levee Scenarios and Impacts to the General Plan

Northern levee breach simulations were run removing approximately 2,000 feet of levee at a location immediately north of the City's General Plan boundary, with a second (separate) breach scenario located approximately 7,000 feet north of the City's General Plan boundary. Without a barrier in place, the flooding through the City is substantial during a levee failure immediately north of the City, with estimated flooding depths as shown on Figure 14. A levee failure approximately 7,000 feet upstream results in flooding as approximated in Figure 15. In order to remove this flooding through the City, a barrier was modeled along the western edge of the City and additional two-dimensional modeling was developed to determine the approximate size of a large channel to convey the flooding around the City. The assumptions for this condition were that the channel and barrier would need to be located inside the General Plan boundary. There is nothing precluding relocating conveyance facilities outside of the General Plan area; however, before any project could be approved it would need to be evaluated in more detail hydraulically for design and would have to obtain the appropriate environmental and construction approvals/permitting and address property rights and compensation. The approximate impact to the footprint of development within the General Plan is presented on Figure 16. The flooding impacts associated with the channel depicted on Figure 16 were modeled using the two-dimensional model. The comparison to existing conditions breaching is presented on Figure 17.

The worst-case condition affecting the City from the north is potentially a levee failure immediately upstream of the General Plan boundary. Accordingly, the subsequent levee removal scenarios evaluated under this study further upstream tend to direct floodwaters into the Colusa Basin Drain flood corridor and avoid the City's main population areas. The peak flow within the river upstream of the Moulton Weir is 160,000 cfs.

While it is unknown at this time how much maximum water could actually spill out of the river, it is assumed that the river channel below ground has some reasonable capacity that would be conveyed downstream below the elevation of ground levels adjacent to the levees. Without extensive analysis along the entire river, the below-ground capacity cannot be known; however, there are certain characteristics about the river that are worth noting. The natural channel began under alluvial conditions, where the incised channel capacity may be larger upstream than downstream, due to the drop in flow energy and the out-of-bank flooding the Sacramento River is historically known for as it approaches the Delta. Since man has constructed upstream reservoirs and also constructed levees to "channelize" the river flow, the effect has created more incised channels with greater below-ground capacity than before. This is due to entrapment of sediment upstream (in reservoirs) and increases in flow velocities for the water this is intended to remain between the levees. Even so, it is conceivable that upstream of the Moulton Weir, as much as 100,000 cfs could leave the river and flow through the Colusa Basin Drain. This estimate is not supported by calculations, but based upon how much the river spills out of the Moulton Weir and the Colusa Weir (at-grade weirs) and how much water is left in the channel from the published profile information. With 100,000 cfs in the Colusa Basin Drain, the water surfaces along the edge of the City would increase approximately two feet higher above the levels of the Colusa Basin Drain watershed runoff, as depicted on the current FEMA mapping. This was based upon modeling this flow in the one-dimensional model of the Colusa Basin Drain provided by Domenichelli and Associates, as well as the planning level two-dimensional modeling developed under this Drainage Master Plan. Figure 18 depicts the two-dimensional modeling results of placing 100,000 cfs into the Colusa Basin Drain corridor somewhere upstream of the City, with no improvements within the City. Blocking this increase in edge flow from entering the City, would require a channel along the western edge of the City; however, it would be much smaller than the channel modeled for the simulated breach immediately north of the City.

The level of detail of this study is approximate and would need to be verified with more rigorous analysis is before proceeding to project implementation.

The impacts to the City's General Plan may affect the proposed land use depending upon where the new channel is placed. If the conveyance replacement channel is constructed within the City's General Plan area, the corridor for the channel is not developable. The estimated channel to convey this flow and the associated flood barrier is shown on Figure 19 in typical cross section. The barrier is presumed to remain inside the General Plan boundary, no matter where the channel is located, since much of the land that is raised to produce a barrier can be constructed large enough to allow development to be built upon.

2. Downstream Levee Scenarios and Impacts to the City

As shown on Figure 1, the shape of the City's General Plan projects southward along Highway 20/45, with a narrowing segment of land that must be protected to the west of the highway, leaving an area between the highway and the river that may remain flooded. The river levee directly touching the General Plan boundary on the east coincides with the projection of Sunrise Boulevard, with the southern tip of the General Plan boundary approximately 1.2 miles southward. If the existing levees were to be certified only to the point where the General Plan boundary and the existing river levee diverges, a significant levee failure from the Sacramento River would flow westward toward the CIP area and back up along Highway 20/45, if these areas within the City were to be protected by a barrier along the Highway. The existing floodplain on Figure 20 clearly shows that this southern portion of the City would be flooded from such a levee failure in an unprotected condition. Therefore, a levee failure scenario was evaluated further downstream, assuming that the levee along the river was certified for 7,000 feet downstream of the Sunrise Boulevard projection point. This distance was selected to attempt to push the Sacramento River failure flow around a natural bend and more southward, away from the City's plan area. The existing conditions flooding resulting from this scenario is presented on Figure 21. As evidenced by this existing condition, a significant amount of water still flows west toward and across the City.

The south levee flooding issues are considerably different than the upstream levee flooding discussed above. It is important to note that it was assumed unreasonable to consider placing barriers and channels within the General Plan boundary along this southern portion of the plan area in order to protect it. The configuration of the General Plan relative to the direction of flooding indicates that a channel parallel to Highway 20/45 would be ineffective, as it is perpendicular to the general flow direction. Therefore, off-site facilities were considered to address this portion of the plan area.

The first scenario to further protect areas within the City was to model these areas as blocked, forcing the water to flow around the southern tip of the General Plan area. Figure 22 shows the increases in maximum water surface elevation resulting from blocking flow with levees assumed to be certified 7,000 feet downstream with approximate increases of two feet immediately east of Highway 20/45. Upon reviewing the river alignment in relation to the City, rather than extend the assumed levee certification further along the river, a scenario was developed to allow the water to be conveyed more efficiently toward and past the southernmost point in the General Plan area. Further assumptions of more efficient conveyance were modeled with a large 200-foot-wide channel from the river, a point approximately 3,800 feet downstream of Sunrise Boulevard, to a point at the southern tip of the General Plan area. With the areas in the City continuing to be blocked from conveying flow, the added channel conveyance did not alleviate the back up of floodwaters along Highway 20/45, and the floodwaters still flowed over the top of

the new channel westward toward the City. Therefore, a barrier was added parallel to the proposed channel to prevent the flooding from entering into the area immediately east of the CIP. This scenario (Figure 23), when compared to the existing conditions depicted on Figure 21, indicates that a barrier and channel work well to direct the flooding around the City with minimal impact. Only a small area with a localized increase of approximately 0.3 feet is shown on Figure 23 at the downstream end of the modeled channel. It is worth noting that improvements under Highway 20/45 were not modeled. To alleviate this small area of increase would require some design flow transitions that are beyond the resolution of the two-dimensional model developed for this report. Further refinement would be required to model the necessary culverts and/or bulging of the channel to allow for slightly smoother transitions back to the existing flow patterns.

V. LIMITATIONS OF THE CURRENT DRAINAGE MASTER PLAN

In accordance with state legislation, any community that proposes to increase its population above 10,000 people will trigger requirements for providing 200-year flood protection by the year 2025, and must provide a detailed plan of how it will achieve such protection, including technical and financial perspectives. The level of effort required to develop a plan was not anticipated as part of the scope of work for this Drainage Master Plan. Addressing the external flooding at a 200-year level would require a detailed assessment of the 200-year flooding conditions within the Sacramento River and the Colusa Basin Drain watershed, and detailed levee integrity and failure evaluations to delineate the 200-year flooding impacts. The interior drainage facilities are currently designed with 100-year flows with freeboard to allow for 200-year conditions to occur without inundating new structures.

The 200-year storm conditions were evaluated utilizing a 24-hour duration storm as a sensitivity analysis on the preferred alternatives scenarios. The total precipitation depth for a 24-hour storm duration is 4.48 inches for the 200-year storm, which is only 0.33 inches more than the 100-year storm (4.15 inches). The resultant water surfaces in the proposed detention ponds increased less than 0.5 feet in all proposed ponds except the proposed detention facility under Alternative C1A-1. This detention facility increased 2.3 feet above the 100-year maximum elevation (47.0) under 200-year storm conditions. The current legislation is unclear regarding interior rainfall runoff that is not associated with flood liability borne by the State of California. The City is currently not within the population threshold, and with slower growth rates will not reach the 10,000 population for some time. Nonetheless, the new 200-year standard could be applicable to the City for interior drainage. Therefore, the recommended minimum pad elevations within the southern portion of the Central Corridor, is 49.8 feet (NAVD88). During a local 200-year rainfall event there will be excess street flooding within the City and close attention should be given to proposed street designs and overland release considerations.

VI. OPINIONS OF PROBABLE COST

Under the local watershed drainage, a separate opinion of probable cost was developed for each alternative. Table 11 through Table 20, provide estimates of the cost for constructing the facilities. Unit costs were determined from current publications relating to heavy construction with appropriate adjustments made for local Sacramento Valley construction conditions. A value of $15,000/acre was provided by the City as an estimate of the cost to purchase land where drainage facilities are proposed. Actual land values will be determined at the time they are needed by a qualified appraisal at the time that the land is required by the City to mitigate flooding.

VII. REFERENCES

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2. California Stormwater Quality Association, "California Best Management Practices Handbook: New Development and Redevelopment Handbook," updated in September 2004.

3. Central Valley Flood Protection Board and U.S. Army Corps of Engineers, Sacramento River Flood Control Project, "Channel Design Profile, Sacramento River."

4. Colusa Industrial Properties – Public Draft "Environmental Impact Report," November 2007.

5. Ensign & Buckley, Colusa Basin Drain, HEC-2 Models. No date.

6. Federal Emergency Management Agency, "Guidelines and Specifications for Flood Hazard Mapping Partners," February 2002.

7 Federal Emergency Management Agency, "Flood Insurance Study, Colusa County, California, Unincorporated Area," Revised.

8. Pacific Municipal Consultants and North Fork Associates, "Draft General Plan," prepared for the City of Colusa. Adopted October 30, 2007.

9. Sacramento City/County, "Drainage Manual Volume 2: Hydrology Standards," December 1996.

10. U.S. Department of Agriculture, NRCS, "Soil Survey of Colusa County, California," 1998 conditions – published unnoted over the internet.

11. U.S. Department of Agriculture, Soil Conservation Service, "Technical Release 55," June 1986.

12. U.S. Department of Defense, "Unified Facilities Criteria, Design: Low Impact Development Manual," October 24, 2004.

13. Wood Rodgers Inc., "Storm Drainage Design Criteria," prepared for the City of Colusa, April 2008.

14. Wood Rodgers Inc., "Problem Identification Report," prepared for the City of Colusa, December 16, 2008 – Revised June 2009.

TABLES

TABLE 1

CITY OF COLUSA
DRAINAGE MASTER PLAN
SUMMARY OF FACILITIES - ALTERNATIVE E1A

DETENTION SUMMARY

No.	Basins	100-Year Storage (ac-ft)	Footprint (ac)	WQ Volume (ac-ft)	Pumping (cfs)	Maximum Water Surface Elevation (ft)
1	DB-E1-1	71.8		24.2	10	50
		63.5		24.2	20	49.6
		56.4		24.2	30	49.2
2	DB-E1-2	27.6	10	6.9		49.6
3	DB-E1-3	65.9	8			47.7
4	DB-E1-4	47.5	12	9.2		45.5
5	DB-E1-5	1.5	0.76	1.2		

CHANNEL SUMMARY

No.	Channels	Length (ft)	Bottom Width (ft)	Depth (ft)	Side Slope
1	CH-E1-1	2,041	8.0	4.0	3.0
2	CH-E1-2	1,083	8.0	6.0	3.0
3	CH-E1-3	1,750	2.5	3.0	3.0
4	CH-E1-4	1,500	2.5	3.0	3.0
5	CH-E1-5	1,900	3.0	3.0	3.0

TABLE 2

CITY OF COLUSA
DRAINAGE MASTER PLAN
SUMMARY OF FACILITIES - ALTERNATIVE E1B

DETENTION SUMMARY

No.	Basins	100-Year Storage (ac-ft)	Footprint (ac)	WQ Volume (ac-ft)	Pumping (cfs)	Maximum Water Surface Elevation (ft)
1	DB-E1-1	130.9		34.9	10	52.3
		120.6		34.9	20	51.9
		111.0		34.9	30	51.6
		101.7		34.9	40	51.3
		92.6		34.9	50	50.9
		72.0		34.9	90	49.8
2	DB-E1-2	21.0	10	6.9		49.2
3	DB-E1-3	10.7	8			46.6
4	DB-E1-4	46.4	12	9.2		45.5
5	DB-E1-5	1.7	1	1.2		

CHANNEL SUMMARY

No.	Channels	Length (ft)	Bottom Width (ft)	Depth (ft)	Side Slope
1	CH-E1-1				
2	CH-E1-2				
3	CH-E1-3	1,750	2.5	3.0	3
4	CH-E1-4	1,500	2.5	3.0	3
5	CH-E1-5	1,900	3.0	3.0	3

TABLE 3

CITY OF COLUSA
DRAINAGE MASTER PLAN
SUMMARY OF FACILITIES - ALTERNATIVE E2A

DETENTION SUMMARY

No.	Basins	100-Year Storage (ac-ft)	Footprint (ac)	WQ Volume (ac-ft)	Pumping (cfs)	Maximum Water Surface Elevation
1	DB-E1-1	70.7		24.2		49.9
2	DB-E1-2	28.3	10	6.9		49.5
3	DB-E1-3	77.3	8			47.7
4	DB-E1-4	47.5	12	9.2		45.5
5	DB-E1-5	1.7	0.7	1.2		

CHANNEL SUMMARY

No.	Channels	Length (ft)	Bottom Width (ft)	Depth (ft)	Side Slope
1	CH-E1-1	2,041	8.0	4.0	3
2	CH-E1-2	1,083	8.0	6.0	3
3	CH-E1-3	1,750	2.5	3.0	3
4	CH-E1-4	1,500	2.5	3.0	3
5	CH-E1-5	1,900	3.0	3.0	3

TABLE 4

CITY OF COLUSA
DRAINAGE MASTER PLAN
SUMMARY OF FACILITIES - ALTERNATIVE E2B

DETENTION SUMMARY

No.	Basins	100-Year Storage (ac-ft)	Footprint (ac)	WQ Volume (ac-ft)	Pumping (cfs)	Maximum Water Surface Elevation (ft)
1	DB-E1-1	101.4		34.9		51.3
2	DB-E1-2	22.5	10	6.9		49.4
3	DB-E1-3	32.3	8			47.1
4	DB-E1-4	45.6	12	9.2		45.3
5	DB-E1-5	1.7	0.7	1.2		

CHANNEL SUMMARY

No.	Channels	Length (ft)	Bottom Width (ft)	Depth (ft)	Side Slope
1	CH-E1-1				
2	CH-E1-2				
3	CH-E1-3	1,750	2.5		3
4	CH-E1-4	1,500	2.5	3.0	3
5	CH-E1-5	1,900	3.0	3.0	3

TABLE 5

CITY OF COLUSA
DRAINAGE MASTER PLAN
SUMMARY OF FACILITIES - ALTERNATIVE C1A-1

DETENTION SUMMARY

No.	Basins	100-Year Storage (ac-ft)	Footprint (ac)	WQ Volume (ac-ft)	Pumping (cfs)	Maximum Water Surface Elevation (ft)
1	DB-C1A-1-1	181.7	22	49.8	10	47

TABLE 6

CITY OF COLUSA
DRAINAGE MASTER PLAN
SUMMARY OF FACILITIES - ALTERNATIVE C1A-2

DETENTION SUMMARY

No.	Basins	100-Year Storage (ac-ft)	Footprint (ac)	WQ Volume (ac-ft)	Pumping (cfs)	Maximum Water Surface Elevation (ft)
1	DB-C1A-2-1	86.0	12.5	30.7	10	46.8
2	DB-C1A-2-2	105.4	13	30.7		48.4

TABLE 7

CITY OF COLUSA
DRAINAGE MASTER PLAN
SUMMARY OF FACILITIES - ALTERNATIVE C1B

DETENTION SUMMARY

No.	Basins	100-Year Storage (ac-ft)	Footprint (ac)	WQ Volume (ac-ft)	Pumping (cfs)	Maximum Water Surface Elevation (ft)
1	DB-C1B-1	79.6	12	26.8	10	46.5

TABLE 8

CITY OF COLUSA
DRAINAGE MASTER PLAN
SUMMARY OF FACILITIES - ALTERNATIVE W1A

DETENTION SUMMARY

No.	Basins	100-Year Storage (ac-ft)	Footprint (ac)	WQ Volume (ac-ft)	Pumping (cfs)
1	DB-W1-1	56.3		40.6	202

CHANNEL SUMMARY

No.	Channels	Length (ft)	Bottom Width (ft)	Depth (ft)	Side Slope
1	CH-W1-1	1,989	10	5	3
2	CH-W1-2	1,396	10	5	3
3	CH-W1-3	5,850	30	5	3
5	CH-W1-4	3,077	35	5	3

TABLE 9

CITY OF COLUSA
DRAINAGE MASTER PLAN
SUMMARY OF FACILITIES - ALTERNATIVE W1B

DETENTION SUMMARY

No.	Basins	100-Year Storage (ac-ft)	Footprint (ac)	WQ Volume (ac-ft)	Pumping (cfs)
1	DB-W1-1	65.5		40.6	280

CHANNEL SUMMARY

No.	Channels	Length (ft)	Bottom Width (ft)	Depth (ft)	Side Slope
1	CH-W1-1	1,989	10	5	3
2	CH-W1-2	1,396	10	5	3
3	CH-W1-3	5,850	30	5	3
4	CH-W1-4	3,077	35	5	3
5	CH-W1-5	1,735	6	4	3
6	CH-W1-6	973	20	5	3
7	CH-W1-7	3,757	20	5	3

TABLE 10

CITY OF COLUSA
DRAINAGE MASTER PLAN
SUMMARY OF FACILITIES - ALTERNATIVE W2

DETENTION SUMMARY

No.	Basins	100-Year Storage (ac-ft)	Footprint (ac)	WQ Volume (ac-ft)	Pumping (cfs)	Maximum Water Surface Elevation (ft)
1	DB-W2-1	21.6	5	14.4		54.2
2	DB-W2-2	16.1	4	10.2		51.1
3	DB-W2-3	46.7	8	15.9	202	46.8

CHANNEL SUMMARY

No.	Channels	Length (ft)	Bottom Width (ft)	Depth (ft)	Side Slope
1	CH-W1-1	1,989	10	5	3
2	CH-W1-2	1,396	10	5	3
3	CH-W1-3	5,850	30	5	3
4	CH-W1-4	3,077	35	5	3
5	CH-W1-5	1,735	6	4	3
6	CH-W1-6	973	20	5	3
7	CH-W1-7	3,757	20	5	3

TABLE 11

CITY OF COLUSA
DRAINAGE MASTER PLAN
ALTERNATIVE E1A - EASTERN SHED

OPINION OF PROBABLE COST

		Item	Quantity	Unit	Unit Cost, $	Cost, $
1.		Detention Basin DB-E1-1 Located West of River Bend				
	a.	Site Clearing	9.7	AC	385	3,734
	b.	Bulk Excavation	39,059	CY	4.52	176,546
	c.	Structural Backfill and Compaction		CY	1.52	0
	d.	Grouted Riprap		CY	108.87	0
	e.	Riprap, Random Broken Stone for Inlet and Outlet Pipes	83	CY	57.84	4,820
	f.	Dewatering	1	LS	150,000	150,000
	g.	Maintenance Road Around Perimeter, 15' Wide		SY	5.06	0
	h.	Mobilization and Demobilization (5% Construction)	1	LS	16,755	16,755
2.		Detention Basin DB-E1-2 Located East of Golf Course				
	a.	Site Clearing	14.0	AC	385	5,390
	b.	Bulk Excavation	87,450	CY	4.52	395,275
	c.	Structural Backfill and Compaction		CY	1.52	0
	d.	Grouted Riprap		CY	108.87	0
	e.	Riprap, Random Broken Stone for Inlet and Outlet Pipes	33	CY	57.84	1,928
	f.	Dewatering	1	LS	150,000	150,000
	g.	Maintenance Road Around Perimeter, 15' Wide	5,306	SY	5.06	26,849
	h.	Mobilization and Demobilization (5% Construction)	1	LS	28,972	28,972
3.		Detention Basin DB-E1-3 Located South of Golf Course				
	a.	Site Clearing	12	AC	385	4,620
	b.	Bulk Excavation	115,750	CY	4.52	523,189
	c.	Structural Backfill and Compaction		CY	1.52	0
	d.	Grouted Riprap		CY	108.87	0
	e.	Riprap, Random Broken Stone	17	CY	57.84	964
	f.	Dewatering	1	LS	150,000	150,000
	g.	Maintenance Road Around Perimeter, 15' Wide	4,920	SY	5.06	24,895
	h.	Mobilization and Demobilization (5% Construction)	1	LS	35,183	35,183
4		Detention Basin DB-E1-4 Located North of the Abandoned Railroad				
	a.	Site Clearing	12	AC	385	4,620
	b.	Bulk Excavation	106,435	CY	4.52	481,088
	c.	Structural Backfill and Compaction		CY	1.52	0
	d.	Grouted Riprap		CY	108.87	0
	e.	Riprap, Random Broken Stone		CY	57.84	0
	f.	Dewatering	1	LS	150,000	150,000
	g.	Maintenance Road Around Perimeter, 15' Wide	4,920	SY	5.06	24,895
	h.	Mobilization and Demobilization (5% Construction)	1	LS	33,030	33,030
5.		Detention Basin DB-E1-5 Located at the Southeastern Portion of the City				
	a.	Site Clearing	0.76	AC	385	293
	b.	Bulk Excavation	5,529	CY	4.52	24,992
	c.	Structural Backfill and Compaction		CY	1.52	0
	d	Grouted Riprap		CY	108.87	0
	e.	Riprap, Random Broken Stone		CY	57.84	0
	f	Dewatering	1	LS	50,000	50,000
	g.	Maintenance Road Around Perimeter, 15' Wide	1,313	SY	5.06	6,644
	h.	Mobilization and Demobilization (5% Construction)	1	LS	4,096	4,096
6.		Conveyance Channel CH-E1-1 Along Highway 20/45				
	a.	Site Clearing	1.5	AC	385	578
	b.	Bulk Excavation	6,047	CY	4.52	27,332
	c.	Structural Backfill and Compaction		CY	1.52	0
	d.	Grouted Riprap		CY	108.87	0
	e.	Riprap, Random Broken Stone		CY	57.84	0
	f.	Maintenance Road (15' Wide)	3,402	SY	5.06	17,214
	g.	Mobilization and Demobilization (5% Construction)	1	LS	2,256	2,256
7		Conveyance Channel CH-E1-2 along Highway 20/45				
	a.	Site Clearing	1.1	AC	385	424
	b.	Bulk Excavation	6,257	CY	4.52	28,282
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d	Grouted Riprap	0	CY	108.87	0
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f	Maintenance Road (15' Wide)	1,805	SY	5.06	9,133
	g.	Mobilization and Demobilization (5% Construction)	1	LS	1,892	1,892

TABLE 11

CITY OF COLUSA
DRAINAGE MASTER PLAN
ALTERNATIVE E1A - EASTERN SHED

OPINION OF PROBABLE COST

		Item	Quantity	Unit	Unit Cost, $	Cost, $
8.		Conveyance Channel CH-E1-3/4 Draining Southerly to Ditch Along Railroad				
	a.	Site Clearing	1.5	AC	385	578
	b.	Bulk Excavation	4,153	CY	4.52	18,772
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	5,417	SY	5.06	27,410
	g.	Mobilization and Demobilization (5% Construction)	1	LS	2,338	2,338
9.		Conveyance Channel CH-E1-5 along abandoned Railroad				
	a	Site Clearing	0.9	AC	385	347
	b.	Bulk Excavation	2,533	CY	4.52	11,449
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	3,167	SY	5.06	16,025
	g.	Mobilization and Demobilization (5% Construction)	1	LS	1,391	1,391
10.		Storm Drains for Eastern Shed Alternative E1A				
	a.	30" Diameter RCP	0	LF	85.00	0
	b.	33" Diameter RCP	0	LF	95.00	0
	c.	36" Diameter RCP	10,390	LF	100.00	1,039,000
	d.	39" Diameter RCP	0	LF	110.00	0
	e.	42" Diameter RCP	0	LF	120.00	0
	f.	48" Diameter RCP	0	LF	140.00	0
	g.	54" Diameter RCP	0	LF	175.00	0
	h.	60" Diameter RCP	1,780	LF	195.00	347,100
	i	66" Diameter RCP	2,718	LF	215.00	584,370
	j.	72" Diameter RCP	0	LF	235.00	0
	k.	78" Diameter RCP	0	LF	300.00	0
	l.	84" Diameter RCP	0	LF	350.00	0
	m.	90" Diameter RCP	0	LF	400.00	0
	n.	Manhole - Large Diameter	13	LS	10,000.00	130,000
	o.	Mixing Vault	0	LS	25,000.00	0
11.		Proposed Berm Along the Southern Boundary				
	a.	Site Clearing	7.5	AC	385	2,888
	b.	Fill Earthwork from Excavated Detention Pond DB-E1-4	8,517	CY	6.75	57,490
	c.	Inspection Trench Excavation	8,517	CY	4.52	38,497
	d.	Inspection Trench recompaction	8,517	CY	6.75	57,490
	e.	FEMA Certification				
	f.	Mobilization and Demobilization (5% Construction)	1	LS	7,818	7,818
12		Exterior Channel Adjacent to the Proposed Berm*				
	a.	Site Clearing	7.5	AC	385	2,888
	b.	Bulk Excavation	8,517	CY	4.52	38,497
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	0	SY	5.06	0
	g.	Mobilization and Demobilization (5% Construction)	1	LS	2,069	2,069
13.		Existing Pond DB-E1-1 Dewatering Pump Station (10 cfs capacity)				
	a.	Pump Station	10	CFS	50,000	500,000
	b.	Mobilization and Demobilization (5% Construction)	1	LS	25,000	25,000
Subtotal						5,477,302
Construction Contingency @ 25%						1,369,326
Engineering/Design @ 8%						438,184
Construction Management and Administration @ 12%						657,276
Subtotal Construction						7,942,088
Land Acquisition = $15,000/ac			68.46	AC	15,000**	1,026,889
TOTAL, $						8,968,977

Notes:

*Final sizing of this channel to be determined upon completion of Sacramento River Levee Failure Analysis.

**This amount provided by Ponticello Enterprises.

TABLE 12

CITY OF COLUSA
DRAINAGE MASTER PLAN
ALTERNATIVE E1B - EASTERN SHED

OPINION OF PROBABLE COST

		Item	Quantity	Unit	Unit Cost, $	Cost, $
1.		Detention Basin DB-E1-1 Located West of River Bend				
	a.	Site Clearing	9.7	AC	385	3,734
	b.	Bulk Excavation	56,321	CY	4.52	254,572
	c	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	0
	e.	Riprap, Random Broken Stone for Inlet and Outlet Pipes	83	CY	57.84	4,820
	f.	Dewatering	1	LS	150,000	150,000
	g.	Maintenance Road Around Perimeter, 15' Wide	0	SY	5.06	0
	h.	Mobilization and Demobilization (5% Construction)	1	LS	20,656	20,656
2.		Detention Basin DB-E1-2 Located East of Golf Course				
	a.	Site Clearing	10	AC	385	3,850
	b.	Bulk Excavation	65,302	CY	4.52	295,166
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	0
	e.	Riprap, Random Broken Stone for Inlet and Outlet Pipes	33	CY	57.84	1,928
	f.	Dewatering	1	LS	150,000	150,000
	g.	Maintenance Road Around Perimeter, 15' Wide	4,500	SY	5.06	22,770
	h.	Mobilization and Demobilization (5% Construction)	1	LS	23,686	23,686
3.		Detention Basin DB-E1-3 Located South of Golf Course				
	a.	Site Clearing	3	AC	385	1,155
	b.	Bulk Excavation	11,990	CY	4.52	54,197
	c	Structural Backfill and Compaction		CY	1.52	0
	d.	Grouted Riprap		CY	108.87	0
	e.	Riprap, Random Broken Stone	17	CY	57.84	964
	f.	Dewatering	1	LS	50,000	50,000
	g.	Maintenance Road Around Perimeter, 15' Wide	22,590	SY	5.06	114,304
	h.	Mobilization and Demobilization (5% Construction)	1	LS	11,031	11,031
4		Detention Basin DB-E1-4 Located North of the Abandoned Railroad				
	a.	Site Clearing	12	AC	385	4,620
	b.	Bulk Excavation	106,435	CY	4.52	481,088
	c.	Structural Backfill and Compaction		CY	1.52	0
	d.	Grouted Riprap		CY	108.87	0
	e.	Riprap, Random Broken Stone		CY	57.84	0
	f.	Dewatering	1	LS	150,000	150,000
	g.	Maintenance Road Around Perimeter, 15' Wide	4,920	SY	5.06	24,895
	h.	Mobilization and Demobilization (5% Construction)	1	LS	33,030	33,030
5.		Detention Basin DB-E1-5 Located at the Southeastern Portion of the City				
	a.	Site Clearing	0.76	AC	385	293
	b.	Bulk Excavation	5,529	CY	4.52	24,992
	c.	Structural Backfill and Compaction		CY	1.52	0
	d	Grouted Riprap		CY	108.87	0
	e.	Riprap, Random Broken Stone		CY	57.84	0
	f	Dewatering	1	LS	50,000	50,000
	g.	Maintenance Road Around Perimeter, 15' Wide	1,313	SY	5.06	6,644
	h.	Mobilization and Demobilization (5% Construction)	1	LS	4,096	4,096
6.		Conveyance Channel CH-E1-3/4 Draining Southerly to Ditch Along Railroad				
	a.	Site Clearing	1.5	AC	385	578
	b.	Bulk Excavation	4,153	CY	4.52	18,772
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f	Maintenance Road (15' Wide)	5,417	SY	5.06	27,410
	g	Mobilization and Demobilization (5% Construction)	1	LS	2,338	2,338
7		Conveyance Channel CH-E1-5 Along Abandoned Railroad				
	a.	Site Clearing	0.9	AC	385	347
	b.	Bulk Excavation	2,533	CY	4.52	11,449
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f	Maintenance Road (15' Wide)	3,167	SY	5.06	16,025
	g.	Mobilization and Demobilization (5% Construction)	1	LS	1,391	1,391
8		Storm Drains for Eastern Shed Alternative E1A				
	a.	30" Diameter RCP	0	LF	85.00	0
	b.	33" Diameter RCP	0	LF	95.00	0

TABLE 12

CITY OF COLUSA
DRAINAGE MASTER PLAN
ALTERNATIVE E1B - EASTERN SHED

OPINION OF PROBABLE COST

Item			Quantity	Unit	Unit Cost, $	Cost, $
	c.	36" Diameter RCP	10,390	LF	100.00	1,039,000
	d.	39" Diameter RCP	0	LF	110.00	0
	e.	42" Diameter RCP	0	LF	120.00	0
	f.	48" Diameter RCP	0	LF	140.00	0
	g.	54" Diameter RCP	0	LF	175.00	0
	h.	60" Diameter RCP	1,780	LF	195.00	347,100
	i.	66" Diameter RCP	4,788	LF	215.00	1,029,420
	j.	72" Diameter RCP	0	LF	235.00	0
	k.	78" Diameter RCP	0	LF	300.00	0
	l.	84" Diameter RCP	0	LF	350.00	0
	m.	90" Diameter RCP	0	LF	400.00	0
	n.	Manhole - Large Diameter	15	LS	10,000.00	150,000
	o	Mixing Vault	0	LS	25,000.00	0
9.	Proposed Berm Along the Southern Boundary					
	a.	Site Clearing	7.5	AC	385	2,888
	b.	Fill Earthwork from Excavated Detention Pond DB-E1-4	8,517	CY	6.75	57,490
	c.	Inspection Trench Excavation	8,517	CY	4.52	38,497
	d.	Inspection Trench Recompaction	8,517	CY	6.75	57,490
	e.	FEMA Certification	1	LS		
	f.	Mobilization and Demobilization (5% Construction)	1	LS	7,818	7,818
10.	Exterior Channel Adjacent to the Proposed Berm*					
	a.	Site Clearing	7.5	AC	385	2,888
	b.	Bulk Excavation	8,517	CY	4.52	38,497
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	0	SY	5.06	0
	g.	Mobilization and Demobilization (5% Construction)	1	LS	2,069	2,069
11	Existing Pond DB-E1-1 Dewatering Pump Station (90 cfs Capacity)					
	a.	Pump Station	90	CFS	50,000	4,500,000
	b	Mobilization and Demobilization (5% Construction)	1	LS	225,000	225,000
Subtotal						9,518,955
Construction Contingency @ 25%						2,379,739
Engineering/Design @ 8%						761,516
Construction Management and Administration @ 12%						1,142,275
Subtotal Construction						13,802,485
Land Acquisition			52.86	AC	15,000**	792,889
TOTAL, $						14,595,374

Notes:
*Final sizing of this channel to be determined upon completion of Sacramento River Levee Failure Analysis.
**This amount provided by Ponticello Enterprises.

TABLE 13

CITY OF COLUSA
DRAINAGE MASTER PLAN
ALTERNATIVE E2A - EASTERN SHED

OPINION OF PROBABLE COST

	Item	Quantity	Unit	Unit Cost, $	Cost, $
1.	Detention Basin DB-E1-1 Located West of River Bend				
a.	Site Clearing	9.7	AC	385	3,734
b.	Bulk Excavation	39,059	CY	4.52	176,546
c.	Structural Backfill and Compaction	0	CY	1.52	0
d	Grouted Riprap	0	CY	108.87	0
e.	Riprap, Random Broken Stone for Inlet and Outlet Pipes	83	CY	57.84	4,820
f.	Dewatering	1	LS	150,000	150,000
g.	Maintenance Road Around Perimeter, 15' Wide	0	SY	5.06	0
h.	Mobilization and Demobilization (5% Construction)	1	LS	16,755	16,755
2.	Detention Basin DB-E1-2 Located East of Golf Course				
a.	Site Clearing	14	AC	385	5,390
b.	Bulk Excavation	87,449	CY	4.52	395,271
c.	Structural Backfill and Compaction	0	CY	1.52	0
d.	Grouted Riprap	0	CY	108.87	0
e.	Riprap, Random Broken Stone	33	CY	57.84	1,928
f.	Dewatering	1	LS	150,000	150,000
g.	Maintenance Road Around Perimeter, 15' Wide	5,306	SY	5.06	26,849
h.	Mobilization and Demobilization (5% Construction)	1	LS	28,972	28,972
3.	Detention Basin DB-E2-3 Located South of Golf Course				
a.	Site Clearing	14	AC	385	5,390
b.	Bulk Excavation	137,495	CY	4.52	621,479
c.	Structural Backfill and Compaction		CY	1.52	0
d.	Grouted Riprap		CY	108.87	0
e.	Riprap, Random Broken Stone	17	CY	57.84	964
f.	Dewatering	1	LS	150,000	150,000
g.	Maintenance Road Around Perimeter, 15' Wide	5,306	SY	5.06	26,849
h.	Mobilization and Demobilization (5% Construction)	1	LS	40,234	40,234
4.	Detention Basin DB-E2-4 Located North of the Abandoned Railroad				
a	Site Clearing	12	AC	385	4,620
b.	Bulk Excavation	106,435	CY	4.52	481,088
c.	Structural Backfill and Compaction		CY	1.52	0
d.	Grouted Riprap		CY	108.87	0
e.	Riprap, Random Broken Stone		CY	57.84	0
f.	Dewatering	1	LS	150,000	150,000
g.	Maintenance Road Around Perimeter, 15' Wide	4,920	SY	5.06	24,895
h.	Mobilization and Demobilization (5% Construction)	1	LS	33,030	33,030
5.	Detention Basin DB-E2-5 Located at the Southeastern Portion of the City				
a.	Site Clearing	0.76	AC	385	293
b	Bulk Excavation	5,744	CY	4.52	25,963
c	Structural Backfill and Compaction		CY	1.52	0
d.	Grouted Riprap		CY	108.87	0
e	Riprap, Random Broken Stone		CY	57.84	0
f.	Dewatering	1	LS	50,000	50,000
g	Maintenance Road Around Perimeter, 15' Wide	1,216	SY	5.06	6,153
h.	Mobilization and Demobilization (5% Construction)	1	LS	4,120	4,120
6.	Conveyance Channel CH-E2-3/4 Draining Southerly to Ditch Along Railroad				
a.	Site Clearing	1.5	AC	385	578
b	Bulk Excavation	4,153	CY	4.52	18,772
c.	Structural Backfill and Compaction	0	CY	1.52	0
d.	Grouted Riprap	0	CY	108.87	
e.	Riprap, Random Broken Stone	0	CY	57.84	0
f.	Maintenance Road (15' Wide)	5,417	SY	5.06	27,410
g.	Mobilization and Demobilization (5% Construction)	1	LS	2,338	2,338
7.	Conveyance Channel CH-E2-5 Along Abandoned Railroad				
a.	Site Clearing	0.9	AC	385	347
b.	Bulk Excavation	2,533	CY	4.52	11,449
c.	Structural Backfill and Compaction	0	CY	1.52	0
d.	Grouted Riprap	0	CY	108.87	
e.	Riprap, Random Broken Stone	0	CY	57.84	0
f.	Maintenance Road (15' Wide)	3,167	SY	5.06	16,025
g.	Mobilization and Demobilization (5% Construction)	1	LS	1,391	1,391

TABLE 13

CITY OF COLUSA
DRAINAGE MASTER PLAN
ALTERNATIVE E2A - EASTERN SHED

OPINION OF PROBABLE COST

		Item	Quantity	Unit	Unit Cost, $	Cost, $
8.		Storm Drains for Eastern Shed Alternative E1A				
	a.	30" Diameter RCP	0	LF	85.00	0
	b	33" Diameter RCP	0	LF	95.00	0
	c.	36" Diameter RCP	10,390	LF	100.00	1,039,000
	d.	39" Diameter RCP	0	LF	110.00	0
	e.	42" Diameter RCP	0	LF	120.00	0
	f.	48" Diameter RCP	0	LF	140.00	0
	g	54" Diameter RCP	0	LF	175.00	0
	h.	60" Diameter RCP	1,780	LF	195.00	347,100
	i.	66" Diameter RCP	2,718	LF	215.00	584,370
	j.	72" Diameter RCP	0	LF	235.00	0
	k.	78" Diameter RCP	0	LF	300.00	0
	l.	84" Diameter RCP	0	LF	350.00	0
	m.	90" Diameter RCP	0	LF	400.00	0
	n.	Manhole - Large Diameter	15	LS	10,000.00	150,000
	o.	Mixing Vault	0	LS	25,000.00	0
9.		Proposed Berm Along the Southern Boundary				
	a.	Site Clearing	7.5	AC	385	2,888
	b.	Fill Earthwork from Excavated Detention Pond DB-E1-4	8,517	CY	6.75	57,490
	c.	Inspection Trench Excavation	8,517	CY	4.52	38,497
	d.	Inspection Trench Recompaction	8,517	CY	6.75	57,490
	e.	FEMA Certification	1	LS		
	f.	Mobilization and Demobilization (5% Construction)	1	LS	3,019	3,019
10.		Exterior Channel Adjacent to the Proposed Berm*				
	a.	Site Clearing	7.5	AC	385	2,888
	b.	Bulk Excavation	8,517	CY	4.52	38,497
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	0	SY	5.06	0
	g.	Mobilization and Demobilization (5% Construction)	1	LS	2,069	2,069
11.		Existing Pond DB-E1-1 Dewatering Pump Station (7 cfs capacity)				
	a.	Pump Station	7	CFS	50,000	350,000
	b	Mobilization and Demobilization (5% Construction)	1	LS	17,500	17,500
Subtotal						5,354,458
Construction Contingency @ 25%						1,338,615
Engineering/Design @ 8%						428,357
Construction Management and Administration @ 12%						642,535
Subtotal Construction						7,763,965
Land Acquisition			67.86	AC	15,000**	1,017,889
TOTAL						8,781,854

Notes:
*Final sizing of this channel to be determined upon completion of Sacramento River Levee Failure Analysis.
**This amount provided by Ponticello Enterprises.

TABLE 14

CITY OF COLUSA
DRAINAGE MASTER PLAN
ALTERNATIVE E2B - EASTERN SHED

OPINION OF PROBABLE COST

		Item	Quantity	Unit	Unit Cost, $	Cost, $
1.		Detention Basin DB-E1-1 located West of River Bend				
	a.	Site Clearing	9.7	AC	385	3,734
	b.	Bulk Excavation	56,321	CY	4.52	254,572
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	0
	e.	Riprap, Random Broken Stone for Inlet and Outlet Pipes	83	CY	57.84	4,820
	f.	Dewatering	1	LS	150,000	150,000
	g.	Maintenance Road Around Perimeter, 15' Wide	0	SY	5.06	0
	h.	Mobilization and Demobilization (5% Construction)	1	LS	20,656	20,656
2.		Detention Basin DB-E2-2 Located East of Golf Course				
	a.	Site Clearing	10	AC	385	3,850
	b.	Bulk Excavation	65,302	CY	4.52	295,166
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	0
	e.	Riprap, Random Broken Stone	33	CY	57.84	1,928
	f.	Dewatering	1	LS	150,000	150,000
	g.	Maintenance Road Around Perimeter, 15' Wide	4,500	SY	5.06	22,770
	h.	Mobilization and Demobilization (5% Construction)	1	LS	23,686	23,686
3.		Detention Basin DB-E2-3 Located South of Golf Course				
	a.	Site Clearing	7	AC	385	2,695
	b.	Bulk Excavation	52,446	CY	4.52	237,056
	c.	Structural Backfill and Compaction		CY	1.52	0
	d.	Grouted Riprap		CY	108.87	0
	e.	Riprap, Random Broken Stone	17	CY	57.84	964
	f.	Dewatering	1	LS	150,000	150,000
	g.	Maintenance Road Around Perimeter, 15' Wide	3,781	SY	5.06	19,133
	h.	Mobilization and Demobilization (5% Construction)	1	LS	20,492	20,492
4.		Detention Basin DB-E2-4 Located North of the Abandoned Railroad				
	a	Site Clearing	12	AC	385	4,620
	b.	Bulk Excavation	106,435	CY	4.52	481,088
	c.	Structural Backfill and Compaction		CY	1.52	0
	d.	Grouted Riprap		CY	108.87	0
	e.	Riprap, Random Broken Stone		CY	57.84	0
	f.	Dewatering	1	LS	150,000	150,000
	g.	Maintenance Road Around Perimeter, 15' Wide	4,920	SY	5.06	24,895
	h	Mobilization and Demobilization (5% Construction)	1	LS	33,030	33,030
5.		Detention Basin DB-E2-5 Located at the Southeastern Portion of the City				
	a.	Site Clearing	0.76	AC	385	293
	b.	Bulk Excavation	5,529	CY	4.52	24,992
	c.	Structural Backfill and Compaction		CY	1.52	0
	d.	Grouted Riprap		CY	108.87	0
	e.	Riprap, Random Broken Stone		CY	57.84	0
	f.	Dewatering	1	LS	50,000	50,000
	g.	Maintenance Road Around Perimeter, 15' Wide	1,313	SY	5.06	6,644
	h.	Mobilization and Demobilization (5% Construction)	1	LS	4,096	4,096
6.		Conveyance Channel CH-E2-1 Along Highway 20/45				
	a.	Site Clearing	1.5	AC	385	578
	b	Bulk Excavation	6,047	CY	4.52	27,332
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	0
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	3,402	SY	5.06	17,214
	g.	Mobilization and Demobilization (5% Construction)	1	LS	2,256	2,256
7.		Conveyance Channel CH-E2-2 Along Highway 20/45				
	a	Site Clearing	1.1	AC	385	424
	b.	Bulk Excavation	6,257	CY	4.52	28,282
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	0
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	1,805	SY	5.06	9,133
	g.	Mobilization and Demobilization (5% Construction)	1	LS	1,892	1,892

TABLE 14

CITY OF COLUSA
DRAINAGE MASTER PLAN
ALTERNATIVE E2B - EASTERN SHED

OPINION OF PROBABLE COST

		Item	Quantity	Unit	Unit Cost, $	Cost, $
8.		Conveyance Channel CH-E2-3/4 Draining Southerly to Ditch Along Railroad				
	a.	Site Clearing	1.5	AC	385	578
	b.	Bulk Excavation	4,153	CY	4.52	18,772
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	5,417	SY	5.06	27,410
	g.	Mobilization and Demobilization (5% Construction)	1	LS	2,338	2,338
9.		Conveyance Channel CH-E2-5 Along Abandoned Railroad				
	a.	Site Clearing	0.9	AC	385	347
	b.	Bulk Excavation	2,533	CY	4.52	11,449
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	3,167	SY	5.06	16,025
	g.	Mobilization and Demobilization (5% Construction)	1	LS	1,391	1,391
10.		Storm Drains for Eastern Shed Alternative E1A				
	a.	30" Diameter RCP	0	LF	85.00	0
	b.	33" Diameter RCP	0	LF	95.00	0
	c.	36" Diameter RCP	10,390	LF	100.00	1,039,000
	d.	39" Diameter RCP	0	LF	110.00	0
	e.	42" Diameter RCP	0	LF	120.00	0
	f.	48" Diameter RCP	0	LF	140.00	0
	g.	54" Diameter RCP	0	LF	175.00	0
	h.	60" Diameter RCP	1,780	LF	195.00	347,100
	i.	66" Diameter RCP	4,788	LF	215.00	1,029,420
	j.	72" Diameter RCP	0	LF	235.00	0
	k.	78" Diameter RCP	0	LF	300.00	0
	l.	84" Diameter RCP	0	LF	350.00	0
	m	90" Diameter RCP	0	LF	400.00	0
	n.	Manhole - Large Diameter	13	LS	10,000.00	130,000
	o.	Mixing Vault	0	LS	25,000.00	0
11.		Proposed Berm Along the Southern Boundary				
	a.	Site Clearing	7.5	AC	385	2,888
	b.	Fill Earthwork from Excavated Detention Pond DB-E1-4	8,517	CY	6.75	57,490
	c.	Inspection Trench Excavation	8,517	CY	4.52	38,497
	d.	Inspection Trench recompaction	8,517	CY	6.75	57,490
	e.	FEMA Certification	1	LS		
	f.	Mobilization and Demobilization (5% Construction)	1	LS	3,019	3,019
12.		Exterior Channel Adjacent to the Proposed Berm*				
	a.	Site Clearing	7.5	AC	385	2,888
	b.	Bulk Excavation	8,517	CY	4.52	38,497
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	0	SY	5.06	0
	g.	Mobilization and Demobilization (5% Construction)	1	LS	2,069	2,069
13.		Existing Pond DB-E1-1 Dewatering Pump Station (7 cfs capacity)				
	a.	Pump Station	7	CFS	50,000	350,000
	b	Mobilization and Demobilization (5% Construction)	1	LS	17,500	17,500
Subtotal						5,422,455
Construction Contingency @ 25%						1,355,614
Engineering/Design @ 8%						433,796
Construction Management and Administration @ 12%						650,695
Subtotal Construction						7,862,560
Land Acquisition			59.46	AC	15,000**	891,889
TOTAL						8,754,449

Notes:
*Final sizing of this channel to be determined upon completion of Sacramento River Levee Failure Analysis.
**This amount provided by Ponticello Enterprises.

TABLE 15

CITY OF COLUSA
DRAINAGE MASTER PLAN
ALTERNATIVE C1A-1 - CENTRAL SHED

OPINION OF PROBABLE COST

	Item	Quantity	Unit	Unit Cost, $	Cost, $
1.	Detention Basin DB-C1-1 Located East of Golf Course				
a.	Site Clearing	22	AC	385	8,470
b.	Bulk Excavation	407,473	CY	4.52	1,841,776
c.	Structural Backfill and Compaction	0	CY	1.52	0
d.	Grouted Riprap	0	CY	108.87	0
e.	Riprap, Random Broken Stone	50	CY	57.84	2,892
f.	Maintenance Road Around Perimeter, 15' Wide	6,626	SY	5.06	33,529
g.	Mobilization and Demobilization (5% Construction)	1	LS	94,333	94,333
2.	Storm Drains for Eastern Shed Alternative E1A				
a.	30" Diameter RCP	0	LF	85.00	0
b.	33" Diameter RCP	0	LF	95.00	0
c.	36" Diameter RCP	1,200	LF	100.00	120,000
d.	39" Diameter RCP	0	LF	110.00	0
e.	42" Diameter RCP	0	LF	120.00	0
f.	48" Diameter RCP	2,700	LF	140.00	378,000
g.	54" Diameter RCP	0	LF	175.00	0
h.	60" Diameter RCP	3,600	LF	195.00	702,000
i.	66" Diameter RCP	0	LF	215.00	0
j.	72" Diameter RCP	550	LF	235.00	129,250
k.	78" Diameter RCP	0	LF	300.00	0
l.	84" Diameter RCP	0	LF	350.00	0
m.	90" Diameter RCP	0	LF	400.00	0
n.	Manhole - Large Diameter	6	LS	10,000.00	60,000
o.	Mixing Vault	0	LS	25,000.00	0
3.	Proposed Berm Along the Southern Boundary				
a.	Site Clearing	8.7	AC	385	3,350
b.	Fill Earthwork from Excavated Detention Pond DB-E1-4	9,852	CY	6.75	66,501
c.	Inspection Trench Excavation	9,852	CY	4.52	44,531
d.	Inspection Trench recompaction	9,852	CY	6.75	66,501
e.	FEMA Certification	1	LS		
f.	Mobilization and Demobilization (5% Construction)	1	LS	9,044	9,044
4.	Exterior Channel Adjacent to the Proposed Berm*				
a	Site Clearing	8.7	AC	385	3,350
b.	Bulk Excavation	9,852	CY	4.52	44,531
c.	Structural Backfill and Compaction	0	CY	1.52	0
d.	Grouted Riprap	0	CY	108.87	
e.	Riprap, Random Broken Stone	0	CY	57.84	0
f.	Maintenance Road (15' Wide)	0	SY	5.06	0
g.	Mobilization and Demobilization (5% Construction)	1	LS	2,394	2,394
5.	Existing Pond DB-E1-1 Dewatering Pump Station (10 cfs capacity)				
a.	Pump Station	10	CFS	50,000	500,000
b	Mobilization and Demobilization (5% Construction)	1	LS	25,000	25,000
Subtotal					4,135,451
Construction Contingency @ 25%					1,033,863
Engineering/Design @ 8%					330,836
Construction Management and Administration @ 12%					496,254
Subtotal Construction					5,996,404
Land Acquisition		39.40	AC	15,000**	591,000
TOTAL					6,587,404

Notes.
*Final sizing of this channel to be determined upon completion of Sacramento River Levee Failure Analysis.
**This amount provided by Ponticello Enterprises.

TABLE 16

CITY OF COLUSA
DRAINAGE MASTER PLAN
ALTERNATIVE C1A-2 - CENTRAL SHED

OPINION OF PROBABLE COST

	Item	Quantity	Unit	Unit Cost, $	Cost, $
1.	Detention Basin DB-C1-1 Located East of Golf Course				
a.	Site Clearing	12.5	AC	385	4,813
b.	Bulk Excavation	164,654	CY	4.52	744,238
c.	Structural Backfill and Compaction	0	CY	1.52	0
d.	Grouted Riprap	0	CY	108.87	0
e.	Riprap, Random Broken Stone	50	CY	57.84	2,892
f.	Maintenance Road Around Perimeter, 15' Wide	5,019	SY	5.06	25,398
g.	Mobilization and Demobilization (5% Construction)	1	LS	38,867.00	38,867
2.	Detention Basin DB-C1-2 Located South of Highway-20				
a.	Site Clearing	13	AC	385	5,005
b.	Bulk Excavation	171,564	CY	4.52	775,468
c.	Structural Backfill and Compaction	0	CY	1.52	0
d.	Grouted Riprap	0	CY	108.87	0
e.	Riprap, Random Broken Stone	50	CY	57.84	2,892
f.	Maintenance Road Around Perimeter, 15' Wide	5,117	SY	5.06	25,891
g.	Mobilization and Demobilization (5% Construction)	1	LS	40,463	40,463
3.	Storm Drains for Eastern Shed Alternative E1A				
a.	30" Diameter RCP	1,150	LF	85.00	97,750
b.	33" Diameter RCP	0	LF	95.00	0
c.	36" Diameter RCP	1,200	LF	100.00	120,000
d.	39" Diameter RCP	0	LF	110.00	0
e.	42" Diameter RCP	1,150	LF	120.00	138,000
f.	48" Diameter RCP	5,500	LF	140.00	770,000
g.	54" Diameter RCP	2,000	LF	175.00	350,000
h.	60" Diameter RCP	7,050	LF	195.00	1,374,750
i.	66" Diameter RCP	1,500	LF	215.00	322,500
j.	72" Diameter RCP	3,000	LF	235.00	705,000
k.	78" Diameter RCP	0	LF	300.00	0
l.	84" Diameter RCP	0	LF	350.00	0
m.	90" Diameter RCP	0	LF	400.00	0
n.	Manhole - Large Diameter	6	LS	10,000.00	60,000
o.	Mixing Vault	0	LS	25,000.00	0
4.	Pavement Replacement				
a.	Remove and Replace Asphalt Concrete Paving	23,225	SY	25.00	580,625
b.	Remove and Replace Aggregate Base Coarse	23,225	SY	20.00	464,500
c.	Traffic Control	1	LS	150,000	150,000
d.	Mobilization and Demobilization	1	LS	59,756	59,756
5.	Proposed Berm Along the Southern Boundary				
a.	Site Clearing	8.7	AC	385	3,350
b.	Fill Earthwork from Excavated Detention Pond DB-E1-4	9,852	CY	6.75	66,501
c.	Inspection Trench Excavation	9,852	CY	4.52	44,531
d.	Inspection Trench recompaction	9,852	CY	6.75	66,501
e.	FEMA Certification	1	LS		
f.	Mobilization and Demobilization (5% Construction)	1	LS	9,044	9,044
6.	Exterior Channel Adjacent to the Proposed Berm*				
a.	Site Clearing	8.7	AC	385	3,350
b.	Bulk Excavation	9,852	CY	4.52	44,531
c.	Structural Backfill and Compaction	0	CY	1.52	0
d.	Grouted Riprap	0	CY	108.87	
e.	Riprap, Random Broken Stone	0	CY	57.84	0
f.	Maintenance Road (15' Wide)	0	SY	5.06	0
g.	Mobilization and Demobilization (5% Construction)	1	LS	2,394	2,394
7.	Existing Pond DB-E1-1 Dewatering Pump Station (10 cfs capacity)				
a.	Pump Station	10	CFS	50,000	500,000
b	Mobilization and Demobilization (5% Construction)	1	LS	25,000	25,000
Subtotal					7,624,008
Construction Contingency @ 25%					1,906,002
Engineering/Design @ 8%					609,921
Construction Management and Administration @ 12%					914,881
Subtotal Construction					11,054,811
Land Acquisition		42.90	AC	15,000**	643,500
TOTAL					11,698,311

Notes:
*Final sizing of this channel to be determined upon completion of Sacramento River Levee Failure Analysis.
**This amount provided by Ponticello Enterprises.

TABLE 17

CITY OF COLUSA
DRAINAGE MASTER PLAN
ALTERNATIVE C1B - CENTRAL SHED

OPINION OF PROBABLE COST

		Item	Quantity	Unit	Unit Cost, $	Cost, $
1.		Detention Basin DB-C1-1 Located East of Golf Course				
	a.	Site Clearing	12	AC	385	4,620
	b.	Bulk Excavation	201,037	CY	4.52	908,685
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d	Grouted Riprap	0	CY	108.87	0
	e.	Riprap, Random Broken Stone	50	CY	57.84	2,892
	f.	Maintenance Road Around Perimeter, 15' Wide	4,920	SY	5.06	24,895
	g.	Mobilization and Demobilization (5% Construction)	1	LS	47,055	47,055
2		Storm Drains for Eastern Shed Alternative E1A				
	a.	30" Diameter RCP	0	LF	85.00	0
	b.	33" Diameter RCP	0	LF	95.00	0
	c.	36" Diameter RCP	1,200	LF	100.00	120,000
	d.	39" Diameter RCP	0	LF	110.00	0
	e.	42" Diameter RCP	0	LF	120.00	0
	f.	48" Diameter RCP	2,700	LF	140.00	378,000
	g.	54" Diameter RCP	0	LF	175.00	0
	h.	60" Diameter RCP	3,600	LF	195.00	702,000
	i.	66" Diameter RCP	0	LF	215.00	0
	j.	72" Diameter RCP	550	LF	235.00	129,250
	k.	78" Diameter RCP	0	LF	300.00	0
	l.	84" Diameter RCP	0	LF	350.00	0
	m.	90" Diameter RCP	0	LF	400.00	0
	n.	Manhole - Large Diameter	6	LS	10,000.00	60,000
	o.	Mixing Vault	0	LS	25,000.00	0
3.		Proposed Berm Along the Southern Boundary				
	a.	Site Clearing	8.7	AC	385	3,350
	b.	Fill Earthwork from Excavated Detention Pond DB-E1-4	9,852	CY	6.75	66,501
	c.	Inspection Trench Excavation	9,852	CY	4.52	44,531
	d.	Inspection Trench recompaction	9,852	CY	6.75	66,501
	e.	FEMA Certification	1	LS		
	f.	Mobilization and Demobilization (5% Construction)	1	LS	9,044	9,044
4.		Exterior Channel Adjacent to the Proposed Berm*				
	a.	Site Clearing	8.7	AC	385	3,350
	b.	Bulk Excavation	9,852	CY	4.52	44,531
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	0	SY	5.06	0
	g.	Mobilization and Demobilization (5% Construction)	1	LS	2,394	2,394
5.		Existing Pond DB-E1-1 Dewatering Pump Station (10 cfs Capacity)				
	a.	Pump Station	10	CFS	50,000	500,000
	d.	Mobilization and Demobilization (5% Construction)	1	LS	25,000	25,000
Subtotal						3,142,598
Construction Contingency @ 25%						785,650
Engineering/Design @ 8%						251,408
Construction Management and Administration @ 12%						377,112
Subtotal Construction						4,556,767
Land Acquisition			29.40	AC	15,000**	441,000
TOTAL						4,997,767

Notes:
*Final sizing of this channel to be determined upon completion of Sacramento River Levee Failure Analysis.
**This amount provided by Ponticello Enterprises.

TABLE 18

CITY OF COLUSA
DRAINAGE MASTER PLAN
ALTERNATIVE W1A - WESTERN SHED

OPINION OF PROBABLE COST

		Item	Quantity	Unit	Unit Cost, $	Cost, $
1.		Detention Basin DB-W1-1 Located Off-site (North of Highway 20/45)				
	a.	Site Clearing	15	AC	385	5,775
	b.	Bulk Excavation	180,613	CY	4.52	816,373
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d	Grouted Riprap	0	CY	108.87	0
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road Around Perimeter, 15' Wide	5,489	SY	5.06	27,774
	g.	Mobilization and Demobilization (5% Construction)	1	LS	42,496	42,496
2		Conveyance Channel CH-W1-1 Along Lurline Ave.				
	a.	Site Clearing	1.8	AC	385	693
	b.	Bulk Excavation	9,208	CY	4.52	41,620
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d	Grouted Riprap	0	CY	108.87	0
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	3,315	SY	5.06	16,774
	g.	Mobilization and Demobilization (5% Construction)	1	LS	2,954	2,954
3		Conveyance Channel CH-W1-2 Along Western Boundary (McCoy Road)				
	a.	Site Clearing	1.3	AC	385	501
	b.	Bulk Excavation	6,463	CY	4.52	29,213
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	0
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	2,327	SY	5.06	11,775
	g.	Mobilization and Demobilization (5% Construction)	1	LS	2,074	2,074
4.		Conveyance Channel CH-W1-3 Along Western Boundary (McCoy/Wilson Ave)				
	a.	Site Clearing	8.1	AC	385	3,119
	b.	Bulk Excavation	48,750	CY	4.52	220,350
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	9,750	SY	5.06	49,335
	g.	Mobilization and Demobilization (5% Construction)	1	LS	13,640	13,640
5.		Conveyance Channel CH-W1-4 Towards Off-site Pond (North of Hwy-20)				
	a.	Site Clearing	4.6	AC	385	1,771
	b.	Bulk Excavation	28,491	CY	4.52	128,779
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	5,128	SY	5.06	25,948
	g.	Mobilization and Demobilization (5% Construction)	1	LS	7,825	7,825
6.		Culverts Across CH-W1-1 & 2 (40' Wide By 25')				
	a.	Structural Excavation	574	CY	24.39	13,998
	b.	Structural Backfill and Compaction	0	CY	1.52	0
	c.	Spread and Compact Excess Earthwork On-site	0	CY	6.75	0
	d.	Access Road 75' Long 15' Wide	958	SY	5.06	4,849
	e.	Cap One Pipe with Concrete on Either End	0	CY	24.39	0
	f.	60-inch RCP	50	LF	195.00	9,750
	g.	Dewatering	1	LS	30,000	30,000
	h.	Mobilization and Demobilization (5% Construction)	1	LS	2,930	2,930
	i.	Additional 10 Culverts of Same Size	10	LS	61,527	615,273
7.		Culverts Across CH-W1-3 & 4 (60' Wide By 25')				
	a.	Structural Excavation	850	CY	24.39	20,729
	b.	Structural Backfill and Compaction	0	CY	1.52	0
	c.	Spread and Compact Excess Earthwork On-site	0	CY	6.75	0
	d.	Access Road 75' Long 15' Wide	958	SY	5.06	4,849
	e.	Cap One Pipe with Concrete on Either End	0	CY	24.39	0
	f.	60" RCP	100	LF	195.00	19,500
	g.	Dewatering	1	LS	30,000	30,000
	h.	Mobilization and Demobilization (5% Construction)	1	LS	3,754	3,754
	i.	Additional 6 Culverts of Same Size	6	LS	78,832	472,993

TABLE 18

CITY OF COLUSA
DRAINAGE MASTER PLAN
ALTERNATIVE W1A - WESTERN SHED

OPINION OF PROBABLE COST

		Item	Quantity	Unit	Unit Cost, $	Cost, $
8.		Storm Drains for Eastern Shed Alternative E1A				
	a.	30" Diameter RCP	2,120	LF	85.00	180,200
	b	33" Diameter RCP	0	LF	95.00	0
	c.	36" Diameter RCP	2,625	LF	100.00	262,500
	d.	39" Diameter RCP	0	LF	110.00	0
	e.	42" Diameter RCP	3,330	LF	120.00	399,600
	f.	48" Diameter RCP	550	LF	140.00	77,000
	g.	54" Diameter RCP	0	LF	175.00	0
	h.	60" Diameter RCP	0	LF	195.00	0
	i.	66" Diameter RCP	0	LF	215.00	0
	j.	72" Diameter RCP	0	LF	235.00	0
	k.	78" Diameter RCP	0	LF	300.00	0
	l.	84" Diameter RCP	0	LF	350.00	0
	m.	90" Diameter RCP	0	LF	400.00	0
	n.	Manhole - Large Diameter	6	LS	10,000.00	60,000
	o	Mixing Vault	0	LS	25,000.00	0
9.		Proposed Berm Along the Southern Boundary				
	a.	Site Clearing	15.5	AC	385	5,968
	b.	Fill Earthwork from Excavated Detention Pond DB-E1-4	17,500	CY	6.75	118,125
	c.	Retractable Highway Flood Barrier	1	LS	100,000	100,000
	d	Inspection Trench Excavation	17,500	CY	4.52	79,100
	e.	Inspection Trench recompaction	17,500	CY	6.75	118,125
	f.	FEMA Certification	1	LS		
	g.	Mobilization and Demobilization (5% Construction)	1	LS	21,066	21,066
10.		Exterior Channel Adjacent to the Proposed Berm*				
	a.	Site Clearing	15.5	AC	385	5,968
	b.	Bulk Excavation	17,500	CY	4.52	79,100
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	0	SY	5.06	0
	g.	Mobilization and Demobilization (5% Construction)	1	LS	4,253	4,253
11.		Proposed Emergency Pump Station (202 cfs)				
	a.	Pump Station	202	CFS	25,000	5,050,000
	b	Mobilization and Demobilization (5% Construction)	1	LS	252,500	252,500
Subtotal						9,490,916
Construction Contingency @ 25%						2,372,729
Engineering/Design @ 8%						759,273
Construction Management and Administration @ 12%						1,138,910
Subtotal Construction						13,761,828
Land Acquisition			61.80	AC	15,000**	927,000
TOTAL						14,688,828

Notes:
*Final sizing of this channel to be determined upon completion of Sacramento River Levee Failure Analysis.
**This amount provided by Ponticello Enterprises.

TABLE 19

CITY OF COLUSA DRAINAGE MASTER PLAN
ALTERNATIVE W1B - WESTERN SHED

OPINION OF PROBABLE COST

		Item	Quantity	Unit	Unit Cost, $	Cost, $
1.		Detention Basin DB-W1-1 Located Off-site (North of Highway 20/45)				
	a.	Site Clearing	18	AC	385	6,930
	b.	Bulk Excavation	236,864	CY	4.52	1,070,623
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	0
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road Around Perimeter, 15' Wide	6,003	SY	5.06	30,376
	g.	Mobilization and Demobilization (5% Construction)	1	LS	55,396	55,396
2.		Conveyance Channel CH-W1-1 Along Lurline Ave.				
	a.	Site Clearing	1.8	AC	385	693
	b.	Bulk Excavation	9,208	CY	4.52	41,620
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	0
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	3,315	SY	5.06	16,774
	g.	Mobilization and Demobilization (5% Construction)	1	LS	2,954	2,954
3.		Conveyance Channel CH-W1-2 Along Western Boundary (McCoy Road)				
	a.	Site Clearing	1.3	AC	385	501
	b.	Bulk Excavation	6,463	CY	4.52	29,213
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	0
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	2,327	SY	5.06	11,775
	g.	Mobilization and Demobilization (5% Construction)	1	LS	2,074	2,074
4.		Conveyance Channel CH-W1-3 Along Western Boundary (McCoy/Wilson Ave)				
	a.	Site Clearing	8.1	AC	385	3,119
	b.	Bulk Excavation	48,750	CY	4.52	220,350
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	9,750	SY	5.06	49,335
	g.	Mobilization and Demobilization (5% Construction)	1	LS	13,640	13,640
5.		Conveyance Channel CH-W1-4 Towards Off-site Pond (North of Hwy-20)				
	a.	Site Clearing	4.6	AC	385	1,771
	b.	Bulk Excavation	28,491	CY	4.52	128,779
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	5,128	SY	5.06	25,948
	g.	Mobilization and Demobilization (5% Construction)	1	LS	7,825	7,825
6.		Conveyance Channel CH-W1-5 from Central Shed				
	a.	Site Clearing	1.2	AC	385	462
	b.	Bulk Excavation	4,627	CY	4.52	20,914
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	2,892	SY	5.06	14,634
	g.	Mobilization and Demobilization (5% Construction)	1	LS	1,800	1,800
7.		Conveyance Channel CH-W1-6 from Central Shed Towards Hwy-20				
	a.	Site Clearing	1.1	AC	385	424
	b.	Bulk Excavation	6,306	CY	4.52	28,503
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, random broken stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	1,622	SY	5.06	8,207
	g.	Mobilization and Demobilization (5% Construction)	1	LS	1,857	1,857
8.		Conveyance Channel CH-W1-7 north of Hwy-20				
	a.	Site Clearing	4.3	AC	385	1,656
	b.	Bulk Excavation	24,351	CY	4.52	110,067
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	6,262	SY	5.06	31,686
	g.	Mobilization and Demobilization (5% Construction)	1	LS	7,170	7,170

TABLE 19

CITY OF COLUSA DRAINAGE MASTER PLAN
ALTERNATIVE W1B - WESTERN SHED

OPINION OF PROBABLE COST

Item			Quantity	Unit	Unit Cost, $	Cost, $
9.		Culverts Across CH-W1-1 & 2 (40' Wide By 25')				
	a.	Structural Excavation	574	CY	24.39	13,998
	b.	Structural Backfill and Compaction	0	CY	1.52	0
	c.	Spread and Compact Excess Earthwork On-site	0	CY	6.75	0
	d.	Access Road 75' Long 15' Wide	958	SY	5.06	4,849
	e.	Cap One Pipe with Concrete on Either End	0	CY	24.39	0
	f.	60" RCP	50	LF	195.00	9,750
	g.	Dewatering	1	LS	30,000	30,000
	h.	Mobilization and Demobilization (5% Construction)	1	LS	2,930	2,930
	i.	Additional 10 Culverts of Same Size	10	LS	61,527	615,273
10.		Culverts Across CH-W1-3 & 4 (60' Wide By 25')				
	a.	Structural Excavation	850	CY	24.39	20,729
	b.	Structural Backfill and Compaction	0	CY	1.52	0
	c.	Spread and Compact Excess Earthwork On-site	0	CY	6.75	0
	d.	Access Road 75' Long 15' Wide	958	SY	5.06	4,849
	e.	Cap One Pipe with Concrete on Either End	0	CY	24.39	0
	f.	60" RCP	100	LF	195.00	19,500
	g.	Dewatering	1	LS	30,000	30,000
	h.	Mobilization and Demobilization (5% Construction)	1	LS	3,754	3,754
	i.	Additional 6 Culverts of Same Size	6	LS	78,832	472,993
11.		Storm Drains for Eastern Shed Alternative E1A				
	a.	30" Diameter RCP	2,120	LF	85.00	180,200
	b.	33" Diameter RCP	0	LF	95.00	0
	c.	36" Diameter RCP	2,625	LF	100.00	262,500
	d.	39" Diameter RCP	0	LF	110.00	0
	e.	42" Diameter RCP	3,330	LF	120.00	399,600
	f.	48" Diameter RCP	550	LF	140.00	77,000
	g.	54" Diameter RCP	0	LF	175.00	0
	h.	60" Diameter RCP	0	LF	195.00	0
	i.	66" Diameter RCP	0	LF	215.00	0
	j.	72" Diameter RCP	0	LF	235.00	0
	k.	78" Diameter RCP	0	LF	300.00	0
	l.	84" Diameter RCP	0	LF	350.00	0
	m.	90" Diameter RCP	0	LF	400.00	0
	n.	Manhole - large diameter	7	LS	10,000.00	70,000
	o.	Mixing Vault	0	LS	25,000.00	0
12.		Proposed Berm Along the Southern Boundary				
	a.	Site Clearing	15.5	AC	385	5,968
	b.	Fill Earthwork from Excavated Detention Pond DB-E1-4	17,500	CY	6.75	118,125
	c.	Retractable Highway Flood Barrier	1	LS	100,000	100,000
	d	Inspection Trench Excavation	17,500	CY	4.52	79,100
	e.	Inspection Trench recompaction	17,500	CY	6.75	118,125
	f.	FEMA Certification	1	LS		
	g.	Mobilization and Demobilization (5% Construction)	1	LS	21,066	21,066
13.		Exterior Channel adjacent to the Proposed Berm*				
	a.	Site Clearing	15.5	AC	385	5,968
	b.	Bulk Excavation	17,500	CY	4.52	79,100
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	0	SY	5.06	0
	g.	Mobilization and Demobilization (5% Construction)	1	LS	4,253	4,253
14.		Proposed Emergency Pump Station (280 cfs)				
	a.	Pump Station	280	CFS	25,000	7,000,000
	b	Mobilization and Demobilization (5% Construction)	1	LS	350,000	350,000
Subtotal						12,046,703
Construction Contingency @ 25%						3,011,676
Engineering/Design @ 8%						963,736
Construction Management and Administration @ 12%						1,445,604
Subtotal Construction						17,467,719
Land Acquisition			71.40	AC	15,000**	1,071,000
TOTAL						18,538,719

Notes:
*Final sizing of this channel to be determined upon completion of Sacramento River Levee Failure Analysis.
**This amount provided by Ponticello Enterprises.

TABLE 20

CITY OF COLUSA
DRAINAGE MASTER PLAN
ALTERNATIVE W2 - WESTERN SHED

OPINION OF PROBABLE COST

		Item	Quantity	Unit	Unit Cost, $	Cost, $
1.		Detention Basin DB-W2-1 Located North of Lurlin Avenue				
	a.	Site Clearing	5	AC	385	1,925
	b.	Bulk Excavation	66,926	CY	4.52	302,505
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d	Grouted Riprap	0	CY	108.87	0
	e.	Riprap, Random Broken Stone	224	CY	57.84	12,961
	f.	Maintenance Road Around Perimeter, 15' Wide	3,211	SY	5.06	16,249
	g.	Side Weir Inlet	1	LS	25,000	25,000
	h.	Mobilization and Demobilization (5% Construction)	1	LS	17,932	17,932
2.		Detention Basin DB-W2-2 Located Between McCoy and Ranch Road				
	a.	Site Clearing	4.0	AC	385	1,540
	b.	Bulk Excavation	51,012	CY	4.52	230,573
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	0
	e	Riprap, Random Broken Stone	202	CY	57.84	11,694
	f.	Maintenance Road Around Perimeter, 15' Wide	2,883	SY	5.06	14,587
	g.	Side Weir Inlet	1	LS	25,000	25,000
	h.	Mobilization and Demobilization (5% Construction)	1	LS	14,170	14,170
3.		Detention Basin DB-W2-3 Located North of Lurlin Avenue				
	a.	Site Clearing	8.0	AC	385	3,080
	b.	Bulk Excavation	117,528	CY	4.52	531,227
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	0
	e.	Riprap, Random Broken Stone	1,099	CY	57.84	63,593
	f.	Maintenance Road Around Perimeter, 15' Wide	4,035	SY	5.06	20,420
	g.	Side Weir Inlet	1	LS	25,000	25,000
	h.	Mobilization and Demobilization (5% Construction)	1	LS	32,166	32,166
4.		Conveyance Channel CH-W1-1 Along Lurline Ave.				
	a.	Site Clearing	1.8	AC	385	693
	b.	Bulk Excavation	9,208	CY	4.52	41,620
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	0
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	3,315	SY	5.06	16,774
	g.	Mobilization and Demobilization (5% Construction)	1	LS	2,954	2,954
5.		Conveyance Channel CH-W1-2 Along Western Boundary (McCoy Road)				
	a.	Site Clearing	1.3	AC	385	501
	b	Bulk Excavation	6,463	CY	4.52	29,213
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	0
	e	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	2,327	SY	5.06	11,775
	g.	Mobilization and Demobilization (5% Construction)	1	LS	2,074	2,074
6.		Conveyance Channel CH-W1-3 Along Western Boundary (McCoy/Wilson Ave)				
	a.	Site Clearing	8.1	AC	385	3,119
	b	Bulk Excavation	48,750	CY	4.52	220,350
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	9,750	SY	5.06	49,335
	g.	Mobilization and Demobilization (5% Construction)	1	LS	13,640	13,640
7.		Conveyance Channel CH-W1-4 Towards Off-site Pond (North of Hwy-20)				
	a.	Site Clearing	4.6	AC	385	1,771
	b.	Bulk Excavation	28,491	AC	4.52	128,779
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f.	Maintenance Road (15' Wide)	5,128	SY	5.06	25,948
	g.	Mobilization and Demobilization (5% Construction)	1	LS	7,825	7,825
8.		Culverts Across CH-W1-1 & 2 (40' Wide By 25')				
	a.	Structural Excavation	574	CY	24.39	13,998
	b.	Structural Backfill and Compaction	0	CY	1.52	0
	c.	Spread and Compact Excess Earthwork On-site	0	CY	6.75	0
	d.	Access Road 75' Long 15' Wide	958	SY	5.06	4,849

TABLE 20

CITY OF COLUSA
DRAINAGE MASTER PLAN
ALTERNATIVE W2 - WESTERN SHED

OPINION OF PROBABLE COST

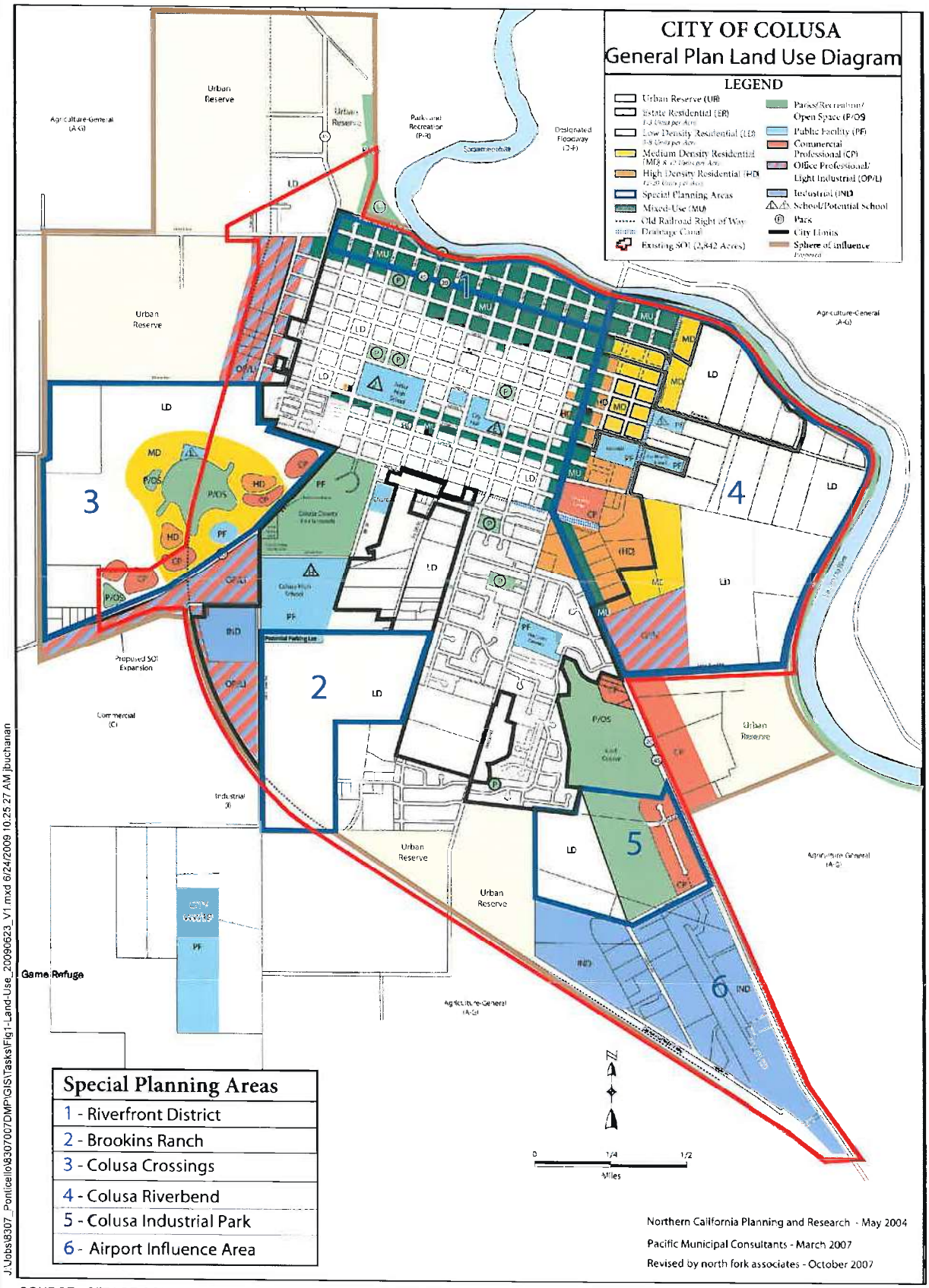
		Item	Quantity	Unit	Unit Cost, $	Cost, $
	e.	Cap One Pipe with Concrete on Either End	0	CY	24.39	0
	f.	60" RCP	50	LF	195.00	9,750
	g.	Dewatering	1	LS	30,000	30,000
	h.	Mobilization and Demobilization (5% Construction)	1	LS	2,930	2,930
	i.	Additional 10 Culverts of Same Size	10	LS	61,527	615,273
9.		Culverts Across CH-W1-3 & 4 (60' Wide By 25')				
	a.	Structural Excavation	850	CY	24.39	20,729
	b.	Structural Backfill and Compaction	0	CY	1.52	0
	c	Spread and Compact Excess Earthwork On-site	0	CY	6.75	0
	d.	Access Road 75' Long 15' Wide	958	SY	5.06	4,849
	e.	Cap One Pipe with Concrete on Either End	0	CY	24.39	0
	f.	60" RCP	100	LF	195.00	19,500
	g.	Dewatering	1	LS	30,000	30,000
	h.	Mobilization and Demobilization (5% Construction)	1	LS	3,754	3,754
	i.	Additional 6 Culverts of Same Size	6	LS	78,832	472,993
10.		Storm Drains for Eastern Shed Alternative E1A				
	a.	30" Diameter RCP	2,120	LF	85.00	180,200
	b.	33" Diameter RCP	0	LF	95.00	0
	c.	36" Diameter RCP	2,625	LF	100.00	262,500
	d.	39" Diameter RCP	0	LF	110.00	0
	e.	42" Diameter RCP	6,330	LF	120.00	759,600
	f	48" Diameter RCP	3,330	LF	140.00	466,200
	g.	54" Diameter RCP	0	LF	175.00	0
	h.	60" Diameter RCP	0	LF	195.00	0
	i.	66" Diameter RCP	0	LF	215.00	0
	j.	72" Diameter RCP	0	LF	235.00	0
	k.	78" Diameter RCP	0	LF	300.00	0
	l.	84" Diameter RCP	0	LF	350.00	0
	m.	90" Diameter RCP	0	LF	400.00	0
	n.	Manhole - Large Diameter	13	LS	10,000.00	130,000
	o.	Mixing Vault	0	LS	25,000.00	0
11.		Proposed Berm Along the Southern Boundary				
	a.	Site Clearing	15.5	AC	385	5,968
	b.	Fill Earthwork from Excavated Detention Pond DB-E1-4	17,500	CY	6.75	118,125
	c.	Retractable Highway Flood Barrier	1	LS	100,000	100,000
	d	Inspection Trench Excavation	17,500	CY	4.52	79,100
	e.	Inspection Trench Recompaction	17,500	CY	6.75	118,125
	f.	FEMA Certification	1	LS		
	g.	Mobilization and Demobilization (5% Construction)	1	LS	21,066	21,066
12.		Exterior Channel Adjacent to the Proposed Berm*				
	a.	Site Clearing	15.5	AC	385	5,968
	b.	Bulk Excavation	17,500	CY	4.52	79,100
	c.	Structural Backfill and Compaction	0	CY	1.52	0
	d.	Grouted Riprap	0	CY	108.87	
	e.	Riprap, Random Broken Stone	0	CY	57.84	0
	f	Maintenance Road (15' Wide)	0	SY	5.06	0
	g.	Mobilization and Demobilization (5% Construction)	1	LS	4,253	4,253
13.		Proposed Emergency Pump Station (202 cfs)				
	a.	Pump Station	202	CFS	25,000	5,050,000
	b	Mobilization and Demobilization (5% Construction)	1	LS	252,500	252,500
Subtotal						10,767,321
Construction Contingency @ 25%						2,691,830
Engineering/Design @ 8%						861,386
Construction Management and Administration @ 12%						1,292,078
Subtotal Construction						15,612,615
Land Acquisition			63.80	AC	15,000**	957,000
TOTAL						16,569,615

Notes:
*Final sizing of this channel to be determined upon completion of Sacramento River Levee Failure Analysis.
**This amount provided by Ponticello Enterprises.

FIGURES

GENERAL PLAN LAND USE DIAGRAM
CITY OF COLUSA DRAINAGE MASTER PLAN

CITY OF COLUSA, CALIFORNIA
JUNE 2009



J:\Jobs\8307_Ponticello\8307007\DMP\GIS\Tasks\Fig1-Land-Use_20090623_V1.mxd 6/24/2009 10:25:27 AM jbuchanan

SOURCE: CITY OF COLUSA GENERAL PLAN, OCTOBER 30, 2007.

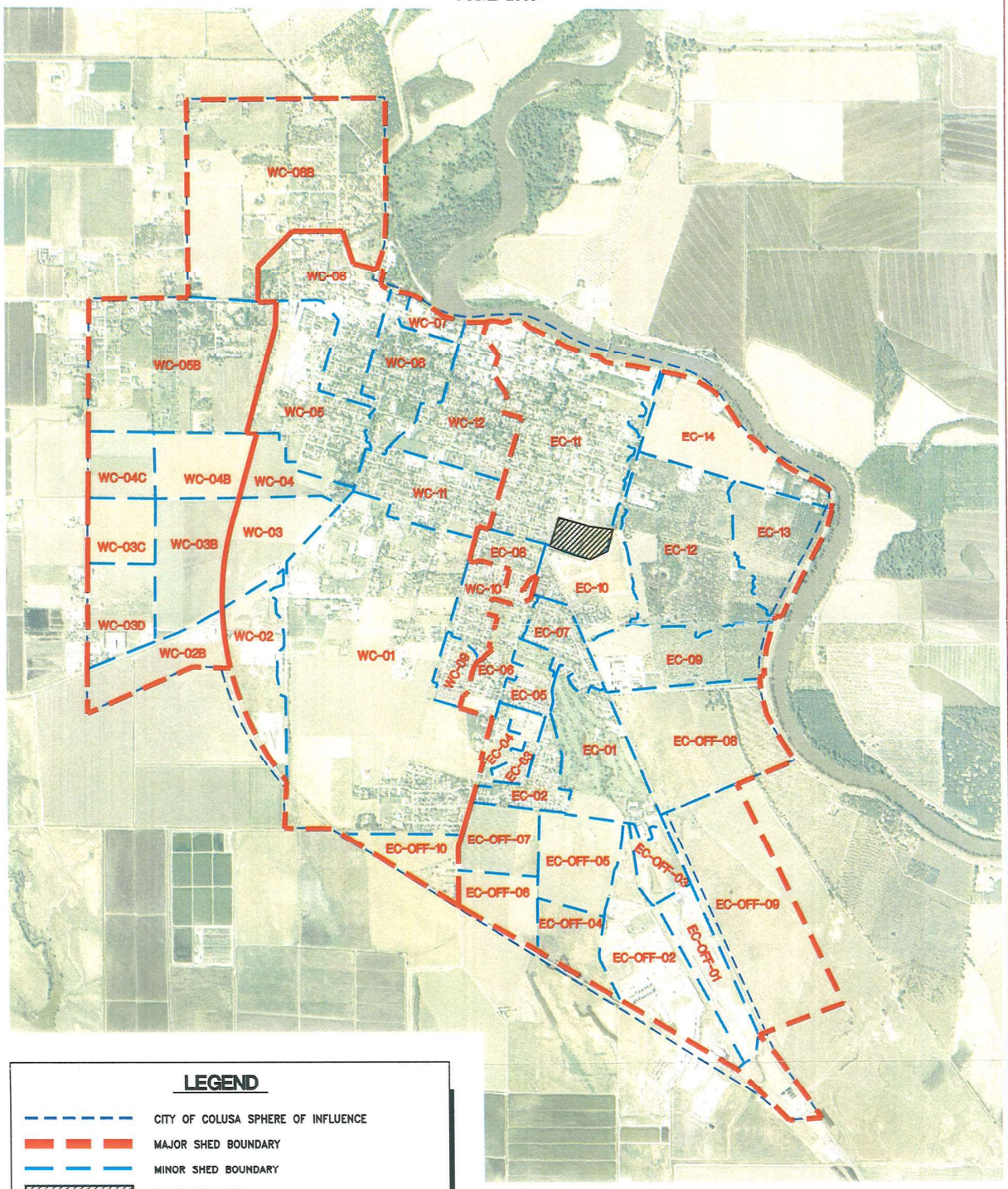
FIGURE 1

DRAINAGE SHED MAP - DEVELOPED CONDITION

CITY OF COLUSA DRAINAGE MASTER PLAN

CITY OF COLUSA CALIFORNIA

JUNE 2009



LEGEND

- CITY OF COLUSA SPHERE OF INFLUENCE
- MAJOR SHED BOUNDARY
- MINOR SHED BOUNDARY
- RETENTION BASIN

0 1000 2000 4000

SCALE:1"=2000'

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

WOOD RODGERS

DEVELOPING INNOVATIVE DESIGN SOLUTIONS

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J:\Jobs\8307_Colusa\8307007DMP\Civil\Studies\Drain\Figures\Alternatives\Figure2-shed map.dwg 6/23/09 1:05pm rsubedi

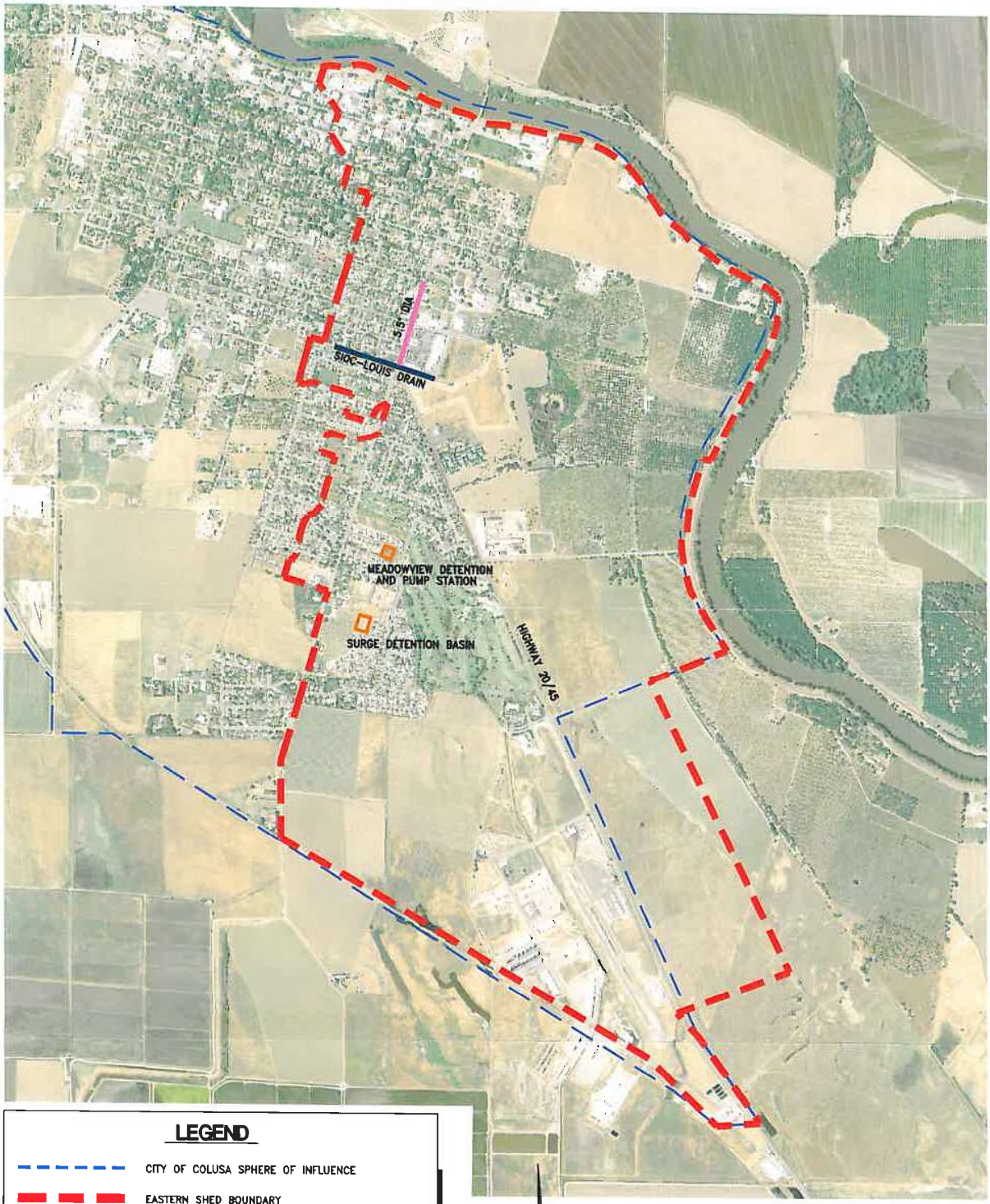
FIGURE 2

EASTERN SHED - EXISTING FLOODING SOLUTIONS

CITY OF COLUSA DRAINAGE MASTER PLAN

CITY OF COLUSA CALIFORNIA

JUNE 2009



SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

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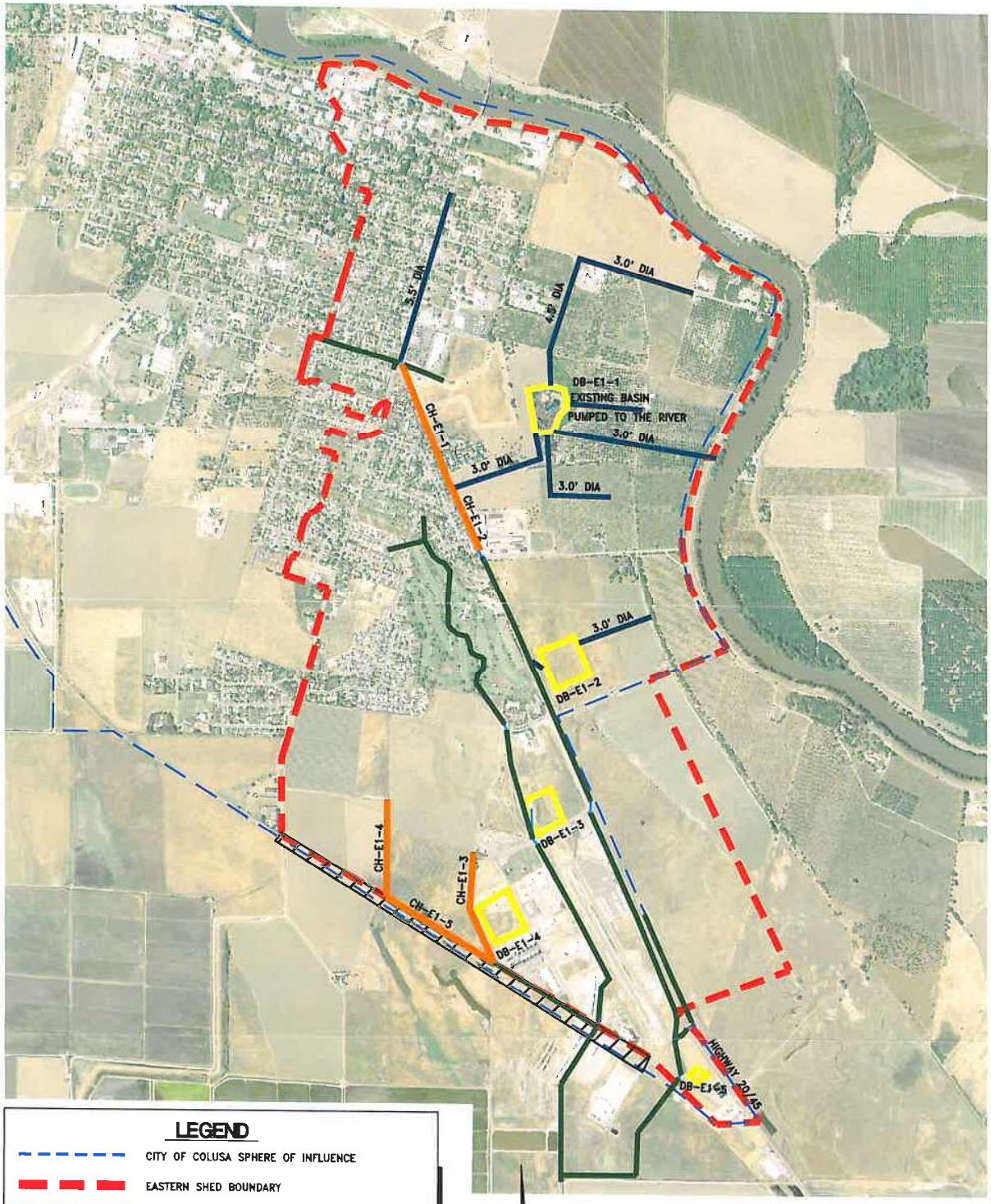
FIGURE 3

ALTERNATIVE E1A - EASTERN SHED

CITY OF COLUSA DRAINAGE MASTER PLAN

CITY OF COLUSA CALIFORNIA

JUNE 2009



SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

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FIGURE 4

ALTERNATIVE E1B - EASTERN SHED

CITY OF COLUSA DRAINAGE MASTER PLAN

CITY OF COLUSA CALIFORNIA

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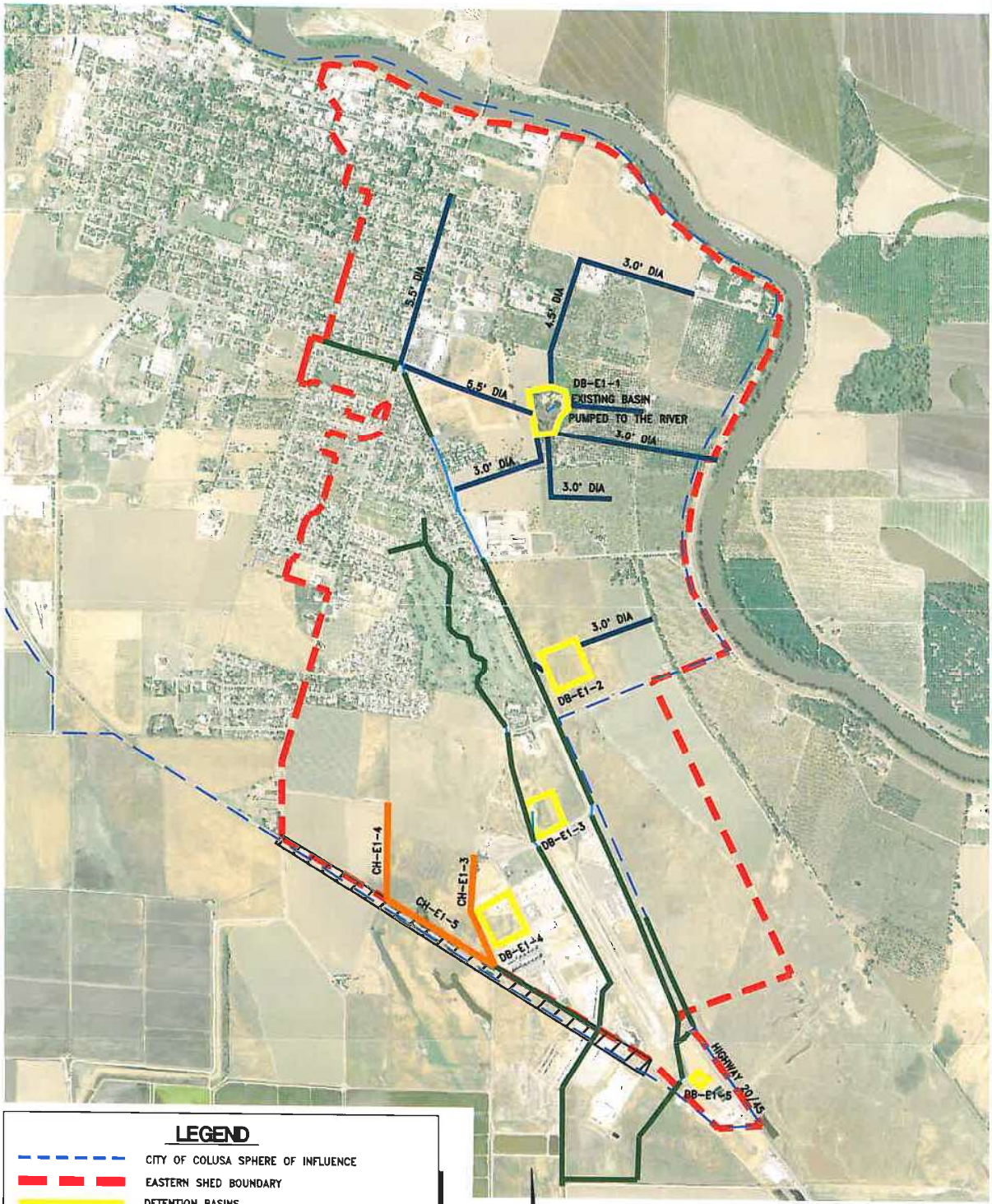

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

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FIGURE 5

ALTERNATIVE E2A - EASTERN SHED

CITY OF COLUSA DRAINAGE MASTER PLAN

CITY OF COLUSA CALIFORNIA

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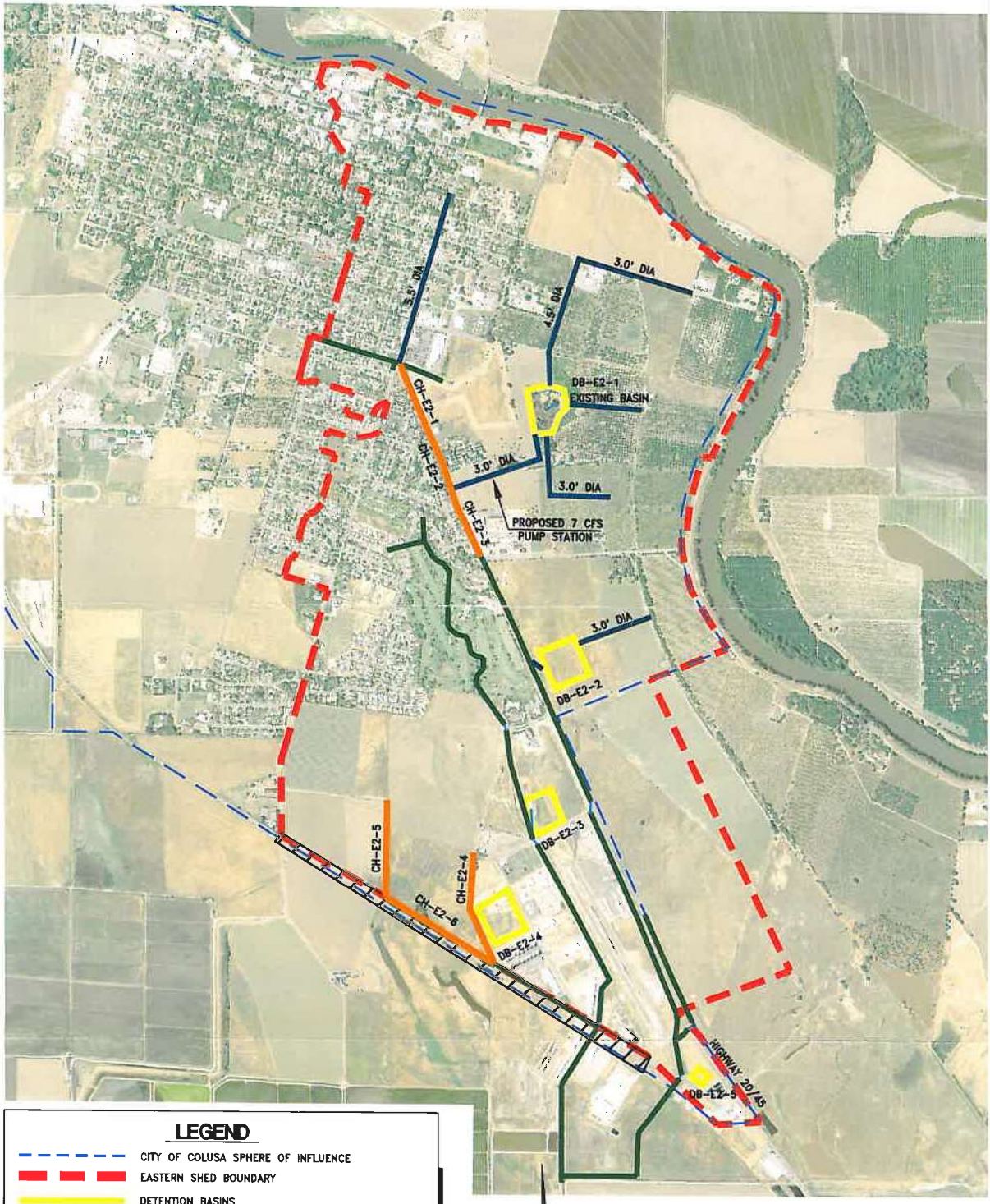

LEGEND

- CITY OF COLUSA SPHERE OF INFLUENCE
- EASTERN SHED BOUNDARY
- DETENTION BASINS
- EXISTING PIPES
- PROPOSED PIPES
- EXISTING CHANNELS
- PROPOSED CHANNELS
- PROPOSED BERM/BARRIER

0 750 1500 3000

SCALE:1"=1500'

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

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FIGURE 6

ALTERNATIVE E2B - EASTERN SHED

CITY OF COLUSA DRAINAGE MASTER PLAN

CITY OF COLUSA CALIFORNIA

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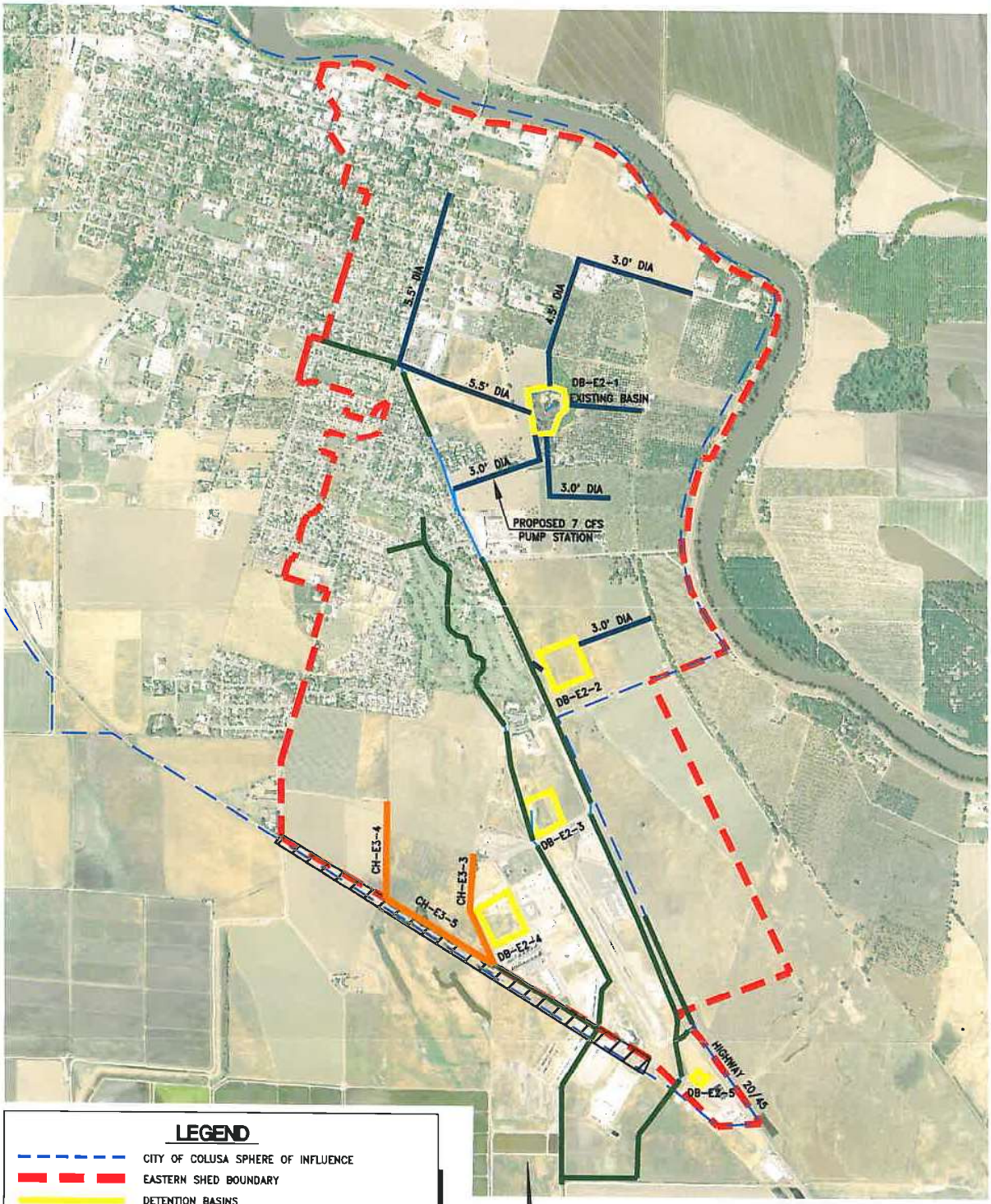

LEGEND

- CITY OF COLUSA SPHERE OF INFLUENCE
- EASTERN SHED BOUNDARY
- DETENTION BASINS
- EXISTING PIPES
- PROPOSED PIPES
- EXISTING CHANNELS
- PROPOSED CHANNELS
- PROPOSED BERM/BARRIER

0 750 1500 3000

SCALE:1"=1500'

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

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FIGURE 7

ALTERNATIVE C1A-1 - CENTRAL SHED

CITY OF COLUSA DRAINAGE MASTER PLAN

CITY OF COLUSA CALIFORNIA

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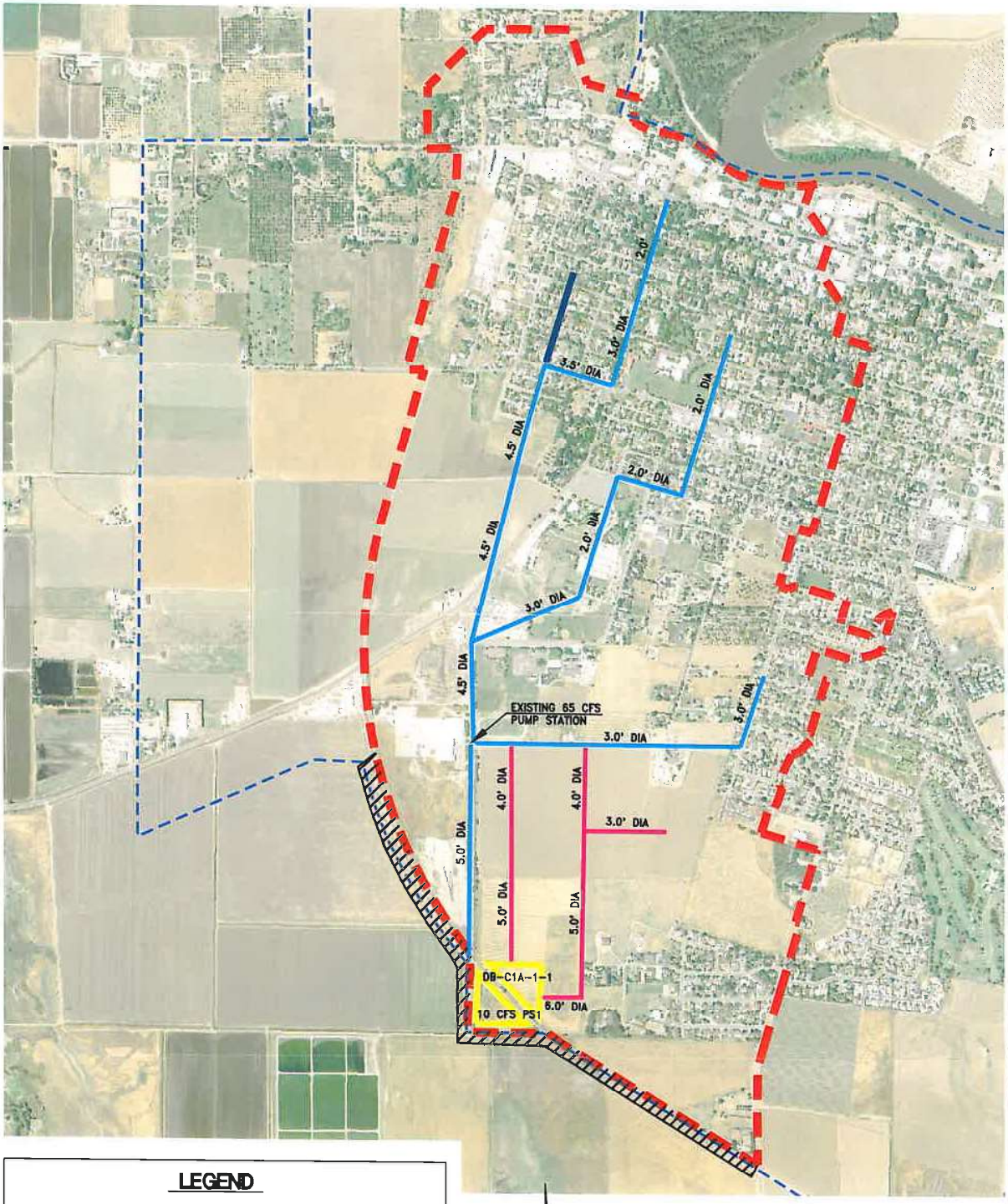

LEGEND

- CITY OF COLUSA SPHERE OF INFLUENCE
- CENTRAL SHED BOUNDARY
- PROPOSED DETENTION BASIN
- EXISTING PIPES
- PROPOSED PIPES
- EXISTING CHANNEL
- PROPOSED BERM/BARRIER

0 600 1200 2400

SCALE:1"=1200'

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

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FIGURE 8

ALTERNATIVE C1A-2 – CENTRAL SHED

CITY OF COLUSA DRAINAGE MASTER PLAN

CITY OF COLUSA CALIFORNIA

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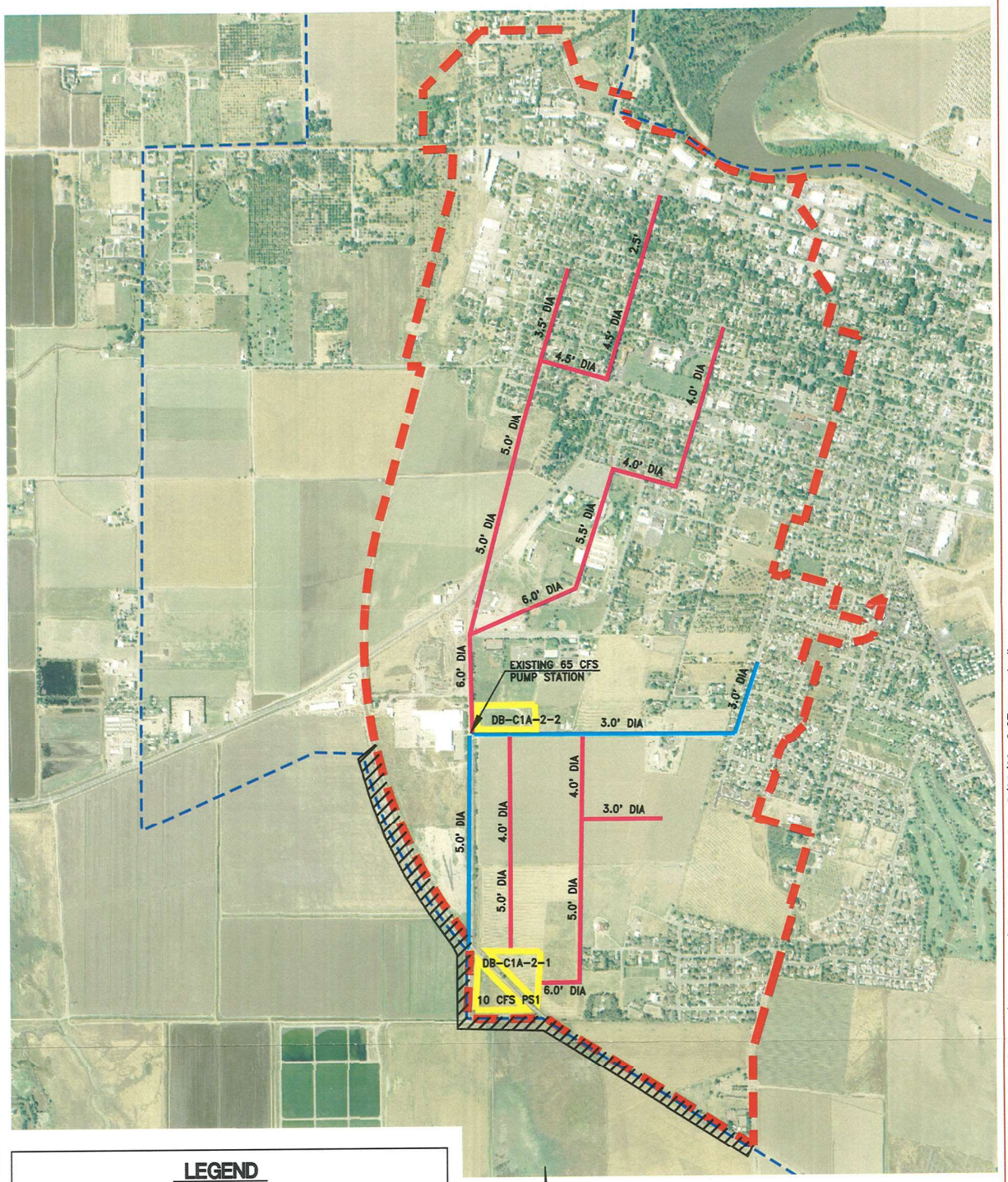

LEGEND

- CITY OF COLUSA SPHERE OF INFLUENCE
- CENTRAL SHED BOUNDARY
- PROPOSED DETENTION BASIN
- EXISTING PIPES
- PROPOSED PIPES
- EXISTING CHANNEL
- PROPOSED BERM/BARRIER

0 600 1200 2400

SCALE: 1"=1200'

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

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FIGURE 9

ALTERNATIVE C1B - CENTRAL SHED

CITY OF COLUSA DRAINAGE MASTER PLAN

CITY OF COLUSA CALIFORNIA

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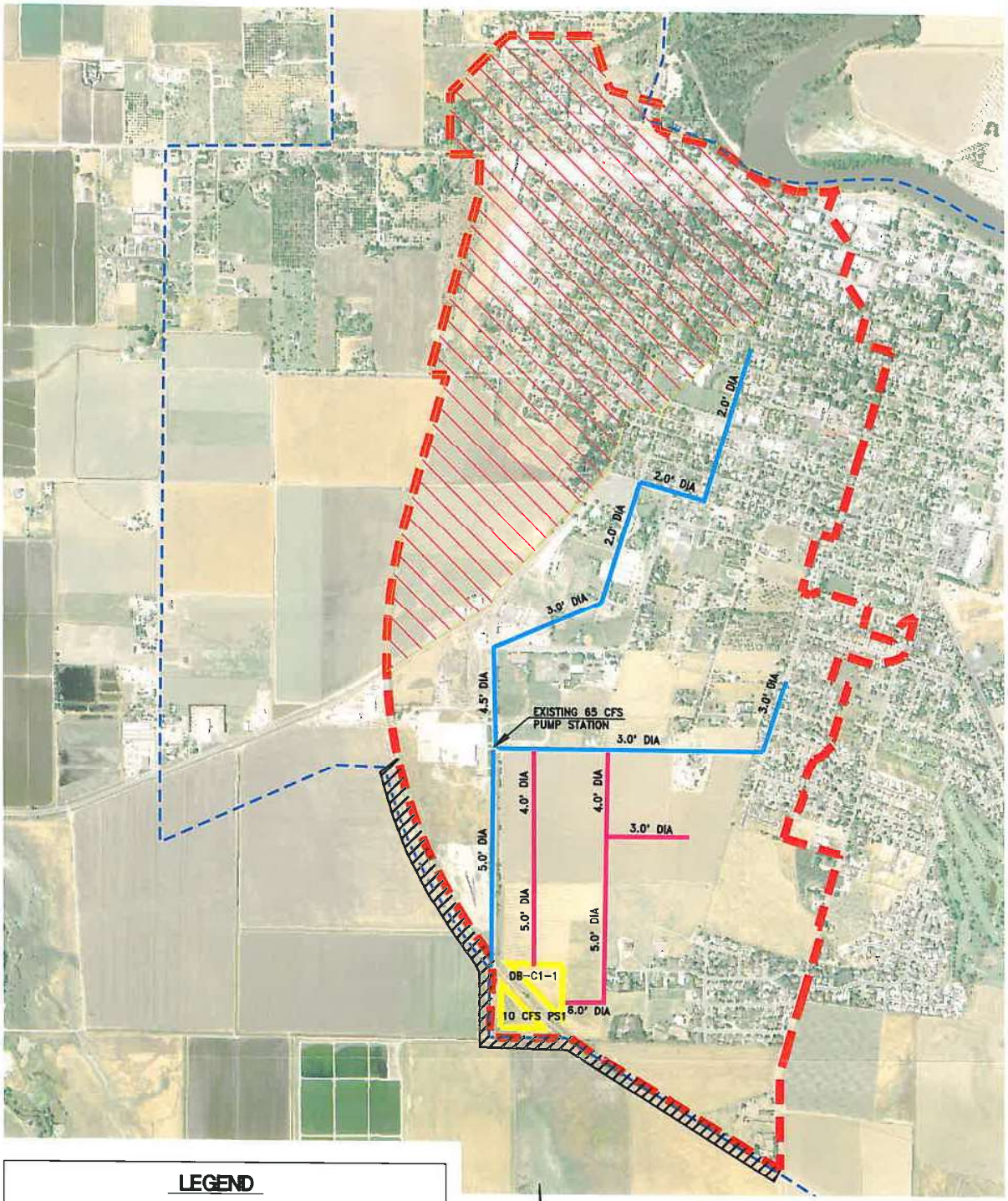

LEGEND

- CITY OF COLUSA SPHERE OF INFLUENCE
- CENTRAL SHED BOUNDARY
- PROPOSED DETENTION BASIN
- EXISTING PIPES
- PROPOSED PIPES
- DRAINAGE AREA DIVERTED WEST
- PROPOSED BERM/BARRIER

0 600 1200 2400

SCALE:1"=1200'

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

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FIGURE 10

ALTERNATIVE W1A - WESTERN SHED

CITY OF COLUSA DRAINAGE MASTER PLAN

CITY OF COLUSA CALIFORNIA

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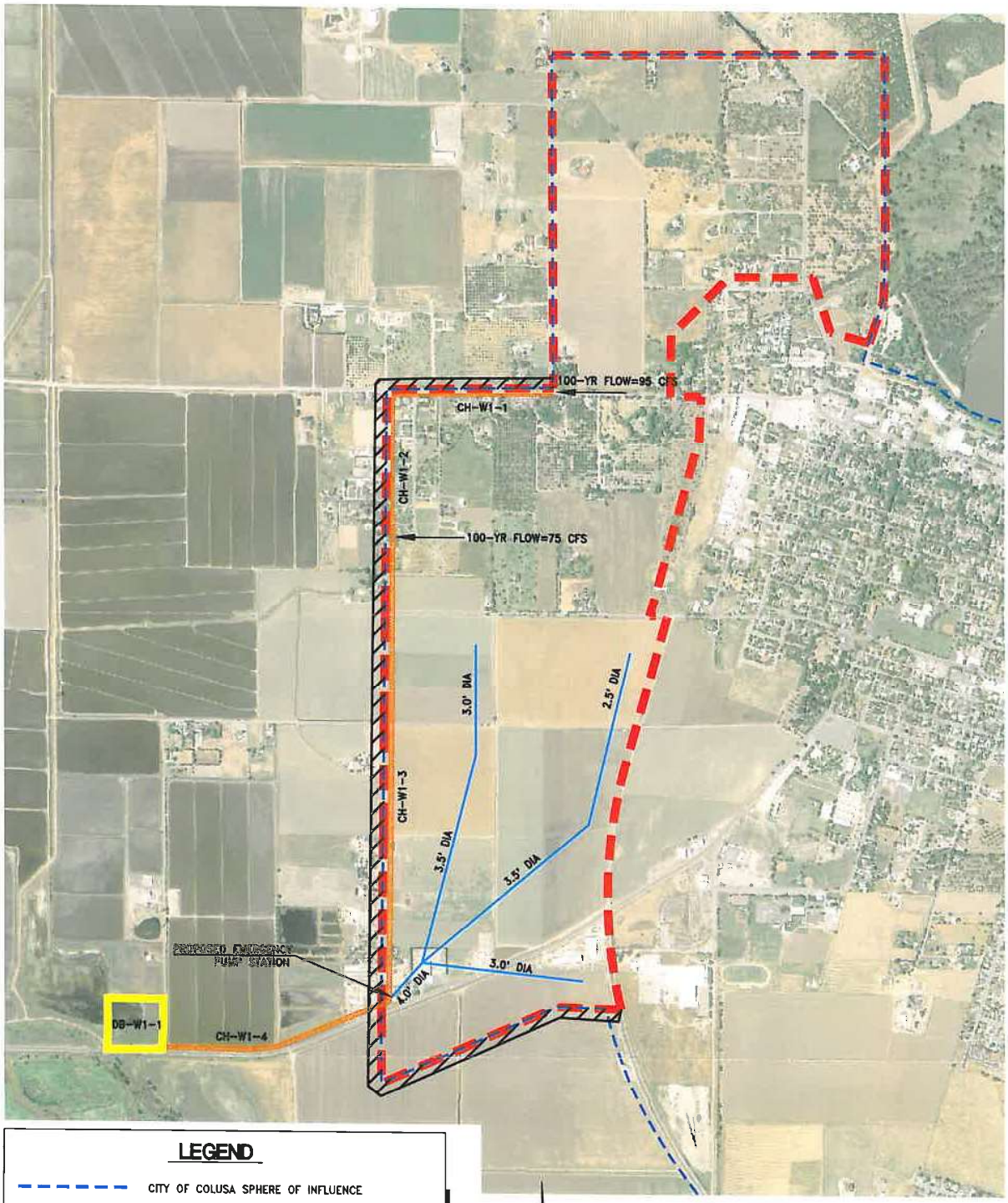

LEGEND

- CITY OF COLUSA SPHERE OF INFLUENCE
- WESTERN SHED BOUNDARY
- DETENTION BASINS
- PROPOSED PIPES
- PROPOSED CHANNEL
- PROPOSED BERM/BARRIER

0 600 1200 2400

SCALE:1"=1200'

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

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FIGURE 11

ALTERNATIVE W1B - WESTERN SHED

CITY OF COLUSA DRAINAGE MASTER PLAN

CITY OF COLUSA CALIFORNIA

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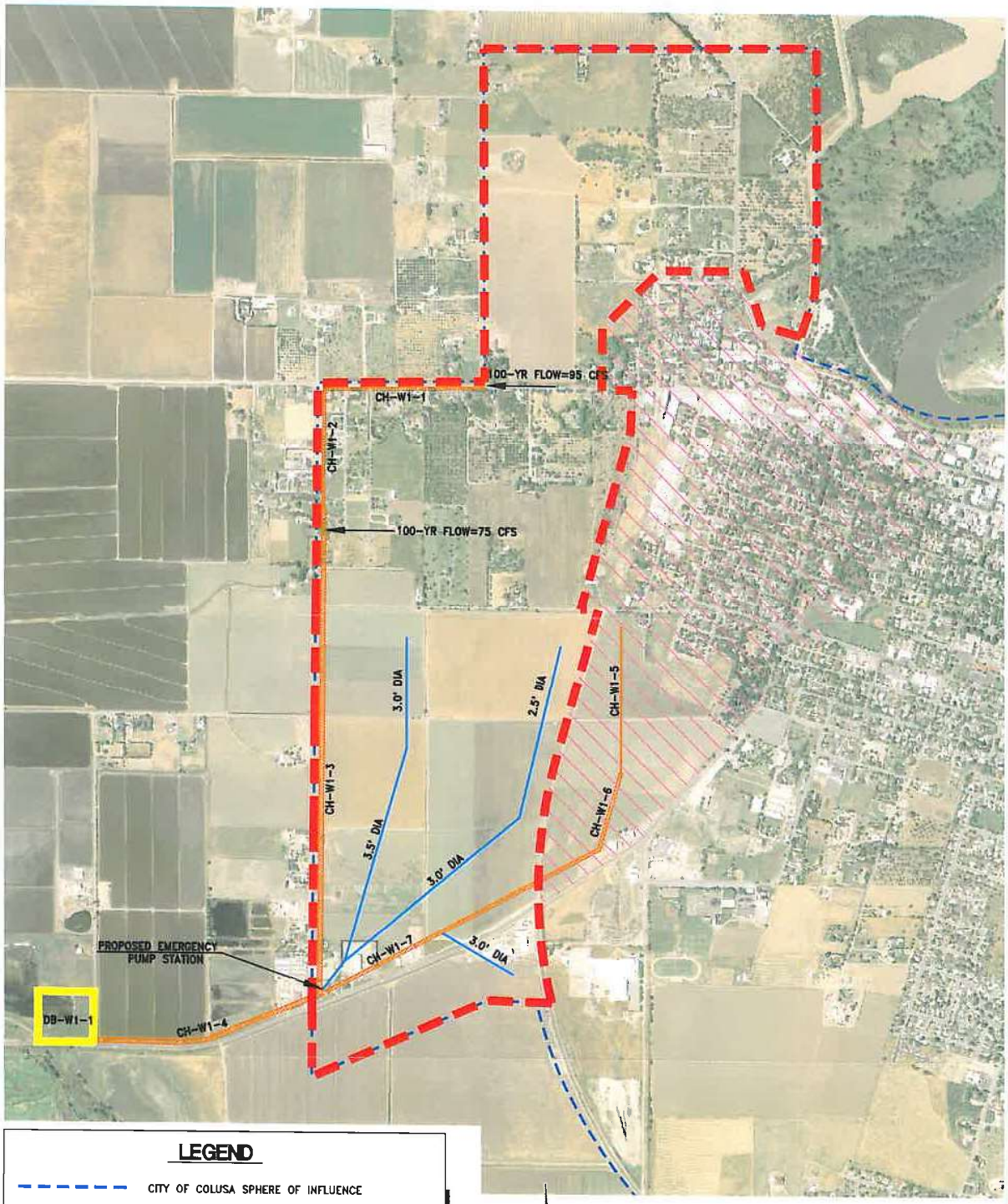

LEGEND

- CITY OF COLUSA SPHERE OF INFLUENCE
- WESTERN SHED BOUNDARY
- DRAINAGE AREA DIVERTED FROM CENTRAL SHED
- DETENTION BASINS
- PROPOSED PIPES
- PROPOSED CHANNEL
- PROPOSED BERM/BARRIER

0 600 1200 2400

SCALE:1"=1200'

N

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

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FIGURE 12

ALTERNATIVE W2 - WESTERN SHED

CITY OF COLUSA DRAINAGE MASTER PLAN

CITY OF COLUSA CALIFORNIA

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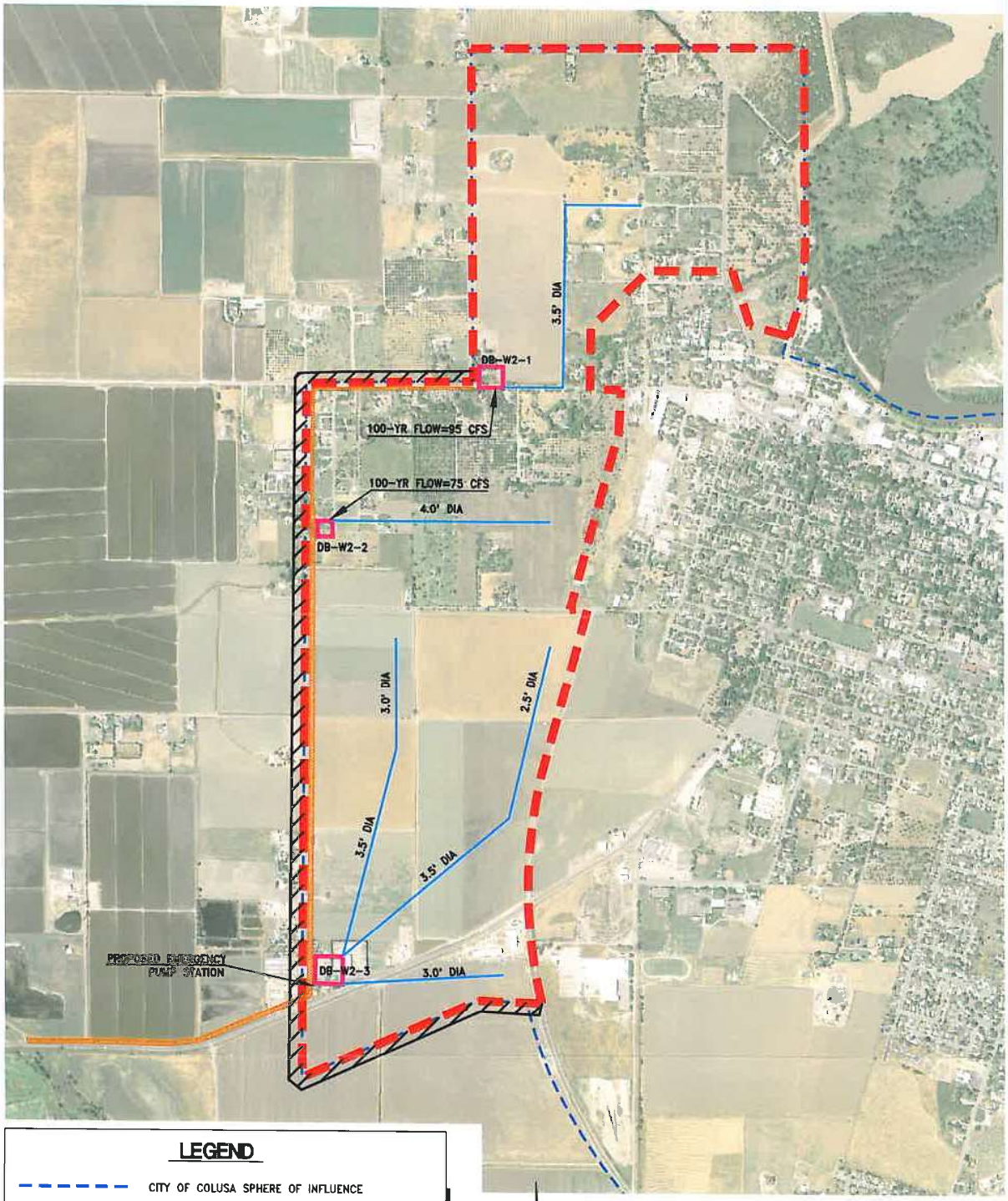

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

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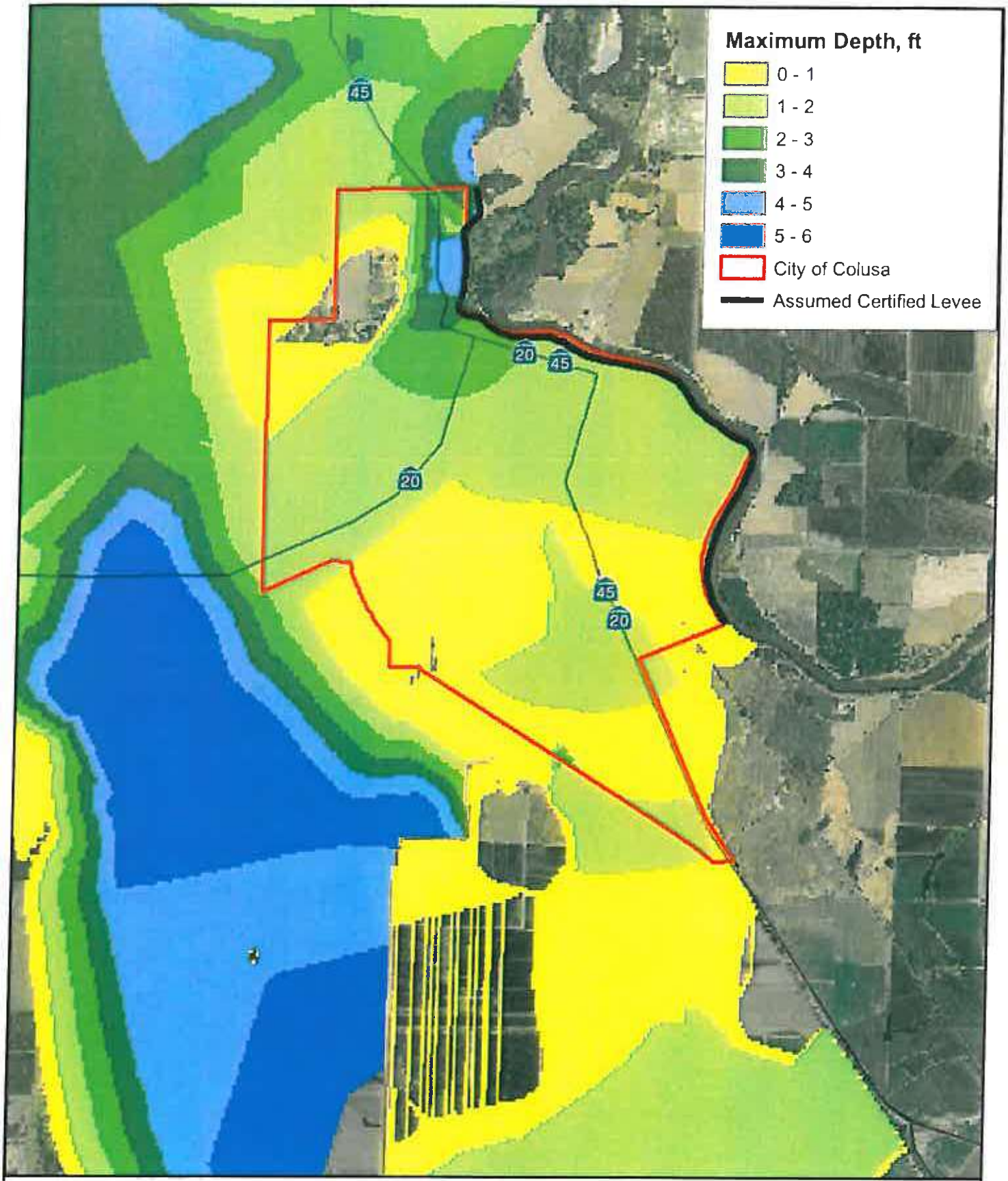
FIGURE 13



EXISTING CONDITION
NORTHERN LEVEE BREACH
0 FEET UPSTREAM

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

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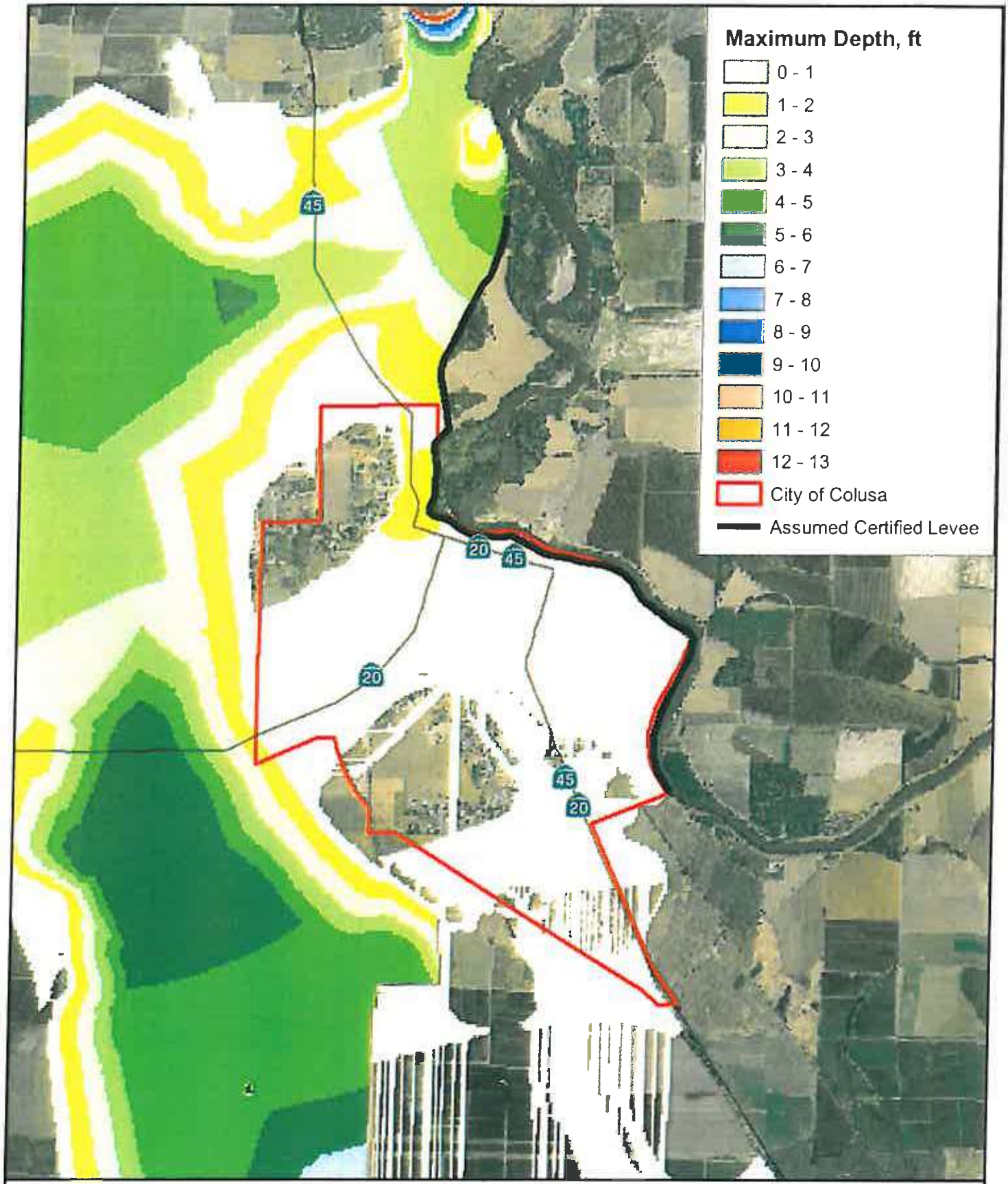
FIGURE 14



EXISTING FLOODING
NORTHERN LEVEE BREACH
7000 FEET UPSTREAM

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

NORTH

0 2,250 4,500

FEET

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FIGURE 15

WESTERN CONCEPTUAL LAYOUT IMPACTS

CITY OF COLUSA DRAINAGE MASTER PLAN

CITY OF COLUSA CALIFORNIA

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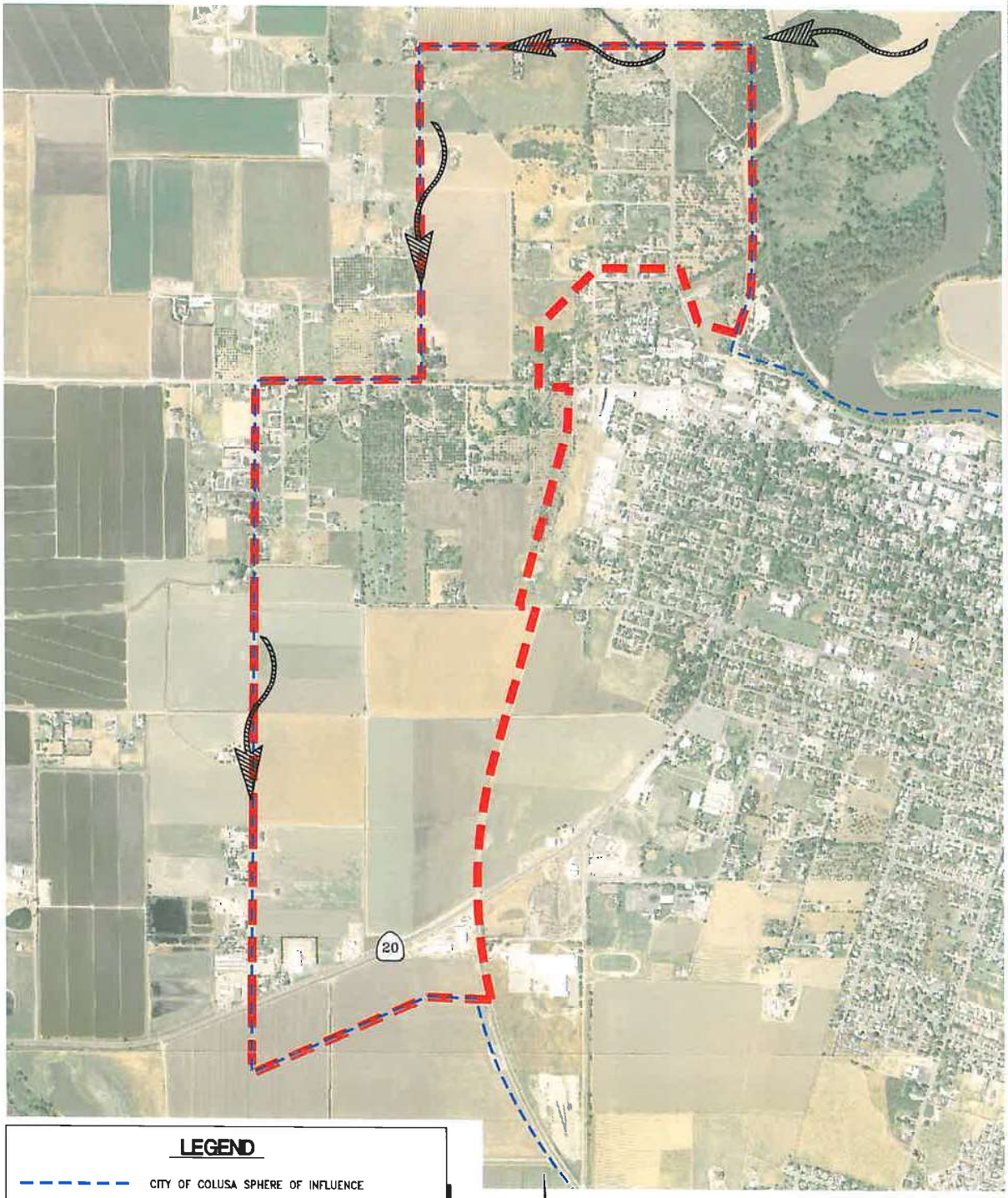

LEGEND

- CITY OF COLUSA SPHERE OF INFLUENCE
- WESTERN SHED BOUNDARY
- FLOW FROM RIVER LEVEE BREACH

0 600 1200 2400

SCALE: 1"=1200'

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7

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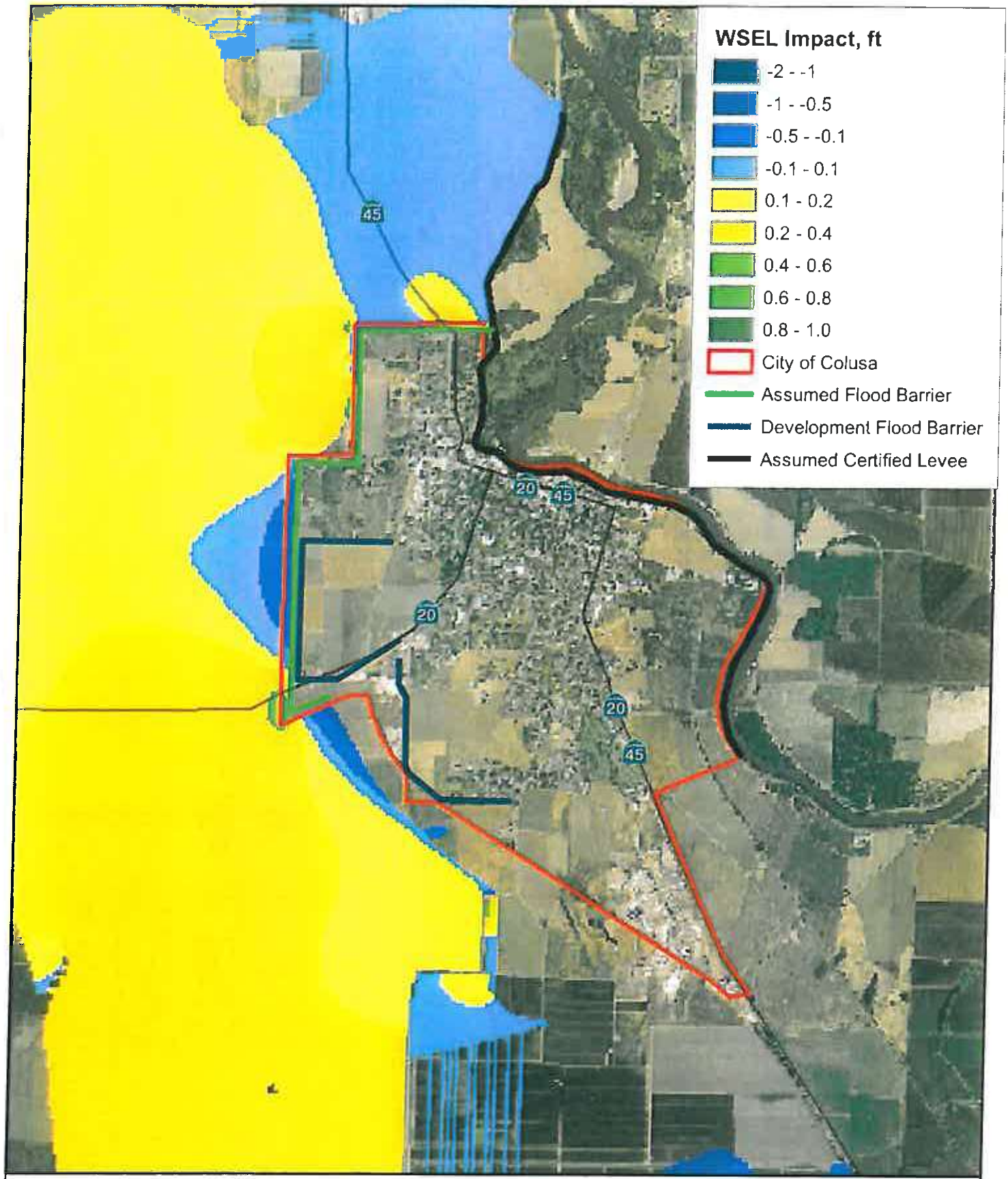
FIGURE 16



2-D COMPARISON
BARRIER/CHANNEL VS. EXISTING
NORTHERN LEVEE BREACH
0 FEET UPSTREAM

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

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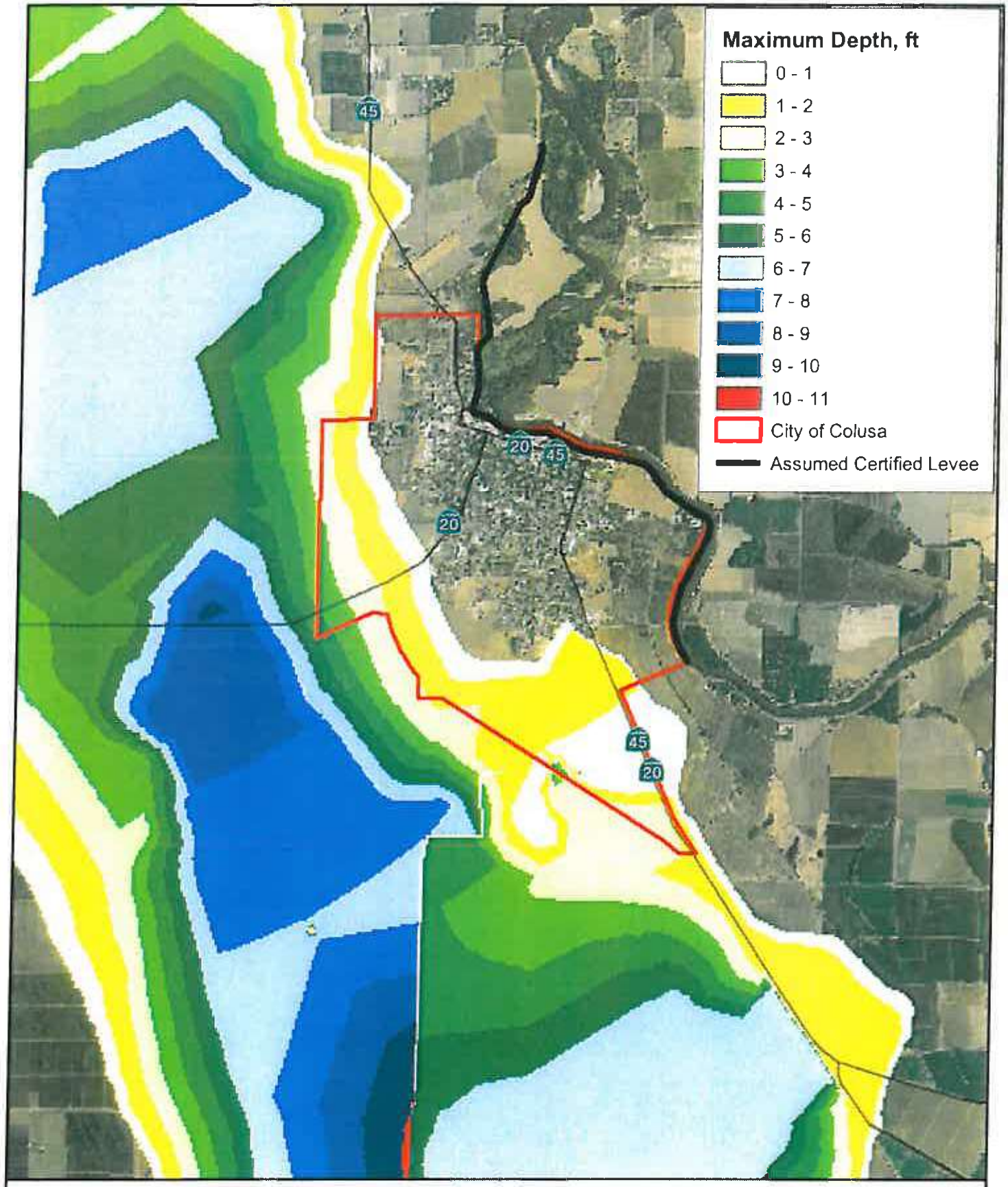
FIGURE 17



2-D FLOODING
100,000 CFS UPSTREAM BREACH

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

NORTH

0 2,500 5,000

FEET

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FIGURE 18

TYPICAL CROSS SECTION - BARRIER/CHANNEL

CITY OF COLUSA DRAINAGE MASTER PLAN

CITY OF COLUSA CALIFORNIA

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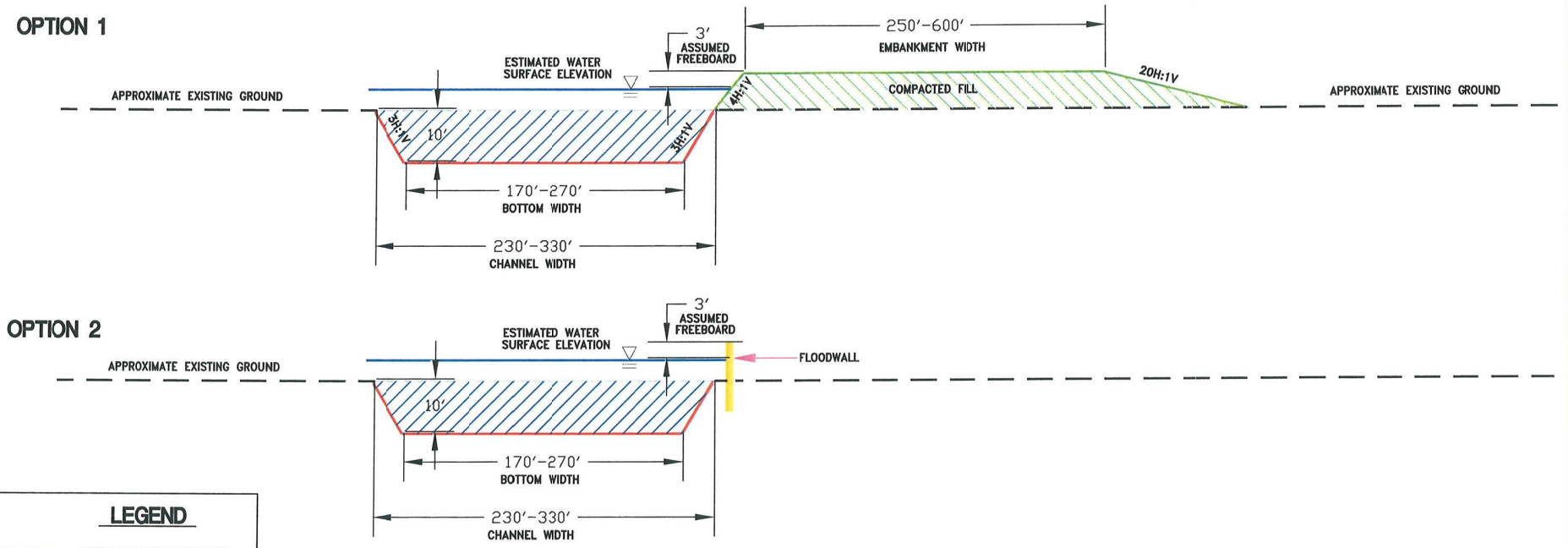

LEGEND

- ESTIMATED WATER SURFACE
- EMBANKMENT
- APPROXIMATE EXISTING GROUND
- EXCAVATED CHANNEL
- EXCAVATION
- COMPACTED FILL

HORIZONTAL SCALE:1"=100'

NOTE: CROSS SECTION LOOKING UPSTREAM.

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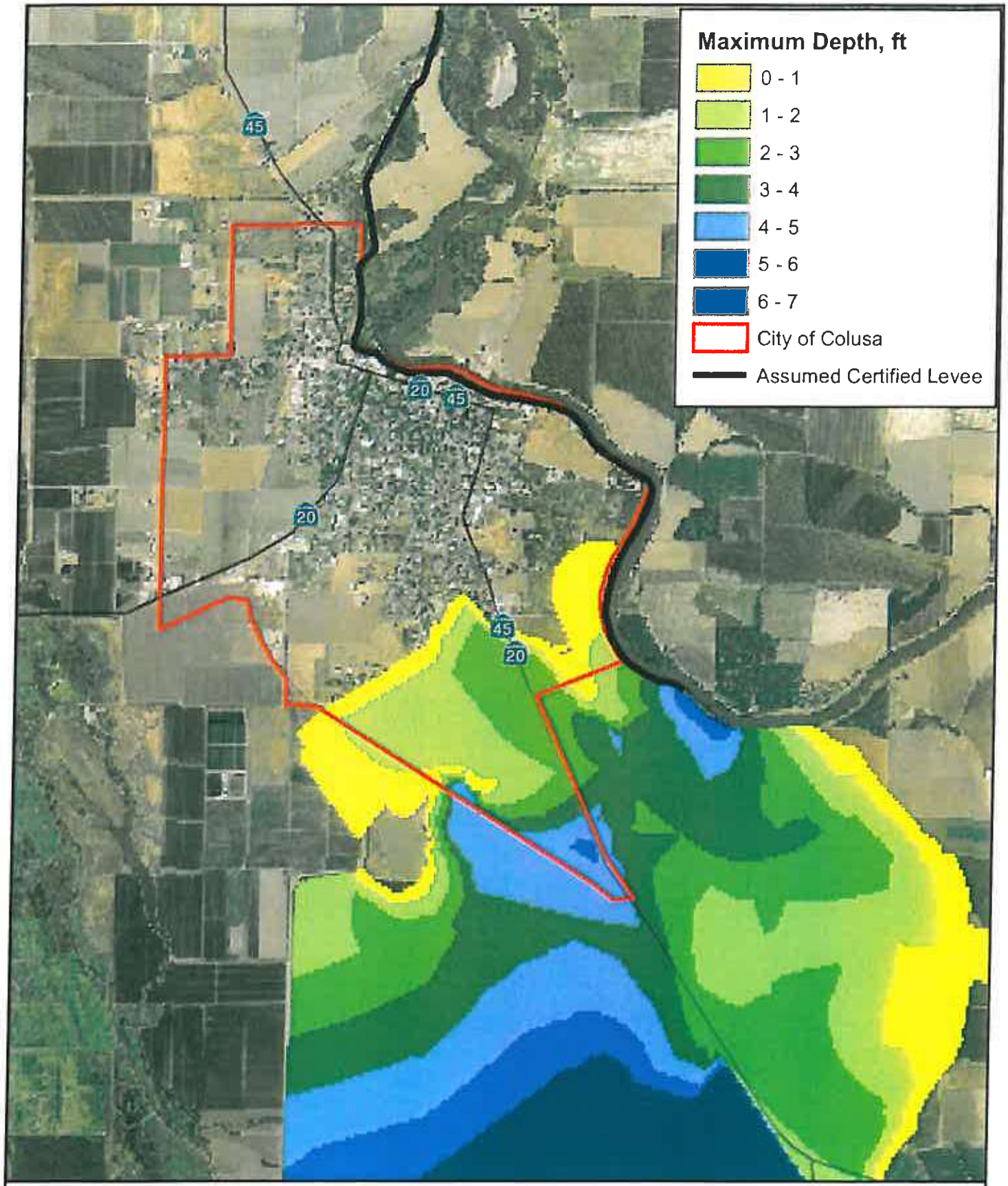
FIGURE 19



EXISTING FLOODING
SOUTHERN LEVEE BREACH
2000 FEET DOWNSTREAM

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

NORTH

0 2,000 4,000

FEET

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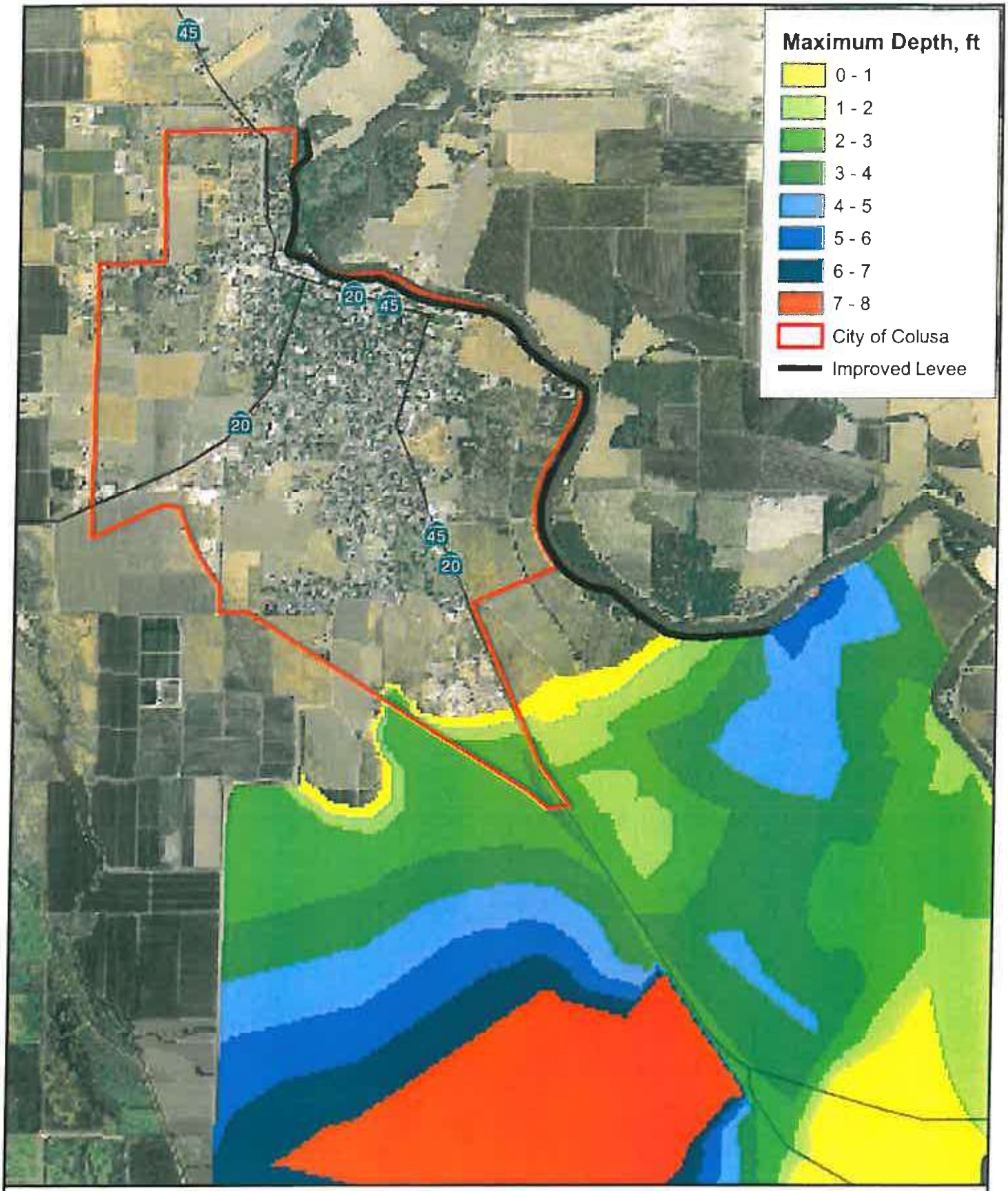
FIGURE 20



EXISTING FLOODING
SOUTHERN LEVEE BREACH
7000 FEET DOWNSTREAM

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

NORTH

0 1,500 3,000

FEET

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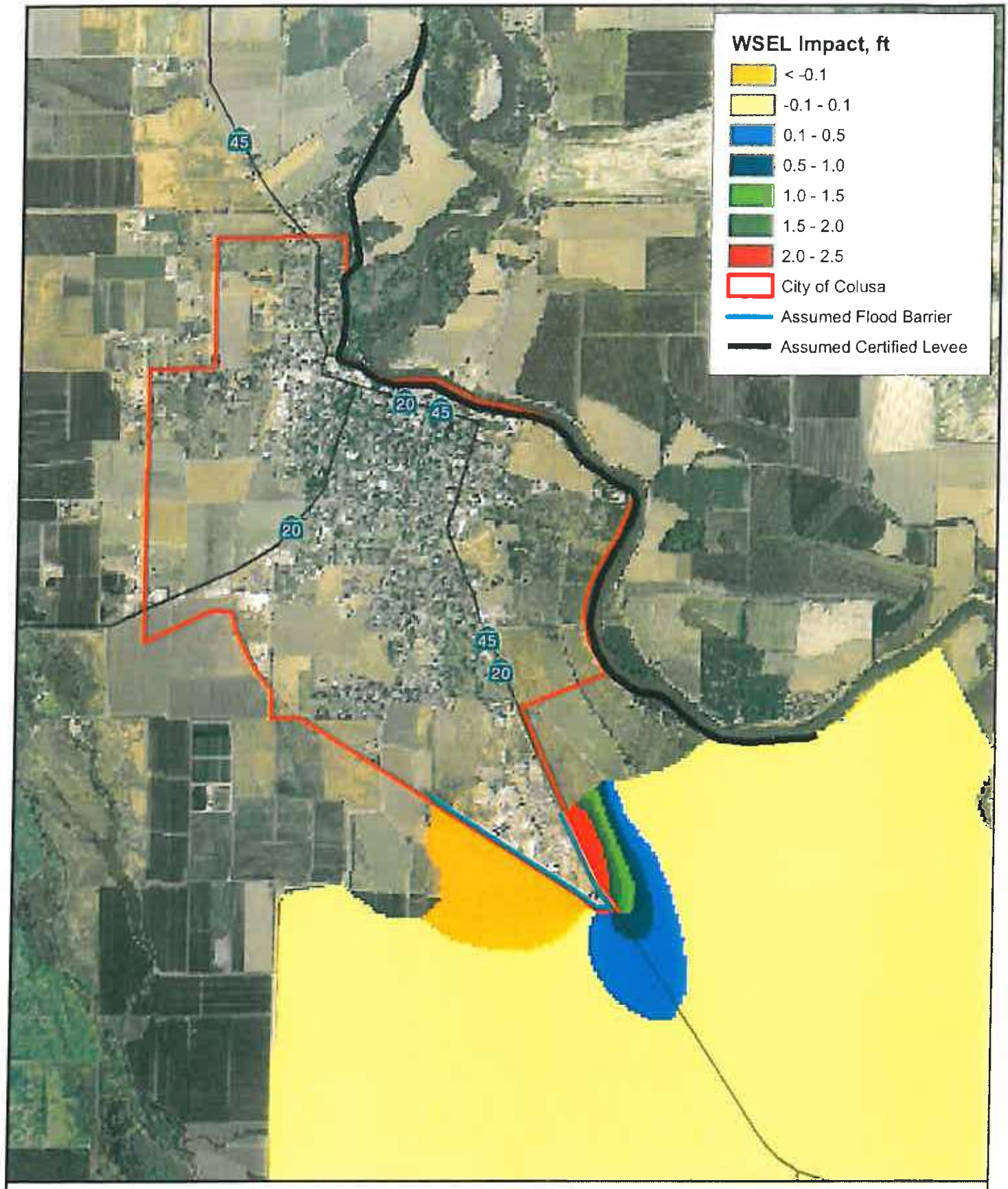
FIGURE 21



2-D COMPARISON
ELEVATED GENERAL PLAN VS. EXISTING

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

NORTH

0 2,000 4,000

FEET

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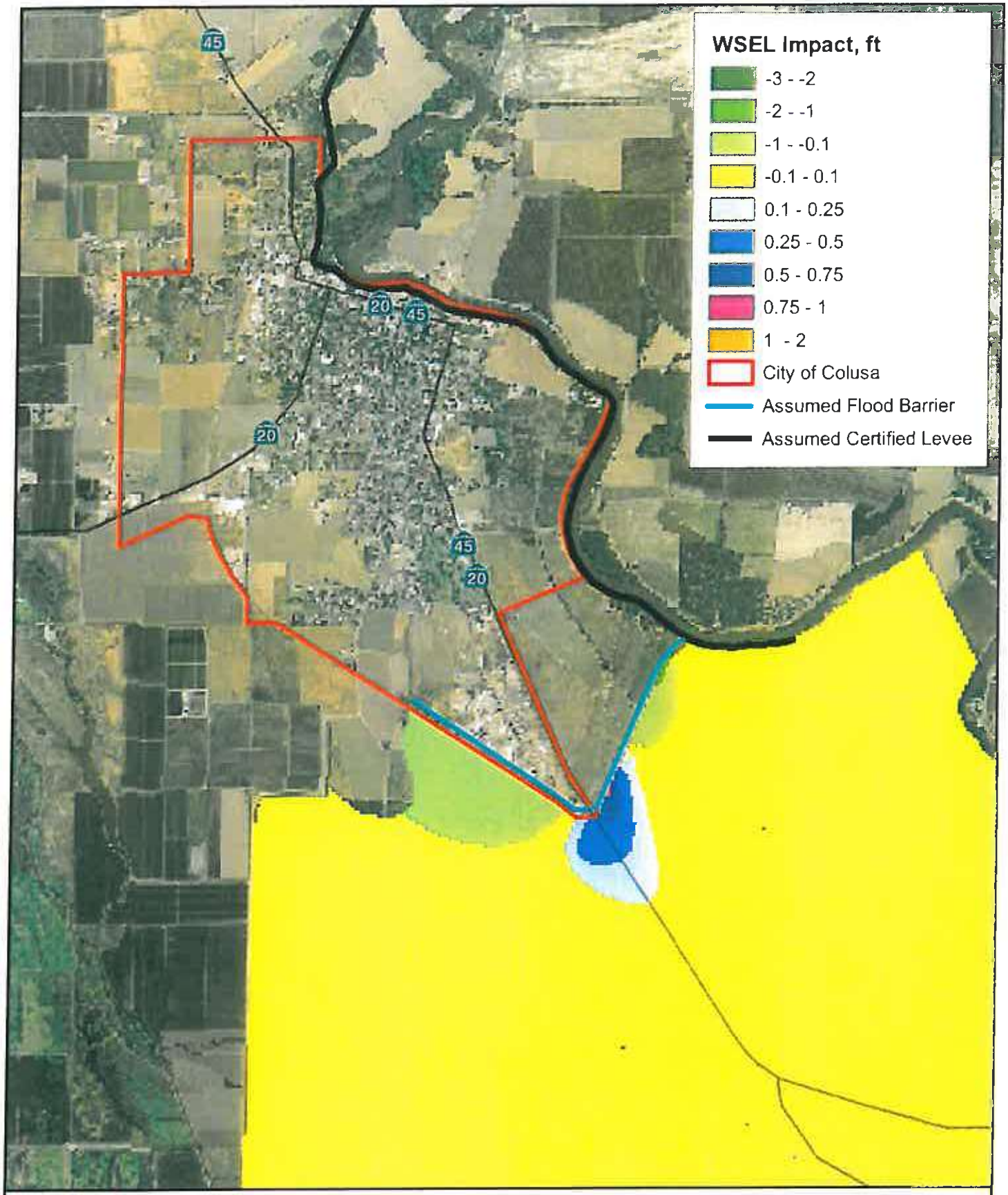
FIGURE 22



2-D COMPARISON
PROPOSED CONDITION WITH
BARRIER/CHANNEL VS. EXISTING CONDITIONS

SOURCE: AERIAL BACKGROUND FROM AERIALS EXPRESS VERSION 5.2.7.

NORTH

0 2,000 4,000

FEET

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FIGURE 23