Columbia River CROSSING

Memorandum

March 31, 2014

TO: CRC Document Controls

FROM: Kevin Gray

SUBJECT: Project Closeout Summary for Columbia River Crossing – Ship Simulation (Master Agreement B31260 WOC #15)

This memorandum, assembled at the time of project closeout, provides a summary of Ship Simulation work completed in support of Section 408 authorizations from the United States Army Corps of Engineers for modifications to navigation channels by the proposed Columbia River Crossings. The intent of the memorandum is to provide information and guidance on the applicable technical and administrative efforts that may be used at a future date towards completion of this project, or a similar effort in the affected area.

Executive Summary

The construction of the Columbia River Crossing includes impacts to Federal Navigation Channels within the Columbia River, regulated and maintained by the United States Army Corps of Engineers (USACE). United States Code (USC) Title 33 Section 408 (known as 33 USC 408 or Section 408) requires that modifications to Federal Projects, including the design of modifications to levees, bank protection, and interior drainage receive authorization from USACE. Acting as a subconsultant to David Evans and Associates (DEA), HDR Engineering led the consultant effort to secure Section 408 authorizations in support of the CRC Environmental Lead. Waterway Simulation Technology, Inc. (WST) provided ship simulation support to the Navigation Section 408 process under a separate Work Order Contract (WOC #15). Additionally, CRC contracted with Columbia River Pilots, Shaver Transportation, Inc., and Bernert Barge Lines, Inc., to provide pilots to assist with simulation studies conducted at the USACE Engineering Research Data Center (ERDC) in Vicksburg, MS.

Section 408 allows non-Federal modifications to USACE projects only when the modifications will not be injurious to the public interest and will not impair the usefulness of such work. Proposed modifications to the Columbia River navigation channel must provide continued navigation and minimize impacts to USACE operations and maintenance (O&M). This task included providing a real-time piloted ship maneuvering simulation study in which a model of the existing, proposed temporary navigation conditions, and proposed project navigation channels, were developed for a selected set of river and diversion discharges. Deep-draft and shallow-draft design vessels of at least two types and sizes were maneuvered, in simulation, between a location upstream of the bridges to a location downstream of the Burlington Northern Santa Fe (BNSF) Railroad Bridge under each of these conditions to determine whether safe control of the vessels or tows could be maintained.

The tests with and without project conditions, and with the conditions produced by the temporary construction plan, provide a measure of the project's impact on existing navigation conditions.

Engineering Manuals (EM) 1110-2-1643 and 1110-2-1611 require that all proposed modifications to a new or authorized federal navigation channel be modeled for the final design, either with a physical model or ship and/or tow maneuvering model studies, to assure safe and efficient navigation. This modeling is regulated by Engineering Regulation (ER) 1110-2-1403. The proposed bridge design and the intervening construction of the new bridge while the existing bridge remains in place will have an impact on navigation. The purpose of the ship/tow maneuvering simulation study being described herein is to determine if construction of the proposed CRC will cause significant navigation impacts and whether

these impacts are beneficial or detrimental to navigation and, if detrimental, to recommend potential resolutions to mitigate such impacts.

In addition to the USACE Review, the process requires an Individual Expert Panel Review (IEPR) to ensure the technical adequacy of all work. Captain (Ret.) Tom Rodino was contracted to observe simulations and provide that review.

As of March 31, 2014, the project team has completed the following:

- Proposed Ship Simulation Study, including Design Vessels and Test Methodology;
- Conducted simulations for deep-draft vessels in December 2013;
- Conducted simulations for shallow-draft vessels at ERDC in January 2014;
- Prepared Deep-Draft Ship Simulation Report (Draft); and,
- Prepared Shallow-Draft Ship Simulation Report (Draft).

The Simulation Reports (Draft) conclude that the CRC would improve navigation safety and efficiency when completed. Navigation through the project area can be conducted safely during construction. The use of assist tug boats and/or training of pilots are recommended for limited periods of construction and river conditions. Conclusions and recommendations from both simulations are provided below.

Deep-Draft Vessel Navigation

Based on the deep-draft vessel navigation simulations, the following conclusions and recommendations are presented:

Conclusions

- Two distinct scenarios for approaching the Upper Vancouver Turning Basin (UVTB) and performing a tug-assisted turn of the design ships (580' x 101') were tested. The simulations showed that both of the scenarios were safe for the design ships using two 3000 hp tractor tugs. These two scenarios were a) transiting directly through the BNSF railroad bridge into the turning basin and b) coming off of the Lafarge dock and driving into the turning basin.
- Both loaded and ships in ballast were tested and found to be safely turned in the UVTB and aligned for departure through the BNSF railroad bridge.
- The scenario in which the design ship departed the Lafarge dock (port-side-to) and backed through the BNSF railroad bridge with tug assist was not shown to be safe. However, restricted capabilities of the simulator visuals and tug operations limited the ability of the pilots to direct this maneuver; therefore, definitive evaluation was not possible based on the limited number of runs completed.
- The pilots did note that they do the backing through the bridge at other sites and that this is a common practice and they did not expect that there would be a problem in real lift if the ship beams were in the range of 88'-96' rather than the test ship's beam of 101'.
- Transit of the deep-draft design vessel (435' x 75') for the proposed 27' VPOTD channel was shown to be safe for upbound and downbound transits. The controlling factor for these maneuvers was passing through the BNSF railroad bridge.
- The pilots thought that an assist tug should be used to slow a downbound ship exiting the Vancouver to the Port of The Dalles (VPOTD) channel and then passing through the BNSF railroad bridge.
- Based on Ship Simulation results and input from the pilots the proposed layouts for the Primary Navigation Channel and the UVTB are safe for navigation.

Recommendations

- Two 3000-hp tractor tugs are recommended for turning the design ship (580' x 101') in the UVTB.
- Navigation markers are needed to mark the southern (Oregon side) edge of the UVTB.
- For transits of deep-draft ships (435' x 75') under the proposed I-5 replacement bridge, navigation markers are needed above and below the two bridge piers bordering the 27' VPOTD. The channel above the bridge should have un-gated buoys marking the channel bends.

Shallow-Draft Vessel Navigation

Based on the shallow-draft vessel navigation simulations, the following conclusions and recommendations are presented:

Conclusions

- The existing I-5 Bridge Spans and navigation channels are considered safe by the pilots and this was demonstrated by the simulations.
- The pilots were pleased with the navigation conditions with the proposed project.
- Based on simulations results and pilot input, the proposed layouts of the navigation channels are safe for transits in this reach of the Columbia River.
- The proposed CRC Bridge will result in conditions for navigation that will be better and safer than the existing conditions.
- The BNSF railroad bridge will continue to be critical and the most difficult location to transit this reach of the river.
- There was a general consensus that no buoys were desired in the channel above the replacement I-5 Bridge and Ryan's Point. Some suggested leaving the junction buoy for a pre-established period of time to help pilots orient to the new conditions.
- Bridge piers must be marked:
    - Buoys placed upstream and downstream of the bridge piers, bounding the navigation spans with a separation (approximately 200') so that the buoys can be identified on the radar in fog.
    - Red lights should be placed on each pier bounding the navigation spans similar to the other Columbia River bridges.
    - Green lights should be placed on the center of the primary span and white lights on the Barge and Alternate Barge Channel spans.
    - The pile caps of the piers near the water level should have the corners marked with directional lighting since they extend out further into the navigation channel than the upper part of the pier.
- The pilots were able to make successful transits for all conditions without any accidents or collisions, under all conditions tested.
- The pilots often commented during the interim condition test runs that even though they made the run successfully, there was no room for error, misjudgment, or mechanical failures or for unexpected situations that might develop and therefore, they considered these conditions unsafe.
- Providing an assist tug on the front of the tow gave the conning pilot control of the front of the tow and allowed the safe movement of tows through the temporary navigation channels in the construction zone with good control under all conditions.

- The pilots considered the loaded tow models to be realistic and generally did not complain about those models and how they handled.
- Even though the validation pilots declared the empty tow models to be acceptable, the pilots in the last week of testing did not consider the tow behavior in wind to be realistic with the towboat at the stern not "sliding" as they experience on the river.

Recommendations

- Interim Conditions
    - Provide all tows an assist tug with 2500- to 3000-hp Z-drive between the United Grain Terminal to above the I-5 Bridge.
    - Develop guidance on the operation of the lift span so that pilots know what the operating rules will be.
    - Provide tie-off or mooring facilities between the Junction Buoy and Ryan Point on both sides of the river.
    - Restrict recreational and fishing boats from the construction area navigation channels; mark by buoys and enforce – there is no allowance for interfering traffic while the tows are maneuvering through this restricted area.
    - Provide a point of contact during construction to provide information about the operations and location of equipment to pilots upon request using radio or phone, as well as post river and construction restriction conditions on the internet for access by towing companies and pilots.
    - Good visibility is required so operations will be suspended during fog although no night operations are acceptable.
    - Construction equipment must be well lighted during night operations.
    - Improve the empty tow models by making measurements of the tows in operations on the river and modifying the tow models to respond appropriately in the wind.
    - Provide training for all pilots prior to beginning construction using the simulation models developed and improved to increase realism.
- Proposed Bridge (Post-Construction)
    - The new bridge will aide in navigation; complete as soon as possible.
    - Mark the bridge piers on either side of each navigation span with red lights on the pier, lights on each corner of the wide portion of the pier near the waterline, 3 vertical green lights on the center of each navigation span, and buoys upstream and downstream of the piers on either side of a navigation channel, separated by approximately 200' to allow identification on radar during fog.

Below is a detailed summary of work status and project deliverables, outstanding work to complete the Ship Simulation support of the Section 408 authorization process, an overview of project history, key decisions, and information on key documents and references.

Status of Work

Table 1 summarizes the disposition of deliverable products, completed within Work Order Contract (WOC) 15, as of March 28, 2014.

Table 1. WOC 15 - Deliverable Status

Task	Deliverable Name	Submittal Date	Location of Files
1.0	Invoices and Progress Reports		
2.1	25% Ship Simulation Progress Report 25% Ship Simulation Progress Report Draft and final of each individual Phase I ESA report. (Draft deliverables are electronic only; up to one hard copy of each final report).	Within six (6) weeks of NTP	G:\CRC\CRC Project Files\Deliverables\B31260 DEA WOC 15
2.2	Pilot cards which describe the principal characteristics of the modeled shallow-draft (tow) vessels.		contained in draft final reports 6.1 and 6.2, Appendix B
2.3	Pilot cards which describe the principal characteristics of deep-draft vessels.		contained in draft final reports 6.1 and 6.2, Appendix B
3.0	Images of the currents in the project study area superimposed on the ECDIS chart on the ERDC simulator.		G:\\CRC\CRC Project Files\Deliverables\B31260 DEA WOC 15\CRC Draft Ship Simulation Report 2-22-2014.docx
4.1	50% Ship Simulation Progress Report for deep-draft vessels		G:\CRC\CRC Project Files\Deliverables\B31260 DEA WOC 15
4.2	50% Ship Simulation Progress Report for shallow-draft (tow) vessels		G:\CRC\CRC Project Files\Deliverables\B31260 DEA WOC 15
5.1	75% Ship Simulation Progress Report for deep-draft vessels	2/18/14	G:\CRC\CRC Project Files\Deliverables\B31260 DEA WOC 15
5.2	75% Ship Simulation Progress Report for shallow-draft (tow) vessels	2/18/14	G:\CRC\CRC Project Files\Deliverables\B31260 DEA WOC 15
6.1	Draft Final Ship Simulation Progress Report for deep-draft vessels	3/10/2014	G:\CRC\CRC Project Files\Deliverables\B31260 DEA WOC 15
6.2	Draft Final Ship Simulation Progress Report for shallow-draft (tow) vessels	3/31/2014	G:\CRC\CRC Project Files\Deliverables\B31260 DEA WOC 15
7.1	Final Ship Simulation Report for deep-draft vessels	Not Applicable – Work Suspended	N/A
7.2	Final Ship Simulation Report for shallow-draft (tow) vessels	Not Applicable – Work Suspended	N/A

Known Issues/Gaps/Unresolved Issues

USACE review and Independent Expert Panel Review (IEPR) have not been completed. Though they were unable to observe the Deep-Draft Simulations at ERDC, USACE Division staff did observe the Shallow-Draft simulations. Captain (Ret.) Tom Rodino, IEPR member, was able to attend all simulation exercises. He has completed a review of the Draft Deep-Draft Ship Simulation Report and is scheduled to complete review of the Draft Shallow-Draft Ship Simulation Report by April 7, 2014.

Evaluation of Future Utility

The Proposed Ship Simulation Study, including Design Vessels and Test Methodology, can provide the framework and vessel codes to conduct future simulation studies, regardless of the proposed construction sequencing and bridge configuration.

The Draft Ship Simulation Reports generated to support the Navigation 408 will retain their value, as long as the configuration and modeling (above) remain the same and *ER 1110-2-1403* remains in effect, as currently written. Note: This assumes USACE does not eliminate the requirement to model for the final design to assure safe and efficient navigation. Changes to policy or regulation could require additional simulations, prior to submission for review to the USACE.

Below is the estimated shelf life of work products, and rough estimate of time and costs, if work is picked up after the expiration date:

- If the project is reinstituted in its present configuration, within the next year +/-, completion of the simulation effort in support of the Navigation 408 approval process could be completed in 3 - 6 months and would cost approximately $50,000. The Ship Simulation Reports could obtain USACE endorsement after one review cycle with the USACE – anticipated with the Navigation 408 60% submittal package and response to comments and update of the reports for the 90% submittal package.
- Substantial delay and/or changes to USACE regulations and/or policies governing the Section 408 Approval Process or changes to project configuration that result in the need to begin new ship simulations would result in adding at least one year to the Navigation 408 process. Completing those studies would likely cost between $500,000 - $900,000, depending upon the changes to Ship Simulation and IEPR requirements, etc.

Outstanding Work – Future Project Proponents

Completion of Ship Simulation review and approval should occur with the 60% and 90% submittal packages outlined above. Note: As of March 31, 2014, the Draft Deep Draft Ship Simulation Report has been completed and is included with the 60% Navigation 408 submittal package (Appendix 2J). The Draft Shallow-Draft Ship Simulation Report has been submitted and reviewed by HDR. Comments from HDR have not yet been addressed in the Draft Report by WST. The CRC team recommends that WST incorporate review comments to ensure that this effort is completed in a manner that is ready for submission to the USACE. The advantage in completing this recommended process with WST now is that if the project is resumed, even years from now, and the design parameters are the same, the simulations will be just as valid then as they are now and the reports will be in the record. On a related note, the CRC team also recommends that ODOT retain Tom Rodino (IEPR) under existing Contract #B31840 to complete his review of that same WST Draft Shallow-Draft Ship Simulation Report, as well as complete the responses to the charge questions relative to the vessel simulations. An IEPR back check of the Final Ship Simulation Reports would have to occur before completion of the Final Reports to be included in the 90% Navigation 408 Submittal Package.

Project History, Milestones & Key Decisions

The Section 408 Approval processes have been initiated and conducted consistent with the Record of Decision for the project.

Key technical decisions associated with the Ship Simulation process are well documented and included with the Proposed Ship Simulation Study, including Design Vessels and Test Methodology and the Draft Ship Simulation Reports.

Project Records

Records of the work conducted under this task can be found at:

- Deliverables and QC Documentation: G:\CRC\CRC Project Files\Deliverables\B31260 DEA WOC 15

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