Attachment 3
Drainage Basin C North Regional Detention Pond and Pump Station

GOALS AND OBJECTIVES

The goal is to obtain grant funding to complete the Drainage Basin C North Regional Detention Pond and Pump Station located within Reclamation District No. 784. Reclamation District No. 784 (RD 784) encompasses a drainage area of approximately 16,500 acres within Yuba County and is roughly bound by the community of Linda to the north, State Route 70 to the east, the Bear River to the south, and the Feather River to the west. Within its watershed, RD 784 operates a system of drainage laterals that convey storm water runoff to a number of pumping plants that discharge the runoff outside of the district boundaries. The Drainage Master Plan includes numerous improvements that are needed to the drainage system. One of the most critical drainage improvements is the completion of the Regional Drainage Facility. The Regional Drainage Facility includes Pump Station No. 10 and the Ella Regional Detention Basin.

The importance of the Regional Drainage Facility, which includes Pump Station No. 10 and the Ella Regional Detention Basin, is because of the limited capacity of the existing conveyance system. Enlargement of the existing conveyance system was considered but determined to be not feasible because of right-of-way limitations and environmental issues. The location of the Regional Drainage Facility was selected as the best because of the ability to intercept the Yuba County Airport storm water runoff as soon as possible. Other locations were considered but eliminated. The Yuba County Airport and the industrial areas at the Airport is a major generator of storm water runoff. This runoff has historically flooded the lower portion of the Industrial Park and the Butterfly/Buttercup residential neighborhood. The Regional Drainage Facility will allow the flow downstream to be mitigated to levels that do not require channel improvements or upgrades. Pump Station No. 10 will then discharge the excess storm water directly to the Feather River to evacuate the detention pond volume below the invert of Lateral 15 to provide the storage space before the next storm event. Without the pump station, the pond would have a dead pool that would not be useable for storage therefore the pump station provides a dual purpose of helping to reduce peak flows and increasing storage runoff volume.

As stated before, the Regional Drainage Facility is one of the most important drainage features proposed in RD 784. The high priority of the improvements is because it relieves flooding on numerous existing residential home sites (over a 100 homes) and businesses (over 30 businesses). The improvements also benefit the other two drainage basins, Drainage Basin A and Drainage B. The benefit to Drainage Basin B is a result of a portion of Basin B north of Plumas Arboga Road and east of Feather River Boulevard will be directed into the Regional Detention Pond. Another benefit to Drainage Basin B is that the flow through a possible breach (FEMA criteria) in the old railroad embankment is also minimized. (FEMA criterion requires that the worst case scenario be considered and that embankments that can breach are not considered in place. This allows Drainage Basin C water to flow directly into Basin B just upstream of Algodon Road.) The reduction in flow and volume reduces the amount of water into Basin B. This reduces flooding on and near the Plumas Lake Golf course and on downstream farm land. There are numerous existing residences located these areas which will have reduced flooding. The benefit to Basin A is similar to the scenario stated above. The amount of water entering Basin A through a possible breach (FEMA criteria) near Lateral No. 5 is greatly reduced or eliminated. The main benefit in this Basin is the reduction in flooding on neighborhood streets and the amount of farm land flooded. Since all of the homes constructed in Basin A were designed to be above the 100 year WSEL, very few homes benefit. There are a few homes directly adjacent to Lateral No. 5 that will have reduced flooding within the yards and streets.

PURPOSE AND NEED

The principal improvements associated with the completion of the Regional Drainage Facility are as follows:

1. Regional Detention Pond: RD 784 has entered into agreements to reimburse developers and property owners that constructed the Regional Detention Pond. A small portion of money was reimbursed during 2011 but all other reimbursements are outstanding. The basic footprint and configuration of the detention basin has been completed with minor improvements required to complete;

2. Lateral 15 Improvements: Lateral 15 shall be extended to discharge directly into the Regional Detention Pond near the northern end of the project. The scope of work includes constructing an open channel from the existing channel to the detention pond'

3. Storm Water Pump Station: Construct a storm water pump station (Pump Station No. 10) capable of pumping 60 cfs including redundant pumping of 30 cfs. The proposed configuration consists of three pump bays, each sized for a 30-cfs vertical turbine pump;

4. The deck of the pump station structure shall be set at the elevation of the estimated 100-yr water surface elevation at the confluence of the Bear River and Feather River, i.e. Elevation 60.0 (NVGD). This is the approximate elevation the flood water reached during the 1997 flood event. This allows the pump station to remain useable to discharge flood water after a flood event. This is the same criteria used on the other pump stations;

5. Provide a motor control system with a SCADA system compatible with the current District standards;

6. Provide a backup generator which is capable of continuous operation of 60 cfs in the permanent configuration. The backup generator shall automatically transfer during periods of power outages. The backup generator will also be located above elevation 60.0 (NVGD);

7. Provide discharge pipes up and over the project levee. Discharge pipes shall be sized for a maximum design velocity of 6 to 8 fps as appropriate for selection of pipe diameter and pump horsepower. The invert of the discharge pipes shall be above the 200 year design water surface or 1957 water surface profile, whichever is greater, and shall have a minimum of two feet of cover. All work, material, and procedures shall be in accordance with Reclamation Board Standard Title 23. RD 784 has already contracted with TRLIA to complete the work and it is under construction. RD 784 has entered into an agreement to reimburse TRLIA to perform the work;

8. Provide Siphon Breaker and Air Relief valve at high point in levee for each discharge pipe. This work was included in the TRLIA work;

9. Provide butterfly valve at top of levee on each discharge pipe. The butterfly valve shall be located in same traffic rated structure. This work was included in the TRLIA work;

10. Provide an outfall structure at the end of the discharge pipe and the beginning of the outfall channel;

11. Provide an automatic drainage gate (flap gate) on the downstream end of each discharge pipe;

12. The outfall canal shall be constructed to handle 90 cfs flow (ultimate capacity of Pump Station with backup pump operating). The outfall channel shall direct water to the old river channel located adjacent to the existing levee alignment. This will be a combination of pipeline and open channel. The configuration of the outfall channel is currently being addressed with TRLIA to avoid the newly constructed Feather River Elderberry (FRET) Mitigation Area. Another option would to discharge flow across the FRET Mitigation area. We have assumed the open channel option at this time;

13. On-off elevations will be field adjusted over the course of the first year of operation to insure proper elevation at the proposed location and to minimize pumping during the summer months. All modifications will be modeled in the HEC-RAS model to insure proper flood protection is maintained;

14. The motor control center shall be programmed such that pump starts shall be rotated that each pump is theoretically used equally;

15. Provide a culvert from the Ella Road ditch to the Regional Detention Pond. The roadside ditch will allow water to flow from Lateral 14 to the Regional Detention Pond;

16. Lateral 15 shall be connected into the upper end of the Regional Detention Basin prior to going under the railroad tracks. This will allow Lateral 17 runoff from the airport two paths of travel to the detention pond;

17. Lateral 17 shall be connected Lateral 15 just upstream of the location where Lateral 17 begins to run parallel to the Railroad. This will consist of placing two seventy-two (72) inch diameter culverts under the Railroad. This will decrease the amount of water in the constrained portion of Lateral 17 behind Butterfly and Buttercup closer to the capacity of the channel.

PURPOSE AND NEED

The purpose of the project goal is to obtain grant funding to complete the Drainage Basin C North Regional Detention Pond and Pump Station. The project is designed to be regional storm drainage management facilities consist with the goals and objectives of the IRWM. One of the main goals is a project with regional benefit. The project is located near the center of Reclamation District No. 784 just downstream of the Yuba County Airport and Industrial Area. The Airport and the surrounding Industrial issues is the largest producer of runoff in the entire system. The location of this peak flow results in conveyance problem from this point south. Without the project, non-project levees are subject to failure, channel improvements are required that are not feasible, roadway crossings need to be updated and numerous other constraints are encountered. The project is designed as a water quality basin, detention basin, surge basin, and pump station. The water quality feature is located just upstream of the Pump Station No. 10. This feature will be designed in accordance with Sacramento Water Quality Design Manual for the Sacramento and South Placer Regions. The detention pond manages the storm water to peak flows that the existing drainage system is capable of handling. The basic design feature is that the existing system is capable of handling about a 10 year storm. With the regional detention and pump station facility, the existing channel facilities with minor improvements would be capable of between a 100 and 200 year storm event. The location of the detention pond also allows RD 784 to regulate flows between Basin B and Basin C or directly to the river depending on the available downstream capacity. The goal would be to pump water only within the downstream gravity flow is obstructed by high water stages in the Bear River. RD 784 would also be able to divert some flows going to Pump Station No. 3 or more water to Pump Station No. 3. Again this provides RD 784 another management tool to regulate the flow within the District. The detention pond is located directly adjacent to Lateral 13 and Lateral 15 which are two of the primary Laterals in the District. Another advantage of the detention pond and pump station is that it reduces water on the main access to the southern Airport Area Industrial Park. Even though only about 30 Industrial Structures (businesses) are removed from the 100 year flood plain another fifteen (15) businesses only access is inundated. This results in those businesses being temporary shutdown. This economic loss is not considered in the grant application.

COMPLETED WORK

In accordance with the proposed project schedule, there will be work completed prior to the grant award date of September 1, 2011. The items of work that should be completed include most of the detention pond, the improvement plans for the pump station, about 50% of the environmental documentation, and the basis of design. The detention pond was recently dedicated to RD 784 from a landowner that constructed the detention pond. RD 784 entered into a reimbursement agreement with the land owner and reimbursed a small portion of

the total amount owed. The land owner agreed to receive the remainder of the payment over time. The improvement plans for the projects are about 30% completed and should be about 60% completed by the time the grant application is awarded. The goal is to start construction in early spring prior to March 1, 2012; however, the scheduled construction start will be closer to May 1, 2012 because of the Central Valley Flood Protection requirement to start after April 15, 2012. There is a strong chance that some of the work is covered in the 2005 mitigate negative declaration for Drainage Basin C Improvements will be started prior to March 1, 2011.

EXISTING DATA AND STUDIES

Numerous studies have been completed that address the need for the Drainage Basin C North Regional Detention Basin and Pump Station. RD 784 has prepared a Drainage Master Plan for the entire District and Master Plans for each subbasin. The Drainage Master Plan considered pumping versus channel upgrades. The District selected the most economical and feasible option for the preferred plan. A nexus study was then completed to address the fair share between new development and existing development. Other studies have been completed for the internal drainage portion of the levee certification process. A complete drainage plan was submitted to FEMA which address existing flooding and an Engineers' Opinion was provided in accordance with 44CFR65.10. A mitigated negative declaration was prepared by RD 784 to address the improvements in the Drainage Basin C master plan. This MND was project level for portions and program level on other work. The outfall line will require additional review because of the changes made due to the setback levee construction and Feather River Elderberry Transplant Area. The environmental process addressed in the schedule will address this work and any other work that requires project level review.

PROJECT TIMING AND PHASING

The Drainage Basin C North Regional Detention Basin and Pump Station is a multi-year phased project. The detention pond construction phase of the project has been completed except for payment for the facilities. RD 784 has entered into reimbursement agreements to construction the detention pond portion of the project. These reimbursement agreements are outstanding with only a small portion reimbursed in 2011. The Pump Station No. 10 phase of the project is schedule to go to construction in March 2012. The project was phased because of lack of funds. The detention pond has now been constructed to full capacity but only a portion of the pond is deemed useable. The detention pond invert is currently lower than the gravity outfall elevation which creates a dead pool. This dead pool cannot not be considered useable until there is a reliable way to pump the water out between storm events. Pump Station No. 10's primary purpose is to excavate the dead pool between storm events. This dead pool will increase the rated storage capacity of the detention pond by over 100%; the pond currently works as a surge basin above the gravity outlet elevation. The surge basin has reduced flooding within adjacent existing residential areas, farming areas, Yuba County Airport, and Yuba County Airport Industrial Park. The Pump Station Pond phase is currently planned to occur in two phases making this project a total of four phases. Phase One was the construction of 31 acres of detention pond, Phase Two was the construction of an additional 19 acres and connection of the Wheeler Ranch Detention Pond, Phase Three will be the construction of main pump station and outflow to Lateral 14, and Phase Four will be the remaining construction of the outfall pipe to the Old Feather River sand canal. The Old Feather River sand channel is above the ordinary highway mark which will help mitigate environmental impact.

SUMMARY

The Regional Drainage Facility project is required as part of the Reclamation District No. 784 Drainage Master Plan. All work shall be in accordance with project geotechnical investigation, Central Valley Flood Protection Board Title 23 Standards, Corps of Engineers' Standards, County of Yuba Standards, Department of Water Resources Standards, and Reclamation District No. 784 Standards. The total project cost for the Regional Drainage Facility is estimated to be $15,908,000 in the impact fee nexus studies. To date RD 784 has used developer funds to acquire a portion of the Regional Detention Pond and a portion of Pump Station No. 10 improvements and design for a total cost of $6,970,000. At this time, RD 784 has about $1,100,000 available for the project. The project is currently about $7,997,000 short to complete.

TASK 1: ADMINISTRATION
The Administration will occur throughout the grant program. The Administration portion of this work will begin if the project is awarded the grant. The schedule includes starting Administration on September 1, 2011. It should be noted that RD 784 provides Administration throughout any project included in the Impact Fee Program. The Administration included in the schedule is the more detailed Administration required for the IRWM.

Deliverables: Preparation of invoices and other deliverables

TASK 2: LABOR COMPLIANCE PROGRAM
The Labor Compliance Program will occur throughout the grant program. The Labor Compliance Program will insure that all work in being expended in accordance with the Grant Program and all construction work has certified payroll based on prevailing wage rates or greater. The schedule includes starting Labor Compliance Program on September 1, 2011. It should be noted that RD 784 provides Labor Compliance as part of any project included in the Impact Fee Program. The Labor Compliance Program included in the schedule is the more detailed program required for the IRWM.

Deliverables: Submission of Labor Compliance Program

TASK 3: REPORTING
Reporting will occur throughout the grant program. The reporting will insure that all work in being expended in accordance with the Grant Program. Quarterly, annual, and final reports will be prepared. The work is part of the budget as direct district administration. The schedule includes starting the Reporting Program on September 1, 2011.

Deliverables: Submission of quarterly, annual, and final reports as specified in the Grant Agreement.

LAND PURCHASE/EASEMENT
Right-of-way is required to complete the project. Most of the right-of-way has been dedicated or will occur within County right-of-way which allows utilities. The two locations which require right-of-way either in fee title or easement are for the outfall to the Old Feather River sand channel and small area between Lateral 15 and the northern end of the detention pond. Reclamation District No. 784 is already working with Three River Levee Improvement Authority (TRLIA) to dedicate the land from the Feather River levee to the old river channel. This right-of-way will consist of an easement sufficient to construct a pipeline and/or open channel. Depending on the final cost of construction and future O&M costs, the design will be the most economical. The other right-of-way required is a small area between the northern boundary of the detention pond and Lateral 15. The easement would be less than 2 acres and will enlarge an existing borrow ditch to drain water from Lateral 15 directly into the detention pond. Currently the water most flow under the railroad through undersized culverts then down Lateral 15 in a section of channel with limited capacity due to the excessive amount of runoff entering the District from the Yuba County Airport and Yuba County Airport Industrial Park within this reach. The water then flows back under the railroad sized and designed for the system. The land is not currently being used for any purpose other than an existing ditch and fallow field. All lands will be acquired in accordance with the Grant guidelines.

Deliverables: Acquisition of Land and Easements

TASK 4: ASSESSMENT AND EVALUATION
Most of the assessment and evaluation of the Drainage Basin C storm water system has been completed. In 2002, Reclamation District has prepared and updated Drainage Master Plans with the latest being July 9, 2007. The project will includes preparing a Basis of Design Report which can be used to obtain environmental certifications and provide the basis for the improvement plans. The latest Drainage Master

Plan for Basin C is actually a Basin of Design which would be updated for this project with more detailed information. The project schedule includes minimal time to update the Basis of Design since most of the work has been completed. We propose to start the work during the month of May 2011 to allow start of construction as close as possible to the March 1, 2012 date.

Deliverables: Technical Studies

TASK 5: FINAL DESIGN

The final design will include 30%, 60%, 90%, and 100%/Final design submittals. In order to start construction as close as possible to March 1, 2012, we may eliminate the 30% submittal. This is also based on much of the work having been already completed and the Basis of Design Report. The design will include improvement plans, specifications, and estimates. All work will meet Central Valley Flood Protection Title 23 Standards, 44CFR65.10, County of Yuba Standards, Reclamation District No. 784 Standards, and any other agency with jurisdiction. Some agency may only have jurisdiction over portions of the project. For instance, the Central Valley Flood Protection Board will have jurisdiction within the floodway and Yuba County within their right-of-way. The final design will also meet or exceed any grant requirements and will include Best Management Practices to insure compliance with the Storm Water Pollution Prevention requirements.

Deliverables: Completion of project plans, specifications, and estimates (PS&E) at the 90 percent and final level.

TASK 6: ENVIRONMENTAL DOCUMENTATION

Most of the environmental work was completed in 2005 as part of the State Clearinghouse Document 2005122051 which was a mitigated negative declaration for the proposed drainage improvements within the Master Drainage Plan for Basin C. Some of the work was program level and other work was considered project level. The environmental documentation will update any program level work to project level and address any changes to the plan since 2005. The main change is the construction of the Feather River Setback Levee and construction of the Feather River Elderberry Transplant (FRET) Area. The FRET has resulted in a change to the alignment of the outfall pipe for the pump station. This work will be addressed in the new environmental documentation. This work will start during the month of May 2011. The environmental documentation and permitting is the critical path on the project. This is shown on the schedule provided.

Deliverables: Approved and adopted CEQA/NEPA documentation

TASK 7: PERMITTING

Permits will be required to complete the project. Some of the permits are very basic and include County of Yuba encroachment permits for performing work within County right-of-way. Other permits required for this project include DFG 1602, Corp 404, Water Quality 401, CVFPB Encroachment Permit, and NPDES Permit. The work within the Floodway required the DFG 1602, Corps 404 (maybe), Water Quality (depends on needing 404), and CVFPB Encroachment Permit. This is main reason that the work within the floodway is considered Phase Four. We can start construction on the improvement on the landside of the levee and once the environmental document is complete and all permits are obtained, the work within the floodway can commence. The system will work in the interim without direct connection to the Old Feather River sand channel. The schedule includes starting permitting as soon as the environmental clearance has been completed. For areas of work with environmental clearance, permitting will commence once the 30% improvement plans are completed.

Deliverables: Section 1602, 404, 402, County of Yuba Encroachment Permit, NPDES, CVFPB, etc

TASK 8: CONSTRUCTION CONTRACTING
The construction contracting will consist of the advertisement of bids, addressing contractor questions, evaluation of bids, review of bid bonds, and award of contract. The advertisement for bids will commence once the improvement plans are finalized and all environmental clearance and permitting is ready. As stated before this project is a phased project which will allow us to proceed with portions of the work prior to other portions being ready. Ideally the entire project will be bid together and this schedule is presented in the schedule. We feel that having the portion of the project located within the floodway as a separate project will allow the rest of the project to proceed earlier than shown in the schedule.

Deliverables: Advertisement for bids, pre-bid contractors meeting, evaluation of bids, award contract

TASK 9.1: MOBLIZATION AND SITE PREPARATION
The contractor will be allowed to mobilization and prepare the site once the notice to proceed has been issued. The notice to proceed will be issued once the contract documents have been reviewed and all bond and paper have been returned. The work will also include preparation of submittal for the long lead time items. Long lead time items include the motor control, generators, pumps, and electric motors. We will allow this work to commence during the mobilization phase to insure a timely construction project.

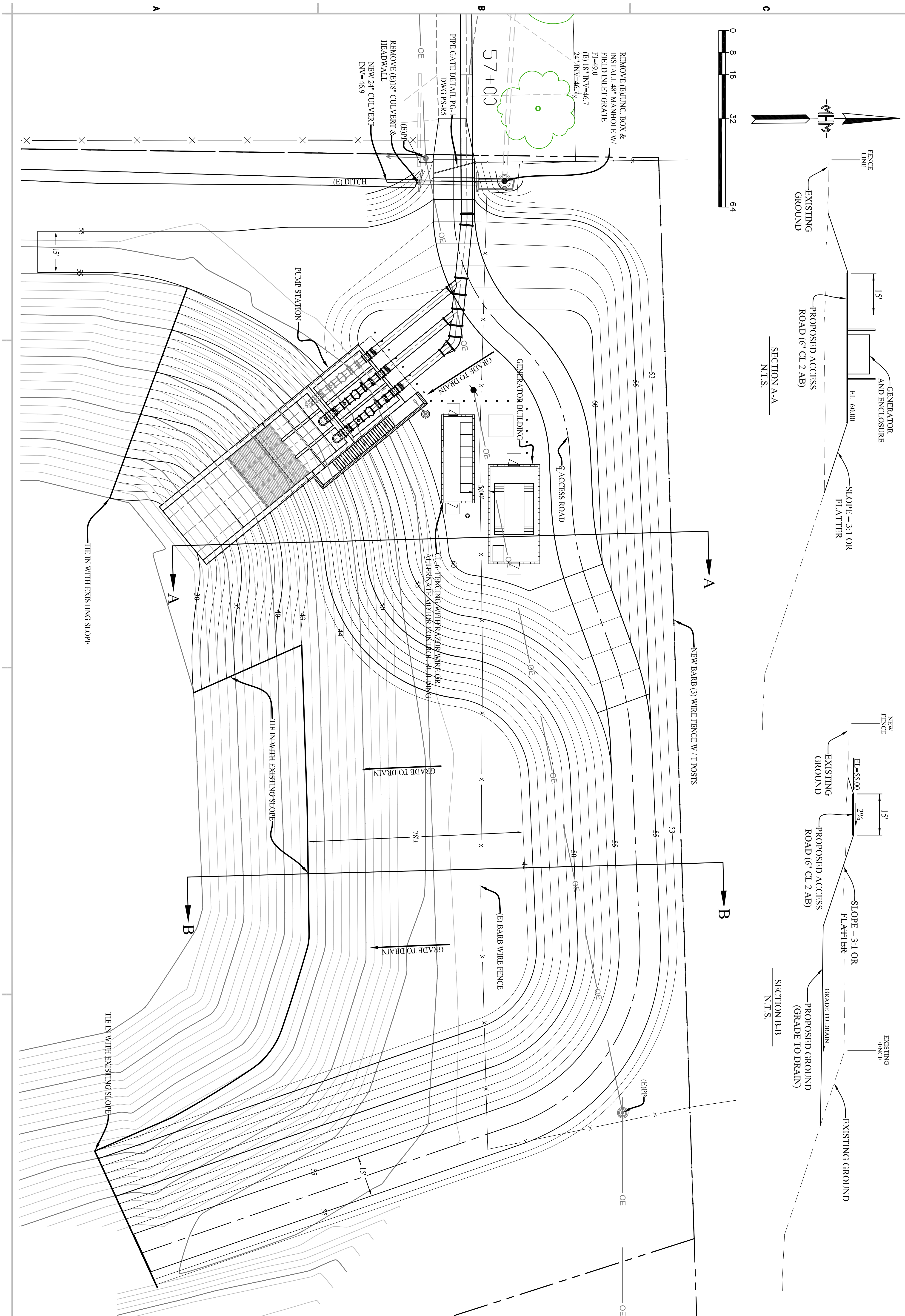
TASK 9.2: PROJECT CONSTRUCTION
The project has four main types of work. The construction of the pump station structure, installation of discharge pipe, earthwork, and electrical. This could lead to three major contractors on the site and possibly four. We may consider bidding each trade as a separate project to maximize completion and to minimize price. All work will be performed in accordance with the approved plans and specifications including all permits obtained. All work will be performed by Class A contractors licensed within the State of California. The pump station because of the complex nature may require a contractor with documented experience. This may result in a pre-qualified bidders list for the pump station and electrical work. The work will commence once the award of contract has been completed. The work within the floodway may have additional constraints and be limited to between April 15 and November 1.

TASK 9.3: PERFORMANCE TESTING AND DEMOBLIZATION
The specifications will require quality control testing by the contractor and the owner will provide Quality Assurance testing. The quality control testing will be conducted by a California registered Civil Engineer. The QC will include construction dailies and other documentation related to the construction of the project. The contractor will be required to prepare an O&M for the pump station and as-built drawings. The demobilization will include proper clean-up of the site and removal of all equipment and material not to be used on the project. Task 9.3 will occur throughout construction and the demobilization will occur once the final punch list items have all been addressed to the satisfaction of the owner and State.

TASK 10: ENVIRONMENTAL COMPLIANCE/MITIGATION/ENHANCEMENT
Throughout the construction of the project, an environmental consultant will be on hand to insure all of the requirements within the environmental document are being addressed. All documentation will be recorded to insure compliance and available to regulators upon request. The environmental consultant will also review construction document to insure that meet all of the mitigation measures and to not result in potential change order situations where the contract specifications allow work not allowed in environmental documentation. This work will commence Task 8 and run through the end of Task 9. Reporting and other documentation required for the construction close-out report will be completed during Task 11.

TASK 11: CONSTRUCTION ADMINISTRATION
Reclamation District No. 784 will perform construction administration and construction management services throughout the construction Labor Compliance Program will occur throughout the grant program.

The Labor Compliance Program will insure that all work in being expended in accordance with the Grant Program and all construction work has certified payroll based on prevailing wage rates or greater. The schedule includes starting Labor Compliance Program on September 1, 2011. It should be noted that RD 784 provides Labor Compliance as part of any project included in the Impact Fee Program. The Labor Compliance Program included in the schedule is the more detailed program required for the IRWM.



M·H·M	ENGINEERING-SURVEYING · MARYSVILLE, CALIF. 95901
Symbol	Description	Date	Approved

Designed by: MHM INCORPORATED	Date: 04-13-11	Rev. A
Drawn by: SMM / Spec No.: 11128	Design file no: 11128	
Reviewed by: JMS	Drawing Code: SD-1	
Submitted by: Civil Engineer	File name: 07131ps_sd1_60cfs; Plot date: 04-13-11; Plot scale: AS NOTED	

POND GRADING PLAN
PUMP STATION NO. 10

Job Title:

Drainage Basin C North Regional Detention Pond And Pump Station No. 10

Yuba County, California

Reclamation District No. 784

Sheet reference number:

Sheet 1 of 1

VICINITY MAP

SCALE 1"=300'

300 150 0 300 900

LOCATION MAP

NOT TO SCALE

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Drawn by: SMM
Spec No.: 11128
Reviewed by: JMS
Submitted by:
Civil Engineer
Date: 04-13-11
Design file size: 11128
Drawing Code: G-2
File name: 0733\pc_gf_66cfs
Plot date: 04-13-11
Plot scale: AS SHOWN
Rev: A

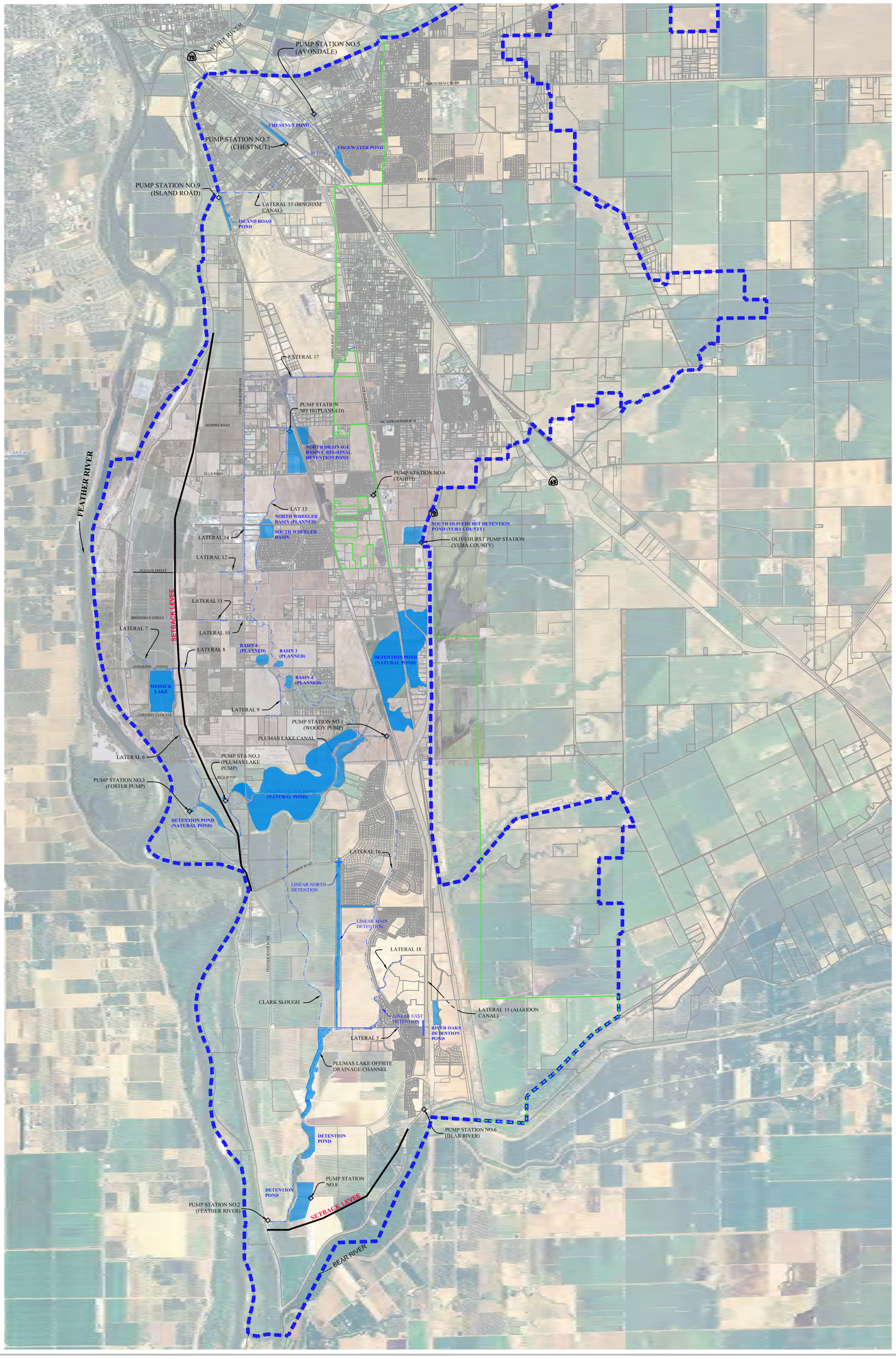
LOCATION, AND
VICINITY MAP
PUMP STATION NO. 10

Job Title:

Drainage Basin C North Regional
Detention Pond And Pump Station No. 10
Yuba County, California
Reclamation District No. 784

Sheet reference number:

Sheet 1 of 1



Sheet reference number: Sheet 1 of 1

Job Title:
Drainage Basin C North Regional
Detention Pond And Pump Station No. 10

Yuba County, California

Reclamation District No. 784

PROJECT SITE ON DISTRICT MAP

Designed by: MHM INCORPORATED		Date: 04-13-11	Rev. A
Drawn by: SMM	Spec No.: 11128	Design file no: 11128	
Reviewed by: JMS		Drawing Code: SD-1	
Submitted by: Civil Engineer		File name: 07131ps_sd1_60cfs Plot date: 04-13-11 Plot scale: AS NOTED	

Symbol	Description	Date	Approved

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UPSTREAM LIMIT OF HYDRAULIC STUDY LATERAL 14, STA 2.815

REACH 4

REACH 6

REACH 7

LATERAL 15

LATERAL 14

UPSTREAM LIMIT LAT 17 PP, STA 2+76

LATERAL 17

UPSTREAM LIMIT OF ELLA POND, STA 390+00

UPSTREAM LIMIT HYDRAULIC STUDY LAT 13, STA 7.172

DOWNSTREAM LIMIT OF ELLA POND AND CONNECTION TO LATERAL 15, STA 363+00

LATERAL 15

UPSTREAM LIMIT OF TOE DITCH HYDRAULIC MODEL/STUDY STA 212+00

LATERAL 13

NORTH WHEELER BASIN

UPSTREAM LIMIT OF WHEELER POND AND PUMP STATION, STA 6.551

SOUTH WHEELER BASIN

DOWNSTREAM LIMIT OF WHEELER POND AND PUMP STATION, STA 6.421

RM27

ELEVATION REFERENCE MARKS

REFERENCE MARK	ELEVATION (FT)	DESCRIPTION OF LOCATION
USGS BM LC36 (NGVD 1929)	58.83	FD STANDARD DISC STAMPED LC 36 1952 #59 IN CONC. BASE OF SIGNAL #1666 ALONE WPRR 1000 NORTH BEAR RIVER
RM27 (NGVD 1929)	62.61	TOP OF FIRE HYDRANT AT INTERSECTION OF MARY AVENUE AND MCGOWAN PARKWAY, ESTABLISHED BY U.S. GEOLOGICAL SURVEY
M 1435 (NGVD 1929)	99.099	NGS BM DISC IN SIDEWALK OF NORTHWEST ABUTMENT OF ERLE ROAD O.H.
BM 2093 (NGVD 1929)	62.59	USED BM BRASS CAP LOCATED AT THE EAST END OF THE EAST-AND-WEST RUNWAY OF YUBA COUNTY AIRPORT
T 743 (NGVD 1929)	71.05	T 743, --ABOUT 1-3/4 MILES SOUTHEAST ALONG THE SOUTHERN PACIFIC CO. RAILROAD FROM THE STATION AT MARYSVILLE, YUBA COUNTY, ABOUT 3/4 MILE SOUTHEAST OF THE SOUTHEAST END OF THE YUBA RIVER BRIDGE, AT RUPERT SIDING, ABOUT 120 FEET SOUTHEAST OF THE CENTERLINE OF A PAVED ROAD, 31.3 FEET NORTHEAST OF THE NORTHEAST RAIL OF THE MAIN TRACK, IN THE TOP OF A 4- BY 9-FOOT CONCRETE FOUNDATION FOR A LOADING CRANE, AND ABOUT LEVEL WITH THE BASE OF THE RAILS.

BFE NOTATION

42.35 NGVD 1929

(44.65) NAVD 88

0 150 300 600 1200

SCALE 1"=600'

RD 784 DRAINAGE STUDY

100-YEAR PROPOSED FLOOD MAP

SUBMITTED BY: M·H·M	DESIGNED BY: SPK	FILE. NO.:
	DRAWN BY: TJM	
	CHECKED BY: S. MINARD	SHT. NO.: 1 or 1
	JOB NO.: 11128	
	FILE NAME: 11128	

RECLAMATION DISTRICT NO. 784

DRAINAGE BASIN C
DRAINAGE MASTER PLAN
BASIS OF DESIGN REPORT

Prepared by

MHM Incorporated
1204 E Street
Marysville, CA 95901

Approved
July 7, 2009

1.0 GENERAL

1.10 PURPOSE

This report is intended to summarize the features and projections of the new drainage models developed in 2008 and early 2009 for Basin C of Reclamation District 784 in South Yuba County. It is also intended to define additional storm runoff improvement facilities to be constructed and the design criteria to be used in preparing plans, specifications, and construction cost estimates for those improvements. This report compares simulated runoff conditions that currently exist in 2009 with those that will exist after full development of facilities discussed in this report and completion of Yuba County subdivisions planned. Land usages in Basin C as indicated in the Plumas Lake Specific Plan and the North Arboga Study Area Plan are incorporated in the future "Ultimate" models. The additional new facilities covered by this report include various pond additions, pond expansions, culvert improvements new pump stations and upgrades to existing pump stations. The design will meet the standards specified by the State of California, Yuba County and RD784.

1.11 Study Overview

Hydrologic runoff has been modeled using HEC-1 and hydraulic modeling, utilizing the HEC-1 runoff has been done using unsteady HEC-RAS analysis. Extensive field topographic surveys of Basin C completed between 2006 and 2008 were used to build the HEC-RAS models. The new models are intended to replace a variety of previous models for the basin. Those include the HEC-1/UNET models used by Mead & Hunt in the 2002 "Master Drainage Plan"; the updates to that study completed by Kit Burton; the 2005 Mead & Hunt "Master Drainage Plan Yuba County Airport" and the Basin C portion of the Wood Rodgers 2008 Application for CLOMR for Ross Ranch Development, Yuba County, California. The models discussed here for Current Conditions are one in the same with the 2009 models submitted to FEMA in support of Countywide Study #08-09-0895S.

An aerial photograph of Basin C with the major pertinent features identified is shown in Figures 1A and 1B. The conditions shown represent "Current Conditions" for the 2009 models. The details are included later in this report, but generally the current conditions include development and improvements completed or currently in progress as of early 2009. The most significant of those are: (1) expansion of Chestnut Pond, (2) improvement of culverts on Lateral 15 (Bingham Canal) in West Linda, (3) Ella Pond and its connections to Basin C, (4) Draper Ranch and Thoroughbred Acres, (5) the new highway interchange at Plumas Lake Blvd., (6) the River Oaks development including River Oaks Pond, and (7) the upgrade of Pump Station #6. Basin C contains approximately 5305 acres, all of which eventually drains to either Pump Station #6 or Pump Station #9. Pump Station #9 is in the north part of Basin C at Island Road and pumps to the Feather River. Pump Station #6 is at the far south end of Basin C and pumps to the Bear River. Internal drainage channels within Basin B are represented in the new HEC-RAS model by 12 reaches, the main ones being Bingham Canal (upstream end of Lateral 15), Lateral 15, Algodon Canal (downstream end of Lateral 15), Lateral 17 and various reaches at the Yuba County Airport. Basin C is bordered on the north by the Yuba River levee, on the east by parts of East Linda, Olivehurst and the Western Pacific Interceptor Canal, on the south by the Bear River Levee, and on the west by the Feather River Levee, RD784 Basin B and RD784 Basin A. Subdivisions referred to in this report can be located by looking at the Subdivision Map for Southern Yuba County prepared by the Yuba County Planning Department, by consulting the Plumas Lake Specific Plan or by referring to the North Arboga Study Area Plan.

Figures 1A and 1B
Aerial Photographs of the RD784 Basin C and Surrounding Areas
Current 2009 Conditions

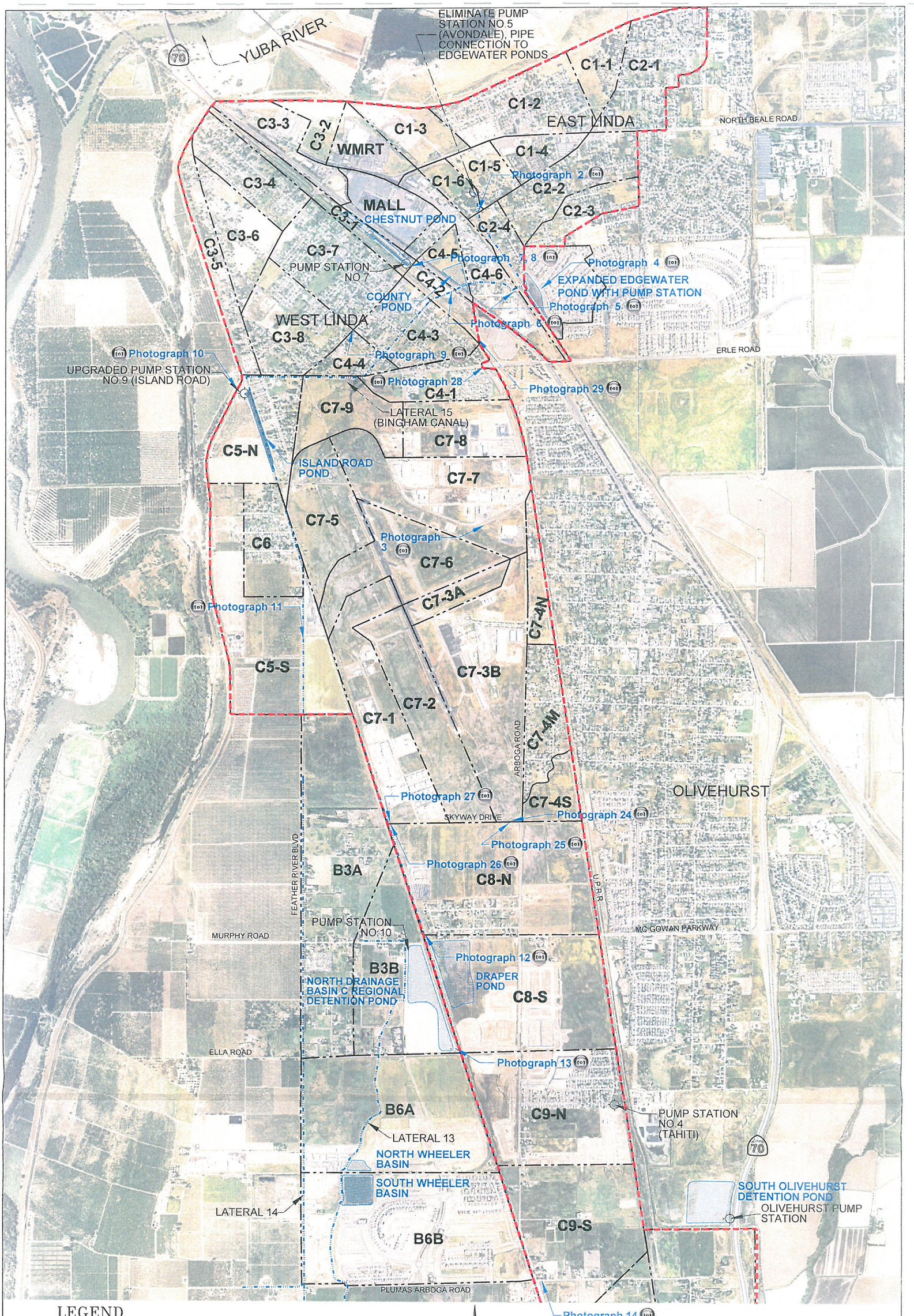


FIGURE 1A
RECLAMATION DISTRICT NUMBER 784
BASIN C FEATURES/SUBSHEDS
CURRENT CONDITIONS
YUBA COUNTY, CALIFORNIA

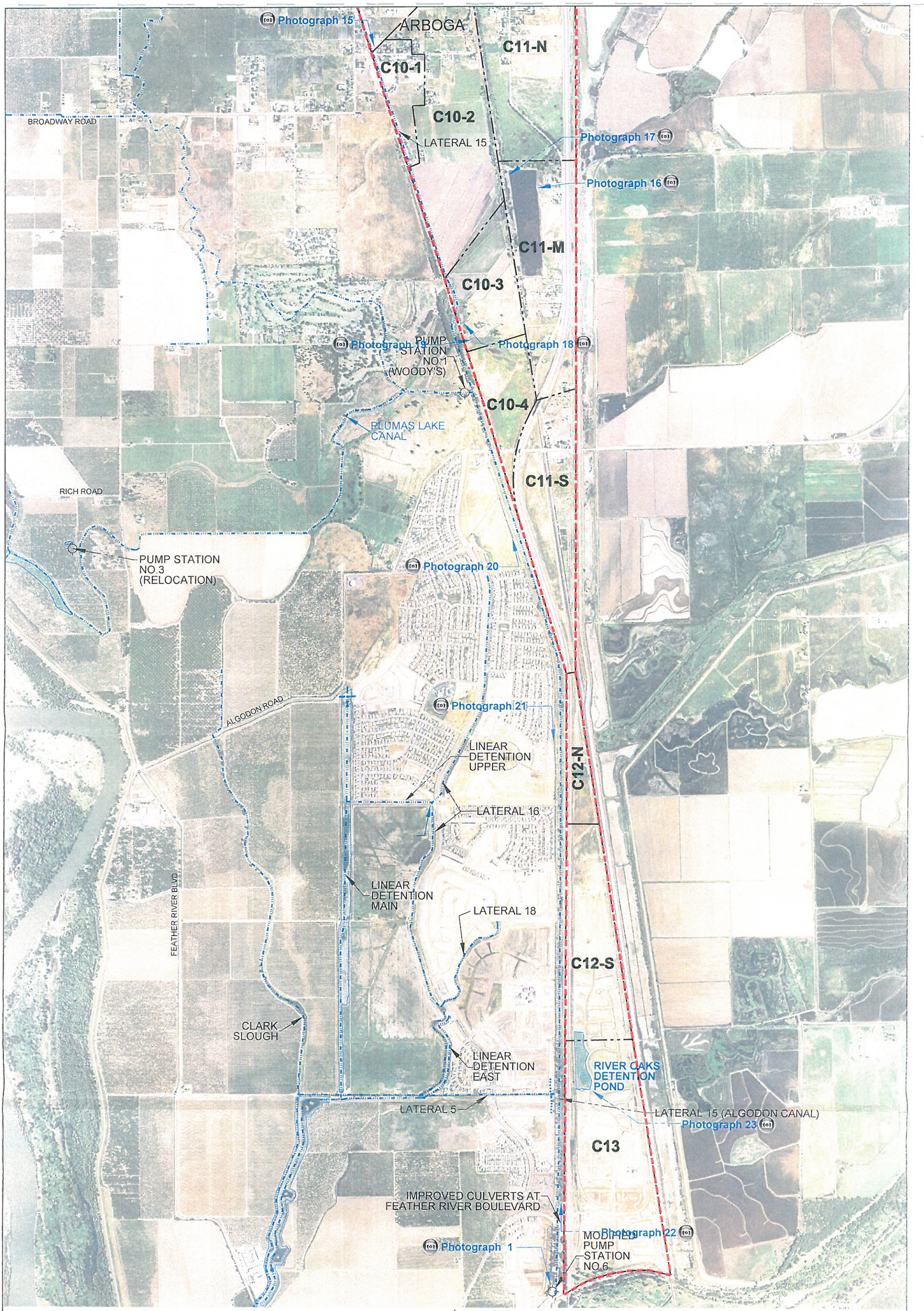


FIGURE 1B
RECLAMATION DISTRICT NUMBER 784
BASIN C FEATURES/SUBSHEDS
CURRENT CONDITIONS
YUBA COUNTY, CALIFORNIA

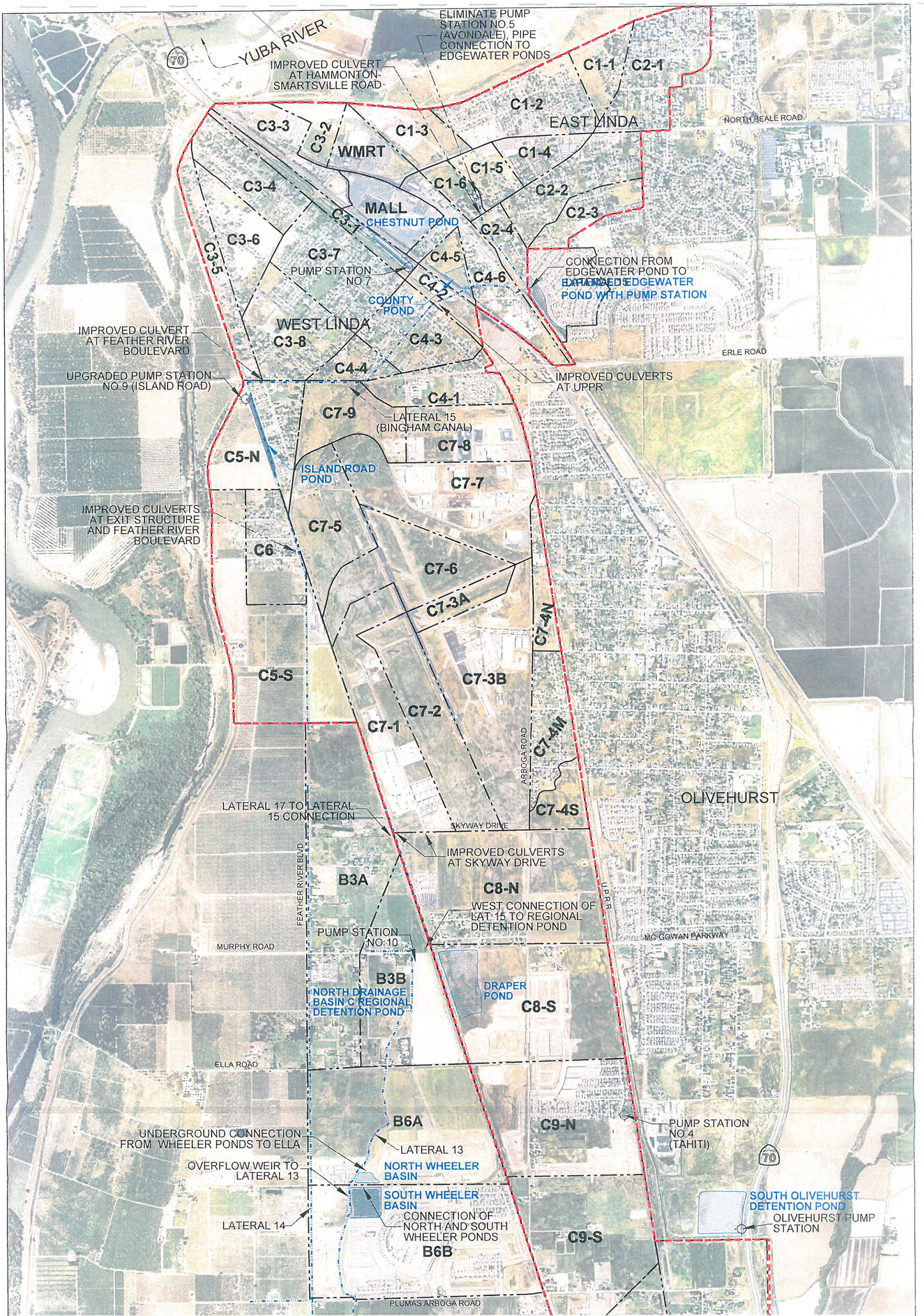
The Current Conditions models have been run for four storm events: The 10-year 24-hour storm, the 100-year 24-hour storm, the 100-year 10-day storm and the 200-year 24-hour storm. Past work for RD784 has usually included the first three of those storms. The 200-year has been added to this study because of the push for protection to the 200-year level. Two 100-year storms are included because one (the 24-hour) will generally produce worst-case channel flows and the other (the 10-day) will generally produce worst case WSEL in areas limited by runoff storage.

The "Ultimate Conditions" model includes all additional subdivision development planned for Basin C with the major pertinent new facilities identified in Figures 2A and 2B. The developed conditions incorporate the development projects indicated in the Plumas Lake Specific Plan, the North Arboga Study Area Plan and the 2005 Subdivision Map for Southern Yuba County. A partial list of some of the more significant projects are: Commercial development near WalMart, Pheasant Pointe, Draper Ranch, Thoroughbred Acres, Hawes Ranch, Feather Glen, unnamed residential development south of Broadway Rd., commercial development such as the Feather River Gateway in the vicinity of the Plumas Lake Interchange, River Oaks South, River Oaks East, River Oaks North and North Pointe. A partial list of planned drainage improvements intended to support the development and correct existing problems include: Elimination of the Avondale Pump Station and replacement with a pipe to Edgewater Pond, enlargement of Edgewater Pond, connection structure between Bingham Canal and Edgewater Pond, a new pump station at Edgewater Pond, construction of a new detention pond at the County Center off Packard Ave., an additional culvert on Bingham Canal at the Union Pacific Railroad, an enlarged box culvert at Feather River Blvd. near Island Rd., upgrades to the Island Rd. Pump Station, improve several culverts south of Island Pond on Lateral 15, a new culvert connection between laterals 15 and 17 near the airport, culvert improvements on lateral 17 at the airport, a Pump Station at Ella Pond (North Drainage Basin C Regional Detention Pond), a new connection between upper Lateral 15 and Ella Pond, construction of Draper Pond and its connections to Lateral 15 and Ella Pond, construction of a second connection between Algodon Canal and the River Oaks Pond (or other approved engineering solution), improved culverts on lower Algodon Canal at Feather River Blvd., and changes to the pumps at Pump Station #6.

The HEC-RAS simulations for the Ultimate Conditions produce lower peak WSELs than the Current Conditions. The worst case situation for almost all regions of Basin C under Ultimate Conditions is the 100-year 10-day storm. There are a few sections of some of the upper reaches that are exceptions to this, where conveyance capacity limits rather than available storage. With the improvements proposed in this report, the Ultimate Conditions model for the 100-year 10-day storm produces incomplete improvements over Current Conditions in the Bingham Canal (Lateral 15 upstream of station 500+00). As discussed elsewhere, without utilizing cost-prohibitive improvements such as pumping to the river from Edgewater Pond, all the problems in Bingham Canal in a 10-day event cannot be solved. On the other hand, the improvements proposed do solve nearly all the long standing flooding issues in Bingham Canal for the 24-hour 100-year storm, and improve conditions under the 100-year 10-day event significantly for all parts of Basin C. Additional projects that could be considered in the future to fully solve the flooding issues in upper Bingham Canal are discussed later in the report, but are not part of the hydraulic models presented.

The vertical datum used throughout this study is NGVD 29. This applies to all topographic surveys and to all computed water surface elevations.

Figure 2A and 2B
Aerial Photographs of the RD784 Basin C and Surrounding Areas
Ultimate Conditions



LEGEND

- PUMP STATION
- LATERAL
- DETENTION POND
- DRAINAGE BASIN BOUNDARY

0 500 1000 2000 4000

SCALE 1"=2000'

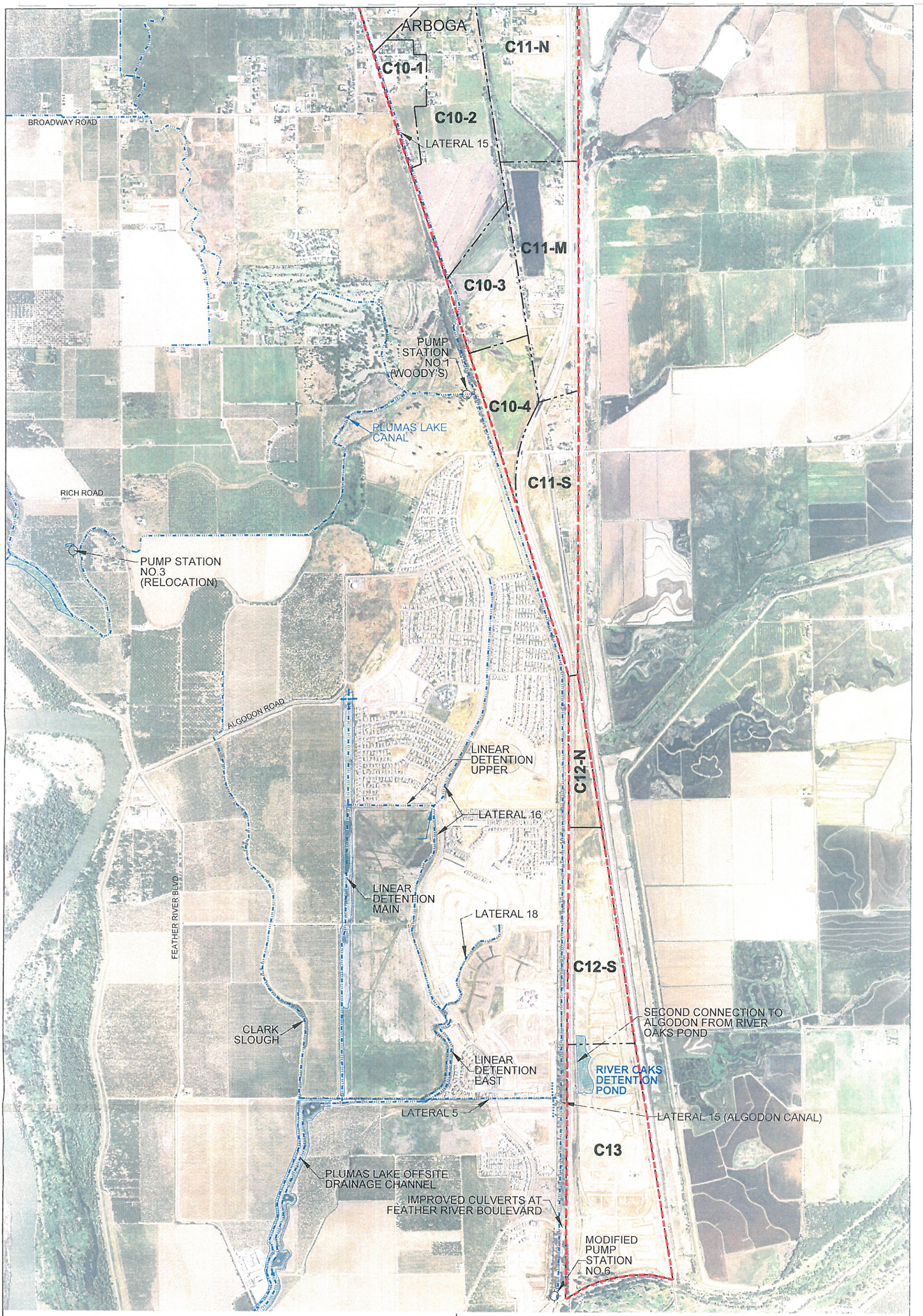
FIGURE 2A

RECLAMATION DISTRICT NUMBER 784

BASIN C FEATURES/SUBSHEDS

ULTIMATE CONDITIONS

YUBA COUNTY, CALIFORNIA



LEGEND

- PUMP STATION
- LATERAL
- DETENTION POND
- DRAINAGE BASIN BOUNDARY

0 500 1000 2000 4000

SCALE 1"=2000'

FIGURE 2B

RECLAMATION DISTRICT NUMBER 784
BASIN C FEATURES/SUBSHEDS
ULTIMATE CONDITIONS
YUBA COUNTY, CALIFORNIA

1.12 Description of the Study Area and Channels

Figures 1A and 1B include the locations of the photographs discussed in this section. The major pertinent existing drainage features are identified in the figures. Basin C is such a long and narrow area, it was split up into the north portion in Figure 1A and the south portion in Figure 1B.

While Basin C is ideally a closed system, the overflow of high water from Basin C into the north end of Basin B is part of the model under Current Conditions. This is a situation that will be corrected for the Ultimate Conditions. The overflow currently occurs only under higher stages in Lateral 15. While the models predict a significant amount of overflow for larger storms, it is non-existent for the 10-year.

There are five pump stations within Basin C; by far the most significant of those is Pump Station #6 at the south end of Basin C which delivers up to 200 CFS to the Bear River. During emergency high-water events, the pump station can be called on to pump at a rate of 267 CFS. The pump station was built in 2006 and includes a redundant pump system and back-up generators. This pump is part of the hydraulic model of the basin, considered to remain operational for all storms. Other pumps in the basin are Pump Station #5 at the north end of Bingham Canal (Lateral 15), Pump Station #7 at Chestnut Pond, Pump Station #9 at Island Road, and Pump Station #4 (Tahiti Pump). Pumps #5 and #7 deliver runoff to the drainage channels of Basin C and are considered to function properly in all storms. Both of these pumps were part of the system covered in the 2007 LOMR case #07-09-1893P. Pump Station #9 is a medium-size pump station at the west end of Island Road in West Linda. It has a long history of operation, pumping from an expanded portion of Lateral 15 to the Feather River. Pump Station #9 is modeled as operational for all storms in this study. Pump Station #4 is at the east side of the Hawes Ranch development. It serves a portion of the local residences, but it is not regularly used. Since it removes runoff from Basin C and delivers it to Clark Lateral to the east of RD784, it is not treated as operational in any of the models in this study.

The 100-year Base Flood Elevations established in this work generally represent a composite of worst case situations. For most of the basin, runoff storage capacity is the limiting parameter and the 10-day 100-year storm produces the highest water surface elevations. There are a few spots in the upper reaches of the Yuba County airport and in the Bingham Canal region where conveyance in the channels controls and the 24-hour 100-year storm produces the highest water surface elevation. With some exceptions noted later, this report uses the higher of the two 100-year storms for each location.

The area of this study is entirely within Reclamation District 784. RD784 is responsible for all the drainage facilities covered. As can be noted in Figures 1A and 1B, Basin C is a mix of residential, commercial and agricultural regions. The primary hydrologic and hydraulic models developed for this study are contained completely within the Basin C drainage boundaries comprising approximately 5305 acres. The Basin C drainage boundary and the RD 784 District boundary do not always coincide. In some places the administrative boundary of the District is outside the physical drainage boundary, in other places the opposite is true. The distinction is particularly evident in the south part of Basin C where the District boundary extends considerably farther to the east than the Basin C drainage boundary. The hydraulic study limits for this Drainage Master Plan excludes most of the community of East Linda. While that area of Basin C is in RD784, the RD784 facilities begin at the Avondale Pump Station (#5). The County system of pipes directs East Linda water to RD784 at that location.

As can be seen in Figures 1A and 1B, Basin C is drained via several main channels. Lateral 15 is the primary drainage channel in the basin extending from the community of East Linda in the north to Pump Station #6 at the Bear River in the south. The south section of Lateral 15 is also known as Algodon Canal, while the north portion of the lateral is known as Bingham Canal. For modeling purposes, the stationing of Lateral 15 begins at the upstream side of Pump Station #6 at station 0+96 and ends in the north at station 632+82 near the Avondale Pump Station. Lateral 15 conveys runoff generally from north to south, passing from East Linda to West Linda, then south past the west side of the airport, then south through the community of Arboga and along the west side of State Route 70 to Pump Station #6. The airport area has a number of reaches which drain to Lateral 17. The names and stationing of the airport area reaches follow the previous Airport Studies done by Mead and Hunt (see the reference section). The longest drainage branch at the airport originates northeast of the airport as Reach 2 and routes in a concrete-lined ditch around the north end of the airport, joining Reach 4 and eventually reaching Lateral 17 at the southwest corner of the airport. The other main ditch serving the airport is Reach 6, which originates near the industrial area in the central part of the airport. Reach 6, like all other ditches at the airport, delivers runoff to Lateral 17. Lateral 17 flows south adjacent to the old railroad and meets Lateral 15 at the point where Lateral 15 flows under the railroad from the west side to the east side. Lateral 17 and Lateral 15 combine at station 0+00 on Lateral 17 and station 393+20 on Lateral 15. The upstream stationing in the airport begins at station 138+40 on Reach 2 and at 104+38 on Reach 6.

Basin C is pumped to the Bear River at the south end of Algodon Canal at Pump Station #6 shown in Photograph 1 (please refer to Figures 1A and 1B for the locations of the photographs).

Photograph 1 – Pump Station #6 at the south end of
Lateral 15 (Algodon Canal) in Basin C.

The pump station currently has a capacity of 200 CFS with three pumps running. It has back-up generator power and a redundant pump system. Although not counted on for design purposes, the pump station can use the fourth pump during emergency high-water events boosting its capacity to 267 CFS. There is also a gravity drain at

Pump Station #6 which operates most of the time, but is closed off when the Bear River is at higher stages. For the purpose of this study, the gravity drain has been ignored consistent with using the worst case scenario of high stages in the Bear River. Under the Ultimate Conditions, with Pump Station #10 (upstream near Ella Road) operational, the capacity of Pump Station #6 will be downgraded to 127 CFS.

Photograph 2 was taken at the upstream end of the study in Lateral 15 in Basin C at about station 629+50. Runoff from much of East Linda, including that pumped by Pump Station #5 is conveyed southward by this ditch. Under the Ultimate Conditions, a storm drain is planned to carry runoff from the region of Pump Station #5 at Avondale Rd. to Edgewater Pond bypassing this section of the Bingham Canal.

Photograph 2 – Upstream end of the study on Lateral 15 in Basin C, looking southwest. This portion of Lateral 15 is known as Bingham Canal.

The upstream end of the longest reach at the airport is shown in Photograph 3. Reach 2 is a concrete-lined ditch that runs around the north end of the airport. The photograph was taken looking upstream toward station 138+40 in Reach 2. This ditch collects runoff from the industrial area north of the airport.

Located just a few thousand feet south of Photograph 2, Edgewater Pond is within the RD784 administrative District, but outside the current (as of 2009) Basin C drainage. Photograph 4 was taken looking southwest across Edgewater Pond. The pond is a surge basin for the Edgewater subdivision which is just to the east of Basin C. While it is next to Lateral 15, they are not currently hydraulically connected. Drainage in this region is to the East Linda/Linda Drain watershed. However, planned under the Ultimate Conditions are a number of improvements to the pond. First is construction of a connection between Lateral 15 and the pond allowing flow in from the lateral to the pond. Second, the pond will be expanded primarily by digging it much deeper. Third, a small pump station will be constructed at the north end of the pond which will pump downstream to the County Center Pond. In addition, as mentioned in conjunction with Photograph 2, runoff from the Avondale Ave. area will be drained via underground storm drain directly to the enlarged Edgewater Pond.

Photograph 3 – Upstream portion of Reach 2 north of Yuba County Airport in Basin C. Looking upstream to the northeast.

Photograph 4 – Edgewater Pond, just to the east of northern Basin C. Looking to the southwest.

Just to the west of Edgewater Pond, Lateral 15 (Bingham Canal) turns west and passes under the Southern Pacific

Railroad and adjacent Lindhurst Ave. This location is pictured in Photograph 5 looking upstream. Partially visible in the distance is Edgewater Pond and the residences in the Edgewater Subdivision. The station shown at Lindhurst Avenue is approximately 607+00. According to the hydraulic models with this study, the area downstream between this point and the location of the freeway in Photograph 6 is expected to experience out-of-channel flooding under Current Conditions. The Chestnut Road crossing in Photograph 6 is approximately at station 592+00. As suggested by Photographs 5 and 6, the passages under the Southern Pacific Railroad, Lindhurst Avenue, State Highway 70 and Chestnut Road do not pose any significant restriction to the flow in Bingham Canal. Just downstream from Photograph 6, Bingham Canal passes under the Union Pacific Railroad. The undersized culverts at that crossing are restrictive, contributing to the expected flooding mentioned upstream. Those culverts are slated for improvement under the Ultimate Conditions. The improvements mentioned from Edgewater Pond to the railroad culvert will lower the water surface in this region. However, according to the hydraulic models, out of channel flooding will still occur, especially in the 100-year 10-day event. Pumping to the river from Edgewater Pond could alleviate this problem, but only at great expense. The Ultimate model presented with this Drainage Master Plan does not include the pumping to the river, but does succeed in meeting the goals for the 100-year 24-hour storm conditions.

Photograph 5 – Bingham Canal (Lateral 15) at Lindhurst Avenue and the Southern Pacific Railroad. Looking to the east in Basin C.

Photograph 6 – Bingham Canal (Lateral 15) at Chestnut Road and Highway 70.
Looking to the southeast in Basin C.

Photograph 7 – Enlarged Chestnut Pond in Basin C.
Looking northwest from the south end of the pond.

Photograph 7 shows an important and recent change to upper Basin C. Chestnut Pond was expanded during the fall of 2007 from approximately 20 acre-feet to the current 42 acre-feet. The pond serves as detention for the commercial areas on the other side of the freeway from the pond. The Feather River Center area, including the

WalMart area is connected to Chestnut Pond under the freeway. The expansion of the pond has resulted in approximately a three foot lowering of the peak water surface in the pond according to the hydraulic models to be discussed later. Figure 1A may be useful in locating the pond with respect to the commercial areas.

The pump station for Chestnut Pond was not altered during the pond 2007 expansion. The pump station is shown in Photograph 8. When operating, Pump Station #7 delivers Chestnut Pond water to the south to the railroad borrow ditch on the east side of the Union Pacific Railroad. The railroad borrow ditch is openly connected to Bingham Canal approximately 800 feet to the south. The pump station sits on high ground associated with the historic Hammonton-Smartville Road. The high ground prevents high water in the Bingham Canal from traveling north into Chestnut Pond.

No additional improvements to Chestnut Pond or Pump Station #7 are incorporated into the hydraulic models with this Drainage Master Plan. However, in the long term the pump station will need an upgrade to provide redundant pumps and/or a back-up generator. This will assure that the pumps will remain operational in any storm regardless of availability of grid power. The pumps will be monitored using SCADA. While an upgrade in capacity of Pump Station #7 could accompany such work, it is assumed for the purpose of modeling in the Drainage Master Plan that the capacity remains as it has been at a total of 16 CFS.

Photograph 8 – Pump Station #7 at Chestnut Pond in Basin C.
Looking north into the south end of the pond.

The railroad borrow north of Bingham Canal (Lateral 15) is discussed above. Although less pronounced, the railroad borrow also continues to the south of Bingham Canal for over a thousand feet, then mostly disappears. An important overflow of the railroad borrow to the south, relieving high water surface levels in Bingham Canal under current conditions is discussed later in this section.

Bingham Canal passes under the Union Pacific Railroad just west of the previous discussion area. As mentioned,

under Ultimate Conditions, the culverts under the railroad will be improved. Downstream the ditch is still referred to as "Bingham Canal" locally, but its alternative designation as Lateral 15 is used in the computer models. As Lateral 15 flows to the southwest through the community of West Linda, it passes through culverts at Arboga Road, Gledhill Avenue and Alicia Avenue. The culverts at those three crossings were improved in 2006. A typical section of this part of Lateral 15 between Alicia and Gledhill is shown in Photograph 9. The section pictured is from approximately station 570+00 to station 577+00.

Photograph 9 – Lateral 15 (Bingham Canal) in Basin C.
Looking upstream from Alicia Ave. toward Gledhill Ave.

Several thousand feet downstream from the location of Photograph 9, Lateral 15 passes under Feather River Blvd. through an undersized box culvert. This box culvert is slated for enlargement in the Ultimate condition models as discussed in section 1.20 of this report.

At the west end of Island Road, Lateral 15 turns south and enters a widened linear detention section often referred to as Island Pond. Pump Station #9 at this location removes part of the runoff by pumping to the Feather River. Photograph 10 shows the pump station and the linear detention at the Island Road location. The pump is at approximately station 533+00. Pump Station #9 uses two pumps with 25 CFS capacity each. Under Ultimate Conditions, the capacity of Pump Station #9 will be increased and the station upgraded.

From there, Lateral 15 flows to the south and passes under Feather River Blvd. Several restrictive culverts in that

area are planned for improvement under the Ultimate Conditions. Those are discussed in section 1.20 of this report. Photograph 11 shows a section of Lateral 15 south of there running next to Feather River Blvd. near station 475+00. Far in the distance in that photo is the location where Lateral 15 turns to the left to cut across to the old railroad berm.

Photograph 10 – The Island Road linear detention and #9 pump station in Basin C. Looking southeast from Island Rd.

Photograph 11 – A section of Lateral 15 next to Feather River Blvd. Looking south in north-central Basin C.

Lateral 15 moves from running next to Feather River Blvd. (as pictured in Photograph 11) to paralleling the old railroad berm which runs of the west side of the Yuba County Airport. After traveling south next to the railroad berm for one mile, Lateral 15 passes under the railroad and meets Lateral 17 which has come southward from the airport area along the east side of the railroad berm. The junction at station 393+20 is shown in Photograph 12. Looking north in that photograph, Lateral 15 is on the left and Lateral 17 on the right. Once the two laterals join, they continue to the south as Lateral 15, seen at the far right of the photo. Though not visible in Photograph 12, four restrictive culverts pass under the railroad here and contribute to the flooding problems upstream of this location on Lateral 15. The Ultimate Conditions model proposes to relieve the problem by creating a connection from the south end of upper Lateral 15 on the left in the photo directly to the Ella Pond a short distance to the south. Additional relief for this area will be provided by the construction of a large pond on the east side of the railroad berm. That pond is part of the Draper Ranch project and will connect to Ella pond via culverts under the railroad berm. A weir structure at the Draper Pond will allow water from Lateral 15 at this location to spill into the pond. These measures should lower the peak water surface in this area by several feet and eliminate the flooding issues which have plagued the Buttercup Lane area at the right edge of Photograph 12.

Photograph 12 – Old railroad berm where Lateral 15 and 17 come together. Looking north with Basin B on left and Basin C on right. Lateral 15 passes under the old railroad here.

Photograph 13 – Ella Pond with expansion in progress visible at left. This facility will become the North Drainage Basin C Regional Detention Basin in the future.

Just south of the confluence of Laterals 15 and 17 is Ella Pond. At this writing, the pond is undergoing an expansion. A photograph of the pond from January 2009 is show as Photograph 13. The view is to the north with the ongoing expansion visible on the left side. The expansion to a storage volume of over 800 acre-feet is expected to be completed in 2009. The facility will be called the "North Drainage Basin C Regional Detention Pond" and will eventually include Pump Station #10. For the Current Conditions of this study, the facility is treated as-is. At the current time there are no pumps at Ella Pond and it serves just as a surge basin. It is connected by gravity line to Lateral 15 and receives the storm drain runoff directly from the Draper Ranch development.

Photograph 14 – Lateral 15 in the central Basin C community of Arboga.
Looking north, upstream toward the arch bridge at Plumas Arboga Rd.

The 2005 Wheeler Ranch development in Basin B included the construction of three arch bridges on Plumas Arboga Road at the south edge of the project. The road crosses Lateral 14 in Basin B, Lateral 13 in Basin B and Lateral 15 in Basin C. The Lateral 15 crossing is shown in Photograph 14 and is typical of the other two concrete arch spans. Photograph 14 was taken looking north and the Wheeler Ranch development can be seen in the distance. The spans do not interfere with the flow in any of the three ditches, but the actual geometry of each crossing is included in the hydraulic models. The bridge shown in Photograph 14 is at station 309+00 on Lateral 15.

The last photograph location identified in Figure 1A is Photograph 14. Locations of photographs discussed after number 14 will be found on Figure 1B.

Photograph 15 – Lateral 15 at Broadway Street in Basin C.
Looking southeast downstream.

Lateral 15 is the main backbone of the Basin C drainage basin. At this point in the discussion, it has passed over half way down the basin from north to south. Photograph 15 is taken at the Broadway Street crossing of Lateral 15 looking south. The large CMP culverts allow plenty of conveyance. The Broadway crossing is at approximately station 293+00 on Lateral 15.

Continuing south from Broadway, Lateral 15 passes through rural, predominantly agricultural areas for almost two miles. In this section, Basin C remains entirely on the east side of the lateral and Basin B is on the west side. The basin boundary in this area running next to Lateral 15 is a convenient and historic delineation, but there are some small exceptions. There are about 15 acres near Broadway in Basin B to the west of Lateral 15 which actually drain to Lateral 15 rather that to the west to Basin B. Rather than redefine the basin boundary for this study, the issue has been handled in the hydrologic models by simply moving 15 acres from subshed B6C in Basin B to subsheds C9-S and C10-1 in Basin C. The Basin C hydraulic model for this section of Lateral 15 below Broadway uses wide cross sections to correctly simulate the flooding that can occur between Lateral 15 and the Union Pacific Railroad. The low agricultural area from approximately station 270+00 to 230+00 is counted on for flood storage.

The wide area of low agricultural land discussed above is just west of the pond shown in Photograph 16. This pond is on the property owned by the Hastey family. This pond is an important part of the hydraulic model for

Basin C. Four large culvers connect this area east of the Union Pacific Railroad to the agricultural area west of the railroad. During high water, much of the low land near the Hastey Pond will flood and become hydraulically connected to the flooded agricultural lowlands west of the railroad. A large amount of stormwater is expected to be stored in this area during severe storm events. The hydraulic models for Basin C include these areas and their interconnections. The simulations as expected show extensive flooding in and around the Hastey Pond and in the low agricultural area between the railroad and Lateral 15.

Photograph 16 – Hastey Pond in Basin C.
Looking northwest toward the Union Pacific Railroad

As stated, the Hastey Pond area is connected to the land on the west of the railroad by four culverts under the tracks. One such culvert is shown in Photograph 17. This is taken from the Hastey property looking west. When the water is high enough on a given side of the railroad, it can pass through the culverts to the other side. The simulations done with this study indicate that flows do take place in both directions through the railroad culverts, but the largest flows are, as expected, in the westward direction. Due to expected future commercial development, the current and ultimate models of this area are quite different hydrographically. However, the hydraulic models of this region are unchanged moving between current conditions to ultimate conditions.

Photograph 17 – Typical culvert under the Union Pacific Railroad connecting the Hastey Pond area to the low agricultural area to the west.

The low area near Lateral 15 directly downstream to the west from the railroad culverts just discussed is shown in Photograph 18. Runoff from the Hastey Pond area that passes through the culverts under the railroad will eventually convey to this location on Lateral 15. The photo is taken from the historic railroad berm that ran through here.

Photograph 18 – Lateral 15 at station 230+00 in Basin C.
Looking north with the low agricultural area visible on the right

Photograph 19 – South Hastey Pond in Basin C.
Looking to the east from a berm next to Lateral 15.

In the same general area as Photograph 18 is an additional low area of storage. It is referred to in this study as South Hastey Pond because it is at the south end of the Hastey family property. This pond has direct access to

lateral 15 as it is on the west side of the Union Pacific Railroad rather than the east side like Hastey Pond. South Hastey Pond is shown in Photograph 19 looking to the east from the abandoned railroad berm with the Union Pacific Railroad visible in the distance. The area was photographed during a dry time. Considerably more flooding is expected in the area during larger storms according to the simulation and that is the case reported by local observers. The area immediately south of this pond and extending to Algodon Road is slated for commercial development as per the Plumas Lake Specific Plan.

Lateral 15 below this point is usually referred to as Algodon Canal, although the hydraulic models use the Lateral 15 designation. Lateral 15 continues south through agricultural areas until reaching Algodon Road at station 198+00. From there to the south, Development within Basin A borders the channel on the west side instead of undeveloped Basin B as was the case to the north of Algodon Road. Less than two thousand feet south of Algodon Road at around station 180+00 is the new Cal Trans freeway interchange at Plumas Lake Drive. The project was completed in the summer of 2008. Photograph 20 shows the work in progress during the spring of 2008. The project made a slight realignment of Algodon Canal and utilized three 8-foot culverts at the new crossing. This new crossing is in the Current Conditions hydraulic models as well as the Ultimate Conditions hydraulic models, and as could be predicted, provides plenty of capacity for flows in the canal.

Photograph 20 – The new Plumas Lake Drive Interchange project during construction in 2008. Looking north with Basin B visible on the left.

Photograph 21 is a January 2009 shot of Algodon Canal (Lateral 15) south of the new Plumas Lake Interchange. This photo was taken near station 130+00 looking south. Basin C is on the left and Basin B is on the right. State Route 70 is visible just to the east of the channel. The channel along this section all the way to Pump Station #6 is a deep trapezoidal cross section, capable if conveying fairly large flow rates.

Photograph 21 – A section of Algodon Canal south of the Plumas Lake Interchange.
Looking south with Basin B on the right and Basin C on the left.

Photograph 22 – Algodon Canal (Lateral 15) in south Basin C.
Looking north from Feather River Blvd.

A view of lower Algodon Canal looking north is shown in Photograph 22. That is a January 2009 photo taken from Feather River Blvd. Basin A is over the berm to the left while Basin C is visible to the right. The houses visible in the distance on the right are part of the River Oaks subdivision. According to the Current Conditions hydraulic models, the relatively small culverts under Feather River Blvd. at this location are inadequate during

large storm events when the pumps at Pump Station #6 are operating at maximum. Still, only modest flooding is predicted, and only in low-lying areas, such as in the distance on the right in the photo where the trees can be seen.

Photograph 23 – River Oaks Detention Pond in south Basin C.
Looking northwest toward State Route 70.

The River Oaks subdivision is to the east of lower Algodon Canal and east of State Route 70. As of this writing, the project is only partly built. However the detention pond for the full project is in place and shown in Photograph 23. The pond will eventually serve the south, east and north River Oaks subdivisions plus the North Pointe subdivision. Under the Current Conditions models this area is treated with the pond in its present configuration, its present connection to Algodon Canal and drainage from development planned for all three River Oak projects. North Pointe is treated as undeveloped in the Current Conditions models, but fully developed in the Ultimate Conditions models. Presently one pipe connects the pond under State Route 70 to Algodon Canal. With full development, a second pipe connection (or other approved engineering solution) is needed and planned. That is the condition simulated in the Ultimate Conditions models.

Lateral 15 is the main drainage backbone for Basin C. At approximately the half way point in its length, it is joined by Lateral 17. Lateral 17 is the main channel out of the airport area and connects to Lateral 15 at station 393+20. That junction was pictured previously in Photograph 12. Views of Lateral 17 much farther upstream are shown in Photographs 24 and 25. These photos were both taken near the southeast corner of the Yuba County Airport. Photograph 24 is taken looking downstream facing west. As can be seen, Lateral 17 is not a high capacity ditch at this location, yet drainage from much of the central part of the airport passes through this ditch. The road on the left is Skyway Drive which is the access to the industrial area at the southwest corner of the airport. Some of the industrial facilities can be seen in Photograph 25 in the distance on the right.

Photograph 24 – Lateral 17, Reach 6 at the south edge of the Yuba County Airport. Looking west from near Arboga Road.

Photograph 25 is at the same location as Photograph 24 except looking upstream instead of downstream. The last water visible in the distance is the confluence of Reach 6 and the Pheasant Pointe portion of Lateral 17. Photograph 25 is looking northeast. The power poles visible are next to Arboga Road. Beyond Arboga Road, the open field is the future site of the Pheasant Pointe development. The project is approved and since downstream improvements (particularly Ella Pond) to support the project are in place, the Current Conditions models in this study conservatively treat shed C7-4S as developed according to the Pheasant Pont Improvement Plans. Part of the Pheasant Pointe plans include piping the stormwater underground along Skyway Drive to the deep portion of Lateral 17. This plan avoids over-taxing the low capacity section of Lateral 17 next to Skyway Drive pictured in Photograph 24. The actual current condition in undeveloped shed C7-4S produces an insignificant amount of runoff to Lateral 17. The hydraulic models (both current and ultimate) with this study incorporate the developed conditions at Pheasant Pointe with delivery of the runoff via underground pipeline to the lower part of Lateral 17 shown in Photograph 27.

Photograph 25 – Lateral 17 at the southeast corner of the Yuba County Airport. Looking northeast in Basin C.

Photograph 26 – Reach 4 at the southwest corner of the Yuba County Airport. Looking north with the airport region on the right.

Photograph 26 was taken at the southwest corner of the airport area looking north in Reach 4 just upstream from its confluence with Lateral 17. The airport region is to the right. The old railroad berm visible on the left separates Reach 4 shown from Lateral 15 on the other side of the berm. Basin B is on the left beyond Lateral 15.

As can be seen, Reach 4 is a deep channel capable of conveying large flows to the south. Reach 3 and Reach 2 much farther upstream feed Reach 4.

Photograph 27 is at the same location as Photograph 26 but looking to the south. The ditch from here heading south is Lateral 17, having just come in from the east side (left side of the photo). Approximately a half mile south, not visible in the photo is the confluence of Lateral 17 with Lateral 15. That spot was pictured previously in Photograph 12. The location pictured in Photograph 27 is the planned location of the outfall from the Pheasant Pointe storm drain pipe.

The hydraulic simulations for Current Conditions of this section of Lateral 17 produce significant overflows into the field shown on the left side of Photograph 27. The modeling agrees with local observers who are aware of the problems such as in the Buttercup/Butterfly Lane area. Future improvements associated with connections and pumping at Ella Pond and the construction of Draper Pond are expected to provide some relief. Those are considered in the Ultimate Conditions models.

Photograph 27 – Lateral 17 at the southwest corner of the Yuba County Airport.
Looking south with the old railroad berm visible on the right.

The upstream end of Lateral 15 is known as Bingham Canal. As mentioned earlier in discussing Photographs 5 and 6, the passage of Bingham Canal under the Union Pacific Railroad near Chestnut Road is restrictive and thought to cause upstream back-up. The local topography nearby has lead to the addition of an important feature in the Current Conditions hydraulic models. High water in the Chestnut Road area can spill to the south via the railroad borrow next to the east side of the Union Pacific tracks. From there, the spill would travel out of the traditional RD784 watershed to the low Erle Road underpass. Photograph 28 shows the Erle Road underpass area. This photo is taken looking east with Erle Road shown passing under the Union Pacific Railroad. Barely visible on the right is a County pump station intended to keep water out of the underpass by pumping it into the

area of the Yuba County Airport. The simulations indicate that during large storm events the pump is expected to fall hopelessly behind in that task. Thus the Current Conditions flood maps included with this report show the underpass flooded. Improvements associated with the Ultimate Conditions hydraulic models are predicted to mostly eliminate the underpass flooding.

Photograph 28 – Erle Road underpass south of Bingham Canal looking east. Bingham Canal is predicted to send overflow to this low roadway.

The spill just discussed has been supported by detailed topographic data collected by MHM survey crews in the railroad borrow south of Bingham Canal between 2006 and 2008. Though the railroad borrow appears to disappear in the south, a route for spill is there and is pictured in Photograph 29. This photo is taken looking north from near Chestnut Road as the road begins to drop down to meet Erle Road. In the distance in the photo, a cell tower and the Chestnut Road mini storage can be seen, both of which are next to Bingham Canal. As suggested by the photo, there is a small notch which allows the overflow to the south. Geometry matching local topography details for this spill route is incorporated in the hydraulic models used for the Current Conditions in the form of a lateral structure. When the water level is high enough in Bingham Canal, the spill becomes active. The mechanism for such spill is retained in the Ultimate Conditions hydraulic models, but the water levels in those models are low enough that they are not predicted to produce significant spill to the Erle Road underpass.

Photograph 29 – The south end of the Railroad borrow south of Bingham Canal.
This is the current high-water spill point from Bingham Canal to the Erle Road underpass.

1.13 Summary of Changes Affecting Drainage in Basin C since the last Flood Insurance Study (of 1981)

This brief description starts geographically near the north end of Basin C and proceeds southward. It does not necessarily represent the project sequence chronologically. All changes mentioned here are incorporated in the hydraulic Current Conditions models supporting this report. The developments discussed below may usually be located by consulting the Subdivision Map for Southern Yuba County.

1. Miscellaneous isolated small private improvements such as residences and outbuildings constructed throughout the basin since 1981.
2. WalMart and other commercial development in north Linda. These improvements were included in 2007 LOMR case #07-09-1893P.
3. The 2007 expansion of Chestnut Pond at Pump Station #7.
4. Culvert 2006 improvements in West Linda on Lateral 15 at Arboga Rd., Gledhill Ave. and Alicia Ave.
5. Pheasant Pointe Improvement Plans. As previously discussed, the developed conditions are modeled even though construction has not started.
6. Ella Basin (Pond) full storage development, including the connection of Lateral 15 to the pond.
7. Draper Ranch North development including the storm drain connection to Ella Pond.
8. Plumas-Arboga Road Arch Bridge at Lateral 15.
9. California Department of Transportation State Route 70 Interchange at Plumas Lake Blvd.
10. River Oaks Subdivision.
11. River Oaks Pond and its connection to Algodon Canal.
12. Construction of new Pump Station #6.

1.20 DESCRIPTION OF PROPOSED IMPROVEMENTS

Basin C currently benefits from a number of channels, ponds and pump stations, as discussed above. Some of those have been completed since the Drainage Master Plan of 2002. This report focuses on additional improvements which are needed to be in place prior to full development of Basin C as depicted in Figures 2A and 2B. These include the following principal features as part of this Drainage Master Plan:

1. Upper Bingham Canal: Change the culvert under Hammonton Smartville Rd. to a 5-foot.
2. Eliminate Pump Station #5 (Avondale Pump Station) and provide a culvert connection between the two sides of Avondale Rd. at the location of Pump Station #5.
3. Provide 2200 foot pipe, 5-foot in diameter from location of Pump Station #5 to Edgewater Pond.
4. Deepen/expand Edgewater Pond to 94 ac-ft at elevation 63 feet.
5. Construct a small pump station at Edgewater Pond that pumps to the County Center Pond. The main 10 CFS pump will turn on at high water (approximately 60 feet), and a small nuisance pump of 2 CFS would operate at all levels including low pond levels. The route for the force main will likely be under Lindhurst Ave. at Bingham, then west on Sartori Ave. to the County Pond.
6. The separating weir structure currently in place between Lateral 15 and Edgewater Pond will be fitted with one-way culverts to only allow water to flow into the pond. The culverts are modeled as four 42-inch with flap gates on the pond side. The inverts on the culverts should be slightly above the invert of Bingham Canal so that nuisance runoff does not enter the pond unnecessarily.
7. Construct a horseshoe weir in Edgewater Pond around the double 30-inch lines that currently connect Edgewater Pond under the Edgewater subdivision to Linda Drain. The weir lip will be set just above the level of the 100-year 24-hour event so that larger storms may spill to the double 30s. The weir will include small nuisance drains so that the 30-inch pipes can drain to the pond in dry weather. The weir will assure that up to the 100-year 24-hour storm, no runoff from the Bingham watershed or from the 54 acres of Edgewater which flow into the pond ever reaches the Linda Drain. This in turn will result in lower peak flows and lower total volume delivered to Linda Drain than Current Conditions.
8. Construct a shallow pond at County center. The pond is modeled with a surface area of 3 acres with the bottom at 55 feet. The pond will be both north and south of Bingham Canal in the vicinity of Packard Ave. It will have weir connection and 24-inch culvert drain with flaps on Lat 15 side. The weir lip will be at 58.5 feet. The County Center will drain to the pond. The existing deep retention pond at the County Center will be part of the new pond, but will need to be filled to the 55-foot level.
9. Upgrade of Pump Station #7 at Chestnut pond. At this time, the capacity is not expected to change, but the Pump Station would be converted to full SCADA monitoring with redundant pump(s) and/or a backup generator.
10. Grade the railroad borrow area south of Bingham to prevent spill to Erle Road in existing "notch" shown in Photograph 29. Grade to a minimum of 60-foot elevation.
11. Add third culvert under UPRR crossing of Bingham Canal. This has been modeled as an additional 54-inch diameter like the two currently in place.
12. Expand the box culvert under Feather River Blvd. to 8 by 6 feet.
13. Increase capacity of two Island Road pumps to 40 CFS each.
14. Upgrade of Pump Station #9 at Island Road. Along with the changes discussed in #13 above and/or #33 below, the Pump Station would be converted to full SCADA monitoring with redundant pump(s) and/or a backup generator(s).

15. Add second 4-foot culvert to the exit structure just south of the Island Road Pond.
16. Convert the double 3-foot culverts in Lat 15 under Feather River Blvd. to double 4-foot.
17. Correct restrictive culverts along the section of Lateral 17 paralleling Skyway Drive at the southwest corner of Yuba County Airport.
18. Construct connection between Laterals 17 and 15 under the old railroad berm at the southwest corner of the airport. This is modeled as twin 6-foot diameter culverts approximately 100 feet long. This connection will help lower the peak water surface level at the southwest corner of the airport.
19. Construct a direct connection from the south end of upper Lateral 15 to Ella Pond. This has been modeled as a trapezoidal ditch approximately 450 feet long with an upstream invert of approximately 46 feet. This connection will require an exit structure at Ella Pond.
20. Construct a pump station ("Pump Station #10) at Ella Pond. Two 30 CFS pumps; one which switches on at 31 feet; the second at 32 feet. Both pumps will switch off at a pond water level of 30 feet. An additional emergency pump of 30 CFS will be available. That pump is modeled currently to turn on at a water surface elevation in the pond of 49 feet. Ella Pond will take on its new designation as the "North Drainage Basin C Regional Detention Pond".
21. Construct Draper Pond with 426 ac-ft of storage below the 55-foot elevation.
22. Construct a weir structure to allow inflow to Draper Pond from Lateral 15. The lip of weir is designed to be at 47.82 feet.
23. Construct the planned culvert connection under the RR berm from Draper Pond to the North Drainage Basin C Regional Detention Pond. This connection is planned to be twin 6-foot pipes.
24. Connect storm drain system as planned from Draper Ranch subdivision to Draper Pond.
25. Conversion of upper Basin B subsheds B3A and B3B to underground drainage delivered to the North Drainage Basin C Regional Detention Pond. This region of Basin B is east of Feather River Blvd. and north of Ella Road.
26. Connection of the two existing Wheeler Ponds. The two ponds are currently separated by the old railroad spur.
27. Provide an exit structure from Wheeler Pond to Lateral 13. Emergency overflow elevation of 49 feet.
28. Construct a 42-inch underground drain from North Wheeler Pond to North Drainage Basin C Regional Detention Pond. The pipe will be approximately 3000 long and needs a flap at the Ella (North Drainage Basin C Regional Detention Pond) end to prevent flow from there back to Wheeler Ponds.
29. Conversion of upper Basin B subsheds B6A and B6B to underground drainage delivered to the Wheeler Ponds. This is already in place for the South Wheeler Ranch property.
30. Construct larger culverts at Feather River Blvd. crossing on lower Algodon Canal. Triple 6-foot diameter culverts are needed for the Ultimate Conditions with the reduced pump capacity at Pump Station #6 (see item 30 below). If this improvement is made prior to the reduction at Pump Station #6, triple 7-foot diameter culverts will be required to handle the situation with all the current pumps operational.
31. Providing that Pump Station #10 is operational at 60 CFS, Pump Station #6 will be reduced to 127 CFS. To accomplish this, three pumps will be operational at Pump Station #6: One 67 CFS pump and two 30 CFS pumps. Should Pump Station #9 (Island Road) be upgraded to 80 CFS capacity, one 30 CFS pump at Pump Station #6 may be removed, reducing the total capacity there to 97 CFS.
32. Provide an additional drainage connection between River Oaks Pond and the Algodon Canal or other engineering solution. The drainage analysis presented in this study indicates an acceptable solution is a forty-eight (48) inch connection under the State Route 70 with an invert of 30 feet or lower and a length of approximately 450 feet. While the Ultimate Condition model presented in this report uses the

additional 48-inch connection, another engineering solution may be considered provided that a more detailed drainage analysis is approved. A detailed drainage analysis (along with economic analysis of long term operation and maintenance costs) may be completed to potentially analyze another engineering solution no later than final maps for two hundred seventy-five (275) residential units. If no additional drainage analysis is completed by the recordation of the two hundred seventy-fifth (275^{th}) residential unit, the proposed solution presented in the Master Drainage Plan shall be considered the approved drainage solution. The proposed drainage improvement shall be constructed prior to or in conjunction with the recordation of the three hundred fiftieth (350^{th}) residential unit unless the drainage analysis is approved otherwise. If any modification to the currently approved tentative maps occurs (i.e. River Oaks South, River Oaks East, River Oaks North, North Pointe) then a drainage analysis will also be required prior to any revised tentative map approval. (River Oaks North TSTM 2008-0002 was considered during the computer modeling and would not be considered a revision for this purpose.) Upon review and approval of the drainage analysis by both the County and RD 784 Board, this solution would become the drainage plan for the River Oaks Sub-Basin of Basin C.

The above improvements will provide for ultimate drainage needs over the basin for the 100-year 24-hour storm. However, there are regions such as upper Bingham Canal which do not find complete relief from the 100-year 10-day event with just the improvements discussed above. Although the above projects do improve the 100-year 10-day situation everywhere on Bingham Canal, some additional projects are recommended which are not part of this Drainage Master Plan. These are intended to solve some of the long-standing flood problems in Bingham Canal and West Linda. The HEC-RAS Ultimate Conditions results reported in this work do not include any of these additional projects. These improvements would give relief to the upper Bingham Canal area for the 100-year 10-day storm.

33. Construction of a new pump and isolated sump at Island Pump Station. This pump would have an "on" at around 46 feet elevation intended to serve the gravity drain from the West Linda Cottonwood Ave. region. This pump station would need to be sized, but would be approximately 40 CFS. Any connection of the sump for this pump to Lateral 15 would be designed primarily around optimizing the drainage of West Linda. However, it is envisioned that the additional pump could also serve to aid the drainage of Lateral 15 in the vicinity of Island Road.
34. Construction of a drainage line between the low Cottonwood Ave. area to the new pump sump described above. The pipe may need a flap gate at the downstream end. This storm drain would need to be sized appropriately, but would be approximately 5-foot diameter, and approximately 1400 feet long. An inlet structure including trash racks would need to be constructed at the upstream end of the storm drain just northeast of Cottonwood Ave.
35. Construction of a Pump Station at Edgewater Pond which will discharge over the Feather River levee, perhaps near the outfall from the Island Pump Station. This pump station would need to be sized, but would be approximately 35 CFS. This pump station would eliminate the need for the proposed pump discharging at the County Center Pond.

1.21 Net Changes to Basin C Drainage Area, Pumping and Storage Associated with the Proposed Improvements

The improvements which are part of this Drainage Master Plan are enumerated in #1 through #32 above. Because a part of Basin B is proposed to drain to the North Drainage Basin C Regional Detention Pond (Ella Pond), and

because part of the Edgewater Subdivision will connect to Bingham Canal (Lateral 15), the effective drainage area served by Basin C will increase. Table 1 which follows is intended to clarify the major changes to the drainage area, total pumping capacity and detention volume. For the purpose of the analysis in this study, the volume of Ella Pond in the Current Conditions models is treated as it is in its partially expanded condition. However, for simplicity, the table below uses the original volume of Ella Pond and the future full volume when it becomes the North Drainage Basin C Regional Detention Pond . The backup or emergency pumps present or

Table 1 – Comparison of Current 2009 Capacities with those Planned under the Ultimate Conditions

Feature	Name	Current Conditions	Ultimate Conditions
Drainage Area	Basin C	5305 acres	6254 acres
	Total Change	-	949 acres increase
Detention Basins	Edgewater	Currently in Linda Drain Watershed	94 ac-ft @ 63 ft.
	County	Retention – not part of system	15 ac-ft @ 60 ft.
	Ella	485 ac-ft @ 55 ft.	839 ac-ft @ 55 ft.
	Draper	0	426 ac-ft @ 55 ft.
	Wheeler Ponds (Combined)	Currently in Basin B	189 ac-ft @ 51 ft.
	Total Change	-	1078 ac-ft increase
Pumps	#5 Avondale	35 CFS	0
	Edgewater	0	12 CFS
	#9 Island	50 CFS	50 or 80* CFS
	#10 Ella	0	60 CFS
	#6 Bear River	200 CFS	127* CFS
	Total Change	-	36 CFS decrease

*If the Island #9 Pumps are increased to 80 CFS, the Pump Station #6 pumps may be reduced to 97 CFS

planned for some of the pump stations are not included in the pumping values shown in the table. The volumes of the detention basins are given to the rim of the basin. Since all detention basins will operate with freeboard, the volumes given are greater than the amount that will ever be used in any design storm event.

Table 1 points to the fact that as RD784 moves from the Current 2009 Conditions for Basin C to those of this Drainage Master Plan, the total drainage area served and the total detention storage available will be increased quite significantly, while the total pumping capacity will be reduced somewhat.

1.22 Background Information

Numerous entities developed the information that has been used in the preparation of this Basis of Design Report. This information consists of reports, maps, drawings, and manuals. The most important are listed below.

1. ***Reclamation District No. 784 Master Drainage Plan***, Mead & Hunt, September, 2002.
2. ***Yuba County Plumas Lake Specific Plan***, updated April 19, 2005.
3. ***Master Drainage Plan Yuba County Airport,*** Mead and Hunt, Sacramento, California, January 21, 2005.
4. ***Supplement to Drainage Master Plan, BASIS OF DESIGN REPORT (Revised), Drainage Basin C/Bingham Canal Drainage Area Proposed Improvements,*** MHM Incorporated, April 3, 2007.
5. ***Reclamation District No. 784 Drainage Basin B Revised Drainage Master Plan***, MHM, Inc., December, 2007.
6. ***Reclamation District No. 784 DRAINAGE BASIN A DRAINAGE MASTER PLAN BASIS OF DESIGN REPORT***, MHM inc. Sept. 30, 2008.
7. ***Flood Insurance Study; Yuba County (Unincorporated Areas)***, November 17, 1981, Federal Emergency Management Agency
8. ***Subdivision Map for Southern Yuba County***, August 31, 2005, Yuba County Planning Dept.
9. ***North Arboga Study Area Plan,*** Yuba County Planning Commission, November 18, 1992.
10. ***Topographic Surveys of the Lower Feather and Bear Rivers for the Sacramento and San Joaquin River Basins Comprehensive Study, California,*** Contract DACW05-99-D-0005, February 14, 2006, Towhill Inc., San Francisco, CA.
11. ***LOMR Case #07-09-1893P for Linda Mall Area, Yuba County, California,*** September 4, 2007, MHM Incorporated.
12. ***LOMR Case #08-09-1121P for Reclamation District 784 Upper Basin A, Yuba County, California,*** MHM Incorporated, May 1, 2008. (The case was cancelled because of the ongoing levee certification)
13. ***CLOMR Case #08-09-0981R for Ross Ranch Development, Yuba County, California,*** March, 2008, Wood Rodgers, Sacramento, CA. (The case was cancelled because of the ongoing levee certification)
14. ***LOMR Case #07-09-1090P for South Olivehurst area, Yuba County, California,*** April 4, 2007, MHM Incorporated.
15. ***LOMR Case #06-09-B119P for East Linda Area, South Olivehurst Interceptor, Yuba County, California,*** December 29, 2005, MHM Incorporated.
16. ***HEC-RAS River Analysis System***, Version 3.1.3, U.S. Army Corps of Engineers, May 2005.
17. ***HEC-1 Flood Hydrograph Package***, U.S. Army Corps of Engineers, September 1990.
18. ***Hydrology Review Report – Linda and Olivehurst Drains, Bear River Basin***, January 1980, U.S. Army Corps of Engineers, Sacramento District.

19. ***South Yuba Drainage Master Plan***, MHM, Inc., September 1981.
20. ***Revised South Yuba Drainage Master Plan***, MHM, Inc., March 1991.
21. ***Introduction to Hydraulics and Hydrology with Applications for Stormwater Management, 2nd. Ed.,*** 2002, John Gribbin, Delmar Thomson Learning.
22. ***Regulations of the Reclamation Board for Encroachment into Adopted Plans of Flood Control,*** March 17, 1995, The Reclamation Board of the State of California.
23. ***Rainfall Analysis for Drainage Design - Bulletin No. 195***, October 1976, Department of Water Resources.
24. ***Standard Plans and Specifications***, July 1992, California Department of Transportation.
25. ***2000 Contract Cost Data***, California Department of Transportation.
26. ***Heavy Construction Cost Data 2000***, 14th Edition, Means.

1.23 Additional Information

In order to implement the Ultimate Conditions improvements, additional field surveying, topographic mapping, right-of-way engineering plus geotechnical exploration and testing will need to be performed as the design and construction documents (plans, specifications, and engineers' estimates of construction costs) are being prepared. A geotechnical consultant will provide soils testing and related design criteria as needed.

1.24 Basin C Improvements: Summary Design Criteria

The basis to complete the designs and prepare contract plans for the Basin C Improvements are summarized below and developed fully in Chapter 2.

- Frequency of the design storm events

    - For the entire Basin C and upper Basin B: A hydrologic configuration consisting of a twenty-four (24) hour, 10-year storm, twenty-four (24) hour, 100-year storm and twenty-four (24) hour, 200-year storm events falling over the entire watershed for the detention channels, pumping systems, and any major new underground conveyance, open channel system and associated culverts;

    - For Basin C south of Island Road and upper Basin B: A hydrologic configuration consisting of a ten(10)-day, 100-year storm falling over the entire watershed for the detention channels, pumping systems, and any major new underground conveyance, open channel system and associated culverts;

    - MHM is prepared to analyze other frequency storms than may be necessary. Additional analysis that FEMA will likely require are the 50-year and the 500-year return events;

    - All design storms will be based on the conventional RD784 hydrographs, which use the Wheatland Gage as their basis.

- Detention Basins

    - The existing detention basins at Edgewater and Ella will be expanded. This is underway at Ella Basin presently and involves mainly an expansion of the foot print and will result in a change in volume (at the 55-foot elevation) from 485 ac-ft to 839 ac-ft. The Edgewater expansion will be primarily achieved through deepening the current footprint. The excavation will increase the capacity at the 63-foot elevation from approximately 19 ac-ft to 94 ac-ft. Draper Pond is a new pond which will have a design capacity of 426 ac-ft at the 55-foot level.

- Pump Stations

    - The required capacities of the various pump station in Basin C are interdependent. The capacity of Pump Station #6 will be changed dependent on what has occurred upstream. Once the new pumps are operational at Ella Pond (North Drainage Basin C Regional Detention Pond), the capacity of Pump Station #6 may be reduced to 127 CFS. If Pump Station #9 (Island Pumps) is upgraded by 30 CFS, Pump Station #6 my be reduced further to 97 CFS;

    - For redundancy each pump station will have at least one back up pump which will allow pumps to be rotated into and out of service on a planned schedule. Should one pump fail during use, the backup pump(s) will immediately be called into service;

    - All pumps and controls shall remain above peak Basin C water level during a the worst 100-year or 200-year storm events;

    - The pumps will be monitored using SCADA, and the pump controls shall be designed accordingly;

    - An emergency backup generator shall be designed for each pump station capable of powering all pumps at the given station. The generator will be designed to automatically activate when a power failure occurs during a time pumping is needed. Sufficient fuel supply shall be provided for an extended power outage;

    - The force main from the new pump station at Edgewater Pond shall be designed to deliver 12 CFS to the County Pond new on Packard Ave.;

    - The force main from the new pump station at Ella Pond shall be designed to deliver 60 CFS normally and 90 CFS in emergencies to the Feather River.

- Minimum side slopes of Detention Basins

    - 3H to 1V waterside;

    - 2H to 1V landside.

- Freeboard

    - All basins will retain at least 2 foot of freeboard above the water surface elevation during a 24-hour, 100-year storm event;

    - All basins will retain at least 1 foot of freeboard above the water surface elevation during a 24-hour, 200-year storm event.

    - All basins will retain at least 1 foot of freeboard above the water surface elevation during a 10-day, 100-year storm event.

- Permanent ramps

    - The maximum grade for the ramps will be 5%. Ramps will be provided at Ella Pond, Edgewater Pond and Draper Pond. The existing point of access and ramps will be utilized at the Wheeler Ponds.

- New and Improved Culverts and Pipelines

    - This Drainage Master Plan includes improved culverts at the following locations: Upper Bingham Canal at Hammonton-Smartville Rd., the UPRR on Bingham Canal, Lower Bingham Canal at Feather River Blvd., the exit structure below Island Pond, on Lateral 17 at the southwest corner of the Airport, the Feather River Blvd. crossing of Lateral 15 below Island Pond, and the Feather River Blvd. crossing of lower Algodon Canal. In each of these cases, the improved culverts shall be designed to produce no more than 6 inches of head loss from its upstream end to its downstream end during the 100-year storm events. The design shall use a minimum velocity of 2 feet per second.

    - This Drainage Master Plan includes new culverts and drainage pipelines at the following locations: Upper Bingham Canal under Avondale Rd. to the location of the current Pump Station #5, from the location of Pump Station #5 to Edgewater Pond (approximately 2200 feet), flapped culverts between Bingham Canal and Edgewater Pond, flapped culvert(s) between the new County Pond and Bingham Canal, connection at the SW corner of the airport from Lateral 17 to Lateral 15, connection under Lateral 15 between Draper Pond and Ella Pond, flapped connection from North Wheeler Pond to Ella Pond, connection between North and South Wheeler Ponds, and a second connection between River Oaks Pond and Algodon Canal (or other approved engineering solution). In each of these cases, the culverts/pipelines shall be designed to produce a head loss of no more than 6 inches more than the invert drop from its upstream end to its downstream end during the 100-year storm events. The design shall use a minimum velocity of 2 feet per second.

- New Weirs and other Connections

    - This Drainage Master Plan includes new weir or ditch connections at the following locations: Horseshoe overflow weir in Edgewater Pond at the existing 30-inch pipes to Linda Drain, weir structure between the County Pond and Bingham Canal, ditch connection between upper Lateral 15 and Ella Pond, an emergency overflow weir between Ella Pond and Lateral 13 in Basin B, weir entrance structure at Draper Pond from lower Lateral 15, and an emergency overflow weir between Wheeler Pond and Lateral 13. The design shall accomplish the goal of maximizing the utilization of storage ponds while minimizing the peak water surface elevations in connected waterways. The design shall function properly for both non-storm conditions and all design storm events.

    - Emergency overflow weirs such as the ones at Edgewater Pond and Wheeler Pond shall impact downstream locations less than historic levels for all storm conditions.

    - The connection between upper Lateral 15 and Ella Pond will require an energy dissipating structure for runoff delivered to the pond. The structure shall prevent erosion during all design storms under the assumption that the Ella Pond water surface is at its lowest level of approximately 30 feet elevation.

1.25 Operation and Maintenance Assumptions

In order to ensure that these pipelines, channels, detention basins, pump stations, and structures do not become overgrown with trees and shrubs, rendered out of service, or clogged with debris such as tires, and other material, it is imperative that the pipelines, channels, detention basins, pump stations and structures be maintained on a regular basis. If adequate maintenance is not performed, the capacity of the respective pipelines, channels, detention basins and pump stations will be reduced. This reduction in flow carrying capacity can result in a higher backwater within the system and causing flooding to adjacent lands and structures. This applies to improvements in place as part of the Current Conditions models as well as those that will be constructed as part of the Ultimate Conditions models. Each jurisdictional entity needs to implement an ongoing maintenance plan that addresses keeping the drainage courses in a condition such that the effective flow area will not be restricted and the effective resistance to flow (i.e. Manning's roughness coefficient) will not be increased over the values utilized in the design analysis.

2.10 HYDROLOGY

U.S. Army Corps of Engineers HEC-1, version 4.1 utilizing the standard RD784 design storms was used to model rainfall runoff over the entire watershed. The first pages of the output from each of the HEC-1 models included in the Appendix is a schematic showing sub basin inflows, nodes, ponds and routing. The watershed subsheds have been modified from the previous studies to better represent the development that has taken place in Basin C, and to utilize the available LIDAR maps of the area (the Towhill report, reference 10). The 2006 LIDAR maps provide much better topo detail than the USGS Quadrangle maps used in old studies such as the September 2002 Master Drainage Plan. Figures 1A and 1B show the subsheds used for this study representing the Current Conditions. The subsheds for the Ultimate Conditions are nearly the same and are shown in Figures 2A and 2B. The hydrologic parameters for the subsheds have been reconfigured for this study. Table 2 displays the values used in this study under Current Conditions. Table 3 displays the values used in this study under Ultimate Conditions. Specifics of the hydrologic parameters are discussed in subsequent sections.

2.11 Storm Frequency and Degree of Protection

The storm frequency and intensities correspond to those used by RD784 in all past work, except that the new 200-year was created by scaling the 100-year. Storms are generally classified by "frequency" or "return period" such a 10-year storm, a 50-year storm, etc. A 10-year storm, for example, is the intensity of storm, which will occur an average of once in every 10-year period, as computed from available data. It might occur this year, next year, or any year, or even twice in one year; but it will have a long-term average occurrence of once in 10 years. The greater the "return period," the greater the intensity of rainfall. The rainfall events were simulated using 10-, 100-, and 200-year frequency storms of 24-hour duration, and 100-year frequency for a 10-day duration. Precipitation totals for those events were 2.87, 4.09, 4.43 and 9.59 inches respectively. The hydrographs have been computed well past the end of the storms so that the hydraulics can be studied as the system returns to normal levels. As an example, the 24-hour storms include hydrograph runoff simulations for 120 hours. Storm precipitation values utilized in the HEC-1 model were subjected to no spatial variability, which conservatively assumes the storm falls over the entire study area simultaneously.

2.12 Infiltration Rate Characteristics

The amount of infiltration is related to the permeability of the surficial soils, the local geomorphology, and the amount and type of vegetation cover or canopy. Soil Survey maps prepared for the Yuba County Soil Conservation Service (hereinafter referred to as "SCS") were used to determine the extent of Type A, B, C, and D hydrological soil groups within the watershed. The areas of each respective soil group were then summarized for each watershed and assigned SCS curve numbers corresponding to a Type II antecedent moisture condition (AMCII), representing the average curve number. As an example, Type "A" (relatively pervious) soils are predominantly localized sand and gravel areas, while the Type "D" (relatively impervious) soils are generally poorly drained clays. The soils in the study area have been classified by the SCS as Types B, C and D, with type D being slightly more common than the other two. The soil characteristics are detailed in Tables 2 and 3.

Table 2
Runoff Parameters – Current 2009 Conditions

Table 2 - RD784 Basins C – Current Conditions Runoff Parameters

Including In-progress Projects 2009

Shed	Area acres	Area sq. mi.	Drainage Description	Drainage Routes To	Main Soil Group	SCS CN	Initial 10% Abstraction inches	% Impervious	Computed SCS Lag Hours	Peak Runoff, CFS 10yr, 24hr	Peak Runoff, CFS 100yr, 24hr
C1-1	37.7	0.0589	Orchard	Upper Bingham	B	65	0.54	2	1.71	4	9
C1-2	100.7	0.1574	Residential/Commercial	Pump#5, to Bingham	B	77	0.30	40	0.69	48	76
C1-3	48.0	0.0749	Industrial/Open	Upper Bingham	B	75	0.33	25	1.01	16	26
C1-4	33.3	0.0520	Residential/Commercial	Pump#5, to Bingham	B	77	0.30	40	0.78	13	22
C1-5	30.4	0.0475	Orchard/Open	Pump#5, to Bingham	B	67	0.49	2	1.49	4	8
C1-6	21.2	0.0331	Orchard/Open	Upper Bingham	B	67	0.49	2	1.45	3	6
WMRT	42.9	0.0670	Commercial/Open	Mall, to Chestnut Pond	B	90	0.11	80	0.61	14	20
MALL	52.4	0.0819	Commercial	Chestnut Pond	D	95	0.05	95	0.20	64	91
C2-1	101.3	0.1582	Mixed Open/Residential	Upper Bingham	D	84	0.19	25	0.62	54	86
C2-2	78.9	0.1233	Mixed Open/Residential	Upper Bingham	D	84	0.19	25	0.73	38	61
C2-3	39.5	0.0617	Mixed Open/Residential	Upper Bingham	D	84	0.19	25	0.69	20	32
C2-4	32.4	0.0507	Mixed Open/Residential	Upper Bingham	D	82	0.22	20	0.88	13	21
C3-1	38.4	0.0600	RR Right-of-way	Chestnut Pond	B	70	0.43	5	1.90	6	11
C3-2	27.3	0.0427	Undeveloped	Mall, to Chestnut	B	69	0.45	2	1.23	5	9
C3-3	55.7	0.0871	Mixed Commercial	Mall, to Chestnut	B	85	0.18	60	0.53	39	58
C3-4	68.4	0.1069	Mixed Open/Residential	Lower Bingham	B	75	0.33	30	1.19	21	35
C3-5	52.4	0.0819	Mixed Open/Residential	Lower Bingham	B	75	0.33	30	0.87	19	32
C3-6	64.8	0.1013	Ag/School/Residential	Lower Bingham	B	68	0.47	20	0.99	17	29
C3-7	103.3	0.1615	Residential	Lower Bingham	B	75	0.33	38	0.66	48	77
C3-8	92.4	0.1444	Ag/Residential	Lower Bingham	B	65	0.54	10	1.15	16	31
C4-1	59.8	0.0935	School/Open/Residential	Lower Bingham	D	86	0.16	30	0.95	27	43
C4-2	23.9	0.0374	Commercial/mini-Storage	Middle Bingham	D	91	0.10	50	0.74	15	22
C4-3	74.9	0.1170	Residential/Open	Lower Bingham	D	86	0.16	30	0.60	44	68
C4-4	26.3	0.0411	Residential/Open	Lower Bingham	D	83	0.20	25	0.35	18	29
C4-5	22.5	0.0352	County Center	Retained - historic runoff to Bingham used for model	D	73	0.74	2	0.95	4	10
C4-6	88.4	0.1381	Residential/Commercial	Middle Bingham	D	91	0.10	45	0.44	69	103
C5-N	102.0	0.1593	Ag/Residential	Lateral 15	B	72	0.39	15	1.72	20	35
C5-S	202.7	0.3168	Agricultural	Lateral 15	B	72	0.39	2	3.13	23	44
C6	68.3	0.1068	Mixed Ag/LDR Residential	Lateral 15	D	82	0.22	20	0.75	30	49
C7-1	143.3	0.2240	Mixed Open/Industrial	Lateral 17	D	89	0.12	30	0.98	69	106
C7-2	120.5	0.1883	Open	Lateral 17	D	84	0.19	5	1.35	37	62
C7-3A	28.8	0.0450	Open/Runway	Lateral 17	D	87	0.15	20	0.22	26	40

Table 2 - RD784 Basins C - Current Conditions Runoff Parameters (Continued)

C7-3B	209.5	0.3274	Open/Industrial	Lateral 17	D	87	0.15	25	1.43	77	119
C7-4N	30.5	0.0477	Open/Residential	Lateral 17	D	82	0.22	10	0.75	13	21
C7-4M	61.3	0.0958	Open/Residential	Lateral 17	D	86	0.16	30	0.58	36	56
C7-4S	32.5	0.0508	Pheasant Point	36"SD to Lateral 17	D	87	0.15	45	0.40	25	38
C7-5	95.2	0.1488	Open/Runway	Lateral 17	D	85	0.18	5	0.49	53	88
C7-6	115.4	0.1803	Open/Runway	Lateral 17	D	87	0.15	10	1.00	48	78
C7-7	170.6	0.2666	Industrial/Open	Lateral 17	D	89	0.12	30	0.73	96	146
C7-8	79.8	0.1247	Industrial/Open	Lateral 17	D	89	0.12	30	0.71	46	70
C7-9	73.3	0.1145	Grassland	Lateral 17	D	80	0.25	2	1.60	17	30
C8-N	252.0	0.3938	Ag/Residential/Industrial	Lateral 17	D	82	0.22	6	2.03	58	98
C8-S	232.0	0.3625	Partial Draper/Thoroughbred	Lateral 15/Ella	D	84	0.19	15	1.07	87	141
Ella	49.9	0.0780	Pond and surroundings	Lateral 15	D	91	0.10	2	0.10	57	88
C9-N	203.1	0.3173	Partial Draper/Hawes/etc.	Lateral 15/Ella	D	86	0.16	20	1.02	85	135
C9-S	208.5	0.3258	Rural/Ag	Lateral 15	D	81	0.23	5	2.11	45	77
C10-1	55.8	0.0872	Ag/Residential	Lateral 15	D	83	0.20	15	0.81	24	39
C10-2	145.3	0.2271	Rural/Ag	C10-3, to Lateral 15	D	81	0.23	5	1.71	35	60
C10-3	208.9	0.3264	Ag/Rice	Lateral 15/Algodon	D	82	0.22	2	3.19	36	62
C11-N	253.6	0.3962	Pasture/Residential	Hastey Pond and C10-3	D	82	0.22	5	2.20	55	93
C11-M	164.7	0.2574	Rural/Ag/Pond	Hastey Pond, to C10-3	D	87	0.15	5	0.97	69	111
C11-S	166.1	0.2596	Rural/Freeway/RR	Lateral 15/Algodon	D	85	0.18	10	8.63	18	30
C12-N	37.7	0.0589	Undeveloped/Brush	Lateral 15/Algodon	D	77	0.30	2	5.13	4	7
C12-S_NP	64.5	0.1008	North Pointe, Undev.	Under SR70, to Algodon	D	78	0.28	2	3.61	9	16
C12-S_RON	64.5	0.1008	River Oaks North	R.O. Pond, to Algodon	D	87	0.15	40	0.64	39	59
C13	246.9	0.3858	River Oaks	R.O. Pond, to Algodon	D	87	0.15	40	0.59	154	234
	5305.0	8.2891									

Table 3
Runoff Parameters – Ultimate Conditions

Table 3 - RD784 Basins C – Ultimate Conditions Runoff Parameters

Shed	Area acres	Area sq. mi.	Drainage Description	Drainage Routes To	Main Soil Group	SCS CN	Initial 10% Abstraction inches	% Impervious	Computed SCS Lag Hours	Peak Runoff, CFS 10yr, 24hr	Peak Runoff, CFS 100yr, 24hr
C1-1	37.7	0.0589	Orchard	Upper Bingham	B	65	0.54	2	1.71	4	9
C1-2	100.7	0.1574	Residential/Commercial	Pump#5, to Bingham	B	77	0.30	40	0.69	48	76
C1-3	48.0	0.0749	Industrial/Open	Upper Bingham	B	75	0.33	25	1.01	16	26
C1-4	33.3	0.0520	Residential/Commercial	Pump#5, to Bingham	B	77	0.30	40	0.78	13	22
C1-5	30.4	0.0475	Orchard/Open	Pump#5, to Bingham	B	67	0.49	2	1.49	4	8
C1-6	21.2	0.0331	Orchard/Open	Upper Bingham	B	67	0.49	2	1.45	3	6
WMRT	42.9	0.0670	WalMart/Commercial	WalMart Pond and Mall Ditch	B	91	0.10	85	0.30	14	20
MALL	52.4	0.0819	Commercial	Chestnut Pond	D	95	0.05	95	0.20	64	91
C2-1	101.3	0.1582	Mixed Open/Residential	Upper Bingham	D	84	0.19	25	0.62	54	86
C2-2	78.9	0.1233	Mixed Open/Residential	Upper Bingham	D	84	0.19	25	0.73	38	61
C2-3	39.5	0.0617	Mixed Open/Residential	Upper Bingham	D	84	0.19	25	0.69	20	32
C2-4	32.4	0.0507	Mixed Open/Residential	Upper Bingham	D	82	0.22	20	0.88	13	21
C3-1	38.4	0.0600	RR Right-of-way	Chestnut Pond	B	70	0.43	5	1.90	6	11
C3-2	27.3	0.0427	Mixed/Pond	Mall, to Chestnut	B	85	0.18	35	0.60	16	25
C3-3	55.7	0.0871	Mixed Commercial	Mall, to Chestnut	B	88	0.14	60	0.50	42	62
C3-4	68.4	0.1069	Mixed Open/Residential	Lower Bingham	B	75	0.33	30	1.19	21	35
C3-5	52.4	0.0819	Mixed Open/Residential	Lower Bingham	B	75	0.33	30	0.87	19	32
C3-6	64.8	0.1013	Ag/School/Residential	Lower Bingham	B	80	0.25	25	0.75	28	46
C3-7	103.3	0.1615	Residential	Lower Bingham	B	75	0.33	38	0.66	48	77
C3-8	92.4	0.1444	Residential	Lower Bingham	B	75	0.33	30	0.70	38	63
C4-1	59.8	0.0935	School/Open/Residential	Lower Bingham	D	87	0.15	33	0.90	29	45
C4-2	23.9	0.0374	Commercial/mini-Storage	Middle Bingham	D	91	0.10	50	0.74	15	22
C4-3	74.9	0.1170	Residential/Open	Lower Bingham	D	86	0.16	30	0.60	44	68
C4-4	26.3	0.0411	Residential/Open	Lower Bingham	D	83	0.20	25	0.35	18	29
C4-5	22.5	0.0352	County Center	County Pond and Bingham	D	91	0.10	50	0.29	22	32
C4-6	88.4	0.1381	Residential/Commercial	Middle Bingham	D	91	0.10	45	0.44	69	103
C5-N	102.0	0.1593	Ag/Residential	Lateral 15	B	72	0.39	15	1.72	20	35
C5-S	202.7	0.3168	Agricultural	Lateral 15	B	72	0.39	2	3.13	23	44
C6	68.3	0.1068	Mixed Ag/MDR Residential	Lateral 15	D	85	0.18	25	0.65	37	58
C7-1	143.3	0.2240	Mixed Open/Industrial	Lateral 17	D	89	0.12	35	0.78	79	121
C7-2	120.5	0.1883	Open	Lateral 17	D	84	0.19	5	1.35	37	62
C7-3A	28.8	0.0450	Open/Runway	Lateral 17	D	87	0.15	20	0.22	26	40
C7-3B	209.5	0.3274	Open/Industrial	Lateral 17	D	90	0.11	35	1.10	98	148
C7-4N	30.5	0.0477	Open/Residential	Lateral 17	D	82	0.22	10	0.75	13	21
C7-4M	61.3	0.0958	Open/Residential	Lateral 17	D	86	0.16	30	0.58	36	56
C7-4S	32.5	0.0508	Pheasant Point	36"SD to Lateral 17	D	87	0.15	45	0.40	25	38
C7-5	95.2	0.1488	Open/Runway	Lateral 17	D	86	0.16	30	0.39	68	106

Table 3 - RD784 Basins C - Ultimate Conditions Runoff Parameters (Continued)

C7-6	115.4	0.1803	Open/Runway	Lateral 17	D	87	0.15	20	0.70	62	96
C7-7	170.6	0.2666	Mixed Industrial	Lateral 17	D	89	0.12	30	0.73	96	146
C7-8	79.8	0.1247	Industrial/Open	Lateral 17	D	89	0.12	30	0.71	46	70
C7-9	73.3	0.1145	Grassland	Lateral 17	D	82	0.22	11	1.60	20	33
C8-N	252.0	0.3938	Ag/Residential/Industrial	Lateral 17	D	82	0.22	6	2.03	58	98
C8-S	232.0	0.3625	Draper/Thoroughbred	Lateral 15/Ella and Draper Ponds	D	87	0.15	45	0.45	169	256
Ella	49.9	0.0780	Pond and surroundings	Lateral 15	D	91	0.10	2	0.10	57	88
C9-N	203.1	0.3173	Draper/Hawes/etc.	Lateral 15/Ella Pond	D	87	0.15	40	0.60	126	192
C9-S	208.5	0.3258	Rural/Feather Glen/Blue Mt.	Lateral 15	D	85	0.18	20	1.10	82	130
C10-1	55.8	0.0872	MDR Residential	Lateral 15	D	87	0.15	35	0.54	36	55
C10-2	225.4	0.3522	MDR Residential	Lateral 15	D	87	0.15	35	0.92	109	167
C10-3	85.6	0.1338	Ag/Rice/Flood Storage	Lateral 15/Algodon	D	82	0.22	2	3.19	15	25
C10-4	66.1	0.1033	Highway Commercial	Lateral 15/Algodon	D	93	0.08	75	0.26	68	98
C11-N	253.6	0.3962	Mixed Business Park	Hastey Pond and C10-3	D	88	0.14	50	0.65	160	240
C11-M	164.7	0.2574	Pond Storage/Mixed Commercial	Hastey Pond, to C10-3	D	90	0.11	40	0.40	131	196
C11-S	143.3	0.2239	Highway Commercial/ Freeway/RR	Lateral 15/Algodon	D	87	0.15	50	0.66	88	133
C12-N	37.7	0.0589	Undeveloped/Brush	Lateral 15/Algodon	D	77	0.30	2	5.13	4	7
C12-S	129	0.2016	North Pointe, River Oaks North	R.O. Pond, to Algodon	D	87	0.15	40	0.64	78	119
C13	246.9	0.3858	River Oaks	R.O. Pond, to Algodon	D	87	0.15	40	0.59	156	237
	5305.0	8.2891									

Portion of Edgewater Subdivision which can drain to Edgewater Pond

X1A-NW	54	0.0844	West Edgewater Subdivision	Edgewater Pond	D	87	0.15	35	0.5	26	56

Portion of Basin B which will drain to Ella Pond

Shed	Area acres	Area sq. mi.	Drainage Description	Drainage Routes To	Main Soil Group	Initial Loss	Uniform Loss	% Impervious	SCS Lag Hours		
B3A	245	0.3830	Mixed/Future Development	Ella Pond	D	0.1	0.01	40	0.900	148	211
B3B	115	0.1800	Mixed/Future Development	Ella Pond	D	0.1	0.01	40	0.680	82	117
B6A	250	0.3910	Wheeler North	Wheeler Ponds to Ella	D	0.2	0.01	51	0.490	210	300
B6B	285	0.4450	Wheeler South	Wheeler Ponds to Ella	D	0.2	0.01	42	0.470	243	346

2.13 Runoff Potential – Curve Numbers and SCS Lag Time

Runoff potential is directly related to land use, and this study has been analyzed for both current and ultimate land use. While the SCS curve number was not used directly in the HEC-1 simulation, it was used in computing the SCS lag time. The SCS lag time is generally considered to be approximately 60% of the time of concentration. The SCS lag time was used directly in the HEC-1 simulation and influences peak runoff significantly. The subsheds with the lowest composite CN were undeveloped orchards with B Type soil resulting in a CN as low as 60. The developed CN varied widely depending on the land use, and the percentage of the drainage Basin actually developed or to be developed. The highest values used were for the areas of concentrated commercial development and poor (Type D) soils such as the developing commercial area near the new freeway interchange, where a composite CN of 93 was used. The Feather River Center uses CN of 95. Most of the other drainage basins used area-weighted CN values between 67 and 87. The curve numbers lag times used are detailed in Tables 2 and 3.

2.14 Runoff Hydrographs – Peak Flows

The primary purpose of the runoff hydrographs from HEC-1 was to produce the input at numerous locations of the HEC-RAS model. The infusion of the runoff hydrographs has been implemented through HEC DSS (Data Storage System). Some of the inputs are from specific subsheds and others are routed hydrographs as various subsheds collect and route to a main channel. Generally, about 35 hydrographs were determined for each model and used as inputs to the HEC-RAS models. This is discussed further in the report in the hydraulic model section. The peak runoff for the 10-year and the 100-year storms from each shed as predicted by HEC-1 is also shown in Tables 2 and 3 (for Current and Ultimate Conditions, respectively). The 100-year is for the 24-hour storm; the 100-year 10-day storm generally produces significantly lower runoff. The results of the HEC-1 computer model are provided in the Appendix of this report.

2.20 HYDRAULICS

2.21 Hydraulic Models

U.S. Corps of Engineers HEC-RAS 3.1.3 unsteady models of Basin C have been developed for two main conditions: (1) Current Conditions, and (2) Ultimate Conditions (Plumas Lake Specific Plan, North Arboga Study Area Plan and South Yuba County Subdivision Plans). The HEC-RAS geometry screens for the Current and Ultimate Conditions hydraulic models are shown in Figures 5 and 6 to give an idea of the components included in the models. Some elaboration of models for each of the conditions will be provided below. The Current Conditions models include all improvements completed and all development under way as of early 2009. Drainage improvements incorporated in the Current Conditions model include those presently in place such as the expanded Chestnut Pond; the culvert improvements in West Linda on Lateral 15 at Arboga Rd., Gledhill Ave. and Alicia Ave.; the expanded Ella Basin (Pond); the Ella Pond connection of Lateral 15; the Draper Ranch North development; the Draper Ranch storm drain connection to Ella Pond; the CalTrans State Route 70 Interchange at Plumas Lake Blvd.; the River Oaks Subdivision; the River Oaks Pond; the River Oaks Pond connection to Algodon Canal; and new Pump Station #6. The Ella Basin expansion is on-going and expected to be completed this year. The Ultimate Conditions model assumes all the improvements (items #1 through #32) in section 1.20 are in place.

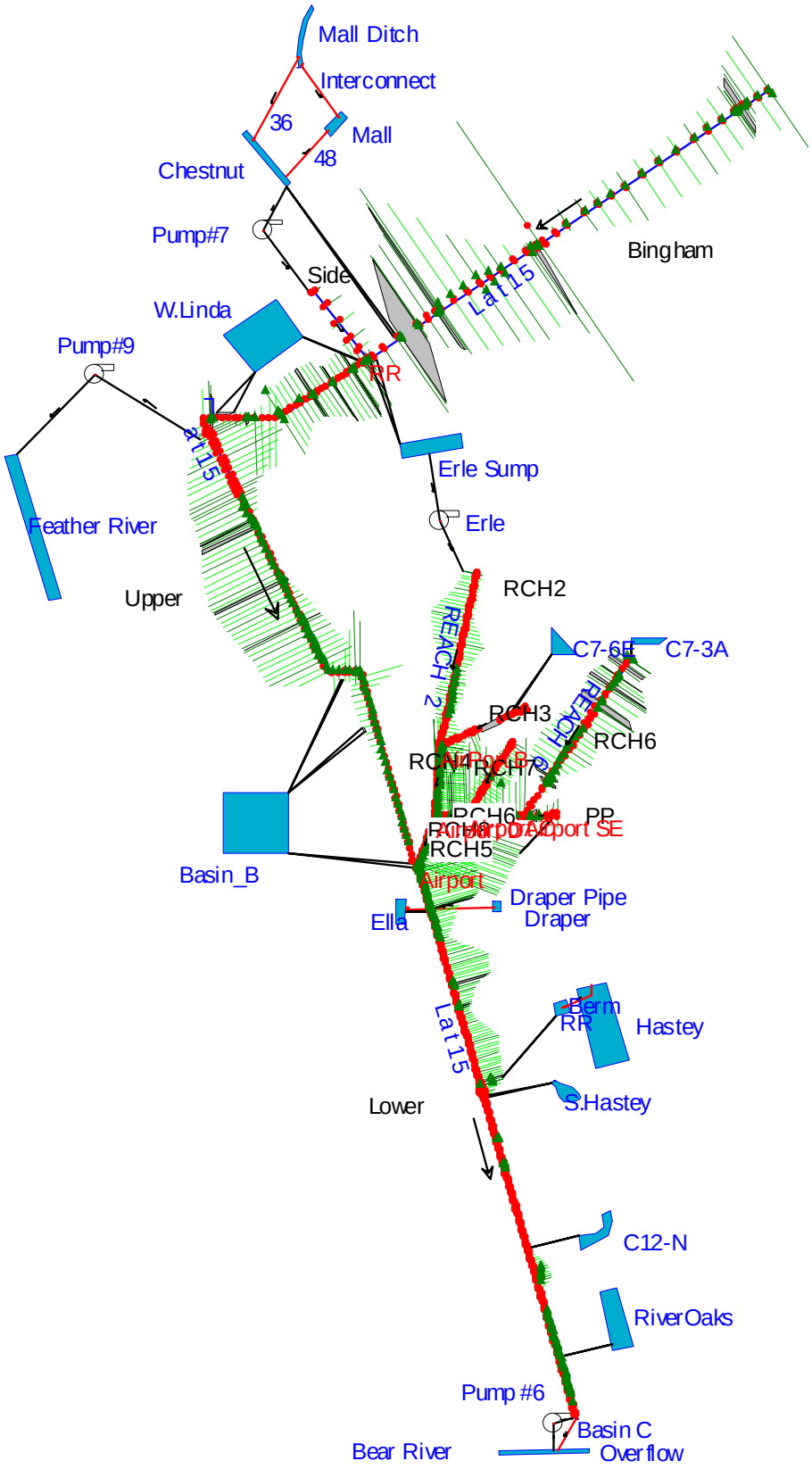


Figure 5 – HEC-RAS Geometry Screen for the Current Conditions

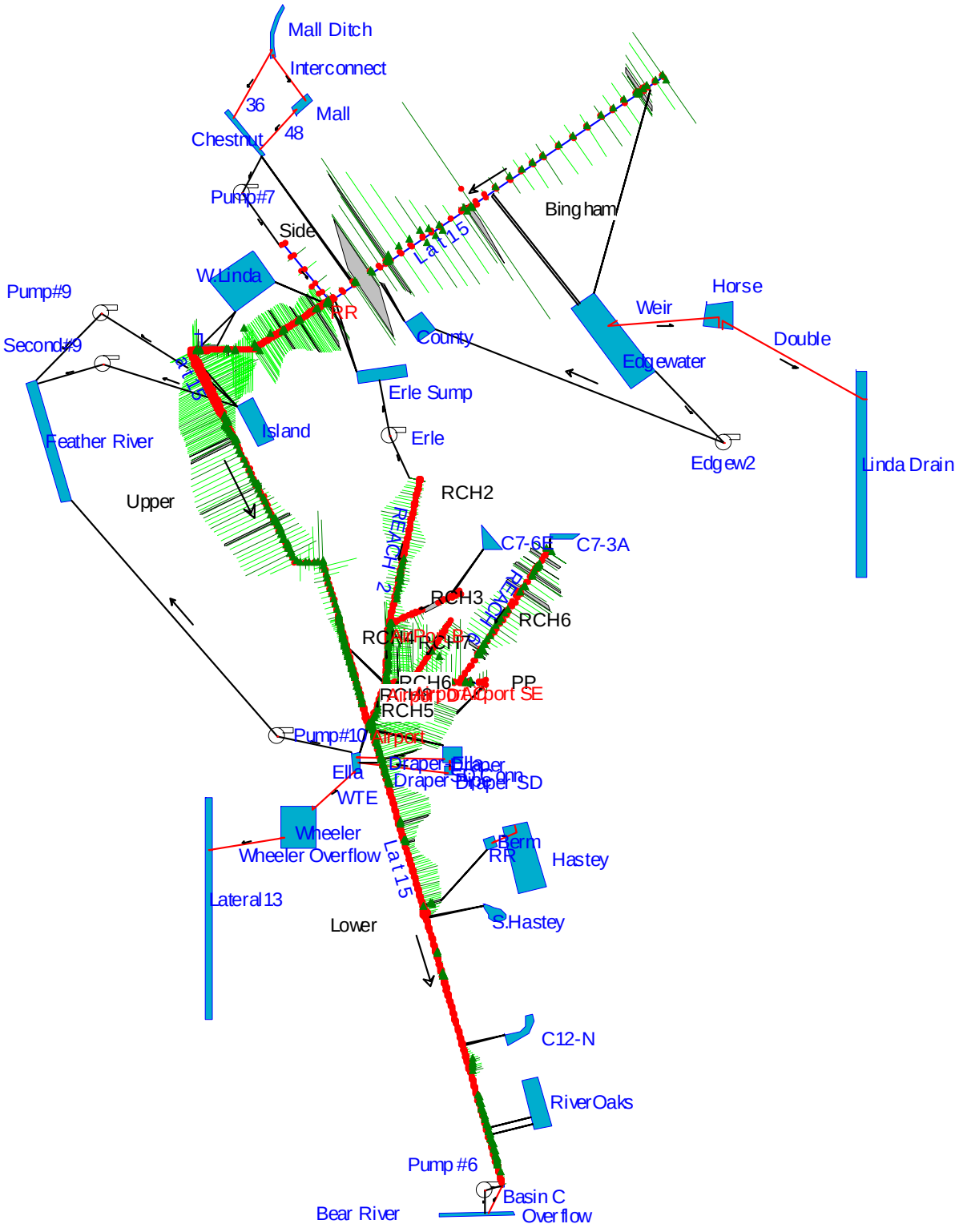


Figure 6 – HEC-RAS Geometry Screen for the Ultimate Conditions

The dynamics of the drainage areas studied here are strongly influenced by the pond storage areas involved. The only way to correctly model the dynamic nature of the ponds and linear detention channels is to use unsteady HEC-RAS modeling. Thus All HEC-RAS modeling done for this study has been unsteady. The HEC-RAS stationing for Basin C is shown in Figures 7A and 7B and was used for all the models discussed in this report. The HEC-RAS models were built from scratch using four main sources of geometry information: (1) The original MHM surveys used for the 2002 Master Drainage Plan, (2) an extensive field topographic survey completed by MHM Inc. between 2006 and 2008, (3) the LIDAR maps produced in the Towill report, and (4) the improvement plans for the developments and the drainage facilities. The datum used was NGVD 1929.

The hydraulic model stationing begins at station 0+96 (feet) at Pump Station #6 at the south edge of Yuba County. The upstream end of the study on Lateral 15 is at station 632+82, or about 12 miles. Lateral 15 is by far the longest channel analyzed in this study. Since Pump Station #6 has redundant pumps and back-up generators, it was not necessary to study any cases in Basin C with the pumps failed as it has been in other locations in RD 784. The new pumps at Pump Station #6 completed in 2006 are rated at 67 CFS each. A base flow of 4 CFS is removed at Pump Station #6 for the Current Conditions model. With the addition of pumps at Ella Pond in the Ultimate Conditions model, the base flow at Pump Station #6 uses a base flow of 3 CFS. These pump characteristics are incorporated into the HEC-RAS models. Gravity outflow at Pump Station #6 is not modeled as operational since it is assumed that the Bear River would be at higher stages during a large storm event and the flap gate would be closed.

The Current Conditions model considers outflow from Basin C to Basin B at the north end of Basin B from high water in Lateral 15 in Basin C. This is not treated as a breach scenario. Sufficiently high stages in Lateral 15 can freely flow over existing ground in upper Basin B. To accomplish this, three lateral structures are used in the Basin C analysis with spill elevations equal to the existing ground adjacent in Basin B. The lateral structures in the Basin C models discharge into a computational storage area “Basin B”, which can be seen in Figure 6. This spill is something that will not occur in the ultimate model because the water level in Lateral 15 is not expected to reach the spill level. Thus the mechanism is not active in the ultimate models and is not included in Figure 7.

Basin C is very dependent on the storage in various natural and man-made detention basins. This is true for both the Current Conditions and the Ultimate Conditions. In each case, storage areas are connected to the drainage system in the hydraulic models in ways consistent with the actual field geometry. Chestnut Pond in the north was covered in the 2007 Linda Mall LOMR case #07-09-1893P. In that LOMR and in the current models used here, the connection from the commercial area northeast of State Route 70 is via two main pipes under the freeway. One is a 36-inch, the other a 48-inch. Both deliver runoff from the Mall to Chestnut Pond. The only change has been the expansion of Chestnut Pond during the fall of 2007 from the former 20 acre-feet to the current 42 acre-feet. The pump station at Chestnut Pond is unchanged. The pumps (one electric, one diesel) with a combined capacity of 16 CFS discharge to the railroad borrow that connects to Lateral 15. This pond and its pumps are unchanged in the Ultimate Conditions model.

Edgewater Pond (Photograph 4) is not currently part of the Basin C drainage system. The Ultimate Conditions model includes the connection and improvement of this pond as described in section 1.20 of this report. The Current Conditions hydraulic model does not include Edgewater Pond, but the Ultimate Conditions HEC-RAS model does include Edgewater with its expanded volume, pumps and connection to Bingham Canal.

Figures 7A and 7B
HEC-RAS Stationing

LEGEND

- PUMP STATION
- LATERAL
- DETENTION POND
- DRAINAGE BASIN BOUNDARY

0 500 1000 2000 4000

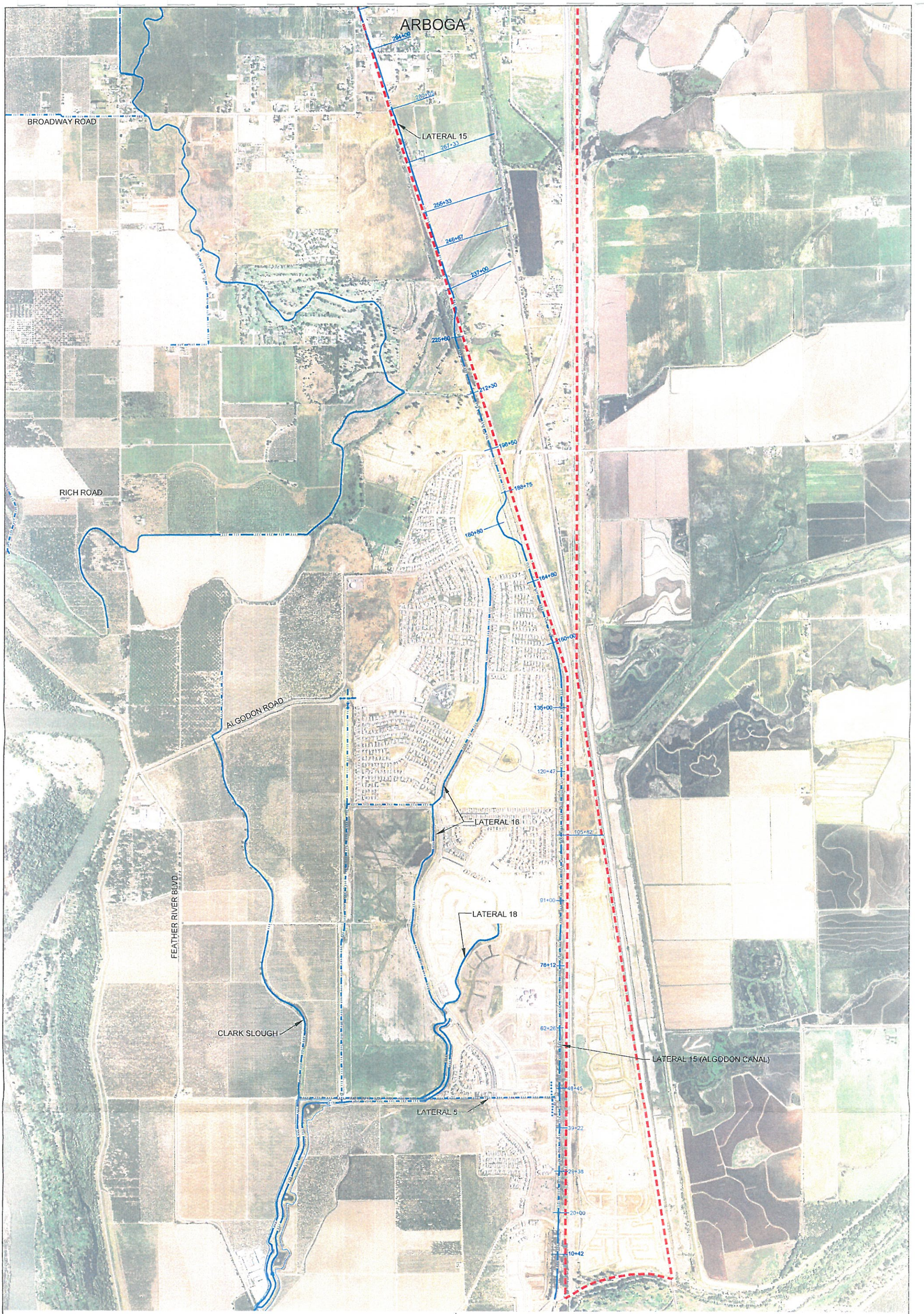
SCALE 1"=2000'

FIGURE 7A

RECLAMATION DISTRICT NUMBER 784

BASIN C HEC-RAS CROSS SECTIONS

YUBA COUNTY, CALIFORNIA



LEGEND

- PUMP STATION
- LATERAL
- DETENTION POND
- DRAINAGE BASIN BOUNDARY

0 500 1000 2000 4000

SCALE 1"=2000'

FIGURE 7B
RECLAMATION DISTRICT NUMBER 784
BASIN C HEC-RAS CROSS SECTIONS
YUBA COUNTY, CALIFORNIA

Just east of State Route 65/70 is a new County Center, completed in 2007 and 2008. While the center currently uses a retention basin and theoretically passes no runoff to Bingham Canal, it is treated in the Current Conditions model as it was before development with the historic runoff delivered to the Basin C drainage, rather than modeled as zero runoff. In the Ultimate Conditions model, the retention pond at the County Center is replaced with a detention basin connected to Lateral 15 with an appropriate structure. The higher expected runoff from the County Center is directed to the County Pond in the Ultimate Conditions model.

West Linda has a low residential area designated in past flood maps as an approximate zone A. Two sources of runoff can contribute to inundate that area: local runoff from West Linda itself, and overflow from Bingham Canal (Lateral 15) in the vicinity of Arboga Road. High water in Bingham Canal between Arboga Road and the Union Pacific Railroad can travel to the northwest and sheet flow into the lower area of West Linda. These mechanisms are both in the hydraulic models. The overflow is handled by a lateral structure in the model just upstream from Arboga Rd. Spill back into Lateral 15 downstream near Island Pond is also possible and included in the model as a lateral structure. The storage is modeled as "W. Linda" with a volume curve determined from contours from the topomap. This inflow has not been corrected in the Ultimate Conditions model. However, correction of this problem is addressed in sections 1.20 of this report as a possible future project.

Just below Island Road, Lateral 15 has a wide cross section often referred to as Island Pond. See Photograph 10. The storage for this section is handled entirely by the channel cross section. MHM conducted topographic surveys in that wide section at a number of cross sections and those were used to build the channel in used by HEC-RAS. Pump Station #9 pumps from this location to the Feather River. The pumps are operated by RD784 and follow the same maintenance and operations schedule as other pumps operated by RD 784. In the Ultimate Condition model incorporates an upgrade to the pump capacity at this location.

The HEC-RAS models for Basin C have two computational storage areas at the Yuba County Airport. One is C7-6E which is a low triangular area between runways in subshed C7-6. Limited outflow is available via pipeline under the runway to the west. The adjacent storage C7-3A is a low rectangular area with limited culvert drainage to the south. Both of these computational ponds are connected with appropriate sized pipes and to the correct channels in the HEC-RAS models. The volume curves were determined from contours from the topomap. These storage areas are treated the same way in both the Current Conditions and the Ultimate Conditions models.

Ella Pond is located just north of Ella Road and west of the old railroad berm which separates Basin B from Basin C. The pond has been referred to alternatively as Ella Basin. In the future, it will be called the "North Drainage Basin C Regional Detention Pond" and will include pumping to the Feather River (future Pump Station #10). For the Current Conditions model, this study treats Ella Pond as just a surge basin as it is in its existing (spring 2009) state. The pond was built in what was historically part of Basin B, but was connected via pipeline under the railroad berm to Lateral 15 in Basin C. Currently, the only drainage from west of the railroad berm delivered to the pond is the direct rainfall on the boundary of the pond property. Thus, that 50 acres has been removed from Basin B and is now part of the Basin C analysis. Because the bottom of the pond is well below the bottom of Lateral 15, a large part of the pond's volume is not currently available. The Current Conditions simulations done for this report assume the water surface in the pond at the beginning of a storm event is already up to the level of the bottom of Lateral 15. The HEC-RAS model uses the volume versus depth of the pond as determined from the improvement plans for the pond expansion. The correct geometry for the pipe connection between the pond and Lateral 15 is modeled in HEC-RAS. The Ultimate Conditions HEC-RAS model includes a

number of changes in the vicinity of Ella Pond. The pond is treated as its full expanded volume and since it will be pumped, the initial conditions are set near the bottom of the pond. The Pump Station #10 is considered to be in place and operational with two 30 CFS pumps and a third emergency back-up pump of 30 CFS. A direct connection from upper Lateral 15 into Ella Pond is included in the Ultimate Conditions model. The model also incorporates nearly 1000 acres of upper Basin B assumed to flow into Ella Pond via an underground storm drain system.

As part of absorbing upper Basin B, the Wheeler Ranch Ponds will become part of the hydraulic model of Basin C ultimately. Runoff from both Wheeler Ranch projects is modeled in the future to deliver to the Wheeler Ponds, then flow by gravity in an underground line to Ella Pond. A flap will be needed at the Ella Pond end of the line to assure the flow is one-way. Excess runoff at Wheeler Ponds can flow over an emergency weir into Lateral 13. The design is intended to deliver much less than historic flows to Lateral 13 even in the most severe situation.

The Current Conditions Basin C hydraulic model includes a computational pond for the Draper Ranch. It is in the model just to collect the runoff from the Draper Ranch subdivision and route it to Ella Pond via a pipe under Lateral 15 and the old railroad berm. As with the other discussions on Ella Pond, the connection from Draper is modeled according to the improvement plans. The Ultimate Conditions model adds the future Draper Pond with a volume over 400 acre-feet. That facility is modeled in HEC-RAS with a weir connection to Lateral 15 near the north end of Ella Pond. Culvert connections between the planned Draper Pond and Ella Pond (North Drainage Basin C Regional Detention Pond) are included in the Ultimate Conditions model.

The Hastey Pond and South Hastey Pond have been discussed previously, and were shown in Photographs 16 and 19. The main Hastey Pond is east of the Union Pacific Railroad and collects runoff from the C11-N and C11-M subsheds. When water levels are low, as shown in the aerial photographs, the pond occupies a rectangular area restricted to the Hastey property in shed C11-M. When water levels rise, the pond covers a region to the north and east into shed C11-N as well. Outflow is via four large culverts at varying elevation under the Union Pacific Railroad. The geometry of the pond has been determined from the topomap and is incorporated into the HEC-RAS models. The information on the culverts under the railroad was gathered by field surveys in 2008. South Hastey pond is a historic low area adjacent to Lateral 15. It was in an area that was not convenient to handle with wide cross sections of the Lateral 15 channel as was done for the low rice fields just north of there. Instead, the South Hastey pond has been modeled as a computation storage area connected to Lateral 15 with appropriate geometry. The storage versus elevation for the pond was determined from the topomap. These ponds are treated identically in the Current Conditions and Ultimate Conditions models.

The pond designated C12-N in the hydraulic model is a small low area east of State Route 70 in subshed C12-N. It is connected to Lateral 15 by a culver under the highway. When water in Lateral 15 is high enough, it can back up and flood the low area in subshed C12-N. The volume versus elevation for the pond was determined from the topomap and used in all the HEC-RAS models, current and ultimate.

The last pond to the south in the Basin C hydraulic model is the River Oaks Detention Pond. This pond serves the River Oaks subdivision and is intended to serve the North Pointe subdivision in the future. It connects to Lateral 15 via a pipe under State Route 70. The geometry of the pond and connection used in the HEC-RAS models were gathered from the improvement plans and verified by field surveys done in 2008. The Ultimate Conditions model of the River Oaks Pond is similar to the Current Conditions but with two changes: (1) an additional connection

under the freeway between the pond and Algodon Canal (or other approved engineering solution), and (2) increased runoff directed to the pond due to additional development such as North Pointe. The modeling done for this study has been completed with the additional 48-inch connection included and at a lower elevation than the current connection. This allows for more complete utilization of the pond. Another engineering solution may be considered upon completion of a detailed drainage analysis which includes long term operation and maintenance costs. A detailed drainage analysis (along with economic analysis of long term operation and maintenance costs) may be completed to potentially analyze another engineering solution no later than final maps for the two hundred seventy-fifth (275th) residential unit. If no additional drainage analysis is completed by the recordation of the two hundred seventy-fifth (275^{th}) residential unit, the proposed solution presented in the Master Drainage Plan shall be considered the approved drainage solution. The proposed drainage improvement shall be constructed prior to or in conjunction with the recordation of the three hundred fiftieth (350^{th}) residential unit unless the drainage analysis is approved otherwise. If any modification to the currently approved tentative maps occurs (i.e. River Oaks South, River Oaks East, River Oaks North, North Pointe) then a drainage analysis will also be required prior to any revised tentative map approval. (River Oaks North TSTM 2008-0002 was considered during the computer modeling and would not be considered a revision for this purpose.) Upon review and approval of the drainage analysis by both the County and RD 784 Board, this solution would become the drainage plan for the River Oaks Sub-Basin of Basin C.

Besides the ponds mentioned above, the HEC-RAS models include the following computational storage areas associated with Basin C: Mall Ditch, Mall, Erle Sump, Basin_B, "Basin C", R.R., Bear River and Feather River. The first two were detailed in the recent Linda Mall LOMR. The last five of these are purely computational tools, not for the purpose of accounting for any significant storage for Basin C. The storage Bear River and Feather River are just for the purpose of providing a pump point for Pump Stations #6, #9 and #10. Their storage is irrelevant to Basin C. The models of Mall, Mall Ditch and Erle Sump use the actual volumes versus elevations for each of those areas determined from the topomap.

The HEC-RAS model covers 13 reaches within Basin C. The HEC-RAS geometry screen, Figures 5 and 6, serve as a visual aid to give an idea of the relative location of the various reaches and other components. More detail is shown in the stationing maps, Figures 7A and 7B. Base flows with a cumulative flow of 4 CFS are used in the upstream reaches of the models and removed at Pump Station #6 with a virtual 4 CFS pump. Initial conditions were in some cases run for set initial conditions and in other cases run from a restart file. Generally, the goal was to produce stable simulations with minimum initial flows and pond elevations. Initial flows in the reaches ranged from 2 CFS to 10 CFS. Initial Basin C pond water surface elevations ranged from 27.5 feet (NGVD 29) at Pump Station #6 to 54 feet at the airport. As mentioned in the hydrology section of this report, input hydrographs to HEC-RAS extend well past the end of the storms. For example, the 24-hour storms use hydrograph inputs and simulation outputs for 120 hours. This insures that peak storage conditions are reached in the simulations. The models have required an extensive amount of optimization in order to produce stable results. The typical spatial slice in the models is about 50 to 100 feet of channel length. The typical time slice for the simulations is around 10 seconds, although some models run at 30 seconds and some require as small as 3 seconds.

Supporting Field Studies

MHM, Inc. has gathered a large amount of field data pertaining to Basin C. A partial topographic survey of the

basin was undertaken in 2006 and 2007, predominantly in the north in and around Bingham Canal. Additional surveys were completed in the summer of 2008 extending from Pump Station #6 in the south to the lower end of Bingham Canal in the north. In addition, the topographic survey done in 2001 for the Mead and Hunt drainage study (see the reference list) has been included in locations where improvements have not changed the conditions since 2001. All channels used in the hydraulic models were surveyed and cross sections taken approximately every 500 feet. All bridges and culverts in the channels were surveyed, including invert elevations, sizes and material. Those were used to build the HEC-RAS model. Topographic information outside the channels was gathered in two ways. In some areas, MHM ground survey crews gathered elevations on wide cross sections. The other source of topographic information is the in the LIDAR maps prepared in 2006 by Towhill Inc. The Topo/Workmaps included with this application display both the Towhill LIDAR and the MHM ground survey points. The datum used for all such survey work has been NGVD 29.

2.22 Modeling Assumptions

The items described below are some of the modeling assumptions and approaches that were used to perform the hydraulic analysis.

Datum — The vertical datum used throughout this study is NGVD 29. This applies to all topographic surveys and to all computed water surface elevations.

Culverts — There are many road crossings on the channels. Some are farm crossings, some are country roads and others are within new subdivisions. All culverts were modeled with the "Highest U.S. E.G." option as opposed to specifying either "Inlet control" or "Outlet control". Inverts and diameters of all culverts were collected during field surveying. Standard values of entrance and exit losses were utilized. Mannings "n" values used ranged from 0.013 to 0.024 depending on size and material. Ineffective areas were used upstream and downstream at all crossing where the cross sections allowed such an approach.

Channel Characteristics and Roughness Factors — Some of the channels in the model are man-made will others are primarily natural. The manning "n" values used for this study ranged from 0.035 to 0.06 in the channels and 0.05 to 0.08 for the overbank area. Standard values of 0.1 and 0.3 were used for contraction and expansion coefficients respectively.

Flows — Input flow hydrographs were determined from the HEC-1 analysis at approximately 35 locations and connected to HEC-RAS via the DSS system. The hydrographs were used as boundary conditions (in some cases Flow Hydrographs, in other cases Lateral Inflow Hydrographs) for the HEC-RAS unsteady flow data.

Base Flows – Base flows of on the order of 1 cfs were used at the upstream ends of most reaches. The Base Flow is removed at Pump Station #6 and at Pump Station #10 in the Ultimate Conditions by the use of virtual pumps operating continually.

Initial Conditions — Because unsteady HEC-RAS models can become unstable in the transition from a dry channel to developed flow, the channels in the models have initial flow values set. The initial conditions were set between 1 to 40 CFS. Initial conditions in the storage areas were set at the natural

level to which the given storage area would drain or pump.

Ponds — Some storage areas in the HEC-RAS models are handled by the topography of the channel cross sections, while others are handles in the simulations as a computational storage area. The volume vs. elevation curves for those ponds were taken from the design drawings and/or by field surveys.

Backwater — No downstream boundary condition on Lateral 15 was required because a very small computational pond was used in the model to represent the pump inlet basin. As water flows in or is pumped out, the model automatically reflects water surface elevation adjustments properly. As discussed below, the backwater level in the Bear River and Feather River has no effect on the current model.

Pump Station – The Pump Stations in the models discharge to the Feather River or the Bear River. In the HEC-RAS model, these "Rivers" are handled as computational storage areas. At this point, the WSEL in the rivers has no bearing on the pump station performance as the pumps are treated as having a conservative value of fixed output rather than a head-dependent output. Thus, the model currently does not vary the pump discharge with the water surface changes on the Lateral 15 side or on the River side.

Levees — The drainage area studied is protected by the WPIC, Bear River and Feather River levees. All models used rely on an underlying assumption that the levees are all intact, functioning properly.

2.23 Design Water Surface Elevations and Flow Rates

Predictions from the new HEC-RAS models will be discussed further, and the output from the models is included in the appendix. As a first discussion, the findings of the previous Drainage Master Plan UNET existing conditions model (2002 RD784 "Master Drainage Plan" by Mead and Hunt) is compared to the results of the HEC-RAS Current Conditions models of this study. The 100-year results are compared in Table 4. The values in the table represent the composite worst case between the 100-year 24-hour storm and the 100-year 10-day storms. In all cases, the pumps are modeled as functioning. The large differences that are observed in Table 4 are to be expected for a number of reasons. For one, there have been significant changes in the Basin C drainage system since 2002, such as the 200 CFS capacity at Pump Station #6 and the addition of the Ella Basin. Those two changes have gone a long way to lowering the water surface elevations in the downstream half of Basin C. For another, the watershed subdivision in the current study is substantially more detailed than in the 2002 work. This is particularly important in the community of Linda and at the Yuba County Airport. The 2002 study was represented by 13 subsheds, while this current study uses 56 subsheds.

A comparison between the Current Conditions model and the Ultimate Conditions model is shown in Tables 5, 6 and 7. These represent the 100-year 10-day storm, the 100-year 24-hour storm and the 10-year 24-hour storm, respectively. As previously discussed, the worst case for nearly all of Basin C is the 100-year 10-day storm. Though peak water surface elevations during the 10-day storm are modeled to improve throughout Basin C with the improvements included in the Ultimate Model, the improvement in the Bingham Canal region (above Island Pond) is minimal and significant flooding is predicted to persist for that longer storm condition. Thus the improvements detailed in section 1.20, items 1 through 32, of this report are presented as correcting the 100-year storm problems throughout Basin C, but in the north above Island Pond, only the 24-hour storm flooding receives relief. Other more expensive measures designed to handle the 100-year 10-day case are discussed as possible

future projects in section 1.20 of this report. Those measures also address other nearby problems, such as the flooding in the low area of West Linda near Cottonwood Ave.

Table 4
Comparison of the 2002 Existing Conditions UNET Model with the 2009 Current Conditions HEC-RAS Model at Various Locations in Basin C (Worst case 100 year Storm)

Location	Peak WSEL (NGVD 29) 2002 Mead and Hunt Study Existing Conditions	Peak WSEL (NGVD 29) HEC-RAS Current Conditions
Algodon Canal at Pump#6 HEC-RAS Sta 0+96	46	40.11
Algodon Canal just above Feather River Blvd., HEC-RAS Sta 17+78	46.5	41.26
Algodon Canal at north Ross Ranch, HEC-RAS Sta 255+33	46.5	42.28
Lateral 15 just above Broadway Rd. HEC-RAS Sta 293+65	50.3	50.18
Lateral 15 just above Ella Rd. HEC-RAS Sta 363+80	54.5	54.27
Lateral 15 at confluence with Lateral 17, HEC-RAS Sta 393+20	54.6	54.72
Lateral 15 just above old railroad berm, HEC-RAS Sta 394+02	55.2	55.13
Lateral 15 below Feather River Blvd., HEC-RAS Sta 504+64	56	56.42
Lateral 15 at Pump #9, Island Pond HEC-RAS Sta 533+30	56.4	57.82
Lateral 15 just above Grand Ave. HEC-RAS Sta 550+50	58.2	59.19
Lateral 15 just above Arboga Rd. HEC-RAS Sta 583+65	61.2	60.30
Bingham Canal just above SR70 HEC-RAS Sta 594+12	61.9	61.09
Bingham Canal just below Hammonton-Smartville Rd., HEC-RAS Sta 629+50	62.8	62.58
Bingham Canal above Hammonton-Smartville Rd., HEC-RAS Sta 632+82	66.4	63.78

While Tables 5, 6 and 7 present water surface elevations and flow rates at some representative locations, more complete HEC-RAS results are shown in the Appendix, including the profile data for stage versus location for different storm events for both Current Conditions and Ultimate Conditions. The Appendix also covers the

additional storm condition for the 200-year 24-hour event. The HEC-RAS models are also available on DVD allowing for predictions of conditions for all storms at all locations throughout the duration of any of the four standard storms.

Table 5
Comparison of Current versus Ultimate Conditions at Various Locations in Basin C
(100-year 10-day storm scenario at each location)

Location	Current 2009 Conditions		Ultimate Conditions	
	Computed Peak WSEL, Feet (NGVD 29)	Peak Flow Rate, CFS	Computed Peak WSEL, Feet (NGVD 29)	Peak Flow Rate, CFS
Algodon Canal at Pump#6 HEC-RAS Sta 0+96	40.11	207	39.76	103
Algodon Canal just above Feather River Blvd., HEC-RAS Sta 17+78	41.26	215	39.81	116
River Oaks Pond	42.00	-	40.34	-
Algodon Canal at north Ross Ranch, HEC-RAS Sta 255+33	42.28	300	40.24	202
Hastey Pond	42.28	-	40.24	-
Lateral 15 just above Broadway Rd. HEC-RAS Sta 293+65	50.18	318	47.71	126
Lateral 15 just above Ella Rd. HEC-RAS Sta 363+80	54.27	264	50.12	43
Ella Pond	53.18	-	50.21	-
Lateral 15 at confluence with Lateral 17, HEC-RAS Sta 393+20	54.72	303	51.32	282
Lateral 15 just above old railroad berm, HEC-RAS Sta 394+02	55.13	75	50.60	-65
Lateral 15 below Feather River Blvd., HEC-RAS Sta 504+64	56.42	77	56.19	86
Lateral 15 at Pump #9, Island Pond HEC-RAS Sta 533+30	57.82	-	56.99	-
Lateral 15 just above Grand Ave. HEC-RAS Sta 550+50	59.19	139	58.40	163
West Linda Ponding	55.56	-	55.56*	-
Lateral 15 just above Arboga Rd. HEC-RAS Sta 583+65	60.30	101	60.25	117
Bingham Canal just below Chestnut Rd., HEC-RAS Sta 592+14	60.82	156	60.68	152

Chestnut Pond	49.87	-	50.22*	-
Bingham Canal just above SR70 HEC-RAS Sta 594+12	61.09	156	60.92	152
Bingham Canal just below Hammonton-Smartville Rd., HEC-RAS Sta 629+50	62.57	57	62.30	36
Bingham Canal above Hammonton-Smartville Rd., HEC-RAS Sta 632+82	63.78	61	62.38	61
Lateral 17 at confluence with Reach 4, HEC-RAS Sta 25+00	54.97	254	54.02	244
Airport Reach 2 confluence with Reach 3, HEC-RAS Sta 50+00	55.31	196	54.78	189
Airport Reach 6 confluence with Lateral 17, HEC-RAS Sta 56+00	55.80	105	55.77	105

* Please see the explanation regarding this value in the accompanying section 2.24 of this report

Table 6
Comparison of Current versus Ultimate Conditions at Various Locations in Basin C
(100-year 24-hour storm scenario at each location)

Location	Current 2009 Conditions		Ultimate Conditions	
	Computed Peak WSEL, Feet (NGVD 29)	Peak Flow Rate, CFS	Computed Peak WSEL, Feet (NGVD 29)	Peak Flow Rate, CFS
Algodon Canal at Pump#6 HEC-RAS Sta 0+96	36.98	204	38.86*	106
Algodon Canal just above Feather River Blvd., HEC-RAS Sta 17+78	37.65	205	38.91*	123
River Oaks Pond	39.21	-	38.99	-
Algodon Canal at north Ross Ranch, HEC-RAS Sta 255+33	40.40	222	39.54	263
Hastey Pond	40.39	-	39.56	-
Lateral 15 just above Broadway Rd. HEC-RAS Sta 293+65	48.93	209	48.18	155
Lateral 15 just above Ella Rd. HEC-RAS Sta 363+80	53.84	275	49.18	39.27
Ella Pond	51.91	-	44.98	-
Lateral 15 at confluence with Lateral 17, HEC-RAS Sta 393+20	54.41	325	51.11	257

Lateral 15 just above old railroad berm, HEC-RAS Sta 394+02	54.93	80	50.28	-54
Lateral 15 below Feather River Blvd., HEC-RAS Sta 504+64	56.03	60	54.96	52
Lateral 15 at Pump #9, Island Pond HEC-RAS Sta 533+30	57.47	-	55.27	-
Lateral 15 just above Grand Ave. HEC-RAS Sta 550+50	58.81	157	58.14	154
West Linda Ponding	54.52	-	54.52*	-
Lateral 15 just above Arboga Rd. HEC-RAS Sta 583+65	60.21	102	59.64	88
Bingham Canal just below Chestnut Rd., HEC-RAS Sta 592+14	60.79	156	59.76	68
Chestnut Pond	49.73	-	50.01*	-
Bingham Canal just above SR70 HEC-RAS Sta 594+12	61.05	156	59.77	68
Bingham Canal just below Hammonton-Smartville Rd., HEC-RAS Sta 629+50	62.58	53	61.95	22
Bingham Canal above Hammonton-Smartville Rd., HEC-RAS Sta 632+82	63.62	60	61.91	60
Lateral 17 at confluence with Reach 4, HEC-RAS Sta 25+00	54.72	289	53.80	215
Airport Reach 2 confluence with Reach 3, HEC-RAS Sta 50+00	55.12	220	54.85	222
Airport Reach 6 confluence with Lateral 17, HEC-RAS Sta 56+00	55.80	110	55.80*	124

* Please see the explanation regarding this value in the accompanying section 2.24 of this report

Table 7
Comparison of Current versus Ultimate Conditions at Various Locations in Basin C
(10-year 24-hour storm scenario at each location)

Location	Current 2009 Conditions		Ultimate Conditions	
	Computed Peak WSEL, Feet (NGVD 29)	Peak Flow Rate, CFS	Computed Peak WSEL, Feet (NGVD 29)	Peak Flow Rate, CFS
Algodon Canal at Pump#6 HEC-RAS Sta 0+96	35.97	138	36.62*	101
Algodon Canal just above Feather River Blvd., HEC-RAS Sta 17+78	36.35	139	36.68*	104

River Oaks Pond	37.37	-	36.81	-
Algodon Canal at north Ross Ranch, HEC-RAS Sta 255+33	39.38	144	39.36	161
Hastey Pond	39.27	-	38.66	-
Lateral 15 just above Broadway Rd. HEC-RAS Sta 293+65	47.90	141	47.23	102
Lateral 15 just above Ella Rd. HEC-RAS Sta 363+80	53.02	244	48.57	28
Ella Pond	50.62	-	39.99	-
Lateral 15 at confluence with Lateral 17, HEC-RAS Sta 393+20	53.74	263	50.31	173
Lateral 15 just above old railroad berm, HEC-RAS Sta 394+02	54.16	72	49.47	-46
Lateral 15 below Feather River Blvd., HEC-RAS Sta 504+64	55.20	50	52.61	-19
Lateral 15 at Pump #9, Island Pond HEC-RAS Sta 533+30	56.45	-	52.62	-
Lateral 15 just above Grand Ave. HEC-RAS Sta 550+50	58.08	140	57.40	119
West Linda Ponding	54.03	-	54.03*	-
Lateral 15 just above Arboga Rd. HEC-RAS Sta 583+65	59.83	103	59.02	62
Bingham Canal just below Chestnut Rd., HEC-RAS Sta 592+14	60.44	112	59.21	39
Chestnut Pond	44.88	-	45.68*	-
Bingham Canal just above SR70 HEC-RAS Sta 594+12	60.58	112	59.23	39
Bingham Canal just below Hammonton-Smartville Rd., HEC-RAS Sta 629+50	62.07	46	61.31	9
Bingham Canal above Hammonton-Smartville Rd., HEC-RAS Sta 632+82	62.92	49	61.34	49
Lateral 17 at confluence with Reach 4, HEC-RAS Sta 25+00	54.14	189	52.88	149
Airport Reach 2 confluence with Reach 3, HEC-RAS Sta 50+00	54.34	130	53.97	138
Airport Reach 6 confluence with Lateral 17, HEC-RAS Sta 56+00	55.28	69	55.28*	78

* Please see the explanation regarding this value in the accompanying section 2.24 of this report

2.24 Special Notes and Explanations Regarding the Ultimate Conditions Water Surface Elevations

A study of Tables 5 through 7 above reveals that the improvements generally result in lower water surface elevations under Ultimate Conditions. A number of the Ultimate Conditions elevations reported in those tables are starred (*). Those starred values fall into two categories: (1) Values that are higher under Ultimate Conditions but with explanation should cause no alarm, and (2) Values that are listed as unchanged but would be higher if development were allowed to proceed without mitigation by entities other than RD784.

In the first of those categories are Chestnut Pond and the south portion of Algodon Canal. Before Chestnut Pond was enlarged in 2007, the peak water surface in the pond was modeled at a little over 53 feet. Part of the justification for enlarging the pond was that it would support further development in the WalMart area. The slight increase in peak water levels in Chestnut Pond under Ultimate Conditions reflects the continued development in the WalMart area. Still, even with that development in the Ultimate Models, the peak levels are several feet lower than they were before the pond was expanded. The slight increase in peak levels between Current and Ultimate Conditions in Chestnut Pond should cause no concern. Even in the worst storm event modeled, the 200-year storm, Chestnut Pond is predicted to maintain approximately four feet of freeboard under Ultimate Conditions.

The lower end of Algodon Canal at stations 0+96 and 17+78 are starred in Tables 6 and 7. Under Ultimate Conditions the peak water surface for the 100-year 24-hour and 10-year 24-hour storms are significantly above the Current Conditions. However, the highest water surfaces there are for the 100-year 10-day storm and the Ultimate Conditions are predicted to produce lower levels than the Current Conditions. Due to the current (and temporary) use of 200 CFS pumping at Pump Station #6, the peak water surfaces under the 24-hour storms are artificially low. They are much lower than the historic existing conditions studied by Mead and Hunt and updated by Kit Burton. The Ultimate Conditions pumping is such that the worst case (the 100-year 10-day storm) is improved over Current Conditions. The fact that the more moderate storms produce higher water under the Ultimate Conditions than under Current Conditions should not be a concern. The levels are well below the 100-year 10-day storm level and well below historic existing conditions. The levels are predicted to be contained within the banks of the Algodon Canal for those Ultimate Conditions storms. This anomaly disappears quickly as one studies conditions upstream from Pump Station #6. For instance, just a few thousand feet upstream at the River Oaks Pond, conditions under Ultimate Conditions are improved over Current Conditions for all storm scenarios.

The second category seen in Tables 5 through 7 is for areas that would indicate a water surface increase due to development if no mitigation interceded. These are in the low area of West Linda and the east side of the Yuba County Airport (Reach 6 station 56+00). In those areas, development assumed in the hydrologic (HEC-1) models produce increased runoff which produce increased flooding not associated with any RD784 facilities. The tables report no increase in water surface level even though the HEC-RAS models predict increases on the order of a tenth of a foot under Ultimate Conditions. The West Linda low area is fed by runoff from subsheds C3-4, C3-7 and C3-8. Future development in those subsheds must be accompanied by some form of mitigation to avoid the increased ponding near Cottonwood Avenue. One solution is discussed in section 1.20 (items #33 and #34) of this report, but since this is viewed as a County drainage issue, it is not included in this RD784 Ultimate Conditions Drainage Master Plan.

A similar situation exists on the east side of the airport. Flooding is predicted to increase with further

development of subshed C7-3B unless it is accompanied by some form of mitigation. Though the rise in water surface is predicted to be small, on the order of a tenth of a foot, the region is very flat and the increased flooding area could be significant. The increase would also impact downstream planned development at Pheasant Pointe. The tables report no increase because it is expected that mitigation will be required by Yuba County before any further development in the central airport area occurs. Since such improvements would be made by the Airport and Yuba County, they are not included in the models for this RD784 Drainage Master Plan.

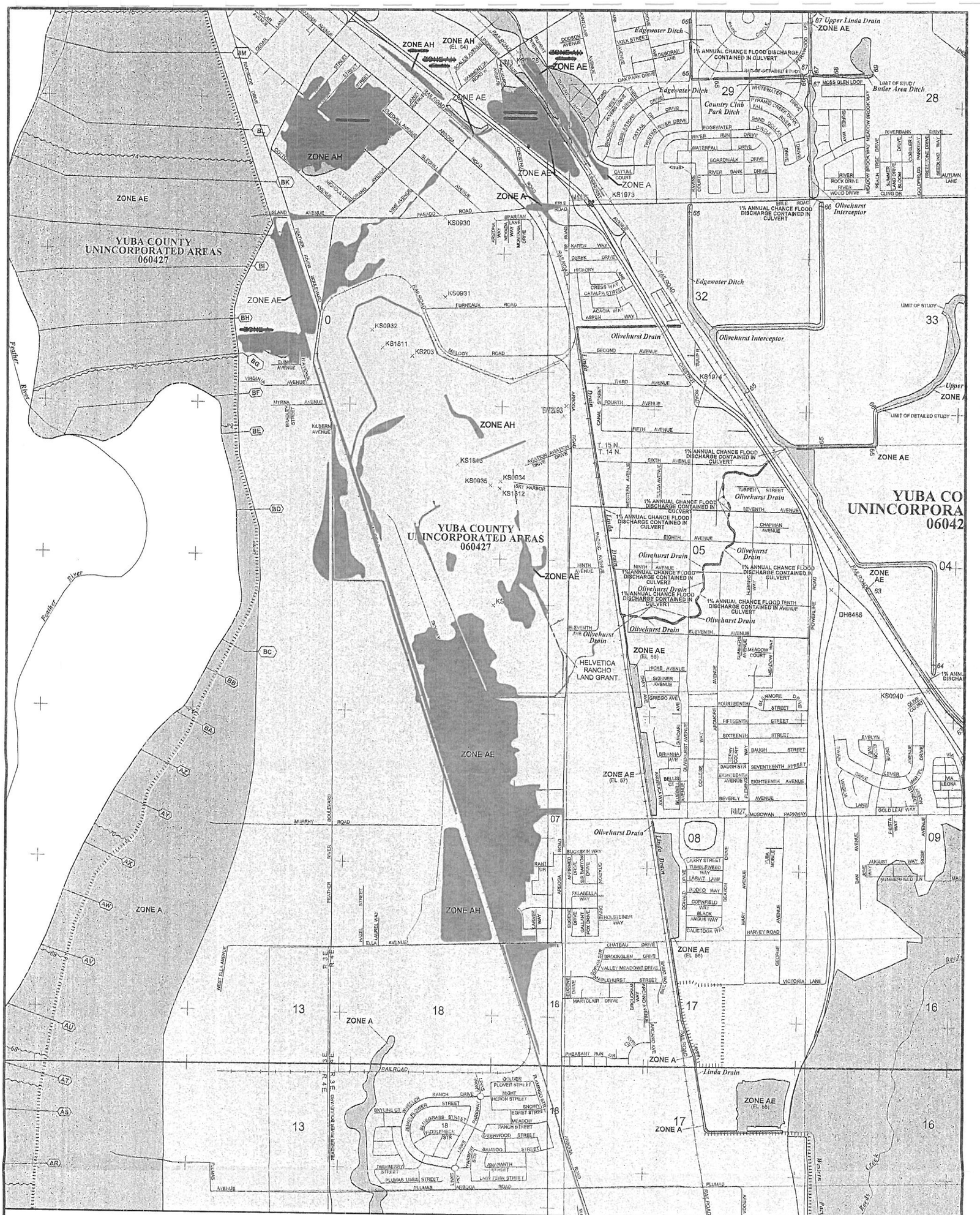
2.25 Predicted Flood Maps under Current and Ultimate Conditions

The 100-year water surface elevations determined from the unsteady HEC-RAS models are plotted on the flood maps in Figures 8A, 8B, 9A and 9B. Figures 8A and 8B show the Current 2009 Conditions prediction of the 100-year flooding. Because the highest water surface elevations can sometimes occur during either the 10-day or 24-hour storm, the map is a composite taking the worst case at each location. While the 100-year 10-day storm is generally the worst case, the 24-hour storm produces the highest water surface elevations at the extreme upstream portion of several of the reaches studied. Figures 9A and 9B represent the Ultimate Conditions with the improvements from section 1.20 of this report, items 1 through 32. Those maps show the 100-year 10-day predicted flooding from the Island Road pumps southward and the 100-year 24-hour predicted flooding upstream from the Island Road pumps. The ultimate model with the improvements in place produces significantly less flooding throughout Basin C and lowers the water surface by as much as two feet in some critical locations. The troublesome regions from the current maps are eliminated in most cases, or at least reduced significantly. Note that several areas which appear as new flooding are actually new storage ponds at the County Center on Packard Ave. and at the west side of Draper Ranch.

The design criteria used for the Edgewater Pond was the 100-year 24-hour storm since mitigation of the 100-year 10-day storm proved impractical. On the other hand, the improvements proposed do solve nearly all the long standing flooding issues in Bingham Canal for the 24-hour 100-year storm, and improve conditions under the 100-year 10-day event significantly for all parts of Basin C. Some flooding remains in the Lindhurst Ave./Sartori Ave. area and the West Linda area. Additional projects that could be considered in the future to fully solve those flooding issues are discussed in section 1.20, but because of cost, are not part of the hydraulic models presented. The flood maps presented do not reflect any of those optional improvements.

Another region which warrants some discussion is the southwest corner of the Yuba County Airport and the open field just south of the airport. The flooding situation in that area is greatly improved by the changes which are part of the Drainage Master Plan. However, some residual flooding can still be seen in that area in Figure 9A. To completely address that residual flooding, other measures such as improving Lateral 17 from the airport to Draper Pond could be investigated. Since the residual flooding in the area is felt to be minimal, the Ultimate Conditions models do not currently include such improvements.

Figures 8A and 8B
100-year Internal Drainage Flood Maps under Current Conditions



ELEVATION REFERENCE MARKS

REFERENCE MARK	ELEVATION (FT)	DESCRIPTION OF LOCATION
USGS BM LC36 (NGVD 1929)	58.83	FD STANDARD DISC STAMPED LC 36 1952 #59 IN CONC. BASE OF SIGNAL #1666 ALONE WPRR 1000 NORTH BEAR RIVER
RM27 (NGVD 1929)	62.61	TOP OF FIRE HYDRANT AT INTERSECTION OF MARY AVENUE AND MCGOWAN PARKWAY. ESTABLISHED BY U.S. GEOLOGICAL SURVEY
M 1435 (1988)	99.099	NGS BM DISC IN SIDEWALK OF NORTHWEST ABUTMENT OF ERLE ROAD O.H.
BM 2093 (NGVD 1929)	62.59	USED BM BRASS CAP LOCATED AT THE EAST END OF THE EAST-AND-WEST RUNWAY OF YUBA COUNTY AIRPORT
T 743 (NGVD 1929)	71.05	T 743. --ABOUT 1-3/4 MILES SOUTHEAST ALONG THE SOUTHERN PACIFIC CO. RAILROAD FROM THE STATION AT MARYSVILLE, YUBA COUNTY, ABOUT 3/4 MILE SOUTHEAST OF THE SOUTHEAST END OF THE YUBA RIVER BRIDGE, AT RUPERT SIDING, ABOUT 120 FEET SOUTHEAST OF THE CENTERLINE OF A PAVED ROAD, 31.3 FEET NORTHEAST OF THE NORTHEAST RAIL OF THE MAIN TRACK, IN THE TOP OF A 4- BY 5-FOOT CONCRETE FOUNDATION FOR A LOADING CRANE, AND ABOUT LEVEL WITH THE BASE OF THE RAILS.

BFE NOTATION

42.35	NGVD 1929
(44.65)	NAVD 88

0 500 1000 2000 4000

SCALE 1"=2000'

FIGURE 8A

RECLAMATION DISTRICT NUMBER 784 BASIN C FLOOD MAP FOR CURRENT CONDITIONS

YUBA COUNTY, CALIFORNIA

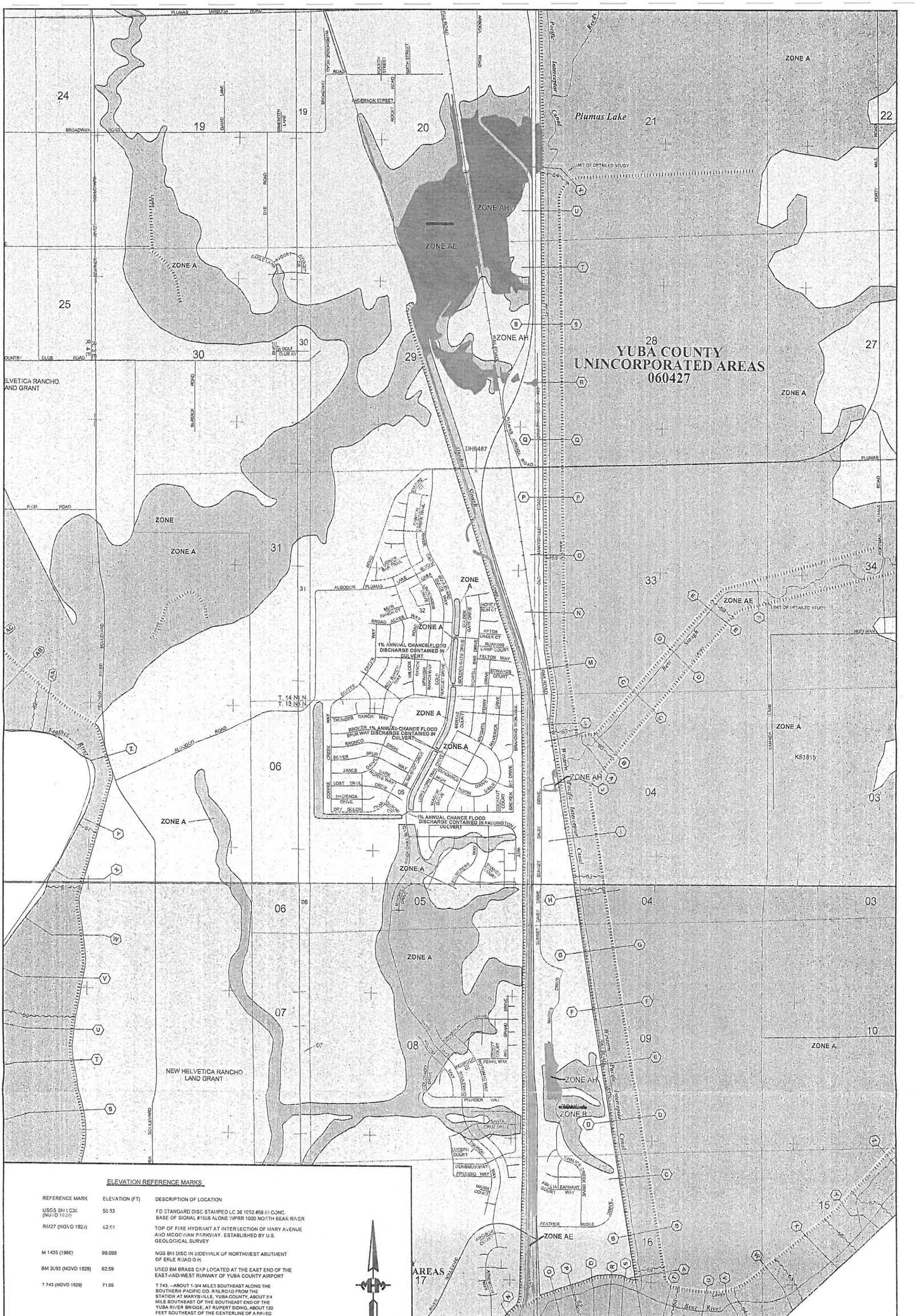
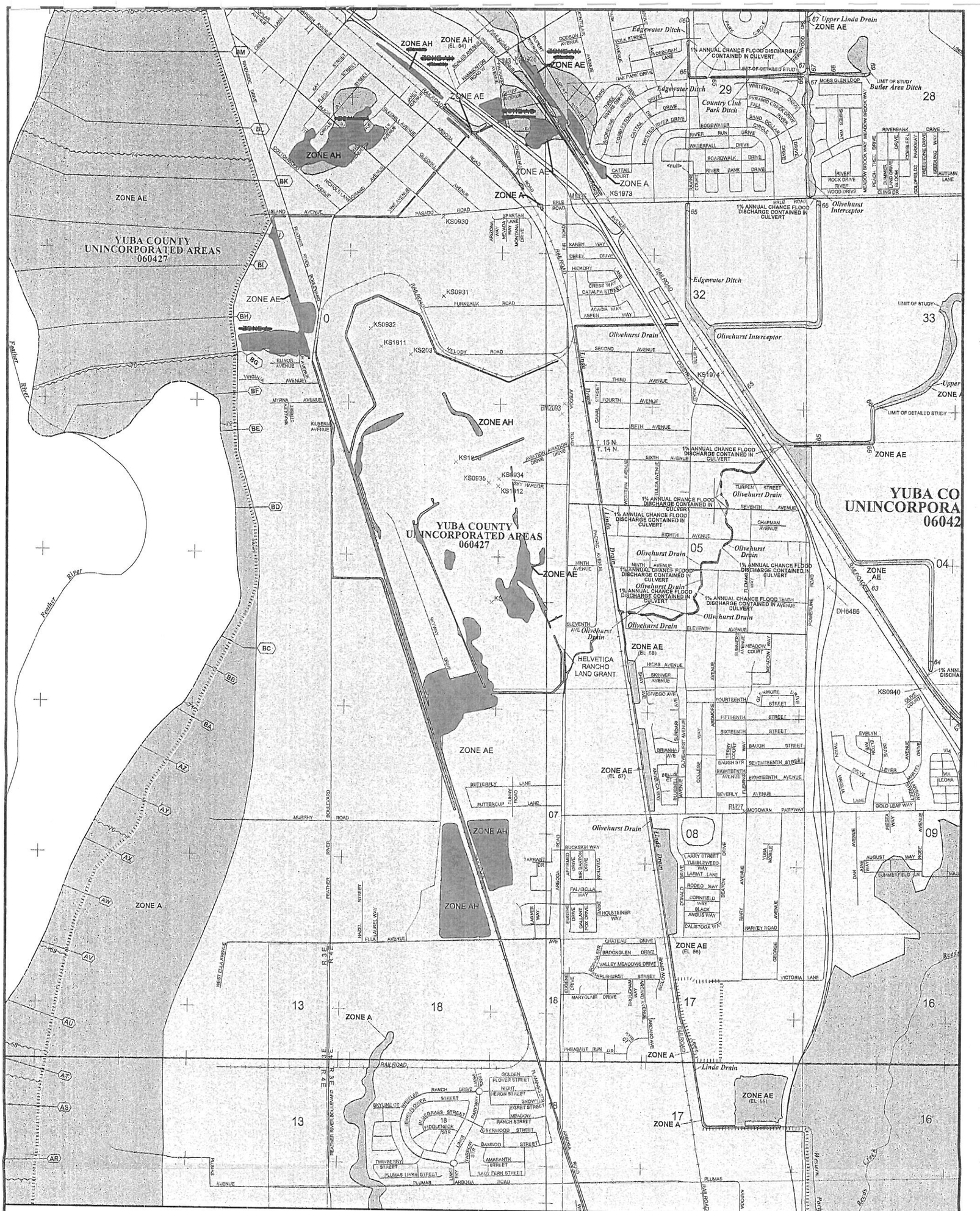


FIGURE 8B
RECLAMATION DISTRICT NUMBER 784
BASIN C FLOOD MAP FOR
CURRENT CONDITIONS
YUBA COUNTY, CALIFORNIA

Figures 9A and 9B
100-year Internal Drainage Flood Maps under Ultimate Conditions



ELEVATION REFERENCE MARKS

REFERENCE MARK	ELEVATION (FT)	DESCRIPTION OF LOCATION
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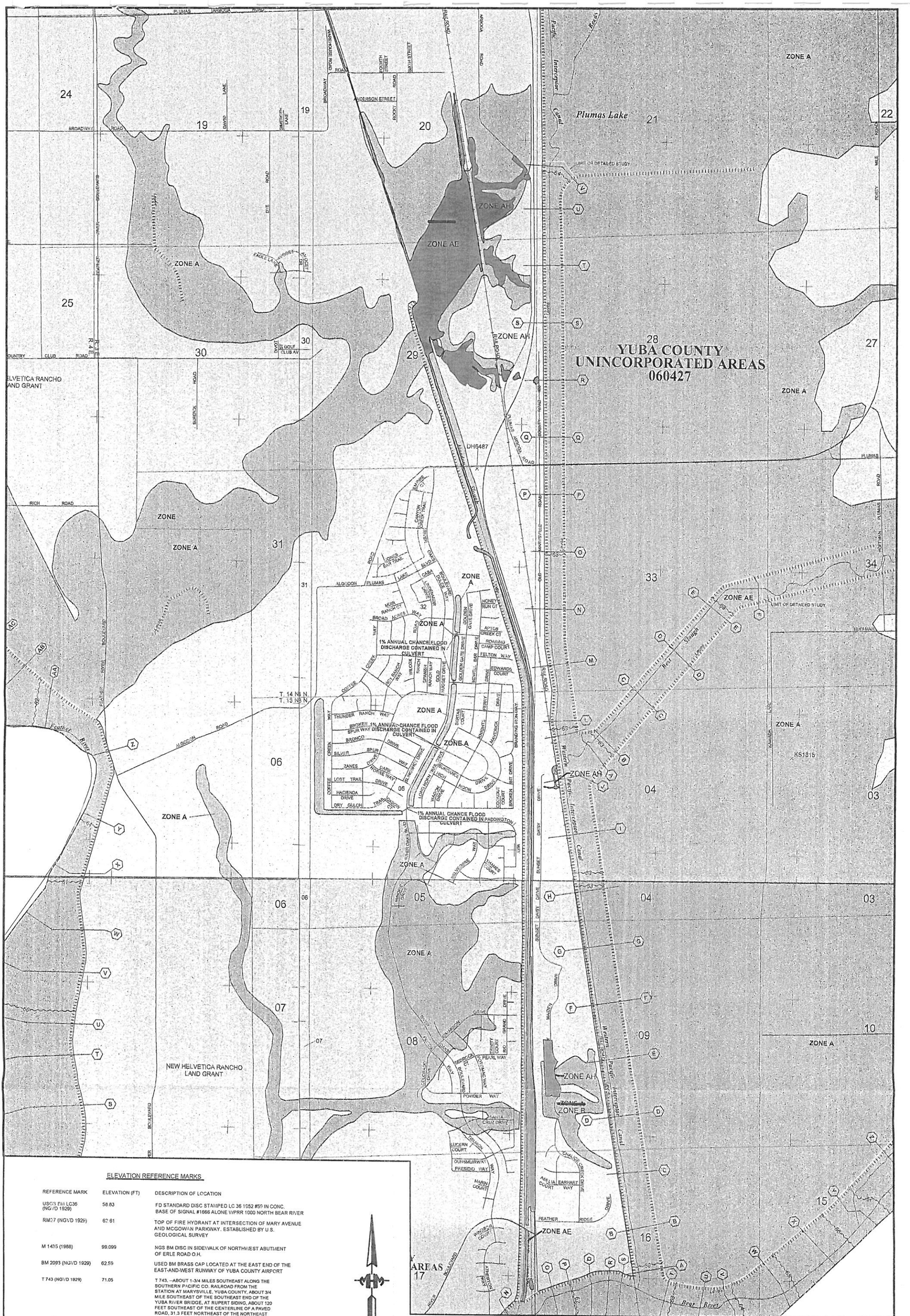
BFE NOTATION

42.35	NGVD 1929
(44.65)	NAVD 88

0 500 1000 2000 4000

SCALE 1"=2000'

FIGURE 9A
RECLAMATION DISTRICT NUMBER 784
BASIN C FLOOD MAP FOR
ULTIMATE CONDITIONS
YUBA COUNTY, CALIFORNIA



ELEVATION REFERENCE MARKS

REFERENCE MARK	ELEVATION (FT)	DESCRIPTION OF LOCATION
USGS FBM LC36 (NGVD 1929)	58.83	FD STANDARD DISC STAMPED LC 36 1952 #59 IN CONC. BASE OF SIGNAL #1666 ALONE WPRR 1000 NORTH BEAR RIVER
RM27 (NGVD 1929)	67.61	TOP OF FIRE HYDRANT AT INTERSECTION OF MARY AVENUE AND MCGOWAN PARKWAY. ESTABLISHED BY U.S. GEOLOGICAL SURVEY
M 1435 (1988)	99.099	NGS BM DISC IN SIDEWALK OF NORTHWEST ABUTMENT OF ERLE ROAD O.H.
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BFE NOTATION

42.35	NGVD 1929
(44.65)	NAVD 88

0 500 1000 2000 4000

SCALE 1"=2000'

FIGURE 9B
RECLAMATION DISTRICT NUMBER 784
BASIN C FLOOD MAP FOR
ULTIMATE CONDITIONS
YUBA COUNTY, CALIFORNIA

2.30 PUMP STATION IMPROVEMENTS

2.31 Development of Plans and Specifications

2.311 Layouts and Details — Site-specific layouts, special details, and standard details should include the following:

- general site layout,
- collection system plan, profile, and details,
- storage unit plan, elevation, and details
- well plan, elevation, and details,
- pump house plan, elevation, and details,
- discharge piping and outfall plan, profile, and details, and
- electrical and mechanical plans and details.

2.312 Specifications, Provisions and General Notes — The designer should use standard specifications to the maximum degree practicable. However, pump stations will usually require special specifications, special provisions, and general notes to include items such as:

- pump performance specifications and tolerances,
- pump installation and testing, and
- special construction requirements.

2.313 Environmental Quality — Any commitments that are made in the EA or EIS should be incorporated into the design. Primary environmental quality issues to be considered include:

- visual impact,
- air quality,
- noise attenuation, and
- water quality.

2.314 Safety — Safety must be a primary consideration for all pump station design and should include provisions for:

- construction personnel,
- inspection and maintenance personnel,
- motorists, and
- the general public.

Provision for adequate access is a primary safety measure for inspection and maintenance personnel. Other considerations include meeting OSHA requirements for station access holes, hoisting, steps, ventilation etc.

2.315 Security — A pump station is often an attraction for children and vandals. The site should be protected both during and after construction. The primary security measures are:

- perimeter fencing,

- intruder alarms,
- concrete or masonry housing, and
- locked louvered windows.

2.32 Testing, Operation and Maintenance

Pump performance tests shall be conducted in place to ensure that pumps perform as specified. Periodic tests during the operational life of the station are appropriate to check continued operating efficiency of the pumping station. Operation and maintenance of pump stations involves frequent inspection, monitoring, and maintenance. RD784 will establish operation and maintenance procedures and schedules. Additionally, it is recommended practice to establish an operation and procedures manual that is to be used after construction of the pump station.

2.40 POND IMPROVEMENTS

2.41 Excavation and Embankments

The storm drainage detention ponds will generally have 3H to 1V waterside slopes, and 2H to 1V landside slopes. A maintenance path of fifteen (15) feet minimum will be provided around perimeter of each pond.

2.411 Cut Slopes — In areas where a cut into the existing ground is required, in general, the excavation slopes in Table 2-5 will apply.

TABLE 2-5
Design Excavation Slopes

Type of Excavation	Minimum Design Slope (H to V)
Temporary cut slopes in soil	1.5 to 1
Permanent cut slopes in soil	2 to 1
Stair-stepped excavation in canal bank	1 to 1
Inspection trench	1 to 1

2.412 Fill Slopes — Fill slopes are to be in accordance with guidelines in Table 2-6.

Table 2-6
Design Fill Slopes

Type of Embankment Fill	Design Slope (H to V)
landside	3 to 1
waterside	4 to 1
ramp	4 to 1

2.413 Design Considerations — Embankment and foundations will be designed by the geotechnical consultant, taking into account the following considerations:

1. Weight of saturated soil mass;

2. Water ponded to the design water surface elevation;

3. Equipment loads to 40 tons;

4. Potential for liquefaction.

The material properties of the levees will be based on the site geotechnical investigations and laboratory testing.

2.414 Freeboard Requirements — All embankments will retain 2 foot of freeboard above the water surface elevation during a 24-hour, 100-year storm event.

2.415 Operation and Maintenance Requirements — In order for the detention pond to provide the required storage, the pond needs to be inspected and maintained on a regular basis. Without regular maintenance the ponds will quickly fill-in and the peak flow rates will increase. Slopes and bottom area need to be kept free of growth of trees and shrubbery that could reduce the storage area. The slopes and foundation also need to be kept free of rodent burrowings, which could allow piping of the embankment material to occur. The slopes will be protected from erosion after construction by seeding with a mixture of suitable grasses and other vegetation.

2.50 STRUCTURAL DESIGN — CONCRETE

Retaining walls and other concrete structures will be designed for earth pressures and hydrostatic loads, the basis, for which, are outlined below.

2.51 Loads

Loads that will be used in design are described in this section. These load related items include dead loads, hydrostatic and uplift pressures, earthquake, bearing capacity, equivalent fluid density, sliding friction, stability, and loading conditions.

2.511 Dead Loads — Dead loads that will be used are as follows:

1. Density of concrete — 150 pounds per cubic foot;
2. Density of steel — 490 pounds per cubic foot;
3. Density of water — 62.4 pounds per cubic foot;
4. Density of moist earth — 125 pounds per cubic foot.

The loadings listed are for general areas only. Where significant point loads could be applied, these will be considered separate from the uniform loadings specified.

2.512 Hydrostatic and Uplift Pressure — Hydrostatic and uplift pressures will be determined in accordance with the Line of Creep Method, as defined in the COE's EM 1110-2-2502, Section 3.19 and/or the Uniform Building Code. The design flood level used to determine pressures will be based upon the design water surface elevations. The pressure will vary based upon the flow path length measured along the bottom of the foundation, including the length of the cut off wall.

2.513 Earthquake — Based upon data received from the geotechnical consultant, horizontal earthquake loading, produced by earth behind retaining structures will be assumed to be a uniform load, equal to 9 times the height of backfill. Seismic loads will only be combined with active earth pressure. Earthquake forces will not be applied to saturated fills since the saturated condition is infrequent nor will incremental earthquake forces be added to moving surcharge loads. The seismic increment for soil backfill will be computed using conventional methods.

2.514 Bearing Capacity — Saturated subgrade ultimate bearing capacity of foundations will be equal to 1,500 psf. Safety factors will used to obtain allowable bearing capacity.

2.515 Equivalent Fluid Density — The equivalent fluid densities that will be used are listed in Table 2-7.

TABLE 2-7
Equivalent Fluid Density

		Equivalent Fluid Density PCF	
Backfill Configuration	Earth Pressure	Drained	Saturated
Level	Active	40	85
	At Rest	60	95
Sloping (3H to 1V)	Active	55	90
	At Rest	80	100
Sloping (4H to 1V)	Active	45	85
	At Rest	70	95
Level	Passive	350	175

2.516 Sliding Friction — For evaluating the stability of retaining walls and other structures, a sliding coefficient of 0.35 between the soil and concrete will be used. Sliding resistance will be based only upon normal load to the foundation.

2.52 Stability

Structures will be designed to resist uplift, overturning and sliding for anticipated normal operation, construction and seismic conditions.

2.521 Loading Conditions — In designing the retaining walls, pump station, and other structure loading conditions and factors of safety will be based upon the Uniform Building Code.

2.53 Concrete Design

2.531 Structural Concrete — Structural concrete for structures will be designed in accordance with the ACI Standard 318-89, *Building Code Requirements for Reinforced Concrete*. The minimum allowable concrete strength will be 3,000 psi.

2.532 Steel Reinforcement — Reinforcing steel will be deformed bars of billet steel conforming to ASTM A615, Grade 60.

2.533 General Design Requirements — All reinforced concrete structures will be designed using the "Strength Design Method."

2.534 Minimum Distribution Reinforcement — Minimum distribution steel will be provided perpendicular to the main reinforcement and will not be less than #4 bars spaced at 18 inches on center.

2.535 Temperature and Shrinkage Reinforcement — Cross-sectional areas of temperature and shrinkage steel reinforcement will be in accordance with the following:

- Wall, each face — minimum percent of the gross area of concrete equal to 0.25 will be used all structures.

2.536 Reinforcing Bar Cover – Clear protective bar cover is listed in Table 2-8.

TABLE 2-8
Clear Protective Bar Cover

Surface	Inches
Surfaces cast against soil	3
Surfaces subject to water	2
Other exterior surfaces	2
Interior surfaces	1.5

2.537 Bar Splices, Anchorages and Development Lengths – Bar splices and development lengths will be in accordance with the ACI Standard 318-89 for all structures.

2.60 DRAINAGE PIPE AND STRUCTURES

The drainage pipe and structures will comply with current industry standards. Structural concrete for drainage structures shall conform to Section 2.50.

2.70 CHANNEL IMPROVEMENTS

Should improvements or maintenance to earthen drainage channels be necessary, the following shall apply.

2.71 Development of Plans and Specifications

2.711 Layouts and Details — Site-specific layouts, special details, and standard details should include the following:

- general site layout,
- collection system plan, profile, and details,
- channel unit plan, elevation, and details

2.712 Specifications, Provisions and General Notes — The designer should use standard specifications to the maximum degree practicable.

2.713 Environmental Quality — Any commitments that are made in the EA, EIS or Clean Water 404 Permit should be incorporated into the design. Primary environmental quality issues to be considered include:

- visual impact,
- air quality,
- impact on wildlife,
- noise attenuation, and
- water quality.

2.714 Safety — Safety must be a primary consideration for all channel design and should include provisions for:

- construction personnel,
- inspection and maintenance personnel,
- motorists, and
- the general public.

2.72 Excavation and Embankments

2.721 Slopes — The channels will generally have 3H to 1V waterside slopes, and 2H to 1V landside slopes. Waterside embankments as steep as 1.5H to 1V may be used if designed and certified by a Geotechnical Engineer. The material properties of embankments will be based on the site geotechnical investigations and laboratory testing.

2.722 Access — A maintenance path of fifteen (15) feet minimum will be provided on each side of the channel. An all-weather road surface must be provided on one side.

2.723 Freeboard Requirements — All embankments will retain 2 foot of freeboard above the water surface elevation during a 24-hour, 100-year storm event.

2.724 Operation and Maintenance Requirements — In order for the channel to provide the required conveyance, the channel needs to be inspected and maintained on a regular basis. Without regular maintenance the channel may fill-in. Slopes and bottom area need to be kept free of growth of trees and shrubbery that could reduce the conveyance capacity. The slopes and foundation also need to be kept free of rodent burrowings, which could allow piping of the embankment material to occur. The slopes will be protected from erosion after construction by seeding with a mixture of suitable grasses and other vegetation.

3.0 BORROW AND DISPOSAL SITES

3.10 BORROW

3.11 General

The extension of the linear detention basin should provide all necessary borrow material. The geotechnical field exploration and laboratory testing will provide the basis of the material's suitability for use as pond embankment and/or pipe backfill. The disposal sites will be evaluated for the following design considerations:

1. Material suitability for pond and backfill construction;

2. Identification of haul routes;

3. Site availability (right-of-way acquisition problems/conditions, including any requirements for temporary construction easement;

4. Environmental concerns.

3.12 Locations

The locations being investigated as sources of disposal of excess material shall be determined, but could include as necessary:

1. The available land within the project area;

2. Any adjacent landowner requiring dirt.

The properties of the material will be identified in a separate report to be prepared by the geotechnical consultant as part of the Detention Pond Design and Construction.

3.13 Environmental Impacts

Design actions regarding environmental impacts will be addressed in the design documents.

3.14 Haul Routes

Haul routes will be specified on the haul route plans. Damages to existing roads will be repaired at the completion of the project. Haul routes will be selected to minimize road damage to the extent feasible.

3.20 DISPOSAL AREAS

3.21 Disposal Areas Within Work Area

Materials that are surplus or unsuitable (such as gravel surfacing, unsuitable materials originating from clearing and grubbing operations, or from other construction activities) may be disposed of within the project work area as follows:

1. Materials stripped or removed from the existing embankments may, if suitable, and subject to the approval of the Engineer, be incorporated into future fills for lot construction or other embankments;

2. At disposal sites located by the contractor, providing they meet current regulations for disposal of materials and are approved by the Engineer.

3. At locations identified by Yuba County.

3.22 Disposal Areas Outside Work Area

Materials that are surplus or unsuitable for use to construct embankments may be disposed of outside the work area as follows:

1. At the Yuba County landfill.

2. At disposal sites located by the contractor, providing the locations meet current regulations for disposal of materials.

4.0 MISCELLANEOUS

4.10 ACCESS RAMPS

4.11 Temporary Ramps

Temporary earthen ramps for construction purposes are not part of the design. With advance approval by Reclamation District 784, the contractor at the Contractor's discretion may construct temporary ramps. Unless a request to the Contractor to the contrary, temporary ramps constructed by the contractor for construction convenience will be removed at the completion of construction.

4.12 Permanent Ramps

Permanent earthen access ramps will be designed for construction at the locations of existing ramps and at other locations shown on the drawings.

4.20 SURVEY MONUMENTS RELOCATION

Locations of survey monuments will be shown on the Contract Drawings. The datum used shall be clearly documented. There may be permanent USGS, FEMA or NGS elevation reference mark monuments within the limits of the project that may require relocation.

4.30 NOT USED

4.40 EROSION PROTECTION

4.41 Proposed Erosion Control Measures

All the disturbed areas will be hydroseeded and/or broadcast seeded as part of the construction work. Areas with limited sunlight, and thus, vegetation will not be considered effective in these locations.

If vegetation does not provide adequate erosion protection, stone protection will be used. For this project, where grass cover is anticipated and velocities are over 4 fps, stone protection will be used. Stone protection will be designed in accordance with Chapter 3 of the COE's EM 1110-2-1601.

4.50 POND AND BANK PROTECTION

4.51 Proposed Pond and Bank Stabilization

Table 4-1 is a summary of the proposed pond and bank stabilization.

TABLE 4-1
PROPOSED POND AND BANK STABILIZATION

Channel Conditions		Proposed Stabilization
1.	Pond and banks appear stable with maximum velocities of less than 3 fps in the hydraulic model.	None - Erosion protection (vegetation) only.
2.	Pond and banks show evidence of local erosion problems, but maximum velocities appear to be less than 3 fps.	Local stone protection, based on a site-by-site investigation.
3.	Pond and banks appear stable with maximum velocities of less than 4 fps.	If the banks can be flattened to 3H to 1V and it is reasonable to maintain a grass cover, hydroseeding and/or broadcast seeding will be deemed adequate.
4.	The pond and banks in the vicinity of outfall structures where velocities are in excess of 3 fps. Condition outlined in Item 3 above cannot be met, i.e. where maintaining a grass cover does not appear to be reasonable.	Stone protection designed and installed in accordance with requirements of Chapter 3 of the COE's EM 1110-2-1601.

4.60 FENCING AND GATES

4.61 General

Reuse of existing gates and fencing will be specified wherever feasible and where the existing fencing and gates comply with RD784 and Yuba County criteria. Contractor installed convenience fencing and/or gates will be removed by the contractor prior to completion of construction.

4.62 Location

Temporary –

1. Chain link fencing will be installed if required for the contractor's convenience.

2. Staging areas will be fenced as deemed necessary by the contractor and/or property owner. Fences may be left in place with approval of the property owner.

Permanent –

1. When existing fences are to be relocated due to right of way revisions, conflicts or other reasons, existing fences will be removed and reused where practical, and if they comply with current RD784 and Yuba County criteria.

2. Some wooden fences and chain-link fences may have to be relocated. If the existing fences cannot reasonably be relocated, new fences, similar to the original fence, will be installed. Wood fencing adjacent to RD 784 facilities are not acceptable. Chain link fencing is the minimum with masonry block or wrought iron acceptable alternatives.

3. If fencing is required around the perimeter of ponds, gates must be provided at a location to allow access to maintenance personnel.

4.63 Criteria

When appropriate and practical, existing fencing and gates will be reused. When new fencing and gates are required, it will meet the requirements of Reclamation District 784, the Yuba County Standards and Caltrans Standards. The types of fencing anticipated are:

1. Chain link fencing – 6 foot high.

2. Gates – 6 feet by 14 foot wide, single and/or double swing gates with locks for access control.

3. Wood fencing adjacent to RD 784 facilities are not acceptable. Chain link fencing is the minimum with masonry block or wrought iron acceptable alternatives.

4.70 CLEARING

4.71 General

Clearing will only be specified in actual areas of improvement work. Clearing will be in accordance with any requirements of the Reclamation District 784, Yuba County and Caltrans Standards.

4.72 Criteria

Clearing criteria is contained in the following list.

1. Organic materials: Strip and dispose of all materials containing organic materials.

2. Brush and trees: Completely remove all trees and brush above ground level. Completely remove all tree and brush stumps, including taproots and lateral roots to 1-1/2 inches in diameter. Grub all stumps to depths of 3 feet for trees and 12 inches for brush.

3. Allowance for removal of organic material, brush and trees will be accounted for in developing the quantities of available embankment materials that can be expected from each borrow site.

4.80 UTILITY LINES

4.81 General

Included is a criterion for handling overhead utility lines, buried pressure flow water pipes, pressure gas mains, other utilities, and related structures.

4.82 Locations

3 Underground utility lines and structures exist within the work limits. Such lines and structures will be located and shown on the plans to the extent possible. Locations will be established by field survey where this is possible. Utility owners known to have facilities within the work area will be contacted to coordinate relocation as needed. Utility locations shown on the plans will be the best available location information based on examination of as-builts and existing owner-furnished information.

4 Potholing during construction is anticipated to verify depth and location of existing utilities. Potholing requirements will be established in consultation with the utility owner.

5 Overhead utility lines also exist along and across the project levees. Locations of these lines will be shown on the plans. Clearances from existing ground will be established by field surveys. Facility owners will be consulted regarding the need to raise existing lines or to temporarily re-guy utility poles to comply with applicable safety orders or for construction convenience. It will be the responsibility of the utility owner to make relocations as required.

4.83 Criteria

Pressure Lines –

a. Pipelines will be analyzed to demonstrate structural capacity to withstand (with adequate margins of safety) all imposed loads, including H-20 vehicular wheel loading. Structural integrity may be maintained by increasing cover or providing load carrying bridging devices.

b. Pipelines will be analyzed to demonstrate structural capacity to withstand (with adequate margins of safety) all imposed loads.

c. Buried pipelines belonging to utilities such as PG&E may require protection during construction. Cover will be in accordance with utility requirements or requirements as specified in design guides and manuals to accommodate traffic during construction and to accommodate H-20 loadings during later operation and maintenance.

d. All pump discharge pipes will be tested at the maximum anticipated pressure before they are covered and put into use.

e. Backfill will be accomplished in compliance with the County of Yuba standards.

Gravity Lines –

a. Existing pipes must be examined and carefully evaluated to determine their structural adequacy if they are to remain in use. The need to repair and/or rehabilitate existing gates and flap gates will be evaluated.

5.0 LANDSCAPING

5.10 GENERAL

There will be no landscaping treatment other than hydroseeding and/or broadcast seeding of pond and channel embankments and other areas that have been stripped of vegetation.

5.20 LOCATION

1. All channel slopes disturbed by construction activities will be hydroseeded to minimize erosion.

2. All other areas disturbed by the Contractor's operations will also be hydroseeded and/or broadcast seeded.

3. Hydroseeding and/or broadcast seeding will be performed during weather conditions that are normal for this type of work.

5.30 CRITERIA

The type of seeding required and how it is to be accomplished will be coordinated with all involved parties.

Specifications for hydroseeding and/or broadcast seeding will include designation of a specific seed mix and application/treatment procedure. To maximize germination, seed mix and treatment/procedures utilized will be appropriate for and compatible with existing site conditions, soil types, site specific environmental conditions, and general Sacramento Valley environmental conditions.

6.0 CONSTRUCTION COST ESTIMATES

6.10 GENERAL

Construction Cost estimates are to be prepared for all work to be performed by the Contractor. Bid items are to be specified for all items required to complete the improvements identified in the Contract Documents for the RD784 Basin C Improvement Project. Quantities are to be calculated by use of information identified in the Contract Documents.

6.20 FORMAT

The format to be used will display the following:

1. Item number
2. Description of item
3. Estimated quantity
4. Unit
5. Unit price
6. Item price
7. Total price.

The quantity units will generally be cubic yard, square yard, acre, ton, each, lump sum, or other unit appropriate for the type of work covered by the estimate or line item.

6.30 CRITERIA

Unit prices for construction cost estimates will be determined through the use of cost data from past jobs of a similar nature; estimating guides such as Means, Dodge, and CALTRANS; reference sources such as *Engineering News Record* quarterly cost roundup; and other appropriate estimating guides. Where necessary, suppliers may be contacted to obtain preliminary or budgetary price information.

7.0 SPECIFICATIONS

7.10 GENERAL

The technical specifications for the required work will be prepared in accordance with the format of Yuba County and the California Department of Transportation.

7.20 FORMAT

The content of each technical specification section will be divided into four main parts as follows:

Part	Description
1	General
2	Products
3	Execution
4	Measurement and Payment

Within each part will be the specific details of what is to be followed by the Contractor in carrying out the work.

7.30 CONTENT

The technical sections that are expected to apply to the Technical Provisions are as follows:

Division	Description
1	Definitions
2	Proposal and Contract Requirements
3	Control of Work
4	Legal Regulations
5	Water and Dust Control
6	Progress of the Work
7	Payment
8	Quantities and Materials
9	Safety-Precautions
10	Description of Work
11	Mobilization-Demobilization
12	Demolition and Reuse of Materials
13	Clearing and Grubbing

14	Earthwork
15	Structure Excavation and Backfill
16	Stone Protection
17	Gravity Piping
18	Discharge Piping
19	Erosion Control
20	Concrete
21+	Others as required

8.0 DESIGN STANDARDS

8.10 GENERAL

The project work will be designed in accordance with standards that are acceptable to Reclamation District No. 784.

9.0 RIGHT-OF-WAY

9.10 GENERAL

To be determined.

9.20 REQUIREMENTS

Any right-of-Way engineering for acquisition of the lands necessary for implementation of the Project will be performed to the current standards of Reclamation District No. 784.

10.0 PERMITS

10.10 GENERAL

Various regulatory agencies have jurisdiction over the Project, including authority to impose conditions affecting Project implementation. These agencies impose their jurisdiction through issuance of conditional permits.

APPENDIX
(Current Conditions HEC-1 Output)

APPENDIX
(Current Conditions HEC-RAS Output)

APPENDIX
(Ultimate Conditions HEC-1 Output)

APPENDIX
(Ultimate Conditions HEC-RAS Output)