



Diversified Building
Solutions, LLC.

June 26, 2014

Maryland Department of the Environment
Oil Control Program
1800 Washington Blvd., Suite 620
Baltimore, MD 21230

Attn: Mr. Chris Ralston, Administrator

Re: Groundwater Remediation
2013/2014 Action Plan Modifications
Case No. 1987-2534-KE
Chester River Hospital Center
100 Brown Street, Chestertown
Kent County, Maryland
Facility ID No. 3168
Project No: 14004.00

Dear Mr. Ralston:

This is in reference to the Chester River Hospital Center (CRHC) 2013 Action Plan which was reviewed and conceptually approved by the Maryland Department of the Environment (MDE) in a letter response dated October 17, 2013 included as Appendix 1. The substance of the MDE response letter focused on a proposed new method for cleaning residual petroleum products that are in a "Smear Zone" in the original area of the spill in the Brown Street area using a patented push-pull surfactant application process. This patented process owned by Ivey International, Inc. uses a combination of over the counter soaps (surfactants) which are better known commercially as Ivey-sol®. By this letter we are requesting your approval of a pilot study of push-pull application of Ivey-sol®. The details of the proposed pilot study are indicated herein.

The October 17, 2013 MDE response letter also recognized the importance of limiting the application of Ivey-sol® to a pilot scale test application that would be limited to areas within the hydraulic control of the pump and treat system which would be limited to areas north of Brown Street. The CRHC design team recommended that the pump and treat/hydraulic control system be shut down just prior to the application of Ivey-sol®. This would encourage a groundwater table rise which would assist in the distribution of surfactant. MDE was concerned that the push-pull process be performed over a short period of time in an expeditious manner so that the hydraulic control system could be quickly reactivated immediately after completion of a pilot scale study. Although we agree that turning the system off for a short period while we do the pilot study and then turning it back on would provide protections from the release of materials down gradient, as noted below, we also believe that leaving the hydraulic controls in place during the Ivey-sol® application would provide an alternative approach worth further consideration.

Although any recovered residuals from the push-pull Ivey-sol® application will be extracted and collected in tanks/drums and disposed of offsite, the CRHC and MDE agree that the Ivey-sol® product and mixture of Ivey-sol® product and any liberated hydrocarbons would not cause adverse effects to the treatment train of the existing pump and treat systems. In relationship to the Ivey-sol® chemical makeup, on October 22, 2013 following receipt of the October 17, 2013 MDE response letter, the CRHC submitted a request to MDE to approve the use of Ivey-sol® through the Underground Injection Control (UIC) Program. Substantive information regarding the patented process was provided directly to MDE by Ivey International, Inc. An extensive scientific and technical review was performed by the UIC Program in cooperation with MDE's Oil Control Program and Water Supply Program. It was concluded by

the MDE team that the injection of Ivey-sol® would not pose a risk to the Town's active water supply wells.

In a more recent letter dated March 25, 2014 addressed to Mr. Forlini (Town's Legal Counsel) included in Appendix 2, MDE provided a list of factors that contributed to this conclusion. On October 24, 2013 Mr. Mike Eisner from MDE's UIC Program issued the UIC approval authorization which allows Ivey International to use Ivey-sol® for the purposes and under the conditions outlined in the 2013 Action Plan as conditionally approved by MDE on October 17, 2013 and subsequently reconfirmed in MDE's letter of March 25, 2014.

It is also noted that Mr. Bob Sipes, Utility Manager from the Town of Chestertown, obtained specific Ivey-sol® information from the US Patent Office and at public meetings with the Mayor and Council and another technical meeting attended by MDE, CRHC, and the Town in April, 2014 publically agreed that he had no objections to the use of the specific chemical makeup of Ivey-sol®. In these same regards, through direct conversations between Mr. George (Bud) Ivey, Mr. Mark Eisner (Town's Hydrogeologic Consultant), and Mr. Bob Sipes, Bud clarified that Ivey-sol® is one hundred percent (100%) biodegradable.

Pilot Scale Study Area:

In the 2013 CRHC Action Plan the Ivey-sol® process and specific Ivey-sol® publications regarding the proposed push-pull process were incorporated and significant information was provided regarding the use of Ivey-sol® to remove residual petroleum products which are adhered to the soils in the area of the original spill. EBA has since provided MDE with copies of cross sections which define this "Smear Zone".

The 2013 Action Plan, defined in general terms, is the proposed push-pull process used to rinse residuals from the "Smear Zone", extract them from the groundwater, and remove the collected material offsite. Specifically proposed injection/extraction of Ivey-sol® in Monitoring Wells – 14, 15, 16, 19, 20, 22, 24, 33, 34, 35, 40, 41, 42, 47, 48, 49, 50, and in RW-3B and RW-5 for a total of nineteen (19) wells. In MDE's letter of October 17, 2013 concern was expressed regarding both the number of wells in the initial Ivey-sol® application and their locations. In their letter to MDE the Town also raised concerns and suggested that any application should be limited to wells within the hydraulic control of the existing pump and treat system. In MDE's response to the Town's inquiries, dated March 25, 2014 they limited the push-pull events and specified that they could only be conducted at six (6) well locations to include RW-6, RW-2D, MW-13, MW-10R, MW-22, and RW-5. MDE further referenced that they expected that all of these well locations were within the area of hydraulic control of the remediation system.

At the meetings with the Town on April 15th and April 21st, Mr. Bob Sipes and/or Mr. Mark Eisner raised questions as to whether or not MW-10R and MW-13 were in fact within the area of hydraulic control of the remediation system. As follow-up to address this particular concern and to be able to learn more about Ivey-sol®, the push-pull process, and other questions concerning the proposed pilot scale study, CRHC authorized Mr. Ivey to speak one-on-one with Mr. Sipes and Mr. Eisner to further address any concerns they may have in these regards. Mr. Ivey provided significant information which was further considered by the Town in their deliberations on this matter.

Additionally, following these meetings CRHC's team has further reviewed the hydrogeological data. Following the review the team is confident that MW-10R and MW-13 are within the hydraulic control of the remediation system. The team; however, has agreed to **remove** MW-10R and MW-13 as injection/extraction wells from the pilot study of the push-pull application. CRHC and its team of consultants believe this change would satisfy **all concerns** raised by the Town and its consultant in these regards. We have further modified the well locations to include MW-22, MW-40, MW-41, and MW-42. This will ensure the continuation of pump and treat operation during the push-pull application. All wells have the well screens above the high water table. We are attaching a revised map showing the proposed injection/extraction wells in Appendix 3 as well as the identification of the well screen elevations relative to the water table.

Pilot Scale Ivey-sol® Application:

In MDE's letter of March 25, 2014 an outline was provided of the steps and process to be undertaken during a week-long injection of the pilot study. CRHC has reviewed these steps in detail and agrees with the process as proposed with several important changes as noted below.

Listed below and incorporated herein as part of the modified Action Plan are the specific actions and events to take place on Days 1, 2, 3, 4, and 5.

Day 1

- A round of gauging and sampling data will be collected and recorded from select wells as indicated in Appendix 4.
- Although the CRHC technical team had a preference for turning the system off prior to initiating the pilot study, Mr. Ivey has indicated that he believes good results can still be achieved with the remediation system left on; therefore, we are now proposing to run the pilot study with the hydraulic controls remaining in place per the Town's request.
- At each well location, a mixture of the Ivey-sol® (approximately 5 gallons) and potable water will be prepared in a 275 gallon tote (a total of 1,100 gallons of Ivey-sol® mixture across the four (4) wells).
- The injection or "Push" portion of the event will involve the Ivey-sol® mixtures being gravity fed into each well (i.e. not pumped under pressure). The gravity feeding of the surfactant mixture may take upwards of one (1) hour or longer depending on the specific well hydraulics.
- The injection wells and surrounding monitoring wells will be gauged periodically during the daily activities.
- Groundwater from the injection wells will also be assessed for surface tension by an approved field testing method. Surface tension results provide a near real time indication of the presence/absence of surfactants.

Day 2

- A round of gauging data will be collected and recorded from select wells as indicated in Appendix 4.
 - Approximately twenty-four (24) hours after injection, a submersible pump will be placed into each injection well and approximately 1,100 gallons of liquids (i.e. groundwater, Ivey-sol®, and LPH) will be extracted from each well as the "Pull" portion of the event. At an average pumping rate of nine (9) gallons per minute, which is the maximum rating for a typical submersible pump, the extraction portion of the event will take upwards of three (3) hours provided that pumping is done simultaneously from all four (4) wells. The extracted liquids will be pumped into two (2) 5,000-gallon poly tanks for temporary storage. The extracted liquids will be transported offsite for proper disposal prior to the next "Pull" event.
 - Once the "Pull" event has been completed, a round of data will be collected and recorded from select wells as indicated in Appendix 4.
 - The next round of Ivey-sol® mixtures will be prepared and injected into the four (4) wells for the second "Push" event.
 - The injection wells and surrounding monitoring wells will be gauged periodically during the daily activities. Groundwater from the injection wells will also be assessed for surface tension throughout the day.
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Day 3

- A round of gauging data will be collected and recorded from select wells as indicated in Appendix 4.
- If not completed on Day 2, the liquids extracted from the Day 2 "Pull" event will commence.
- Once the "Pull" event has been completed, a round of data will be collected and recorded from select wells as indicated in Appendix 4.
- The next round of Ivey-sol® mixtures will be prepared and injected into the four (4) wells for the third and final "Push" event of the pilot test.
- The injection wells and surrounding monitoring wells will be gauged periodically during the daily activities. Groundwater from the wells will also be assessed for surface tension throughout the day.

Day 4

- A round of gauging data will be collected and recorded from select wells as indicated in Appendix 4.
- The liquids extracted from the Day 3 "Pull" event will be transported offsite.
- Approximately twenty-four (24) hours after the Day 3 injection, the third and final "Pull" event will commence.
- Once the "Pull" event has been completed, a round of gauging data will be collected and recorded from select wells as indicated on the attached table. Groundwater from the injection wells will also be assessed for surface tension throughout the day.

Day 5

- Monitoring well gauging and sampling will be completed as indicated in Appendix 4.
- The liquids extracted from the Day 4 "Pull" event will be transported offsite.

For a minimum of three (3) months following the pilot test, monitoring wells will be gauged and sampled for the presence of volatile organic compounds (VOCs) (via EPA Method 8260), total petroleum hydrocarbons (TPH-DRO and TPH-GRO) (via EPA Method 8015), and surfactants (via EPA Method SM5540D). The particular wells to be sampled and the sampling frequencies are detailed in Appendix 4.

Safeguards and Protections:

Throughout the history of the project and all of the documents associated with Case No. 1987-2534-KE, the underlying directive has been to protect and preserve the groundwater of the State in the areas of the spill through various action items directed at remediation and restoration as necessary to protect the category of use for drinking water. MDE, CRHC, and its consultants share the Town's concern that everything be done during the remediation process to ensure the protection of the Town's water supply.

Over the last six (6) months emphasis has been placed on the levels of protection required to further remediate the site. Specifically, the pump and treat system has been quite effective in controlling the groundwater gradient in the area of the spill so that levels of TPH-DRO/TPH-GRO and other petroleum residuals do not have adverse impact on Town's water supply. The samplings in the down gradient wells have demonstrated the effectiveness of the hydraulic control pump and treat system. With the free product removed, the principal threat to the Town's water supply are the residuals that are bound in the soils which continue to be in a place that could potentially impact down gradient groundwater should further action not be taken to remove these contaminants that are located in the "Smear Zone". As discussed above, the Ivey-sol® process is a proven method which offers a significant **promise** of removing these remaining risks of contamination. As indicated earlier and shown in documented results of Ivey-sol® process this "promise" is based on successful application of Ivey-sol® in removing petroleum based contaminants from "Smear Zone".

Questions that have been raised by MDE and the Town are associated with the chemical makeup of Ivey-sol®, the need to efficiently and effectively remove washed soil solutions after each application, to understand and manage groundwater travel times, and to contain residuals within an area where hydraulic controls are in place. CRHC believes that the UIC Program's review and approval process has thoroughly vetted the concerns over the chemical itself to be used as a surfactant in the process which led to the approval of its use in this application. Limiting the application of Ivey-sol® to a pilot scale study totally within the control of the hydraulic pump and treat system as defined above further minimizes any potential risk of contaminants moving downstream.

MDE's letter of March 25, 2014 gives an in depth summary of the UIC Program and Water Supply Program reviews which focused on the factors and safeguards that led MDE to the conclusion that Ivey-sol® and the associated push-pull process is safe for the application proposed at a pilot scale level. Specifically MDE and CRHC's technical team have reviewed the hydraulic controls in place, biodegradability of the material, toxicity, temperature, pH, monitoring system in place, and concluded that adequate assurances and protections are in place to support the proposed application.

Additionally, Ivey International, Inc. provided a comprehensive list of references, testimonials, and project summaries which were used in part by MDE and CRHC in recommending and approving the use of Ivey-sol®. These documents have been included in Appendix 5 for further review and use.

The Town raised a question about the benefits of adding a dye to the injection material in order to be able to use it as a tracer and be assured that the surfactants had been fully removed. We believe in this case that the use of dye will not improve the desired outcomes and assurances. MDE has required testing for the Ivey-sol® in accordance with approved EPA testing method 1 provided. The testing for the presence, absence of Ivey-sol® allows it to be the tracer. Further, the Ivey-sol® lowers the water surface tension improving the radius of diffusion and the radius of capture around the application wells. The dye used as a tracer does not affect surface tension, so it would not be a good simulation of the Ivey-sol® application. Also, by leaving the hydraulic controls in place this should provide the added assurance for recovering of Ivey-sol® that everyone is looking for.

We believe that this modified 2014 Action Plan and revised Pilot Study has optimized opportunities to provide all of the necessary assurances for implementing the Pilot Study while putting the necessary safeguards in place to protect the Town's water supply. To the extent that CRHC's technical team could accept and incorporate suggestions of Mr. Mark Eisner's letter of May 9, 2014 (Appendix 6), we have. Although we have eliminated the two (2) wells that the Town suggested and agreed to run the pump and treat system for hydraulic control, we have indicated that adding dye is not a necessary action nor do we believe that any additional wells need to be installed at this time. EBA has noted from their study of the historic data that forty (40) out of the forty-one (41) existing well screens are located at or above the high water table. If we achieve good results from the Pilot Study and develop a further plan to expand Ivey-sol® applications in other areas, we can reconsider the need for any new wells at that time.

However, CRHC and its legal counsel are proposing to provide further protections for MDE and the Town by moving forward following the interpretive results of the pilot scale study with a Consent Agreement between MDE and CRHC which will identify further actions to remediate the site and to provide the necessary protections so that these residuals cannot affect the Town's water supply. Also, in regards to the need to provide financial assurances/guarantees we would suggest to MDE that there are sufficient protections under State law and through CRHC's own financial standing in the community and through its own insurance policies to provide the level of protections that are warranted. We might add that over the past twenty (20) plus years in dealing with this remediation case, CRHC has always met its financial obligations.

Mr. Chris Ralston
June 26, 2014
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We hope that this Modified Action Plan meets with your approval and we look forward to working with MDE and the Town towards achieving desired outcomes. Also, please note that we have just been advised by Mr. Ivey that the only available time that he has in the near future to complete this pilot study July 28th – August 1st.

Sincerely,

Diversified Building Solutions, LLC



Dane S. Bauer
Vice President | Director of Special Services

Enclosures

- Appendix 1: October 17, 2013 MDE Conceptual Approval Letter*
- Appendix 2: March 25, 2014 MDE Response Letter*
- Appendix 3: Map of Proposed Injection/Extraction Wells*
- Appendix 4: MDE Chart for Gauging and Sampling Data*
- Appendix 5: Ivey International, Inc. References, Testimonials, and Project Summaries*
- Appendix 6: May 9, 2014 Advanced Land and Water, Inc. Letter*

Cc: Mr. Kenneth Kozel, President | CEO, Shore Regional Health
Mr. Mark Wasserman, Senior Vice President | External Affairs, University of Maryland Medical System
Mr. Robert Summers, PhD, Secretary, Maryland Department of the Environment
Mr. Chris Cerino, Mayor, Town of Chestertown
Mr. Michael Powell, Esq., Managing Member | COO, Gordon-Feinblatt, LLC
Mr. Michael Forlini, Esq., Member, Funk & Bolton, PA

Appendix 1
October 17, 2013 MDE Conceptual Approval Letter



MARYLAND DEPARTMENT OF THE ENVIRONMENT

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October 17, 2013

Mr. Scott Burleson
Site Executive
Shore Regional Health – Chestertown
100 Brown Street
Chestertown MD 21620

RE: GROUNDWATER REMEDIATION 2013 ACTION PLAN APPROVAL

Case No. 1987-2534-KE

Chester River Hospital Center

100 Brown Street, Chestertown

Kent County, Maryland

Facility I.D. No. 3168

Dear Mr. Burleson:

On July 22, 2013, the Chester River Hospital Center (CRHC) submitted a draft version of the referenced plan for the Maryland Department of the Environment (MDE) to review and comment on. The plan called for the injection of a surfactant solution, Ivey-sol, to assist in "dissolving" the residual adsorbed / absorbed petroleum hydrocarbons into the shallow groundwater formation. A "Push-Pull" method would be employed to assist in the distribution efforts. The "dissolved" petroleum hydrocarbons will then be available for extraction and ex situ treatment.

The Department completed an initial review of the draft plan and provided comments to CRHC on August 2, 2013 (enclosed). On August 22, 2013, an email from the CRHC's consultant was received with various attachments for the Department to review in anticipation of the upcoming technical meeting (enclosed). On August 26, 2013, the technical meeting was held at the MDE's office with representatives of the CRHC and MDE to discuss the proposed plan.

On September 13, 2012, the Department received the revised *Groundwater Remediation 2013 Action Plan*. The Department has reviewed the plan and agrees that the technology can be successful in making more petroleum hydrocarbons available for recovery and treatment. The following is a review of the initial concerns noted by the Department and how each was addressed. The Department's final comments on each concern are presented in italics. Additionally, the Department's conditional approval follows at the end of the letter.

Review of MDE's August 2, 2013 Comments and Responses

- The plan is conceptual in nature and does not detail where the injection and extraction points will be located. The treatment should be focused on the area of greatest residual source mass. This area is generally defined by the areas exhibiting the highest concentrations of total petroleum hydrocarbons – diesel range organics (TPH-DRO) and measureable free product. Treating areas that are downgradient from the source area will not provide for long term or sustained remediation.

CRHC Response: We agree with the areas to be targeted for the Ivey-sol “Push-Pull” application. The plan will include treatment of the areas exhibiting the greatest residual source mass to include:

- Wells with measurable free product
 - MW-47 (May, June, 2013)
 - RW-3b (June, 2013)
- Wells with highest concentration of TPH-DRO
 - MW-14 (410 mg/L)
 - MW-41 (410 mg/L)

MDE Response: *The plan is aggressive with proposed injection and extraction points located all over the site. Although wells with measurable free product (MW47 and RW3B) and wells with the highest concentrations (MW14 and MW41) are targeted, the proposal to utilize up to 19 existing wells and 5 new wells across the defined monitoring zone and outside of the documented capture zone could result in the liberation of liquid phase hydrocarbons (LPH) or high dissolved phase concentrations without an ability to recapture. Additionally, it is still not clear as to the depth of the targeted injections or extraction events.*

The Department has prepared the enclosed map to indicate the approximate LPH footprint at the site. The footprint was determined based upon the existing well gauging data showing where LPH have been detected. The LPH footprint will generally represent the area where residual (adsorbed and entrained) LPH are likely to be encountered and is the general area where the surfactant injection efforts should be focused. Based on the identified LPH footprint and the existing pump and treat system, the Department is approving a limited initial implementation of the surfactant and use of the pump and treat system to maintain hydraulic control. This requirement is further detailed later in the letter.

- The existing smear zone should be identified to determine the depths of residual hydrocarbons. This can be accomplished through review of previously collected boring logs (if sufficient detail exists) and previously collected soil data. The point of this exercise is to identify the general geometry of the residual mass so that the injections are targeted. By not completing this exercise and relying on “pouring” the surfactant solutions into existing wells, the solution will generally not distribute vertically to any significant degree. Using the existing recovery wells to influence the local hydraulics can assist with vertical distribution to a degree. However, it is often beneficial to install appropriately constructed injection wells to target the residual mass and better guarantee contact with the source area.

CRHC Response: We agree and EBA will review existing data with Earth Data to provide further insight regarding the existing smear zone characteristics, which will be discussed with MDE at our proposed August 26, 2013 meeting. At that time we will outline what we believe to be the smear zone and discuss further with MDE regarding the process and procedure for implementing the Ivey-sol application.

MDE Response: The presented tables and graphs do not identify the smear zone relative to well construction and screen intervals. Screen intervals are a very important factor when determining delivery mechanisms, extraction options, and calculating radius of influence. It is not readily apparent what the relationship is between the smear zone, the existing well screens, and the pumping and non-pumping water levels at the site.

- Because the technology does make additional hydrocarbons available for migration in the groundwater, demonstrating adequate hydraulic control is a critical component to the MDE approving this plan. CRHC must demonstrate this through presentation of past hydrogeologic work (e.g., presenting of past pumping tests, established cones of depression) and presentation of updated information if new recovery wells are installed.

CRHC Response: We have been in discussion with Earth Data regarding hydraulic control and will be discussing this further with you at the August 26, 2013 meeting. We understand that the soils at the site are sands and silty sands. Based upon extensive Ivey-sol experience on various sites with similar soils and utilizing 4-Inch diameter Injection Wells (IW) that the injection diffusion radius would likely be between 10 and 20 feet. We will continue to review the available information to locate injection wells optimally so as to promote and maximize the results of the Ivey-sol application

MDE Response: This comment has not been sufficiently addressed. While injection radius is an important design factor with regard to plan implementation, the more important factor is hydraulic control. As the technology is designed to mobilize otherwise immobile hydrocarbons, there must be a predictable means of recovering the mobilized hydrocarbons. The existing pump and treat system has demonstrated sufficient hydraulic control for the areas to the north of Brown Street. The proposed "Push-Pull" methods discussed are generic in presentation and simply rely on "available methods" for the "Pull" or extraction piece. While there is not sufficient detail presented to allow the Department to approve the plan as presented, the Department will approve a limited initial implementation as described below.

- The plan must include the specific wells to be used for 1) monitoring, 2) injection, and 3) extraction. Any new wells proposed to be installed for these purposes must also be identified and the installation details presented.

CRHC Response: Our Team will provide a map with proposed locations of new wells and will be prepared to discuss further at the August 26, 2013 meeting.

MDE Response: The following existing points were proposed to be used as injection and extraction points: RW3; RW5; MW14; MW15; MW16; MW19; MW20; MW22; MW24; MW33; MW34; MW35; MW40; MW41; MW42; MW47; MW48; MW49; and MW50. Five additional 4-inch diameter injection/extraction points were also proposed: MW8R; MW51; MW52; MW53; and MW54.

All injections are proposed as "Push-Pull" where there is an injection and extraction from the same point, not a "Push" of the material into one well and a "Pull" of the material through the formation for recovery at an extraction point. It is unclear as to how treatment of the formation will be distinguished from localized treatment of the injection/extraction wells.

Prior to system shut-down and surfactant injection, the following wells are proposed to be gauged and sampled: MW15; MW16, MW19, MW20; MW24; MW33; MW34; MW35; MW48; MW49; and MW50.

- It is not clear from the plan if the intention is to use the same wells for injection, extraction, and monitoring or if separate wells will be used for each function. The MDE generally does not allow for one well to serve all three purposes as this generally leads to only cleaning of the well and immediately adjacent formation.

CRHC Response: The plan includes the utilization of existing 4-Inch diameter monitoring wells as injection points followed by extraction points once the residence time of Ivey-sol has elapsed (24 hours). In our professional opinion, utilizing the existing wells would provide the maximum site coverage required. During this period we understand that these monitoring wells will not be used for prescribed monitoring of the sites performance, with the exception of the EPA approved Ivey-sol field test which is essential as a performance monitoring tool during the application operation.

MDE Response: With such a large area proposed for injection and recovery, the Department is concerned that there is not a large enough population of wells to monitor the progress of the treatments to ensure that down-gradient sensitive receptors are protected. Therefore, the Department is approving a limited use of the surfactant process as described further below.

- The plan must present and discuss measurable endpoints for the activities. This is critical to both parties agreeing to what will constitute completion of the remediation project.

CRHC Response: Our proposal is to eliminate the free product and TPH-DRO as an indication that remediation is complete and that the process for case closure can be more fully documented. We assume that year end quarterly reports will be the basis for this determination. At that time, in addition to the standard reporting requirements prescribed by MDE, our team will provide an end of process report which provides our professional opinion on the success of the Ivey-sol applications.

MDE Response: Eliminating free product and TPH-DRO in monitoring wells is the understood goal of the proposed remediation plan. As with all forms of remedial actions, the Department will require a minimum of one year post-remedial monitoring prior to determining case closure. This would begin when it has been analytically demonstrated that all surfactant has been purged from the formation.

- The MDE agrees that the existing recovery well network and the existing pump and treat system can be used to assist in the proposed remediation. However, the extent that the existing pump and treat system will be used is not clear from the proposal.

CRHC Response: So as to separate the existing pump and treat process from this added Ivey-sol application which will only last for thirty (30) days, the CRHC Team is recommending that the pump and treat process be shut down during the Ivey-sol application. The Team has fully evaluated the pros and cons of leaving the pump and treat system on and have not been able to conclude that it would in any way benefit the Ivey-sol process. To the extent that the pump and treat system may need to be turned on at a later date will depend solely on the success of the "Push-Pull" application. At this time, based on Ivey International's experience on other sites, this process typically removes any residuals and results in an end point in and of itself to the remediation process.

MDE Response: It is proposed that the pump and treat system be shut down during the Ivey-sol process. Previous post shut-down gauging confirmed that water table rebounded to non-pumping equilibrium within three days of cessation of pumping. This would provide for a high water table and possible delivery of treatment above the smear zone and not where it will be most effective. If the system is shut down prior to delivery of surfactant, it is highly encouraged that the injection event be completed in an expeditious manner so that the groundwater table rise can assist in the distribution of the surfactant.

Vacuum trucks will not be reliably effective at this site due to the water table depths; therefore, a series of submersible pumps will likely be required for the "Pull" operations. The Department strongly suggests that the CRHC consider using the existing pump and treat system to function as the "Pull" force. At a minimum, the pump and treat system must be fully operational and able to be immediately turned on at short notice.

- A discussion of any potential complications of the Ivey-sol chemical with the treatment train of the existing pump and treat system must be presented.

CRHC Response: Ivey International has been able to verify that Mycelx treatment process being very similar to GAC treatment systems, and clients globally who he has worked with have reported no negative effect from his Ivey-sol application on wastewater treatment systems. These treatment systems have included but are not limited to; oil/water separators, GAC treatment systems, organo-clay, membrane separation, bioreactors, air strippers, and use of coagulants and flocculants. However, by turning the pump and treat system off during the Ivey-sol application the extracted water will be collected in tanks/drums and disposed of offsite at approved facilities.

MDE Response: The Department understands that the Ivey-sol product and mixture of the Ivey-sol product and any liberated hydrocarbons will not cause adverse effects to the treatment train of the existing pump and treat system.

- If the extracted water will be hauled off-site for treatment and disposal, a discussion of any potential complications to haulers must also be presented.

CRHC Response: There will be no complications to haulers as the Ivey-sol chemicals are all compounds which can be ordinarily found in common use and disposal practices. This can be discussed further at our August 26, 2013 meeting in such a way that those present agree not to disclose responses which would in any way negatively affect the patented process.

MDE Response: The Department understands that the Ivey-sol product and mixture of the Ivey-sol product and any liberated hydrocarbons will not cause adverse effects to the treatment train of any off-site treatment systems that the water may be hauled to.

- An MSDS sheet for the Ivey-sol chemical must be submitted. Documentation must also be presented on how the extracted material meets with typical NPDES permit requirements.

CRHC Response: The requested MSDS sheet is attached for your information and use.

MDE Response: Received as part of the August 22, 2013 email and attached to this letter.

- Because there have been detections of several volatile organic compounds (VOCs), including naphthalene and PCE, the MDE will require sampling of VOCs during this implementation of the plan as they will also likely increase in concentration during treatment.
- The MDE requires the sampling of groundwater for the EPA methods identified in the Ivey International Plan (EPA Method SM5540D and EPA Method SM5540C). Analysis of these parameters should be completed for quarterly sampling events.

CRHC Response: Sampling for VOCs including Oxygenates via EPA Method 8260B will be included in the monitoring plan. Groundwater sampling for the presence of Ivey-sol surfactant will be performed on a quarterly basis by either EPA Method SM5540D or EPA Method SM5540C.

MDE Response: The proposal includes analysis for TPH-DRO one week after injections and quarterly sampling of the injection/extraction wells and off-site down-gradient monitoring wells (MW17, MW18, MW23, MW25, MW28, and MW29) for TPH-DRO by EPA Method 8015, full suite VOCs by EPA Method 8260, and for MBAS by EPA Method 5540C.

Because of the vicinity of this site in relationship to sensitive receptors, the Department requires submittal of analytical data reports as received from the laboratory. This can be accomplished by emailing laboratory analytical data packages to the MDE project team. Standard reporting timelines can be followed for the full reports.

Ivey-sol is described as a nonionic surfactant. EPA Method 5540C discusses anionic surfactants as methylene blue active substances (MBAS) and EPA Method 5540D discusses nonionic surfactants as cobalt thiocyanate active substances (CTAS). The Department's understanding is that EPA Method 5540D would be applicable to the Ivey-sol formulation.

- The proposal does not specifically define what the residence time will be for the Ivey-sol chemical. In other similar implementations approved in Maryland, 24 hours has been typical. Please define either the time or the decision matrix that will be used to determine in the field.

CRHC Response: Based on experience at numerous sites the residence time for the applications will be 24 hours.

MDE Response: *The Department understands that the residence time for the Ivey-sol product will be 24 hour, but notes that the Remediation Action Plan does not define the residence time.*

- The Wastewater Permits Program has determined the injection wells will be permitted by rule under the Underground Injection Control program. A letter will be issued to the CRHC as part of the final plan approval.

CRHC Response: No response.

MDE Response: *No "Request for a Rule" has been submitted under separate cover and was not included as part of the proposal. CRHC must submit a letter to the MDE Water Management Administration as agreed during the August 22, 2013 meeting.*

Conditional Plan Approval

The Department generally does not approve a corrective action of this magnitude without an initial pilot test. Given the proximity of the sensitive receptors, the Department is approving the implementation of the Ivey-sol product and "Push-Pull" application with the following restrictions:

- At this time, the Department does not approve the injection of Ivey-sol in any area south of Brown Street.

- On July 24, 2013, 0.41 feet of free product was measured in well RW3B. The Department does not have a record of being contacted within 2 hours of the detection and there is no documentation of whether LPH were recovered as required in the agreed to plans.

The fact that there was measurable LPH in the subsurface after the treatment system had been running for little more than a month indicates there is still residual LPH that could be mobilized by the introduction of the surfactant solution. Because of this recognized risk, the Department will only approve a limited pilot scale testing of the Ivey-sol product.

The implementation will be limited to the area defined by wells RW6, RW2D, MW13, and MW10R. Injection in this area will ensure that any potential LPH or high dissolved phase concentrations that are mobilized would be within the known capture zone of the remediation system. This allows for the Department to gain confidence in CRHC's implementation of the proposed corrective action while maintaining a level of protection from the hydraulic control of the pump and treat system.

The Department will allow CRHC to perform the Ivey-sol "Push-Pull" application within this area up to three times over the proposed two week timeframe. Although the plan does not detail the "Pull" mechanism with any specifics, the Department will allow CRHC to utilize available technologies it sees fit for the job. However, the pump and treat system must be immediately ready to turn back on if directed. Following this time frame, the Department will require the treatment system to be turned back on while wells are monitored for a period of at least three months. At that time, the Department and CRHC can determine the next steps.

- The Department makes the following recommendation for CRHC to consider. Using the recovery system to expose the smear zone is a very effective strategy to ensure penetration of surfactant into the formation. Typically, the surfactant can be injected into numerous wells simultaneously and then the system is turned off to allow the water table to rise. Once the water table has returned to roughly static conditions, the treatment system can be restarted to remove the mobilized hydrocarbons and surfactant. When doing this, typically a poly tank is connected to the system to catch the initial surge of surfactant-impacted water and emulsified product to keep from clogging the groundwater treatment system.
- There were no discussions on the construction details of the proposed wells other than they would be a 4-inch diameter. It is assumed the well construction will be similar to existing wells. The Department approves the installation of MW8R. The Department recommends CRHC consider the installation of one or more of the remaining proposed wells in the parking lot north of Brown Street. Alternatively, CRHC could wait to install the remaining wells south of Brown Street until the Department approves the use of Ivey-sol in that area.
- Over 85,000 gallons of product have moved through the pumping wells and LPH have been measured in many other wells through the history of the case. The Department recommends all monitoring and pumping wells that have historically contained measurable LPH be redeveloped using a small amount of surfactant prior to surfactant injection. This will provide more accurate post treatment gauging

Mr. Scott Burleson
Case No. 1987-2534-KE
Page - 9 -

data. It is important to determine if detected LPH or high dissolved concentrations are coming from the formation or from an oily screen and gravel pack.

If you have any questions, please contact me at 410-537-3499 (email: susan.bull@maryland.gov).

Sincerely,

Handwritten signature of Susan R. Bull in black ink, followed by the word "FOR" in a bold, sans-serif font.

Susan R. Bull, Eastern Region Section Head
Remediation and State-Lead Division
Oil Control Program

SRB/chr

cc: Mayor Margo G. Bailey (Town of Chestertown)
Mr. Bill Ingersoll (Manager-Town of Chestertown)
Mr. John Beskid (Kent County Health Dept.)
Mr. Andrew Bullen (Earth Data, Inc.)
Mr. Dane Bauer (Daft McCune Walker, Inc.)
Mr. Kunal Gangopadhyay (EBA Engineering, Inc.)
Ching-Tzone Tien, Ph. D, P.E.
Mr. John Grace
Mr. Saeid Kasraei
Mr. Andrew B. Miller
Mr. Christopher H. Ralston
Mr. Horacio Tablada

Appendix 2
March 25, 2014 MDE Response Letter



MARYLAND DEPARTMENT OF THE ENVIRONMENT

Oil Control Program, Suite 620, 1800 Washington Blvd., Baltimore MD 21230-1719
410-537-3442 410-537-3092 (fax) 1-800-633-6101, ext. 3442

Martin O'Malley
Governor

Robert M. Summers, Ph.D.
Secretary

MAR 26 2014

Anthony G. Brown
Lieutenant Governor

March 25, 2014

Michael Forlini, Esquire
Funk & Bolton
36 South Charles Street, 12th Floor
Baltimore MD 21201

RE: RESPONSES TO QUESTIONS
Case No. 1987-2534-KE
Chester River Hospital Center
100 Brown Street, Chestertown
Kent County, Maryland
Facility I.D. No. 3168

Dear Mr. Forlini:

The Maryland Department of the Environment (MDE) appreciates the opportunity to respond to the Town of Chestertown's (the Town) questions and concerns raised in your November 5, 2013 letter. The Department has prepared the following responses to address the Town's concerns, both presented in your letter and in Mr. William Ingersoll's October 23, 2013 letter. Once the Town has reviewed the responses, the MDE would like to again meet with the Town and the Chester River Hospital Center / Shore Regional Health (the Hospital) and its consultants to discuss any remaining concerns.

After extensive scientific and technical review by the Department's Oil Control Program (OCP), Underground Injection Control (UIC) Program, and Water Supply Program (WSP) and the imposition of requirements for appropriate safeguards, the MDE concluded that the approved injection of Ivey-sol for this short-term, small-scale pilot will not pose a risk to the Town's active water supply wells. Factors that lead the MDE to this conclusion included:

- the limiting of approval of the Hospital's remediation plan to a short-term, small-scale pilot study;
- a review of groundwater flow rates and the biodegradability rate of Ivey-sol, which together show that 100 percent of the surfactant can be expected to degrade before it could ever reach the Town's active municipal well field;
- the active recovery of surfactant, petroleum, and groundwater that will take place during the injection activities and afterwards by the pump and treat system;
- a review of the properties of Ivey-sol, which shows its only noted health effects are abdominal discomfort due to ingestion (which would not be expected to occur) and minor skin irritation while handling (for which precautions will be taken)

- additional required monitoring to ensure that all Ivey-sol has been recovered and/or degraded; and
- the fact that actions such as additional groundwater pumping could be taken if surfactant or contaminants are detected in down gradient monitoring wells.

The pilot project was approved because the proposed technology may lead to the removal of significant residual petroleum from the Aquia aquifer on the Hospital property (i.e. the source area), which would represent a significant step toward a final resolution of contamination issues and would afford greater protection to the Town's drinking water supply wells.

This letter presents background on the development and approval of the Hospital's remediation plan, followed by a summary of the approved pilot scale version of the plan. The letter also addresses specific concerns related to the evaluation of the proposed and approved plan by the UIC Program, as well as the OCP and WSP. Finally, the letter addresses other concerns presented by the Town.

Background

On July 22, 2013, the Hospital submitted a draft version of a corrective action plan for the MDE's review and comment. The plan called for the injection of a surfactant solution, Ivey-sol, to assist in "dissolving" the residual adsorbed / absorbed petroleum hydrocarbons into the shallow groundwater formation. A "Push-Pull" method was proposed to assist in the distribution ("Push") and extraction ("Pull") efforts. Residual "dissolved" petroleum hydrocarbons would then be more available for extraction by the on-site pump and treat system.

The Department completed an initial review of the draft plan and provided comments to the Hospital on August 2, 2013. On August 22, 2013, an email from the Hospital's consultant was received with various attachments for the Department to review in anticipation of a technical meeting held on August 26, 2013 at the MDE's office with representatives of the Hospital and MDE to discuss the proposed plan.

On September 13, 2012, the Department received the revised *Groundwater Remediation 2013 Action Plan*. The Department reviewed the plan and agreed that the technology could be successful in extracting more residual petroleum contamination than the current pump and treat system could do alone. The Department approved the proposal with several modifications as detailed in the October 17, 2013 letter and summarized below.

On October 28, 2013, representatives from the Town, the Hospital and its consulting team, and the MDE met to discuss the plan. In the days following the meeting, the Department received the letters from Mr. Ingersoll and you, which presented the Town's concerns with the remediation plan.

Approved Pilot Test Plan Summary

While contaminants are being prevented from moving down gradient via a hydraulic barrier between the source area and the Town's active well field (i.e. the pump and treat system), the system is no longer removing significant amounts of contaminants. A better long term practice to minimize the risk of movement of contaminants toward the Town's active well field is to remove the contaminants at the source

area. The approved pilot project will provide important information to assess the feasibility of removing additional petroleum hydrocarbons from the formation and groundwater in the source area.

As discussed in the Department's October 17, 2013 plan approval letter, the MDE had several concerns with the *Groundwater Remediation 2013 Action Plan*. Generally, the concerns were related to the overly aggressive nature of the proposal, the nature of surfactants, and the lack of hydraulic control where some of the injection was proposed. Because of these concerns, the MDE approved the plan with several modifications, the most significant of which was to limit the scope of the plan to a smaller pilot scale demonstration with more protective monitoring. The following summary is provided to further explain what was ultimately approved as a pilot test of the Ivey-sol surfactant injections.

The week prior to shutting off the recovery system, routine sampling and gauging of wells will occur. The analysis for surfactants by EPA Method SM5540D will be added to the list of sample analyses for select wells to gather baseline conditions prior to the injection activities (see attached table). Injection and extraction events (i.e. "Push-Pull" events) will be conducted at six wells: RW6, RW2D, MW13, MW10R, MW22, and RW5 (see attached map). All six locations are within the area approved by the MDE and all locations are within the area of hydraulic control of the remediation system.

The following summarizes the major steps to be taken during the week long injection portion of the pilot test.

Day 1

- A round of gauging and sampling data will be collected and recorded from select wells as indicated on the attached table.
- The remediation system will be turned off.
- At each well location, a mixture of the Ivey-sol (approximately 5 gallons) and potable water will be prepared in a 275-gallon tote (a total of 1,650 gallons of Ivey-sol mixture across the six wells).
- The injection, or "Push," portion of the event will involve the Ivey-sol mixtures being gravity fed into each well (i.e. not pumped under pressure). The gravity feeding of the surfactant mixture may take upwards of 1 hour or longer depending on the specific well hydraulics.
- The injection wells and surrounding monitoring wells will be gauged periodically during the daily activities.
- Groundwater from the wells will also be assessed for surface tension by an approved field testing method. Surface tension results provide a near real time indication of the presence/absence of surfactants.

Day 2

- A round of gauging and sampling data will be collected and recorded from select wells as indicated on the attached table.
- Approximately 24 hours after the injection, a submersible pump will be placed into each injection well and approximately 1.650 gallons of liquids (i.e. groundwater, Ivey-sol, and LPH) will be extracted from each well as the "Pull" portion of the event (roughly 10,000 gallons total). At an average pumping rate of 9 gallons per minute, which is the maximum rating for a typical

submersible pump, the extraction portion of the event will take upwards of 3 hours provided that pumping is done simultaneously from all six wells. The extracted liquids will be pumped into two 5,000-gallon poly tanks for temporary storage. The extracted liquids will be transported off-site for proper disposal prior to the next "Pull" event.

- Once the "Pull" event has been completed, a round of data will be collected and recorded from select wells as indicated on the attached table.
- The next round of Ivey-sol mixtures will be prepared and injected into the six wells for the second "Push" event.
- The injection wells and surrounding monitoring wells will be gauged periodically during the daily activities. Groundwater from the wells will also be assessed for surface tension throughout the day.

Day 3

- A round of gauging and sampling data will be collected and recorded from select wells as indicated on the attached table.
- If not completed on Day 2, the liquids extracted from the Day 2 "Pull" event will be transported off-site.
- Approximately 24 hours after the Day 2 injection, the second "Pull" event will commence.
- Once the "Pull" event has been completed, a round of data will be collected and recorded from select wells as indicated on the attached table.
- The next round of Ivey-sol mixtures will be prepared and injected into the six wells for the third and final "Push" event of the pilot test.
- The injection wells and surrounding monitoring wells will be gauged periodically during the daily activities. Groundwater from the wells will also be assessed for surface tension throughout the day.

Day 4

- A round of gauging and sampling data will be collected and recorded from select wells as indicated on the attached table.
- The liquids extracted from the Day 3 "Pull" event will be transported off-site.
- Approximately 24 hours after the Day 3 injection, the third and final "Pull" event will commence.
- Once the "Pull" event has been completed, a round of gauging data will be collected and recorded from select wells as indicated on the attached table. Groundwater from the wells will also be assessed for surface tension throughout the day.

Day 5

- Monitoring well gauging and sampling will be completed as indicated on the attached table. Groundwater from the wells will also be assessed for surface tension.
- The liquids extracted from the Day 4 "Pull" event will be transported off-site.
- The recovery system will be restarted.

For a minimum of three months following the pilot test, monitoring wells will be gauged and sampled for the presence of volatile organic compounds (VOCs) (via EPA Method 8260), total petroleum

hydrocarbons (TPH-DRO) (via EPA Method 8015), and surfactants (via EPA Method SM5540D). The particular wells to be sampled and the sampling frequencies are detailed on the attached table.

UIC Program and WSP Review

The Hospital location is within the source water assessment area for the Town's well field as delineated by the WSP in the *Source Water Assessment for the Town of Chestertown*, December 2003. The petroleum release was identified in the WSP's report as a potential risk to the Town's well field. For this reason the WSP was requested to provide comments on the proposed use of Ivey-sol to enhance petroleum hydrocarbon removal. The UIC Program, however, has regulatory authority concerning the injection of any material into an underground source of drinking water.

In line with these responsibilities the WSP and the UIC Program thoroughly reviewed the use of Ivey-sol in conjunction with the "Push-Pull" methodology in the proposed groundwater remediation project. The review identified several factors and safeguards, summarized below, that collectively allowed the MDE to conclude that the approved short-term, small-scale pilot will not pose a risk to the Town's active water supply wells. The factors and safeguards that lead MDE to this conclusion are discussed below.

Hydraulics

The hospital is located within the 10-year time of travel (i.e. Zone 2) of the WSP's *Source Water Assessment*. Based on the Hospital's location within Zone 2, it is estimated that there would be a 2-year time of travel for groundwater flowing from the Hospital to the Town's active well field, which would equate to roughly 2 feet per day. Based upon measured values from the on-site wells and logged geology, an estimated time of travel was calculated to be 0.4 feet per day (146 feet per year), with the equivalent time of travel from the Hospital to the Town's active well field at approximately 10 years. Looking at the analytical data from the monitoring wells after the June 2012 shutdown of the system, it took approximately 10 months for total petroleum hydrocarbons in the diesel range (TPH-DRO) to be detected again in a well approximately 100 feet away from known residual source areas. The time for the TPH-DRO to travel that distance is on par with the 0.4 feet per day or 10 year time of travel value. In either case, there is a range of time in which a contaminant may be able to reach the Town's active well field. These time of travel estimates (i.e. 2 years to 10 years) do not take into consideration any other processes such as biodegradation, diffusion, and dispersion. Taking these factors into account, whether for the surfactant Ivey-sol or the petroleum contaminants, the likely time of travel from the Hospital to the Town's active municipal well field is greater than 2 years.

Using the more aggressive estimate of 2 feet per day, during the course of the approved groundwater pump and treat system for up to a week, there would be an approximate 14 feet of potential travel from an injection well. The furthest down gradient approved injection well is MW13. The demonstrated radius of influence from the pump and treat system extends approximately 90 feet down gradient from MW13 (see attached Figure 3, December 18, 2013 Water Contour map). The result is that while the pump and treat system will be turned off for an approved period of time, once turned back on it will recover groundwater, surfactants, and "dissolved" petroleum from the area of MW13 and the other injection wells.

Additionally, part of the remedial approach is to conduct a recovery event ("Pull" event) from each injection well 24 hours after the "Push" event. During the "Pull" events, approximately six (6) times the volume of injected surfactant solution will be extracted from each injection well. There will be three such "Pull" events conducted on successive days totaling approximately 30,000 gallons of liquid extracted from the pilot test area.

Based on the Department's assessment of the approved pilot test injection of Ivey-sol coupled with the "Push-Pull" procedure, the restarting of the remediation system, and the overall groundwater movement, the MDE expects the surfactants to remain within the pilot test area.

Biodegradability

The Material Safety Data Sheet (MSDS) # 120829 for Ivey-sol states that the biodegradability of Ivey sol is greater than 90 percent in 28 days. If there are any residual surfactants not removed by the "Pull" part of this process or the restart of the pump and treat system, these residuals are expected to biodegrade at the stated biodegradation rate. At this rate, the concentrations potentially detectable would be in the parts per trillion range at approximately six months after injection. It is very conservative to predict that 100 percent of the Ivey-sol would degrade prior to reaching the active municipal well field even at the more aggressive time of travel estimate (i.e. 2 years).

Toxicity

Based on a review of the Ivey-sol MSDS and information obtained by the Department from Ivey International, Inc. labeled as "patented and or proprietary," there are no chemicals in Ivey-sol regulated per the "2012 Edition of the Drinking Water Standards and Health Advisories, EPA document 822-S-12-001." Further, the MSDS gives no indication of adverse toxicological effects. However, mild skin irritation due to direct skin contact and abdominal discomfort due to ingestion of the product are noted. Ivey-sol is not expected to be ingested in a pure or dissolved form as discussed above. Workers will use proper personal protective equipment to limit any exposures to Ivey-sol during the pilot test.

Temperature and pH

Section 10 of the MSDS ("Stability and Reactivity") states to "avoid strong bases at high temperatures, strong acids..." as they may cause product decomposition. There is no reason to anticipate that strong acids or bases, with or without high temperatures, would exist in the subsurface. Therefore, there is no reasonable potential for degradation resulting from exposure to strong acids or bases and high temperatures.

Monitoring

As an additional measure, the approved sampling will act to ensure that all Ivey-sol has been recovered and/or degraded and that all VOCs are adequately monitored. If there were some amount of the surfactant or contaminants detected in down gradient monitoring wells, actions could be taken (e.g., additional groundwater pumping) within sufficient time to mitigate those concerns prior to surfactants or contaminants reaching the Town's active well field.

UIC Program Rule Authorization Determination

Federal UIC regulations, which Maryland incorporates by reference, support State and Federal UIC programs to Rule authorize injection practices with the goal of groundwater remediation, including the use of surfactants, or to issue a discharge permit. There is State and Federal precedent for Rule authorizing the subsurface emplacement of fluids with the goal of remediating contaminated groundwater. These types of injection practices are not characterized as disposal, therefore Rule authorization is the typical determination.

In this case, a Groundwater Discharge Permit was not required for the injection of Ivey-sol in the approved pilot scale project, and instead the use of Ivey-sol was authorized by Rule, which is typical of such groundwater remediation plans. However as stated in our Rule authorization, "the Department reserves the right to require additional operational requirements, including monitoring, and obtaining a Groundwater Discharge Permit, if found necessary to further protect underground sources of drinking water." Rule authorization is also contingent upon compliance with the conditions and restrictions detailed in the Department's October 17, 2013 letter, along with any additions and modifications made as part of the extended review process. Finally, it is important to note that this Rule authorization is limited to this short term, small footprint pilot project. Any planned expansion of the use of Ivey-sol beyond this pilot project will require a new review of whether or not a UIC Groundwater Discharge Permit would be required.

Additional Concerns

The Department understands that Ivey International, Inc. has provided the Town with information about projects where Ivey-sol was used. If additional information is required by the Town, those requests should be directed to the Hospital and its consultants.

The Department is not aware of any financial assurance or bond that has been executed, and is not aware of any requirement for one to be executed. To the extent that any impact to the Town's active municipal wells is directly attributable to the actions or inactions of the Hospital, the MDE would consider the Hospital to be responsible for any necessary mitigation. The Town will need to explore its legal rights through its own legal counsel.

The Department will evaluate the success of the pilot test by taking several factors into consideration including: overall petroleum mass removal; evaluation of the results from the post-injection monitoring; the ability of Ivey-sol to be injected into the wells; and the ability of Ivey-sol and contaminants to be extracted. As for measurable endpoints to consider for determining final case closure, the Hospital has proposed to eliminate the free product and TPH-DRO. As with all OCP remediation cases, a minimum of one year post-remedial monitoring prior to determining final case closure is required.

As demonstrated in the attached cross-sections, the subsurface geology is relatively uniform and the smear zone is adequately characterized. The existing well network adequately covers the site and the monitoring wells are constructed to depths that coincide with the upper portions of the municipal wells.

The OCP Compliance Division recently completed a compliance inspection on the Hospital in relation to the ongoing use of the current underground storage tank (UST), previously abandoned USTs, and aboveground storage tank operations. The OCP Compliance Division concluded that all operations were found to be in compliance and there was no evidence of an ongoing or recent release.

Summary

The UIC Program, the OCP, and the WSP have been working in concert in reviewing the proposed remediation plan, and collectively agreed to the reduced pilot scale implementation that was ultimately approved by the MDE. The pilot project was approved because the proposed technology may lead to the removal of significant residual petroleum from the source area. As detailed in this letter, the MDE has concluded that as approved the injection of Ivey-sol for this short-term, small-scale pilot does not pose a risk to the active water supply wells of the Town.

If you have any questions, please contact me at 410-537-3443 (email: chris.ralston@maryland.gov) or the case manager, Ms. Susan Bull, at 410-537-3499 (email: susan.bull@maryland.gov).

Sincerely,



Christopher H. Ralston, Administrator
Oil Control Program

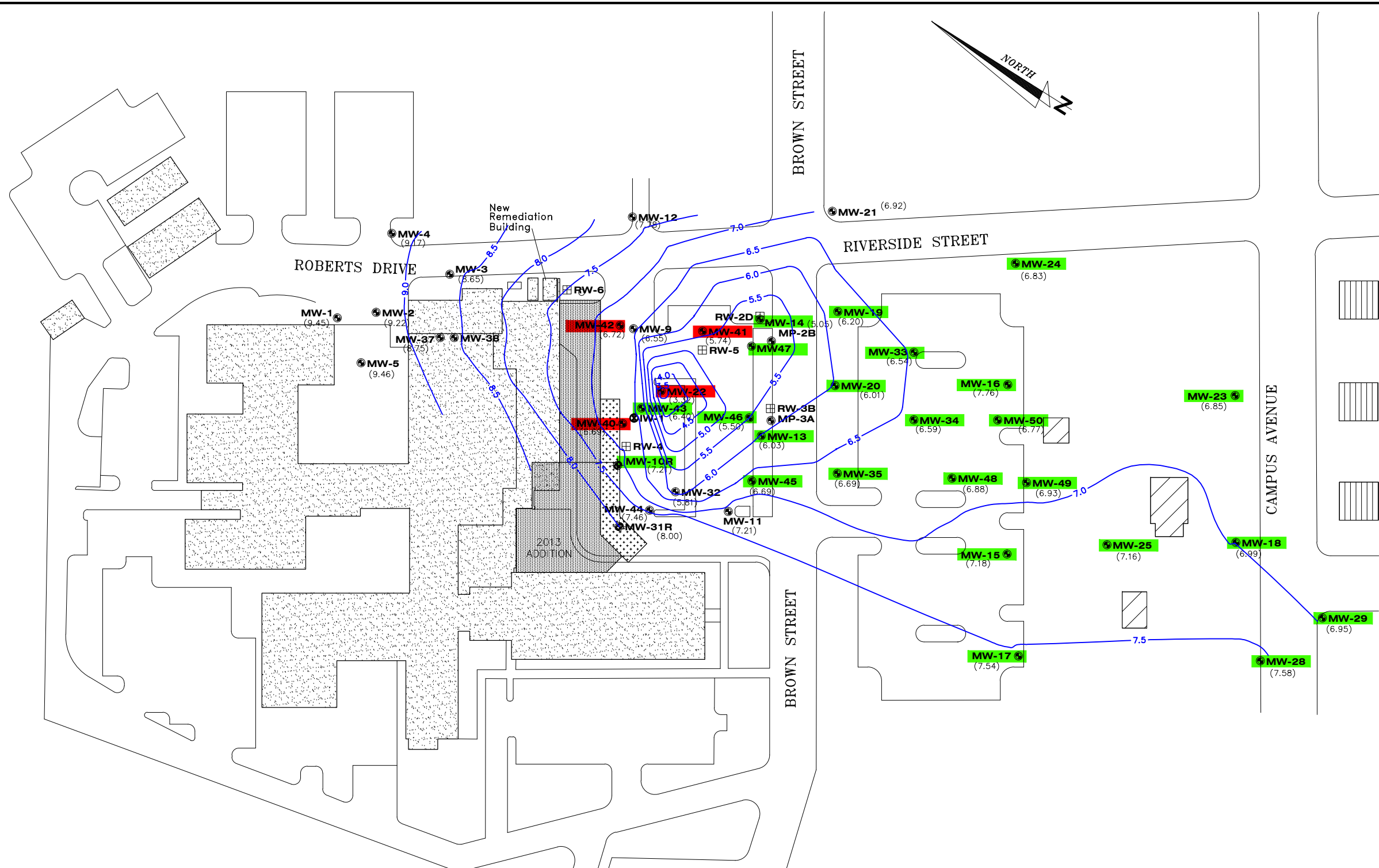
CHR/nln

Enclosures

cc: Mayor Chris Cerino (Town of Chestertown)
Mr. Bill Ingersoll (Manager-Town of Chestertown)
Mr. John Beskid (Kent County Health Dept.)
Mr. Kenneth Kozel (Shore Regional Health)
Michael Powell, Esquire (Gordon Feinblatt)
Mr. Dane Bauer (Daft McCune Walker, Inc.)
Mr. Kunal Gangopadhyay (EBA Engineering, Inc.)
Mr. Andrew Bullen (Earth Data, Inc.)
Lynn Angotti, Esquire (Office of the Attorney General)
Mr. Michael Eisner
Ching-Tzone Tien, Ph. D, P.E.
Mr. John Grace
Mr. Saeid Kasraei
Ms. Susan Bull
Mr. Andrew B. Miller
Mr. Horacio Tablada

Appendix 3
Map of Proposed Injection/Extraction Wells

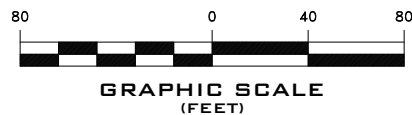
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LEGEND

- MW-40 MONITORING WELL
- RW-3B RECOVERY WELL
- IW-1 INJECTION WELL
- PILOT STUDY INJECTION/EXTRACTION WELLS
- PILOT STUDY MONITORING LOCATIONS

5.50 04/28/2014 (FT. MSL)



APPENDIX 3
PILOT STUDY
FOR
**CHESTER RIVER
HOSPITAL CENTER**
CHESTERTOWN, MARYLAND

EBA ENGINEERING, INC.
4813 SETON DRIVE
BALTIMORE, MD. 21215
Tel: (410) 358-7171 Fax: (410) 358-7213
www.ebaengineering.com

PROJECT:	SCALE:
4070-00	AS SHOWN
DRAWN BY:	DATE:
DK	06/26/2014

Appendix 3 - Map of Proposed Injection/Extraction Wells

Well Screen High Water Elevation Data
Chester River Hospital Center

Monitoring Well	Well Diameter	Top of Casing	Total Depth	Screen Interval Depth		Top of Screen Elev.	High Water Elevation (HWE)	HWE Within Well Screen?
MW-1	4"	57.05	60	40	60	17.05	11.86	YES
MW-2	4"	56.37	60	40	60	16.37	11.32	YES
MW-3	4"	50.55	58	38	58	12.55	11.05	YES
MW-4	4"	53.4	60	40	60	13.4	11.55	YES
MW-5	4"	61.08	65	45	65	16.08	11.40	YES
MW-9	4"	46.1	47	37	47	9.1	11.88	NO
MW-10R	2"	48.7	54	29	54	19.7	11.91	YES
MW-11	4"	41.49	46	23	46	18.49	10.08	YES
MW-12	4"	44.46	48	33	48	11.46	10.38	YES
MW-13	4"	41.7	44	29	44	12.7	9.78	YES
MW-14	4"	41.38	43	23	43	18.38	10.06	YES
MW-15	4"	35.01	45	20	45	15.01	9.46	YES
MW-16	4"	35.55	39	24	39	11.55	9.74	YES
MW-17	4"	35.49	38	23	38	12.49	10.41	YES
MW-18	4"	35.82	39	25	39	10.82	9.87	YES
MW-19	4"	38.85	46	23	46	15.85	9.44	YES
MW-20	4"	38.72	43	23	43	15.72	9.48	YES
MW-21	4"	38.55	43	23	43	15.55	9.71	YES
MW-22	4"	47.04	56	26	56	21.04	10.28	YES
MW-23	4"	35.95	40	25	40	10.95	9.69	YES
MW-24	4"	36.56	40	25	40	11.56	9.68	YES
MW-25	4"	36.1	40	25	40	11.1	10.05	YES
MW-28	4"	35.9	39	24	39	11.9	10.46	YES
MW-29	4"	35.15	39	24	39	11.15	9.84	YES
MW-31R	2"	47.4	54	29	54	18.4	11.21	YES
MW-32	4"	47.41	47	32	47	15.41	10.26	YES
MW-33	4"	36.52	41	26	41	10.52	9.59	YES
MW-34	4"	36.64	41	26	41	10.64	9.64	YES
MW-35	4"	38.62	43	28	43	10.62	9.84	YES
MW-37	4"	50.54	70	11	70	39.54	14.71	YES
MW-40	4"	48.69	55	30	55	18.69	10.55	YES
MW-41	4"	42.92	55	30	55	12.92	10.11	YES
MW-42	2"	46.15	50	30	50	16.15	10.43	YES
MW-43	2"	47.9	50	30	50	17.9	10.35	YES
MW-44	2"	47.2	50	30	50	17.2	10.37	YES
MW-45	2"	40.91	45	25	45	15.91	9.80	YES
MW-46	2"	41.08	48	28	48	13.08	9.78	YES
MW-47	2"	40.74	50	30	50	10.74	9.87	YES
MW-48	2"	36.22	55	25	55	11.22	9.09	YES
MW-49	2"	35.49	55	25	55	10.49	8.81	YES
MW-50	2"	35.64	55	25	55	10.64	8.90	YES

Appendix 4
MDE Chart for Gauging and Sampling Data

MDE Case No. 1987-2534-KE - Chester River Hospital Center
Pilot Test Well Designations

Well ID	TOC Elevation (ft)	Well Diameter (in)	Well Depth (ft)	Top of Screen Depth (ft)	Tag Number	Comments	Pilot Test Well Type	Gauging Frequency	Sampling Frequency	Analytes Sampled
RW-1B	46.71	6	60	35	KE-94-0592	abandoned Aug '13				
RW-2D	40.54	6	55	30	KE-94-0593					
RW-3B	39.45	6	55	30	KE-94-0594					
RW-4	48.15	6	54	29	KE-94-0796	raised TOC by 2.46 (18 Dec 12)				
RW-5	43.34	6	55	30	KE-94-0809	raised TOC by 0.42 (8 Apr 11)				
RW-6	47.22	6	57	32	KE-94-0797					
MW-1	57.05	4	60	40	KE-81-1375					
MW-2	56.37	4	60	40	KE-81-137					
MW-3	50.55	4	58	38	KE-81-1444					
MW-3b										
MW-4	53.40	4	60	40	KE-81-1443	raised TOC by 0.75 (25 Jun 07)				
MW-5	61.08	4	65	45	KE-88-0093					
MW-6		4	54	34	KE-88-0094	abandoned Nov '00				
MW-7		4	48	38	KE-88-0167	abandoned Nov '00				
MW-8		4	47	37	KE-88-0168	abandoned Aug '13				
MW-9	46.10	4	47	37	KE-88-0169	lowered TOC by 0.85 (15 Oct 12)				
MW-10		4	50	30	KE-88-0185	abandoned Nov '12				
MW-10R	48.70	2	54	29	KE-95-1066		Monitoring Well	B, D, A	B, A	PT
MW-11	41.49	4	46	23	KE-88-0186					
MW-12	44.46	4	48	33	KE-88-0187					
MW-13	41.70	4	44	29	KE-88-0188	raised TOC by 0.88 (1 May 02)	Monitoring Well	B, D, A	B, A	PT
MW-14	41.38	4	43	23	KE-88-0189	raised TOC by 0.7 (8 Apr 02)	Monitoring Well	B, D, A	B, A	PT
MW-15	35.01	4	45	20	KE-88-0196		Monitoring Well	A	A	PT
MW-16	35.55	4	39	24	KE-88-0197		Monitoring Well	A	A	PT
MW-17	35.49	4	38	23	KE-88-0198		Monitoring Well	A	A	PT
MW-18	35.82	4	39	25	KE-88-0199		Monitoring Well	A	A	PT

Well ID	TOC Elevation (ft)	Well Diameter (in)	Well Depth (ft)	Top of Screen Depth (ft)	Tag Number	Comments	Pilot Test Well Type	Gauging Frequency	Sampling Frequency	Analytes Sampled
MW-19	38.85	4	46	23	KE-88-0209		Monitoring Well	B, D, A	B, A	PT
MW-20	38.72	4	43	23	KE-88-0213		Monitoring Well	B, D, A	B, A	PT
MW-21	38.55	4	43	23	KE-88-0214					
MW-22	47.04	4	56	26	KE-88-0207	raised TOC by 1.29 (18 Dec 12)	Injection Well	B, D, A	B, A	PT
MW-23	35.95	4	40	25	KE-88-0225		Monitoring Well	A	A	PT
MW-24	36.56	4	40	25	KE-88-0226		Monitoring Well	A	A	PT
MW-25	36.10	4	40	25	KE-88-0227		Monitoring Well	A	A	PT
MW-27		4	45	25	KE-88-0229	abandoned Nov '06				
MW-28	35.90	4	39	24	KE-88-0230		Monitoring Well	A	A	PT
MW-29	35.15	4	39	24	KE-88-0231		Monitoring Well	A	A	PT
MW-30		4	49	34	KE-88-023_	abandoned Nov '00				
MW-31		4	48	33	KE-88-0391	abandoned Nov '12				
MW-31R	47.40	2	54	29	KE-95-1067					
MW-32	47.41	4	47	32	KE-88-0392	raised TOC by 2.81 (18 Dec 12)				
MW-33	36.52	4	41	26	KE-88-0415		Monitoring Well	B, D, A	B, A	PT
MW-34	36.64	4	41	26	KE-88-0416		Monitoring Well	B, D, A	B, A	PT
MW-35	38.62	4	43	28	KE-88-0417		Monitoring Well	B, D, A	B, A	PT
MW-37	50.54	4	70	11	KE-88-0497	lowered TOC by 1.03 (28 Sep 10)				
MW-38		4	55	40	KE-92-0002	pump stuck in collapsed well				
MW-40	48.69	4	55	30	KE-94-0803	raised TOC by 0.46 (9 Jun 09); raised TOC by 2.13 (18 Dec 12); resurvey May '13	Injection Well	B, D, A	B, A	PT
MW-41	42.92	4	55	30	KE-94-0802		Injection Well	B, D, A	B, A	PT
RW-1A		6	56	36	KE-88-0190	abandoned Jan '01				
RW-2A		6	47	27	KE-88-0224	abandoned Mar '08				
RW-2B		6	60	30	KE-88-0425	abandoned Mar '08				
MP-2B		2	60	30	na					
RW-2C		6				abandoned Sep '03				
RW-3A		6	60	30	KE-88-0411	abandoned Sep '03				

Well ID	TOC Elevation (ft)	Well Diameter (in)	Well Depth (ft)	Top of Screen Depth (ft)	Tag Number	Comments	Pilot Test Well Type	Gauging Frequency	Sampling Frequency	Analytes Sampled
MP-3A		2	60	30	na					
MW-42	46.15	2	50	30	KE-95-0342	lowered TOC by 0.89 (15 Oct 12)	Injection Well	B, D, A	B, A	PT
MW-43	47.90	2	50	30	KE-95-0343	raised TOC by 1.48 (18 Dec 12); resurvey May '13	Monitoring Well	B, D, A	B, A	PT
MW-44	47.20	2	50	30	KE-95-0344	raised TOC by 0.8 (18 Dec 12); resurvey May '13				
MW-45	40.91	2	45	25	KE-95-0345		Monitoring Well	B, D, A	B, A	PT
MW-46	41.08	2	48	28	KE-95-0346		Monitoring Well	B, D, A	B, A	PT
MW-47	40.74	2	50	30	KE-95-0347		Monitoring Well	B, D, A	B, A	PT
IW-1		4	61	31	KE-95-0752	raised TOC by 1.64 (18 Dec 12)				
MW-48	36.22	2			KE-95-1113		Monitoring Well	A	A	PT
MW-49	35.49	2			KE-95-1114		Monitoring Well	A	A	PT
MW-50	35.64	2			KE-95-1115		Monitoring Well	A	A	PT

Notes

- Indicates well to be used for injection of Ivey-sol during the pilot test
- Indicates a well to be used for monitoring during the pilot test.

Frequency

- B - Before Sampled and gauged prior to injection of Ivey-sol.
- D - During Gauged during the Ivey-sol injection events.
- A - After Sampled and gauged one week and monthly for at least three months after Ivey-sol injection events.

Analytes

PT - Pilot Test Sampled for VOCs via EPA Method 8260, TPH-DRO/TPH-GRO via EPA Method 8015, and surfactants via EPA Method SM5540D.

Appendix 5
Ivey International, Inc. References, Testimonials, and Project Summaries



Ivey International Inc.

"Today's Environmental Solutions For A Better Tomorrow"

AWARDS

Ivey International Inc. has achieved international recognition for the development of several innovative remediation technologies to treat contaminated air, soil and groundwater. It has been nominated for and received several national and international environmental awards. A few of these accomplishments have been listed below for your review.

For more information about the company and the products we market globally, please visit www.iveyinternational.com.

2011

The 2011 **MYSTIC Environmental Excellence Award** For Innovative Remediation Technology Development (November 4, 2011).

The 2011 **Roy F. Weston Award** at the 26th International Conference on Solid Waste Technology and Management in Philadelphia, PA, USA. (March 26, 2011).

2008

The 2007 **Environmental Business Journal Bronze Award** Technology Achievement (February 20, 2008).

2007

The 2006 **North American Frost & Sullivan Award** for Technology Innovation (February 7, 2007).

The 2006 **Environmental Business Journal** Remediation Technology Merit Award (February 28, 2007).

2006

The 2006 **Globe Award** for Environmental Innovation and Application (March 31, 2006).

2005

In 2005 George A. Ivey, was inducted as a **Leading Scientist of the World**, in the field of Science & Engineering, by the International Biographical Centre, Cambridge, England.

2004

In 2004, Ivey International Inc. was a **National Finalist** for a National Canadian Urban Institute (CUI) **Brownfield Remediation Award**.



Client Testimonials

"We used Ivey-sol surfactant technology and experienced a greater than 400% enhancement of contaminant mass recovery! This innovative technology significantly sped up remediation saving my clients time and money! We were very pleased with the results and would recommend others to try it"

Dan Smith, Principle Hydrogeologist
Metric Earth Services, LLC

"Using low concentrations of Ivey-sol solution, free product was successfully removed from shale. Soil shale washing with Ivey-sol is a cost-effective technology for on-site treatment of impacted soils. Based on the parameters above, projected treatment price for a small scale project (< 2,000 tones) would be \$35 per ton, which is currently less expensive than disposing of the impacted material at a landfill and replacement with clean fill. Obviously, with larger projects, the economies of scale will drive the price down even lower"

Kyle Dacey, Manager of Technical Services
Terratechnik Environmental Ltd.

"The in-situ application of the Ivey-sol surfactant technology significantly increased the DNAPL and BTEX mass recovery from the impacted soil and groundwater on-site. We were very pleased by these results leading to our recommending a full scale site application as a rapid and cost effective method to achieve site clean-up"

Martin Beaudoin, Project Engineer
Sanexen Environmental Services Inc.

"Ivey-sol has been proven highly effective at remediating both oil-based contamination and chlorinated solvents in a variety of different soil types, ranging from sands to clays. Given the current need for innovative and cost-effective cleanup technologies, usage of Ivey-sol will significantly increase in the upcoming years."

Bruce Tunnicliffe, President
Vertex Environmental Inc.

"I credit this technology with saving my company tens of thousands of dollars after using it to treat a fuel-oil spill. Drinking water was contaminated and I looked at a number of technologies. They wanted to put recovery towers in and stripper systems costing more than \$100,000, and I was told remediation would take five to seven years. But Ivey-sol did it in less than 18 months saving some \$60,000, while meeting stringent environmental standards."

Peter Clark, President
Clark Oil Co. Ltd. (Ultramar)

Ivey International Inc.

Tel: +1 604 538 1168 Fax: +1 888 640 3622 Email: info@iveyinternational.com Web: www.iveyinternational.com

"After excavation and bio-piling of the soil, the surfactant enhanced bioremediation (SEB) treatment was applied and the bio-pile was covered. Daily aeration was done during the treatment period. After only 12 weeks samples were taken from the bio-pile showing that the remediation of the fuel-oil and PAH contamination was completed to the BC Environmental Standards and safe for reuse on-site"

**Tony Robson, Director Mining & Equipment
Quinsam Coal Corporation**

"This process is very cost effective and will save between \$40,000 to \$60,000 compared to the closest available technology that we are aware of. Our division has been working closely with Ivey International for over a year and is convinced this is the future for in-situ remediation."

**Steve Wasson, P. Eng., Coordinator of Environmental Services
Key Safety Services Inc.**

"We increased the TPH Mass Recovery Rate by 10x, removed TPH-d from vadose zone and lowered groundwater concentrations. Regulatory Agency agrees to a risk based closure in contamination levels continue to decrease"

**Galen Kenoyer, Senior Hydrogeologist
Chris D'Sa, Senior Project Manager**



"I think the future for the Ivey-sol surfactant technology is bright. It's based on sound science and Ivey International Inc. has lots of field application experience"

**Lisa Rear, P.Bio.
Environmental Consultant**

"We observed a noticeable drop in the level of contaminants within a two-month period"

**Brad Shybunka, Senior Project Manager Operations.
Bio-Synergy Inc.**

"We used a combination of Ivey-sol technology and soil excavation. It certainly saved us the headache of having to do more by way of foundation excavation. The result was the important thing. Ivey-sol was a good add-on to the original excavation and we got the results we wanted"

**Mike Roy, Senior Claims Adjuster
Plant Hope Adjusters Ltd.**

"The project we are now working on is in tight clay soil, 6 meters deep, 35 meters by 20 meters in area. The projected clean up will be nine to 12 months. This is very fast compared to any other in-situ process that we are aware of. The only thing faster is digging up the site and hauling away the soil."

**Terry Timothy, Manager of Environmental Services
Key Safety Services Inc.**

Ivey International Inc.

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"Our research has confirmed that the Ivey-sol surfactant technology increases the controlled solubility and rate of MTBE recovery from impacted soil and groundwater by >740%"

Dr. Davis Craft
University of Alberta

"Our research has shown that the Ivey-sol surfactant technology can increase the controlled solubility rate of PCB into groundwater by >900%"

Dr. Davis Craft
University of Alberta

"The name of the game is satisfactory results and closing the file as quickly as possible. Ivey-sol technology is a big help when excavation isn't an attractive option"

Bill McCann, Senior Claims Adjuster
Halifax Insurance

"We accomplished more with \$50,000 of Ivey-sol than we did with the first \$500,000 we spent on the site over the previous 4 years. Ivey-sol increased our rate of contaminant recovery by >400%"

Dan Smith, Hydrogeologist
HANDEX of Connecticut

"We had to evacuate the building after the oil spill, it was a mess. Ivey-sol cleaned up the site up rapidly. It improved the air, soil and groundwater quality"

John Vidditto
Developer/ Property Owner

For more information about the Ivey-sol surfactant technology, learn about our other innovative remediation technologies, to find a local distributor, or obtain free technical support, visit www.iveyinternational.com

Ivey International Inc.

Tel: +1 604 538 1168 Fax: +1 888 640 3622 Email: info@iveyinternational.com Web: www.iveyinternational.com



STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION



July 23, 2004

George A. Ivey, B.Sc., CES, CESA
Senior Remediation Specialist
Ivey International Inc.
PO Box 706
Campbell River, BC
Canada V9W 6J3

Dear George,

As we discussed, I am writing this to confirm observations of the effectiveness of Ivey-Sol and to comment on regulatory impacts as related to the Inland Fuels Property on Route 111 (Main Street) in Monroe, Connecticut.

I cannot offer a general approval for statewide application of Ivey-Sol, or any other technology, but am able to offer the following assessment of the results from this application, based on field observations and monitoring results. Residual petroleum related compounds from historic home heating oil leakage are tightly bound to site soils and had not mobilized significantly for many years, perhaps decades. Remediation of this site is complicated by its location in the floodplain of a small river and the Town of Monroe's enforcement of wetland and floodplain ordinances which made physical removal of polluted soils impossible.

Standard pump and treat technologies are of limited value at this site due to the lack of mobility of the petroleum residuals. As a result, the use of Ivey-Sol appeared to be appropriate, and the DEP issued the Authorization to conduct both a limited pilot test and based on initial results, subsequent site-wide use of Ivey-Sol.

The Department generally does not issue closure statements indicating success or failure of remedial technologies, but I can offer the following comments regarding the use of Ivey-Sol at this site. It was clear that the use of Ivey-Sol significantly increased the rate of release of petroleum previously bound in site soils.

A more important consideration from the Department's standpoint is the effect on other water resources. On-site observations and monitoring data indicated that the released petroleum was intercepted by the on-site network of wells and that both petroleum and remaining Ivey-Sol were readily treated by the activated carbon treatment system. There was no visual impact on effluent quality, as well as no mortality in aquatic toxicity testing on treatment system effluent. In summation, I have not seen any adverse impact from the use of Ivey-Sol and expect that any residual product has degraded through natural biological processes.

Please feel free to contact me at (860) 424-3827 with questions.

Sincerely,

Donald J. Gonyea, EA3
Bureau of Water Management

Surfactant Enhanced HVDPE Remediation of Petroleum Contaminated Soil, Bedrock and Groundwater

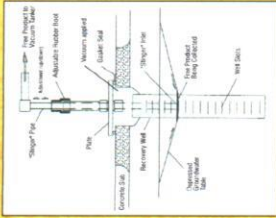
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 Today's Environmental Solutions For A Better Tomorrow™
 www.iveyinternational.com

Galen Kenoyer, PhD, PG and Chris D'Sa, MS – TRC, Los Angeles, California, USA
 George A. Ivey, B.Sc., CES, CESA, P.Chem – Ivey International Inc., BC, Canada

TRC
 Results you can rely on
 www.trcsolutions.com

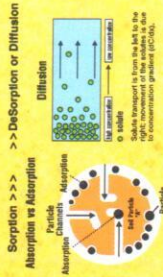
Pilot Test Approach

- Ivey-Sol 103 pilot scale injection undertaken over 5 days in July/09
- Four injection events.
- One injection well
- Five surrounding recovery and monitoring wells
- Mobile HVDPE system capable of 28 Inch. Hg vacuum and 800 SCFM
- Groundwater recovery – 0.24 gpm

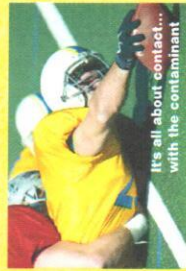


HVDPE Extraction Well
 Diagram shows radius of influence and potential LNAPL collection

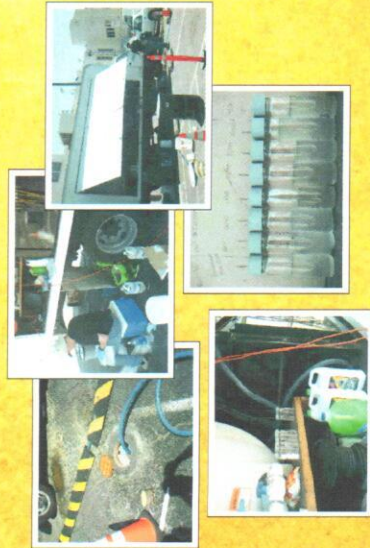
Remediation Challenge



- Recalcitrant petroleum product residuals in fractured bedrock
- Persistent concentrations in groundwater after 12 years of remediation – incl. pumping, HVDPE

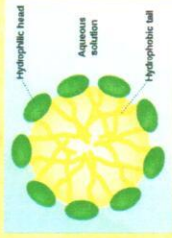


It's all about contact... with the contaminant.



Surfactant Chemistry

Surfactant Structure



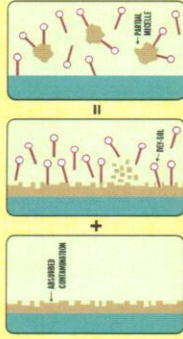
Hydrophilic (water loving) and Hydrophobic (water hating oil-like) Groupings allow for Mobilization of many Organic Contaminants

Classes of Surfactants

- Anionic:** Have one or more negatively (-) charged groupings; commonly used in laundry detergent
- Cationic:** Have one or more positively (+) charged groupings, typically poor detergents, but well suited for use as germicides, fabric softeners and emulsifiers.
- Ampholytic:** Contain both anionic and cationic groupings; prefer neutral pH and found in products such as hair shampoo, skin cleaners and carpet shampoo.
- Ionic Surfactants make up >95% of the surfactant used around the world.**
- Non-ionic:** Have no ionic constituents or groupings; largest single group of SAA and have a correspondingly wide range of chemical characteristics. Ivey-sol® surfactant mixtures are non-ionic and have the unique ability to selectively desorb contamination (LNAPL, DNAPL's, PAH, PCB, DCE, TCE, PCE), etc.

Why Ivey-sol® Surfactants?

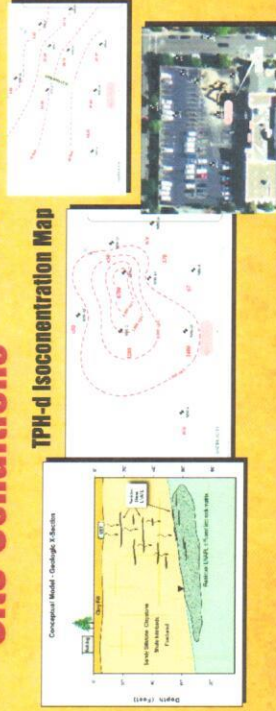
- Improves desorption of target contaminants from soil
- Lowers the surface tension of water improving both its wetting and associated permeability (K) properties
- Effective as a stand alone technology for soil washing
- Effective to improve other remediation techniques (i.e., P&T, Soil Washing, Bioremediation, Chemical Oxidation/Reduction)



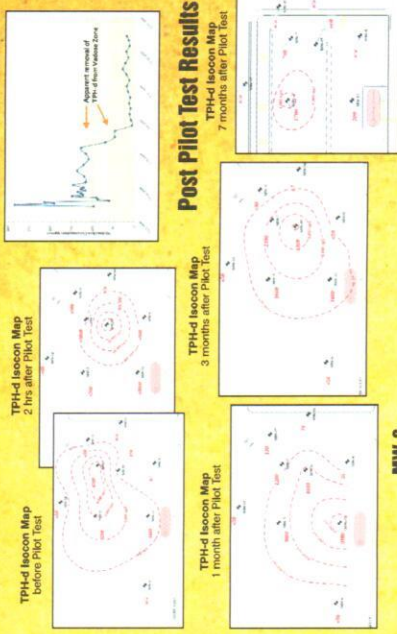
NAPL vs. DNAPL

Site Conditions

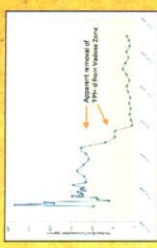
Site GW Gradient



Results Before and During Test



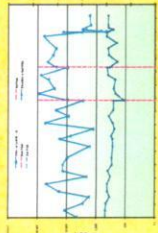
HVDPE Vapor Concentrations



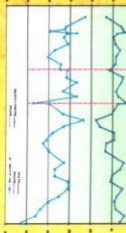
Post Pilot Test Results



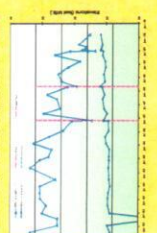
MW-2
 [L: 160 x 10 mg/day - 1,655 x 10 mg/day] ± 100% = **59.6%**



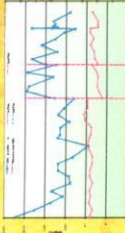
MW-11
 [L: 678 x 10 mg/day - 1,273 x 10 mg/day] ± 100% = **95.5%**



MW-7
 [L: 175 x 10 mg/day - 3,311 x 10 mg/day] ± 100% = **68.2%**



MW-15
 [L: 107 x 10 mg/day - 2,200 x 10 mg/day] ± 100% = **1,599%** Standard Deviation
 [L: 67 x 10 mg/day - 2,611 x 10 mg/day] ± 100% = **1,924%** Peak-PAH



Pilot Test Summary

- Hydraulic control achieved
- Radius of influence of > 60 ft
- Removed TPH-d from vadose zone
- Lowered groundwater concentrations

We increased the TPH-d recovery by >590% to >1,924% across all the wells on-site

Ivey International Inc.

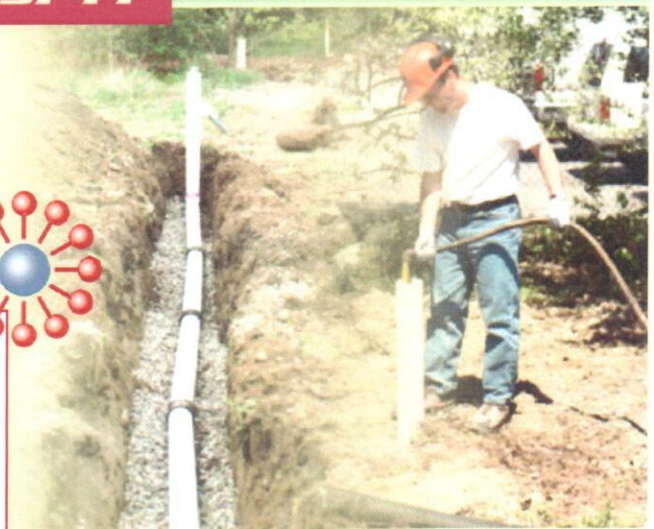
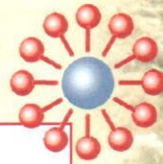
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Ivey International Inc.

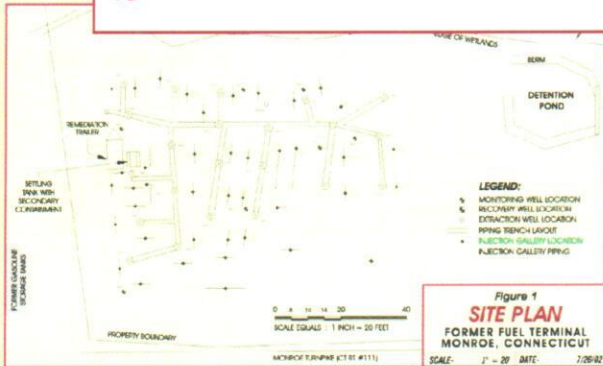
Case Study: Monroe, Connecticut, USA

Monroe Facts:

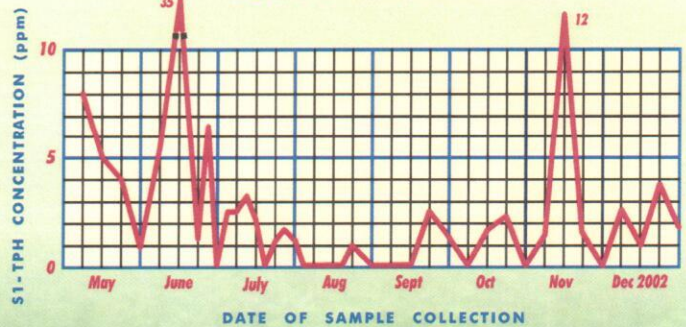
- Former heating oil terminal from the mid-1950's to the late 1970's
- No. 2 fuel oil was stored at the site
- Multiple releases occurred over time
- Site and surrounding area are wetlands, with the former terminal area elevated with fill material for commercial use
- Irregular fill consisting of sand, silt, gravel and boulders with some timbers and metal buried throughout the site
- Sensitive receptors are adjacent stream and down-gradient potable wells
- High vacuum (dual phase) extraction system in use at the site since late 1999
- Selective Phase Transfer Technology (SPTT) system installed in May 2002
- Monthly SPTT injections commenced in May 2002



Site Images



Influent Total Petroleum Hydrocarbon Concentration



Conclusions:

- Mass Recovery = Flow Rate x Concentration
- Mass Recovery (pounds per day) = gallons per minute (gpm) x mg/l x 0.012
- $3.785 \text{ l/gal} \times 1 \text{ lb}/454,000 \text{ mg} \times 1440 \text{ minutes/day} = 0.012$
- Mass Recovery prior to the injection period is based on an average influent concentration of 0.75 mg/l
- $8 \text{ gpm} \times 0.75 \text{ mg/l} \times 0.012 = 0.072 \text{ lbs/day} = 3.269 \times 10^{-4} \text{ mg/day}$ (prior to SPTT use)
- Mass Recovery during the injection period is based on a concentration average calculated using the post injection peak concentrations of 3.07 mg/l
- $8 \text{ gpm} \times 3.07 \text{ mg/l} \times 0.012 = 0.29472 \text{ lbs/day} = 13.38 \times 10^{-4} \text{ mg/day}$ (during SPTT use)
- **Pre vs. post injection mass removal rates show an increase of 409.3%**



Handex Environmental, Inc.
PRACTICAL ENVIRONMENTAL SOLUTIONS

Today's Environmental Solutions For a Better Tomorrow.™

“ The Ivey-sol surfactant products significantly enhanced our contaminant mass recovery by >400%, and put a rapid end to a 5 year plus remediation project in less than 9 months. We were very pleased with the results and would recommend it's use to enhancing site remediation. ”

Dan Smith, Project Manager – Handex Environmental, Inc.

Appendix 6
May 9, 2014 Advanced Land and Water, Inc. Letter

May 9, 2014

Mr. Dane Bauer
George, Miles & Buhr, LLC
120 Sparks Valley Road, Suite A
Sparks, MD 21152



7540 Main St. Suite 7
Sykesville, MD 21784
PHONE 410-795-4626
FAX 410-795-4611
www.alwi.com

Re: Chestertown Concerns About Hospital's Ivey-Sol Pilot Test Plan
ALWI Project No. KE3N109

Dear Mr. Bauer:

As an element of continuing professional services we are providing to the Town of Chestertown (the Town), Advanced Land and Water, Inc. (ALWI) has summarized our concerns (as well as those of the Town) and current recommendations with respect to the proposed Ivey-Sol pilot test discussed when we met together, on April 15.

On April 24, Mr. George (Bud) Ivey participated in a teleconference with Bob Sipes of the Town and the undersigned, during which several technical questions were asked and addressed. Later that day, Mr. Ivey circulated an email summary of that teleconference. While it serves as a good summary of the technical issues discussed, Mr. Sipes and I both feel it mischaracterizes our overall satisfaction with the pilot testing plan as it now exists. Distinct concerns remain unaddressed.

This letter was prepared to summarize the chief unaddressed concerns and unanswered questions, as of this juncture. They include but are not necessarily restricted to the following:

1. **Financial Assurances / Guarantees-** The Town seeks an enforceable legal means, such as a bond, to fund investigation, remediation and/or replacement of supply well(s) jeopardized or contaminated by the Hospital and/or its remedial efforts, whether in connection with Ivey-Sol or otherwise. We understand that the Town's and Hospital's attorneys may be the ones to address this concern and requirement with greater specificity.
2. **Hydrologic Control During Ivey-Sol Pilot Injection-** Bud Ivey explained that pilot testing could occur and could provide meaningful data, whether or not pump-and-treat remediation continued during pilot testing. The Town would feel more comfortable if the cone-of-depression now apparent on various maps that have been circulated remained a reflection of actual water table conditions during the whole period of Ivey-Sol pilot testing. Keeping that measure of artificial hydrologic control, operational at all times, simply is more protective than not doing so. If the Hospital and/or MDE continue to countenance a pilot test wherein the remedial pump-and-treat is turned off, even briefly the Town is concerned that several and possibly many/most of the now-existing injection, monitoring and/or recovery wells have tops-of-well-screens too deep to see and intercept free-phase liquid hydrocarbon that may be liberated during the Ivey-Sol pilot testing process.
3. **Concern over Efficacy of Ivey-Sol and Released Contaminant Removal (After Injection)-** The Town feels that the representation that Ivey-Sol and its liberated diesel contaminants will be 100% removed during the "pull" phase of "push-pull" deployment lacks substantiation. Best would be a full and accurate understanding of how this is known. The Town conceptualized a program wherein dyed water was "pushed" and then "pulled" to demonstrate the radius of influence and recapture effectiveness, in advance of actual Ivey-Sol deployment. Similarly, we at ALWI thought of using dyed water as the Ivey-Sol dilution agent. In either case, removal of all of the detectable dye (versus not) could help illustrate what otherwise seems a mere representation without clear supporting facts. In its revised work plan, the Hospital should propose precisely how it intends to monitor and thus know, that full Ivey-Sol (and released contaminant) recapture has occurred during the "pull" phase.

This concern lessens but is not eliminated with continuance of the pump-and-treat throughout the push-pull process.

4. **Better Hydrogeologic Characterization** - We and the Town feel that there is need and basis for better hydrogeologic characterization. As aforementioned, Bud Ivey did not address our continuing concern about the shallowness of groundwater levels and the depths of the existing screens. The Town remains concerned that liberated product will go undetected past one or more monitoring wells because their screens are set too deeply to intercept free-phase liquid hydrocarbon if liberated. The available cross-sections, printed at poorly legible scales and absent reference maps (or not provided to the Town), illustrate this concern plainly.
5. **Timing/Scheduling of Ivey-Sol Pilot Testing**- We understand that the Hospital seeks for testing to occur soon, during the 2014 high-groundwater-levels season. We have recommended to the Town that spring 2014 Ivey-Sol pilot testing occur only while the hydrologic control achieved by current pump-and-treat continues unabated and/or only if several additional monitoring wells with shallower well screens first are installed. We recognize that there may not be time for installing such wells before groundwater levels naturally decline, but Bud-Ivey's suggestion that such additional wells be installed only before more full-blown Ivey-Sol deployment seems unnecessarily risky. They should be installed now. Another option may entail delaying pilot testing until prevailing groundwater elevations are lower in the fall, but this may lessen the remedial efficacy at shallow horizons. In any event, the revised work plan should clearly and unequivocally address how the water table in the contaminated area will be and will remain against the screens of monitoring wells, before, during and after Ivey-sol pilot testing.
6. **Concerns About Plume Extent, Two-Year Travel Time Calculation and Basis** - The Town feels that the extent of the plume is not known with certainty and that the basis for the two-year travel time determination be presented with documentary support. By way of example, the Town feels that the appearance of product in wells across Brown Street and all the way to Monitoring Well 18 on Campus Avenue, following an experimental turn-off of the system by the consultants for the Hospital two years ago, supports its grave concerns and reservations concerning the predictability of underground movement in the aquifer. With respect to travel time, we are concerned that the methods involved with introducing Ivey-Sol with a large quantity of water will have the effect of creating a temporary groundwater mound at the location(s) of injection. This mound may have the effect of steepening groundwater gradient, accelerating groundwater velocity and shortening consequent travel times. Such mounding effects and consequent groundwater velocity acceleration further supports the need for continuous pump-and-treat during Ivey-Sol pilot testing. The revised pilot testing plan should address the temporary groundwater mounding and velocity issue in detail.
7. **Limits on Extensiveness of Pilot Testing**- The Town seeks a clear commitment that the revised pilot testing work plan reflect four (or fewer) wells for pilot testing and not the six as first proposed. Those directly upgradient of the present locus of the pump-and-treat cone-of-depression seem more appropriate test injection locations than do wells of more of a cross-gradient position. The revised work plan should reflect or otherwise address this concern.
8. **Relevant Case Studies and Related Communications**- I have had the opportunity to be copied recently on certain emails between Bob Sipes of the Town and Bud Ivey. Generally these emails related to the Town's request for correlative case history information on the successful use of Ivey-Sol for remedial efforts in other municipal groundwater capture areas and/or source water protection zones. The California case history seems not correlative inasmuch as the aquifer seems not used locally as a municipal supply for the affected jurisdiction. The Connecticut information seems more marketing information than an actual case history. We also understand that Bob Sipes was unsuccessful in his attempts to contact managers of the affected Connecticut system. As such, to us it

seems that the Town's request for correlative information on the successful deployment of Ivey-Sol in like circumstances remains both a reasonable and an unaddressed request.

The Town does not seek to unreasonably delay or restrict the Hospital in cleaning up its spill. The Town respectfully requests that the Hospital and MDE support these reasonable requests to comprehensively address the concerns set forth above. Further, the Town seeks to be an active participant in all further discussions and negotiations regarding Ivey-Sol specifically and the remedial effort in general. The position of the release in the Town's source water protection area warrants this. The Hospital release cannot be treated like any other spill and the Hospital cannot be treated like any other party responsible. The situation is unique and the Town's request and positions need to be respected due to their responsibilities to protect the source of water for the Hospital and Town.

By copy of this letter and on behalf of the Town we respectfully request that the MDE Oil Control Program not to allow Ivey-Sol pilot testing deployment until these issues and concerns are addressed to the full satisfaction of all parties. We also ask the Hospital not to continue to seek such permission until and unless the Town's concerns first are addressed, and not to characterize the thoughts, opinions or determinations of the Town in communication with the agency.

The Town looks forward to the opportunity to continue to work with the Hospital and MDE toward an appropriate and constructive resolution to the satisfaction of all parties. Thank you for your attention.

Sincerely,



MARK W. EISNER, P.G.
President

MWE/tib

Cc: Bud Ivey – Ivey International, Inc.
Chris Ralston – MDE Oil Control Program
Susan Bull – MDE Oil Control Program
John Grace – MDE Source Protection and Appropriation Division
Bob Sipes – Town of Chestertown
Bill Ingersoll – Town of Chestertown
Kenneth Kozel - Shore Health System