

WATERSHED

Science & Engineering

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Memorandum

To: Chehalis River basin Flood Authority

From: Larry Karpack

Date: May 16, 2012

Re: **Chehalis River Basin Hydraulic Model Development Work Plan (UPDATE)**

Watershed Science & Engineering (WSE) and subconsultants WEST Consultants, Pacific Geomatic Services and Minister Glaeser Surveying were retained in September 2011 by the Chehalis River Basin Flood Authority (Flood Authority) to develop hydraulic modeling and analysis of the Chehalis River to address the requirement in ESHB 2020 "to calculate flood levels, flood damages, and benefits of proposed flood mitigation projects for the lower portions of the river". The Work Plan for was finalized in October 2011 and amended to include work on key tributaries in January 2012. This document provides a status update on the work to date including several tasks that were not envisioned at the time of the work plan and others that have required significantly greater or lesser efforts than originally scoped. The final work plan as prepared by the Flood Authority and WSE is shown below in black text. Following each task is a detailed status report and budget update, shown in blue. The budget updates are current as of April 30, 2012 and the scope updates are current as of May 15, 2012.

As documented below the project has required significantly greater effort to refine, calibrate, correct, and remodel portions of the basin that were included in the previous modeling done for FEMA (NHC, 2010). There has also been a much higher level of coordination than originally envisioned including coordination with Jim Kramer, significant coordination with WSDOT and other members the State tech review team, and regular communication with the Flood Authority's Coordinator, Lara Fowler. On the other hand, several tasks have required less effort than originally budgeted in particular extension of the model from Montesano to Aberdeen. Table 1 below shows the original budget and remaining amount by task. Recognizing that several task are only partially complete and others have not yet been started we believe that although the level of effort on individual tasks has been different than originally scoped the overall original budget for this project is adequate to complete the remaining tasks.

The original project schedule called for delivery of a draft report by March 15, 2012. Due to the added level of coordination with WSDOT, the State technical team, the Chehalis Tribe, Jim Kramer (OFM), and the Flood Authority the project schedule has been extended. In addition the significant modifications to the Twin Cities model have taken considerable time and effort as detailed below. The current schedule, coordinated with Jim Kramer and Lara Fowler, calls for delivery of the draft report by June 30, 2012.

Table 1: Budget Status Update (current as of April 30, 2012)

Task/Sub Task	Budget Total	Remaining Total
Task 1 - Overall Project Management, Stakeholder Involvement, Regular Communication with Flood Authority	\$35,200.00	\$15,719.18
Task 2 - Initial Basin Reconnaissance, Canvass Stakeholders, Obtain and organize data	\$9,040.00	\$91.20
Task 3 - Conduct Adequacy Review of Existing Floodplain Topographic and LiDAR Data	\$0.00	\$0.00
Task 4 - Detailed Work Plan Development	\$19,440.00	\$194.67
Task 5 - Refine USACE Hydraulic Model to reflect Flood Authority Interest	\$148,033.08	\$24,952.37
5a - Obtain new channel survey data for the Chehalis River between Grand Mound (RM 60.6) and Porter (RM 33)		
5b - Refine model of Chehalis River between Lewis/Thurston County line and Porter		
5c - Extend Corps Hydraulic Model downstream from Montesano to Aberdeen		
5d - Refine hydraulic model of main stem Chehalis River		
Task 6 - Extend Hydraulic Modeling (Including Survey, Hydrology and Hydraulics)	\$60,000.00	-\$20,701.81
6a - Expand or refine Corps hydrology analysis		
6b - Refine/revise/extend hydraulic modeling of tributaries		
6c - Review and refine Twin Cities model		
6d - Re-cut cross sections using "best available" LiDAR		
Task 7 - QA/QC Technical Review of WEST Consultants Hydrologic and Hydraulic Modeling	\$13,140.00	\$3,312.50
Task 8 - Technical Evaluation, Reporting of Flood Relief Alternatives to Flood Authority	\$44,500.00	\$33,378.07
8a - Upstream Storage and Corps Levee Project		
8b - Additional Flood Relief Alternative(s)		
Task 9 - Provide QA/QC Technical Review of WSE Flood Relief Alternatives Analysis	\$6,460.00	\$6,460.00
Task 10 - Milestone Meetings / Conference Calls with Flood Authority	\$18,960.00	\$7,614.60
Task 11 - Comprehensive Project Report	\$28,080.00	\$28,080.00
Disbursements and Markup	\$17,107.15	\$9,488.59
Totals	\$399,960.23	\$108,589.37

Detailed Work Plan:

This work plan was developed by Watershed Science and Engineering (WSE) in coordination with the Chehalis River Basin Flood Authority (Flood Authority) to define the tasks necessary to develop hydraulic modeling and analysis of the Chehalis River to address the ESHB 2020 requirement "to complete the hydraulic model for the Chehalis river to calculate flood levels, flood damages, and benefits of proposed flood mitigation projects for the lower portions of the river". In addition, the work plan outlines other tasks that will be conducted to aid the Flood Authority to accomplish its goals and objectives. For each task the work plan outlines the scope, schedule, and budget.

Task 1 - Overall Project Management, Stakeholder Involvement, Regular Communication with Flood Authority

WSE will be responsible to the Flood Authority for the overall management of the model development project. This will include making sure work is completed and delivered in a timely manner and that agreed upon schedules and budgets are met. WSE will administer the contract including providing monthly invoicing and progress reports. In addition, WSE will lead consultant team presentations to the Flood Authority coincident with key milestones and as necessary to keep the Flood Authority fully informed about the status of the work. WSE will also coordinate stakeholder input to the model development project to ensure key objectives are understood and, to the extent possible, met within this project. WEST Consultants will provide support in the form of presentations and communications to the Flood Authority.

WSE will lead this task with support from WEST Consultants.

Projected Task Completion Date: This Task will extend through the duration of the Contract with the Flood Authority.

Task Budget: \$36,738

Scope and Budget Status Update: This Task is proceeding as scoped. The level of coordination has been at about the level anticipated. There is currently \$15,719 remaining in the budget for this task.

Task 2 - Initial Basin Reconnaissance

Conduct targeted field reconnaissance of the basin, contact key stakeholder groups, coordinate with the State technical team, gather information (including topographic and survey data), begin stakeholder involvement process, elicit modeling goals and objectives of key stakeholders, determine extent of past and concurrent modeling efforts (FEMA, USACE, Anchor, WEST Consultants, etc.). (Input from WEST Consultants will be particularly important for working with the USACE to understand their current modeling efforts in the lower Chehalis basin).

WSE will lead this task with support from WEST Consultants.

Projected Task Completion Date: October 30, 2011.

Task Budget: \$9,428

Scope and Budget Status Update: This Task has been completed. The level of effort was similar to what was anticipated and the entire task budget was used to complete the work.

Task 3 - Conduct Adequacy Review of Existing Floodplain Topographic and LiDAR Data

This task has been deferred. No work is currently planned on this task.

Scope and Budget Status Update: No work was done under this task and no budget was used.

Task 4 - Detailed Work Plan Development

This detailed Work Plan has been developed to guide the remaining tasks in the Chehalis River hydraulic model development project. The Work Plan includes schedule milestones, scope information and estimated costs for each task. Table 1 provides a detailed summary of the level of effort.

This draft Work Plan may be distributed by the Flood Authority to interested agencies and Tribes for review and comment. Any comments received from the agencies and Tribes will be reviewed by the Flood Authority and forwarded to WSE to respond to in a final Work Plan. The Flood Authority shall review and approve the final Work Plan prior to it becoming effective. The final Work Plan shall be incorporated into the Agreement between WSE and Lewis County and shall be subject to all terms and conditions of that Agreement. The Work Plan may subsequently be amended by mutual consent of the parties with the approval of the Flood Authority.

WSE will lead this task with support from WEST Consultants.

Projected Task Completion Date: October 20, 2011.

Task Budget: \$19,690

Scope and Budget Status Update: This Task has been completed. The level of effort was similar to what was anticipated and the entire task budget was used to complete the work.

Task 5 - Refine USACE Hydraulic Model to reflect Flood Authority Interest

WEST Consultants is currently under contract to the USACE to develop a hydraulic model of the Chehalis River (Pe Ell to Montesano with the exception of Grand Mound to Porter) under the Basin-wide General Investigation (GI). The USACE project includes collection of bathymetric survey data for model cross sections in several reaches and the development of hydrologic data for the basin. Based on stakeholder input, the Flood Authority may desire to have the WSE project team modify, enhance, or refine that hydrologic and hydraulic modeling effort to better facilitate modeling and analysis related to key stakeholder objectives.

The following sub-tasks have been identified and included in the detailed work plan:

Task 5a - Obtain new channel survey data for the Chehalis River between Grand Mound (RM 60.6) and Porter (RM 33) - The Corps Twin Cities hydraulic model includes cross sections in this reach but the exact location of those cross sections cannot be determined from the available model documentation. A portion of the reach, from RM 41 to Grand Mound, was surveyed by Minister Glaeser in 2001 for the Corps but that survey data is now more than 10 years old and not likely to be representative of current channel conditions. Given these facts, and knowing

that a reliable model of this reach is critical for meeting ESHB 2020 requirements, additional survey data collection to support model development for this reach (Task 5b) is needed.

Survey data collection will be conducted by PGS or another sub-consultant.

Projected Sub-Task Completion Date: November 15, 2011.

Sub-Task Budget: \$38,365.

Scope and Budget Status Update: This Task has been completed. The level of effort was as anticipated. Approximately \$1,000 remains in the budget for this task and can be reallocated to other model development tasks.

Task 5b - Refine model of Chehalis River between Lewis/Thurston County line and Porter - This reach is in the Twin Cities hydraulic model and additional model development for this reach is not currently part of the Corps GI study contract. However, the past modeling work by the Corps and/or FEMA did not include georeferencing or otherwise cleaning up this reach of the model. The current model can be used to produce water level information but it cannot be used for automated floodplain mapping. Further, the accuracy and/or reliability of the simulations in this reach of the model have not been evaluated to our knowledge. This task entails developing a new hydraulic model using the cross section data described in Task 5a and the 2002 PSLC LiDAR data. Some level of model validation or calibration will be conducted; however, the validation effort is not expected to be significant.

WEST Consultants will be primarily responsible for this sub-task

Projected Sub-Task Completion Date: December 15, 2011.

Sub-Task Budget: \$31,873

Scope and Budget Status Update: This Task is complete. The level of effort for the model development in this reach was as anticipated. Approximately \$2,700 remains in the budget for task, which may be used for additional model refinements or relocated to other model development tasks.

Task 5c - Extend Corps Hydraulic Model downstream from Montesano to Aberdeen - the GI Study contract includes development of a hydraulic model for the Chehalis River upstream of the confluence with the Wynoochee River at Montesano. The Chehalis River reach downstream of the Wynoochee River confluence is significantly tidally influenced and potentially more hydraulically complex due to significant side channels and backwater channels in the floodplain. The Corps felt that accurately modeling this area would require a 2-dimensional hydraulic model (HEC-RAS is a 1-dimensional model). Despite the complexity involved in the lower reach we believe that this reach could be modeled using HEC-RAS, although the modeling might be subject to greater uncertainty than the less complex reaches upstream. In order to extend the model to Aberdeen additional channel and overbank survey data would also need to be collected. Model development for this reach may require some additional hydrologic analysis to provide inflows for hydraulic model calibration and validation.

WSE will be primarily responsible for this sub-task with survey support from PGS

Projected Sub-Task Completion Date: December 15, 2011.

Sub-Task Budget: Survey \$17,000 (channel) \$12,500 (overbank), model development \$53,165,
Total \$82,665

Scope and Budget Status Update: This Task has been completed. The level of effort for the model development in this reach was significantly less than anticipated. The level of effort for the model development in this reach was as anticipated. Approximately \$21,500 remains in the budget for task, which may be used for additional model refinements or relocated to other model development tasks.

Task 5d - Refine hydraulic model of main stem Chehalis River - as noted previously WEST is currently working with the Corps to develop a hydraulic model of the mainstem Chehalis River from Montesano to Pe Ell. However, the model may not be sufficiently detailed in all locations to meet the needs of the Flood Authority and stakeholders. To the extent that the Flood Authority identifies particular areas of interest for hydraulic modeling along the main stem the intent of this task would be to evaluate the Corps model and refine it as necessary meet the needs of the Flood Authority and stakeholders. This task will be done in two phases, the first to identify areas of interest for refined hydraulic modeling and specific data requirements and the second to refine the model. The scope for this sub-task will be refined in collaboration with the Flood Authority Project sub-committee following initial information collection.

Projected Sub-Task Completion Date: to be determined.

Sub-Task Budget: \$ 7,500 (preliminary budget assumed based on available project funding)

Scope and Budget Status Update: No budget was authorized for this task and nothing has been charged to Task 5d.

Total Task Budget: \$148,033

Scope and Budget Status Update: This hydraulic model development task has been completed. The level of effort for the model development included in the original work plan was less than anticipated. However, as noted below the level of effort for review, refinement, correction, and improvement of the FEMA Twin Cities model was significantly greater than anticipated as documented under Task 6c. Overall, there is approximately \$25,000 remaining in the budget for Task 5 (Tasks 5a, 5b, 5c, and 5d).

Task 6 - Extend Hydraulic Modeling (Including Survey, Hydrology and Hydraulics)

It is anticipated that the work currently being done by WEST Consultants for the USACE can be leveraged extensively to meet the needs for hydraulic modeling in the lower Chehalis River. If this proves to be true, it will free up resources to allow the Flood Authority to conduct additional modeling efforts to meet stakeholder needs. The detailed work plan developed in Task 4 will define which rivers/reaches will be modeled and whether additional survey and/or hydrologic data development is required.

The following sub-tasks have been identified and included in the detailed work plan:

Task 6a - Expand or refine Corps hydrology analysis – This sub-task has been deferred. No work is currently planned on this task.

Scope and Budget Status Update: No budget was authorized for this task. However, requests by the State review team and additional efforts needed to develop hydrologic inputs for model calibration required work that was not required or funded by the Corps. Overall, this work by WSE and WEST consultants has required approximately \$4,200, which will need to be reallocated from other tasks.

Task 6b - Refine/revise/extend hydraulic modeling of tributaries - (Satsop River, Black River, Skookumchuck River, Newaukum River) – as noted previously the Twin Cities hydraulic model includes tributaries but these may not be in the model correctly. Furthermore the tributary models may be outdated, limited in extent, or poorly configured. The intent of this task would be to evaluate the existing models, refine them as possible, replace them as necessary, and extend them as desired to meet the needs of the Flood Authority and stakeholders. Tributaries within the new model reach downstream of Grand Mound will also be evaluated for additional modeling. This task will be done in two phases, the first to obtain any previous hydraulic modeling and identify additional modeling needs and the second to develop the tributary models. The scope for this sub-task will be refined in collaboration with the Flood Authority Project sub-committee following initial information collection.

Projected Sub-Task Completion Date: to be determined.

Sub-Task Budget: \$ 60,000 (preliminary budget assumed based on available project funding)

Scope and Budget Status Update: Work on this task is complete. The authorized budget for Task 6b (authorized by the Flood Authority in February 2012) was \$45,100 which was essentially all used in completing the authorized work.

Task 6c - Review and refine Twin Cities model cross section layout – This sub-task has been deferred. No work is currently planned on this task.

Scope and Budget Status Update: No budget was authorized for this task. However, as noted above the level of effort for review, refinement, correction, and improvement of the FEMA/NHC Twin Cities model was significant. Overall, this work by WSE and WEST consultants has required approximately \$31,500, which will need to be reallocated from other tasks.

Task 6d - Re-cut cross sections using “best available” LiDAR – This sub-task has been deferred. No work is currently planned on this task.

Scope and Budget Status Update: New LiDAR data is not yet available for the project area. Nothing has been charged to Task 6d and there is no budget for this task.

Total Task Budget: \$ 60,000 (preliminary budget assumed based on available project funding)

Scope and Budget Status Update: Extensions of the hydraulic model have been completed. Including the effort to review, refine, correct, and improve the FEMA Twin Cities model approximately \$81,000 has been charged to this task while the total original budget was \$60,000. There is approximately \$25,000 surplus in Task 5, which can be reallocated to cover these additional unscoped efforts.

Task 7 - QA/QC Technical Review of WEST Consultants Hydrologic and Hydraulic Modeling

Under the USACE Contract, WEST Consultants will develop hydrologic data for the Chehalis River basin and calibrate the Baseline Hydraulic Model of Chehalis River. This work is expected to be complete by December 31, 2011. As previously described, the USACE model may be refined and/or expanded under the Flood Authority Contract. To the extent possible, the refined/expanded model will be calibrated by WEST Consultants as part of its work for the USACE. If significant model refinements or modifications make it necessary for additional model calibration to be conducted under the Flood Authority contract, that work would be done under Tasks 5 and 6. Through the USACE work and Tasks 5 and 6 of this contract, baseline hydrologic and hydraulic modeling and analysis will be developed. These baseline analyses will be subject to independent technical review to ensure they adequately meet the needs and objectives of the Flood Authority as defined in the work plan.

WSE will lead this task.

Projected Task Completion Date: January 15, 2012.

Task Budget: \$ 13,215

Scope and Budget Status Update: WSE reviewed WEST's work, both for the Corps and for the Flood Authority portions of the model. WSE and WEST also reviewed the work previously completed by NHC for FEMA and the work previously completed by the Corps in the development of the Twin Cities model. Overall there is approximately \$3,300 remaining in the original budget for Task 7. It is not clear to what level additional review will be required.

Task 8 - Technical Evaluation, Reporting of Flood Relief Alternatives to Flood Authority

A range of possible flood damage reduction projects are under consideration for the upper areas of the Chehalis River. These include (1) upstream storage projects on the Upper Chehalis, South Fork Chehalis and Skookumchuck Dams, (2) USACE proposed levee modifications and (3) combinations of storage and levee projects. WSE will lead this task with support from WEST Consultants for the evaluation of the USACE Levee Project and Skookumchuck storage.

Task 8a - Under this sub-task, alternative upstream conditions will be evaluated and compared to the baseline condition. Specific activities shall include definition of alternative upstream conditions, hydraulic modeling and analysis, and reporting of results. The alternative to be modeled under Task 8a includes the proposed upstream retention facility on the main stem Chehalis River above Pe Ell. The hydrologic effect of the upstream retention facility will be determined either from previous analyses or by running the upstream model. The effect of the upstream projects will be input to the lower Chehalis River made as a change in the hydrologic input at the upstream end of the model. The lower Chehalis River model will then be run with the changed hydrologic inputs and differences in terms of simulated water levels at various locations will be tabulated. WEST Consultants is currently under contract to the USACE to conduct an evaluation of the potential downstream effects of the USACE Twin Cities Levee project. The results of that analysis will be integrated into WSE's summary.

Projected Sub-Task Completion Date: February 22, 2012.

Sub-Task Budget: \$ 18,663

Scope and Budget Status Update: The first iteration of work on this task has been essentially completed. Approximately \$8,000 remains in the budget. However, at a meeting on May 9, 2012 WSDOT informed the consultant team that they wanted to make additional changes to the model baseline geometry to reflect the MTB project that has been designed, permitted, and funded and will be constructed this summer. This will require the flood relief alternatives to be remodeled.

Task 8b - WEST is currently under contract with the Corps to simulate the performance of the lower Chehalis River with and without the Twin Cities levee project and Skookumchuck storage. The Flood Authority contract with WSE includes simulating the lower reach with and without the proposed upstream retention facility on the main stem Chehalis and then comparing the results of these three scenarios (baseline, Corps levee project, upstream retention). The Flood Authority may wish to evaluate additional flood relief alternatives or other scenarios. These may include combinations of the previously described projects or additional new flood relief projects as identified by the Flood Authority and Stakeholders. This task would include hydrologic data development and hydraulic simulation of the alternatives using the models described above and reporting of the impacts/benefits of the alternative. The budget herein assumes that one additional flood relief alternative, similar in scope and complexity to the earlier alternatives, is evaluated. Budget includes allowance for WEST Consultants, assuming additional hydrologic data is required.

Projected Sub-Task Completion Date: February 22, 2012.

Sub-Task Budget: currently \$26,538 (For budget purposes an assumption was made that one additional flood relief alternative, of similar complexity to the ones already being evaluated, would be defined and evaluated. This assumption will be reevaluated over the course of the study as additional information becomes available regarding possible flood relief alternatives)

Scope and Budget Status Update: Preliminary modeling of eight (8) additional flood relief alternatives has been completed. However, at a meeting on May 9, 2012 WSDOT informed the consultant team that they wanted to make additional changes to the model baseline geometry to reflect the MTB project that has been designed, permitted, and funded and will be constructed this summer. This will require the flood relief alternatives to be remodeled. There is currently \$25,400 remaining in the budget for this task.

Projected Task Completion Date: February 22, 2012.

Task Budget: \$ 45,200

Scope and Budget Status Update: Preliminary modeling of nine (9) flood relief alternatives has been completed. However, at a meeting on May 9, 2012 WSDOT informed the consultant team that they wanted to make additional changes to the model baseline geometry to reflect the MTB project that has been designed, permitted, and funded and will be constructed this summer. This will require the flood relief alternatives to be remodeled. There is currently \$33,400 remaining in the budget for this task (including sub-tasks 8a and 8b).

Task 9 - Provide QA/QC Technical Review of WSE Flood Relief Alternatives Analysis

The flood relief alternatives analyses described in Task 8 will be subject to independent technical review to ensure the needs and objectives of the Flood Authority are adequately met as defined in the Work Plan.

WEST Consultants will review work performed by WSE and WSE will review work performed by WEST Consultants.

Projected Task Completion Date: February 29, 2012.

Task Budget: \$ 6,710

Scope and Budget Status Update: No work has been conducted under this task. There is currently \$6,400 (not including disbursements) remaining in the budget for this task.

Task 10 - Milestone Meetings / Conference Calls with Flood Authority

WSE will coordinate presentations, communications and information transfer to the Flood Authority at key milestones in the project to ensure Flood Authority members are kept fully informed. The milestones and schedule will be determined during the Work Plan Development in Task 3.

WSE will lead this task with support from WEST Consultants.

Projected Task Completion Date: This Task will extend through the duration of the Contract with the Flood Authority.

Task Budget: \$ 19,473

Scope and Budget Status Update: This Task is proceeding as scoped. The level of effort has been at about the level anticipated. There is currently \$7,600 remaining in the budget for this task. However, as the project duration is extended to accommodate coordination with Jim Kramer (OFM) and WSDOT there is a risk that the budget for this task will not be sufficient.

Task 11 – Comprehensive Project Report

WSE will prepare a project report to document the findings of the hydraulic model investigations described above. A draft report will be prepared and submitted to the Flood Authority for review and comment. Upon receipt of comments, a final report will be prepared and distributed.

WSE will lead this task with support from WEST Consultants.

Projected Task Completion Date: Draft Report March 15, 2012; Final Report 10 days following receipt of consolidated comments from Flood Authority.

Task Budget: \$ 29,105

Scope and Budget Status Update: No work has been conducted under this task. The draft report is now anticipated to be completed by June 30 2012 with the final report 10 days following review comments by the Flood Authority. There is currently \$28,080 (not including disbursements) remaining in the budget for this task.