Delta Science Program Independent Review Panel

for the

Feasibility Study of Shore-Based Ballast Water Reception and Treatment Facilities in California

Report 2: Feedback on Tasks 2-5 and Long Beach Public meeting (8/30/3016)

1 Introduction

In mid-2015, the Delta Stewardship Council's (Council) Science Program convened an independent review panel (Panel) to provide expert evaluation of a feasibility study for the potential use of shore-based ballast water reception and treatment facilities to meet California's interim performance standards for the discharge of ballast water (Cal. Code of Regs. section 2293 Title 2). The purpose of the feasibility study is to meet a mandate in the Marine Invasive Species Act for the State Lands Commission to identify and conduct research about the means by which to reduce or eliminate a release or establishment of nonindigenous species by shipping vessels. The study, initiated in mid-2015, will culminate in a report that is based on verified, substantiated publically-available data and documents and includes detailed analyses (costs, logistics, etc.). The report will detail the potential of shore-based ballast water treatment to enable regulated vessels to comply with California's interim performance standards and will contribute to the understanding of a potentially broader and more effective range of compliance options.

1.1 Panel Membership[1]

The five members of the interdisciplinary panel (listed below) bring together expertise in chemistry, ecology, fisheries and aquatic biology, natural resources economics, ship operations, environmental compliance, treatment technologies, and environmental engineering.

- William (Bill) J. Cooper, Ph.D., University of California, Irvine, (Panel Chair)
- Audrey D Levine, Ph.D., P.E., University of California, Santa Cruz (Lead Author)
- Christine M Moffitt, Ph.D., University of Idaho
- Steven C. Hackett, Ph.D., Humboldt State University
- Rick Harkins, P.E.

1.2 Charge Questions

The Council's Science Program asked the Panel to review materials and participate in a series of public meetings. The Panel was asked to consider thirteen charge questions:

1. Does the literature review report cover all pertinent information related to the feasibility of shore-based treatment facilities?
2. Do the findings render adequate insights to understanding vessel types, treatment plants and facilities?
3. Does the assessment of case studies provide adequate knowledge to assess feasibility of ballast water transfer, storage and treatment?

[1] http://deltacouncil.ca.gov/feasibility-study-shore-based-ballast-water-reception-and-treatment-facilities-california-0

4. Are site descriptions complete, are they representative of the range of port facilities in California, and do they contain the necessary information from which to evaluate the application of a given engineering solution and their potential of meeting California's interim standards?
5. Are potential engineering solutions clearly defined and described?
6. Are the evaluation criteria clearly defined and described?
7. Are linkages between elements of the report clear?
8. Is the report of sufficient robustness and scientific quality that it appropriately identifies and considers applicable technologies, economic implications, and considers applicable solutions?
9. What, if any, additional engineering solutions should be considered?
10. What, if any, additional evaluation criteria should be considered?
11. Are the engineering solutions described in the report feasible to implement?
12. Do the recommendations and implications fully answer questions related to feasibility of shore-based treatment facilities?
13. If not, what needs to be considered to improve the feasibility analysis of the potential solutions?

1.3 Report context

The Panel has agreed to participate in three public meetings that track the feasibility study progress. The kick-off meeting, held in October 2015, oriented the Panel to the study scope. The Panel's initial impressions and recommendations were submitted to the Council in November 2015. This Panel report focuses on progress that was reported during the second public meeting, held on August 30, 2016 in Long Beach, CA. Prior to the meeting, Panel members had an opportunity to tour the Port of Long Beach and observe some of the technical and operational challenges related to managing ballast water.

The August 2016 meeting included presentations, discussions, and public comments related to shore-based treatment in the context of five case study sites (Stockton, Oakland, Port Hueneme, El Segundo, and Long Beach). The discussions centered on technical and practical considerations relevant to vessels (Task 2), ports (Task 3), shore-based facilities (Task 4), and treatment technologies (Task 5).

- Task 2: Retrofitting and Outfitting of Vessels
- Task 3: Retrofitting of Ports and Wharfs
- Task 4: Shore-Based Ballast Water Treatment and Storage
- Task 5: Assessment of Treatment Technologies

This report summarizes the Panel's observations, findings, and recommendations for each deliverable. The meeting also provided an opportunity for the Panel to review the charge questions.

2 Progress review

The project team provided the Panel with a summary of findings from Tasks 2, 3, 4 and 5 during the August 2016 meeting. The Panel also reviewed the reports from each task. In general, the Panel found each report to be well organized with clear descriptions of each task, summaries of findings, and technical documentation. Overall, the Panel commends the project team for the quality of the work and the tremendous progress to-date. The Panel appreciates the level of detail that was provided and found the team to be responsive to questions and comments.

As the project moves forward to its next phase, the Panel would like to offer some general overarching suggestions on economic analysis, scale-up considerations, and report-to-report inconsistencies.

- **Economic analysis:** The Panel appreciates the logic of including economic analyses within each task report, however, it would be helpful if the project team could compile the components of the individual analyses into a levelized cost of ballast water management. A unified methodology that incorporates the relative costs of port modifications, investments, and operations required to support ballast water treatment and storage is necessary to enable decision-makers to understand the economic implications of various scenarios. The Panel recommends integrating the cost analysis of port and wharf modifications (Task 3) with the shore-based ballast water treatment and storage costs (Task 4). In this unified cost analysis, the Panel would like to see inclusion of all relevant costs (including operation and maintenance along with clearly quantifiable opportunity costs), with an ultimate goal of calculating a unified levelized cost of ballast water management per unit volume by port case study, using an appropriate discount rate (or range) and capital improvement lifetime. These levelized ballast water management costs, even if rough order of magnitude (ROM) estimates are employed to compensate for the lack of verifiable data, could then be discussed and compared with each other and with other documented unitized water management costs. This approach will also eliminate potential inconsistencies and sources of confusion. Some discussion of methods to apportion and amortize the costs among different port-ballast water scenarios would also be useful.
- **Scale-up considerations:** While the case-study approach provides a good framework for analysis of specific vessel types, the Panel would like to remind the project team to recognize the limitations of this approach. While there is a need to examine specific vessels and ports, it is important not to lose sight of the overarching goals of the study. As such, methodologies for scale-up should be developed and tested to identify gaps in the current knowledge-base (e.g. Charge Question 3).
- **Inconsistencies across the task reports:** The Panel noted several inconsistencies among the task reports. Since each report is essentially written as a stand-alone document, it would be helpful if open-ended references to other reports are resolved. For example, the discussions about the shoreside transfer facility (booster station) span Tasks 2, 3, and 4. The text in Task 2 states that the details are provided in Task 3. However, Page 13 of task 3 indicates "….intermediate dockside lift stations are required to complete the transfer. The details of those lift stations are provided in task 4." Task 4 (page 18) references Table 4 as the basis for the estimates the cost of lift stations—however Table 4 is entitled "Port of Stockton Case Study Summary." The Panel recommends a critical review of the cross-references among the reports to minimize potential sources of confusion.

The Panel's observations and recommendations for each task are summarized below.

2.1 Task 2: Retrofitting and Outfitting of Vessels

The focus of Task 2 is the feasibility of shipboard modifications that can enable efficient and effective pumping of ballast water to treatment facilities. The report considers the constraints associated with different vessel types and operational requirements that encompass prevalent scenarios at each of the case-study ports. Cost-estimates for proposed vessel-specific modifications are summarized.

The Panel found that the Task 2 deliverables were well-presented and that the scope, methodologies, and analyses were clear. The Panel appreciated the level of detail provided on the vessel cross-sections and piping complexities. The Panel also endorses the "zero tolerance" approach that the team advocated for preventing spills (analogous to practices for handling liquid petroleum). Specific comments and recommendations for Task 2 include:

1. **Pumps, flowrates, and booster stations**: The Panel noted that there may be some inconsistencies between the pump capacities and the flowrates needed to process the required volumes of ballast water. The Panel recommends that the project team verify the flowrates used to generate the report (12 m/s vs 10 ft/sec) and relate the values to industry piping standards (e.g. Harrington's and Cranes'). The Panel also recommends that the team use consistent terminology to refer to booster stations (as opposed to lift stations which are more relevant to pumping stormwater and wastewater).
2. **Hydraulics**: The Panel felt that the descriptions of how the flowrates are controlled was incomplete and recommended that a hydraulic model be used to evaluate the need for booster pumps, eductors, or staging of operations to ensure continuity of flow, mitigating of spills, and consistency of operations.
3. **Ballasting rates:** The Panel recommends that the project team confirm the flow-control assumptions relating to the feasibility of shipboard pumps to provide the suction required to lift water from the main deck and the role of the booster pumps in achieving the desired flowrates. The Panel would like to see the project team provide evidence for determining whether the ship-board pumps have adequate capacity to lift water to the main deck. The Panel would like to see calculations of flow rates and pressure losses that stem from running centrifugal pumps in parallel and the practical factors that govern ballasting rates. The Panel also would like to see an explanation of shoreside control of ballasting rates along with additional details on how the ballasting process affects the trim, heel, and draft of the ships.
4. **Hoses**: The Panel would like to see some additional analysis of the relevant options for hoses that can be used for conveying water from the vessels. It is important to point out the challenges and safety precautions that are related to handling hoses and mooring lines. Methods for ensuring compatibility between the sizes of flanges and hoses should also be included.
5. **Datasets**: The Panel appreciates the value of using retrospective datasets, however, stresses the importance of considering how future changes in shipping and port operations may invalidate the conclusions and recommendations. The Panel suggests that the project team add a section that itemizes the implications of plausible future scenarios that are relevant to decision-makers. A sensitivity analysis may provide a useful framework to identify key issues. In addition, the Panel recommends that the project team consider ways to accommodate the future traffic and demands that may be associated with growth in shipping (locally, nationally, and internationally).
6. **Cost estimates**: The Panel noted that the project team grouped vessels by type to estimate vessel retrofit costs. Given that there can be considerable heterogeneity within each vessel type, the Panel suggests that the use of unitary retrofit costs by vessel type may be misleading. The Panel would like to see the range of retrofit costs by vessel type in addition to the unitary retrofit cost by type (currently provided), with clear explanations for why the unitary retrofit estimate falls where it does within each range. The Panel also recommends that the project team consider how the logistics of vessel modifications affect the cost estimates. For example, costs will likely differ if the work is conducted in Asian, US, or European shipyards. In addition, the out-of-service time needs to be considered in the cost estimate as it is likely that the retrofits will not coincide with "normal" yard outages. The Panel would also like to see a discussion of emerging trends in vessel configurations by type, and how vessel designs might affect retrofit costs.

Task 3: Retrofitting of Ports and Wharfs

The focus of Task 3 is the modifications to ports and wharves that would be necessary for receiving ballast water from ships at each of the case study sites. The report considers the vessel hydraulics, berthing arrangements, and the feasibility of shore-based facilities. In addition, this task considered the use of intermediate mobile vessel transfers (ship to barge) of ballast.

The Panel found the Task 3 deliverables to be well-crafted. The Panel concurs with the project team about the complexity and variability of shore-based operations and the challenges of land-side connections, particularly in situations where cargo-handling equipment is competing for limited space. The Panel appreciates the practical approach that was evident throughout the report and the sensitivity towards the need to accommodate simultaneous operations. The Panel observed many of these complications and challenges during the Long Beach port site visit. Specific suggestions and recommendations for Task 3 include:

1. **Ship-to-barge conveyance.** After the site visit to the port and evaluation of suitable shore-based offloading, the Panel believes that more consideration should be placed in the evaluation of ship to barge conveyances. Specific analysis of how traffic patterns associated with this option may affect the operation and hierarchy of berthing areas would be useful, particularly in circumstances where there is inadequate space to accommodate additional vessel activity. The Panel also suggests that it could be prudent to consider new and emerging developments in conveyance structures and port design.
2. **Logistical considerations.** The Panel appreciates the complexities and uncertainties associated with retrofitting ports and wharfs. As ports plan for future developments, it would be important to develop a framework for accommodating these changes. For example, physical and economic analyses should incorporate the fact that existing structures may not be static.
3. **Inputs for regulatory permitting and review.** The Panel would like to see additional discussion of regulatory permitting and review. Cost considerations for this component should also be itemized.

2.2 Task 4: Shore-Based Ballast Water Treatment and Storage

Task 4 addresses the feasibility of shore-based facilities for storage and treatment of ballast water. The report provides an analysis of the potential volumes of ballast water that would need to be accommodated and applies basic concepts of stormwater management systems to simulate the required capacity and operational considerations. The report also considers the feasibility of using existing wastewater treatment facilities to handle the ballast water flows.

The Panel found the approach for Task 4 to be practical in terms of using the stormwater analogy to address the intermittent and widely varying flows that can be associated with ballast water. However, the Panel noted some discrepancies with respect to stormwater handling that were not highlighted in the report. The Panel also concurs that, under most circumstances, the use of existing wastewater treatment facilities is impractical and could lead to operational problems, particularly due to the salt loadings that can be associated with ballast water. The Panel also appreciated the analysis of the amount of land that would be needed to house the treatment facilities and the challenges of siting these facilities near a terminal, due to the prime value of real estate in many waterfront areas. The Panel's suggestions and comments on Task 4 relate to cost estimates, permitting, recycling and reuse, and lift stations.

1. **Cost estimates**: The Panel wondered whether the cost estimates in the report considered environmental and seismic requirements. In addition, the Panel suggested that the project team consider ways to account for the lost opportunity costs that might be associated with the construction activities. The Panel questioned the use of a twenty-year design life and suggested that perhaps a forty or fifty-year design life would be more appropriate. The Panel would like to see clear justifications for the assumptions used in the analysis including the design life assumption.
2. **Permitting**: The Panel concurs with the project team on the importance of permitting and emphasized the need for early engagement with the different regulatory groups and stakeholders.
3. **Recycling and reuse**: The Panel encourages the project team to consider the feasibility of recycling or reusing the treated ballast water. This analysis should explore conditions under which additional storage and conveyance structures might be needed and potential revenues or cost-savings that might be associated with the product water.
4. **Lift stations:** Details and description of lift station(s) are needed along with details of the cost estimate and an explanation of how they work in conjunction with the ship, the ship's pumps and the ship's crew.

2.3 Task 5: Assessment of Treatment Technologies

Task 5 is somewhat of a stand-alone report that evaluates the feasibility of using existing treatment technologies to process ballast water. The project team conducted a systematic review of existing physical and chemical technologies that are widely used for water treatment. Treatment efficacy was evaluated using published data on microbial removal efficiency (in terms of reported log-reductions). The option of blending ballast water with treated wastewater was also considered. The report also presents published numerical standards from the US Coast Guard (Phase 1) and California (Interim and Final). Cost estimates were developed based on required capacities.

The Panel voiced a number of questions related to Task 5:

1. **Definitions:** While the Panel appreciates the nuances of interpreting regulatory standards and guidelines, it would be helpful if the team provides a working definition of non-detect and the sample volumes that would be needed to ensure compliance.
2. **Literature survey**: The Panel was concerned that the literature review of desalination technology may be biased as it appears to rely on a small group of publications.
3. **Pathogen control:** The Panel would like to see more attention given to virus removal as ballast water may represent an important pathway for virus transmission.
4. **Chemical contaminants:** While the Panel acknowledges that current and proposed standards focus on controlling multiple forms of biota including zooplankton and microorganisms, the project team is encouraged to look at other potential contaminants that might be associated with ballast water. The Panel recommends that the potential for formation of disinfection byproducts (DBPs) should also be considered in the analysis, particularly since the use of chemical disinfectants is proposed.
5. **Monitoring:** The Panel encourages the team to recommend a monitoring strategy to verify the performance of the treatment units.

6. **Details on technology selection:** The Panel recommends that the project team consider using the "multiple barrier" treatment approach that has been widely adopted for drinking water facilities to avoid over-reliance on a single technology. The Panel would like to see more details on the proposed filtration systems, particularly the methods for ensuring that biota associated with backwash water and residuals are inactivated prior to discharge.
7. **Coagulation chemistry:** The Panel would like to see more detail on the coagulant selection, particularly under varying levels of dissolved salts and alkalinity. The team could draw on "lessons learned" from coagulation chemistry applications in desalination.
8. **Reuse versus discharge**: The Panel encourages the team to consider different end-uses of the treated ballast water. Incorporating reuse might require additional storage or conveyance structures that need to be considered in the analysis.
9. **Permitting**: The Panel encourages the team to map out the pathway for permitting treatment facilities to ensure that key issues are identified early in the decision-making process. Involving decision-makers at the pre-design phase may be instrumental in meeting the projected regulatory deadlines.

3 Public Comments

The panel reviewed and considered the public oral comments, and the two written documents. The Panel recommends that the project team consider the insights offered by the user groups, particularly the factors that are relevant to economic and infrastructural aspects of ballast water management. The comments highlighted the value of using actual scenarios to evaluate the scale-up needs for retrofitting all vessels of all types at all ports that will be necessary to meet all compliance requirements. The Panel agrees with the need to consider scenarios that incorporate future growth, potential changes in shipping, and regulatory changes. The Panel also agrees with the importance of incorporating redundancy, personnel, physical space constraints, and back-up capacity in the analysis of the retrofit and upgrade options.

4 Conclusions and Recommendations

The Panel commends the project team for the work that has been completed to date. The Panel looks forward to clarification of the issues that were raised relative to each task report and follow-up on specific comments related to:

- Economic analysis
- Hydraulic systems
- Scale-up
- Future-casting
- Regulatory landscape