Buzzards Bay Project
National Estuary Program

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April 16, 2004

Captain Landry:

The Buzzards Bay Project National Estuary Program has received the Bouchard Transportation Company's March 2004 response to our report dated February 3, 2004 and titled "An interim analysis of the June 14, 2003 report by Independent Maritime Consulting Ltd. on the volume of oil spilled by the Bouchard Transportation Company tank barge Bouchard No. 120 in Buzzards Bay." Our report was essentially an evaluation of the David Hall report "Investigation and reconciliation of cargo quantities for *Bouchard No. 120* oil spill at Buzzards Bay, April 2003," dated June 14, 2003, and ullage reports prepared by inspectors for the firm Caleb Brett. The Caleb Brett inspector reports from the *Bouchard No. 120* in Buzzards Bay were the basis of the estimated 98,000 gallons spilled as reported in May 2003. In his June 2003 report, Mr. Hall discounted the Caleb Brett inspector ullage reports as accurately quantifying oil remaining on board the *Bouchard No. 120,* or remaining on the lightering vessel *Bouchard No. 10*. Instead, his estimate of the volume of oil spilled focused on the volume of oil collected in the Caddell Dry Dock and Repair Company shipyards, after the *Bouchard No. 120* and the *Bouchard No. 10* were hot water washed and cleaned.

In February 2004, the Buzzards Bay Project undertook the review of oil spilled because we wanted to better understand the cleanup costs and environmental impacts associated with a specific volume of No. 6 fuel oil. We provided our analysis to various parties, including the Trustees of the Bouchard No. 120 Natural Resource Damage Assessment, and other interested parties involved with the spill.

The Bouchard Transportation Company's response to our February 2004 interim analysis consisted of a cover letter from the company, a 15-page rebuttal by Mr. Hall, and a two-page comment letter by the firm Minton, Treharne & Davies (USA), Inc. Mr. Hall's rebuttal answered some questions in our February report, but ignored some key issues. His March 2004 report also provides new calculations suggesting how potential clingage of oil to the tanks might have amounted to 2,000 barrels, or 84,000 gallons. Mr. Hall suggests that this clingage helps explains the unexpectedly large volume of oil not accounted for by the Caleb Brett inspectors in Buzzards Bay where 98,000 gallons appeared spilled, or at the Mirant station, where 168,500 gallons were unaccounted for.

The Buzzards Bay Project is sponsored by the U.S. Environmental Protection Agency and the Massachusetts Executive Office of Environmental Affairs through the Coastal Zone Management Office.

In the Minton, Treharne & Davies comment letter, the author (Denis McGrath) noted that in the "context of a 4,000,000 gallon bulk oil movement, the percentage differences [of oil volumes measured] fall within accepted margins of error for marine custody transfers." The author concluded, "Based on our evaluation of the available evidence, data and information, as well as our review of the interpretations offered in the various papers put forward, we would be of the opinion to concur with the conclusions offered by D. Hall."

Mr. Hall correctly concluded that the key concern identified in our February 2004 analysis was that the volume of oil collected at the shipyard appeared unrealistically high. However, rather than providing answers to all the specific questions raised, Mr. Hall instead provided an unscientific discussion of bell curves[1], and a hypothetical, albeit useful, estimate of potential clingage and other unaccounted oil. Most importantly, Mr. Hall failed to address concerns raised about the adjustments made to the volume of oil collected based on single sample tests for the "water and sediment" content of the oil.

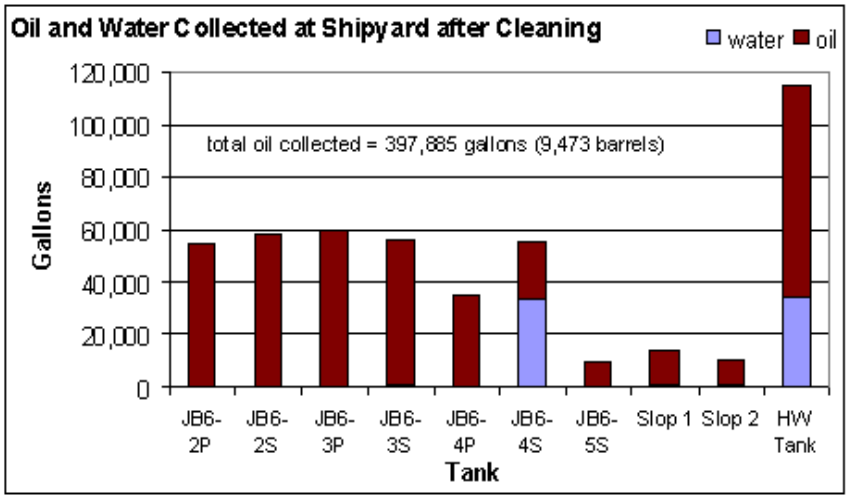
The greatest problem with the shipyard data was that the volume of oil collected in the shipyard from the *Bouchard No. 120* and *Bouchard No. 10*, plus the volume of oil received by Mirant exceeded the total volume of oil aboard the *Bouchard No. 120* before the accident, an impossibility implying no oil was spilled in Buzzards Bay. These shipyard oil volumes do not even include some oil that was burned to heat water and some oil that was shipped out of the shipyard because it was clogging pumps.

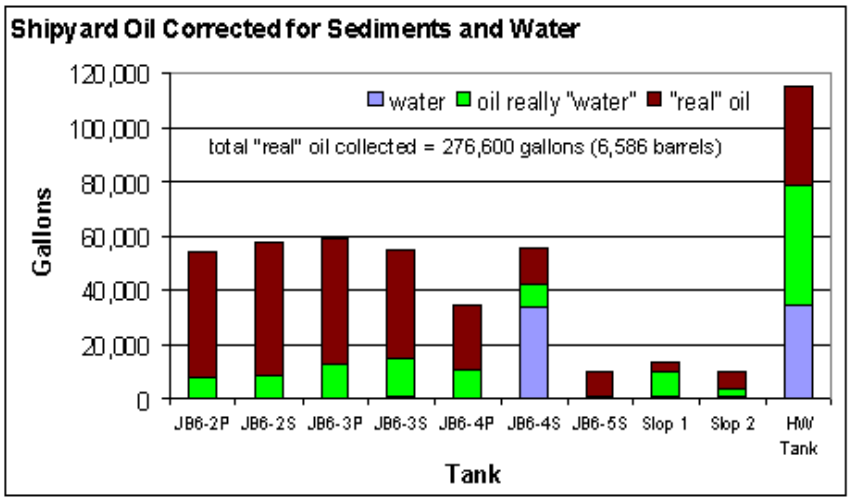
Mr. Hall was able to resolve this problem of too much oil, by adjusting the oil volumes in each of the ten tanks by measuring the "water and sediment" content of the oil layer (Appendix P, Method D1796). The "water and sediment" content of the oil layer was highly variable and ranged from 14% to 70%. However, in one tank (JB5S) a different assay was used to measure water only (Method D95) in the oil layer. This tank was found to have only 6.5% water. The highly variable results and two different methods used seem inexplicable. Mr. Hall notes, "the samples taken of the oil were what are termed 'running samples.' This technique of sampling makes the best effort to sample the entire column of oil." Mr. Hall needs to precisely describe the sampling device and protocols on the collection of these samples to demonstrate they are representative of the entire oil column. These adjustments were the basis of the calculations concluding that 22,000 to 55,000 gallons of oil were spilled in Buzzards Bay. Mr. Hall's findings are summarized in the two figures on the next page. The top chart is the volume of oil actually documented in the tanks by the Caleb Brett inspectors; the bottom graph shows the adjustments for the sediment and water analyses.

This approach is problematic for a number of reasons. First, the volume corrections made were based on a single oil sample in each tank. The problem to be answered is analogous to shaking a

[1] Mr. Hall's discussion of bell curves is flawed on numerous levels, as illustrated by this statement in support of his 55,000 gallon estimate: "the amount of the spill might be plotted on the X axis from zero on the left, to a number at point X on the right, of more than 100,000 gallons. The midpoint between 0 and X corresponds to an estimate of 55,000 bbls." Besides the fact that no statistical uncertainty can be ascribed to the measurements with the data provided, zero gallons spilled represents no one's estimate, and as noted below, the volume spilled could exceed 100,000 gallons depending on the water content of the oil delivered to Mirant.

bottle of salad dressing then attempting to measure the water content in the oil layer. Clearly, the water content will be higher near the bottom of the oil layer, than at the top. Mr. Hall's statement that these were "running samples" is not descriptive of the depth in which the oil sample was taken or how the sampling was conducted to ensure that different levels of oil were integrated in the sampling process. Mr. Hall needs to provide a better explanation of the "running samples" technique to demonstrate that the single samples collected successfully integrated the sediment and water content of the column of oil.





Furthermore, there appears to be no basis for the calculation of sediments in the oil. The "sediments" in the oil, which are actually part of the oil cargo itself, and part of residual material at the bottom of the tanks, should not be subtracted. Method D1796, a centrifuge method that utilizes solvents, quantifies non-hydrocarbon sludge, clays, and other sediments that are suspended in the oil, and in this case, would have also measured any sediments and sludge which may have accumulated in the bottoms of the tanks of the B120 after years of service which were removed with the hot wash. Hall did not make a similar correction for water and sediments in the cargo delivered to Mirant. If just 1% of the oil delivered to Mirant were "water and sediment" by method D1796, an additional 37,000 gallons of oil would not be accounted for and could be presumed to have been spilled in Buzzards Bay.

There are other uncertainties with the shipyard data. After the *Bouchard No. 120* and the *Bouchard No. 10* delivered their oil to Mirant, they traveled to the Caddell shipyards and all remaining liquids were removed from the tanks, pumps, and lines, including any non-hydrocarbon sediments at the bottom of the tanks. The contents of both vessels were combined, together with hot water washes used to clean the vessels. These liquids, removed from the *Bouchard No. 120* and *Bouchard No. 10*, were contained in three shore tanks, and a third vessel, the *Jay Bee VI*. No information was provided as to the residual oil content of the shore tanks of the *Jay Bee VI* before they received the contents of the *Bouchard No. 120* and *Bouchard No. 10*.

Without addressing the issue of the sediment and water assay, Mr. Hall suggests that the Caleb Brett inspectors could have overlooked 84,000 gallons of residual oil in clingage and other residuals based on his hypothetical estimates of clingage. Hall undertook this exercise, in part to explain the fact that after the *Bouchard No. 120* and *Bouchard No. 10* delivered their oil at the Mirant facility, it appeared that roughly 168,500 gallons (4,011 barrels) of initial oil volume was missing. This was much higher than the estimated 98,000 gallons spilled based on inspector measurements made while the *Bouchard No. 120* was anchored in Buzzards Bay the day after the accident. The apparently missing 168,000 gallons however was not all spilled; some amount was transferred to two tanks of slop oil water mixtures on the *Bouchard No. 10*, and some small amount existed as clingage on the walls of the tanks on the *Bouchard No. 120* and *Bouchard No. 10*.

Hall presents his estimate of 84,000 gallons of clingage to support his 55,000-gallon estimate of oil spilled, but this estimate seems to lack adequate justification. While Mr. Hall provides an elegant and seemingly reasonable estimate of the surface area of the *Bouchard No. 120* tanks and structural supports, he then suggests that an average of one half inch of oil clung to the sides of all the tanks, for an estimated 23,604 gallons of oil clingage (562 barrels). He views this estimate as too low, and with little rationale suggests that the likely volume was actually around 2,000 barrels, or roughly 84,000 gallons. That is, even if 1/2 inch of oil clung to the side surfaces of all the tanks, another 60,396 gallons (1,438 barrels) was still trapped in various areas not documented by the Caleb Brett inspectors, who measured only oil on the bottom of the tanks with their oil remaining on board estimates.

What is the basis of the half-inch layer? Mr. Hall shows a picture from a study of Gambian crude oil stuck to a refrigerated pipe to a thickness of 1/2 inch. In the study, the refrigerated pipe was cooled down to different temperatures, in this case down to 0º F. The Gambian crude was an example of the greatest amount of clingage in the report. The temperature of Buzzards Bay at the time of the accident was 44º F. The picture below shows the actual clingage of the No. 6 oil washing ashore, at ambient seawater temperature, two days after the accident. As shown by the picture, actual clingage was on the order of a few millimeters. This picture contradicts Mr. Halls' statement that this fuel oil "happens to have the consistency of Jell-O when its temperature falls below 95 degrees F." Even the 1984 report Mr. Hall included as an appendix to his recent report shows the clingage drops to negligible levels when the temperature of the oil is above 70º F. As Mr. Hall noted in his report, when the *Bouchard No. 120* delivered its oil to Mirant three days after the accident, oil in eight of the ten tanks was still between 93.6º F and 122.8º F. In fact, 7 of the 10 tanks were above 100º F. The two cooled tanks with seawater had temperatures of 50º F and 99º F, respectively. The warm temperatures of the oil, even if exposed to a single hull with water on the other side at 44º F would not seem to support Mr. Hall's assertion that a half-inch layer of oil would have existed in all the tanks, particularly in light of the photograph of the cold oil below.

Mr. Hall correctly asserts that the volume of oil remaining on board (ROB) would include any theoretical clingage in the bottom of the tank, and he subtracts the bottom of the tanks from his clingage calculations. However, he notes that the longitudinal support structures and transverse beams could have resulted in misestimates of the amount of oil remaining on board by the Caleb

Brett inspectors because there could be different depths of oil in the various sections. Mr. Hall does not identify the actual height of the longitudinal support features on the bottom of the oil compartments in the *Bouchard No. 120*, and the picture shown may in fact be from another vessel. In any case, from the ullage report in Appendix I of Hall's June 2003 report, it can be calculated that the depth of oil ROB ranges between 6 inches and 20 inches, with 5 out of 9 tanks above 10 inches of oil remaining. It is hard to judge from the photographs, but some of the features highlighted as traps for oil would be included in the measurement by the Caleb Brett inspectors of oil remaining on board in the bottom of the tanks.

Actual clingage of cold *Bouchard No. 120* oil that washed ashore 2 days after the spill. By this time, the oil had likely lost some of its most volatile constituents and was at ambient water temperature (around 44º F).

Of course, even with a half an inch of clingage on the *Bouchard No. 120* and *Bouchard No. 10*, Mr. Hall accounted for only 20,304 gallons (562 barrels). Mr. Hall goes on to assert that he believed this half inch of oil on all surfaces was too conservative, and that there must have been more clingage of oil on the vessel. He states: "I feel certain that there were far larger amounts of clingage than amounted to a uniform ½ inch. The amount of oil clinging to internal structures could have been greater, by a factor of 3 to 5 times, than the amount outlined in the clingage calculations above."

Mr. Hall does not directly suggest a 2.5-inch thick layer of Jell-O-like oil coating all surfaces of the tanks, but suggests other mechanisms for trapped oil, some of which appear to contradict the fact that "clingage" in the bottom of tanks would have been included in the Caleb Brett inspectors of oil remaining in the tanks after delivery. Hall abandons the half-inch clingage calculation, and concludes that the actual clingage of oil must have been closer to 2,000 barrels (84,000 gallons). He states, "I believe it is entirely probable that the immeasurable amount of ROB, on the B 120 and B 10 as clingage and oil that was prevented from draining to the pumps, due to it being unheated, and the fact that the barges were afloat in cold seawater, was probably more than 2,000 bbls." This volume is 2.1% of the total cargo on the *Bouchard No. 120*.

What is the justification for this volume? Mr. Hall first cites a report that he includes as an appendix, about the 1974 *Metula* tanker accident. The *Metula* was a 1,067[2] foot long Very Large Crude Carrier (VLCC) that was transporting more than 194,000 tons (roughly 60 million gallons) of crude oil, about 15 times the capacity of the *Bouchard No. 120*. The vessel had grounded in

[2] Harm, Roy W., VLCC "METULA" OIL SPILL, Report No. CG-D-54-75, Task No. 4111.15.1, December 1974, FINAL REPORT, Document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

the Straights of Magellan off Chile during the southern hemisphere winter, and was stranded two months before the vessel was freed. The unheated oil was lightered to other tankers, and after the two-month period, it was estimated "about 2,000 tons remained in the ship, mostly in clingage." This example does not seem meaningful given the accident circumstances in Buzzards Bay, but in any case, the total remaining on board the *Metula* was estimated at 1% of the cargo, *mostly* in clingage.

Mr. Hall then cites an example of a vessel on which he was involved in which the heating system had failed, so that the oil had become too viscous, and the last foot of oil in the tanks could not be pumped off the vessel. Mr. Hall had to have the remaining oil hot washed out of the tanks because he had to pick up a delivery of jet fuel. Mr. Hall concludes, "my recollection is that cargo owners claimed for the loss of some 500 tons with respect to a 30,000 ton cargo or 1.7% of the amount of the cargo." This measurable oil remaining on board at the bottom of the tanks hardly seems like an example of unmeasured clingage.

In the end, many factors detract from Mr. Hall's proposed conceptual clingage volume including the fact that 7 of 10 tanks were heated above 100º F, that the oil was fairly viscous even when cooled to Buzzards Bay temperatures, and the fact that oil on the bottom of the tanks and among the bottom lateral supports was already included in the Caleb Brett inspector estimates of oil remaining on board. Mr. Hall does note that oil levels could have varied in the sub-compartments in the bottom of the tanks, but he should give the height of the laterals to demonstrate they were higher than the actual depths of oil remaining on each of the tanks on the *Bouchard No. 120*.

Just as there are conceptual problems with the hypothetical clingage estimates proposed by Mr. Hall, there are conceptual problems also between comparing hot wash oil volumes to ullage reports. A fundamental question is whether the starting volume, which was based on ullage measurements by inspectors from Caleb Brett, can be compared to a final volume, which includes all oil derived from a hot washing of all internal areas of the vessel. The Caleb Brett inspector estimates were based on oil levels of the vessel leaving Eagle Point. Undoubtedly there was some clingage and other trapped oil that was not measured. For example, the tanks on departure were actually 3/4 full. There was additional oil clingage on the top 1/4 sides of the tanks, as well as in lines, pumps, and other interstices that were not included in the starting volume in Hall's calculations. If there was no accident, and the vessel was hot washed after its delivery to Mirant, would the volume of oil at Mirant and the hot wash oil volumes equal the estimated oil volume based on the ullage report at Eagle Point? How much additional oil would have been found after hot washing as compared to the remaining on board (ROB) measurements? It seems possible that hot water washing would capture some oil volumes not included in the ullage estimates.

On the matter of the speed of the vessel, Mr. Hall is correct that the *average* speed of the vessel between the accident site and Buoy BB, its first stop, was 5.1 knots. However, the point of my comment about the vessel's speed was that it was likely traveling at 10 knots at the time of the accident. At a public meeting, a coast official stated that the vessel operator (now known to be the First Mate) was unaware that he had struck bottom and was continuing at operating speed into Buzzards Bay before receiving calls that the vessel was leaking oil. Obviously, the vessel gradually decelerated and came to rest at buoy BB before the operator called in coordinates to

the Coast Guard at 5:30 PM. Even if the vessel traveled only one half hour (5 miles) at 10 knots, the laminar and turbulent forces across a 10-foot by 2-foot hole would be considerable.

Mr. Hall suggests that "If the oil contains a lot of paraffin wax it may have properties that cause it to be almost self sealing when contacted by cold sea water," and "if the cargo is highly viscous at low temperatures then it may also have self sealing properties when in contact with cold sea water." Clearly, the conspicuous volumes of oil washed ashore in Buzzards Bay contradict this statement, and the comment does not seem applicable to the actual fluid characteristics of the oil in the first few days of the spill while floating in 44º F Buzzards Bay waters.

Mr. Hall notes that list and trim of the damaged *Bouchard No. 120* were not accounted for. Because Caleb Brett recorded the list and trim, anyone with the ullage report software, including Mr. Hall could provide the corrected measurements. Even so, as Mr. Hall notes, the repeatability of the Caleb Brett estimate may only be 0.3 %. This was the difference in volume on the *Bouchard No. 120* when it was half full after its acquisition of oil at the Amerada Hess oil facility on April 23, and its arrival at the Eagle Point facility the same day (Appendix D vs. Appendix E of his June 2003 report.)

While admittedly there is a small percent of uncertainty in the Caleb Brett inspector reports, the uncertainty associated with the Caddell shipyard appears greater. Unlike the direct measurements of oil and water levels in the tanks by the Caleb Brett inspectors, Mr. Hall had to adjust all his oil volumes recorded based on a single sample for analysis of "sediment and water" contained in the oil of each tank. Having had to review and interpret laboratory data, and develope quality assurance and quality control plan for sample analysis for more than 25 years, I recognize that multiplying large volumes of oil by even small correction factors as Mr. Hall has done, can skew the results depending on what correction factors are used, and their reliability. This is particularly true in light of the tremendous, unexplained, variability of "sediment and water" content of the oil layer found in nine tanks at Caddell, which in turn were considerably higher than the one sample measured for water only. Furthermore, the failure to conduct similar sediment and water content measurements of the Mirant oil delivery make interpretation of Hall's data exceedingly difficult.

In the end, Mr. Hall and I will choose to disagree on various points. However, for our review to be complete of his June 2003 report, we still require some of the specific information requested in our February 2004 interim report that were left unanswered. This specific information requested from Mr. Hall is as follows:

1) On May 23, the Caddell shipyard noted they had 3,515 barrels of oil from the B10, based on levels gauged on the *Jay Bee VI*, which received the contents of the B10. Only the May 28 ullage report of the *Jay Bee VI* was provided. We are requesting the earlier ullage report on which the May 23 Caddell shipyard letter is based.

2) At the Caddell shipyard, did the shore tanks or the *Jay Bee VI* contain any waste oil or oil and water mixture before they received oil from the *Bouchard No. 10* and *Bouchard No. 120*? A statement or ullage reports should be provided from Caddell as to their status before the cleaning of the Bouchard tankers.

3) The "*Jey Bee IV*" is referenced in two documents with estimated oil volumes (see Appendix P1). Was the J*ey Bee IV* another vessel handling oil at Caddell, or was this a typographical error? If this is an actual vessel, do ullage reports exist for this vessel? Also, the terms SMP and SI in this ullage report should be explained.

4) Mr. Hall indicated that Caddell shipped out some oil and water because it was clogging their equipment, and Caddell burned some of the oil for heating the water used in washes. These volumes were not accounted for in the calculations, and estimates of these losses must be provided. Because oil-water mixtures are typically treated as hazardous waste, adequate documentation should exist of this oil transported off the Caddell site.

5) Mr. Hall assumes the water fractions of the Caleb Brett ullage reports actually contain appreciable amounts of oil, or that the vessels contained clingage of oil, but the water fraction in the Caddell shore tanks and *Jay Bee VI* tanks are presumed to contain only water, and no clingage was calculated for the *Jay Bee VI*. These estimates of oil should not be omitted.

6) Mr. Hall reported a single value of "sediment and water" content of the oil in each of the ten tanks or vessel compartments sampled at the Caddell. In his March 2004 report, Mr. Hall describes these as "running samples" which "sample the entire column of oil." Mr. Hall needs to precisely describe the sampling device and protocols on the collection of these samples to demonstrate that the samples integrated the entire oil column. Also, one sample was measured for water only, and the rest for sediment and water. Why is this the case? If the other samples were also measured for water only, please provide this data.

7) In his first report, Mr. Hall notes that if the oil delivered to Mirant contained water, then perhaps a greater volume of oil could have been spilled. We are requesting that Hall provide the water and sediment assay results of the *Bouchard No. 120* delivery to Mirant and any other sediment or water estimates made of the oil delivery by Mirant. If Hall does not provide this data, we request that the United States Coast Guard request this information from Mirant directly. This assay is usually routinely performed with deliveries, even when there is no accidental water contamination as occurred in this accident.

8) In Mr. Hall's March 18 correspondence he states "Clingage of cargo on internal structures is one of the reasons for calculating the VEF (Vessel Experience Factor) as outlined in my previous report." However, the calculations provided in Mr. Hall's June 2003 (method 3) reduced the volume of oil leaving Eagle Point by a VEF of 1.0047 (a reduction of 0.47% or roughly 18,850 gallons). The Caddell shipyard hot washed the tanks of the *Bouchard No. 120* and *Bouchard No. 10*. The residual oil stuck to the sides of the tanks collected and included in the calculations would seem to be already included in the Vessel Experience Factor used. Furthermore, before the accident, the tanks aboard the *Bouchard No. 120* were only 3/4 full. Was there clingage in the top 1/4 sides of all the tanks that may not have been accounted for in the last ullage report before the accident? If there was no accident, and the *Bouchard No. 120* was hot washed at Caddell, would the volume of oil collected in a hot wash plus the delivered oil equal the volume leaving Eagle Point? Mr. Hall should address this potential double counting of clingage or even omissions of clingage not included in the ullage report volume before the accident.

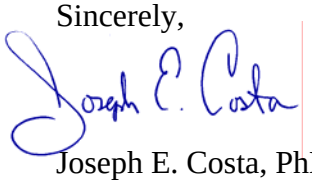
9) Mr. Hall continues to note that "Measurements of the cargo in Buzzard's Bay were made when the B 120 was not on an even keel," which led to inaccuracies in the estimated volume. The trim and list were provided on the Caleb Brett inspector's ullage reports. Ullage software and spreadsheets can correct for these trim and list factors, and Mr. Hall should provide an adjusted volume based on the information provided.

10) The ullage reports in Hall's first report are very difficult to read as they are copies of faxes and the first column of tank names is cut off. We request clean copies of these ullage reports, particularly Appendixes C, D, E, F, G, H, I, J, K, K2, and K3.

In the end, the Coast Guard and others reviewing the data associated with this spill, will have to consider both the Caleb Brett Intertek inspector reports from Buzzards Bay and at Mirant, and the reported oil volume collected in the shipyards after the tankers were hot washed and their contents transferred to ten tanks on shore, and in a third tank barge. The Caleb Brett ullage reports are the industry standard for quantifying oil on vessels, and these ullage reports are based on the depths of oil and water in each tank. Mr. Hall's calculations and approach of measuring oil collected in the Caddell shipyard could be useful if the data and information described above were collected and provided. The single greatest confounding factor was the fact that sediment and water correction factors (and not just water) were based on single samples that were highly variable, and not demonstrated to average water and sediment content of the oil layer in each tank. Furthermore, no similar data was provided for the oil delivered to Mirant to adjust the actual volume delivered. This approach adds uncertainty because small errors multiplied by large volumes can exceed the volume of oil spilled. These confounding factors, plus the questionable comparability of oil volumes between ullage reports and hot wash oil volumes, together with multiple transfers of oil and water in 10 additional tanks at the shipyards add more uncertainty to Hall's conclusions.

Finally, to put Mr. Hall's adjustments for sediment and water into perspective, I will recommend that the NRDA Trustees repeat assays "water and sediments" (Method D1796) and water content (Method D95) on oil samples collected from various tanks on the *Bouchard No. 120* after the accident. This data, together with any water content assays determinations conducted by the Mirant electrical generating facility will help refine some of the uncertainty in Mr. Hall's analysis

Sincerely,



Joseph E. Costa, PhD
Executive Director

cc. NRDA Trustees, Richard Packard (Massachusetts DEP), Aquatic Injury Technical Work Group, David Hall (Independent Marine Consultants, Ltd.), Lt. Shade, USCG Marine Safety Center, Washington DC