FLOOD CONTROL AGENDA ITEM # _____ January 24, 2012

COUNTY OF ALAMEDA
PUBLIC WORKS AGENCY
399 Elmhurst Street • Hayward, CA 94544-1307
(510) 670-5480

January 10, 2012

The Honorable Board of Supervisors
County Administration Building
1221 Oak Street
Oakland, CA 94612

Dear Board Members:

SUBJECT: MODIFICATION TO AGREEMENT WITH DHI WATER & ENVIRONMENT, INC. TO PERFORM SPECIALIZED COASTAL HAZARD ANALYSIS AND MAPPING OF SELECT SHORELINE AREAS OF ALAMEDA COUNTY

RECOMMENDATION:

Approve and execute Modification No. 1 to Procurement Contract No. C-4922 between Alameda County Flood Control and Water Conservation District and DHI Water & Environment, Inc., (Managing Director: Dr. Timothy Hazlett; Location: Portland, OR) to provide specialized coastal hazard analysis and mapping services, to modify the project scope of work and increase the contract amount from $540,963.00 to $1,250,963.00, an increase of $710,000.00, of which amount 85% ($600,000) is being funded by FEMA and 15% ($110,000) by the District, with no change in the contract period of January 2010 through January 2013.

SUMMARY/DISCUSSION:

In January 2010, the Board approved an agreement between Alameda County Flood Control and Water Conservation District (District) and DHI Water & Environment, Inc. to provide specialized coastal hazard analysis and mapping services for the Federal Emergency Management Agency (FEMA) and the District in an amount not to exceed $540,963 for the period January 2010 through January 2013.

At that time, FEMA Region IX was also conducting regional hydrodynamic and wave models of the San Francisco Bay (Regional Model). Due to common interest, the District and FEMA Region IX entered into a collaborative agreement to study select shoreline areas of Alameda County for coastal flood hazards. This collaborative work has been conducted under the District's coastal hazard analysis contract with DHI Water & Environment, Inc. FEMA Region

IX, through their Cooperating Technical Partners Partnership Program awarded the District a grant in the amount of $360,000.00 to complete this study.

The initial stages of the contract work were related to development of the regional model of the San Francisco Bay to provide boundary conditions for the local coastal hazard analysis. This effort, which is essential to the completion of the coastal hazard analysis, has turned out to be much more complex than initially anticipated and has consumed the original project budget. Both the District and FEMA believed it appropriate to expend the funds necessary to complete the regional model in a diligent manner that will produce the most accurate analysis of coastal hazards along the Alameda County bay shoreline. FEMA and District has agreed on the increased cost of the project of which $600,000 of the $710,000 will be funded by FEMA and the remainder by the District.

SELECTION AND CRITERIA:

DHI Water & Environment, Inc. was selected to provide the above services through a competitive consultant selection process meeting Agency guidelines. A qualifications-based selection method was followed to obtain a shortlist as mandated by Government Code Sections 4525-4529.5 for selecting professional engineering firms. Subsequent to the selection process, the District applied for and was awarded FEMA Cooperating Technical Partners grant funds to be used toward this project. Federal grant fund regulations prohibit the use of local geographical preferences. Therefore, the SLEB requirement for this contract has been waived. The Auditor-Controller Agency Office of Contract Compliance has issued Federal Funds SLEB Waiver No. F117A.

A Request for Qualifications (RFQ) was issued on December 9, 2008, and mailed to 54 consultants providing hydrologic and hydraulic engineering services as listed in the SLEB database administered by the Alameda County Auditor Controller's Agency, and the consultant database administered by Alameda County Public Works Agency (ACPWA). Of the 54 total consultants, 29 (54 percent) were located in Alameda County. The RFQ was also posted on the ACPWA's website for 12 days. Nine consultants submitted Statements of Qualification (SOQs) that were due on December 24, 2008. Upon evaluation of the nine SOQs, four consultants were shorted-listed and invited to submit a formal proposal.

A pre-proposal meeting attended by the four firms was held on January 13, 2009. After the pre-proposal meeting, one firm, URS Corporation, elected to drop out of the procurement process. Then, just prior to the oral interviews, another of the shortlisted firms, Wood Rodgers, Inc. elected to team up as a subconsultant to one of the other shortlisted firms, DHI Water & Environment, Inc. Ultimately, two firms submitted proposals and participated in oral interviews at the District offices on January 27, 2009.

A selection committee comprised of three District representatives evaluated and rated the consultants' proposals and oral interviews. Evaluation criteria included relevant experience,

qualifications, written proposal/oral presentation and interview, level of SLEB participation, and overall approach to the project. The two consultants were ranked as follows:

Vendor	*Location*	*Local (within Alameda Co.)*	*SLEB*	*Subcontract Min 20% to SLEB*
1. DHI Water & Environment, Inc.	*Portland, OR*	*No*	*No*	*Yes*
2. northwest hydraulic consultants	*W.Sacramento, CA*	*No*	*No*	*Yes*

FINANCING:

There is no net County cost as a result of the action. The additional funds for this contract in the amount of $710,000.00 are available and budgeted in Fund 21801, Organization 270301, Account 610261 (Professional and Specialized Services), Program 50906. Of the $710,000 amount, 85% ($600,000) is being funded by FEMA and 15% ($110,000) by the District. The District has received a total of $960,000.00 in grant funds from the Federal Emergency Management Agency to be applied towards the cost of this project.

Yours truly,

Daniel Woldesenbet, Ph.D., P.E.
Director of Public Works

c: Andrew Massey, Deputy County Counsel
Susan Wewetzer, Principal Auditor, Auditor-Controller

Attachment: Modification of Agreement

DW:RS

REVISED 1/17/12

MODIFICATION OF AGREEMENT
With DHI Water & Environment, Inc.

This Modification of Agreement for Professional Services is made and entered into by and between the Alameda County Flood Control and Water Conservation District, hereinafter referred to as DISTRICT, and DHI Water & Environment, Inc., hereinafter referred to as CONSULTANT.

WITNESSETH

Whereas, DISTRICT and CONSULTANT have previously entered into Agreement C-4922, executed January 12, 2010, to perform specialized coastal hazard analysis and mapping services for the DISTRICT; and

Whereas, DISTRICT desires to modify said agreement to provide additional funds in the amount of seven hundred ten thousand and no/100 dollars ($710,000.00), of which $600,000.00 is offset by a grant awarded by FEMA; and modify the existing scope of work.

It is mutually agreed by DISTRICT and CONSULTANT to modify said agreement as follows:

1. Under Appendix B, Payments to Consultant, Section 1. Amount of Compensation for Services of Consultant, paragraph 1.1, the first sentence is revised to reflect the increase in funds and shall read as follows: "The amount of compensation to be paid to Consultant for all services under this Agreement shall not exceed one-million two-hundred fifty thousand nine-hundred sixty-three dollars ($1,250,963) referred to hereafter as the Not To Exceed Amount ("NTE")."

2. Exhibit A, Scope of Work is revised to include "Task 3" as attached, effective January 24, 2012, and continuing through the remainder of the contract period.

It is understood and agreed that all other terms and conditions of Procurement Contract No. C-4922 shall remain in full force and effect as if fully set forth herein.

EXECUTION

Alameda County Flood Control and Water Conservation District

By: _____
President
Board of Supervisors

Date: _____

Approved as to form:
Donna R. Ziegler, County Counsel

By: _____
Deputy County Counsel

DHI Water & Environment, Inc.

By: _____ PE, D.WRE, CFM
Michael Anderson, PE, D.WRE, CFM
Vice President

Date: 1/12/2012

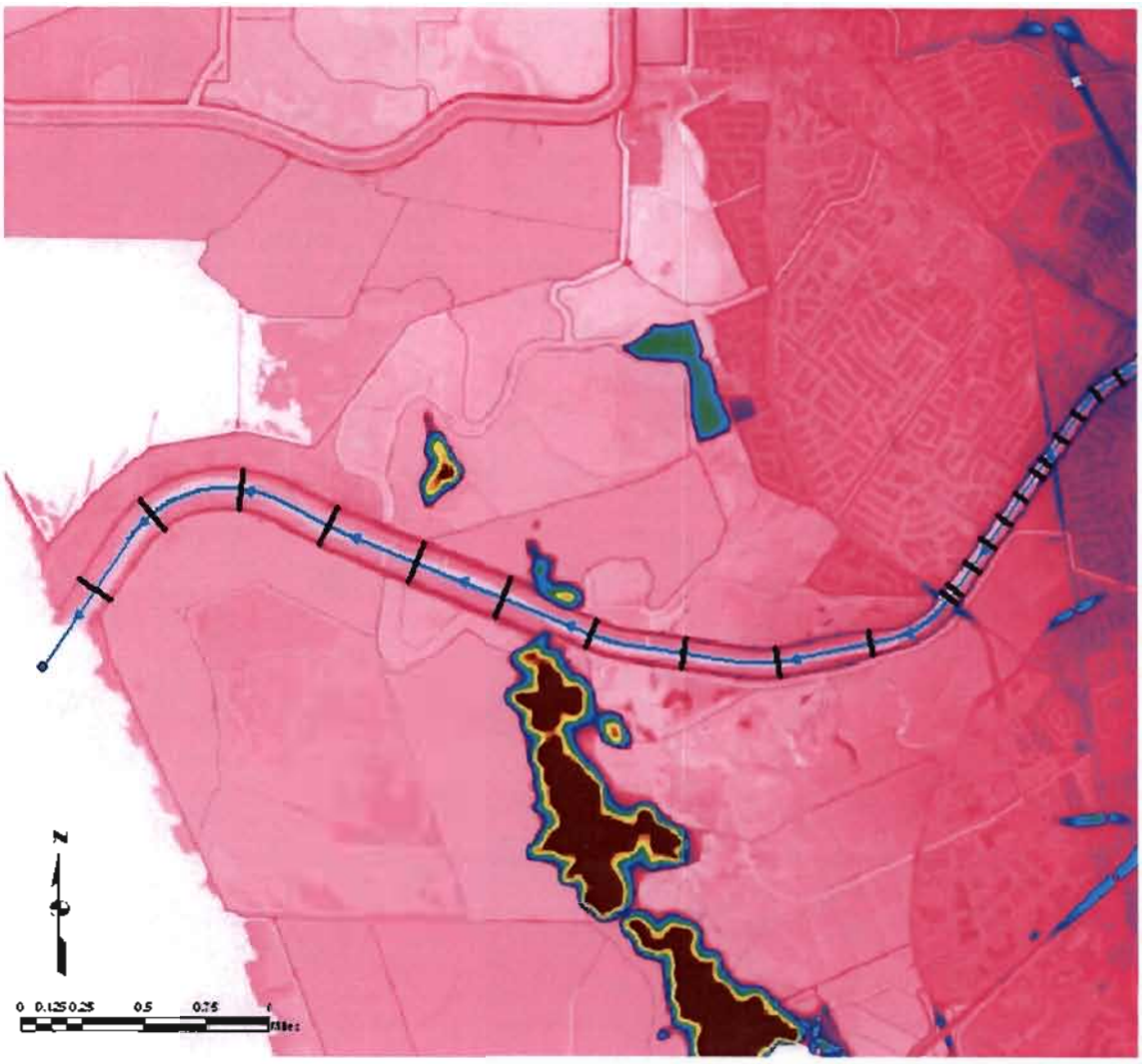
Tax Payer I.D. No. 23-2904467

By signing above, signatory warrants and represents that he/she executed this Modification in his/her authorized capacity and that by his/her signature on this Modification, he/she or the entity upon behalf of which he/she acted, executed this Modification.

Coastal Hazard Analysis

Alameda County Flood Control and Water Conservation District

Scope of Work



Alameda County Flood Control and Water Conservation District

Scope of Work
December 2009

Coastal Hazard Analysis

Scope of Work

319 SW Washington St.
Ste. 614
Portland, OR 97204

Tel: (503) 827-5900
Fax: (503) 827-5905

Website: http://www.dhi.us
Email: rla@dhi.us

Client	Client's representative
Alameda County Flood Control and Water Conservation District	Rohin Saleh

Project	Document No
Coastal Hazard Analysis Scope of Work	4021.656.15
Authors	Date
Robert Annear Dale Kerper	December 14, 2009
	Approved by Robert Annear

Revision	Description	By	Checked	Approved	Date
00	Draft	DRK	RLA	RLA	12/14/09

Key words	Classification
	☐ Open ☐ Internal ☒ Proprietary

Distribution		No of Copies
Alameda County	Rohin Saleh	1
DHI Inc.	Robert Annear, Dale Kerper	1

Contents

1 ALAMEDA COUNTY COASTAL FLOOD MODELING

1.1 Introduction

FEMA is currently in the process of completing a coastal hazard mapping study for the San Francisco Bay. The District is in the process of forming a collaborative agreement with FEMA in order to help expedite this study for select shoreline areas of Alameda County. This project describes the effort to complete a coastal transect analysis for a portion of Alameda County and to complete additional analyses to support the District's needs with respect to understanding coastal flood hazards.

1.2 Scope of Work

The scope of work for this project has been divided into 13 tasks. They are as follows:

1. Regional Model Boundary Conditions
2. Zone 2 Transect Analysis
3. Zone 6 Transect Analysis
4. Review of existing regional model setup with the District
5. Zone 2 Mapping
6. Zone 3A Mapping
7. Zone 5 Mapping
8. Zone 6 Mapping
9. Technical Advisory Group to provide peer review and expert guidance/Contingency
10. Post-processing and GIS Database Update
11. Documentation and Technology and Knowledge Transfer
12. Project Management and QA/QC
13. Peer Review & Recommendations for Detailed Study

DHI will proceed with the tasks 1-3 and 5-11 detailed in this Scope of Work only after the peer review work by Philip Williams and Associates has been completed as detailed in Task 13 and based on recommendations outlined by the County. To support PWA's review in Task 13 DHI will utilize Task 4 and 12 to support the review efforts.

1.2.1 Task 1 – Regional Model Boundary Conditions

Introduction

DHI is currently running regional hydrodynamic and wave models of the San Francisco Bay for FEMA Region IX. The purpose of the regional model is to provide boundary conditions to local coastal hazard analysis. The regional model is operated for a continuous 30-year period (1973-2002), a long enough period from which extreme analysis can be performed for 100 and 500-year return periods.

Objective

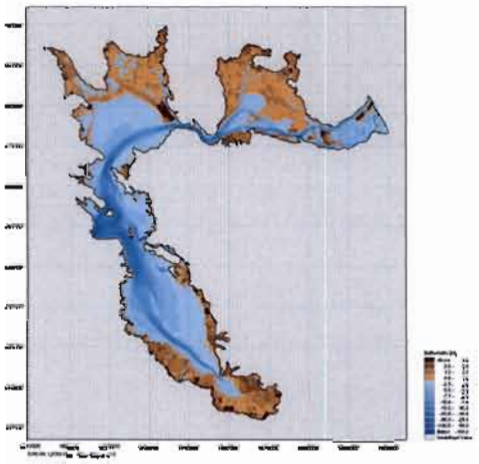
Utilize the regional model to develop boundary conditions for use in the local transect models.

Assumptions

- This task will use model results from a concurrent project that DHI is conducting for FEMA Region IX. No additional simulations will be done as part of this task.

Activities

- Analyze and prepare regional model results for transect boundary transfer.



Deliverables

- Regional model setup files and description
- Regional model output files for transect analysis
- Access to output data for other studies

1.2.2 Tasks 2 and 3 – Transect Analysis – WHAFIS

Objectives

Perform a coastal transect analysis for areas where there is potential for overland flow from storm surge and waves

Methodology

DHI will perform the coastal hazard analysis using FEMA's WHAFIS (Wave Height Analysis for Flood Insurance Studies) software and boundary conditions from the regional models. The WHAFIS analysis is based on transects cut from the bathymetric and topographic datasets available to the study. Topographical transects will be cut from a combination dataset developed from the current FEMA study and from the District's LiDAR dataset. The use of the District's LiDAR dataset is contingent on whether it can be shown to meet FEMA's requirements and standards.

Boundary conditions (wave height, wave period, wind speed, still water level, etc) from the regional model are applied at the offshore end of the transects. FEMA's WHAFIS model transforms the wave conditions across land based on variations in vegetation types, buildings, bathymetric features, wind fetch length, etc., and then prescribes the FEMA hazard zone designation (AE and VE - see Table one for zone definitions) and Base Flood Elevations (BFE) at zone change locations. Spacing between WHAFIS transects could depend on shoreline variation, land use, and other local complexities, and could range from 100 meter to 1000 meter spacing. WHAFIS transects will be developed from near San Lorenzo Creek to the north (Zone 2), and to the county boundary to the south (south of Dumbarton Bridge in Zone 6).

WHAFIS transect simulations will include running steady-state 100-year and 500-year conditions. The offshore boundary will be applied using 100-year and 500-year regional wave and current modeling results, and wind speed applied in a direction in-line with the transect. Initial WHAFIS model simulations will include leaving all levees (certified and non-certified) in the transect. WHAFIS analysis will progress to the first levee, where freeboard and or run-up/overtopping analysis will be performed to establish VE-Zone designations and BFE elevations. Run-up and overtopping analysis will be performed using the Technical Advisory Committee for Water Retaining Structures (TAW) method described in FEMA Guidelines and Specifications. Then the levee will be removed (since none of the Districts levees are currently accredited by FEMA) until the next one is encountered, freeboard and run-up analysis will be performed, and so on, until all levees have been included along the transect.

Table 1. Selected FEMA FLOOD Hazard Zones

Zone code	Definition
AE	Base Flood Elevation determined.
AH	Flood depth of 1 to 3 ft (usually areas of ponding); base flood elevations determined.

AO	Flood depth of 1 to 3 ft (usually sheet flow on sloping terrain); average depths determined. For areas with alluvial fan flooding, velocity also determined.
VE	Coastal flood velocity hazard (wave action); base flood elevation determined.
X	Areas determined to be outside 500-year floodplain.

Technically, based on FEMA specifications, once a levee is failed or removed, it cannot offer protection from storm surge. However, remnant (partially failed) structures or barriers, can in some cases offer some form of wave protection. FEMA guidance is not clear on this point, but there are some possibilities that can be explored depending on the type of structure, type of construction, etc. DHI will work with the District and FEMA to work towards a suitable method of application for this special case.

The results from WHAFIS provide wave height envelopes, and VE and AE zone designation for mapping.

DHI will work closely with the District and FEMA to determine the most appropriate treatment of outer "non-certified" barriers. These outer barriers will not meet FEMA requirements for flood control from the point of view of holding back storm surge. But for the overland wave analysis, it will be worthwhile to investigate whether these structures can be considered (even as remnants) as partial wave breaks, offering some protection to the designed inner levee systems.

Assumptions

- The District's LiDAR dataset will be available for cutting topographic transects.
- Transect analysis north of San Lorenzo Creek will not be performed under this scope of work.
- FEMA Floodplain Mapping will not be performed under this scope.

Activities

- Conduct the coastal hazard analysis using FEMA's WHAFIS software and boundary conditions from the regional models. Between 80 and 100 transects will be created and analyzed. Consult with District staff regarding the general assumptions behind the transect analysis such as the data sources used and the selected transect spacing prior to execution of the modeling.

Deliverables

- WHAFIS and wave run-up setup files
- WHAFIS and wave run-up result files for mapping

- Report that can provide the basis for FEMA Technical Support Data Notebook (TSDN).

1.2.3 Task 4 –Review of Existing Regional Model

Introduction

The existing regional model was not developed specifically to provide results for coastal analysis in locations south of the San Mateo Bridge, and FEMA's schedule may not allow time for a complete upgrade of the model setup in this region to include special features in this region (i.e. include new District LiDAR, include new levee alignment and crest heights, include creek inputs, control structures, etc.). DHI is trying to update the model with the latest levee and creek flow information before running the regional simulations, but won't have time to update the topography with new LiDAR data.

Objective

The District and DHI will work together to assure the regional model is adequate for the District's needs. If the existing model is found lacking some important features, this review will serve as a basis to recommend future model grid enhancements, and with the possibility of re-running the regional model with an updated mesh.

Activities

- Review existing regional model and, if necessary, provide recommendations for enhancements.
- Provide technical support to Phillip Williams and Associates (PWA) during their model review task (Task 14).

Deliverables

- Memorandum describing proposed enhancements to regional model and technical support provided to PWA.

1.2.4 Tasks 5 through 8 –Mapping of Coastal Hazards

Objective

Translate the hydraulic analysis from the combined MIKE 21, WHAFIS and run-up analysis into a DFIRM.

Methodology

DHI and Nolte will work together to produce FEMA flood hazard maps based on the coastal modeling analysis. DHI will provide and interpret the modeling results to Nolte so that Nolte can prepare the maps. DHI will provide internal review of the maps produced by Nolte.

This will be done in accordance with FEMA's Guidelines and Specifications Appendix D.4.9 on Coastal Flooding and Mapping. The model is to be run on a series of transects from a point just north of San Lorenzo Creek southward to the Alameda / Santa Clara county line. Nolte Associates will identify flood insurance risk zones and BFEs based on model results along each transect. The existing topography, coastal structure effects, and wave analysis are all important to proper identification of flood risk zones. The resulting DFIRM is intended to be technically correct and easy to use.

Activities

- Setup work maps with contour lines, buildings, structures, vegetation, and transect lines.
- Identify changes in flood risk zones along each transect on work maps.
- Interpolate flood risk boundaries changes between transects to create flood risk zones in GIS.
- Attribute Flood risk zones (VE, AE, AH, AO, and X) and BFEs in the DFIRM geodatabase tables.
- Perform QA/QC on geodatabase of flood risk zones.
- Submit geodatabase to FEMA's Mapping Information Platform (MIP).

Deliverables

- DFIRM geodatabase containing flood risk zones and BFEs
- Metadata for geodatabase
- Digital workmaps
- TSDN folder containing support data from the mapping task
- Task summary report

1.2.5 Task 9 – Technical Advisory Group/Contingency

Introduction

Dr. Robert Dean (Professor Emeritus, University of Florida) and Dr. David Divoky (AECOM - Watershed Concepts) are available to the study team to provide peer review of the coastal study, and to provide expert advice as necessary. Both have participated in the development of FEMA guidelines for Pacific Coast studies, and they have both provided similar roles to DHI and FEMA for Phase 1 of the San Francisco Bay Flood Insurance Study (FIS), and for the Del Norte County FIS performed by DHI and Nolte. Having access to such experts has proven

invaluable to the previous studies. The review and advisory sessions would take place through a combination of conference calls and memorandums.

Deliverables

- Advice memos and reviews attached to final documentation as appendices.

1.2.6 Task 10 – Post-processing and GIS Database Update

Objective

Provide information generated under this project in GIS formats that will be consistent with GIS geodatabases used by the District.

Methodology

Existing tools and algorithms will be used to transform the transect-based WHAFIS results to digital flood maps in a GIS format that conforms to the project's geodatabase specifications.

Activities

- Post-processing of WHAFIS results to GIS data format consistent with the project data structure.
- Convert other project-generated products to provide data in format consistent with the project data structure and geodatabase.

Deliverables

- Data of all project-generated spatial information organized and uploaded to the project geodatabase.

1.2.7 Task 11 –Documentation and Information/Technology/Knowledge Transfer

Objective

The objective of this task is to document all of the background, methodology, results and conclusions of the study in a final technical report, and provide model input files, results, and animations to the District.

Activities

- Compile all model input files, results, animations, and associated final products and deliver to the District electronically.

- Progress reports and final deliverables will be posted to the dedicated project SharePoint site.
- Prepare a final technical report documenting the background, methodology, results, and conclusions of the study. The report will include all relevant text, tables, and figures needed in order to convey the activities and findings of the work performed under this scope of work. The peer review memorandums will be provided as an appendix to each report. The District will be given a draft of the report and invited to provide edits/comments. If additions or revisions are required, the team will provide a second final draft of the report.

Deliverables

- Power point files, model input files, model result files, animations, and associated products. When feasible, these files will be placed on the project SharePoint site.
- Technical reports detailing the work performed under this scope of work.

1.2.8 Task 12 – Project Management and QA/QC

Objective

The primary purpose of project management is to ensure client satisfaction and provide overall project coordination, management of the work, and good communication with the District and amongst the various consultants on the project team. Additional project management activities will include establishing and maintaining the project schedule and budget, allocation of staff to project tasks, managing subconsultants, and reviewing and issuing invoices. A SharePoint site will be established for the project which will serve as a key communication and data management tool. The site will allow for meeting notes, announcements, reports, and data to be posted and exchanged amongst the team members and with the District. It is anticipated that meetings will be held monthly with the District to provide project status reports. Meetings with the District will also be held prior to all public meetings to review materials to be presented. Additional meetings will be held as needed to discuss pressing or emerging issues that require prompt attention or to share results at key project milestones. This task also includes providing overall quality assurance and quality control (QA/QC) of all of the work completed under this scope based on the requirements of ISO 9001:2008 to ensure that the requirements of the District are met in a cost effective and timely manner.

Activities

- General administration activities such as invoicing, including sub-consultant invoicing.
- General quality assurance to ensure that the implementation and delivery of processes and deliverables achieve the District's objectives
- Setup, maintenance and coordination of the project SharePoint site

- Establishing and maintaining the project schedule and budget
- Coordination and preparation of all deliverables
- Project status updates (monthly reports and status of schedule)
- Documentation of change management (e.g. developing additional scope or amending the existing scope)
- Conduct periodic meetings amongst the project team members
- Conduct periodic meetings with District
- Conduct meetings with the District prior to public meetings.
- Documentation of key communications and meeting minutes
- Scope Management - controlling the project to ensure it will meet the project objectives.

1.2.9 Task 13 – Peer Review & Recommendations for Detailed Study

Objective

The objective of the task includes a peer review of the current studies, mainly south bay USACE and north bay FEMA studies, including initial recommendations for possible detailed coastal studies to follow. The scope for this task has been broken into several subtasks and is intended to be carried out by Phillip William and Associates, Inc. (PWA).

1. Peer Review USACE Study: Review the coastal hydraulic analyses accomplished for the SSFBSS and provide an assessment of its applicability to the FEMA mapping Re-study. Contact SCVWD and USACE staff to gather documents for review. We anticipate having access to the estimates for existing conditions, and therefore do not expect to review future (with project and sea level rise) components. The USACE has already provided reports and results to the County although some additional documents may be requested (e.g. reviews by others). The review will focus on the following components:

    a. Bay hydrodynamic model – Results of the Corps' RMA-2 modeling, including Bay water levels, comprised of astronomic tides and extreme water level events, including propagation of oceanic surge, wind, and the effect of regional runoff;

    b. Overland flood propagation – Treatment of salt pond and other levees, including erosion, overtopping and breaching, and propagation of Bay waters and wave action to developed areas. Implicit to this review are several discrete wave analysis modules for wind wave generation, wave transformation over shallow waters, erosion, run-up, overtopping and ponding.

    The review will consider the analysis results relative to available data and estimates from other modeling efforts (e.g. FEMA, SBSP and USGS). The review will also consider conformance with FEMA Guidelines for Pacific Coast Flood Studies. PWA will develop a technical memorandum summarizing the Peer Review. If appropriate, PWA anticipates reviewing a draft with the SCVWD and USACE prior to finalizing. One hardcopy and one digital reproducible copy will be provided for each submittal.

2. Peer Review FEMA Study: Review the coastal hydraulic analysis for the FEMA Coastal Flood Mapping Re-study for San Francisco Bay, and provide an assessment of its applicability to coastal flood protection and flood hazard mapping in southern Alameda County. Contact FEMA Region IX (Oakland office) and FEMA contractors to gather documents for review. We anticipate having access to information via the County's CTP agreement, to allow the following key reviews:

    a. Bay hydrodynamic model – same as Task 1a, but for the DHI Mike 21 model.

b. Overland flood propagation - based on the work to be performed by DHI as described in Section II below.

We understand that the MIKE 21 model is essentially completed and being used for the north and central Bay studies, but has not been verified for use in the south Bay. Also, we anticipate access to documents describing the overall methodology to be used, and any results of application of FEMA's WHAFIS or PWHAFIS (see Task 3) model in the north and central Bay studies. The review will also consider consistency with the SSFBSS. PWA will develop a technical memorandum summarizing the Peer Review. One hardcopy and one digital reproducible copy will be provided for each submittal.

DHI Water & Environment, Inc will support the PWA model review by providing necessary model files and have the modelers be available to answer questions.

3. Pilot Modeling of Overland Wave Propagation: Apply the WHAFIS / P-WHAFIS software (Wave Height Analysis for Flood Insurance Study; P-WHAFIS refers to a version for the Pacific coast) for one (1) location in Alameda County selected to be generally representative of the area south of the San Mateo Bridge. This software provides estimates of wave propagation across land inundated by a storm event. While developed for the east and gulf coasts to analyze areas inundated by hurricane storm surge, FEMA's Pacific Coast Guidelines recommends its use in areas like the Bay floodplain, and FEMA will use it in the Bay studies. The software addresses wave dissipation due to obstructions and marsh vegetation as well as wave growth due to onshore winds. PWA will apply P-WHAFIS for four (4) scenarios:

   a. Existing Grades – based on available survey data;
   b. USACE Methods – partial levee failure, inundation and wave propagation during flood event;
   c. FEMA Methods – levee removal due to uncertified status;
   d. District – To be determined with District, but possibly comprised of upgraded outboard and new /upgraded inboard levees, providing a two level protection system.

   Implicit in this modeling are selection of water level and wave conditions, and their joint probability of occurrence. PWA will select several combinations in consultation with the County, based on the peer reviews (Tasks 1 and 2), consideration of historic data, and PWA's professional judgment. While there are multiple complexities and fine points with this Task, the intent is to provide an assessment of the effect of different assumptions on calculated flood results. PWA will develop a brief memorandum summarizing the modeling and results. One hardcopy and one digital reproducible copy will be provided for each submittal.

4. PWA will present the findings from the previous three tasks and discuss with key stakeholders such as FEMA, Alameda County and other study contractors. The focus of the presentation will be to present Peer Review findings and begin the discussion on approaches for completing the coastal flood mapping for the South Bay.

Schedule for this task:

PWA anticipates the following schedule, which depends on assumed start dates, and a sequence of work comprised of Task 1 and 2 being essentially completed before completion of Task 3, followed by Task 4. PWA has already started Task 1 under an existing contract. However, completion of Task 1 and the other Tasks is predicated on an agreement and notice to proceed from the County.

Task		Start	Duration	Completion
1.	Peer Review USACE Study	October*	5 months	February, 2010
2.	Peer Review FEMA Study	January, 2010	2 months	February, 2010
3.	Modeling of Overland Wave Propagation	February, 2010	2 to 3 months	April, 2010
4.	Recommendations	April, 2010	2 months	June, 2010
	Total	From NTP**	6 to 7 months	June, 2010

* This review has started under the Integration Contract with the County.

** Presumes Notice to Proceed (NTP) for the proposed work is received on January 2.

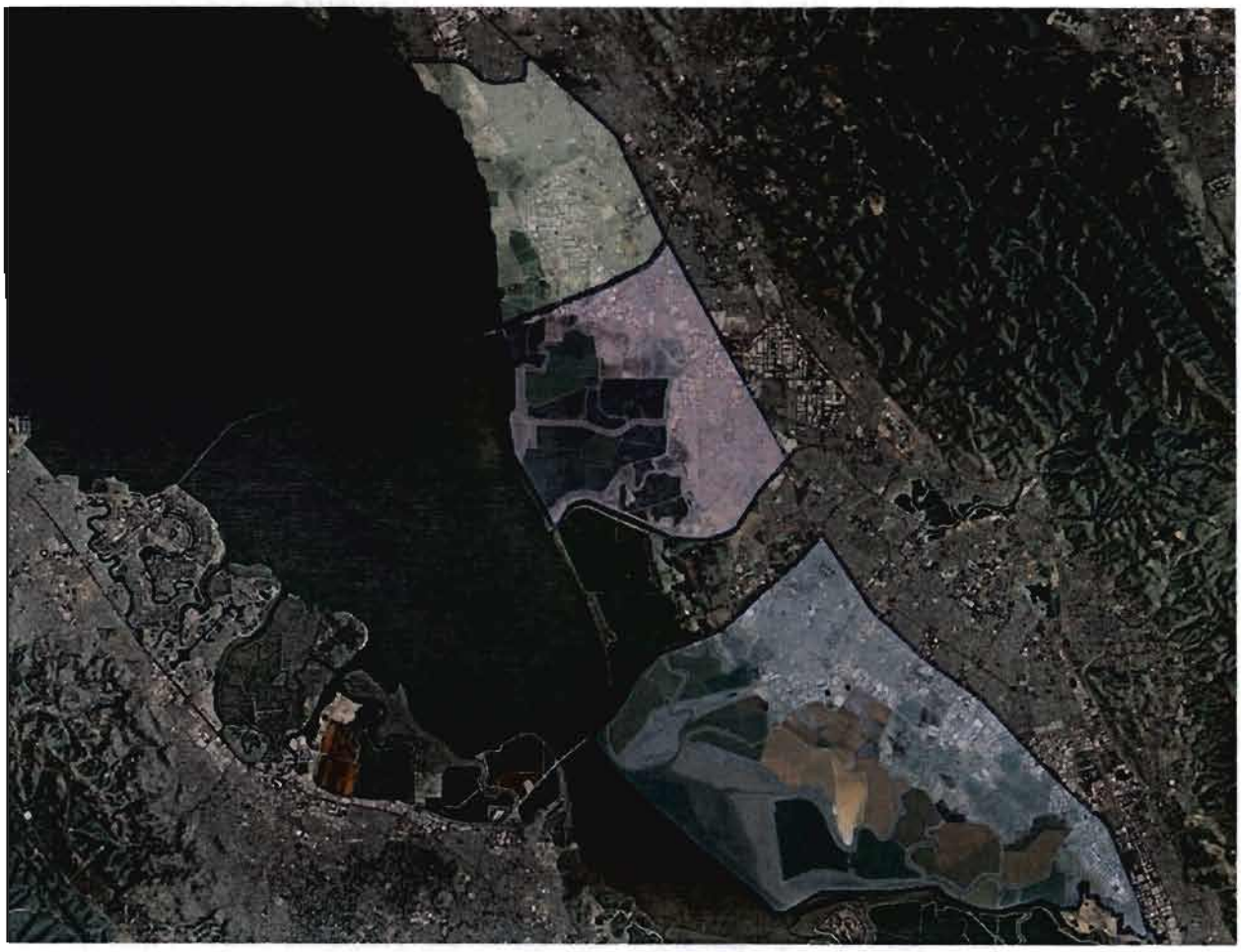
1.3 Project Budget

Project Budget

	Coastal Hazard Analysis	
Task #	**Task**	
1	Regional Model Boundary Conditions	$17,574
2	Zone 2 Transect Analysis	$40,196
3	Zone 6 Transect Analysis	$165,071
4	Review of Existing Regional Model	$17,574
5	Zone 2 Mapping	$18,904
6	Zone 3A Mapping	$18,904
7	Zone 5 Mapping	$18,904
8	Zone 6 Mapping	$18,904
9	Technical Advisory Group (TAG)/Contingency	$20,803
10	Post-Processing and GIS Database Update	$15,597
11	Documentation and Information/Technology/Knowledge Transfer	$17,574
12	Project Management and QA/QC	$39,691
13	Peer Review & Recommendations for Detailed Study	$131,270
	Total cost	**$540,963**

Coastal Hazards Analysis
Scope of Work Update

Alameda County Flood Control and Water Conservation District



Alameda County

Scope of Work Update
May 2011

Coastal Hazards Analysis
Scope of Work Update

380 Stevens Avenue
Suite 205
Solana Beach, CA 92075

Tel: (760) 942-9626
Fax: (760) 942-9631

www.dhigroup.com
drk@dhi.us

Client	Client's representative
Alameda County Flood Control and Water Conservation District	Rohin Saleh

Project	Reference No
Coastal Hazard Analysis Scope of Work Update	41800405
Authors	**Date**
Dale Kerper Julio Zyserman	31 May 2011
	Approved by
	Dale Kerper

1	Update: Regional Model Only	drk	jaz	thz	4/4/2011
0	Draft	drk	jaz	thz	3/4/2011
Revision	Description	By	Checked	Approved	Date

Key words	Classification
South San Francisco Bay WHAFIS Storm surge Levees Breaches	☐ Open ☐ Internal ☒ Proprietary

Distribution		No of Copies
Client:	Rohin Saleh	1
DHI:	drk, jaz, thz	3

CONTENTS

APPENDICES

1 INTRODUCTION

The following scope of work update is based on testing and further analysis of the San Francisco Bay regional model developed for FEMA, internal reviews from ESA PWA and discussions with FEMA, Alameda County and the BakerAECOM PTS team. The following items are recommended for modification to the existing Scope of Work for the coastal hazards study, related to the regional model only.

The document is arranged as follows.

Section 2 Regional Model Updates

- Assessment of DHI EVA Analysis and 31-year Period
- Levee Improvements and Sensitivity Tests
- Adjustment of the SWL for Additional Storage
- Review of VDATUM Conversions
- Acquire USACE Data
- Freshwater Inflow Sensitivity Tests
- Update, Calibrate and Validate the Regional Model
- Perform Extended Hindcast of the Regional Models
- Extract and Analyze Results of the Updated Regional Models
- Regional Modeling Memo
- Regional Model Review Support

Section 3 Cost & Schedule

2 REGIONAL MODEL UPDATES

Subtasks below denoted with an asterisk (*) indicate that work is in progress on this task.

2.1 Assessment of DHI EVA Analysis and 31-year Period *

ESA PWA performed initial review analysis and submitted a memo for review by David Divoky. DHI is providing support as required to develop an EVA methodology in conjunction with Alameda County, FEMA, and ESA PWA. Findings obtained so far are varied:

- Regarding the 31-year period, it is generally considered to be minimally acceptable, but a longer period could improve confidence in the extreme water levels in the south bay. Further discussion regarding a longer modeling period is presented in sections below.

- Regarding the estimated 1% and 0.2% annual chance (100-year and 500-year) water levels using the EVA GEV/ML method, comparison to other methods such as Weibull, Gumbel and GEV/LMOM shows that the adopted distribution seems to provide reasonable results in the north and central bay, but seems to over-predict in the far south bay. A Weibull distribution predicts extreme levels that fall about half way in-between the GEV/ML and Gumbel distributions in the south bay, and might be a more suitable candidate for future analysis.

To complete this task, DHI will provide recommendations for the most appropriate EVA distribution for analysis of extreme water levels in the south bay based on a thorough evaluation of the various methods, statistics distribution parameters, and scientific expertise. DHI will consult Dr. Henrik Madsen from DHI Denmark to assist in developing the scientific basis for the selection criteria. Dr. Madsen is a recognized expert in the field of extreme value statistics (Madsen, 1997). Preliminary examination and testing that has been performed looks promising. But as described in the sections below, a longer hindcast period will be simulated, say greater than 50 years. If so, then the selection process may become even more evident and the approach for final determination of the selected method will be revisited at that time.

Deliverables: A brief memorandum will be prepared including recommendations for choosing an appropriate EVA method.

2.2 Levee Improvements and Sensitivity Tests

DHI will update the levees into the MIKE 21 model. It is agreed that the method previously used by DHI (i.e. 30 foot buffers, choosing largest terrain elevation value within buffer) provides "conservative" crest height elevations, and may influence predicted extreme water levels in the far south bay. An alternate method will be used to rebuild levee crest elevations in the model for Alameda, Santa Clara and

San Mateo counties. No modifications will be made in the North Bay. Sensitivity model simulations will be performed to assess the effect these levee crest elevation assumptions have on the regional predicted water levels.

The levee improvements will be achieved by utilizing a combination of procedures. First, the buffer width will be reduced to approximately 5 feet. Since the buffer is so narrow, it will be critical that the crest centerline is identified very accurately. This will be achieved using a combination of high resolution aerial photos and LiDAR hillshade rasters to locate the levee crest. Once the levee crest centerline has been established and the 5 foot buffer has been defined, the statistics (e.g. min, max, mean, and standard deviation) of all LiDAR points within each MIKE 21 model grid cell's buffer zone will be calculated and reviewed. Based on these statistics, a characteristic value, such as the mean, will be adopted as the levee crest elevation for each MIKE 21 model grid cell. In the case where these statistics are inconclusive or the levee crest is heavily vegetated, the area will be flagged, and an appropriate interpretation will made on a case by case basis.

Once the levees have been built into the MIKE 21 grid, the two storms from 1983, also known as Storm 01 and Storm 02, will be re-run, and results compared to output from the original model. The study team will provide recommendations based on the comparison, and whether or not significant differences in flood levels are found.

Alameda County will provide high resolution digital aerial photos covering both Alameda and Santa Clara Counties.

It is assumed that all LiDAR data provided to DHI for levee and model grid updating will meet the standards for use by FEMA. If further certification is required, it will be up to the counties (Alameda, Santa Clara and San Mateo) to provide the necessary certification, or to gain approval from FEMA for use in this study.

Deliverables: A brief memorandum describing the procedure for determination of levee crest elevations, and including a presentation of sensitivity test results. Digital files of computed levee buffer and crest elevations. Updated MIKE 21 grid with levee crests included.

2.3 *Adjustment of the SWL for Additional Storage **

At some locations in the far south bay, the estimated 100 and 500-year SWL could be higher than the levee crest elevation. In these locations, within the 31-years that the regional model was exercised, the levees may have never been overtopped (or only slightly overtopped) since the model does not actually simulate the 100-year event. The issue here is that the 100-year level is determined from statistics, but may be missing some important physics. In the case of an extreme surge (>100-year) actually occurring, overtopping into the floodplain, where there is substantial storage, could reduce the actual 100-year surge level. However, the statistics cannot account for the additional storage at the 100 and 500-year levels. The purpose of this task is to develop a procedure to provide a correction to the extreme SWL due to the increased storage. The methodology would include running a

series of additional simulations, where boundary conditions are applied to the regional model that represent the extreme events as determined from EVA 100-year and 500-year surge levels. These simulations would be executed using the revised levee representation (see previous task). The response of the model using the water levels associated with the extreme event as boundary conditions would be used to develop a correlation or correction to the statistical water level at the long return periods.

Deliverables: A brief memorandum including model testing, proposed methodology, and preliminary analysis of SWL adjustment technique.

*2.4 Review of VDATUM Conversions **

During the FEMA San Francisco Bay regional modeling study, DHI performed a number of vertical datum conversions. This was especially true for data that is natively reported relative to a tidal datum, such as MLLW or MSL. To convert elevation data from a tidal datum to the NAVD88 standard, the NOAA program, VDATUM (April 2009) was used. The data that were converted are as follows:

- GEODAS bathymetry soundings for the Central and North Bay, and offshore Pacific Ocean
- USACE dredging bathymetries
- Older NOAA tide gages, specifically in the south bay, such as Coyote Creek, Redwood City, San Mateo Bridge, San Leandro Marina, where the water level data was only provided relative to the MLLW datum.

Recently it has been reported that VDATUM 2009 is not accurate in the south bay, and should not have been used to convert tidal datum. The error is less pronounced in the central and north bay, and it is believed that model bathymetry and topography are likely not affected appreciably. The implication is mainly that the older NOAA tide gages in the south bay that were used in the storm surge calibration (especially Coyote Creek), may have been referenced to NAVD88 using an invalid datum conversion. This needs to be re-evaluated, and could possibly require a re-calibration of the regional model for the south bay. It is not expected that this will affect conditions in the north or central bays appreciably. But all of these matters need to be checked and reported.

The model will be updated as necessary based on findings of this review.

Deliverables: A brief memorandum describing the vertical datum corrections that will be used in place of VDATUM 2009, and including discussion of how that affects the existing model grid and NOAA gages, eventually it will include an updated model grid.

2.5 Acquire USACE Data

ESA PWA and FEMA Region IX will attempt to acquire south bay wave measurements from USACE. If data are acquired, DHI will prepare the acquired data into suitable digital MIKE 21 format and will make a comparison to MIKE 21 wave model results, as an additional validation and to provide increased confidence in model wind-wave results in the south bay.

ESA PWA and FEMA will work together to acquire the 100-year discharge rates that USACE used as tributary inputs into their modeling effort.

Deliverables: A brief memorandum will be prepared to describe the data that has been acquired and the results from the comparison of measurements to model results.

2.6 Freshwater Inflow Sensitivity Tests

In the previous regional modeling effort, DHI included freshwater inflows into the regional model, but not with the south bay in mind. Some sensitivity tests were carried out early in the study, but it is recommended that DHI perform additional sensitivity tests to address this matter more specifically for the south bay. Minimally two model simulations should be considered. For both runs, the model would be simulated for a period during a large south bay surge event. In one case we would apply the mean discharge in all tributaries, and in the second case using the maximum or 100-year discharge rate in all tributaries. The scenarios will be agreed upon between DHI and Alameda County. The results from the sensitivity tests will be analyzed by DHI, and recommendations will be made based on the findings.

Deliverables: A brief memorandum will be prepared to describe the model testing that was performed, including an analysis of the results, and a recommendation for final implementation.

2.7 Update, Calibrate and Validate the Regional Model

Based on the findings and recommendations of the above mentioned items, the surge model should be updated to incorporate these improvements.

Once updated, the surge model should be re-validated (and calibrated if necessary). This would use the same events previously used, and then the model would be re-run for the full hindcast period.

NOAA, ESA PWA, and Moffat & Nichol have intermittently collected additional tidal elevation data for the South Bay between 2000 and 2005. DHI will simulate an additional 5 to 10 event periods where it will be possible to validate the model against water levels recorded at these tide gages. DHI will coordinate with Alameda County which additional events will be simulated.

ESA PWA will provide the data they and Moffat & Nichol collected to DHI. NOAA data is publicly available on its website.

Additional data will be required and acquired by DHI as follows:

- Wind data from National Climatic Data Center (NCDC) for the three wind stations, SFO, OAK, and Travis AFB for the period, to create wind fields for the model.
- Water levels at Presidio for the open ocean model boundary condition.
- DWR Dayflow Sacramento River discharge

Other tributary inflows will also need to be included, especially in the south bay (i.e. San Lorenzo Creek, Alameda Creek, Coyote Creek, Alviso Slough, etc). DHI, ESA PWA and Alameda County will work collaboratively to develop these datasets for inclusion into the model. Findings from Section 2.6 will be applied in developing these boundary conditions.

If additional wave data can be acquired from the USACE, additional wave model validation will be performed. Re-calibration is not expected to be necessary, and will only be performed if comparison of model results to measured waves varies appreciably. But this is not currently considered as a scope item.

Deliverables: A brief memorandum will be prepared describing the final model setup, including bathymetry, wind fields, and other boundary conditions. Results from the calibration/validation will also be presented.

2.8 *Perform Extended Hindcast of the Regional Models*

The existing FEMA regional surge and wave models were simulated for the period, 1/1/1973, to 1/1/2004. It is recommended to extend the period, especially since the regional model would need to be re-run with the updated south bay improvements anyway.

For the storm surge and seas models it should be possible to increase the hindcast length considerably. However, swell modeling relying on OWI GROW data (starting in 1973) can only be updated to 2010 (and at additional cost). Fortunately for the south bay (south of San Mateo bridge), swells are very small and can be ignored for further analysis.

For storm surge and seas, the following additional data would need to be acquired

- Presidio tide gage
- Dayflow Sacramento River discharge
- Freshwater inflows
- Wind observations from SFO, OAK and Travis AFB

Mean daily discharges from the DWR Dayflow model are available from 1956 through 2009. There is mention on the Dayflow website of data going back to 1930, but we were so far unable to locate data pre-1956, and it is probably missing for the reason that data quality is suspect prior to 1956.

Verified hourly water levels from the Presidio gage are available from about 1901 to the present.

Wind observations for the 3 main stations exist concurrently from 1948. At Oakland there is a period from 1965 through 1972 where wind observations are 3-hourly versus 1-hourly, otherwise hourly coverage at the three stations appears to be quite good. These data would need to be purchased from NCDC.

Swells are very small in the south bay, and should not be needed for analysis south of San Mateo Bridge or even immediately north of the bridge. But just to complete the assessment, for swells, currently OWI's GROW data starts at 1973, which would prevent producing results from 1948 or 1956 based on GROW alone. However, GROW data is likely available up to 2010, at some additional cost. It might be possible to use the older Pacific WIS data starting in 1956 for the swells from 1956 to 1973. These data are not considered best quality, and are considered to be generally conservative. If swells are to be re-run, given the generally small swell heights in the south bay, use of the WIS hindcast data is likely sufficient for application to Alameda County where the swell height will be significantly attenuated. But again, it is not deemed necessary to re-run swells just for the south bay.

For freshwater inflows besides the Sacramento River, additional flow rates would need to be acquired. Full time series of discharges for the entire simulation period may be difficult to develop or obtain. Depending on the results of sensitivity tests proposed above, an option could be to simply use Q100 discharges for all time steps.

It appears from this assessment that it should be possible to run the regional model for Alameda County from 1956 through 2009 (and possibly through 2010) to lengthen the hindcast from 31 years to 54 or 55 years. DHI recommends to model this extended period to provide improved confidence in the estimated extreme water levels in the south bay.

Deliverables: Model setup files.

2.9 *Extract and Analyze Results of Updated Regional Model*

The +55 years of time series will be extracted at locations that can be used for the detailed coastal analysis. This includes performing EVA analysis of those data.

Deliverables: Extracted model data, EVA analysis results.

2.10 Regional Modeling Report Memorandum

The full report and TSDN will not be covered under this Scope of Work, but will be covered in a future task order. A brief memorandum will be prepared based on memoranda developed for the previous Section 2 subtasks and including a final status of the regional modeling work

Deliverables: A brief memorandum report describing the regional model will be prepared and delivered in digital PDF format.

2.11 Regional Model Review Support

The BakerAECOM team, along with ESA-PWA, will be performing interim review with regards to the regional modeling. Interim review milestones for the regional modeling are proposed as follows:

a) Updated model grid with new levee crests
b) Model calibration and validation
c) Regional model report

Deliverables: Memorandum and report described in the previous sections. Review responses and updated report.

ESA PWA scope of services for performing internal review has been provided, and is attached as Appendix A to this updated scope of work.

2.12 PM QA/QC

PM tasks include coordinating the work tasks performed by DHI together with ESA-PWA and the Client, Alameda County. This includes general coordination of meetings, conference calls, fulfillment of contractual obligations, changes to the scope of work, invoicing and preparing monthly progress reporting.

The QA/QC role is to ensure that all aspects of the data processing (inputs and outputs) and the modeling has been documented, checked and properly applied.

3 COST

Table 4 Project Budget

Original Scope of Work (tasks that have been completed)		
TASK	**DESCRIPTION**	**COST**
1	Regional Model Boundary Conditions	$40,526
4	Review of Existing Regional Model	$24,125
13	Project Management and QA/QC	$35,137
14	Peer Review & Recommendations for Detailed Study	$131,402
	TOTAL - Original Scope of Work	**$231,190**
Updated Scope of Work		
TASK	**DESCRIPTION**	**COST**
2.1	Assessment of DHI EVA Analysis and 31-year Period	$17,270
2.2	Levee Improvements and Sensitivity Tests	$43,612
2.3	Adjustment of SWL for Additional Storage	$6,136
2.4	Review of VDATUM Conversions	$2,000
2.5	Acquire USACE Data	$4,857
2.6	Freshwater Inflow Sensitivity Tests	$6,018
2.7	Update, Calibrate and Validate the Regional Model	$50,910
2.8	Perform Extended Hindcast of the Regional Models (surge and seas)	$40,539
2.9	Extract and Analyze Results of the Updated Regional Model	$24,542
2.10	Regional Modeling Report - Memorandum only	$10,402
2.11	Regional Model Review Support	$26,542
2.12	PM QA/QC	$27,802
2.13	ESA PWA Review	$49,140
	TOTAL TASK 2 - Regional Modeling	**$309,771**
	TOTAL PROJECT COST	**$540,961**

No costs have been included to cover preparation of a final report or a FEMA TSDN. It is assumed this will be covered under future scope of work budgets. Cost also does not include public outreach material preparations or meetings. It is assumed that Alameda County will cover this component of the study.

Terms and Conditions will be agreed at time of contract signing.

4 REFERENCES

DHI Water & Environment, Inc. (2010). "Regional Coastal Hazard Modeling Study for North and Central San Francisco Bay". Report prepared for FEMA, 175 pp.

Madsen, Henrik, Rasmussen, P.F, Rosbjerg, Dan. "Comparison of annual maximum series and partial duration series methods for modeling extreme hydrologic events". AGU, Water Resources Research, Vol. 33, No. 4.pp 74-757. April 1997.

Appendix A – ESA PWA Scope of Work

ESA PWA

550 Kearny Street
Suite 900
San Francisco, CA 94108
415.262.2300 phone
415.262.2303 fax

www.pwa-ltd.com

memorandum (DRAFT)

date May 31, 2011

to Rohin Saleh (ACWCFCD)

cc Dale Kerper (DHI)

from Matt Brennan and Bob Battalio

subject Contract Modification for Alameda County Coastal Flood Study – Regional Model Updates

ESA PWA has been assisting Alameda County, a Cooperating Technical Partner (CTP) with FEMA, to develop a methodology and recommendations for mapping coastal flood hazard along its San Francisco Bay shoreline. As part of our effort, ESA PWA has reviewed DHI's Coastal Flood study which focused on the North and Central Bay. Besides providing independent review of this study, we have provided and will continue to provide technical support to inform appropriate refinements the modeling study for the South Bay. The scope of work, schedule and budget for this technical support is described below. At the request of Alameda County, ESA PWA has already worked on a number of technical support sub-tasks.

The South Bay was not the focus of DHI's Coastal Flood study and therefore did not receive the same level of attention dedicated to the North and Central Bays (DHI, 2010). Our previous review and technical analyses identified several aspects of the modeling which would benefit from refinements and/or additional sensitivity analysis (ESA PWA, 2010). These refinements are intended to improve the model's utility and level of confidence when its results are used as inputs for the South Bay nearshore hydraulic analysis. ESA PWA recommended refinements to DHI's modeling of South Bay include revisions to extreme value analysis, bathymetry, model validation, freshwater discharge, and hindcast simulations.

SCOPE OF WORK

To assist with implementing these recommendations, ESA PWA has provide and will continue to provide technical support to the County and DHI. We will continue with in the co-operative manner established with DHI in prior reviews of the regional model. This work is part of a larger contract, of which ESA PWA's work falls under Task 2 and is numbered accordingly. Technical support sub-tasks, include the following, with sub-tasks that have already been started marked with an asterisk (*):

2.1 Assessment of DHI EVA Analysis and 31-year Period*

The prior regional modeling of only spanned 31 years, which, when compared to the more than 100-year record at the Golden Gate, biases extreme events upwards, particularly in the South Bay where tides are amplified. ESA PWA will quantify potential bias stemming from the 31-year hindcast record and its implications for deepwater and nearshore extreme value analysis. Based on this assessment, ESA PWA will recommend a hindcast period of record for the South Bay.

Once hindcast modeling has been executed, extreme value distributions are fit to the model output to extrapolate conditions at specified annual chance thresholds. Analysis of prior regional modeling results indicates a significant spread in predicted water levels at low frequencies (e.g. 1% and 0.2% annual chance) as a function of fitting method and distribution. The distribution and method recommended in FEMA's Pacific Coast Guidelines (maximum likelihood fit of GEV) often producing results at the upper end of the range for the South Bay. ESA PWA will develop and recommend a methodology for fitting extreme value distributions in the South Bay.

2.2 Levee improvements and sensitivity tests*

ESA PWA will assess the quality and accuracy of existing South Bay bathymetry and topography data. ESA PWA will provide data to DHI as needed.

ESA PWA will assess the initial representation of the levee crests within the model and then review changes to the levee representation within the regional model that are intended to more accurately represent actual levee crest elevations. ESA PWA will also review corresponding water level responses to these levee changes.

2.3 Adjustment of SWL for Additional Storage*

The water levels at the 1% and 0.2% annual chance are likely to be larger than the conditions which occurred historically and were modeled as part of the hindcast. Therefore, these statistical estimates of water level may not fully account for reduced water levels resulting from storage in the adjacent salt ponds. ESA PWA will provide an initial estimate of overtopping rates and potential volumes transferred to storage areas. To provide a more detailed comparison to the statistically-derived water levels, synthetic extreme events will be simulated with DHI's regional model. ESA PWA will assist with synthetic event selection and review model results.

2.4 Review of VDATUM Conversions*

ESA PWA will coordinate with professional surveyors and USACE regarding vertical datum conversions in the South Bay to ensure that best know conversions between tidal and absolute vertical datums are applied to the South Bay study.

2.5 Acquire USACE Data

ESA PWA will acquire, interpret, and compare USACE data and modeling results to DHI modeling results to enhance confidence in DHI modeling efforts and characterize difference between the USACE South Bay Shoreline Study and DHI's study.

2.6 Freshwater Inflow Sensitivity Tests

ESA PWA will recommend scenarios for the major freshwater flow sources to the South Bay and review results of corresponding sensitivity analysis to these flows.

2.7 Update, Calibrate and Validate the Regional Model

ESA PWA will provide to DHI the water level data collected in the South Bay between 2000 and 2005. This data will serve as additional data to validate the regional model for both tidal and storm surge conditions. ESA PWA will assess model skill at predicting these observed water levels.

2.11 Regional Model Review Support

After the refinements above have been implemented in the model, an extended hindcast of water level and waves will be executed by DHI. Results of the updated regional model will be subject to extreme value analysis by DHI ESA . PWA will review these new regional model hindcast results and associated extreme value analysis, as well as DHI's memorandum documenting refinements to the regional modeling for the South Bay.

SCHEDULE

The schedule for this task will be largely determined by DHI's effort to refine the regional model. Their initial estimate for this effort is approximately six months. ESA PWA will provide its technical support in a timely manner to assist with meeting this target completion timeframe.

BUDGET

The estimated budget for this task is shown in the table below. Approximately one third of this budget has been expended on technical support sub-tasks that ESA PWA has already worked on, as indicated by the asterisks in the list above.

Labor	**Hours**	**Rate ($/hr)**	
Principal (Bob Battalio)	120	$215	$25,800
Sr. Associate (Matt Brennan)	120	$175	$21,000
		Total	$46,800

Coastal Hazards Analysis

Scope of Work Task 3

Alameda County Flood Control and Water Conservation District

Alameda County

Proposal
January 2012

TASK 3 2-D MODELING OF COASTAL HAZARDS

In the original scope of work for this study, it was envisioned to perform WHAFIS and run-up analysis only, for somewhere between 80 and 100 transects in Zones 2 and 6. After various levels of review, discussions and testing, District's Contractor is now proposing a mixture of 1D and 2D modeling, from the San Mateo Bridge to the southern bay extent of Alameda County.

Task 3.1 Pilot Study – MIKE 21 Model

The Contractor has been testing fine grid MIKE 21 models in the south bay, including the overland areas, to assess the feasibility and utility of using a 2D model to augment the traditional WHAFIS type of approach. The test model uses new LiDAR data and includes updated levee heights at a 15 to 20 meter grid spacing (compared to the 100 meter regional model grid). This model was simulated in two main conditions as follows:

- Case 1 – all non-certified levees removed
- Case 2 – all non-certified levees remain, but with pre-determined wide breaches connecting all ponds

In cases where all levees were removed from the analysis for storm surge, it can be expected and will be shown that little to no benefit can be achieved through 2D modeling. The entire overland area will be flooded to levels comparable to the SWL at the outer boundary. Additionally, these tests will likely show that wind effects can impose an additional setup on the total surge level. However, in Case 2, where the levees remain in the model, but have been breached, analogous to a managed restoration plan, or to a conservative failed breach width, it can be expected and will be shown that a significant reduction in the total water level can be expected due to the attenuation of the tide and surge through the breaches.

Based on the results from these tests, a combined 1D and 2D modeling approach is recommended for further development.

Note that WHAFIS analysis will still be performed in either case to determine the overland wave growth and wave crest envelope for hazard zone determination. However, if 2D modeling produces an improved SWL overland, the spatially varying SWL determined from 2D modeling will be included along the WHAFIS profiles.

Deliverables: A brief memorandum describing the model setups for the tests, a presentation of results, and recommendations for final implementation.

Task 3.2 1D and 2D Local Surge Modeling

3.2.1 Treatment of Levees for Surge Analysis

The following recommendations are based on analysis of the Pilot Study performed in Section 3.1.

Option 1: Project the Regional SWL Inland – Levees Removed

Simple projection of the 1% and 0.2% annual chance SWL will be applied in areas where the levees are not analyzed for their ability to impede tidal inundation. For these levees and other high ground features, we will assume that the Bay water levels propagate into their lee without analysis of the precise path or hydraulic modification. One area has been identified where this simple projection analysis can be applied, and is shown below in Figure 3.1.

Figure 3.1 Area for simple SWL projection, assuming levees are completely removed.

WHAFIS model transects would be applied in this area using a constant SWL along the entire profile, based on the offshore SWL. Although it is assumed that levees have been removed for the storm surge, it is assumed that levees will remain mostly intact for the WHAFIS modeling of wave growth and propagation, assuming the levees are significant structures/features that would provide substantial protection against incident waves. This is described further in Section 3.3 below.

Option 2: Develop 2D MIKE 21 Surge Model – Levees Breached

The MIKE 21 surge model will be applied to simulate the local overland flow in the three areas shown in Figure 3.2 below. These are areas where it has been identified that overland surge may be attenuated if levee breaches are considered rather than applying complete levee removal.

Figure 3.2 Proposed areas for 2D overland surge modeling

The proposed method would incorporate simulating the conditions representing the ~55 annual maximum events, assuming the regional model hindcast period has been extended to 55 years.

Model grids for the local 2D models would have a 15-25 meter grid resolution or finer.

Breach widths would be developed based on expected catastrophic breach widths. Guidance for breach widths may be available from multiple sources. It may be possible to use information available from the USACE study. The primary sub-contractor may also have experience specifically with real breaches that have occurred in the bay. Additional empirical information may be available from other databases. The U.S. Bureau of Reclamation has compiled empirical data on embankment failure relationships that could be useful (Wahl, 1998). The Contractor has experience applying these relations in riverine/levee applications. See Table 3.1 below for a summary of the US Bureau of Reclamation relations. These relations are typically based on some ratio of the structure height, H, to the breach width, B.

Table 3.1 Breach parameter relations based on dam-failure case studies. Reprinted from U.S. Bureau of Reclamation report document (Wahl, 1998)

Reference	Number of Case Studies	Relations Proposed (S.I. units, meters, m^3/s, hours)
Johnson and Illes (1976)		$0.5h_d \le B \le 3h_d$ for earthfill dams
Singh and Snorrason (1982, 1984)	20	$2h_d \le B \le 5h_d$ 0.15 m $\le d_{ovtop} \le$ 0.61 m 0.25 hr $\le t_f \le$ 1.0 hr
MacDonald and Langridge-Monopolis (1984)	42	Earthfill dams: $V_{er} = 0.0261(V_{out} * h_w)^{0.769}$ [best-fit] $t_f = 0.0179(V_{er})^{0.364}$ [upper envelope] Non-earthfill dams: $V_{er} = 0.00348(V_{out} * h_w)^{0.852}$ [best fit]
FERC (1987)		B is normally 2-4 times h_d B can range from 1-5 times h_d Z = 0.25 to 1.0 [engineered, compacted dams] Z = 1 to 2 [non-engineered, slag or refuse dams] t_f = 0.1-1 hours [engineered, compacted earth dam] t_f = 0.1-0.5 hours [non-engineered, poorly compacted]
Froehlich (1987)	43	$\overline{B}^* = 0.47K_o\left(S^*\right)^{0.25}$ K_o = 1.4 overtopping; 1.0 otherwise $Z = 0.75K_c(h_w^*)^{1.57}(\overline{W}^*)^{0.73}$ K_c = 0.6 with corewall; 1.0 without a corewall $t_f^* = 79(S^*)^{0.47}$
Reclamation (1988)		$B = (3)h_w$ $t_f = (0.011)B$
Singh and Scarlatos (1988)	52	Breach geometry and time of failure tendencies B_{top}/B_{bottom} averages 1.29
Von Thun and Gillette (1990)	57	B, Z, t_f guidance (see discussion)
Dewey and Gillette (1993)	57	Breach initiation model; B, Z, t_f guidance
Froehlich (1995b)	63	$\overline{B} = 0.1803K_o V_w^{0.32} h_b^{0.19}$ $t_f = 0.00254V_w^{0.53}h_b^{(-0.90)}$ K_o= 1.4 for overtopping; 1.0 otherwise

There is a large uncertainty in breach analysis data, and it is proposed that sensitivity tests be performed based on various assumptions of breach width to assess the effectiveness of the various methods. The Contractor will work together with the District, the primary sub-contractor and FEMA to agree upon a final choice based on the sensitivity analysis.

It is proposed that WHAFIS be applied to determine wave conditions on top of the 2D surge results rather than running a 2D wave model.

Deliverables: A brief memorandum describing the final methodology, and including results from the sensitivity tests of breach width assumptions.

3.2.2 Development of Local 2D Models

- Regional model storm surge and wave results will be analyzed and prepared for use as boundary conditions into the local 2D models and WHAFIS.

- Model grids will be developed for the three areas shown in Figure 3.2, at a grid spacing of 15 meters or finer.
- When the 2D model is applied south of Dumbarton Bridge, the local 2D model will include the entire bay south of the Dumbarton Bridge to properly represent the hydraulic conditions.
- Roughness maps will be based on regional values in the offshore regions, and land use in the overland areas.
- Winds will be based on SFO Airport wind observations for all three model areas.
- The annual maximum storm surges from the regional model, at the local model boundary, will be used to select the events to model in 2D.

Deliverables: A brief memorandum describing the development of boundary condition files from regional model surge and wave results. Digital boundary condition files.

3.2.3 Simulation of 2D Overland MIKE 21 Models

Using the model grids, breach assumptions and boundary conditions described above, each of the three sub domains will be simulated for each annual max event.

Deliverables: Flow model setup and results files.

3.2.4 EVA Analysis of 2D Overland MIKE 21 Models

For each of the sub domain models, the results from the simulations will be analyzed using an appropriate EVA method (see Section 2.1). EVA analysis will only be performed in areas flooded by every annual max event. In areas that were flooded, but not by all events, an extrapolation of the SWL surface will be performed based on engineering judgment and local ground elevations.

Task 3.3 Coastal Hazard Analysis and Mapping

The following tasks are required to compute the overland wave conditions to be added on top of the SWL, using WHAFIS, and also to compute run-up and overtopping at the flooded shoreline structures, using the Technical Advisory Committee for Water Retaining Structures (TAW) method and other methods given in the FEMA guidelines and specifications.

3.3.1 WHAFIS Wave Analysis

WHAFIS will be applied to determine overland wave conditions and hazard zone determination. One modification from the normal application of WHAFIS will be to use the spatially varying 1% annual chance SWL from the local 2D storm surge models (for the three sub domains), compared to simply using the offshore SWL and projecting it shoreward, as will be applied in the one area identified in Section 3.2.1, Option1. It is assumed that 120 transects will be analyzed. WHAFIS analysis will only be performed for the 1% annual chance conditions.

In all cases, levees will not be removed from the profiles for the WHAFIS analysis.

The application of WHAFIS will be otherwise consistent with FEMA guidelines.

Deliverables: A brief memorandum will be produced to present the WHAFIS model setup, input files, and output results in digital format.

3.3.2 1D Run-up and Overtopping

Run-up and overtopping analysis will be performed for the 1% annual chance conditions using the TAW method described in FEMA Guidelines and Specifications.

Deliverables: A brief memorandum will be produced to present the TAW model setup, input files, and output results in digital format.

3.3.3 Hazard Mapping

The hydraulic analysis from the combined MIKE 21, WHAFIS and run-up analysis will be translated into GIS products delineating BFE contours and Hazard Zone delineations. The Contractor and mapping sub-contractor will work together to produce FEMA flood hazard work maps based on the coastal modeling analysis. The Contractor will provide and interpret the modeling results to the mapping sub-contractor so that the mapping sub-contractor can prepare the final maps. The Contractor will provide internal review of the maps produced by the mapping sub-contractor.

This work will be done in accordance with FEMA's Guidelines and Specifications Appendix D.4.9 on Coastal Flooding and Mapping.

Deliverables: A brief memorandum will be produced to present the mapping procedure, and GIS work map products will be produced.

Task 3.4 TSDN and Reporting

Reporting of this study will include the production of a Technical Support Data Notebook (TSDN) that conforms to FEMA standards for Coastal Studies in Sheltered Waters. This will include both regional and local modeling and analysis.

Task 3.5 Local Modeling and Mapping Review Support

The BakerAECOM team, along with the primary sub-contractor will be performing interim review with regards to the local modeling and mapping. Interim review milestones for the local modeling are proposed as follows:

a) 2D model, breaching and WHAFIS methodology

b) 2D model results and analysis

c) WHAFIS and TAW model results and analysis

d) GIS work map products

e) Hydraulic modeling report and TSDN

Deliverables: Memorandum, report, and supporting data. Review responses and updated report.

The primary sub-contractor scope of services for performing internal review has been provided, and is presented under Task 3.8 of this scope of work.

Task 3.6 Post-processing and GIS Database Update

Some of the information generated under this project will be provided in GIS format whenever practicable. For example, WHAFIS transects can be easily supplied as shapefiles. 2D model bathymetry grids, inundation maps, Manning roughness maps, work maps, etc., can be converted to rasters for easy storage in GIS.

However, large 2D time varying model output files, wind maps, spatially varying boundary files are not practical to store in the GIS and will not be converted. If they need to be included into the District's GIS geodatabase, the Contractor recommends that the geodatabase links to the MIKE output data, rather than converting the files.

Task 3.7 Project Management, QA/QC

Project Management tasks include coordinating the work tasks performed by the Contractor together with the sub-contractor(s) and the District. This includes general coordination of meetings, conference calls, fulfillment of contractual obligations, changes to the scope of work, invoicing and preparing monthly progress reporting.

The QA/QC role is to ensure that all aspects of the data processing (inputs and outputs) and the modeling has been documented, checked and properly applied.

Task 3.8 Overland Propagation Modeling Review, QA/QC, Support

The primary sub-contractor will assist the District with the refinement and implementation of overland propagation modeling along the Alameda Shoreline to support FEMA's ongoing regional flood study for San Francisco Bay. Work on this task is likely to include the following:

- **Coordinate with FEMA** – The treatment of salt ponds, levees and marshes in Alameda County requires special consideration to be consistent with the FEMA guidelines and provide reliable results. As such, FEMA approval of District's study methodology will require coordination with FEMA, e.g. their Integrated Process Team. The primary sub-contractor will present the proposed study methodology to the IPT, respond to the IPT's comments, and revise the methodology in response to these comments.
- **Review Central Bay nearshore hydraulic analysis** – Concurrent with the South Bay nearshore study, Baker is conducting nearshore hydraulic analysis for the northern portion of Alameda County's shoreline that falls within the Central Bay. The primary sub-contractor will review Baker's study for consistency with South Bay methodology and results.
- **Integrate flood management with restoration** – District wishes to integrate its flood management efforts with agency land managers who are tasked with restoring habitat along the South Bay shoreline. The primary sub-contractor will assist the District with locating and sizing the proposed breaches in the salt ponds levees to balance flood attenuation and ecologic benefits. The proposed breaches will be modeled by the Contractor; the primary sub-contractor will assist with model results evaluation and interpretation. The primary sub-contractor's experience with planning and designing the South Bay Salt Ponds Restoration Project makes that firm uniquely qualified to assist in this integration.
- **Levee stability analysis** – After reviewing drafts of the Corps Shoreline Study, the primary sub-contractor believes that the Corps levee stability assessment and methodology can provide guidance on the treatment of Alameda County levees. However, the Corps work has thus far only covered limited portions of Alameda County. Therefore, the primary sub-contractor will adapt the

Corps' approach to levee stability for application to the remainder of Alameda County's South Bay levees.

- **Coordination with Corps Shoreline Study** - The U.S. Army Corps of Engineers (USACE) is currently studying the flood hazard in portions of the South Bay. Their approach includes physical process models of water levels and waves and a Monte Carlo model to assign flood event frequency. It is anticipated that the results of the Shoreline Study will be adopted by FEMA for use in Santa Clara County, which lies across the South Bay from southern Alameda County. The primary sub-contractor has reviewed preliminary drafts of the Shoreline Study reports. The primary sub-contractor will review Corps findings, model output, and revised study report for consistency with the overland propagation modeling in Alameda County.
- **Public outreach** – The primary sub-contractor will assist the District and FEMA in developing figures, presentations materials, and non-technical written documents to assist with communicating the results of the South Bay to the public.

SCHEDULE

The activities documented in this MAS No. 3 shall be completed in accordance with Table 6.1 Mapping Activities Schedule, which should drive the schedule within the MIP. If changes to this schedule are required, the responsible Mapping Partner shall coordinate with FEMA and the other Mapping Partners in a timely manner. Please also identify to whom the products associated with each task are to be submitted to (i.e. the MIP, FEMA Regional Office, etc.).

Mapping Activities Schedule

ACTIVITIES		Estimated START DATE	Estimated END DATE	Estimated COST
Task 3.1	Pilot Study – MIKE 21 Model	12/1/2011	1/1/2012	$2,080
Task 3.2	1D and 2D Local Surge Modeling	1/1/2012	4/30/2012	$97,964
Task 3.3	Coastal Hazard Analysis and Mapping	4/30/2012	10/31/2012	$344,942
Task 3.4	TSDN and Reporting	10/31/2012	12/31/2012	$99,341
Task 3.5	Local Modeling and Mapping Review Support	12/31/2012	1/31/2013	$25,418
Task 3.6	Post-Processing and GIS Database Update	12/31/2012	1/31/2013	$16,432
Task 3.7	Project Management, QA/QC	10/1/2011	1/31/2013	$66,124
Task 3.8	Overland Propagation Modeling (ESA PWA + reinstitution of DHI's cost for reporting)	10/1/2011	1/31/2013	$57,699
TOTAL COST				$710,000

Alameda County Flood Control and Water Conservation District Coastal Hazard Analysis
(Contract C-4922, Ref # 41800405)

Fee Schedule for Task 3

380 Stevens Avenue,
Suite 205
Solana Beach, CA 92075

Tel: +1 (760) 942-9626
Fax: +1 (760) 942-9631
Email: drk@dhi.us
Web: www.dhi.us
Date: 1/10/2012

Person	Title	2012 RATE
Engelmann, Arnold	GIS Programmer/Analyst	$142
Johnson, Cheryl	Senior Coastal Engineer, PE	$177
Kerper, Dale	Principal Coastal Engineer, PE	$167
Kilgren, Ryan	Water Resources, EIT	$128
Shen, Tao	Coastal Modeler, MS	$135
Zyserman, Julio	Senior Coastal Sediment Engineer, Ph.D.	$167

- Expenses are invoiced at 100% of cost.
- Rates for deposition and trial time are 1.5 times those shown above.
- Regular Mileage is per IRS rate ($0.555/mile) or as otherwise specified in contract.

Alameda County Coastal Hazard Analysis Project
Modification No. 1

Original Contract - Scope of Work and Budget

Task	Original Budget	Expenditures through February	Remaining Budget
1. Regional Model Boundary Conditions	$17,574.00	$40,526.09	-$22,952.09
2. Zone 2 Transect Analysis	$40,196.00	$0.00	$40,196.00
3. Zone 6 Transect Analysis	$165,071.00	$0.00	$165,071.00
4. Review of Existing Regional Model	$17,574.00	$24,125.14	-$6,551.14
5. Zone 2 Mapping	$18,904.00	$0.00	$18,904.00
6. Zone 3A Mapping	$18,904.00	$0.00	$18,904.00
7. Zone 5 Mapping	$18,904.00	$0.00	$18,904.00
8. Zone 6 Mapping	$18,904.00	$0.00	$18,904.00
9. Technical Advisory Group (TAG)/Contingency	$20,803.00	$0.00	$20,803.00
10. Post-Processing and GIS Database Update	$15,597.00	$0.00	$15,597.00
11. Documentation and Information/Technology/Knowledge Transfer	$17,574.00	$0.00	$17,574.00
12. (blank)			
13. Project Management and QA/QC	$39,691.00	$35,136.63	$4,554.37
14. Peer Review & Recommendations for Detailed Study			
14.1 Peer Review USACE Study	$39,773.00	$37,485.01	$2,287.99
14.2 Peer Review FEMA Study	$29,463.00	$29,098.14	$364.86
14.3 Modeling of Overland Wave Propagation	$39,543.00	$31,822.91	$7,720.09
14.4 Recommendations	$22,491.00	$32,995.83	-$10,504.83
Totals	$540,966.00	$231,189.75	$309,776.25

Expenditures for Work Done through February 2011	$231,189.75
Balance as of 2011-02-28	$309,776.25

Updated Scope of Work, Including Expansion of Task Nos. 1, 4 & 14 of the Original Scope of Work

(Work Related to Completion of the San Francisco Bay Regional Model)

Task 2	Budget
2.1 Assessment of DHI EVA Analysis and 31-Year Period	$17,270
2.2 Levee Improvements and Sensitivity Tests	$43,612
2.3 Adjustment of the SWL for Additional Storage	$6,136
2.4 Review of VDATUM Conversions	$2,000
2.5 Acquire USACE Data	$4,857
2.6 Freshwater Inflow Sensitivity Tests	$6,018
2.7 Update, Calibrate and Validate the Regional Model	$50,910
2.8 Perform Extended Hindcast of the Regional Models	$40,539
2.9 Extract and Analyze Results of Updated Regional Model	$24,542
2.10 Regional Modeling Report Memorandum	$10,402
2.11 Regional Model Review Support	$26,542
2.12 PM QA/QC	$27,802
2.13 ESA PWA Review (w/5% markup)	$49,140
Total Cost Task 2 - Regional Modeling	$309,770

Total Contract Expenditures Prior to Contract Modification **$540,960.00**

Modification to Scope of Work and Budget

Amendment of Mapping Activities Tasks from the Original Scope of Work

Task 3	Budget	
3.1 Pilot Study - MIKE 21 Model	$2,080	
3.2 1D and 2D Local Surge Modeling	$97,964	
3.3 Coastal Hazard Analysis and Mapping		
3.3.1 WHAFIS Wave Analysis	$221,229	
3.3.2 1D Run-Up and Overtopping	$47,382	$344,942
3.3.3 Hazard Mapping	$76,331	
3.4 TSDN and Reporting	$99,341	
3.5 Local Modeling and Mapping Review Support	$25,418	
3.6 Post-Processing and GIS Database Update	$16,432	
3.7 Project Management, QA/QC	$66,124	
3.8 Overland Propagation Modeling		
(ESA PWA + reinstitution of DHI's cost for reporting)	$57,699	
Total Cost Task 3 - 2D Modeling of Coastal Hazards	$710,000	

New Total Contract Amount **$1,250,960.00**