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Flood Emergency Response Program

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High Water Event Data Collection Manual

California Department of Water Resources

October 2010

FloodSAFE CALIFORNIA DEPARTMENT OF WATER RESOURCES

High Water Event
Data Collection Manual

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Abbreviations and Acronyms

Coop Ag	Cooperating Agency
CDEC	California Data Exchange Center
CNRFC	Califonria-Nevada River Forecast Center
CVFPB	Central Vally Flood Protection Board
DFM	Division of Flood Management
DOE	Division of Engineering
DWR	California Department of Water Resources
FDC	Flood Data Committee
FOC	Flood Operations Center
FPIIB	Floodplian Integrity and Inspection Branch
GIS	Geographic Information System
HW	High Water
HWM	High Water Mark
JOC	Joint Operations Center
LMA	Local Maintaining Agency
MA	Maintenance Agency
NWS	National Weather Service
QA/QC	Quality Assessment/ Quality Control
QPF	Quantititative Precipitation Forecast
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

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Executive Summary

High water data provides basic information on the performance of the flood system and an objective method to characterize a historical high water event. High water data are a valuable resource in understanding current flood system conditions and guiding future flood system improvements.

The importance of high water data has long been recognized. Chaired by the DFM Chief, a flood data committee was initiated in the 1970's as an effort to organize and standardize high water data collection efforts across the State of California. This committee established protocols for data collection, including, when to initiate data collection and who would collect data on a reach-by-reach basis. Since high water data collection was typically tied to emergency funds, there was no funding mechanism to allow the flood data committee to continue to function on a permanent basis. The committee last met in 2003.

DWR currently has many ongoing efforts (FloodSAFE, CVFED) aimed to characterize and enhance the level of protection provided flood system. As such, the collection and organization of high water data is more critical now than ever. This report was developed to document and organize DWR's high water data collection program. The report has been organized into the following distinct areas:

- Pre-season activities
- Initiation of high water data collection
- Obtaining high water staking and surveying
- Acquiring aerial photography and/or videography
- Data QA/QC and archiving

In addition to the report elements, there is flow chart (Appendix A and a copy in the Executive Summary) which is color coded such that the group (within and outside of DWR) responsible for carrying out each activity on the chart is identified. These groups are:

- Joint Operations Center (JOC)
- Hydrology and Flood Operations Office
- Hydrology Branch
- Flood Project Inspection and Integrity Branch (FPIIB)
- Cooperative agency

- Photogrammetry and Mapping
- Graphic Services

In developing the material for this report, representatives of the agencies have been contacted and interviewed to ensure their roles in the high water data collection process has been accurately understood and/or portrayed. The interview transcripts are contained in Appendix D.

This report provides a framework for the Department's high water data collection program. It is thought that this effort will promote successful execution of future high water data collection activities and provide the framework to facilitate future high water data collection enhancements.

It is noted that with rapidly advancing technology more robust methods of data collection will be needed in the future. A separate report will address this issue.

California Department of Water Resources - Division of Flood Management
High Water Documentation Program - Flow Chart
(Checklist for Pre-Season Actions)

[Task #1 Program]

Review criteria for high water (HW) staking

(Ref. 4.1)

Coordinate Agency participation (LMA, Corps, USGS, etc...)

(Ref. 4.2)

Review format for HW staking archiving - Update as needed

(Ref. 4.3)

Update criteria for aerial photography/videography

(Ref. 4.4)

Update criteria for photography type (capture medium, scale) based on condition (levee break, high water, etc...)

(Ref. 4.5)

Assure all contracts are in place that are required to support staking, surveying, photography, videography

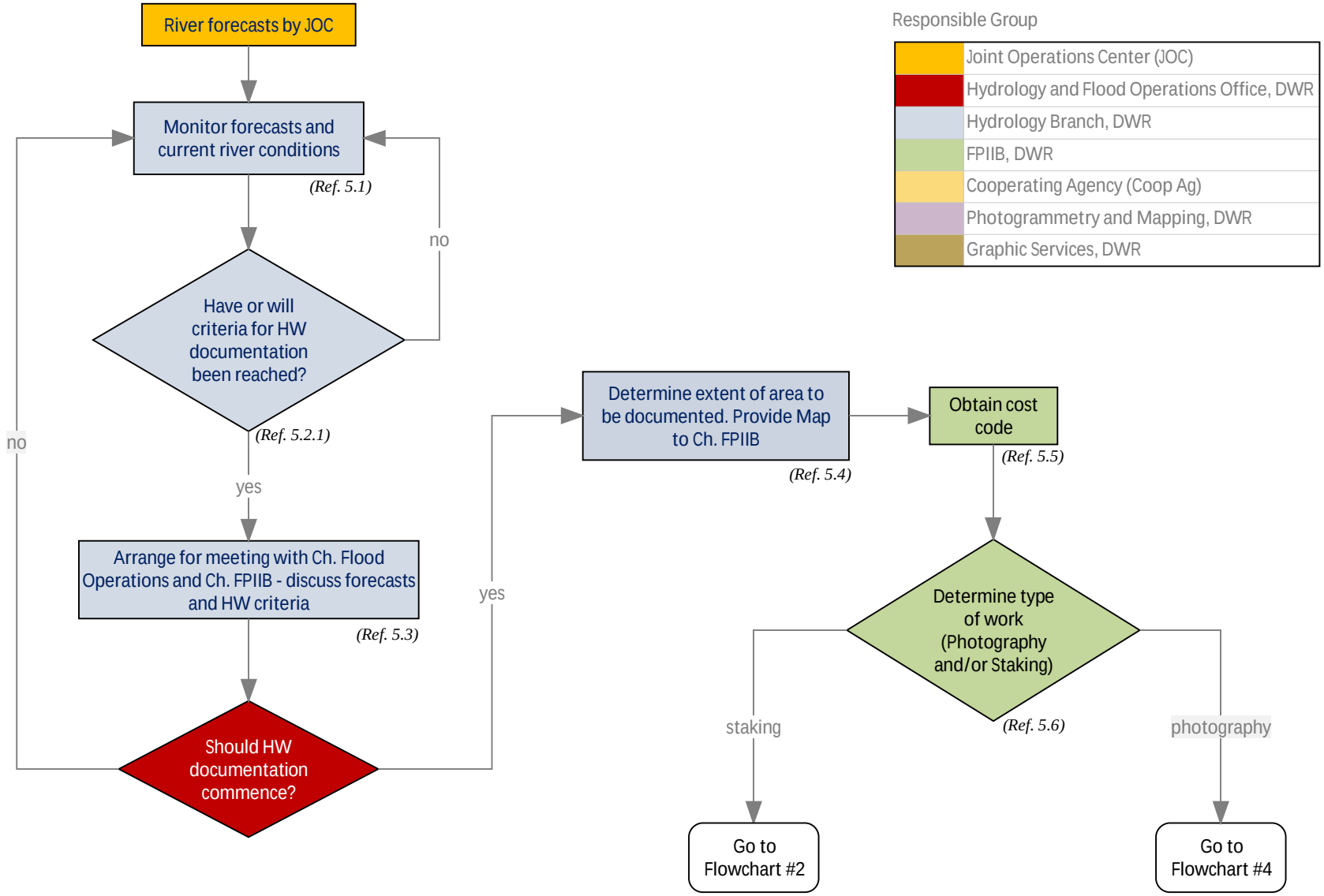
(Ref. 4.6)

Responsible Group

	Joint Operations Center (JOC)
	Hydrology and Flood Operations Office, DWR
	Hydrology Branch, DWR
	FPIIB, DWR
	Cooperating Agency (Coop Ag)
	Photogrammetry and Mapping, DWR
	Graphic Services, DWR

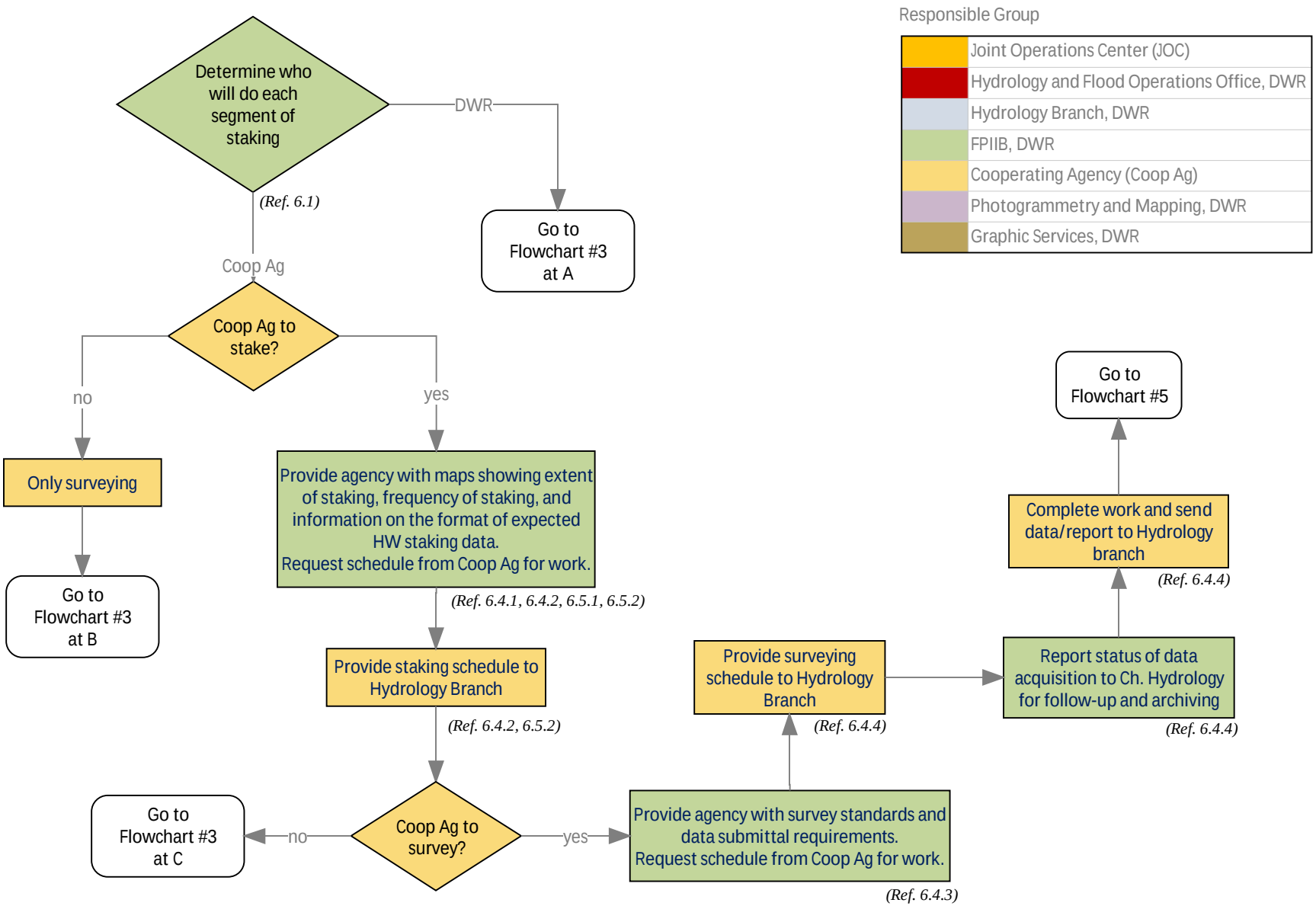
California Department of Water Resources - Division of Flood Management
High Water Documentation Program - Flow Chart
(Flowchart #1: Decision Process to Initiate High Water Documentation)

[Task #1 Program]



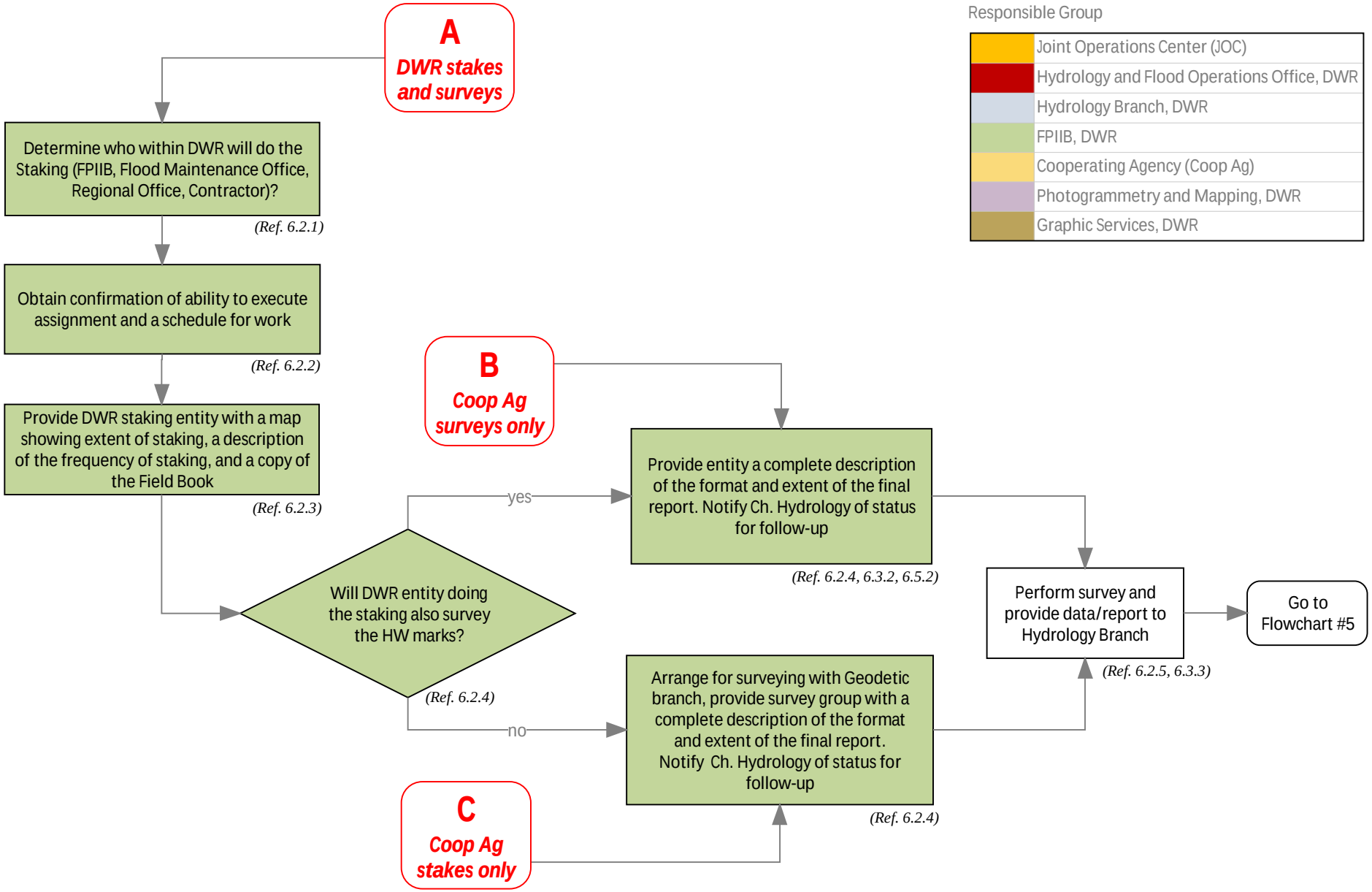
California Department of Water Resources - Division of Flood Management
High Water Documentation Program - Flow Chart
(Flowchart #2: Obtain High Water Staking - Page 1/2)

[Task #1 Program]



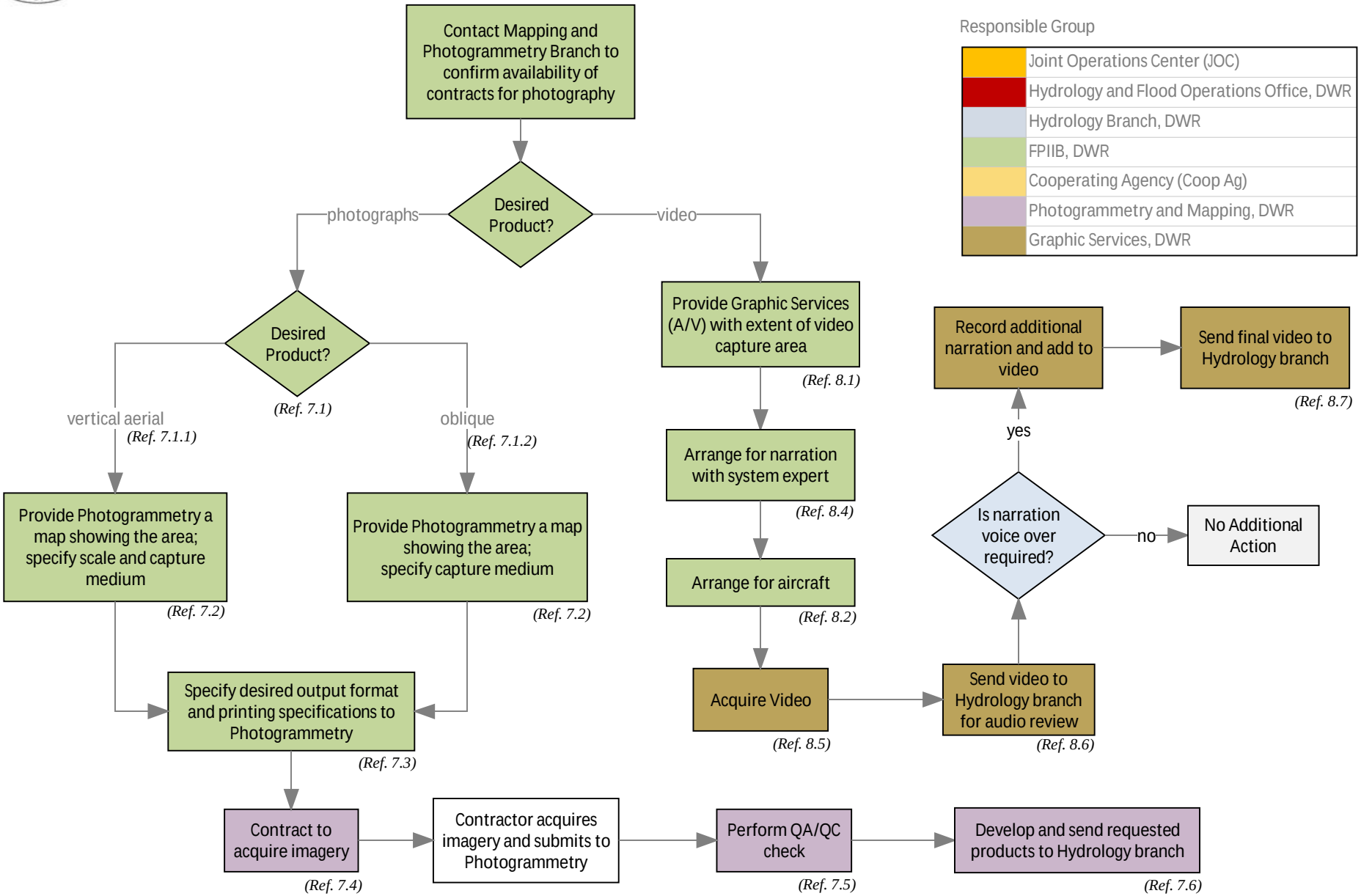
California Department of Water Resources - Division of Flood Management
High Water Documentation Program - Flow Chart
(Flowchart #3: Obtain High Water Staking - Page 2/2)

[Task #1 Program]



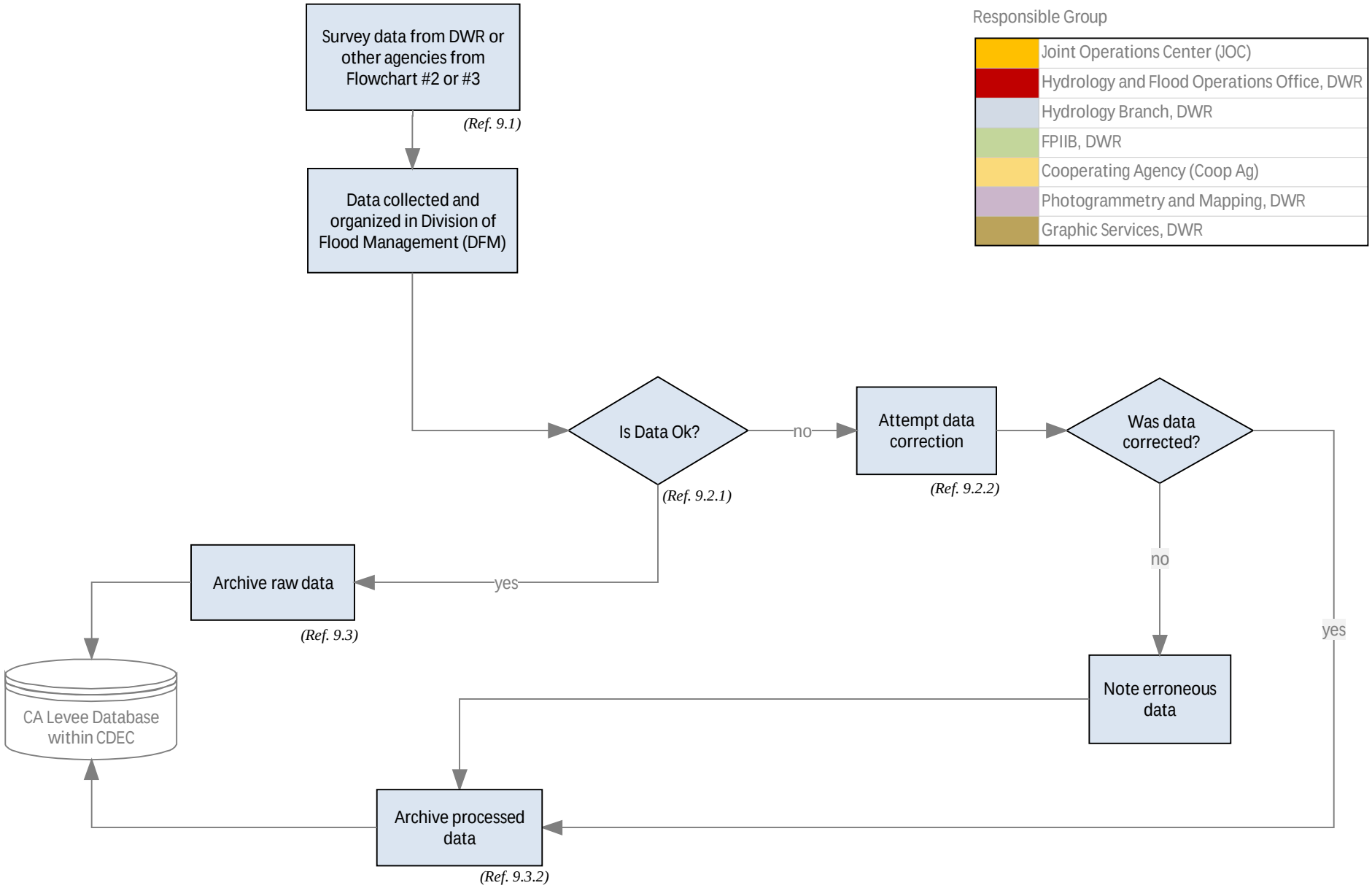
California Department of Water Resources - Division of Flood Management
High Water Documentation Program - Flow Chart
(Flowchart #4: Acquisition of Photography and Videography)

[Task #1 Program]



California Department of Water Resources - Division of Flood Management
High Water Documentation Program - Flow Chart
(Flowchart #5: Data QA/QC and Archiving)

[Task #1 Program]



1 Introduction

1.1 Motivation

The California Department of Water Resources (DWR) has initiated a high water data collection and documentation effort to fulfill the following objectives:

- Coordinate high water data collection resources;
- Maintain appropriate criteria for initializing data collection;
- Survey high water marks;
- Collect aerial photography and videography;
- Set and maintain updated standard procedures for collecting flood data;
- Establish and maintain temporary benchmarks, base maps, and field manuals;
- Centralize, automate, and maintain collected data to increase availability.

This high water data collection manual has been developed to formalize the procedures and standards which will help in meeting these objectives

1.2 Data Uses

It is anticipated that high water data collected under this program will, at a minimum, be used for the following purposes:

- Hydrologic analysis
- Hydraulic performance of rivers and channels
- Levee stability and freeboard analysis
- Seepage studies

Other uses may become more apparent as the data is collected and centralized or as new analyses and techniques are developed.

2 Background

2.1 General data collection

High water data collection refers to the information which is collected during a high water (e.g., flood) event. Although the means and techniques for data collection have evolved throughout time, high water data has been collected and stored in California for well over 100 years.

High water data may be captured by several means. The commonly utilized methods of collection are:

- Continuously recording stream gages
- Observing staff gages
- Crest gages
- High water staking
- Aerial photography
- Aerial videography

These methods are employed to fulfill the purpose of high water data collection. Although the focus of any given high water data collection effort may be quite narrowly focused, the underlying purpose generally falls into one of two broad categories:

- To gain an understanding of the behavior of a water system
- To document a flood or high water event
- To support Hydraulic Model Calibration

2.2 Flood Data Committee

The Flood Data Committee (FDC) was conceived in the 1970's. Its membership consisted of personnel from DWR Flood management and from cooperating federal, state, and local agencies. Its purpose was to coordinate the collection of field flood data. The FDC intended to collect flood data primarily for engineering studies and to provide basic data for documentation of large floods and to assist in forensic studies associated with litigation. The FDC was to discuss and update the criteria as needed. It was intended that this program would be ongoing year round and meet at least twice a year. Due to lack of funding and a clear commitment from all participating agencies, the FDC is no longer active.

2.3 Emergency Operations - SEMS ICS

High water data will frequently be collected when DWR is responding to a flood emergency. During these periods the organizational structure is temporarily modified to streamline the organizations response to the emergency. This report has identified the operational units of DWR and their respective responsibilities under non-emergency periods. During emergency conditions they will maintain their responsibilities even though they may have a new emergency organizational designation.

3 Organization

This report is organized such that it can be accessed in two ways. First, it can be read from beginning to end for a comprehensive view of the DWR high water data collection program organization. Secondly, this document can be used as a reference manual in conjunction with the flowchart provided in Appendix A. This flowchart is a comprehensive representation of the high water data collection process for DWR. On the flowchart, each task associated with high water data collection is defined and assigned a responsible group to carry out the task. The report organization closely follows the organization of this flow chart. The high water documentation program is under the management of the Chief of the Division of Flood Management at DWR. The DFM provides for monitoring of high water conditions, training for DWR staff and Cooperating Agency (Coop Ag) personnel and for systematic archiving of high water data.

4 Pre-Season Activities

DWR and Coop Ag participation in pre-season activities is important to ensure personnel are prepared for HW data collection during the upcoming flood season. Furthermore, pre-season review and coordination allows for year-to-year changes to the HW data collection program that are necessary to ensure its adaptability and successful implementation.

4.1 Review criteria for high water staking

The current criteria for initiating High Water Documentation Program are included in Appendix B of this report. It is the responsibility of the Hydrology Branch to ensure the criteria are up to date and represent the goals and objectives of the HW data collection program.

4.2 Cooperating Agency (Coop Ag) participation

Cooperating Agency (Coop Ag) participation is a key component in the successful implantation of the HW data collection program. The Coop Ags provide the necessary manpower to carry out the collection of HW information. Active Coop Ag participation is especially crucial during large flood events, when DWR staff may be fully occupied with other, non-HW collection related duties.

During the pre-season, the Chief of FPIIB must assess the ability of Coop Ag's participation in the HW data collection program. To do this, the Chief of FPIIB will perform the following actions:

- Check with Coop Ag points of contact to ensure their participation and verify contact information
- Organize and facilitate a pre-season meeting for DWR staff and Coop Ags with critical HW data collection responsibilities to ensure each participant is aware of their responsibilities and standard of the HW data collection program. (This could be a portion of another pre-season meeting to training session.)

4.3 Review format for high water staking archiving

The format of data collection in HW documentation program is outlined in Appendix C. It is the responsibility of the Hydrology Branch to review this format to make sure it meets the

current requirements and needs of the program. If revisions are necessary, it is the responsibility of the Hydrology Branch to update this standard.

4.4 Update criteria for aerial photography/videography

Aerial photography/videography provides an integrated view of large areas during high water events as well as a cost effective way of interpreting the response of the flood system. Therefore, the Hydrology Branch should the review (on an annual basis) the criteria for aerial photography/videography to ensure it is kept up to date and reflects current techniques and standards of practice. This should include reviewing:

- standards for percentage allowable overlapping (See section 7.2)
- type of aerial photography (vertical or oblique) (See Section 7.1)

The Hydrology Branch, along with FPIIB, needs to coordinate with the Geodetic Branch of DOE for aerial photography and the Graphic Services Branch for videography.

4.5 Update criteria for type of photography based on condition

The Hydrology Branch is to update the criteria for photography based on specific conditions, e.g., levee breaks, high water events, etc. In this process, the Hydrology Branch should review scale/resolution as well as of the photography medium. (See Table 2 in Section 7.2)

4.6 Assure all contracts are in place

Review and ensure that all contracts are in place for different activities under high water documentation program, i.e. staking, surveying, acquiring photography/videography, etc.. The contract could be within DWR entities (offices/branches), between DWR entities and Coop Ags, and/ or between DWR entities and responsible private companies. These contracts are primarily with aerial photography companies and for field services (AE contracts) if needed. The FPIIB is responsible for this activity.

5 Initiation of High Water Documentation

The HW documentation criteria are established to assist in initializing the data collection process. The current criteria are shown in Appendix B. Data to be collected once the decision is made to gather the data may include:

- HW staking and surveying
- Aerial photography
- Videography
- Recording of statements
- Ground-based photography
- Other suitable forms that provide relevant information to document a high-water event

The decision to collect data usually involves consideration of funding, timing, and relative benefits, among other things

If the high water data collection criteria are met for a particular waterway, close coordination between the DWR entities (office/branches) and Coop Ags must be maintained. It is the responsibility of the Hydrology Branch to coordinate these activities.

5.1 Monitor forecasts and river conditions

This task is performed by the River Forecasting Section of the Hydrology Branch, which is a component of the joint NWS/DWR river forecasting program. From about mid-October through July a joint State-Federal forecast team continuously monitors river stages and weather conditions to maintain awareness of any high water potential. As major storm systems approach California, forecasters from the NWS and DWR predict the location, amount and timing of expected precipitation and snow level, commonly referred to as quantitative precipitation forecast or QPF. The QPF is used to produce forecasts of watershed runoff and reservoir inflow that are then used to make river forecasts.

5.2 Evaluate criteria for high water documentation

5.2.1 Screening criteria

If runoff is sufficient to raise streams to threatening levels, then NWS/DWR issue these forecasts as official public bulletins for all the ten hydrologic regions of California (Figure 1). At this time, maintaining agencies (MA) on leveed streams are required to patrol their levees on a 24-hour basis as long as the river level is at or above monitor stage, and until the threat to the levees is reduced.

Figure 1. Hydrologic Regions of California

5.2.2 Trigger criteria

Appendix B contains the existing trigger criteria which are used to determine, on a reach-by-reach basis, when HW documentation is to commence.

5.3 Discuss forecasts and high water criteria

When waterways are forecast to rise above (flow or stage) their respective trigger levels (Appendix B), the Chief of Hydrology Branch arranges a meeting with the Chiefs of Flood Operations Office and FPIIB to review the forecast information in conjunction with the trigger criteria. Based on this assessment, the Chief of the Hydrology and Flood Operations Office decides whether or not to commence HW documentation acquisition.

5.4 Determine area extent of documentation

Once the decision has been made by the Hydrology and Flood Operations Office to commence HW data acquisition, the Chief of Hydrology Branch of DWR determines extent of area for which high water documentation will be provided. A map delineating these areas selected for documentation will be provided to the Chief of the FPIIB.

5.5 Obtain cost code

The FPIIB coordinates with the DWR Finance Department to obtain cost codes to which data acquisition related to high water documentation program can be charged. In case of delay in getting the ultimate cost codes, the Chief of FPIIB may request temporary cost codes from the Finance Department to cover immediate expenses.

5.6 Determine type of documentation

The FPIIB must determine the type of works to be performed under the high water documentation program, i.e. high water staking, aerial photographs, or video. This determination needs to be made quickly to maximize the opportunity to gather the highest quality data. Table 1 lists the factors that may influence the type of documentation to be ordered.

Table 1. HW documentation type by need.	
Type	**Needed When**
Stake/survey	• When absolute water surface elevations are desired to characterize flood system • Whenever a levee failure occurs
Aerial photography	• When overall or lateral extent of flooding needs to be captured • When overall property damaged needs to be assessed • Whenever a levee failure occurs
Video	• When flooding in a large area needs to be captured • When progression of flood through time needs to be captured • When documentation of flood fight activities is desired

6 High Water Staking and Surveying

6.1 Form teams to accomplish HW staking and surveying

In order to accomplish the HW documentation, the appropriate agency needs to be identified. A tabulation of criteria for staking is attached as Appendix B.

FPIIB must complete several actions to provide requisite information to the entity doing the staking. In all cases, FPIIB must provide maps showing the area to be staked for each individual group of HW stakers. The map will include instructions on the frequency of stakes. For the most part, the main river system and bypass stakes will be placed at intervals of approximately 1 mile. Additional stakes will be placed upstream and downstream from bridges and tributary confluences (within 500 feet, if possible). If it is determined that more frequent staking is desirable the map should include the appropriate instructions. FPIIB should also prepare instructions for the format and standards that will be needed to complete the surveys of the HW stakes. Samples of standard forms to be completed by the staking and/or surveying teams are attached as Appendix C.

Four cases (scenarios) may arise depending on responsibility and roles assumed by DWR and its Coop Ags:

Case 1: DWR performs both staking and surveying (Section 6.2)

Case 2: DWR performs staking and not surveying (Section 6.3)

Case 3: Cooperating Agency performs both staking and surveying (Section 6.4)

Case 4: Cooperating Agency performs staking and not surveying (Section 6.5)

6.2 Case 1:- DWR will stake and survey

6.2.1 Determine who within DWR will do the Staking (FPIIB, Flood Maintenance Office, Regional Office, Contractor)?

FPIIB determines and assigns responsibility of staking to different offices, Regions/ branches/ sections within DWR. The decision to stake HWMs usually involves consideration of funding, timing, relative benefits, manpower availability, and other factors.

6.2.2 Obtain confirmation of ability to execute assignment and a schedule for work

Once an entity (office, region/ branch/section) within DWR is assigned the responsibility for the high water staking and/or surveying, FPIIB contacts the respective DWR entity to confirm the assignment and also to obtain a schedule for work. Experience has shown that the HWMs completed closest (in time) to the occurrence of the peak are most reliable.

6.2.3 Provide DWR staking entity with a map showing extent of staking, a description of the frequency of staking

As discussed above (6.1) a map, staking frequency and survey requirements and guidance on how to perform the staking will be provided to the DWR organizational element responsible for obtaining the HW data.

6.2.4 Arrange for surveying

If the DWR entity that conducted the staking also agrees to survey the HWMs, FPIIB would provide that entity a complete description of the format and extent of the final report. Otherwise, i.e. if that DWR entity does not survey HWMs, it would be the responsibility of FPIIB to task the Geodetic Branch, Division of Engineering of DWR to provide the survey of the HW Staking. FPIIB will provide all necessary documents, e.g. maps showing area to be surveyed, format of reporting requirements, instructions and guidelines for the survey, etc to the Geodetic Branch. The standard format for the survey data (see Appendix C) will be provided to the Geodetic Branch. If the Geodetic Branch does not have the capability to complete the survey “in-house”, they may use AE contracts to get the work completed. They will deliver the survey outputs to the Geodetic Branch, which in turn will submit the outputs to the Hydrology Branch.

6.2.5 Data Submittal

The completed surveyed HWM data will be submitted to FPIIB. FPIIB will confirm the package is complete and transmit to the Hydrology Branch for archiving.

6.3 Case 2:- DWR will stake but not survey

In this case, DWR will do the staking by themselves and get the surveying done by the Cooperating Agencies (Coop Ags). DWR’s major Coop Ags include USACE, USGS, LMAs, MAs, local counties and regional flood control agencies.

6.3.1 Perform tasks 6.2.1 to 6.2.3

6.3.2 Provide Coop Ags with survey standards and data submittal requirements

After completing the staking, FPIIB is to provide each Coop Ag the staking documentation and a complete description of the format and reporting standards. Appendix C provides a sample survey form.

6.3.3 Report status of data acquisition to Chief, Hydrology Branch for follow-up and archiving

FPIIB will receive the final survey report and review for completeness. Once it is accepted, the report will be forwarded to the Chief of Hydrology for archiving. FPIIB should maintain a log of communications consisting of date, time, name of the Coop Ag entity, persons contacted and the gist of communications. This log should be maintained until the HW documentation is completed.

6.4 Case 3:- Coop Ag will stake and survey

Historically, Coop-Ags have helped DWR in staking and surveying different regions/stream reaches during high water events. However, it is very important to ensure coordinated efforts between DWR and these Coop Ags during high water events. Therefore, every year before the flood season, FPIIB, in consultation with the Hydrology Branch, will contact each agency identified as being willing to stake and/or survey high water marks and verify they are still intending to complete the work if requested and to obtain the latest contact information. FPIIB will organize annual training programs through the Outreach component under the Local Agency Assessment Program to provide instruction for Coop Ag personnel on the fundamentals of HW staking.

6.4.1 Provide agency with maps showing extent of staking, frequency of staking, and information on the format of expected HW staking data

As discussed above (6.1) a map, staking frequency and survey and staking methods will be provided to the Coop Ag responsible for obtaining the HW data.

6.4.2 Request schedule from Coop Ag

FPIIB will coordinate with each Coop Ag to obtain a tentative staking and surveying schedule. Experience has shown that the HWM's completed closest (in time) to the

occurrence of the peak are most reliable. If the Coop Ag is not able to complete the scheduled work in a timely fashion, the FPIIB will locate another entity to perform the data collection. It is the responsibility of each Coop Ag to provide detailed schedules for staking and surveying to FPIIB. FPIIB will provide a copy of the schedule to the Hydrology Branch.

6.4.3 Provide agency with survey standards and data submittal requirements

An important task of FPIIB is to provide each Coop Ag, assigned to do the surveying also apart from staking, with a complete description of the format and reporting standards. Appendix C provides this form.

6.4.4 Report status of data acquisition to Chief, Hydrology Branch for follow-up and archiving

FPIIB will receive the final survey report and review for completeness. Once it is accepted, the report will be forwarded to the Chief of Hydrology for archiving. FPIIB should maintain a log of communications consisting of date, time, name of the Coop Ag entity, persons contacted and the gist of communications. This log should be maintained until the HW documentation is completed.

6.5 Case 4:- Coop Ag will stake but not survey

6.5.1 Perform tasks 6.4.1 to 6.4.2

6.5.2 Perform tasks 6.3.2

7 Acquisition of Aerial Photography

Aerial photographs have the advantage of providing an integrated view of large areas. This characteristic also examines and interprets flooding across large areas and determines spatial relationships, which is not possible from ground observations and terrestrial photography. Aerial photographs are cost effective in interpreting and managing a vast amount of data. They can play a significant role in mapping floodplains. For extreme flood events that include flooding of areas protected by flood control levees, aerial photography provides the most complete documentation. Multiple sets of aerial photographs can describe the wetting and drying of flood plain areas. If the potential for litigation exists during a major flood operation, aerial photography provides a useful method for understanding the sequence and extent of flood damage.

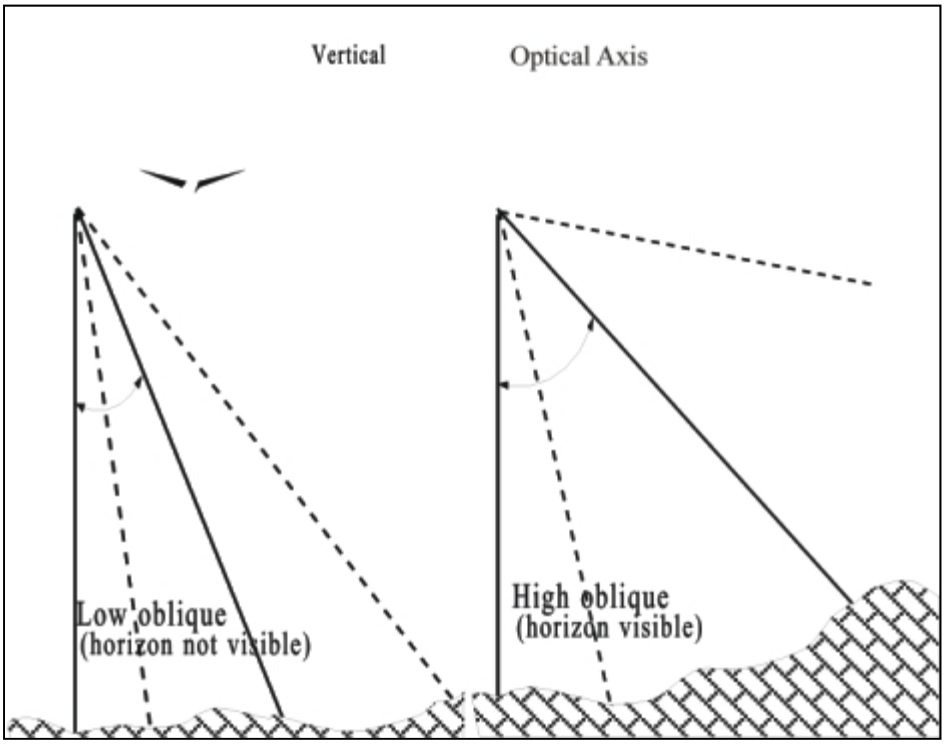
Aerial photography will be obtained by contacting the Mapping and Photogrammetry Section of Geodetic Branch, Division of Engineering, DWR. This Section maintains aerial photography of Department projects and special events such as floods and fires. Aerial photographs taken at the requests of other agencies or in cooperation with them are also maintained by this Section. The Division of Engineering's (DOE) photogrammetrists and surveyors in the Mapping Section provide the following services:

- All types of surveying and photogrammetric services
- Maintaining an inventory of computer software used for manipulation, extraction, and compilation of geodetic and topographic maps, cross sections, and other information
- Administration of contracts for obtaining controlled aerial photography
- Preparation of orthographically corrected aerial photographs
- Establishing and maintaining standards for photogrammetry products produced for and by the Department.

7.1 Determine type

Aerial photographs may be either vertical or oblique. Vertical photographs can be truly vertical, or slightly tilted (less than 3º from the vertical). Most aerial photos are tilted to some degree. Therefore, the use of the term vertical photographs in this chapter assumes truly vertical photographs, while in reality they might be tilted up to 3º. Oblique aerial photos are photographs purposely taken with an angle between 3º and 90º from the vertical. They can be low oblique (if the horizon is not visible) or high oblique (if the horizon is visible) (Figure 2).

Figure 2. Low Oblique versus High Oblique Aerial Photographs



7.1.1 Vertical aerial photography

These images are taken from directly above a property or site. This view is also known as map-like images or bird's eye view that gives a 90º straight down view. Vertical aerial photographs are best suited for (i) GIS, (ii) surveying, (iii) engineering, (iv) aerial mapping, (v) site planning, etc. They have the following advantages:

- Vertical photographs present approximately uniform scale throughout the photo. It follows that making measurements (e.g., distances and directions) on vertical photographs is easier and more accurate.

- Because of a constant scale throughout a vertical photograph, the determination of directions (i.e., bearing or azimuth) can be performed in the same manner as a map. This is not true for an oblique photo because of the distortions.

- Because of a constant scale, vertical photographs are easier to interpret than oblique photographs. Furthermore, tall objects (e.g., buildings, trees, hills, etc.) will not mask other objects as much as they would on oblique photos.

- Vertical photographs are simple to use in photogrammetry, as minimal mathematical correction is required.

- To some extent and under certain conditions (e.g., flat terrain), a vertical aerial photograph may be used as a map if a coordinate grid system and legend information are added.

- Stereoscopic study is also more effective on vertical than on oblique photographs.

7.1.2 Oblique aerial photography

These images are taken from the side of the aircraft at an angle of the property and ground, allowing one to appreciate the land perspective, height of buildings and vegetation. These images can be acquired at different height levels, according to the needs. Oblique aerial photographs are best suited for (i) legal, (ii) insurance claims, (iii) commercial real estate, (iv) residential real estate, (v) engineers, (vi) construction progress, (vii) marketing, etc. They have the following advantages:

- An oblique photograph covers much more ground area than a vertical photo taken from the same altitude and with the same focal length.

- If an area is frequently covered by cloud layer, it may be too low and/or impossible to take vertical photographs, but there may be enough clearance for oblique coverage.

- Oblique photos have a more natural view because we are accustomed to seeing the ground features obliquely. For example, tall objects such as bridges, buildings, towers, trees, etc. will be more recognizable because the silhouettes of these objects are visible.

- Objects that are under trees or under other tall objects may not be visible on vertical photos if they are viewed from above. Also some objects, such as ridges, cliffs, caves, etc., may not show on a vertical photograph if they are directly beneath the camera.

- Determination of feature elevations is more accurate using oblique photograph than vertical aerial photographs.

7.2 Provide map showing the area; specify scale and capture medium

It is the responsibility of FPIIB to provide the Mapping and Photogrammetry Section a map showing the area to be photographed. FPIIB also needs to explore whether there exists any predetermined flight-lines for the Sacramento and San Joaquin Valley. If the flight-lines are available, FPIIB provides the required flight-lines to the Mapping and Photogrammetry Section so that the latter can take the aerial photographs on those flight-lines only. In this case, FPIIB also needs to specify the percentage overlap to the Mapping and Photogrammetry Section (generally varies between 20-60% but 60% would be normal). In case of non-availability of the flight-lines, FPIIB provides the latitudes and longitudes of the

intended area to be photographed and also specifies the scale of the aerial photographs. Table 2 provides guidance for the scale of the photography.

Table 2. Aerial photography scale factors.		
Scale	**Measurement**	**Historical Uses**
1:24,000	**1” = 2,000’**	documenting long lengths of rivers; scale for 7.5 deg USGS quadrangle maps
1:12,000	**1”= 1,000’**	flood documentation; scale used for the State and Corps River atlas
1:6,000	**1” = 500’**	smaller areas; to define specific features
1:2,400	**1”=200’**	a levee break area or an area of high interest (small area)

It is generally possible to have photographs enlarged up to 10 times the negative scale without losing the ability to interpret the photograph. In most cases, the capture medium will be film unless it is determined that digital data can be reasonably stored and maintained.

7.3 Specify desired output format and printing specifications

FPIIB also specifies the desired output format and printing specification to the Mapping and Photogrammetry Section. Normally, two sets of prints of the film photography should be ordered. If other agencies desire prints, they can also be ordered. The Mapping and Photogrammetry Section also keeps a set of check prints used to verify compliance with contract specifications.

7.4 Contract to acquire imagery

Once notified by FPIIB, the Mapping and Photogrammetry Section contacts the contractors to start acquiring aerial imagery. The Mapping and Photogrammetry Section normally has two contractors, one for Northern California and the other for Southern California, with whom they have signed open end contracts. Once the Mapping and Photogrammetry Section receives the directives and cost codes from the FPIIB, they activate those contractors and specify the desired flight-paths, scale, overlap and resolution of aerial photography to those contractors. The contractors obtain the requested aerial photography and submit the final products to the Mapping and Photogrammetry Section upon completion of tasks.

7.5 Perform QA/QC check

Once the contractors hand over the aerial photographs to the Mapping and Photogrammetry Section, it is the responsibility of the latter to perform a QA/QC check on the submittals. The Mapping and Photogrammetry Section verifies that the submitted products are as per the instructions given to the contractors e.g. scale, flight-paths, percentage overlaps, resolution, etc.

7.6 Develop and send requested products to Hydrology branch

Once the Mapping and Photogrammetry (M&P) Section is satisfied with the quality of the aerial photographs, they submit the products, in requested formats (film or digital), to FBIIB which, in turn, submits the imagery to the Hydrology Branch for archiving and future use. It should be noted that the M&P Section also maintains a set of prints of the film photography.

8 Acquisition of Video

Aerial videography will be obtained by contacting the Graphic Services Branch of DWR. This branch provides graphic design, drafting, photography, video production, and audio-visual services for the Public Affairs Office's many types of publications, exhibits, and displays. These services are also available to other organizations within DWR and to other State agencies through Interagency Agreement, as well.

8.1 Provide Graphic Services (Audio/Video) with extent of video capture area

It is the responsibility of FPIIB to arrange and provide extent of video coverage and required resolution of final product to the Graphic Services Branch of DWR. The area to be covered must be accurately defined. Basic existing maps must be used in this definition. If the area to be covered is not on the map, a geographical description is important: GPS points, single elements, etc. A satellite image, even with a medium resolution is useful in the preparatory phase.

8.2 Arrange for aircraft

FPIIB is also required to arrange for a light aircraft used for filming by the Graphic Services Branch of DWR. For this purpose, FPIIB may, through the Governor's Office, seek help of light aircrafts or helicopters used by the National Guards. This aircraft must allow for fixing the camera, and generally removing one lateral door. It should allow for a flight at the required altitude as required by the flight plan. The aircraft must have instruments on board that enable the flight plan to be followed with the expected accuracy.

8.3 Arrange for authority and weather conditions

Many flights require special permission to fly. All restrictions and administrative rules must be assessed and followed by FPIIB before undertaking a flight exercise. All necessary flying and filming permits must be handed over to the Graphic Services Branch of DWR.

It is imperative to know the weather conditions. They must also conform to the flight plan drawn, because it is not advisable to fly above clouds. Wind and turbulence directly affect the seating of the aircraft and the quality of average verticality of the video. Intense vertical sunlight often creates "hot spots" in the images. Despite this, sunlight improves the contrast and the sharpness of the video images. It is thus better to undertake a flight exercise on a

clear and sunlit day. On the other hand, avoid unsystematic and consecutive exposure to the sun, which will lead to sharp differences in the contrast and brightness of the images.

8.4 Arrange for narration with system expert

Sometimes, it is difficult to recognize the location and/or direction of videography. Therefore, it is highly desirable to arrange for narration along with the videography. The narrator should have experience in the target area and should frequently refer to location and direction of flight. This improves the quality of the product and also helps in post processing and analysis of the video product.

8.5 Acquire Video

It is the task of the Graphic Services Branch to acquire the videography as per guidelines provided by FPIIB. They should prepare the aircraft on the day of flight, fix the camera in the designated place in the aircraft. Once the videography is accomplished, Graphic Services Branch of DWR should submit the final product to the Hydrology Branch for review.

8.6 Review audio and video

Hydrology Branch will also review whether any further voice over narration is required or not. If that is needed, Hydrology Branch will coordinate with Graphic Services to record additional narration and add the narration to the video.

8.7 Submit to Hydrology Branch

The final product will then be submitted to the Hydrology Branch. It is the responsibility of the Hydrology Branch to properly label the video and archive it according to the proper standards.

9 Data QA/QC and Archiving

9.1 Data collection and organization

Collecting and properly storing all data pertaining to high water documentation program is of critical importance. As already mentioned in Chapter 6, all staking and/or surveying agencies, both within or outside DWR, will be provided a standard form of data collection as provided in Appendix C to ensure homogeneity in data collection. Once collected, the Hydrology Branch will collect and organize (reach by reach and/or agency by agency) all high water data. They will also organize the aerial photographs and/or video, if ordered and obtained, from the Geodetic Branch and the Graphic Services Branch, respectively.

9.2 Data checking and correction

9.2.1 Criteria for checking and identification of outliers

Once all data in specified format are collected and organized by the Hydrology Branch, their next task is to select random data samples and check for quality of data. The primary purpose of this check is to ensure data quality and screen potential outlier data. The detection of outliers depends on how and where the data is collected. The following methods may potentially be employed to detect outliers:

- Comparison of collected high water marks with hydraulic profile; perhaps derived from a hydraulic model.
- Comparison of collected high water data with known recorded observational values (other high water level observations or relative reference marks, such as top of levee or other structures within the waterway).

9.2.2 Correction

Once the reviewers at the Hydrology Branch are convinced of the presence of outliers in the dataset, the next step is to provide a notation that the data point is an outlier. Similarly, if the reviewers at the Hydrology Branch find any discrepancies in the units of measurements, it is their task to rectify those.

9.3 Data archiving

9.3.1 Format and place of archiving

Once the QA/QC is done, it is extremely important that all data collected have the same format for archiving. The surveyed data should at least include all three x, y, and z

coordinates, description of the horizontal and vertical datum used, and a date and time stamp of the data collection. A photograph is also desired. It is highly recommended that the Hydrology Branch prepare GIS compatible shapefiles using the above information and geo-reference the photographs. The Hydrology Branch will take initiatives to store all geo-coded data under the California Levee Database within California Data Exchange Center (CDEC).

9.3.2 Documentation and notification procedure

It is the task of the Hydrology Branch to report on the data collected after each high water event. A brief summary report should contain an itemization of the data that has been collected. The summary should be disseminated to all cooperating agencies within DWR.

Appendix A Program Flowchart

The flow chart presented is broken into several pieces which correspond to certain aspects of the DWR high water data collection effort. These pieces are:

- Checklist for pre-season activities
- Decision Process to Initiate High Water Documentation [Flowchart #1]
- Obtain High Water Staking – Page 1/2 [Flowchart #2]
- Obtain High Water Staking - Page 2/2 [Flowchart #3]
- Acquisition of Photography and Videography [Flowchart #4]
- Data QA/QC and Archiving [Flowchart #5]

The flowcharts are color coded such that the responsible group for each cart activity is identified. These groups are:

- Joint Operations Center (JOC)
- Hydrology and Flood Operations Office
- Hydrology Branch
- FPIIB
- Cooperating Agency[1]
- Photogrammetry and Mapping
- Graphic Services

[1] This characterization treats DWR Maintenance Area personnel as if they were a cooperating agency.

California Department of Water Resources - Division of Flood Management
High Water Documentation Program - Flow Chart
(Checklist for Pre-Season Actions)

[Task #1 Program]

Review criteria for high water (HW) staking

(Ref. 4.1)

Coordinate Agency participation (LMA, Corps, USGS, etc...)

(Ref. 4.2)

Review format for HW staking archiving - Update as needed

(Ref. 4.3)

Update criteria for aerial photography/videography

(Ref. 4.4)

Update criteria for photography type (capture medium, scale) based on condition (levee break, high water, etc...)

(Ref. 4.5)

Assure all contracts are in place that are required to support staking, surveying, photography, videography

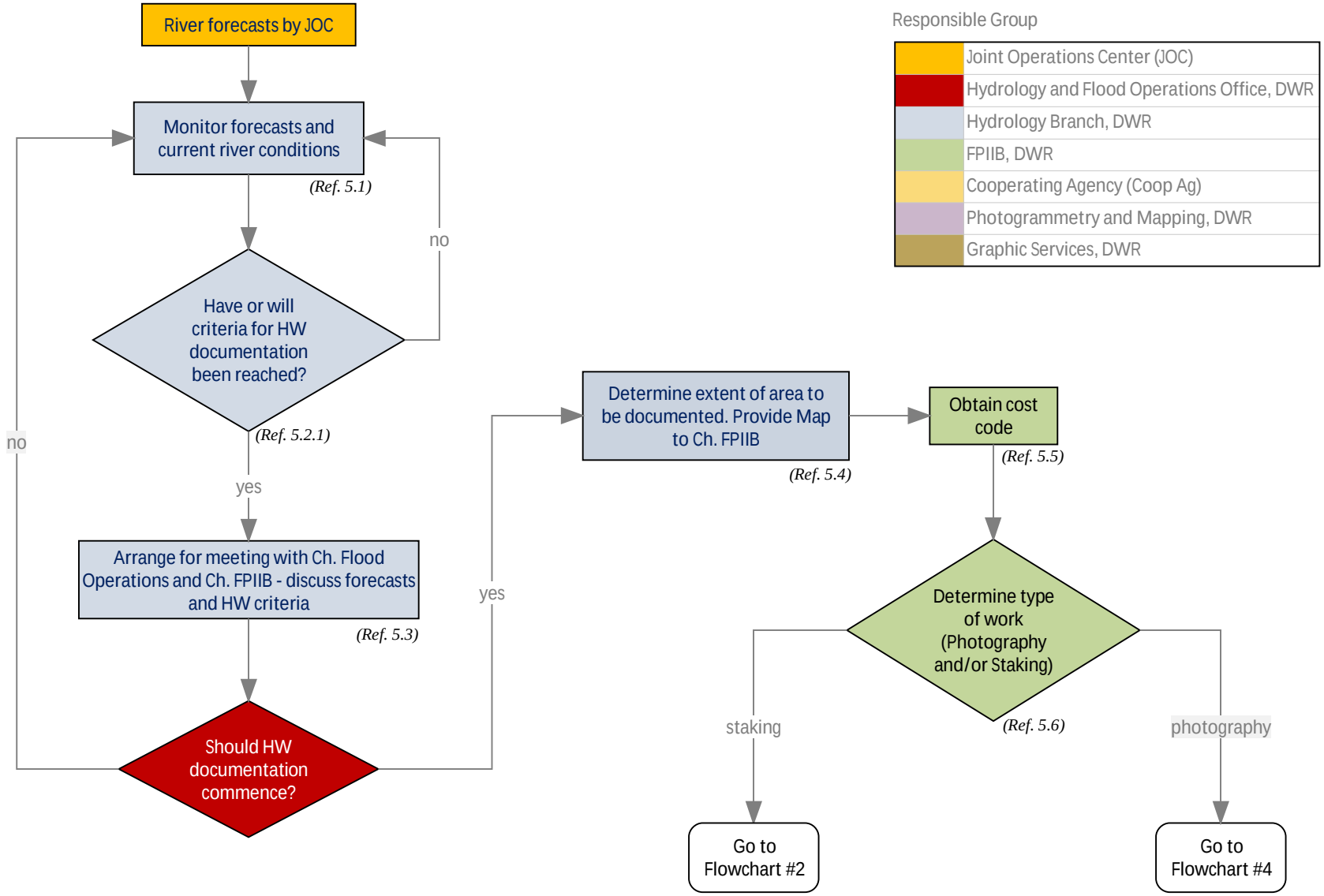
(Ref. 4.6)

Responsible Group

	Joint Operations Center (JOC)
	Hydrology and Flood Operations Office, DWR
	Hydrology Branch, DWR
	FPIIB, DWR
	Cooperating Agency (Coop Ag)
	Photogrammetry and Mapping, DWR
	Graphic Services, DWR

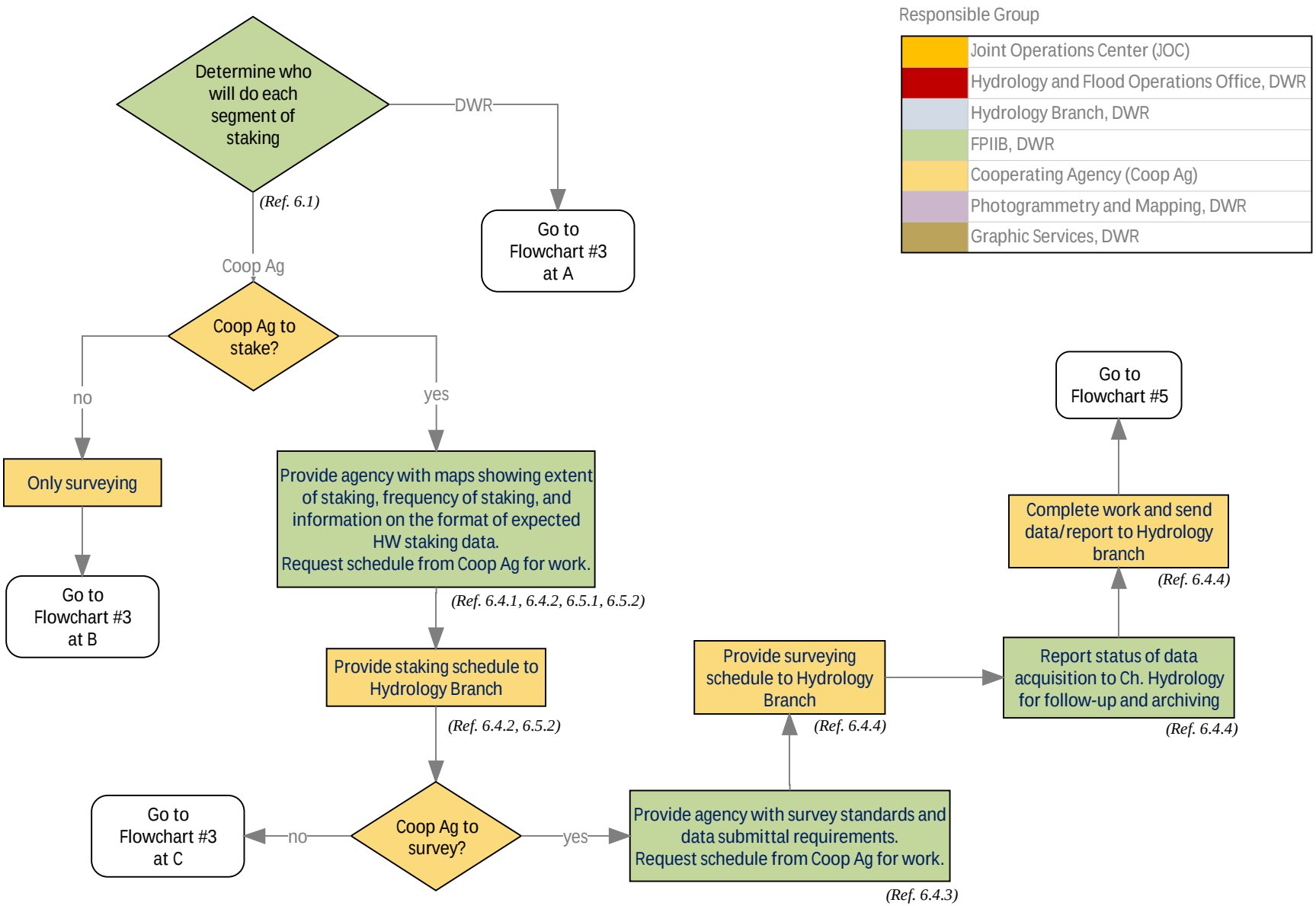
California Department of Water Resources - Division of Flood Management
High Water Documentation Program - Flow Chart
(Flowchart #1: Decision Process to Initiate High Water Documentation)

[Task #1 Program]



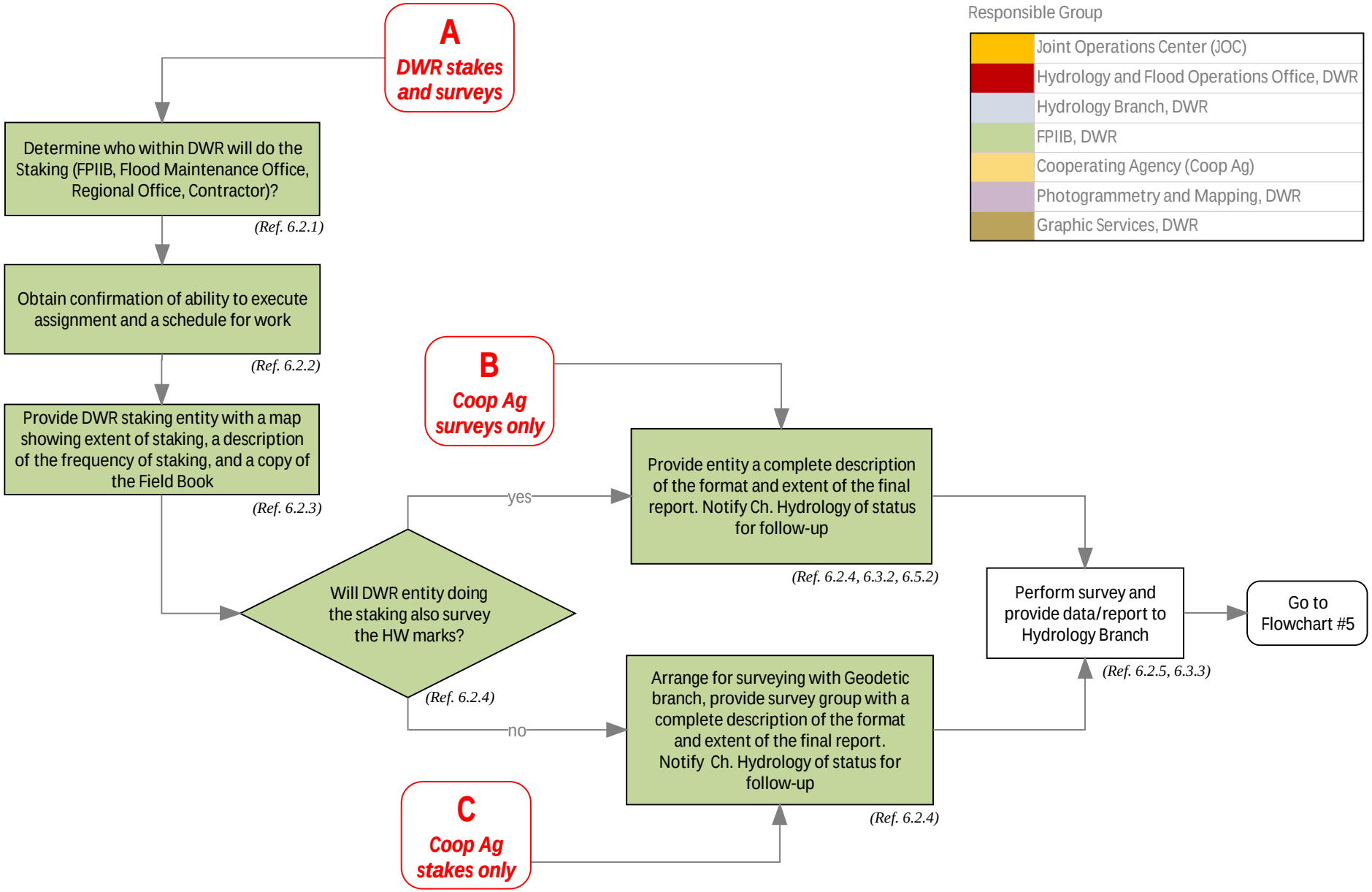
California Department of Water Resources - Division of Flood Management
High Water Documentation Program - Flow Chart
(Flowchart #2: Obtain High Water Staking - Page 1/2)

[Task #1 Program]



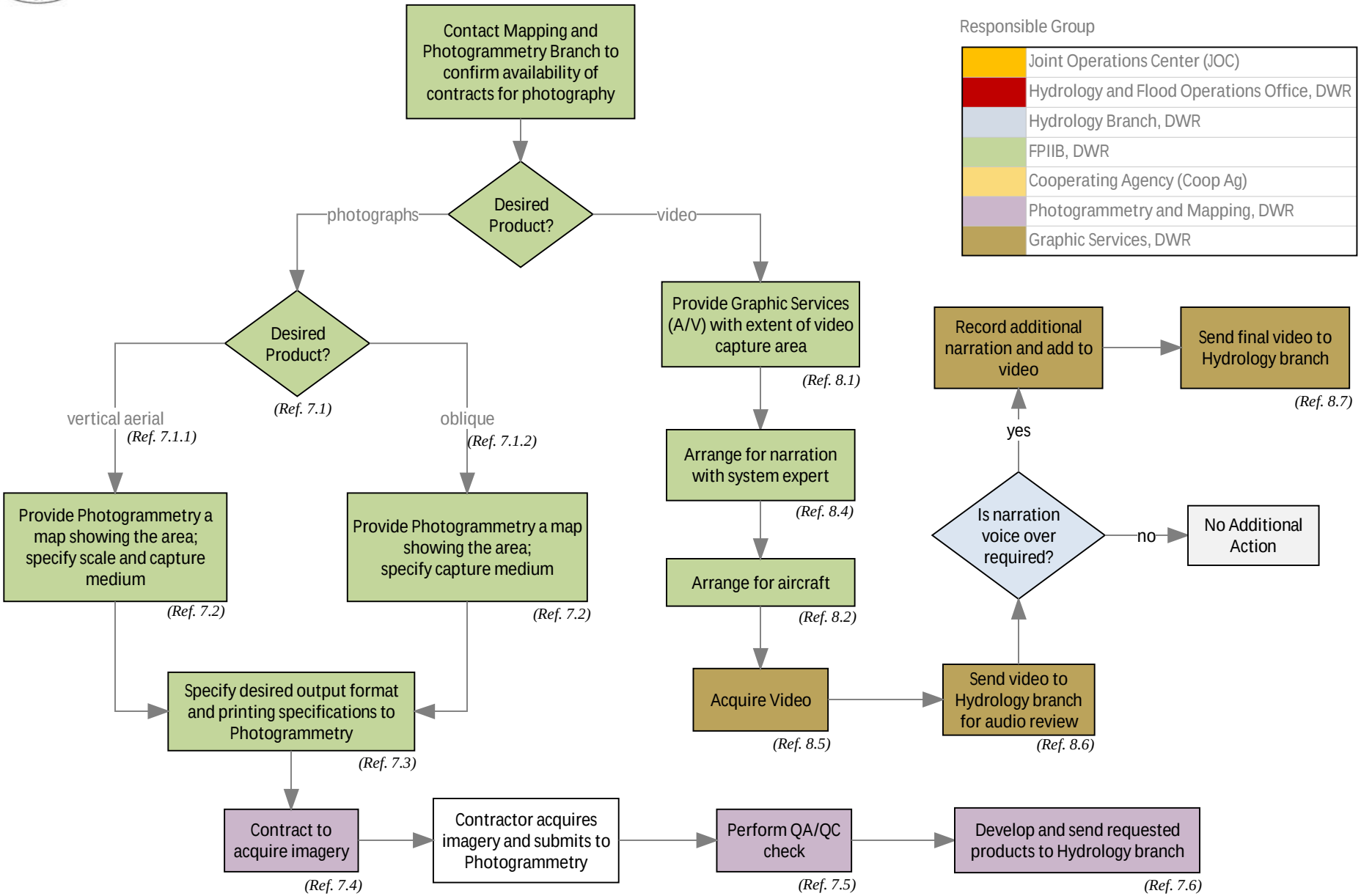
California Department of Water Resources - Division of Flood Management
High Water Documentation Program - Flow Chart
(Flowchart #3: Obtain High Water Staking - Page 2/2)

[Task #1 Program]



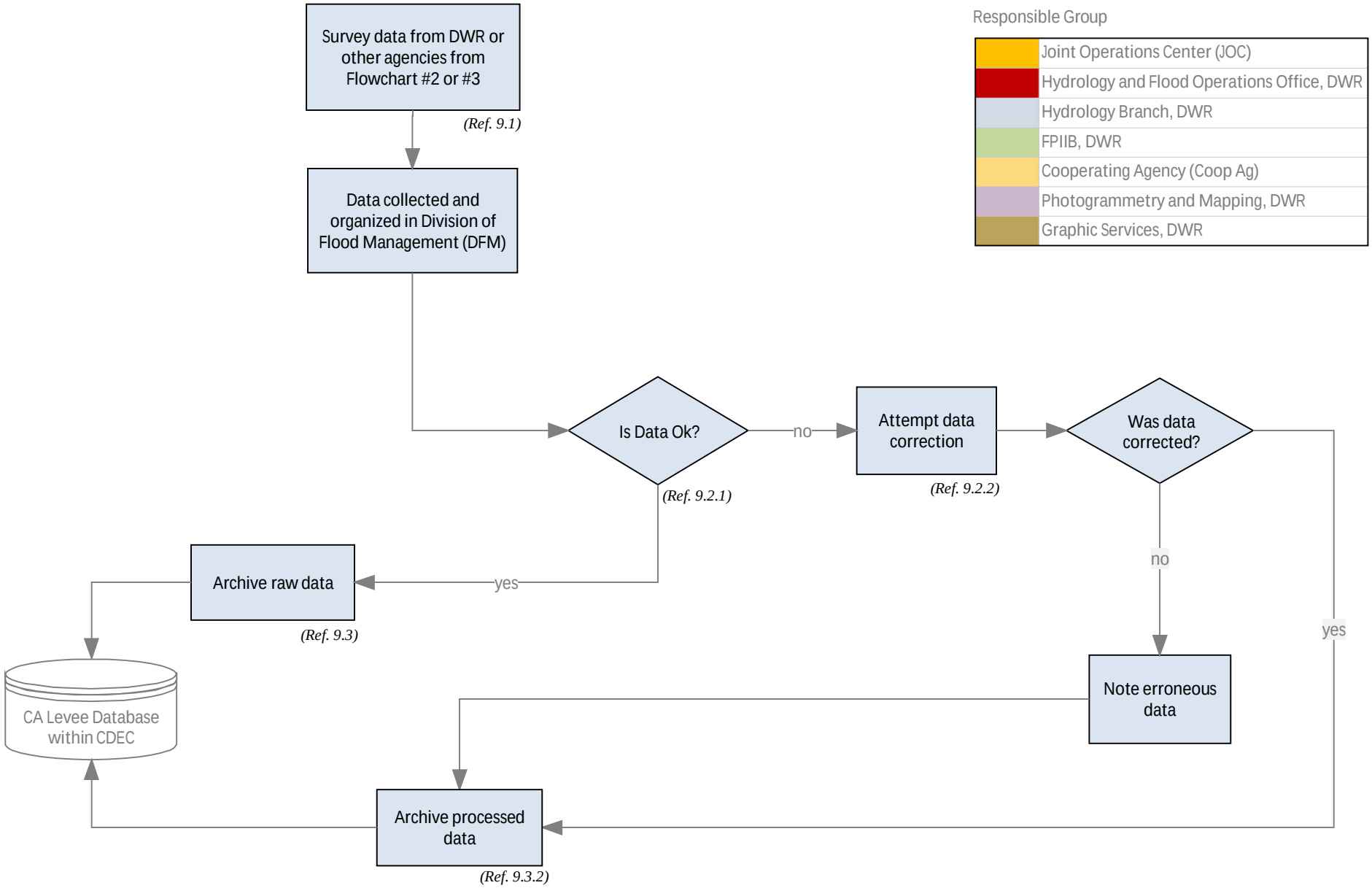
California Department of Water Resources - Division of Flood Management
High Water Documentation Program - Flow Chart
(Flowchart #4: Acquisition of Photography and Videography)

[Task #1 Program]



California Department of Water Resources - Division of Flood Management
High Water Documentation Program - Flow Chart
(Flowchart #5: Data QA/QC and Archiving)

[Task #1 Program]



Appendix B Trigger Criteria

The high water data triggers presented in this appendix were developed as part of the flood data committee in the late 1990's. The trigger values and the concept of sponsoring agencies for particular river reaches may no longer be valid. It is anticipated that these triggers will be re-evaluated and potentially reformulated as the high water data collection program progresses.

HIGH WATER DOCUMENTATION CRITERIA

SACRAMENTO RIVER						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Keswick Darn to Bails Ferry Bridge				79,000 cfs release from Keswick Dam gage	KES	Maximum objective release from Shasta Dam at Keswick Darn
Balls Ferry Bridge to Dicus Slough				27.0' (100,000 cfs) 2.7 miles above Bend Bridge	AND	Operation Criteria
Dicus Slough to Butte City Bridge				***114.0' (100,000 cfs) at Ord Ferry***	ORD	Threshold for spill into Butte Basin
Butte Basin - St. John Rd to 2.5 mi. south of Glenn-Colusa county line				114.0' (100,000 cfs) at Ord Ferry	ORD	Significant flow into Butte Basin
Butte City Bridge to Tisdale Weir				65.5' at Colusa Weir (3.5' over weir)	*CLW	Significant flow into Butte Basin and weirs are fully active
Moulton Weir and vicinity				79.0' at Moulton Weir (2.0' over weir)	MLW	Significant flow into bypass
Colusa Weir and vicinity				65.5 at Colusa Weir (3.5' over weir)	CLW	System is full of water
Tisdale Weir to Verona				50.3' (30,000 cfs) Wilkins Slough	WLK	50-year design flow
Verona to Walnut Grove				Exceeding 27.5' at I Street	1ST	Beginning of opening of Sacramento Weir
Walnut Grove to Rio Vista				Exceeding 27.5' at I Street and 9.0' tide at Rio Vista	1ST RVB	USCOE O&M Manual flood stage

LITTLE CHICO CREEK						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Diversion Structure to Highway 99				3,000 cfs at Diversion Structure		Maximum design flow
Southern Pacific Tracks to Taffe Road				3.000 cfs at Diversion Structure		Maximum design flow

MUD CREEK						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Junction of Sycamore Creek to Big Chico Creek				***(1) *15 feet at new Big Chico gage*** or (2) 9,500 cfs at Diversion Structure	***'BIC***	***(1) Approximately 12,000 cfs in Big Chico Creek*** or (2) Maximum design flow

SYCAMORE CREEK						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Big Chico Creek Diversion Structure to Mud Creek				***(1) 15 feet at new Big Chico gage*** or (2) 10,000 cfs at Diversion Structure	***BIC***	***(1)Approximately 12,000 cfs in Big Chico Creek*** or (2) Maximum design flow

LINDO CHANNEL						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Big Chico Creek Diversion Structure to Southern Pacific Railroad Bridge				***(1) 15 feet at new Big Chico gage*** ***or (2) 4500 cfs at Diversion Structure***	***BIC***	***(1)Approximately 12,000 cfs in Big Chico Creek*** ***or (2) Estimated channel capacity***

CHEROKEE CANAL						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Gage-Shippee Road to Highway 162				10.0' at Highway 162		Flood stage

FEATHER RIVER						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Fish Barrier Dam to Sutter Bypass				89.0' (50,000 cfs) at Gridley	GRL	Start of overbank flow
Fish Barrier Dam to Sutter Bypass (both banks including Honcut Creek So. Bank Levee)				***65.0' at Yuba City***	YUB	High, relative frequent, flow

YUBA RIVER						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Daguerre Point Darn to Mouth				***65.0' at Yuba City***	YUB	Water reaches south levee

BEAR RIVER						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Western Pacific Rail Road to Mouth				309.2' at Camp Far West Reservoir (approximately 30,000 cfs)	CFW	25-year design flow

SUTTER BYPASS						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Butte Slough Outfall Gates to Verona				55.0' at Butte Slough near Meridian (approximately 36,000 cfs)	BSL	Butte Basin is fully active

WILLOW CREEK						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
One mile upstream of 1-5 to confluence with Colusa Drain				51.0' (6,000 cfs) Colusa Drain at Highway 20 (mile 40)	CDR	Flooding to properties becomes significant

COLUSA BASIN DRAIN						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Mouth of Willow Creek to Knights Landing Outfall Gates				51.0' (6,000 cfs) Colusa Drain at Highway 20 (mile 40)	CDR	Flooding of properties becomes significant and threat to project levees begins

KNIGHTS LANDING RIDGE CUT						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Knights Landing Ridge Outfall Gates to Yolo Bypass				34.0' at Knights Landing Outfall Gates	KNL	Flooding of properties becomes significant and threat to project levees begins

DRY CREEK - SACRAMENTO						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Roseville to Natomas East Main Drain				37.0' (5,000 cfs) at Elkhorn Boulevard	VRS	Flooding of adjacent area begins

NATOMAS CROSS CANAL						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
From Sacramento River to Pleasant Grove Creek				39.0' Sacramento R @ Verona	VON	

NATOMAS EAST MAIN DRAIN						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Pleasant Grove Creek to American River				90,000 cfs release below Folsom 5,000 cfs Dry Creek @ Vernon	FOL VRS	

AMERICAN RIVER						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Nimbus Dam to Sacramento River				90,000 cfs release below Folsom Dam	FOL	High river stage

CACHE CREEK						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Road 102 Bridge to end of Training Levee				79-4' (25,000 cfs) at Yolo	CCY	Flow sat to determine capacities at training levees. Reevaluate as USCOE construction proceeds

PUTAH CREEK						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Winters to Yolo Bypass				20,000 cfs release from Monticello Dam	***BER**	Intermediate flow determining carrying capacity of stream

SACRAMENTO BYPASS						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Entire length from the Sacramento Weir to Yolo Bypass				Exceeding 27.5' at I Street	IST	Beginning of opening of Sacramento Weir

YOLO BYPASS						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Fremont Weir to 1-80				36.5 at Fremont Weir (3.0' over weir)	FRE	Significant Overflow into Yolo Bypass
I-80 to North Boundary of Liberty Island				23.2' at Lisbon	LIS	Design water surface elevation
North Boundary of Liberty Island to Cache Slough				19.5' at Lisbon	LIS	Liberty Island floods

COSUMNES RIVER						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Michigan Bar to Benson's Ferry (Thornton)				8.4' (10,000 cfs) at Michigan Bar or 43.9' at McConnell	MHB MCC	Out of bank flow

MOKELUMNE RIVER						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Camanche Dam to Mouth				5,000 cfs release from Camanche Darn or 10,000 cfs at Michigan Bar	***CMN** MHB	Design release from Camanche Dam

CACHE SLOUGH						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Lindsay Slough to Mouth				27.5' at I Street and 9.0' tide at Rio Vista	IST RVB	Stages above 9.0' threaten flooding of low-lying Delta Tracts nearby

MINER SLOUGH						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Sutter Slough to Cache Slough				27.5' at I Street and 9.0' tide at Rio Vista	IST RVB	Stages above 9.0' threaten flooding of low-lying Delta Tracts nearby

SUTTER SLOUGH						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Sacramento River to Steamboat Slough				27.5' at I Street and 9.0' tide at Rio Vista	IST RVB	Stages above 9.0' threaten flooding of low-lying Delta Tracts nearby

STEAMBOAT SLOUGH						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Head to Mouth				27.5' at I Street and 9.0' tide at Rio Vista	IST RVB	Stages above 9.0' threaten flooding of low-lying Delta Tracts nearby

GEORGIANA SLOUGH						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Head to Mouth				27.5' at I Street and 9.0' tide at Rio Vista	IST RVB	Stages above 9.0' threaten flooding of low-lying Delta Tracts nearby

THREEMILE SLOUGH						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Sacramento River to San Joaquin River				27.5' at I Street and 9.0' tide at Rio Vista	IST RVB	Stages above 9.0' threaten flooding of low-lying Delta Tracts nearby

OTHER DELTA AREA						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Any Delta Area				27.5 at I Street and 9.0' tide at Rio Vista plus as needed	IST RVB	Stages above 9.0' threaten flooding of low-lying Delta Tracts nearby

SAN JOAQUIN RIVER						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Friant Dam to Gravelly Ford				8,000 cfs release from Friant Dam	MIL	Design release from Friant Dam
Gravelly Ford to Merced River; Chowchilla, Eastside and Mariposa Bypasses				8,000 cfs release from Friant Dam or 5,500 cfs in Chowchilla Bypass	MIL CBP	Chowchilla design capacity is 5,500 cfs
Merced River to Tuolumne River				69.4' (45,000 cfs) at Newman	NEW	Design capacity - reevaluate!
Tuolumne River to Stanislaus River				45.2' (46,000 cfs) at Maze Road Bridge	MRB	Design capacity - reevaluate!
Stanislaus River to Stockton				29.0' (31,000 cfs) at Vernalis	VNS	Levees project design is 34.2' (52,000 cfs) seepage & other problems occur at 29.0'

PARADISE CUT						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Head to Mouth				29.0' (31,000 cfs) at Vernalis	VNS	Levees project design is 34.2' (52,000 cfs) seepage & other problems occur at 29.0'

OLD RIVER						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
San Joaquin River to Middle River				29.0' (31,000 cfs) at Vernalis	VNS	Levees project design is 34.2' (52,000 cfs) seepage & other problems occur at 29.0'

STOCKTON DIVERSION CANAL						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Mormon Slough to Calaveras River				13,0' (12,500 cfs) at Bellota	***MRS**	Design flow

CALAVERAS RIVER						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Stockton Diversion Canal to San Joaquin River				13,0' (12,500 cfs) at Bellota	***MRS**	Design flow

LITTLEJOHNS CREEK						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Farmington Reservoir to San Joaquin via French Camp slough				2,000 cfs	***FRM**	Design Flow

STANISLAUS RIVER						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
New Melones Dam to San Joaquin River				***"13' (8,000 cfs) at Orange Blossom***	OBB	Design release from New Melones Dam

TUOLUMNE RIVER						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Don Pedro Darn to San Joaquin River				54.7 (9,000 cfs) at Modesto	MOD	Design flow

MERCED RIVER						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
New Exchequer Dam to San Joaquin River				69.4'(6,000 cfs) at Stevinson	MST	Design release from New Exchequer Dam

MERCED COUNTY STREAM GROUP						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Includes Bear, Black Rascal, Owens & Mariposa Creeks, from Merced's County Line to East Side Bypass				16.0' (5,000 cfs) in Bear Creek at McKee Road	***MCK**	Needs to be revised to comply with USCOE project under construction

CHOWCHILLA RIVER						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Buchanan Darn to Chowchilla Bypass, including Ash and Berenda Sloughs				7,000 cfs release from Buchanan Dam	BUC	Design release from Buchanan Dam

FRESNO RIVER						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Hidden Dam to Chowchilla Bypass				3,000 cfs release from Hidden Dam and 5,000 cfs within project levees	HID	Design release from Hidden Dam is 5,000 cfs - 8.0 miles of unimproved channel may not hold 5,000 cfs

KINGS RIVER						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Piedra to Stratford				13,000 cfs at Piedra	PNF	Objective flow in river
Crescent Weir to Mendota Pool				4,750 cfs below Crescent Weir	CSW	Design flow

KAWEAH RIVER - THREE RIVERS AREA						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Middle Fork Sequoia Park to Terminus Dam				50,000 cfs at Three Rivers	TRM	Channel capacity Verify and update designated floodways
North Fork Middle Fork to 4.0 miles upstream				50,000 cfs at Three Rivers	TRM	Channel capacity Verify and update designated floodways
South Fork Middle Fork to 3.0 miles upstream				50,00D cfs at Three Rivers	TRM	Channel capacity Verify and update designated floodways

KAWEAH RIVER - BELOW TERMINUS DAM						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Kaweah River Terminus Dam to Visalia				5,000 cfs at McKays Point	TRM	Channel capacity Verity and update designated floodways
St. Johns River Kaweah River to Cross Creek				5,000 cfs at McKays Point	TRM	Channel capacity Verify and update designated floodways
Cross Creek St. Johns River to Tulare Lake				5,000 cfs at McKays Point	TRM	Channel capacity Verify and update designated floodways
Mill Creek Kaweah River to Cross Creek				5,000 cfs at McKays Point	TRM	Channel capacity Verify and update designated floodways

TULE RIVER - SPRINGVILLE AREA						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
North Fork Middle Fork to Rancheria Road				20,000 cfs at Springville	SCC	Channel capacity Verify and update designated floodways
Middle Fork - Upper end of Lake Success to 2.1 miles upstream from County Road Bridge				20,000 cfs at Springville	SCC	Channel capacity Verify and update designated floodways
South Fork - Upper end of Lake Success to Tule River Indian Reservation				7,000 cfs near Success	SCC	Channel capacity Verify and update designated floodways

TULE RIVER - DOWNSTREAM FROM SUCCESS DAM						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Success Dam to County Line and Porter Slough from Tule River to Road 192				3,200 cfs release from Success Dam	SCC	Channel capacity Verify and update designated floodways

DEER CREEK						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Tulare Lake to 5 miles upstream of Terra Bella (flooded area only)				1,500 cfs at Kilbreth		Channel capacity Verify and update designated floodways

WHITE RIVER						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
DucOr to Tulare Lake (flooded area only)				1,500 cfs near Ducor	***•VVRD***	Channel capacity Verify and update designated floodways

KERN RIVER - KERNVILLE AREA						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
North Fork above Isabella Darn				Flow greater than 20,000 cfs	ISB	Verify and update designated floodways

KERN RIVER						
REACH	RIVER MILE	LEFT / RIGHT	SPONSOR	CRITERIA	CDEC ID	REASON FOR SELECTING CRITERIA
Mouth of canyon to Second Point				10.3' (2.000 cfs) at First Point	ISB	Verify & update designated floodways - eroding banks, changing course, & uncontrolled local flow creates a rare event.
Second Point to Buena Vista Lake				1.5' (2,000 cfs) at Second Point	ISB	
Buena Vista Lake to Concrete Weir				1.5' (2,000 cfs) at Second Point	ISB	
Concrete Weir to Hart Station				1,000 cfs at Concrete Weir	ISB	
Hart Station to Tulare Lake				500 cfs at Hart Station	ISB	

Appendix C Staking and Surveying Data Form

This appendix contains the forms for submitting staked and surveyed high water to the Hydrology Branch. These forms are designed so that the data is standardized and can be easily uploaded to CDEC, after it has been checked.

DEPARTMENT OF WATER RESOURCES
HIGH WATER DOCUMENTATION PROGRAM
HIGH WATER DATA COLLECTION REPORT (FOR STAKERS)

River Name:
Reach Name:
Staking Agency:

DATE (mm/dd/yy)	TIME (hh:mm)	LEFT/RIGHT	X Coordinate (Top of levee)	Y Coordinate (Top of levee)	CONFIDENCE IN STAKING (HIGH/ MEDIUM/ LOW)	COMMENTS*

** Must provide comments if confidence is low*

DEPARTMENT OF WATER RESOURCES
HIGH WATER DOCUMENTATION PROGRAM
HIGH WATER DATA COLLECTION REPORT (FOR SURVEYORS)

River Name:
Reach Name: **Horizontal Datum:**
Surveying Agency: **Vertical Datum:**

DATE	TIME	LEFT/RIGHT	X Coordinate	Y Coordinate	Z Coordinate		
(mm/dd/yy)	(hh:mm)		(Top of levee)	(Top of levee)	(High water line)	(Existing water surface)	(Top of levee)

Appendix D Interview Notes

This appendix contains notes from interviews that were conducted to formulate this HW data collection program. The interviewees have been provided a copy of these notes for comment, and, whenever they were provided, their response comments have been incorporated into the final interview notes presented herein.

High Water Documentation Program
Interview with Ruppert Grauberger
March 08, 2010

List of Attendees: Ruppert Grauberger, Chief, Mapping and Photogrammetry Branch
Joseph Countryman, MBK Engineers
Ben Tustison, MBK Engineers
Rajat Saha, MBK Engineers

Place: Resources Building, 1416 Ninth St., Sacramento, CA
Meeting Start Time: 01:30 PM
Meeting End Time: 02:30 PM

Ruppert Grauberger is Chief of DWR's Mapping and Photogrammetry Branch

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Mr. Grauberger mentioned that so far, there is only institutional knowledge about high water staking operations and there is an urgent need to develop protocols. He said that aerial photographs had been and are used extensively during high water events. He mentioned that he has two contactors, one in northern CA and the other in southern CA, with whom he has pre-set contracts for taking aerial photographs during flood emergencies. Once he gets the information of declared emergency and wants to take aerial photographs, he needs to specify scale, flight paths and resolution to the contractors and they will do the aerial photography. Rates from the contractors are tied to:

1. Mobilization
2. Mileage from contractor's base of operations
3. Length of flight line
4. Number of exposures (overlap)

Upon request, he agreed to send MBK Engineers the current contractor's rates based upon these factors.

Mr. Grauberger mentioned that he receives a funding number from the requesting office in flood management along with go-ahead instructions to capture aerial photographs. His office then gives instructions to the flight companies and gets the work done. Mr. Grauberger mentioned that the Geospatial Information Officer (GIO), under the command of Chief Information Officer (CIO) is currently identifying needs for other state agencies that engage in emergency response operations.

Mr. Countryman ask Mr. Grauberger if he was aware of predetermined flight lines in the Sacramento and San Joaquin basins because Mr. Countryman believed these flight lines

existed. Mr. Grauberger stated that such flight lines did not exist in his office but that perhaps Flood Management had developed them.

Mr. Grauberger mentioned that his branch stores the aerial photographs in film cans which have a distinct advantage over the digital photos because of easiness of storage and better quality. His office can order either digital data flights or film flights. The digital flights can include different parameters, such as infra red, etc. He mentioned that digital photographs require a lot of storage space, which currently is beyond his office's ability to maintain. He mentioned that generally there is a 60% overlap between two consecutive photographs lengthways and 30% overlap for parallel flightlines. He suggested that the manual under preparation should include and recommend use of aerial photographs and sometimes videographs also as those give accurate depiction of flood extents at a reasonable cost. He also mentioned the importance of narration during such flights to determine absolute location. It is possible that digital flights provide more complete data but that a method of permanent archiving and retrieval must be developed if digital data is to be collected.

Mr. Grauberger thought it would be helpful if Flood Management predetermined the scale of the photography in advance of needing the data as this would help them to determine the number of photographs necessary to meet a requested flight.

High Water Documentation Program
Interview with Michal Mierzwa
March 08, 2010

List of Attendees: Michal Mierzwa, Chief, River Forecasting Branch
Ben Tustison, MBK Engineers
Rajat Saha, MBK Engineers

Place: 3310 El Camino Avenue, Sacramento
Meeting Start Time: 9:30 AM
Meeting End Time: 10:45 AM

Michal Mierzwa is Chief of DWR's River Forecasting Branch

Michael explained the role of the River Forecasting section and how it relates to high water data collection. He also explained the roles of other entities with DWR as they relate to forecasting and high water data collection.

Michael provided some office memoranda (attached) which were developed for January 2010 storm events. These e-mails shows forecast precipitation amounts and estimated return intervals using the Bulletin 195-10 Long Duration Precipitation Frequency Data report. He indicated the role of River Forecasting is to analyze and indentify critical locations during storm events and make recommendations as to where other DWR groups (e.g., flood project integrity and inspection branch) should be focusing their attention.

Michael provided additional e-mails which focused on the development of rating curves for gaging sites, specifically the lack of rating curve data for extremely high flows. It was suggested that additional effort should be expended to measure flows during extreme flood events. The difficulties and safety issues with collecting flow data during high water was discussed.

Michael mentioned that one great advantage of developing protocols and procedures for high water stake data collection was to obtain better authentic high water data which could be used for hydraulic modeling. Those hydraulic model outputs could in turn be used to improve forecasting.

Michael explained that regional DWR Districts (Northern, South Central, etc…), due to their proximity to the gaging sites and expertise in data collection practices, have a large role in data collection. These regional offices have contracts to perform such tasks as data collection, rating curve development, etc… Regarding storage of the data, Michael mentioned that local agencies send the high water stage data to CDEC (no QA/QC check at this point) and eventually DWR's Water Data Library (WDL). The data is verified before entry into the WDL.

Michael explained that DWR is concerned with filling in the gaps in the available high water data. An example he gave was the recently completed Three River Levee Improvement Authority levee setback projects on the Bear and Feather Rivers. Michael stated that DWR does not have any high water data collected with these projects in place but obtaining some would allow them to check the current (with these projects in place) flood system performance.

Michael suggested that high water manual should include (1) process of generating automatic warning calls when the stage reaches a threshold level; (2) duration the levee patrollers need to be out in the field during high water events and frequency of data collection; (3) process of checking archived data to find gaps and suggestions for remedial measures.

We showed Michael the 1997 Post-Flood report developed by DWR. Michael indicated Herb Hereth (retired) was an author of that report and that Herb would be a good interview for this project. Michael indicated that Herb often attends the Monday and/or Thursday weather briefings at the flood center and that may be a good time to catch up with him. We asked Michael what he thought a good trigger would be to initiate this level of documentation in the future. Michael mentioned that the 1997 post-flood report was a more specific version of the Bulletin 69 series and that he thought it would be appropriate to develop such a document every time an emergency declaration is made within the State.

Michael inquired as to whether we were doing anything Delta-specific with the high water documentation. We responded that we did not think so. Michael provided additional contacts with Delta expertise and mentioned that the local maintaining agencies (LMA) did yearly staking which could benefit high water data collection.

Michael also brought us to one of the weekly weather briefings and gave us a tour of the National Weather Service forecast office and California-Nevada River Forecasting Center (CNRFC).

Following the meeting, Michael followed up with some additional contacts we might want to interview for this project. Those e-mails are attached.

High Water Documentation Program
Interview with Boone Lek
March 09, 2010

List of Attendees: (1) Boone Lek, Chief, Forecast-Coordinated Operations
(2) Joe Countryman, MBK Engineers
(3) Ben Tustison, MBK Engineers

Place: 3310 El Camino Avenue, Sacramento
Meeting Start Time: 9:30 AM
Meeting End Time: 10:00 AM

Prior to the meeting, Boone provided the following summary of his role in high water data collection:

> *For the last couple of years, I manage stream gaging contracts with 2 entities: the USGS and DWR Division of Planning and Local Assistance. All gages contracted with the USGS and DPLA are forecast points. Under the contract these entities do 6 to 9 regular stream measurement. Because we had gone thru 3 consecutive dry years and finally were forecasting good runoff (including weir flow) into the flood control system, I requested Northern District of DPLA to make some flow measurements. I am interested in documenting or creating a protocol for requesting such flow measurements of all our contracted gages. Many of the gages are in the North Coast and not along the state-federal flood control project levees.*

Boone mentioned that he expected the high water documentation protocol to establish the F-CO interest in gaging data collection, updating rating curves, and updating gage coordinates as maintenance is performed. Boone mentioned that many of the DWR gage coordinates on CDEC misrepresented the gage coordinates or are not accurate enough to pinpoint precise gage locations.

Boone mentioned a $10 million flood emergency fund that Gary Bardini (Chief DFM) is working to establish. This fund could cover flood fighting, surveying, and photogrammetry during a flood event.

Boone mentioned that Jay Punia (formerly in Bill Croyle's Position), Jim Coe, and Herb Hereth would make good contacts for this effort.

Also discussed was DWR's proposed efforts to create a Bulletin 69 (post-flood report) template which could be used to more rapidly develop and disseminate information on a flood after the event. GEI is assisting with this work

High Water Documentation Program
Interview with the Levee Inspectors
March 09, 2010

List of Attendees: (1) Michal Koller, Engineer, WR,
(2) Herman Phillips, Inspector,
(3) Richard Willoughby, Inspector,
(4) John Williamson, Inspector,
(5) Rick Burnett, Flood Fight Specialist,
(6) Joe Countryman, MBK; and
(7) Rajat Saha, MBK

Place: 3310 El Camino Avenue, Sacramento
Meeting Start Time: 2:00 PM
Meeting End Time: 3:00 PM

The group said that the last time they did HW staking was during spring, 2006 in the San Joaquin and Firebaugh areas. During that flood event, they had 2 weeks time to do the HW staking. Since there were no guidelines, they started with staking at every 100 ft distance but soon realized that was too much! Ultimately, they took HW staking data at every ½ mile.

The group mentioned that they thought the responsibility for HW staking should be with the respective reclamation districts or LMA's. Now it appears to be the joint responsibility of DWR and local agencies. The group also mentioned that the HW stage data was presented and stored in Bulletin 69. But they were not aware of the existence of any protocols and defined procedures for HW staking. The group opined that a HW staking manual would definitely be a very useful document.

The group briefly mentioned how the procedures they follow to set the High Water Stakes. The 4 main components were one (small) Peg for delineating HW mark (HWM) with a guard stake proximate to the HWM peg, one stake to mark the current flow line and one lath on the levee crown to demarcate the location of the HWM stake. The time and date of the staking should be written on the lath and each stake should be properly identified. A permanent marker should be used for the identification markings. In addition, a log book should be maintained that would have an entry for each stake that would note the time and day and a very brief description.

The group recommended life vests for field personnel while walking down the slope during a HW event. They also suggested the use of rope to provide additional safety while walking down the levee slope if a two man crew was marking during the high water. The group agreed that patrollers are the best group to drive the stakes.

The group mentioned that they photographed the staking locations for future reference and at times took photos to document the extent of flooding.

The group mentioned that in normal practice, the engineers or inspectors go for data collection about 1-2 weeks after that actual HW event and at that time, it becomes difficult to notice where the HW lines were. Therefore, the group suggested local levee patrollers should be made the designated personnel for HW staking as they patrol the levee frequently during a HW event. They also believe that use of handheld GPS might be introduced to enhance the HW data collection process. Inspectors have plenty of off-time during patrolling to use for collection of the GPS points.

The group has no clear idea about the command chain and source of funding. They stated that when they were requested to do the staking they received a charge number to use for the activity. They also noted that they had different charge numbers for different locations. They mentioned the orders for HW staking used to come from the Flood Center. They felt that ICT and Emergency Response Unit might be good sources of information in this regard. They recommended MBK to contact Ricardo Pineda of DWR also for this purpose.

They were uncertain as to when the High Water Stakes were surveyed but believe that the survey work was done 1 to 2 weeks following the staking. They thought the survey work was done by the DWR district personnel. They were also uncertain as to where the High Water Staking data was archived. They indicated that the LMA's may archive some HWM data and suggested contacting Reggie Hill of LSJLD.

High Water Documentation Program
Interview with Nate Hershey
March 09, 2010

List of Attendees: (1) Nate Hershey, MBK
(2) Joe Countryman, MBK; and
(3) Rajat Saha, MBK

Place: 1771 Tribute Rd. Ste-A, Sacramento, CA 95815
Meeting Start Time: 1:00 PM
Meeting End Time: 1:45 PM

Rajat Saha and Joe Countryman met with Nate Hershey on 3/9/2010 to discuss what would be required to obtain elevation data for HWM Staking along several miles of levee reach. Until recently, GPS has not been used to gather location and elevation data following the marking of High Water. Instead, spirit surveys originating from known bench marks were the method of data collection. The purpose of the interview was to understand how the use of survey grade GPS would affect the data collection procedures.

Mr. Hershey noted that there is a false impression that data can be accurately gathered simply by taking a GPS unit to the field, setup on the stake and you receive an accurate XYZ location reading (including elevation) without any additional research or preparation. He emphasized that the survey process must be calibrated to known bench marks before the survey could be completed. He thought for a linear survey along many miles of river length that benchmarks spaced a maximum of 5 miles apart would provide adequate coverage for the required calibration. This assumes a desired vertical accuracy of a few tenths, plus or minus. The calibration could be established utilizing a Virtual Survey Network (VSN) via cell phone and then the High Water Mark survey could be completed by taking the GPS unit to each staking location.

Mr. Hershey noted that the personnel performing the HWM staking should be aware of certain basic GPS limitations in order to provide the most useful staking locations. Stakes should not be placed under trees. A clear view of the sky should be paramount in selecting a staking location whenever possible. Cell phone coverage for each staking location would increase the probability of being able to use the VSN for data collection. In the event the VSN was not available for use, a traditional real time kinematic (RTK) base station setup could be used for data acquisition, as well as traditional surveying methods.

He also noted that real time data could be gathered during high water and that that data could be later fit to a calibrated control network. This would enhance the ability to quickly gather the critical data and to later determine the actual elevation of the marks. He indicated that the surveyors could email the xyz data for each location to the office while still in the field and that would allow data processing to begin very expeditiously during a critical event.

Mr. Hershey also indicated that if the agencies concerned with this data (DWR, Corps, USGS, others) would cooperatively establish the control points to be used for calibration and update it at an accepted regular interval, the gathering of the high water data would be greatly expedited. During the discussion, Mr. Countryman noted that an uncalibrated GPS survey that included both top of levee and high water data could be used to provide an accurate freeboard calculation. Mr. Hershey concurred.

High Water Documentation Program
Telephonic Interview of Jay Punia by Joe Countryman
March 11, 2010

List of Attendees: Via telephone, Joseph Countryman and Jay Punia

Meeting Start Time: approx 9:00 AM
Meeting End Time: approx 9:20 AM

Jay Punia was Chief of DWR's Flood Operations Branch since 1998 and became General Manager of The Reclamation Board in 2006. He has over 30 years of proven high level experience in flood operations and control. He was the Department of Water Resources' point man in fighting California floods.

Jay Punia mentioned that during high water (HW) events or flood emergency, the State's operations are controlled by the Standardized Emergency Management System (SEMS). [Under SEMS, all levels of government share responsibility for flood fighting. Local government agencies, including special districts, state agencies and federal agencies all have specific responsibilities during a flood fight. The necessity to initiate a flood fight may result from overflow of a natural waterway, overflow of a waterway confined by levees, rising lake waters, dam overtopping, failure of a levee, or other circumstances. Flood fighting is initiated when a threat to life and property exists. Emergency response to flood threats will be conducted using the Standardized Emergency Management System (SEMS). SEMS includes the Incident Command System (ICS), mutual aid, multi/inter-agency coordination and the operational area concept. There are five levels to the SEMS hierarchy: field, local, operational area, regional and state]. During an emergency, under the directive of the Director, DWR, the State goes into an emergency program mode. At that time, the Department of Finance releases a series of charge numbers to cover and track all expenses made during that emergency. Bill (Willam) Croyle, who is currently the Supervising Engineer in DWR's Flood Operations Branch, acts as the head of flood emergency operations.

Mr. Punia mentioned that without declaration of emergency, it is very difficult for DWR to spend money during HW events or flood emergency as DWR would need to have the activity budgeted under normal operations. Therefore, HW staking, aerial photography etc would require a charge number for normal operations. Many times this type of funding is not available. Furthermore, Jay mentioned that there are two types of emergency situations, one is the DWR declared emergency under which DWR will receive charge numbers through the Department of Finance for conducting required operations during the emergency period. This department wide emergency operation allows the full use of DWR resources during the emergency period. The second situation is when the Governor declares a State of emergency. In this case, the full resources of the state become available during the emergency period. For instance, during a State declared emergency, the National Guards' resources would become available. Under that circumstance, DWR may take the help from the National Guard and use

their facilities such as helicopters and fixed wing aircraft for aerial reconnaissance. Mr. Punia noted that standard, pre-negotiated contracts exist for things like reconnaissance flights and aerial photography that can be exercised during an emergency.

Mr. Punia offered that in his experience, levee patrollers were the best source of manpower to do the HW staking. This is because the patrollers are already on site and are familiar with the levee system. Agency (DWR, Corps, etc) staking usually occurs sometime after the flood event and produce less reliable results. He thought that adding a separate segment to Flood Fight School to train the personnel in HW staking procedures would provide a sound basis for acquainting the key levee patrol individuals with the important requirements of HWM staking. Mr. Punia noted that during high water an individual at the FOC is designated with the responsibility to check actual and forecast river conditions with the responsibility for staking and photography found in the 1993 committee notes. If the criteria is forecast to meet or exceed the triggers set forth, the will call the agencies so assigned that the trigger has or will be exceeded. The agency must then determine if they will develop the High Water data.

He also stated that the CVFPB does not have an independently controlled budget to pursue high water staking and photography. Therefore, the CVFPB should not be designated as responsible for areas to be staked or photographed. At the same time, the CVFPB should be involved in determining areas for HW documentation and for the establishment of criteria for the initiation of documentation.

Mr. Punia suggested Ricardo Pineda as a valuable source for further information in this regard.

High Water Documentation Program
Telephonic Interview of Brian Smith
March 17, 2010

List of Attendees: Via telephone, Brian Smith, Joseph Countryman, Ben Tustison and Rajat Saha

Meeting Start Time: approx 1:00 pm
Meeting End Time: approx 1:30 pm

Brian Smith is Chief of the Statewide Planning Branch in DWR's South Central Region Office.

Brian Smith stated that during high water emergency in 2006, he served in two ways – (1) led Incident Command Team (ICT) in the field to conduct flood fight but not high water staking; and (2) organized or directed regional emergency functions as directed from Flood Operations Center (FOC). However, he recalled that his Branch collected some high water data during the 1997 event. During 1997 flood event, his team went to the field around 1-2 weeks after the flood peak; staked and collected the high water data using GPS; and sent data to the Sacramento district office. He mentioned that he received instructions from DWR's Division of Flood Management (DFM). However, he suggested that we talk to Kevin Faulkenberry to get more details in this regard. Mr. Smith mentioned that during an emergency, flood control operations are organized by the Flood Operations Center in accordance with the Incident Command System (ICS).

Brian Smith described that currently there are 3 ICTs operational during an emergency; one is in the San Joaquin Valley. ICTs are formed with DWR staff only and there is no limit of team members. As per the requirement, ICT's may ask for more personnel and/or specific equipment. As an example, he mentioned that the ICT that worked with him during the 2006 flood event consisted on 22 DWR staff pulled out from 8 different DWR offices.

Although Mr. Smith mentioned that during a high water emergency, DWR assigns an Executive on Duty. He/she might be Director, FOC; Deputy Director, FOC; or Chief, Division of Flood Management. Regarding funding procedures, he suggested Sunny Fong, Art Hinojosa and/or Garry Bardini's as people to contact.

When asked whether he has any high water data that he collected previously, Mr. Smith said that during high water events, there was specific instruction for collecting, coding, storing and officially transmitting high water data to the head office. However, he was unclear about the storage and uses of those data. He mentioned that the Corp might have used the 1997 high water data as they came up with a whole new set of 100-yr flow data after 1997 flood event.

When asked for suggested improvements Mr. Smith mentioned that high water staking should be a primary duty of the Regional Offices. LMAs' levee patrollers may take the lead role in high water data collection in their area jurisdiction. He felt that the LMA's could supplement DWR high water data collection by surveying and collecting data for specific

areas. He strongly felt that proper instruments and clear instructions should be provided in advance of emergency. He opined that there were no clear protocols documented, to his knowledge. His staff used some “old manual” for 1997 high water staking. A copy of the “manual” was requested from him by MBK. He opined that the effort to develop high water data collection manual would be extremely helpful.

High Water Documentation Program
Telephonic Interview of John Clements
March 17, 2010

List of Attendees: Via telephone, John Clements, Joseph Countryman, Ben Tustison and Rajat Saha

Meeting Start Time: approx 1:45 pm
Meeting End Time: approx 2:30 pm

John Clements mentioned that he is presently in charge of the DWR Northern Region's stream gaging data collection program and that his staff currently operates about 50 stream gages (22 under DFM contract) with three (3) crews to do gaging. His other duties have historically included high water staking and performing emergency management activities (e.g. Tsunami-type simulations). Mr. Clements said that during high water events, his personnel collect not only stage data but also flow data. He mentioned that he is currently mainly using Acoustic Doppler Velocity Profilers (ADVP) to measure the flows. He also suggested that provision for additional similar instruments should be included in the HW Program recommendations. However, he mentioned that these ADVPs may not be as accurate as advertised for high flows when substantial beload movement occurs. John Clements mentioned that recently Boone Lek had sanctioned $25,000 for procuring a multiple frequency ADVP.

Mr. Clements explained the automatic transmittal of Northern Region's gage data, as well as its verification and archival. Most of the gaged data is automatically transmitted to CDEC on a real-time basis for dissemination and storage upon its recording. Some of the gaged data is not transmitted to CDEC. The CDEC data is subject to revision. The Region uses a software program called Hydstra for archiving and verifying the data (raw recorded stage, discharge measurements, rating curves, etc…). Verified data is automatically sent to the DWR Water Data Library (WDL) once a week (on Thursday) for archival and dissemination via the internet.

Mr. Clements mentioned that Bill Mendenhall and Todd Hillaire in the Region are currently leading the high water staking operations. Mr. Clements was unsure who in the department initiates High Water Staking activities during emergency and was also unsure about the funding structure. He mentioned that during flood emergencies, orders normally come with a charge number, but High Water Staking is not in the annual budget. However, he mentioned that under normal circumstances (except emergency) there is no operating budget for such activities. Mr. Clements mentioned there have been past, unfortunate instances in the Region where high water staking has been ordered and performed without ever receiving the subsequent directive to survey the stakes.

Mr. Countryman asked if they routinely checked the stream gage datum to determine if changes have occurred at the gages. Mr. Clements said that though he would like to have such a program he did not have funding for it. Mr. Clements was also unsure about who

initiates the aerial photography activity during high water events, although he has used aerial photographs extensively.

Mr. Clements strongly suggested incorporation of new and improved stream gages especially where flows are bypassing the existing gages. He also emphasized a good gaging program was dependent upon the availability of steady funding from DFM and other Divisions within the Department. Mr. Clements also emphasized the need for a carefully thought out program for selecting the gaging sites as well as archiving the data that is collected.

High Water Documentation Program
Interview with Ricardo Pineda
March 18, 2010

List of Attendees: Ricardo Pineda, Chief, Floodplain Management Branch (FMB)
Raul Barba, Engineer, WR, FMB
Tasmin Eusuff, FPIIB
Joseph Countryman, MBK Engineers
Rajat Saha, MBK Engineers

Meeting Start Time: 11:00 AM
Meeting End Time: 12:00 Noon

Ricardo Pineda is Chief of DWR's Floodplain Management Branch

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Ricardo Pineda mentioned that he was actively involved in high water staking program during 1995 and 1997 flood events and also did some work during 2006 flood event. However, he mentioned that after departmental budget cut in 2000, the responsibility was transferred to Jeremy Arrich's group, i.e. Flood Project Integrity and Inspection Branch (FPIIB). He mentioned that although the Flood Data Committee (also known as the Ad Hoc Committee) was scheduled to me twice every year – once before and once after the monsoon season, it met for the last time in 2000. After 2000, the departmental budget cut prevented the Committee's biennial meeting.

Mr. Pineda would like to see the HW documentation include areas outside the Central Valley and in particular aerial photography that might help in the delineation of flood risk areas.

When asked, Ricardo Pineda was unclear about the funding mechanism during flood emergency. He opined similarly to Jay Punia that during emergency, the Finance Department used to provide a series of charge numbers. However, he mentioned that it was up to the DFM to assess the workload and assign tasks accordingly and bills and charges were taken care of after the event was over. He mentioned that funding was never an issue, particularly under Public Assistance (PA) program during federally declared emergency where FEMA reimbursed 75% of the costs incurred.

Mr. Pineda emphasized that a goal should be to maximize the efficiency of district and regional offices of DWR, LMAs, Corps, USGS, SAFCA, etc and proper coordination of those agencies with DFM during flood emergency. When asked whether surveying and high water staking should be done by local levee patroller, he mentioned that in the past, similar initiatives resulted mixed success. According to him, accurate surveys should be done by the DWR's surveyors and manpower availability is not an issue, as currently DFM has more than 300 staff to serve as back-up during high water events. He suggested that staking should be done as soon as possible after the high water event. He thought it would be good if staking was done at predetermined locations such that staking would occur at the same locations for different flood events.

Mr. Countryman noticed that the CVFBP was responsible for vast reaches of the flood system and he stated that he did not believe they were properly staffed to cover these areas. Mr. Pineda agreed that the CVFBB does not have enough manpower and has insufficient funding to conduct the HW activity they were signed up for in 2000. He suggested that the CVFPB areas should be the responsibility of DWR. However, he agreed that the CVFPB be included in the planning phase.

Ricardo Pineda suggested that the HW manual should contain recommendations to use improved equipment such as GPS, ADFM (Acoustic Doppler Flow Meter), etc. He agreed that Mr. Countryman's proposal to install low cost stage gages would help in collecting data that could be used in calibration of unsteady state hydraulic modeling and provide time series information on water levels that high water staking cannot provide. However, he also mentioned similar recommendations were made during the Flood Data Committee meetings also but never got implemented, primarily because of the ad hoc nature of the committee and the availability of funding.

Ricardo Pineda was particularly enthusiastic about developing protocols and procedures for high water data collection as he mentioned that currently there are no standard protocols to store data and to provide quality control to the archiving process. He suggested that DWR should nominate one project manager (PM) to look after archiving data. He regretted the loss of data, field notes, measurement books etc. that can occur when individuals are relocated when office locations change. He emphasized that a master database maintained as part of the flood data acquisition process (CDEC?) should included in planning of HW data archiving. Tasmin Eusuff at this point mentioned that GEI has been tasked by DWR to develop a plan for a master data management plan within CDEC.

Ricardo Pineda suggested MBK should contact Jon Ericson for more information regarding high water data collection, and Art Hinojosa or Gary Bardini for information related to overall management and funding procedures.

High Water Documentation Program
Interview with William (Bill) Croyle
March 23, 2010

Telephonic discussion with Joe Countryman, MBK Engineers

Meeting Start Time: 11:00 AM
Meeting End Time: 11:30 Noon

Willium (Bill) Croyle is the Chief of the Flood Operations Branch, Hydrology and Flood Operations office, DWR

The undersigned called Mr. Croyle to determine if he could sit in on an interview that was scheduled with Art Hinojosa on 3/24/2010. Mr. Croyle was not available that day so we proceeded to discuss issues and procedures for High Water Documentation.

Mr. Croyle related that under most High Water documentation incidents the management structure would be under their emergency mobilization protocol (SEMS). He would expect that a request for HW documentation would come from the Flood Operations Chief to the Logistic Chief on the ICT. The Logistics Chief would obtain a Q number (a Finance and accounting control number) and order the HW documentation. The Q number would be tied to a specific emergency threat that could be tracked from a cost perspective. Under a non-emergency request for HW documentation the Ch Flood Operations Branch would request the work and likewise obtain a Q# to track costs.

Mr. Croyle stated that when a request went out for HW Staking it should also have a coordinated request for survey documentation and a definition of what the final product that is expected when the documentation is complete. That is the product should be a formal report or the final product should consist of particular characteristics. The final destination of the data would be described. Mr. Countryman told him that based on interviews; this has not been the case in the past.

Mr. Countryman suggested that since ICT's are formed on a temporary basis and may only last a few weeks before disbanding, there may be a lack of follow-up on collection and archiving of data. Mr. Croyle wasn't sure but acknowledged that a clear delineation of follow-up responsibilities is desirable.

Mr. Croyle expressed appreciation for the efforts that were being made to define and enhance the collection of HW data.

High Water Documentation Program
Telephonic Interview with Iris Yamagata
March 23, 2010

List of Attendees: Iris Yamagata, Surface and Groundwater Data Section, SC Region
Pat Huckabay, DWR Northern Region
Joseph Countryman, MBK Engineers
Ben Tustison, MBK Engineers
Rajat Saha, MBK Engineers

Meeting Start Time: 01:00 PM
Meeting End Time: 01:45 PM

Iris Yamagata is the Chief of the Surface and Groundwater Data Section, SC Region, DWR

Iris Yamagata said her office is severely affected by the budget cut and reduction of staff by nearly 50% in past 15 years. She mentioned that her office use to maintain around 100 gage stations in the 1970's. Currently they maintain only 16 gages. The discontinued stations were the result of General Funding cuts and funding cuts from cooperators. With staff salary increases from labor negotiations, cost of living, and overhead increases, the cost per gaging site is quite expensive. If further General Funding cuts are experienced the basic data program would be in jeopardy. She further mentioned that increased environmental requirements under CEQA/NEPA, which is different for different regions within the Department of Water Resources, is also making the task of adding, retrofitting or maintaining the surface water gages more and more difficult.

The Hydstra software is used to populate the flow stage database. Hydstra was purchased approximately four year ago and the Northern Region Office in Red Bluff is assisting the Fresno office in evaluating the current conditions of the data sets and improve the continuity, consistency and accuracy of the data. Pat Huckabay of the Northern Region mentioned that Hydstra cannot be used to store high water data. Ms. Yamagata mentioned that her office is not actively performing any high water staking and surveying and recommended Brian Smith, Kevin Faulkenberry and Paul Romero be contacted for information on that activity. However, she said their Regional office did some high water staking and surveying upon request from DFM during 2006(?)/2007 flood event (the effort was not funded by DWR). 3-4 crews were sent to stake high water marks, to survey and take pictures. She was unsure ~~if~~ where the data is located in the office and the HWM's were placed on a GIS map.

Ms. Yamagata was not sure who initiates the high water staking and surveying process on behalf of DWR but anticipated that it would be somebody from either Hydrology Branch or Flood Management Branch of DWR. She recommended MBK to contact Art Hinojosa or Boone Lek for more information.

She expressed appreciation for the efforts that were being made to define and enhance the collection of HW data. She emphasized that a steady funding source for data collection was

very important and should be noted in our report. She also thought that reinstatement of some of the gage stations that have been discontinued should be considered. Ms. Yamagata would provide MBK with a list of discontinued gaging stations.

High Water Documentation Program
Interview with Key Staff at FOC
March 24, 2010

List of Attendees: Art Hinojosa, Chief, Hydrology and Flood Operations Office, DWR
Daniel Meyersohn, Acting Chief, FPIIB, DWR
Tasmin Eusuff, FPIIB, DWR
Michael Koller, FPIIB, DWR
Md. Haq, FPIIB, DWR
Joseph Countryman, MBK Engineers
Rajat Saha, MBK Engineers

Meeting Start Time: 10:00 AM
Meeting End Time: 11:45 AM

Prior to Art Hinojosa's coming, Joe Countryman of MBK and MD Haq of FPIIB, DWR discussed about the scenarios that might arise due to levee failure and potential application of multiple aerial photographies in a single day. Mr. Countryman agreed and replied that that would help estimating the temporal as well as spatial propagation of wetting front and extent of inundation as well. Mr. Haq stated that frequent readings of staff gages immediately after levee failure would help in estimating wetting-front build-up time, which, in future, would help in H&H modeling.

After Mr. Hinojosa's arrival, Mr. Countryman started the interview by asking if the Flood Data Committee (FDC), which met in 2000 for the last time, is still operational or not. He also pointed out the issues discussed in various previous meetings relating to lack of proper guidelines of high water staking, responsibilities to collect data, storage and maintenance of collected data etc. Mr. Hinojosa stated that the High Water Data collection process should start with a clean slate and that the FDC procedures should not be the current standard. He believed that the storage of collected data will not be a big issue once the survey data is placed in a standard format. Mr. Hinojosa mentioned that while the River Forecasting Section should provide the information as to when a flood would reach its peak, it would be the task of the Hydrology Branch to provide overall monitoring and initiate additional high water data collection (staking, Photogrammetry, and video). He stated that the Hydrology Branch Chief should act as overall coordinator and make the recommendation for high water documentation to begin. The DWR-FPIIB Chief would execute the HW documentation and coordinate with the LMAs, DWR offices and other agencies to have the documentation completed. Once the documentation was accomplished, the Chief of the Hydrology Branch would be responsible for the archiving of the data.

Daniel Meyersohn suggested that the staking could be a responsibility of the LMAs and MAs and DWR could offer to perform the surveying. This procedure would encourage LMA participation. Tasmin Eusuff pointed out that in that case, this has to be included in the DWR's planning process. Mr. Hinojosa agreed that this approach had promise and that

coordination with DWR's Geodetic Branch would be very important. It was mentioned that that other cooperating agencies may also be able to complete the surveying with the help of DWR.

Tasmin Eusuff suggested that DWR does not have enough manpower to survey High Water throughout the Sacramento and San Joaquin Valleys. Joe Countryman suggested that DWR should take help from other partner agencies like the Corps, SAFCA, San Joaquin County etc… Everybody agreed to this suggestion. At this point, Mr. Hinojosa mentioned that special emphasis would be given to the reaches used by the Hydrology Branch for forecasting. In effect, areas that are part of the State/Federal levee system would be given priority.

Joe Countryman pointed out the need to collect stream flow measurements at existing stream gages during high water conditions. This is needed to improve the rating curves during high flow conditions. Mr. Hinojosa said that DWR supports district/ regional offices for high water measurements along with USGS. Joe Countryman also emphasized that the request for high water documentation should include a statement as to "what is expected back" in the form and format of documentation. This would facilitate a consistent set of data being returned for archiving. This concept was accepted by all present.

Mr. Hinojosa mentioned that at least one Excel table containing (x,y,z) points of measurement should be reported back; though the best thing would be a shape file in GIS that could be produced in the form of a map. At that point, Mr. Meyersohn mentioned that the timestamps should also be reported along with the (x,y,z) points to indicate time trend of data collected. Art Hinojosa mentioned that a copy of the data, in the form of a summary report, would also be provided to the partner agencies/LMAs/regional or district offices which could be extremely valuable for them and would also help them.

Daniel Meyersohn wanted to know "what to do" with the existing historic data that resides within the department. All agreed that capture of this existing data would be useful.

The meeting was adjourned. Additional discussions between Joe Countryman and Daniel Meyersohn were held. Mr. Meyersohn suggested that irrigation pump stations could be a good place for installing staff gages, which will help reduce noise (systematic and random error) in data collected. He also suggested that slant gages may also be recommended for better reading purposes, if found cost effective. Mr. Countryman and Mr. Meyersohn discussed that if installing vertical staff gages at each measurement location appears to be expensive, it could be installed only at the irrigation pump locations. Mr. Meyersohn mentioned that DWR could possibly install those gages and the district/regional offices or LMAs or the partners would read them during high water conditions and report the readings to CDEC. A big advantage of this is that timing information for the event would be gained and the reading would be taken at the same location for each event.

Daniel Meyersohn also explored whether it is possible to stake and survey at every 1/4 mile rather than the normal practice of staking at every 1/2 mile. Mr. Countryman mentioned that it might be too much for the HW stakers and for the surveyors. However, both of them

agreed that staking on both sides of the river/stream would provide valuable information and some overlap of data.

The meeting adjourned around 11:45 AM.

High Water Documentation Program
Telephonic Interview of Kevin Faulkenberry, Paul Romero and Dave Encinas
April 06, 2010

List of Attendees: Via telephone, Kevin Faulkenberry, Paul Romero, Dave Encinas, Joseph Countryman and Rajat Saha

Meeting Start Time: 09:00 am
Meeting End Time: 10:00 am

Kevin Faulkenberry, Paul Romero and Dave Encinas discussed their previous experiences of high water staking and surveying; issues related to those experiences; and suggestions for further improvement. Mr. Faulkenberry stated that High Water documentation was very important and was critical for the calibration of flood system hydraulic models. He stated that besides staking, the actual surveying of a high water profile (during a flood) is possible with existing technology.

When asked about the HW documentation during the 2006 flood, they indicated that DWR staked the high water and the USBR surveyed the stakes to develop the elevation data.

They were asked about the 1997 flood and they stated that for that flood the regional office did some high water staking and surveyed the stakes themselves. Mr. Faulkenberry said that the data was not of the best quality because of the last minute decision to get the data they missed the peak for the San Joaquin River and only managed to survey the debris line. They found it very difficult to point out whether the debris lines were for high water in the main channel or for backwater or side channel conditions. They said that there were no funds or efforts to process and correct the collected data. They stated that the same thing also happened after 2006 flood event when they received the survey files (in ASCII point description files) from USBR and there was not funding to process the data and to verify its functionality.

Mr. Faulkenberry and Mr. Romero strongly suggested that during flood events, proper instructions of tasks are required ahead of time and a team with a definite plan and goal in mind should be deployed. Small teams for specific watershed areas should be formed to establish the High Water documentation/staking plan specific to that area. This plan would be in place ahead of a flood event and would include important information as to location and frequency of high water documentation. They suggested that the team should be comprised of a surveyor, an H&H modeler (who would help guide the location and frequency of data to collect) and a supervisor with a system wide perspective. The structure would be similar to the ICT emergency team organization but specifically for high water documentation in a particular region. This team would oversee the High Water documentation for its designated area. Also, Mr. Faulkenberry opined that high water surface profiles have limited usefulness unless accompanied by reasonable flow estimates. Therefore careful consideration needs to be given to the collection of flow data during a flood event. The issue of availability of personnel to do high water staking during a flood event was discussed. All of them suggested

that the availability of a standing consultants' contract should be considered. The consultant would execute the plan developed by the regional teams and would provide a complete package of staking and surveying, including QA/QC. They emphasized DWR high water teams need to have at least one person with local knowledge on the team. It was discussed that the DWR high water planning teams would meet once prior to the start of the flood season to review the status of the plan in their respective areas.

At this point, Joe Countryman suggested an alternative of putting staff gages at irrigation pump locations so that multiple reading during a flood event could be obtained. Mr. Faulkenberry, Mr. Romero and Mr. Encinas supported the idea. They all accepted that putting staff gages at every half mile would result in an efficient data generation. However, they pointed out that those staff gages would need periodic maintenance and annual surveys to be able to document any subsidence. Since there would be costs associated with these activities, that would need to be worked out. Mr. Faulkenberry also stated that similar initiatives had already been taken in the San Joaquin basin by placing pressure transducers at various locations as part of the San Joaquin River Restoration Program.

Mr. Countryman also explored whether they have a good benchmark network within the San Joaquin basin so that GPS instruments could be used for high water staking elevations. Mr. Faulkenberry affirmed that the network existed. He mentioned that the ongoing LIDARs have good network coverage also.

Mr. Countryman asked about other forms of documentation, such as, video helicopter flights. Mr. Faulkenberry suggested that there should be proper guidelines to conduct aerial (helicopter) photography. In particular guidelines should be provided on what to video and how to provide voice over descriptions. He also mentioned that a scope for helicopter video recon be included in the manual.

Mr. Countryman asked about the utilization of local districts to perform high water documentation activities. They acknowledged the potential but pointed out that many local districts require support and training before reliable data could be developed.

When asked about funding mechanism of high water staking activities by Rajat Saha, Mr. Faulkenberry said that funding had always been an issue. He said that sometimes during the State declared flood emergency, they used to get flood emergency account numbers to charge their times. But, according to him, this was not always true and sometimes it takes a long time to get reimbursed. He opined it would be a good idea to develop guidelines for obtaining a funding mechanism in the manual.

At the end, it was re-emphasized to form a coordinated team effort to manage and execute the high water staking. They all agreed to Mr. Countryman's suggestion that deploying the teams and the start of high water initiatives should be based on forecasts rather than after occurrence of an actual event in order to ensure timely staking and surveying.

High Water Documentation Program
Telephone Interview of Teresa Chaney
April 15, 2010

List of Attendees: Teresa Chaney, Chief, DWR Graphic Services
Ben Tustison, MBK Engineers

Interview Start Time: 1:00 PM
Interview End Time: 1:05 PM

Teresa Chaney is the Chief of DWR's Graphic Services department. Ms. Chaney was interviewed to assess the role of DWR Graphic Services in the collection of videography during a flood event. Ms. Chaney explained that Graphic Services is able to collect high definition video and that all video is digitally collected. Graphic Services has a contract for conducting helicopter flights, so both the helicopter and video capture could be arranged by Graphic Services during a flood event. Graphic Services does not have a contract in place for fixed-wing aircraft.

Ms. Chaney mentioned that Graphic Services is also capable of editing video and its associated audio. Ms. Chaney indicated that Graphic Services could facilitate re-narration of the video after it had been collected, if necessary.

Ms. Chaney suggested that more detailed questions regarding Graphic Services videography could be directed to Mark Lambert (cell: 916-716-1790). Mr. Lambert oversees the video portion of the Graphic Services department.

High Water Documentation Program
Meeting with key DWR personnel at FOC
May 05, 2010

List of Attendees: Michal Koller, FPIIB
Tasmin Eusuff, FPIIB
Daniel Meyersohn, FPIIB
Joseph Chang, FPIIB
Anthony McDonald, FPIIB
Jon Ericson, Chief, Hydrology Br.
Chris Smith, GEI
Melissa Cansdale, GEI
Joe Countryman, MBK Engineers
Rajat Saha, MBK Engineers
Ben Tustison, MBK Engineers (on call)

Meeting Start Time: 3:30 PM
Meeting End Time: 5:30 PM

The objective of this meeting was to review the operational flowchart for High Water (HW) Documentation Program prepared by MBK Engineers. The meeting started with Joe Countryman explaining the different components of the flowchart and how the entire flowchart has been conceptualized step-by-step. He referred to his discussion with Ricardo Pineda and stated that there is no existing structure of HW documentation procedure and that the Ad-hoc committee (also known as the Flood Data Committee that formed after the 1993 flood event) does not exist. Everybody agreed to this. Mr. Countryman stated that the flowchart will guide the development of the High Water Documentation Manual. Once it is agreed that the flowchart represents the direction that DWR wants to go with High Water Documentation, MBK will begin to write the Manual. In addition, it was mentioned that Task 3 would be an evaluation with recommendations on how to improve upon the traditional high water staking methods.

While everybody was pleased with the flowchart, Jon Ericson, Chief of Hydrology Br., stated that the flowchart should be different when the department runs through emergency mode, i.e. through the Incident Command System (ICS). For this case, all activities are coordinated through ICS's four major Sections – Operations, Planning, Logistics, and Finance/ Administration. However, he mentioned that the same activities as mentioned in the current flowchart will still be performed but the responsible agencies or branches will now be different and under ICS.

Mr. Countryman stated the importance of coordinated efforts among different DWR departments (e.g. Hydrology and Flood Operations Office, Hydrology Br., FPIIB, Photogrammetry and Mapping Section) as well as that between other partner agencies e.g.

USACE, USGS, USBR, Rec. Board etc). At this point, Mr. Ericson suggested that training programs should be organized through the Outreach component under the Local Agency Assessment Program to involve and increase coordination. A discussion was held on the need for a MoU between DWR and other agencies for ensuring their performance during the HW events. Mr. Countryman opined against making a legally binding MoU. He suggested a non-binding MoU or simply a Letter of Intent from participating agencies instead. Mr. Ericson agreed and assured that he will look into this further. The next workshop in June under Local Agency Program and Outreach Program will provide an opportunity to determine the interest in interagency cooperation in High Water documentation. When asked by Chris Smith whether the determination of interagency participation would hamper the project schedule or not, Mr. Countryman said that this will not affect the project schedule because the current flowchart has DWR as managing the effort and using other agencies as necessary.

Joseph Chang, Daniel Meyersohn, Jon Ericson and Joe Countryman discussed at length about prioritizing locations of HW documentation. The major suggestions include:

- Prioritization should be based on stage.
- Priority should be given to important hydraulic areas like Sutter Bypass, major confluences etc.
- Before prioritizing, it would be evaluated whether the location under consideration falls in the project or non-project facility areas.
- Triggers should be lowered to increase documentation where the safety deficiencies (e.g. levee) are greater and vice versa.

Everybody agreed to Mr. Countryman's proposal that levee inspectors should not be involved to stake HW marks. Considering the limited manpower availability during HW events and also the risk of jeopardizing the quality of data in absence of good manpower availability, Mr. Ericson suggested that during formation of a staking or surveying team, at least one skilled surveyor will be engaged in each group and his task would be to guide the team. Mr. Chang also emphasized on repeatability of data collection at same locations which would help in time series analysis at those locations. Everybody agreed to those. Mr. Chang also thought it would be helpful if a person familiar with hydraulic modeling was on the team and Mr. Countryman agreed.

Tasmin Eusuff pointed some editorial comments of the flowchart which Rajat Saha said he would take care of those. Ms. Eusuff also asked whether procurement of flights for videography is the task of FPIIB, DWR or not. Mr. Countryman confirmed that this situation only arises during emergency declarations. Mr. Ericson also agreed to this and added that it would be covered under the Logistics Section of ICT.

DWR members of the group were concerned about the relevancy of the involvement of DPLA (Department of Planning and Local Assistance) and use of Water Data Library in analyzing and storing HW data. Mr. Saha of MBK Engineers assured them that he will talk to Michael Mierzwa on this and update the flowchart.

For additional information, contact:
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