INFRASTRUCTURE COMMITTEE MEETING
6:00 P.M.
Monday, October 26, 2015

HAMPDEN TOWN OFFICE

A G E N D A

1. MINUTES – 9/28/2015 Meeting
2. OLD BUSINESS
   a. Pine Tree Landfill Post Closure Monitoring – update – Town Manager Angus Jennings
3. NEW BUSINESS
   a. Town-wide Capital Planning –goals for FY17 budget cycle – Town Manager Angus Jennings
   b. Transfer Station layout, circulation and operations – potential short-term and longer-term concepts – DPW Director Sean Currier
   c. Fees Ordinance section on sewer connection fees – Referral from Town Council
   d. Turtlehead Park / Marina – condition of dock and boat ramp
   e. Municipal Building HVAC System and Software
4. PUBLIC COMMENTS
5. COMMITTEE MEMBER COMMENTS

**INFRASTRUCTURE COMMITTEE MEETING**
Monday, September 28, 2015

**MEETING MINUTES – DRAFT**

*Attending:*

*Councilor Dennis Marble, Chair*
*Councilor Stephen Wilde*
*Mayor David Ryder*
*Councilor Terry McAvoy*
*Councilor William Shakespeare*
*Town Manager Angus Jennings*
*Recreation Director Shelley Abbott*
*Public Works Director Sean Currier*
*Resident Tom Brann*

*Councilor Marble called the meeting to order at 6:03 p.m.*

1. **MEETING MINUTES – 8/4/2015 Meeting** – *Motion by Councilor McAvoy, seconded by Ryder Ryder to approved the October 5, 2015 minutes. Unanimous (5-0) vote in favor.*
2. **OLD BUSINESS**
   a. **Parking at Lura Hoit Pool and Soccer Field** – *Manager Jennings presented background information regarding concerns that have been raised about parking at the pool facility overflowing onto Western Ave. Parking demand tends to be greatest on Thursday evenings and Saturday morning to midday in the fall as a result of soccer programming. Manager Jennings reported that this parking overflow was especially acute on the first Thursday of fall youth soccer (Sept. 10), but has improved in the couple of weeks since then due to staff actions including additional "no parking" signage installed on the south side of Western Avenue; and placement of orange cones on the north side of the road at the Pool driveway, the crosswalk and Evergreen Drive to provide adequate separation of parking from pedestrian and vehicular access points to ensure sight distance. Manager Jennings reported on a recent meeting including DPW Director Currier, Recreation Director Abbott and Public Safety Chief Rogers. Chief Rogers reported that his officers have not expressed safety concerns regarding the current parking situation, since the noted changes. He has planned public safety staffing appropriately to ensure officer availability for scheduled events expected to draw many participants, such as a soccer tournament the weekend of October 3-4. One additional change that Director Abbott will make for the 2016 program brochure will be to omit timing for soccer programs from the registration flyer, but instead provide this post-registration once Recreation staff knows overall attendance to allow staff to stagger program start times to minimize parking shortages and overflow.*

      *Councilor Wilde noted that there are restrictions on addition of impervious surface to the site resulting from DEP regulations that prevent us from adding new parking spaces without DEP permitting approval. Director Abbott expressed concern about a concept plan to convert the volleyball court to parking because this public amenity receives use for its intended purpose, and reflects prior public investment. Councilor Ryder asked whether youth soccer programs could be run at the VFW Fields to reduce parking pressures at the pool site. Director Abbott responded that those fields are heavily used by Little League, and that the timing*

*would conflict with times needed for soccer programs. She discussed the option to run two soccer games at a time, rather than three (as is done now) in order to reduce the number of participants in each time slot, but indicated that in order to accommodate the same number of participants this would extend staffing hours.*

*Councilor Ryder asked whether soccer programs could be hosted at Dorothea Dix Park, especially non-game skills training that would be appropriate for younger kids.*

*Director Currier asked whether parking capacity is a concern at the VFW fields. Councilor Marble indicated that it's busy every now and then. Director Currier asked whether the former ice rink site (at the VFW fields) might be a viable site for additional field space, or parking. Councilor Marble suggested that staff continue to look into solutions to the field space and parking issues. Councilor McAvoy indicated that it would be impractical to make changes this fall, but that over the longer term he'd like to see the Recreation Department find other locations to program activities.*

*Mayor Ryder asked whether the VFW ice rink site should be explored as a potential field location. Councilor Marble indicated that this could be reviewed in the context of looking at parking and site utilization, generally, in the Town Center. Councilor McAvoy asked whether materials removed from catch basins during cleaning could be used as backfill on the ice rink site, and Director Currier indicated that this may be possible. Councilor Marble expressed support to explore alternative programming locations including the ice rink site and the VFW fields.*

*Tom Brann indicated that the old ice rink used to hold 4" of standing water. He noted that there is a lot of space between the VFW ball fields and Main Road. He asked whether the drainage swale north of the pool building could be buried to increase parking on that site. He indicated that the sand volleyball court was originally intended to be flooded and frozen in the winter to serve as an ice skating rink, but Director Abbott indicated that the valve required to do so had not been installed.*

*Councilor Marble requested a progress update from staff in a couple of months.*

**3. NEW BUSINESS**

a. **Request to use Recreation Clearing account funds – Shelley Abbott, Recreation Director – $4,215.00 for Boiler Rooms Door Replacement at Skehan Recreation Center; and $7,455.82 for purchase of replacement mower – Referral from Services Committee** *– Director Abbott presented the results of her solicitation of multiple cost estimates for the replacement of boiler room doors at the Skehan Center, and recommended acceptance of the proposal from Exactitude in the amount of $2,980 and to fund the purchase from the Recreation clearing account. Motion by Councilor Wilde, seconded by Mayor Ryder, to refer the matter to the Finance Committee with a recommendation to accept the Exactitude bid. Motion passed 5-0.*

*Director Currier presented the results of his solicitation of multiple cost estimates for the purchase of a replacement mower, and recommended acceptance of the*

*proposal from Hammond Tractor in Fairfield in the amount of $4,500 (including trade-in value). Councilor McAvoy asked whether the mower would be used on non-Recreation property. Director Currier responded that it would be used primarily on Recreation property, including the Pool property, VFW, Ballfield Road, and the field behind the Skehan Center, and would also be used at Lakeview Cemetery. Councilor Shakespeare asked about the rationale of buying the mower now rather than waiting until spring. Director Currier responded that the current mower has logged 1,930 hours, and he wanted to preserve the value of the current mower for trade-in. Motion by Mayor Ryder, seconded by Councilor Wilde, to refer the matter to the Finance Committee with a recommendation to accept the bid from Hammond Tractor and to fund the purchase from the Recreation clearing account. Resident Tom Brann expressed his opinion that this matter reflects extreme micromanagement, and that the Council should be concerned with whether the lawns get mowed rather than the specifics of equipment purchasing. Motion passed 5-0.*

**b. DPW Director Project Updates**

**a. MS4 Stormwater Permit Compliance / Catch Basin Cleaning** – *Manager Jennings provided background regarding the need for catch basin cleaning as part of the Town's MS4 permit requirements. He explained that, although this work is required during the current fiscal year under the terms of the permit, no funds were budgeted.*

*Councilor McAvoy said that it's important for the Town to stay on top of this issue. Mayor Ryder asked whether this work was something we have to do or something we should do. Director Currier replied that this is something we are required to do, and that it's the Town's responsibility to comply with the permit conditions. He expressed his goal of getting the work done in order to be able to address stormwater management issues (including catch basin cleaning) on a preventive basis rather than waiting until the catch basins have accumulated a lot of material.*

*Manager Jennings stated that he anticipates bringing forward a proposal to the Finance Committee and to the Council to fund this work, drawing from cost savings elsewhere in the FY16 budget, to allow the work to go forward this fall***.**

**b. Route 1A/Main Road North sidewalks** – *Director Currier provided the Council an update on work that MaineDOT has programmed to resurface Main Road North and to add new sidewalks, anticipated in 2018. Director Currier had noticed that the sidewalk plans did not include widening of the bridge near the Water District and, without widening the bridge, sidewalks wouldn't be feasible. He had brought this matter to the attention of MaineDOT, and it appears that the state may revisit the design to potentially include this work. The Town would be responsible for a 10% share of construction costs for any such work.*

**c. Transfer Station "Swap Shop"** – *Director Currier provided background regarding the type of items that are sometimes left at the Swap Shop, including*

*at times hazardous materials such as discarded propane tanks. He reported that it takes a fair amount of staff time to clean up the Swap Shop after each weekend, and raised concerns regarding haphazard parking patterns, internal traffic flow issues and, in general, the amount of materials left in the Swap Shop that have no repurpose value and become junk that must be disposed of – sometimes incurring disposal costs – by the DPW. Mayor Ryder asked about staffing levels, and whether the Swap Shop could be monitored more closely. Director Currier responded that, with two people working, one is responsible for operating the compactors and the other is generally occupied, especially during C&D weekends. Councilor Shakespeare asked whether, if we continue to operate the Swap Shop, it could be relocated for improved visibility and management. Councilor Marble suggested that there may not be enough room within the fenced-in portion of the Transfer Station to do all that we're trying to do out there. Councilor McAvoy said that when the Swap Shop was first opened it was serving a purpose, but now it's not clear that it's functioning as the community resource it was intended to be.*

*Director Currier said that the fence can't be moved without a DEP permitting process, and that he'd look into this in more detail with the DEP.*

*Councilor Shakespeare provided a brief history of the Transfer Station, including stating that rules were adopted in 2003 to restrict trailers in an effort to keep commercial contractors from using the facility (which is intended for non-commercial residential use). The Council has previously said that a resident could use a dump trailer, but that the Council never updated the posted weight limit restriction. He expressed his opinion that the Council needs to get rid of the weight limits at the Transfer Station.*

*Manager Jennings recommended that the Transfer Station Rules and Regulations, and associated documents that communicate the rules to the public, be brought to the next meeting of the Council.*

*Councilor McAvoy said that the C&D operations should be on a future agenda, as he is alarmed by the amount (tonnage) of solid waste based on Hampden's population.*

*Mayor Ryder directed that the weight limit posted on the Transfer Station signage be addressed.*

*It was agreed that the Transfer Station Rules and Regulations, and associated materials, would be placed on the next Town Council agenda.*

4. **PUBLIC COMMENTS** – *None.*

5. **COMMITTEE MEMBER COMMENTS** – *None.*

*There being no further business, the meeting was adjourned at 7:50 p.m.*

Respectfully submitted –
Angus Jennings, Town Manager

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TO: Town Council Infrastructure Committee (Dennis Marble, Chair)

FROM: Angus Jennings, Town Manager

DATE: October 22, 2015

RE: Notes for Infrastructure Committee Meeting of October 26

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The following notes are provided in preparation for Monday evening's meeting. Where noted, supporting materials are attached. Public Works Director Sean Currier will be in attendance to support the discussion of several items on the agenda.

Pine Tree Landfill Post Closure Monitoring

I have spent some time looking into protocols regarding the Pine Tree Landfill post closure reporting. As you may know, up until about two years ago, the Town retained services from Drumlin Environmental, LLC (and, at times, Soil Metrics, LLC working through Drumlin) including peer review of the regular reporting that Casella sends to DEP.

In the course of my review, including conversations with Matt Reynolds from Drumlin and Karen Knuuti from DEP, I learned the following:

- Drumlin's work was pursuant to a 2005 task order agreement with the Town, but this has never been updated, and Drumlin has not prepared any reporting for the Town since 12/4/13 (a copy of which is attached).
- DEP personnel are reviewing the reporting from Casella, and in some cases are responding with detailed analyses. The two most recent memos, from June and July 2015, are also attached. In my conversation with DEP I learned that **the Town has not been copied on DEP correspondence** (including the two 2015 memos). DEP was under the assumption that Drumlin, who has been copied on the memos, was in turn briefing the Town. Now that DEP understands this isn't happening, they will copy us on their Pine Tree related correspondence going forward.

It appears to me that DEP is paying close attention to Casella's reporting. However, DEP acknowledges that, while their staff has strong technical capability, they sometimes have capacity issues due to overall workload. Due to the technical nature of the

reporting, and the importance of this matter to the Town and its residents, I have invited Drumlin LLC to recommend a work scope to re-engage their services. The 5-year post closure report is due in April 2016, and represents a significant milestone in the post closure process. I would like for the Council to understand the options regarding potential third-party review of this matter. It is anticipated that a proposed scope and budget for Drumlin's continued work will be available in time for consideration at the November 16 meeting of the Finance Committee and Council.

Notably, a report was received today from the Maine Center for Disease Control and Prevention finding that "there is no evidence of increased cancer cases in the town of Hampden or a cancer cluster in the Coldbrook Road neighborhood." This report, which I have not yet had time to review in detail, is enclosed in support of Monday's discussion.

Town-Wide Capital Planning

I have had conversations with some if not all Councilors individually about the goal of re-establishing a formal multi-year capital planning process in 2016, and have also discussed this objective with Department Heads whose operations rely on periodic capital expenditures.

I do not have specific information to discuss at Monday's meeting, other than to bring this topic forward for discussion on a public agenda. Because other items on Monday's agenda have potential capital implications, I think it will be helpful to begin to solidify an approach to documenting Town-wide capital needs. While this does not preclude consideration of any potential urgent matters (if any) outside of this process, I think a Town-wide framework will help the Council weigh relative priority of various items.

Transfer Station Layout, Circulation and Operations

As part of his ongoing review of DPW Operations, Director Sean Currier has brought forward a number of ideas regarding both short-term (no- or low-budget) and longer-term changes to the layout at the Transfer Station. He has preliminarily discussed these options with DEP during a recent site visit in order to ensure that we understand any potential restrictions. At Monday's meeting, Sean will brief the Committee regarding these ideas in order to seek your direction.

Somewhat related to the above, in correspondence sent to me on August 20 – prior to my official start date – former Town Manager Lessard advised me that the issue of whether or not school groups and the like should be allowed to conduct fundraisers at the Transfer Station was a continuing item before the Infrastructure Committee. Because this had been sent to my personal email account, I had overlooked this issue until recently. Upon review of recent Infrastructure Committee meeting minutes it does not appear that the Committee reached resolution regarding this matter. It is therefore reintroduced for consideration.

Fees Ordinance: Sewer Connection Fees

Annual review of the Fees Ordinance began at the October 19 Council meeting. Leading up to that meeting, correspondence from DPW and Code Enforcement suggested the need to look at the sewer connection fee, as well as other protocols associated with management of the sewer infrastructure, and planning for financing longer term system maintenance and expansion. This section of the Fees Ordinance was referred to the Infrastructure Committee for further discussion. The materials from the Council packet are enclosed.

Turtlehead Park / Marina Dock and Boat Ramp

During the Public Comments portion of a previous meeting, a citizen brought forward the issue of the condition of the dock and the ramp at the Town Marina. Since that time, I have visited the site, and reviewed various documents related to the Town's transfer of ownership of a portion of the Marina to Hamlin's Marina. It appears clear based on these documents that the land transfer did not include transfer of the dock. Notably, the dock includes a fueling station.

Since that time, Dean Bennett and I met with Dan Higgins of Hamlin's to discuss this matter. Mr. Higgins has reported that, over the years, Hamlin's has removed the docks from the water each November and returned them to the water in the spring.

Mr. Higgins raised concern regarding maintenance needed for both the docks and the ramp. Mr. Higgins was in receipt of a June 2015 cost estimate provided by Wellman Paving estimating costs of $24,790 for the work on the ramp, and not including any work on the docks. Photos provided by Mr. Higgins, and the estimate from Wellman, are attached.

The Hampden Harbor Ordinance, last updated in 2003, is enclosed as it may have relevance to the discussion. DPW Director Currier will be in attendance in his capacity as Harbor Master.

Municipal Building HVAC and Software

I have held meetings in recent weeks with Town staff regarding ongoing concerns regarding the air handler and temperature control system serving the Municipal Building (including Public Safety).

The temperature controls system has not been updated since 2002, and there are known discrepancies between reported temperature and actual temperature in different zones within the building. The computer that runs the temperature control software is the oldest workstation in the building, and the software itself is incompatible with a newer operating system. In addition to daily concerns (related to temperature, air circulation and cold drafts in specific locations), there is also concern about the potential for a system breakdown, and resulting disruptions to operations.

It is believed that updates to the workstation and software, and targeted adjustments to air vents, would both resolve current issues, avoid a potential breakdown – and very likely result in greater efficiency (and cost savings) associated with heating and cooling the building.

We will brief the Committee regarding these matters on Monday. We will also review these matters with our vendor Penobscot Temperature Controls to get a better understanding of how these issues could best be addressed. DPW Director Currier will be in attendance in his capacity as Facilities Manager.

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| | Drumlin Environmental, LLC<br>*Hydrogeologic and Engineering Consultants*<br><br>**Soil Metrics, LLC** | |

**To:** Mike Booth, John Sevee, SME
Steve Farrar, MDEP
**From**: Steve Rabasca, Hampden Technical Consultant
**Date:** January 15, 2007
**Re**: Stability Analysis, Secure III Closure, Pine Tree Landfill
**Cc**: Town of Hampden

This letter summarizes my review of the document titled: Stability Analysis, Secure III Closure, Pine Tree Landfill, Hampden, Maine, dated September 2006. The report includes the results of global and cover stability analyses in support of the PLT plans to modify the final closure slopes from 3H:1V to 2.5H:1V.

## 1.0 Global Stability Analyses

The global stability analyses were performed in order to evaluate the factor of safety for hypothetical deep seated failures to occur through the entire waste mass and foundation soils or along the Secure III liner interface. The following items summarize my review of the global stability analysis:

1.1 Representative Cross Sections: Nine cross sections were selected for evaluation of the global stability to represent the worst-case slope/foundation/liner slope conditions expected across the site. The sections selected appear to be a reasonable representation of the various slopes and foundation conditions at the landfill. Many of these sections were previously evaluated under the initial design of Secure III prepared by SME.

1.2 Selection of Waste and Material Properties: The waste and soil material properties presented in Table 2-1 appear reasonable, based on the field, laboratory and monitoring data presented in other reports.

1.3: Selection of Peak and Large Displacement (LD) strengths for Liner Interfaces: The text of the report indicates that the lowest peak interface strength was used in the analysis when considering failure surfaces at the Secure III liner interfaces. The required factor of safety for this condition is 1.5. The text of the report also states that for the LD analyses, the LD strength for the low peak was used, with a minimum required FS of 1.0, per SME internal guidance. This guidance is based on a paper from Gilbert, (2001).

- Is using the LD strength of the lowest peak and a FS > 1.0 consistent with current practice in Maine and in the industry in general?

- In some instances the low-peak LD corresponds to the low LD strength (many of the side-slope liner tests). In other instances (Phase VI and Phase VII base liners), the low-peak LD is much higher than the low LD strength. There was some inconsistency in how the LD strength was used in the analyses, for instance:
    - Analyses for Sections 6-5 and 6-7 used the LD of the low-peak for the base liner strength. The factors of safety were just above 1.0. The side slope strength was based on the "LD confirmation average", not the low.
    - For Sections 7-2, 7-4 and 7-6, it is unclear if the low-peak LD or the low LD strength was used. The plot in Attachment 2-2 shows that the LD of low-peak was used. (see discussion of Phase VII strengths in next bullet.)
    - For Sections 8-1, 8-2 and 8-5, the "Base LD Min" was identified but it was unclear from the plot in Attachment 2-2 if this corresponded to the low-peak LD or if it was the low LD strength. The data table points did not match up with the strength function plot in the Slope\W file. The Phase VIII strengths for peak and LD should be more clearly identified, showing the entire confirmation test database (the low stress data points were not included), and how the strength envelope was determined.
    - Section 8-8 used the "LD revised Phase 1-V msr" interpretation. Same as previous bullet, the strength envelope should be more clearly identified and the interpretation explained.
    - A paper by Stark and Choi (2004) presents a recommendation for selecting a peak composite failure envelope that included the entire range for the anticipated normal stresses. There are also recommendations for developing a residual strength envelop based on the peak composite envelope.
- For the Phase VII Base Liner strength selection, the low peak interface was identified as the Clay/GCL interface, based on one test. Are there additional tests available to confirm this number? The plot of the data shows that the lowest GC/HDPE envelope strength envelope is very close to the lowest GCL/Clay peak strength envelope, and is actually the lowest peak between normal stress levels of about 2,300 to 4,600 psf. If you compare the LD strength envelopes for GCL/Clay and GC/HDPE, the GD/HDPE has a much lower envelope. This example is easily handled by the recommendations presented by Stark and Choi (2004).
- A similar argument could be made for the Phase VI base liner strengths where the GCL/Clay interface had the lowest peak strength. The GCL/HDPE interface was not that much lower than the GCL/HDPE envelope, yet the LD envelope for GCL/HDPE is much lower than the LD envelope for the GCL/HDPE.
- One further note on the LD issue is related to the stability analyses for Phase III-C, Stage 2, contained in SME, February, 2003. In this report, the liner interface strengths used as justification for the analyses were based on the Phase VI and Phase VIIIa and are shown on Figures 2 of that report for the peak strength envelope and Figure 3 for the LD Envelopes. There are two points where the methodologies for this 2003 analysis differ from the methodologies presented in the Secure III closure design.

    - The first point is that for the peak strength envelope, the lowest peak value was chosen up to a normal stress of 6,000 psf, then the envelope was

horizontal after that so the peak shear strength was 6000 psf. For the Secure III analyses, the peak strength was extrapolated to a much higher value. Why was the methodology changed?

- The second point was the selection of the LD envelope. The same database was used to develop this envelope (Phase VI and Phase VIII-A). The peak envelope above looks like it is the GCL/Clay interface, and the lowest peak envelope. The LD envelope selected looks like it is the low LD envelope using the internal GCL LD values. Why was the methodology for using the low LD strength for Phase VIII-C changed to use the Low Peak LD values for the Secure III closure?

There are a variety of opinions on the topic that have been put forth on this project as well as throughout the industry. In my opinion, the most rationale method presented to date, and perhaps the most recent on the topic, is presented in the paper titled "Peak versus residual interface strengths for landfill liner and cover design", Stark and Choi, *Geosynthetics International*, Volume 11, No 6, (2004). I have attached a copy for you reference. The method in this paper recommends two design scenarios using a combination of peak and residual strengths, and also has recommendations for selection the appropriate strength envelope of peak and residual strengths, based on a composite of the interfaces over the normal stress range anticipated for the base liner, side slopes and cover system. In summary, I believe that this issue should be discussed further and that a rational and defensible approach to the use of interface strengths for the landfill liner stability analyses be used on this project.

<u>1.4 Global Stability Analysis Results:</u> SME provided several Slope/W analysis files for review. These were checked against the results in Table 2-3. These analyses were checked and it appears that the minimum circles found in the search routines were identified. Pending resolution of the above liner strength issue, these will be checked further.

<u>1.5 Seismic Stability:</u> A pseudostatic analysis was performed using the peak ground accelerations of 0.04g and 0.14g for the 50 and 250 year exposure periods. The DEP regulations state that:

a) The maximum bedrock horizontal acceleration must be determined based on a seismic hazard map or a site-specific seismic risk assessment and must be modified to account for the influence of the site soils, engineered components, and the waste mass.

and

b) Unless otherwise approved by the Department, the seismic stability assessment must include an evaluation of permanent deformation, an evaluation of waste and soil strength loss due to cyclic loading, and an evaluation of liquefaction potential.

As discussed further in this letter, the guidance from (Richardson and Kavazanjian, (1995), also recommends that the seismic coefficient be modified to reflect the amplification through the waste.

**2.0 Interface Stability Analyses (Cover Stability):**

2.1 Drainage Sand Strength: Table 3-1 and Attachment 3-2 indicates a peak strength of $\phi$ = 23 degrees, c (cohesion) = 210 psf, and a post-peak strength of $\phi$ = 19 degrees, c = 160 psf. Generally speaking, clean sand similar to the drainage sand tested, should have no cohesion. The cohesion exhibited in the direct shear tests may be due to apparent cohesion, caused by negative pore pressures in an unsaturated or partially saturated test specimen. This is not true "cohesion" and may be caused by an increase in the effective stress due to negative pore water pressures. This apparent cohesion becomes more significant in tests performed under low confining stresses. The problems that may arise using cohesion in the stability analyses would be when the sand layer in the field becomes saturated. If this occurs, the effects of negative pore pressures may disappear, and the shear resistance would have to rely on phi only. Considering that at least a portion of the sand layer may become partially saturated, it is suggested that additional testing of the sand be done to determine the friction angle of the sand under fully saturated conditions. If the specimen is performed with the shear box flooded, you should be certain that the sample is fully saturated before testing and not partially saturated. Several tests should be done to document that the strength of the sand drainage layer is not lower than the critical interface strength of 30 degrees.

Density of the test specimen is also important. The specimens should be tested at a density that can be reasonable expected to be achieved in the field, placed on a 2.5H:1V side slope. There should be ample documentation for documentation of the density and percent compaction from previous construction.

2.2 Vegetative Cover Soil Strength: The Vegetative Cover Soil (VCS) samples in Attachment 3-2 were tested at confining stresses of 475, 1,123, 2,419, and 3,082 psf. These are well above the confining stresses in the field. The testing to support this strength should be performed at representative (low) confining stresses to be expected in the field. Page 3-10, bullet 3 indicates that this testing will be performed.

2.3 Clay Strength: The compacted clay strength value of 1,000 psf is reasonable value to assume for this analysis. Attachment 3-2 does not provide testing for the clay soil strength.

2.4 Interface Strengths: The interface strengths selected for the analysis were based on data from interface testing at the facility from the previous cover system for Phase I-V. The minimum value selected was a 30 degree interface friction angle at the sand/Geocomposite drain interface. The associated large displacement (LD) friction angle was 28 degrees. The values presented are reasonable values for this stage of the design and will be confirmed using site specific tests, however I would follow the recommendations presented by Stark and Choi

2.5 Seismic Loading: The report references that the cover design seismic stability was evaluated using the same loading conditions as the global stability. The global stability was evaluated

using the pseudo-static approach, based on the recommendations of "Seismic Design Guidance for Municipal Solid Waste Landfill Facilities", (Richardson and Kavazanjian, (1995). The peak seismic coefficients for the PTL site were based on the USGS seismic hazard maps the peak horizontal acceleration with a 10 percent probability of exceedance over 50 and 250 year periods. The peak seismic coefficients were 0.04g for the 50 year period, and 0.14g for the 250 year period. These seismic coefficients represent ground motion in bedrock. The referenced guidance document recommends that an amplification factor be estimated to represent the peak motion at the top of the landfill for design of cover systems.

2.6 Geocomposite Drainage Requirements: The drainage evaluation indicated that the required transmissivity of the geocomposite drain is $4 \times 10^{-4}$ $m^2$/sec. The conformance testing should model field conditions, including soil to composite contact and a minimum 100 hour seating prior to testing. The test should also be run at the expected gradient in the field.

2.7 Stability Analysis Results: The cover soil stability analysis was performed using Slope/W. The model was set up for a 100 foot long section of the cap that included two surface water berms. A search for the lowest factor of safety with a slip circle forced along the interface of the Sand/Geocomopsite indicated a factor of safety of 1.6 (run number C-A-2-S, run1). As indicated in the text, this slip surface follows the notches in the buried drainage trenches, and slippage would likely break out on the VCS on the first buried drainage trench. I agree with this assessment.

A manually drawn slip surface was then drawn represented by file name C-A-3-S, Run 1, resulting in a FS = 1.8 for static and 1.5 for seismic. This surface however, appears to also follow one of the buried drainage trenches, therefore, why wouldn't the same argument hold for this slip surface as made for the C-A-S-2, Run 1 case above?

Looking at the geometry, it looks like the critical slip surface would begin somewhere within a surface water berm (because this would have the highest driving stress), and the surface would end just before the first buried drainage trench. It looks like Run: "O-C-2-S Run 5 manual sand d5slgp-msr" used something along these lines, however, it looks like the surface water berm soils are absent from the stability profile. The surface water berm soils represent a significant driving stress, therefore, make sure they are included in the analysis. I would like to a have SME forward me the slope W file for the cover soil analyses so that I may check them further.

As a check on this analysis, I made an infinite slope calculation using a method which accounts for the slope height and a passive wedge at the toe. This analysis using the interface friction angle of 30 degrees, a slope height of 10 feet (about the height between drainage notches) indicated a FS of 1.63. The factor of safety drops to 1.5 if there is 0.3 feet of head (seepage) in the drainage layer, and the FS is approximately 1.0 is there is full saturation of the cover soils. As the slope height becomes higher (30 feet or roughly the height between the surface water berms), the factor of safety drops to 1.5, and the influence of the passive wedge diminishes. (Note that these analyses do not account for the surface water berm soils as additional driving stress, which could make the FS lower.)
The infinite slope factor of safety (no passive wedge), is 1.44 for the no seepage condition. It is recommended that some simplified spread sheet calculations for the cover system stability be

performed to supplement/confirm the stability analyses performed using Slope/W. Also additional runs should be made with Slope/W with surfaces through the surface water berm exiting the slope just before the first buried drainage trench downstream.

As indicated previously, the seismic coefficient should be modified to reflect the amplification through the waste as recommended in (Richardson and Kavazanjian, (1995).

**3.0 General Design Issues:**

- Has the use of a turf reinforcement product been considered for the 2.5H:1V side slopes in order to protect and reinforce the slopes in the period between seeding and the establishment of grass cover?
- The grade of the diversion swales should be designed to consider the impacts of long-term settlement such that the grade does not drop below the minimum required over the lifetime for the facility.
- It is critical to the function of the overall cap drainage system that the intermediate drainage swales be designed so that the surface flow does not undercut and erode the vegetative cover. This could overwhelm the cap drainage system.
- What are the details of the down spout? Is this a solid pipe, and if so what is the magnitude storm that it is designed for?
- What is the design storm event for the surface water run off in?
- What impact will freezing have in the function of the cover drainage system?
- Do you think that a vegetative cover soil with a PI of 15 is possible? This would be a clay soil similar to the clay liner material, or possibly an organic rich soil. I think the requirement for no filter analysis if the PI is 15 or greater would be applicable if it were in contact with the Geocomposite Drain. The Soil Conservation Service has applicable filter requirements for fine grained soils. I would not expect that filtering would be a problem for an organic rich soil with significant fines next to a clean fine to coarse sand similar to the drainage sand.

  If you have any questions or comments regarding this review, please do not hesitate to contact me

# Technical Note

# Peak versus residual interface strengths for landfill liner and cover design

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Received 22 October 2003, revised 21 September 2004, accepted 21 September 2004

ABSTRACT: The rationale for using peak, residual, or a combination of these shear strengths for the analysis of geosynthetic-lined slopes and design recommendations for landfill liner and cover systems is presented herein. Landfill liner systems using geosynthetics that contain sideslopes are recommended to be designed using the methodology presented by Stark and Poeppel: (1) assign residual shear strengths to the sideslopes and peak shear strengths to the base of the liner system and satisfy a factor of safety greater than 1.5; and also (2) assign residual strengths to the sideslopes and base of the liner system and satisfy a factor of safety greater than unity. The authors recommend that the stability of landfill cover systems be analysed using peak shear strengths with a factor of safety greater than 1.5 because of the absence of large detrimental shear displacement along the weakest interface. If, for some reason, the slope angle of the cover system exceeds the friction angle of the weakest interface, or large displacements such as construction-induced displacements or seismically induced displacements are expected, a residual shear strength with a factor of safety greater than unity should be used for the cover design. In both liner and cover designs a peak composite failure envelope that describes the weakest interface should be used to represent the peak shear strength, and the residual failure that corresponds to the peak composite failure envelope should be used instead of the lowest residual failure envelope.

KEYWORDS: Geosynthetics, Interface shear resistance, Design, Direct shear test, Ring shear test, Shear strength, Slope stability

REFERENCE: Stark, T. D. & Choi, H. (2004). Peak versus residual interface strengths for landfill liner and cover design. *Geosynthetics International*, **11**, No. 6, 491–498

## 1. INTRODUCTION

The main objectives of this manuscript are to clarify the recommendations for the design of geosynthetic-lined landfill liner slopes presented by Stark and Poeppel (1994) and to present new recommendations for the design of landfill cover systems. This discussion is limited to slope instability that might occur along a soil–geosynthetic or geosynthetic–geosynthetic interface. This discussion does not relate to possible slope instability that may develop in soils underlying a waste containment facility or through the waste materials.

The selection of the interface shear strength that should be used for design of the liner and cover system is important because it affects the disposal capacity of a waste containment facility. The usual design objective for waste containment facilities is to maximise storage capacity. Thus sideslopes are designed and constructed as steeply as possible, and the waste height and slope will be as high and steep as possible, respectively. Many researchers (e.g. Martin *et al.* 1984; Saxena and Wong 1984; Koerner *et al.* 1986; Williams and Houlihan 1987; Negussey *et al.* 1989; Bove 1990; Mitchell *et al.* 1990; O'Rourke *et al.* 1990; Takasumi *et al.* 1991; Yegian and Lahlaf 1992; Stark and Poeppel 1994; Stark *et al.* 1996; Dove and Frost 1999) have shown that the residual interface shear resistance can be as much as 50–60% lower than the peak interface shear resistance. Thus use of a residual strength in design results in substantially flatter slopes, smaller disposal capacity, and decreased

revenue. However, a number of case histories (Seed *et al.* 1990; Seed and Boulanger 1991; Byrne *et al.* 1992; Stark 1999) show that an overestimate of the geosynthetic–geosynthetic interface shear resistance can lead to slope instability and substantial remediation costs.

## 2. DESIGN OF LANDFILL LINER SYSTEMS

### 2.1. General

Stark and Poeppel (1994) present a design approach that uses a combination of the peak and residual for the design of landfill liner systems. This recommendation is based on the interface testing for and back-analysis of the slope instability in the Kettleman Hills Hazardous Waste Facility. Stark and Poeppel (1994) conclude that two design scenarios should be considered in stability analyses of geosynthetic liner systems. This recommendation has been verified with other case histories (e.g. Stark *et al.* 1998, 2001).

The first design scenario uses the peak interface shear resistance along the base or bottom of the landfill liner system and the residual interface shear resistance along the sideslope(s) of the liner system and satisfying a 2-D factor of safety of at least 1.5 for the final slope configuration, at least 1.3 for interim slopes, and 1.1 to 1.3 depending on the design seismic event. The second scenario involves ensuring that the 2-D factor of safety exceeds unity when the appropriate (discussed subsequently) residual interface shear resistance is applied to the base and sideslopes of the liner system. The second design scenario is considered because the peak interface strength is usually mobilised at a small laboratory displacement (Stark *et al.* 1996). Because of the uncertainty of the relationship between laboratory shear displacements and field shear displacements, the effect of progressive failure, and possible shear displacement caused by earthquake shaking, this scenario should be carefully considered. In other words, if everything goes wrong, i.e. a residual interface strength is mobilised along the weakest interface, the slope should remain stable because the 2-D factor of safety is greater than unity. If the residual interface strength is measured in a direct shear apparatus, a factor of safety greater than unity, e.g. 1.1, should be considered to compensate for the limited continuous shear displacement applied in this apparatus (Stark and Poeppel 1994; Marr and Christopher 2003).

There are uncertainties surrounding the application of these design scenarios. The main uncertainties are related to determining the residual shear resistance that should be used for the sideslopes and whether or not this recommendation is applicable to the design of the cover system. This manuscript is focused on clarifying the authors' opinion with regard to the use and applicability of these design scenarios in the design of landfill geosynthetic-lined slopes. Thiel (2001) correctly limits this recommendation to the design of liner systems, which is reflected in the title of his paper. Stark and Poeppel (1994) consider only the liner system at the Kettleman Hills Facility and other liner systems and not a final cover system.

Stark and Poeppel (1994) conclude that a residual interface shear resistance is mobilised along the sideslopes of liner systems, and the critical interface on the sideslope can differ from the base of the liner. The residual strength can be mobilised for many reasons including waste settlement or creep that leads to shear displacements along specific interfaces (Long *et al.* 1995), waste placement activities (Yazdani *et al.* 1995), lateral movement or bulging of waste (Stark *et al.* 2000), construction activity of the liner system (McKelvey 1994), thermal expansion/contraction of the geosynthetics, stress transfer between the waste on the sideslope and the landfill base that is acting as a buttress (Stark and Poeppel 1994), strain or displacement incompatibility between the waste and geosynthetic interface of interest (Eid *et al.* 2000), and/or earthquake-induced displacements. These shear displacements may lead to mobilisation of a residual strength, which can result in progressive failure effects between the sideslope and at least a portion of the base of a bottom liner system (Byrne 1994; Stark and Poeppel 1994; Gilbert and Byrne 1996; Reddy *et al.* 1996; Filz *et al.* 2001). Additional evidence of these shear displacement mechanisms has been developed since 1994 and is presented in the following sections to reinforce the recommendations in Stark and Poeppel (1994).

### 2.2. Development of residual interface strength condition

A residual interface shear resistance will develop in the field only if detrimental shear displacement occurs along a geosynthetic interface in the liner system. The two important factors in the above statement are: (1) detrimental or damaging shear displacement, and (2) the interface along which this detrimental shear displacement will occur. Detrimental shear displacement means that the interface shear resistance is being reduced from the peak value because shear displacement is occurring.

The two main areas for slope instability in the cross-section shown in Figure 1 are a slide mass near the slope face, i.e. toe area, and the entire waste mass sliding along a failure surface that extends along the base of the landfill and up the sideslope. The stability of the slope face area is controlled by the interface in the base liner system exhibiting the lowest peak strength and the waste strength, and is independent of the sideslope.

The stability of the entire waste mass sliding along a failure surface that extends along the base of the landfill and up the sideslope is the focus of the design recommendation of using a residual interface strength on the sideslope. The driving force or force causing instability in this scenario is the triangle of waste above the sideslope of the landfill. The stability of this triangle of waste is controlled by the interface shear resistance mobilised along the sideslope and base of the landfill. The majority of the shear resistance in this failure mode is derived from the base of the landfill because the

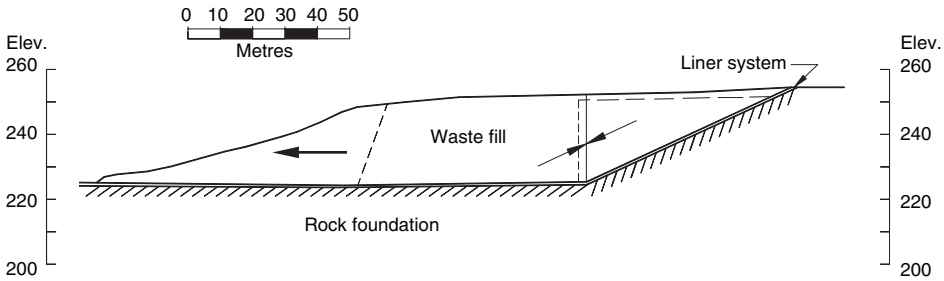


**Figure 1. Schematic diagram illustrating mobilisation of buttressing effect of waste on the base of the landfill**

normal stress is greatest along the base, and the failure surface is longer assuming that the same interfaces appear on the sideslope and the base of the landfill. The interface shear resistance along the base is given by $\sigma'_n \tan \delta_p$, where $\delta_p$ is the peak interface fiction angle of the weakest interface and $\sigma'_n$ is the effective normal stress acting on this interface. Thus the practice of installing smooth HDPE geomembrane on the base and textured HDPE on the sideslope for value engineering and drainage layer stability purposes may have detrimental effects on stability because the smooth HDPE geomembrane will exhibit a smaller interface strength than textured HDPE.

Because of the low shear resistance exhibited by geosynthetic interfaces, the triangle of waste in Figure 1 must mobilise some shear resistance along the base of the landfill to prevent instability. The shear resistance of geosynthetic interfaces along the sideslope is low because of the low $\sigma'_n$ and $\delta_p$ along the sideslope. This results in shear displacement along the weakest interface in the sideslope liner system, mobilising the passive resistance of the MSW along the base of the landfill. This stress transfer mechanism is especially relevant to MSW because of the compressible nature of MSW. If the base of the landfill were filled with an incompressible material, such as concrete, the shear displacement required to mobilise the shear resistance along the base of the landfill would be smaller. However, the compressible nature of MSW results in significant deformation being required to mobilise the shear resistance along the base of the landfill, especially at the sideslope/base transition. This stress transfer phenomenon has been duplicated using numerical methods by Byrne (1994), Gilbert and Byrne (1996), and Reddy *et al.* (1996).

Byrne (1994) was the first to use numerical methods to depict the behaviour of a liner system in response to waste placement to investigate the shear strength mobilised along the base and sideslope for the Kettleman Hills slope failure. Byrne (1994) uses the finite difference computer code FLAC (Cundall 1976) to recreate the filling process and shear strength mobilised in the base and sideslope of the liner system at the Kettleman Hills facility. The initial analysis involves placement of waste to a depth that is 3 m lower than the depth at failure. The second stage corresponds to the waste depth at failure of about 30 m. The results of the first stage of waste placement indicate a stable condition, but a residual strength condition is mobilised along the sideslope and a post-peak shear strength condition is mobilised along the initial portion (about 20%) of the base of the landfill in the vicinity of the sideslope. Over the remaining 80% of the landfill base, the induced shear stress is resisted by 60% of the peak shear strength.

After placement of the second stage of waste placement, i.e. waste depth at failure, failure along the liner system is imminent. A residual strength condition is mobilised along the sideslope, and the zone of post-peak shear strength along the base of the landfill now extends about 40% of the length of the base from the sideslope. Over the remaining 60% of the landfill base the shear stress is resisted by about 90% of the available peak shear strength. Placement of another 1 m of waste is sufficient to cause slope instability (Byrne 1994).

Subsequent finite element analyses of the Kettleman Hills slope failure (e.g. Reddy *et al.* 1996; Filz *et al.* 2001) indicate similar conclusions as those reached by Byrne (1994). These conclusions are that the shear resistances mobilised along the base and sideslope of the landfill are not equal, and the use of a peak smooth geomembrane–clay interface shear resistance along the entire failure surface does not predict the failure. More importantly, use of a peak smooth geomembrane–clay interface strength overpredicts the mobilised strength, and thus a combination of peak and residual strengths should be used in 2-D limit equilibrium methods.

Progressive failure occurs in slopes in which the driving force exceeds the mobilised strength of the weakest layer, e.g. the slope angle exceeds the friction angle of the weak layer (Mesri and Shahien 2003). If this occurs, the interface at the location where the driving force exceeds the interface friction angle becomes overstressed. If this local overstressing is great enough that the interface yields and shear displacement occurs, the shear stresses applied to this location are transferred to the interface element adjacent to this overstressing because the interface is undergoing a post-peak strength loss and cannot restrain the imposed shear stresses. If the existing shear stresses and the transferred shear stresses are great enough to cause the adjacent portion of the interface to yield, the overstressing will be transferred further. This process can continue until enough of the interface is overstressed that a slope failure occurs. If the shear strength of the weakest interface increases sufficiently, the initial overstressing can be arrested and slope failure is averted. Thus the fact that a limited

portion of the interface achieves a post-peak condition does not mean the entire slope should be designed using residual interface strength. Byrne (1994) shows a residual strength condition developing along the entire sideslope and transferring stresses to the base of the landfill. Gilbert and Byrne (1996), Reddy *et al.* (1996) and Filz *et al.* (2001) also suggest the possibility of progressive failure occurring along a liner interface, and thus a residual or post-peak strength, respectively, may be applicable.

In summary, these analyses support the conclusion that a residual interface strength can be mobilised along a landfill sideslope while a peak interface strength is mobilised along the base.

### 2.3. Composite failure envelope design for bottom liner system

The interface along which detrimental shear displacement may occur is the interface that exhibits the lowest peak interface shear resistance in the bottom liner system regardless of the value of the residual interface shear resistance. For example, if the interface with the lowest peak interface shear resistance exhibits the highest residual interface shear resistance, the detrimental shear displacement may still occur along this interface but the resulting stability will be controlled by the residual interface shear resistance along this interface and not the lowest residual interface strength, e.g. a GCL. The reason for not mobilising the lowest residual interface shear resistance is that detrimental shear displacement will not occur along an interface with a higher peak strength before movement is initiated along the interface with the lowest peak interface strength. If detrimental shear displacement does not initiate along an interface, the shear resistance cannot drop to the residual value. In other words, there is no evidence that an interface can somehow end up at a residual strength condition if it is not subjected to detrimental shear displacement.

The failure envelope that corresponds to the lowest peak interface strength may correspond to the strength of one or more interfaces because geosynthetic interface strength is stress-dependent and non-linear (Stark and Poeppel 1994; Stark *et al.* 1996; Fox *et al.* 1998; Dove and Frost 1999). If more than one interface is used to develop the failure envelope for the interface with the lowest peak strength, the failure envelope is referred to as a composite failure envelope. The selection of a composite failure envelope for a multi-layer liner system is discussed at the end of the liner and cover system discussion.

The proper failure envelope for use in the design scenarios for bottom liner systems is reviewed in this section. This procedure is primarily for liner system design because of the large range in normal stress along the liner system. However, this procedure can be used for a cover system too. The range of normal stress is usually small in a cover system, i.e. 2.5–20.0 kPa, so the weakest peak interface strength usually does not change over this range in normal stress. However, if the weakest peak interface strength does change over this small normal stress range, a composite failure envelope should be developed for cover design purposes using the procedure described below.

The procedure for constructing a peak composite failure envelope uses the following three steps:

1. Determine the interface(s) or material(s) in the composite liner system that exhibit(s) the lowest peak strength for the full range of normal stresses encountered along the bottom liner system.
2. Determine the peak composite failure envelope for the weakest interface(s) or material(s) in the composite liner system for the full range of effective normal stresses encountered along the liner system.
3. Determine the residual composite failure envelope that corresponds to the peak composite failure envelope in Step 2.

The resulting peak and residual composite failure envelopes are used in the two design scenarios presented by Stark and Poeppel (1994) and discussed in Section 2.1. An example of developing a peak composite failure envelope is presented in Figures 2–5. Figure 2 presents the peak failure envelopes for the following interfaces measured using a torsional ring shear device (Stark and Poeppel 1994):

- nonwoven geotextile–smooth HDPE geomembrane (GM);
- clay–smooth GM; and
- geonet–smooth GM.

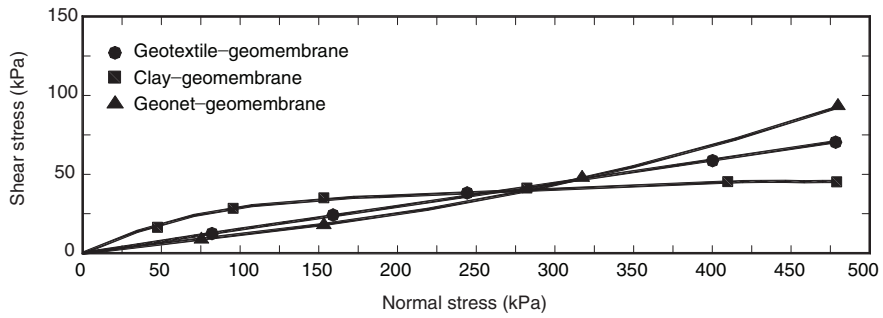


**Figure 2. Peak failure envelopes for three components of the composite liner system at Kettleman Hills Waste Repository (Stark and Poeppel 1994)**

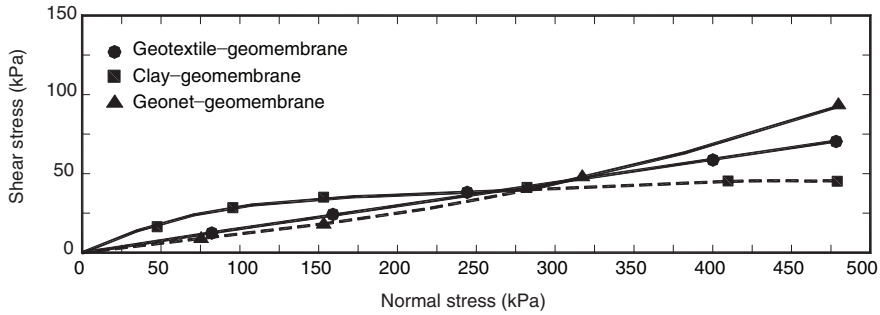


**Figure 3. Peak composite failure envelope for three components of the composite base liner system at Kettleman Hills Waste Repository**

For $\sigma'_n \leq 280$ kPa, the geonet–smooth GM interface exhibits the lowest peak shear strength and is the critical or weakest peak interface strength. However, the clay–smooth GM interface is critical for $\sigma'_n > 280$ kPa. Therefore a composite failure envelope, illustrated by the dashed line in Figure 3, should be used to represent the peak interface strength of the liner system. In other words, the peak composite failure envelope represents the weakest composite interface, and this shear displacement will occur along this composite interface before some other interfaces. Therefore this composite interface is the interface along which a residual strength condition could develop.

Figure 4 shows the individual residual strength failure envelopes for the same liner interfaces shown in Figure 2, and Figure 5 shows the design residual failure envelope (dashed) for the liner system. The design residual failure envelope corresponds to the peak composite failure envelope and does not simply represent the lowest residual composite failure envelope. The geotextile–smooth GM interface exhibits the lowest residual shear strength, but this residual envelope is not used for design because the peak strength of the geotextile–smooth GM interface will not be exceeded (see Figure 2) before the peak composite failure envelope is exceeded. Thus a residual strength condition will not be mobilised along the geotextile–smooth GM interface because detrimental shear displacement will occur on the geonet–GM and/or the clay–GM interface before it occurs on the geotextile–GM interface. Thus the residual composite failure envelope is between the highest and lowest residual failure envelopes.

In this example, there is not a large difference between the peak failure envelope of the geotextile–GM and geonet–GM interfaces at $\sigma'_n \leq 280$ kPa, so it may be prudent in this case to design for both of these interfaces at $\sigma'_n \leq 280$ kPa, which would involve checking to ensure the factor of safety is also greater than unity if the residual failure of the geotextile–GM interface is used for $\sigma'_n \leq 280$ kPa.

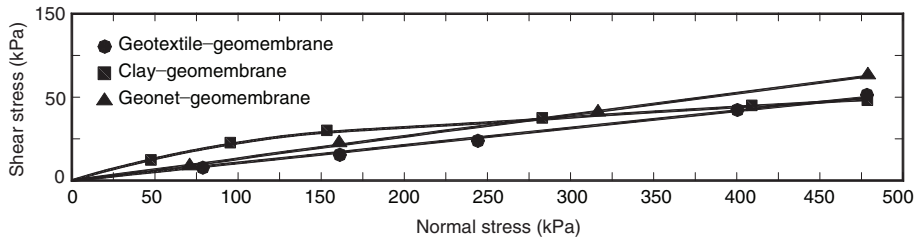


**Figure 4. Residual failure envelopes for three components of the composite base liner system at Kettleman Hills Waste Repository (Stark and Poeppel 1994)**

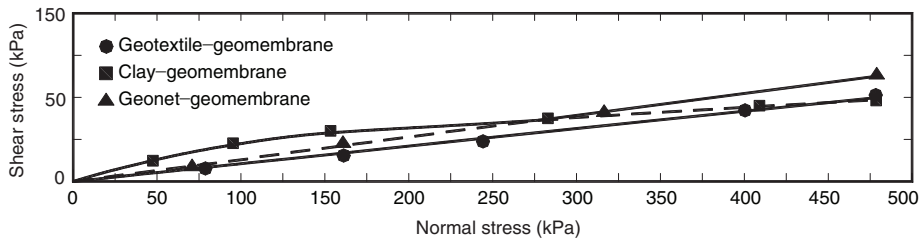


**Figure 5. Design residual failure envelope for three components of the composite base liner system at Kettleman Hills Waste Repository**

The proper selection of a composite failure envelope for design is especially important when a bottom liner system contains a reinforced GCL because of the high peak strength and low residual strength of hydrated bentonite (Stark and Eid 1996; Fox *et al.* 1998). With a reinforced GCL, other interfaces that exhibit a large post-peak strength loss, e.g. nonwoven geotextile–textured GM or double-sided drainage composite-textured GM, should also be evaluated to develop a representative composite failure envelope. The residual failure envelope for any hydrated GCL will plot well below the geotextile–smooth GM residual failure envelope in Figure 4 because it corresponds to the shear strength of hydrated bentonite. However, the peak strength envelope for an encapsulated unreinforced GCL and a reinforced GCL is likely to be significantly higher than that for many other typical interfaces in the liner system. If so, the GCL peak shear strength will not be exceeded, and the GCL will not reach a residual shear condition. Thus the GCL internal residual envelope should not be used for the sideslopes (design steps 1 and 2) or the base liner (design step 2). Use of the GCL internal residual failure envelope under these conditions would be unnecessarily conservative. This emphasises that the main design issue surrounding GCLs is not shear strength but hydraulic equivalence (Stark *et al.* 2004).

In summary, designers should not simply use the minimum residual failure envelope for design, but should determine which materials will reach a residual shear condition and then use the corresponding residual composite failure envelope for design. This is accomplished by first establishing the minimum peak composite failure envelope.

## 3. DESIGN OF LANDFILL COVER SYSTEMS

The proper methodology for selection of the design failure envelope for a cover system differs from the liner system design because of differences in the expected detrimental shear displacements. In particular, the design scenarios presented by Stark and Poeppel (1994) are not applicable to cover systems. Unpublished two- and three-dimensional back-analyses of cover failure studies by the first author show that peak interface strengths are mobilised throughout a cover system. This results for a number of reasons, including the presence of low shear stresses, low normal stresses (which limit detrimental, i.e. damage-inducing, shear displacements to a geosynthetic interface), smaller shear displacements required for stress transfer in soil cover than in MSW, and smaller settlements of the compacted soil veneer as compared with MSW. Although there is an opportunity for considerable construction-induced shear displacements to occur in cover systems, these displacements can be minimised by placing cover materials from bottom to the top of the sideslopes or by including tensile reinforcement (Koerner and Soong 1998). Therefore it is recommended that the stability of cover systems be analysed using the peak shear strength of the weakest interface, or if applicable the weakest composite interface, with a factor of safety greater than 1.5.

There are some situations where a residual interface shear resistance with a factor of safety greater than unity should be used in cover system design. If the slope angle of the final cover system is greater than a peak interface shear strength of the weakest interface, progressive failure can occur (Gilbert and Byrne 1996). As denoted previously, progressive failure occurs in slopes in which the driving force exceeds the mobilised strength of the weak layer, i.e. the slope angle exceeds the friction angle of the weak layer. Also, when large displacements such as construction-induced displacements or seismically induced displacements can be expected, the use of residual shear strength is recommended.

Thus, if the average slope angle of the cover system is greater than the lowest peak interface friction angle, a residual interface friction angle should be used for design. However, cover systems reinforced with tensile members can limit the progressive displacement on the weakest layer, and thus a residual interface shear strength will not fully mobilise. In such a case, the stability of a cover system can be analysed using the peak shear strength of the weakest interface with the factor of safety greater than 1.5.

## 4. RECOMMENDATIONS

The following recommendations can be discerned from information presented in this paper.

1. Detrimental, or damaging, shear displacement may occur within geosynthetic-lined landfill liner sideslopes owing to construction activities, thermal expansion/contraction, large displacements needed to mobilise the passive resistance of a waste buttresses on the base liner, strain or displacement incompatibility between the waste and geosynthetic interfaces, earthquake-induced displacement, lateral waste movement, waste placement procedures, or waste settlement. These shear displacements can lead to mobilisation of a post-peak strength and/or progressive failure effects between the sideslopes and base of a bottom liner system.
2. The failure envelope that corresponds to the lowest peak interface strength may correspond to one or more geosynthetic interfaces because geosynthetic interface strength is stress-dependent. If more than one interface is used to develop the failure envelope for the interface with the lowest peak strength, the envelope is referred to as a composite failure envelope. The procedure for constructing a peak composite failure envelope for multi-layer liner and cover systems uses the following three steps:
   (a) Determine the interface(s) or material(s) in the composite liner system exhibiting the lowest peak strength for the full range of normal stresses encountered along the bottom liner system.

(b) Determine the peak composite failure envelope for the weakest interface(s) or material(s) in the composite liner system for the full range of effective normal stresses encountered along the liner system.
(c) Determine the residual composite failure envelope that corresponds to the peak composite failure envelope in Step (b).

3. Utilising the peak and residual composite failure envelopes obtained above, the two design scenarios for the bottom liner systems with a sideslope presented by Stark and Poeppel (1994) can be used:
   (a) assign residual shear strengths to the sideslopes and peak shear strengths to the base of the liner system and satisfy a factor of safety greater than 1.5; and
   (b) assign residual strengths to the sideslopes and base of the liner system and satisfy a factor of safety greater than 1.0 or 1.1 if direct shear data are used.
4. The stability of geosynthetic cover systems can be analysed using the peak shear strength of the weakest interface, or if necessary the weakest composite interface, with the factor of safety greater than 1.5. The use of a peak interface strength is recommended for the cover system because of the lack of or limited amount of detrimental shear displacement along the weakest interface in a cover system compared with a liner sideslope. However, if the average slope angle of the cover system is greater than the lowest peak interface friction angle, or large displacements such as construction-induced displacements or seismically induced displacements are expected, a residual interface friction angle should be used for design.

## REFERENCES


Bove, J. A. (1990). Direct shear friction testing for geosynthetics in waste containment. *Proceedings of ASTM Symposium on Geosynthetic Testing for Waste Containment Applications*, Special Technical Publication 1081, pp. 241–256.

Byrne, R. J. (1994). Design issues with strain softening interfaces in landfill liners. *Proceedings of Waste Tech'94 Conference*, National Solid Waste Management Association, San Francisco, CA, January, pp. 26.

Byrne, R. J., Kendall, J. & Brown, S. (1992). Cause and mechanism of failure, Kettleman Hills Landfill B-19, Unit IA. *Proceedings of ASCE Specialty Conference on Performance and Stability of Slopes and Embankments—II*, ASCE, New York, pp. 1188–1215.

Cundall, P. A. (1976). Explicit finite element difference methods in geomechanics. *Proceedings of ASCE Specialty Conference on Numerical Methods in Geomechanics*, ASCE, New York, Vol. 1, pp. 132–150.

Dove, J. E. & Frost, J. D. (1999). Peak friction behavior of smooth geomembrane-particle interfaces. *Journal of Geotechnical and Geoenvironmental Engineering, ASCE*, **125**, No. 7, 544–555.

Eid, H. T., Stark, T. D., Evans, W. D. & Sherry, P. (2000). Municipal solid waste landfill slope failure I: foundation and waste properties. *Journal of Geotechnical and Geoenvironmental Engineering, ASCE*, **126**, No. 5, 397–407.

Filz, G. M., Esterhuizen, J. J. B. & Duncan, J. M. (2001). Progressive failure of liner waste impoundments. *Journal of Geotechnical and Geoenvironmental Engineering, ASCE*, **127**, No. 10, 841–848.

Fox, P. J., Rowland, M. G. & Scheithe, J. R. (1998). Internal shear strength of three geosynthetic clay liners. *Journal of Geotechnical and Geoenvironmental Engineering, ASCE*, **124**, No. 10, 933–944.

Gilbert, R. B. & Byrne, R. J. (1996). Strain-softening behavior of waste containment system interfaces. *Geosynthetics International*, **3**, No. 2, 181–203.

Koerner, R. M., Martin, J. P. & Koerner, G. R. (1986). Shear strength parameters between geomembranes and cohesive soils. *Geotextiles and Geomembranes*, **4**, No. 1, 21–30.

Koerner, R. M. & Soong, T. Y. (1998). Analysis and design of veneer cover soils. *Proceedings of 6th International Conference on Geosynthetics*, Atlanta, GA, Vol. 1, pp. 1–23.

Long, J. H., Gilbert, R. B. & Daly, J. J. (1995). Effect of waste settlement on sloped lining systems. *Proceeding of Geosynthetics '95*, Nashville, TN, Vol. 2, pp. 729–744.

Martin, J. P., Koerner, R. M. & Whitty, J. E. (1984). Experimental friction evaluation of slippage between geomembranes, geotextiles, and soils. *Proceedings of International Conference on Geomembranes*, Denver, CO, pp. 191–196.

Marr, W. A. & Christopher, B. (2003). Recommended design strength for needlepunched geosynthetic clay liner products. *Geotechnical Fabrics Report*, IFAI, Vol. 16, October–November, pp. 18–23.

McKelvey, J. A. III (1994). Consideration of equipment loadings in geosynthetic lined slope designs. *Proceedings of 8th International Conference on Computer Methods and Advances in Geomechanics*, Rotterdam, Vol. 2, pp. 1371–1377.

Mesri, G. & Shahien, M. (2003). Residual shear strength mobilized in first-time slope failures. *Journal of Geotechnical and Geoenvironmental Engineering, ASCE*, **129**, No. 1, 12–31.

Mitchell, J. K., Seed, R. B. & Seed, H. B. (1990). Kettleman Hills waste landfill slope failure I: liner-system properties. *Journal of Geotechnical Engineering, ASCE*, **116**, No. 4, 647–668.

Negussey, D., Wijewickreme, W. K. D. & Vaid, Y. P. (1989). Geomembrane interface friction. *Canadian Geotechnical Journal*, **26**, No. 1, 165–169.

O'Rourke, T. D., Druschel, S. J. & Netravali, A. N. (1990). Shear strength characteristics of sand polymer interfaces. *Journal of Geotechnical Engineering, ASCE*, **116**, No. 3, 451–469.

Reddy, K. R., Kosgi, S. & Motan, S. (1996). Interface shear behavior of landfill composite liner systems: a finite element analysis. *Geosynthetics International*, **3**, No. 2, 247–275.

Saxena, S. K. & Wong, Y. T. (1984). Friction characteristics of a geomembrane. *Proceedings of International Conference on Geomembranes*, Denver, CO, pp. 187–190.

Seed, R. B. & Boulanger, R. W. (1991). Smooth HDPE-clay liner interface shear strengths: compaction effects. *Journal of Geotechnical Engineering, ASCE*, **117**, No. 4, 686–693.

Seed, R. B., Mitchell, J. K. & Seed, H. B. (1990). Kettleman Hills waste landfill slope failure II: stability analysis. *Journal of Geotechnical Engineering, ASCE*, **116**, No. 4, 669–689.

Stark, T. D. (1999). Stability of waste containment facilities. *Proceedings of Waste Tech '99*, National Solid Wastes Management Association, New Orleans, LA, pp. 1–24.

Stark, T. D. & Eid, H. T. (1996). Shear behavior of reinforced geosynthetic clay liners. *Geosynthetics International*, **3**, No. 6, 771–786.

Stark, T. D. & Poeppel, A. R. (1994) Landfill liner interface strengths from torsional ring shear tests. *Journal of Geotechnical Engineering, ASCE*, **120**, No. 3, 597–615.

Stark, T. D., Williamson, T. A. & Eid, H. T. (1996). HDPE geomembrane/geotextile interface shear strength. *Journal of Geotechnical Engineering, ASCE*, **122**, No. 3, 197–203.

Stark, T. D., Arellano, D., Evans, W. D., Wilson, V. & Gonda, J. (1998). Unreinforced geosynthetic clay liner case history. *Geosynthetics International*, **5**, No. 5, 521–544.

Stark, T. D., Eid, H. T., Evans, W. D. & Sherry, P. (2000). Municipal solid waste landfill slope failure II: stability analyses. *Journal of Geotechnical and Geoenvironmental Engineering, ASCE*, **126**, No. 5, 408–419.

Stark, T. D., Evans, W. D. & Wilson, V. (2001). Avoiding the slippery slope. *Waste Age*, Waste Systems and Technology, February, 42–45.

Stark, T. D., Choi, H. & Akhtarshard, R. (2004). Occurrence and effect of bentonite migration in geosynthetic clay liners. *Geosynthetics International*, **11**, No. 4, 296–310.

Takasumi, D. L., Green, K. R. & Holtz, R. D. (1991). Soil-geosynthetic interface strength characteristics: a review of state-of-the-art testing procedures. *Proceedings of Geosynthetics '91 Conference*, Atlanta, GA, Vol. 1, pp. 87–100.

Thiel, R. (2001). Peak versus residual strength for bottom liner stability analyses. *Proceedings of the 15th Annual Geosynthetics Research Institute Conference, Hot Topics in Geosynthetics II*, Houston, TX, Geosynthetics Institute, Folsom, PA, pp. 40–70.

Williams, N. D. & Houlihan, M. F. (1987). Evaluation of interface friction properties between geosynthetics and soils. *Proceeding of Geosynthetics '87 Conference*, New Orleans, LA, Vol. 2, pp. 616–627.
Yazdani, R., Campbell, J. L. & Koerner, G. R. (1995). Long-term in situ measurements of a high density polyethylene geomembrane in a municipal solid waste landfill. *Proceedings of Geosynthetics '95*, Nashville, TN, Vol. 3, pp. 893–905.
Yegian, M. K. & Lahlaf, A. M. (1992). Discussion of 'Kettleman Hills waste landfill slope failure I: liner-system properties'. *Journal of Geotechnical Engineering, ASCE*, **118**, No. 4, 643–645.

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STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

PAUL R. LEPAGE
GOVERNOR

PATRICIA W. AHO
COMMISSIONER

June 25, 2015

Wayne Boyd, Divisional Landfill Manager
Jeremy Labbe, Environmental Manager
Pine Tree Landfill
358 Emerson Mill Road
Hampden, ME 04444

Re: Leachate recirculation

Dear Wayne and Jeremy:

Steve Farrar has reviewed the 2014 post-closure leachate recirculation report, and prepared the enclosed memo.

He recommends approval of the proposed 2015 program; we had given verbal approval to proceed on May 15, 20145 when we were on site for an inspection. Please go ahead with the 2015 program if you haven't already.

As in last year's memo, Steve asks for the calculations supporting moisture removed as condensate and consumed in methane formation; please provide this information.

Please contact me if you have questions.

Sincerely,

KAREN KNUUTI
Division of Solid Waste Management
Bureau of Remediation and Waste Management
Eastern Maine Regional Office

Copy: Richard Heath
Steve Farrar
Mike Booth
Matt Reynolds
Steve Rabasca
Toni King

PTL 2014 leachate recirc rpt

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**MEMORANDUM**

TO: Karen Knuuti; Project Manager - Eastern Maine Regional Office
FROM: Stephen E. Farrar, P.E.; Environmental Engineer Specialist - Technical Services
DATE: June 18, 2015
SUBJ: Pine Tree Landfill
Post-Closure Leachate Recirculation
File No. 2103.4039

**********

We have completed an engineering evaluation of the following document:

*Pine Tree Landfill - 2014 Post-Closure Leachate Recirculation Report* (Report) prepared by Pine Tree Landfill of Hampden, Maine

The Report was included as Attachment A to the Pine Tree Landfill (PTL) 2014 Annual Report[1] and summarizes the implementation and results of the PTL leachate recirculation program during 2014 as well as the proposed program for 2015. The intent of leachate recirculation is to enhance waste mass stabilization and landfill gas (LFG) production and methane concentration in order to maximize electricity generation from PTL's on-site 3.1 Megawatt Landfill Gas-to-Energy (LFGTE) Facility first placed on line in January of 2008. The LFGTE Facility is has not been operating at full capacity due to an insufficient supply of methane. The viability of leachate recirculation as a method to improve both the quantity and quality of extracted LFG was demonstrated through a pilot project conducted during 2009[2]. Infrastructure to support full-scale recirculation during the post-closure period was installed as part of the final phase of landfill closure during 2010.

The Post-Closure Recirculation Plan[3] (Plan), as supplemented annually, provides for leachate introduction back into PTL's Secure III Landfill (Landfill) through four horizontal trenches located directly under the final cover system at the top of the Landfill, through selected vertical LFG extraction wells and horizontal collectors, or a combination thereof. During 2014 PTL applied a total of 6,148,064 gallons of leachate into the four horizontal recirculation trenches and one horizontal LFG collector trench.

---

[1] *2014 Annual Report - Pine Tree Landfill - Hampden, Maine* Pine Tree Landfill, April 2015
[2] *Pine Tree Landfill - Leachate Recirculation Pilot Program - Final Report* Sevee & Maher Engineers, Inc., June 2010
[3] *Pine Tree Landfill - Post-Closure Leachate Recirculation Plan - Hampden, Maine* Sevee & Maher Engineers, Inc., January 2011, updated April 2011

The 2015 proposal (covering the period from May 2015 to April 2016) is to continue the leachate recirculation program in two phases. The first phase will be to add leachate to seven collection trenches and four vertical extraction wells. A small amount of leachate will be added to the recirculation trenches concurrent with this phase. The second phase, to be completed during the winter months of 2015/2016, includes full scale loading of the recirculation trenches. A total of approximately 7,800,000 gallons of leachate is proposed to be recirculated during the period. Note that the collection trenches and extraction wells proposed are the same points proposed for the 2014 program however, with the exception of GCT-107, they were not used due to staffing issues.

We offer the following observations and recommendations.

1. LFG monitoring data (methane ($CH_4$) concentration and gas flow rates) as measured at the LFGTE Facility (FLARE3) through the end of 2014 (as well as through June of 2015) continue to indicate an ongoing modest decline in total energy extraction since leachate recirculation was initiated during the summer of 2011. The decline is likely the result final closure of the Landfill in 2010 and not an indication that leachate recirculation is ineffective.

2. Hydrogen sulfide ($H_2S$) monitoring at the LFGTE Facility did not indicate any apparent trend in the LFG $H_2S$ concentration during 2014. The concentrations from January to May averaged about 20 percent higher than those from July through October. This may be a result of not recirculating leachate during May and June (the concentrations generally rebounded during November and December). In any event, sulfur loading remains well within the treatment capability of the Thiopaq system. The data will continue to be gathered during 2015.

3. LFG collected from within the zone of influence of the recirculation trenches during 2014 remained at about the same level as 2013 which amounts to an increase of over four fold from 2012. Taken as a percentage of the total LFG extracted from the Landfill the contribution from the zone of influence has increased each year since recirculation began. All of this is an indication that recirculation is having a positive effect on LFG production in the area. We note that 46% of the LFG collected from the zone of influence during 2014 came from a single extraction well (GW-8G), however the performance at several other wells (GW-38, 53, 114, 8B, and 8E) appears to be improved over pre-recirculation conditions.

4. Leachate collection system pumping records do not appear to indicate any significant short-circuiting of the recirculated leachate during 2014. No other unexplained or unexpected change in flow rates is evident.

5. Other monitoring activities associated, directly or indirectly, with the leachate recirculation program, including ambient air $H_2S$ concentrations, geotechnical monitoring, and LFG temperature measurements, did not indicate any significant adverse impacts due to the program during 2014.

6. Periodic visual inspections conducted in support of the recirculation program during 2014 did not indicate any adverse impacts due to the program.

7. A water budget has been completed and indicates that as of the end of 2014 approximately 17,614,700 of the estimated 36,000,000 gallons of absorptive capacity of the waste mass within the zone of influence of the four leachate recirculation trenches remains available. Calculations in support of the moisture removed as condensate and consumed in the formation of methane should be provided. We are not able to confirm the figures in Table 5-3 with the data available to us, probably due to differences in the methods used to calculate average temperature and LFG flow rate values.

8. We recommend your approval to continue the PTL leachate recirculation program as proposed for 2015.

Please let me know if there are any questions or if you require additional assistance at this time.

cc: Richard Heath, C.G.

STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

PAUL R. LEPAGE
GOVERNOR

PATRICIA W. AHO
COMMISSIONER

July 22, 2015

Wayne Boyd, Divisional Landfill Manager
Jeremy Labbe, Environmental Manager
Pine Tree Landfill
358 Emerson Mill Road
Hampden, ME 04444

Re: 2014 water quality monitoring review

Dear Wayne and Jeremy:

Richard has completed his review of the 2014 water quality report and water quality data obtained through April 2015. Please see the enclosed copy of his memo to me; it includes 3 recommendations.

Richard agrees with SME's recommendations included in the 2014 water quality review; please implement them, if you haven't already. He also recommends additional investigation into the cause of increasing specific conductance measured at MW-03-802B, MW03-803A, and MW03-803B. Richard also comments that he has assumed MW-916 and MW-917 are "off-site" wells, but the annual report refers to them as "on-site" locations. Please clarify where the wells are with respect to the property boundary.

Please contact me if you have questions.

Sincerely,

KAREN KNUUTI
Division of Solid Waste Management
Bureau of Remediation and Waste Management
Eastern Maine Regional Office

ec: Richard Heath, Steve Farrar, Mike Booth, Steve Rabasca, Matt Reynolds, Toni King

PTL 2014 H2O quality review

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STATE OF MAINE
Department of Environmental Protection (MEDEP)
Bureau of Remediation and Waste Management

**MEMORANDUM**

TO: Karen Knuuti, Project Manager, Division of Solid Waste

FROM: Richard Heath, Senior Geologist, Division of Technical Services

DATE: July 15, 2015

RE: 2014 Water Quality Report
April 2015
and
April 2015 Water Quality Data Results
May 21, 2015
Pine Tree Landfill
Hampden, Maine

Consultant – SME, Inc.

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## General Comments

Post-closure monitoring results through Year-End 2014 and April 2015 are summarized in the following figures and tables:

- Figure 1 – Monitoring Wells located to the South of the Landfill;
- Figure 2 – Monitoring Wells located to the West of the Landfill;
- Figure 3 – Monitoring Wells located to the East of the Landfill;
- Figure 4 – Surface Water;
- Figure 5 – Residential Wells;
- Figure 6 – Leachate; and
- Figure 7 – Dissolved Methane.

The following tables are also included in this memorandum:

- Table 1A – Summary of Water Quality by Sample Location;
- Table 1B – Comparison of Corrective Action Criteria with Monitoring Results;
- Table 2 – Summary of Mann Kendall Trend Analysis;
- Tables 3A,B – Summary of MCL and MEG Exceedances; and
- Table 4 – Summary of Detection of Volatile Organic Compounds (VOCs).

## General Comments

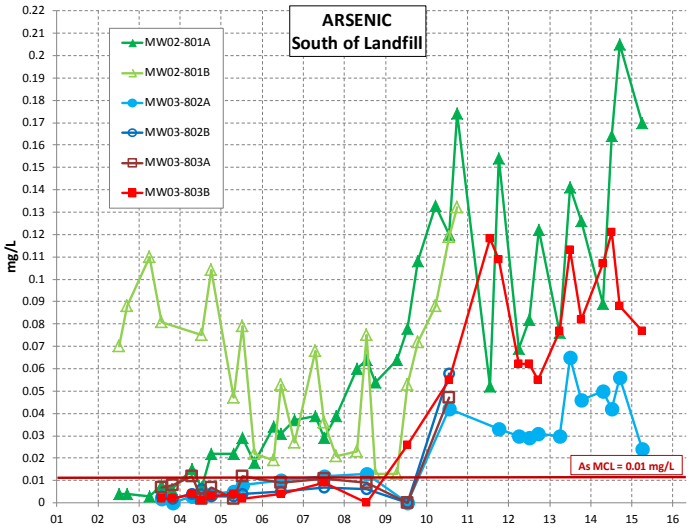
As indicated in Table 1 and Figures 1 through 5, general water quality for 2014 and April 2015 is consistent with previous results. A number of locations remain strongly impacted but, with a few exceptions, most parameters concentrations are stable or have decreased since 2010 (Table 1). The following bullets provide specific discussion regarding several issues at the site.

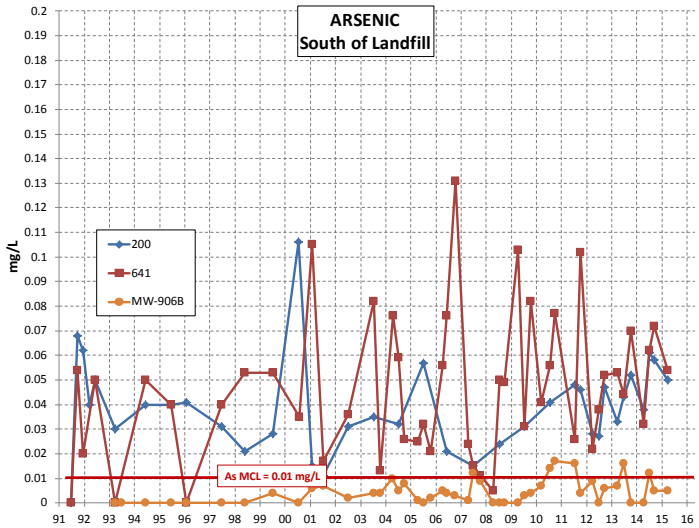
- A statistically significant increase in specific conductance measurements at monitoring wells MW03-802B and MW03-803A has occurred since 2010 (Table 2). Time-series plots indicate a variable but relatively continual increase at both wells since they were installed in 2003. The wells have been monitored for field parameters since 2011. A similar increase has occurred at MW03-803B, although April 2015 results show a decrease in specific conductance and other parameters (Figure 1).

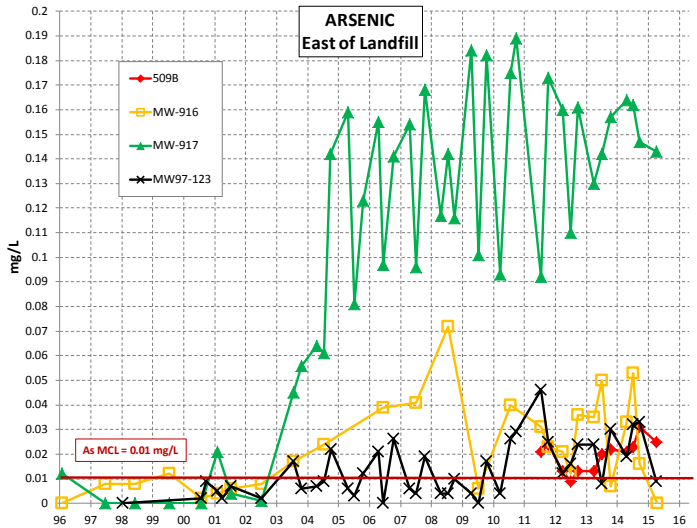
  Based on pre-2011 inorganic results at MW03-802B and MW03-803A, and current inorganic results at MW03-803B, deterioration of groundwater quality appears to be related to the migration and dissolution of landfill gas in the vicinity of the wells (Figure 1). However, dissolved methane results have declined at MW03-802B and MW03-803A while specific conductance has increased indicating this may not be the case (Figure 7). Additional chemical analysis may be necessary to assess the cause behind deteriorating water quality at MW03-802B and MW03-803A.

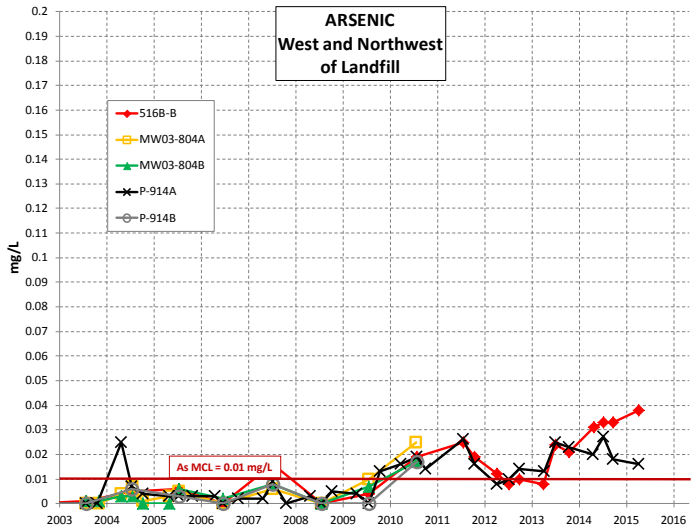
- Based on 2014/Apr 2015 dissolved methane results, the extent of LGF migration appears to be shrinking in the areas surrounding the landfill (Figure 7).

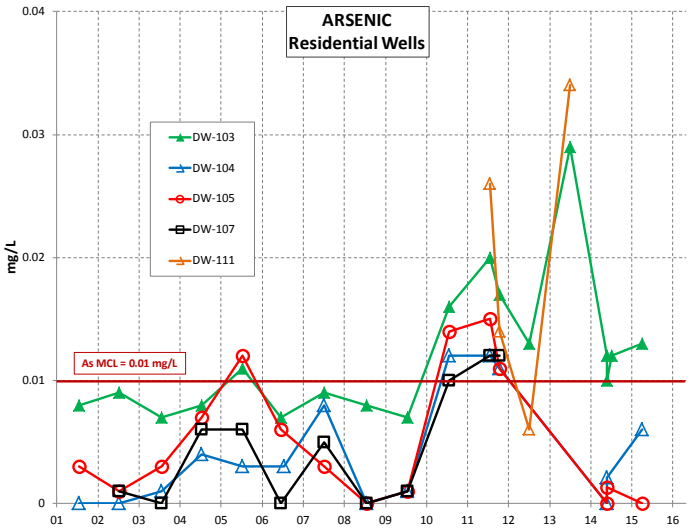
- Elevated on-site arsenic concentrations and LFG migration resulted in implementation of the 2014 Supplemental Residential Water Quality Monitoring Program. The results of the program did not suggest widespread impact of the closed landfill on water quality of the surrounding residential wells included in the investigation. The facility agreed to include arsenic sampling at the historically sampled residential wells around the PTL facility during the three sampling rounds in 2015. The following figures show arsenic results through April 2015.




ARSENIC
South of Landfill
mg/L
200
641
MW-906B
As MCL = 0.01 mg/L


ARSENIC
East of Landfill
mg/L
509B
MW-916
MW-917
MW97-123
As MCL = 0.01 mg/L


ARSENIC
West and Northwest
of Landfill
mg/L
516B-B
MW03-804A
MW03-804B
P-914A
P-914B
As MCL = 0.01 mg/L




Arsenic concentrations in 2014/Apr 2015 are generally consistent with previous results. Note that arsenic levels for residential wells DW-104 and DW-105 dropped below the MCL in 2014/Apr 2015 and were reported as non-detect in some instances. A detailed summary of my understanding of the possible causes behind elevated arsenic levels at PTL monitoring locations is provided in a November 2014 memorandum[1].

- Most monitoring locations did not meet the site specific "Successful Corrective Action Criteria" in 2014/Apr 2015 (Table 1B). A number of MCL and MEG thresholds were exceeded at multiple monitoring locations in 2014/Apr 2015 (Table3). Exceedance of MCL/MEG thresholds are not an on-site criteria for successful corrective action.

- Surface water results did not indicate significant impact by the landfill in 2014/Apr 2015. No ambient water quality criteria were exceeded during this period.

**Recommendations**

1. I have assumed that monitoring wells MW-916 and MW-917 are located "off-site" based on previously reviewed figures. The annual report refers to these locations as "on-site". The location of the monitoring wells relative to the property boundary should be clarified given the specific requirements of the corrective action criteria.

2. I recommend additional investigation into the cause of increasing specific conductance measurements at monitoring wells MW03-802B, MW03-803A, and MW03-803B.

3. I concur with recommendations provided by SME in the 2014 Annual Report and support their implementation.

pc Steve Farrar

[1] Heath, Richard, MEDEP, memorandum to Karen Knuuti, MEDEP, RE: New England Waste Services of Maine dba Pine Tree Landfill, Response to Richard Heath's, Review of 2013 Water Quality Monitoring Results, August 26, 2014, memorandum dated November 12, 2014.

# TABLE 1A

**SUMMARY OF WATER QUALITY BY SAMPLE LOCATIONS**
**YEAR-END 2014 and APRIL 2015**
**PINE TREE LANDFILL**

| Sample Location | Aquifer Type | Monitoring Level | Indication of Contamination | Exceedance of Arsenic MCL 0.01 mg/L in 2014 - Apr 2015 | Prodominant Parameter Trend Direction Since 2010 (See Note 1) | Possible Source of Water Quality Impact | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Landfill Gas | Conventional Landfill Leachate | Releases of Secure Landfill Leachate | Comments (specific to changes in 2014 - Apr 2015) |
| **Figure 1 - South of Landfill** | | | | | | | | | |
| 200 | O | Post-Closure | **Moderate** | X | **Down** | | X | X | **Elevated As.** |
| 641 | SB | Post-Closure | **Strong** | X | **Down** | | X | X | **Elevated As.** |
| MW-906B | SB | Post-Closure | Slight | X | **Down** | | X | X | |
| MW02-801A | DB | Post-Closure | **Strong** | X | **Down** | X | X | X | **As continues to increase** |
| MW02-801B | O | Field Parameters | **Strong** | | | X | X | X | |
| MW03-802A | DB | Post-Closure | **Moderate** | X | **Down** | X | X | | |
| MW03-802B | SB/O | Field Parameters | **Strong** | NA | **Up*** | X | X | | ***Specific conductance is increasing indicating ongoing impact to water quality.*** |
| MW03-803A | DB | Field Parameters | **Strong** | NA | **Up*** | X | X | | ***Specific conductance is increasing indicating ongoing impact to water quality.*** |
| MW03-803B | SB | Post-Closure | **Strong** | X | | X | X | | **As continues to increase** |
| **Figure 2 - West of Landfill** | | | | | | | | | |
| 516B-B | SB | Post-Closure | **Strong** | X | | X | X | X | **As continues to increase** |
| P-914A | DB | Post-Closure | **Moderate** | X | **Down** | X | | | |
| P-914B | SB | Field Parameters | **Moderate** | NA | | X | | | Previously declining trends appear to have stabilized above 500 µmhos/cm. |
| MW03-804A | DB | Field Parameters | **Moderate** | NA | **Down** | | X | | Previously declining trends appear to have stabilized above 700 µmhos/cm. |
| **Figure 3 - East of Landfill** | | | | | | | | | |
| MW98-601A | SB | Field Parameters | **Strong** | NA | | X | X | X | |
| MW98-601B | O | Field Parameters | **Strong** | NA | | X | X | X | |
| MW01-602B | SB | Field Parameters | Slight | NA | **Down*** | X | X | X | Sharp decrease in parameter levels in 2008. |
| MW-97-123 | DB | Post-Closure | **Strong** | X | | X | X | X | Sharp decrease in parameter levels in April 2015. |
| MW-916 | SB | Post-Closure | **Moderate** | X | | X | | | Significant reduction in parameter levels likely due to LFS removal. |
| MW-917 | DB | Post-Closure | **Strong** | X | **Down** | X | | | Significant reduction in parameter levels likely due to LFS removal. **Elevated As.** |
| 509A | SB | Field Parameters | **Strong** | NA | | X | X | X | Impacted groundwater. |
| 509B | O | Post-Closure | **Moderate** | X | | X | X | X | |
| P-911B | O | Field Parameters | **Strong** | NA | **Down*** | X | X | | Impacted groundwater. |
| **Figure 4 - Surface Water** | | | | | | | | | |
| SW-A (background) | | Post-Closure | | NA | | | | | |
| SW-C | | Post-Closure | | NA | | | | | |
| SW-D (background) | | Post-Closure | **Moderate** | NA | | | | | |
| SW-E | | Post-Closure | **Moderate** | NA | | X | X | | |
| **Figure 5 - Residential Wells** | | | | | | | | | |
| DW04-109 * (Bedrock Monitoring Well) | | Post-Closure | **Moderate** | | | | | | |
| DW-103 (Water Supply Well) | DB | Post-Closure | Slight | X | | X | | | |
| DW-111 (Water Supply Well) | DB | Post-Closure | **NO MONITORING RESULTS IN 2014 - April 2015** | | | | | | |

# TABLE 1A

**SUMMARY OF WATER QUALITY BY SAMPLE LOCATIONS**
**YEAR-END 2014 and APRIL 2015**
**PINE TREE LANDFILL**

Notes:

1.) Predominant parameter trend direction based on statistical evaluation of water quality data (see Table 2A) and visual inspection of time-series plots included in Figures 1, 2, 3, 4, and 5. ChemStat version 5 software used to perform Mann Kendall trend analysis to determine statistical significance of parameter trends. Trends for locations with field parameters only identified with "*" and may be bsaed on visual observations of time-series plots.

2.) Definitions:
GW = groundwater
SW = surface water
WS = water supply well

SB = shallow bedrock
DB = deep bedrock
O = overburden

3.) Qualitative determination of "Indication of Contamination" as follows:
Strong = Specific Conductance > 1000 µmhos/cm
Moderate = Specific Conductance between 500 and 1000 µmhos/cm
Slight = Specific Conductance between background water quality and 500 µmhos/cm

# TABLE 1B

**COMPARISON TO GROUNDWATER SUCCESSFUL CORRECTIVE ACTION CRITERIA**
**YEAR-END 2014 and APRIL 2015**
**PINE TREE LANDFILL**

| Sample Location | Monitoring Level | On-Site Groundwater Criteria | Off-Site Groundwater Criteria | | |
|---|---|---|---|---|---|
| | | Less than 500 µmhos/cm Specfic Conductance | No Exceedance of MCL/MEG Thresholds | Less than 400 µmhos/cm Specific Conductance Private Water Supply Wells | Less Than 700 µg/L Dissolved Methane Water Supply Wells |
| **Figure 1 - South of Landfill** | | | | | |
| 200 | Post-Closure | **ACHIEVED*** | | | |
| 641 | Post-Closure | Not Achieved | | | |
| MW-906B | Post-Closure | **ACHIEVED*** | | | |
| MW02-801A | Post-Closure | Not Achieved | | | |
| MW02-801B | **Field Parameters** | Not Achieved | | | |
| MW03-802A | Post-Closure | Not Achieved | | | |
| MW03-802B | **Field Parameters** | Not Achieved | | | |
| MW03-803A | **Field Parameters** | Not Achieved | | | |
| MW03-803B | Post-Closure | Not Achieved | | | |
| **Figure 2 - West of Landfill** | | | | | |
| 516B-B | Post-Closure | Not Achieved | | | |
| P-914A | Post-Closure | Not Achieved | | | |
| P-914B | **Field Parameters** | Not Achieved | | | |
| MW03-804A | **Field Parameters** | Not Achieved | | | |
| **Figure 3 - East of Landfill** | | | | | |
| MW98-601A | **Field Parameters** | Not Achieved | | | |
| MW98-601B | **Field Parameters** | Not Achieved | | | |
| MW01-602B | **Field Parameters** | **ACHIEVED** | | | |
| MW-97-123 | Post-Closure | Not Achieved | | | |
| MW-916 | Post-Closure | | Not Achieved | | |
| MW-917 | Post-Closure | | Not Achieved | | |
| 509A | **Field Parameters** | Not Achieved | | | |
| 509B | Post-Closure | Not Achieved | | | |
| P-911B | **Field Parameters** | Not Achieved | | | |
| **Figure 5 - Residential Wells** | | | | | |
| DW04-109 | Post-Closure | | Not Achieved | Not Achieved | **ACHIEVED**** |
| DW-103 | Post-Closure | | Not Achieved | Not Achieved | **ACHIEVED** |
| DW-111 | Post-Closure | | Not accessible in 2014 and April 2015 | | |

Note: "*" Specfic Conductance measurements fluxuated above and below 500 µmhos/cm in 2014 and April 2015
"**" Dissolved methane exceeded 700 µg/L at DW04-109 in April 2014

**TABLE 2**
Mann-Kandall Trend Analysis
PINE TREE LANDFILL
2010 thru April 2015

| Location | Trend | Confidence Level | CATIONS | | | | ANIONS | | | | | REDOX SENSITIVE | | | INDICATOR | | | MISC | Total Positive Results |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | CALCIUM | MAGNESIUM | SODIUM | POTASSIUM | ALKALINITY, BICARBONATE | CHLORIDE | SULFATE | NITRATE AS N | TOTAL ORGANIC CARBON | DISSOLVED OXYGEN | IRON | MANGANESE | PH | SPECIFIC CONDUCTANCE | TOTAL DISSOLVED SOLIDS | ARSENIC | |
| **FIGURE 1 - SOUTH OF LANDFILL** | | | | | | | | | | | | | | | | | | | |
| 200 | Down | 95% | TRUE | TRUE | TRUE | FALSE | TRUE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | TRUE | FALSE | 7 |
| | | 99% | FALSE | TRUE | TRUE | FALSE | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | FALSE | 4 |
| | Up | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | 1 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | 1 |
| 641 | Down | 95% | TRUE | TRUE | TRUE | TRUE | TRUE | TRUE | TRUE | | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | TRUE | FALSE | 9 |
| | | 99% | FALSE | TRUE | TRUE | TRUE | FALSE | TRUE | TRUE | | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | FALSE | 6 |
| | Up | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| MW-906B | Down | 95% | FALSE | FALSE | TRUE | FALSE | FALSE | TRUE | TRUE | | TRUE | FALSE | FALSE | FALSE | FALSE | TRUE | TRUE | FALSE | 6 |
| | | 99% | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | | TRUE | FALSE | FALSE | FALSE | FALSE | TRUE | TRUE | FALSE | 4 |
| | Up | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| MW02-801A | Down | 95% | TRUE | TRUE | FALSE | FALSE | TRUE | TRUE | FALSE | | TRUE | FALSE | FALSE | TRUE | FALSE | TRUE | TRUE | FALSE | 8 |
| | | 99% | TRUE | TRUE | FALSE | FALSE | TRUE | TRUE | FALSE | | TRUE | FALSE | FALSE | TRUE | FALSE | TRUE | TRUE | FALSE | 8 |
| | Up | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| MW02-801B | Down | 95% | PARAMETERS NOT MONITORED | | | | | | | | | | | | FALSE | FALSE | PARAMETERS NOT MONITORED | | 0 |
| | | 99% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| | Up | 95% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| | | 99% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| MW03-802A | Down | 95% | FALSE | TRUE | TRUE | TRUE | TRUE | TRUE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | TRUE | FALSE | 8 |
| | | 99% | FALSE | TRUE | TRUE | TRUE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | FALSE | FALSE | 5 |
| | Up | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| MW03-802B | Down | 95% | PARAMETERS NOT MONITORED | | | | | | | | | | | | FALSE | FALSE | PARAMETERS NOT MONITORED | | 0 |
| | | 99% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| | Up | 95% | | | | | | | | | | | | | TRUE | TRUE | | | 2 |
| | | 99% | | | | | | | | | | | | | FALSE | TRUE | | | 1 |
| MW03-803A | Down | 95% | PARAMETERS NOT MONITORED | | | | | | | | | | | | FALSE | FALSE | PARAMETERS NOT MONITORED | | 0 |
| | | 99% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| | Up | 95% | | | | | | | | | | | | | FALSE | TRUE | | | 1 |
| | | 99% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| MW03-803B | Down | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | Up | 95% | FALSE | TRUE | FALSE | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | 3 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| **FIGURE 2 - WEST OF LANDFILL** | | | | | | | | | | | | | | | | | | | |
| 516B-B | Down | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 2 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | Up | 95% | TRUE | FALSE | TRUE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | TRUE | TRUE | 6 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | 2 |
| P-914A | Down | 95% | FALSE | FALSE | FALSE | FALSE | TRUE | FALSE | FALSE | | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 1 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | Up | 95% | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | TRUE | | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | FALSE | 3 |
| | | 99% | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | TRUE | | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 2 |
| P-914B | Down | 95% | PARAMETERS NOT MONITORED | | | | | | | | | | | | FALSE | FALSE | PARAMETERS NOT MONITORED | | 1 |
| | | 99% | | | | | | | | | | | | | FALSE | FALSE | | | 1 |
| | Up | 95% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| | | 99% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| MW03-804A | Down | 95% | PARAMETERS NOT MONITORED | | | | | | | | | | | | FALSE | FALSE | PARAMETERS NOT MONITORED | | 0 |
| | | 99% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| | Up | 95% | | | | | | | | | | | | | TRUE | FALSE | | | 1 |
| | | 99% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| **FIGURE 3 - EAST OF LANDFILL** | | | | | | | | | | | | | | | | | | | |
| MW98-601A | Down | 95% | PARAMETERS NOT MONITORED | | | | | | | | | | | | FALSE | FALSE | PARAMETERS NOT MONITORED | | 1 |
| | | 99% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| | Up | 95% | | | | | | | | | | | | | TRUE | FALSE | | | 1 |
| | | 99% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| MW98-601B | Down | 95% | PARAMETERS NOT MONITORED | | | | | | | | | | | | FALSE | FALSE | PARAMETERS NOT MONITORED | | 0 |
| | | 99% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| | Up | 95% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| | | 99% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |

**TABLE 2**
Mann-Kandall Trend Analysis
PINE TREE LANDFILL
2010 thru April 2015

| Location | Trend | Confidence Level | CATIONS | | | | ANIONS | | | | | REDOX SENSITIVE | | | INDICATOR | | | MISC | Total Positive Results |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | CALCIUM | MAGNESIUM | SODIUM | POTASSIUM | ALKALINITY, BICARBONATE | CHLORIDE | SULFATE | NITRATE AS N | TOTAL ORGANIC CARBON | DISSOLVED OXYGEN | IRON | MANGANESE | PH | SPECIFIC CONDUCTANCE | TOTAL DISSOLVED SOLIDS | ARSENIC | |
| MW01-602B | Down | 95% | PARAMETERS NOT MONITORED | | | | | | | | | | | | FALSE | TRUE | PARAMETERS NOT MONITORED | | 1 |
| | | 99% | | | | | | | | | | | | | FALSE | TRUE | | | 1 |
| | Up | 95% | | | | | | | | | | | | | TRUE | FALSE | | | 1 |
| | | 99% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| MW97-123 | Down | 95% | TRUE | FALSE | FALSE | FALSE | TRUE | FALSE | FALSE | | TRUE | FALSE | FALSE | FALSE | FALSE | TRUE | TRUE | FALSE | 5 |
| | | 99% | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | TRUE | FALSE | 3 |
| | Up | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | 1 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | 1 |
| MW-916 | Down | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | Up | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 1 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 1 |
| MW-917 | Down | 95% | TRUE | TRUE | FALSE | FALSE | TRUE | FALSE | FALSE | | TRUE | FALSE | TRUE | FALSE | FALSE | TRUE | TRUE | FALSE | 7 |
| | | 99% | TRUE | TRUE | FALSE | FALSE | TRUE | FALSE | FALSE | | FALSE | FALSE | TRUE | FALSE | FALSE | TRUE | TRUE | FALSE | 6 |
| | Up | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 1 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| 509A | Down | 95% | PARAMETERS NOT MONITORED | | | | | | | | | | | | TRUE | FALSE | PARAMETERS NOT MONITORED | | 1 |
| | | 99% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| | Up | 95% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| | | 99% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| 509B | Down | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | | FALSE | FALSE | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | 2 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | Up | 95% | FALSE | TRUE | TRUE | FALSE | FALSE | FALSE | FALSE | | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | TRUE | 4 |
| | | 99% | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | 2 |
| P-911B | Down | 95% | PARAMETERS NOT MONITORED | | | | | | | | | | | | FALSE | TRUE | PARAMETERS NOT MONITORED | | 1 |
| | | 99% | | | | | | | | | | | | | FALSE | TRUE | | | 1 |
| | Up | 95% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| | | 99% | | | | | | | | | | | | | FALSE | FALSE | | | 0 |
| **FIGURE 4 - SURFACE WATER** | | | | | | | | | | | | | | | | | | | |
| SW-A | Down | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | Up | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 1 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| SW-C | Down | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | Up | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 1 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| SW-D | Down | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | Up | 95% | FALSE | FALSE | FALSE | TRUE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 2 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| SW-E | Down | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | Up | 95% | FALSE | FALSE | TRUE | TRUE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 3 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | TRUE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 1 |
| **FIGURE 5 - RESIDENTIAL WELLS** | | | | | | | | | | | | | | | | | | | |
| DW04-109 | Down | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | Up | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| DW-103 | Down | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | Up | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| DW-111 | Down | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | Up | 95% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |
| | | 99% | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 0 |

**TABLE 3A**
PINE TREE LANDFILL
Exceedance of
Maximum Contaminant Levels (MCLs)
and
Maximum Exposure Guidelines (MEGs)
2014 and April 2015

| Standard | Parameter | Date | Threshold | 200 | 509B | 516B-B | 641 | MW02-801A | MW03-802A | MW03-803B | MW-906B | MW-916 | MW-917 | MW97-123 | P-914A | DW-103 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/L | | | | | | | | | | | | | |
| MCL | ARSENIC | Apr-14 | 0.01 | 0.038 | 0.021 | 0.031 | 0.032 | 0.089 | 0.051 | 0.107 | | 0.033 | 0.164 | 0.019 | 0.02 | |
| | | Jun-14 | | | | | | | | | | | | | | 0.013 |
| | | Jul-14 | | 0.064 | 0.023 | 0.033 | 0.062 | 0.164 | 0.042 | 0.128 | 0.012 | 0.053 | 0.162 | 0.058 | 0.027 | 0.012 |
| | | Sep-14 | | 0.063 | 0.031 | 0.033 | 0.072 | 0.205 | 0.056 | 0.088 | | 0.016 | 0.147 | 0.033 | 0.018 | |
| | | Apr-15 | | 0.053 | 0.025 | 0.038 | 0.054 | 0.17 | 0.024 | 0.077 | | | 0.143 | | 0.016 | 0.013 |
| | LEAD | Jul-14 | 0.015 | | | | | 0.019 | | 0.02 | | | | | | |
| | VINYL CHLORIDE | Jul-14 | 0.002 | | | | | | | 0.007 | | | | | | |
| | | | | | | | | | | | | | | | | |
| MEG | ARSENIC | Apr-14 | 0.01 | 0.038 | 0.021 | 0.031 | 0.032 | 0.089 | 0.051 | 0.107 | | 0.033 | 0.164 | 0.019 | 0.02 | |
| | | Jun-14 | | | | | | | | | | | | | | 0.013 |
| | | Jul-14 | | 0.064 | 0.023 | 0.033 | 0.062 | 0.164 | 0.042 | 0.128 | 0.012 | 0.053 | 0.162 | 0.058 | 0.027 | 0.012 |
| | | Sep-14 | | 0.063 | 0.031 | 0.033 | 0.072 | 0.205 | 0.056 | 0.088 | | 0.016 | 0.147 | 0.033 | 0.018 | |
| | | Apr-15 | | 0.053 | 0.025 | 0.038 | 0.054 | 0.17 | 0.024 | 0.077 | | | 0.143 | | 0.016 | 0.013 |
| | BENZENE | Jul-14 | 0.004 | | | | | 0.004 | | | | | | | | |
| | COBALT | Jul-14 | 0.01 | | | | | 0.015 | | 0.107 | | | | | | |
| | IRON | Apr-14 | 5 | 5.48 | | | 5.45 | 7.61 | 12.3 | 22.1 | | | 9.87 | | | |
| | | Jul-14 | | 7.29 | | | 7.83 | 8.66 | 7.93 | 11 | | | 10 | | | |
| | | Sep-14 | | 6.47 | | | 9.61 | 8.56 | 9.74 | | | | 8.97 | | | |
| | | Apr-15 | | 9.46 | | | 5.19 | 7.71 | | 8.01 | | | 8.21 | 9.38 | | |
| | LEAD | Jul-14 | 0.01 | | | | | 0.019 | | 0.02 | | | | | | |
| | MANGANESE | Jul-14 | 0.5 | 1.46 | 8.45 | 2.17 | 3.93 | 2.9 | | 49.4 | 1.26 | 1.52 | 0.82 | 2.65 | 1.52 | |
| | NICKEL | Jul-14 | 0.02 | | | | | 0.161 | | 0.022 | | | | | | |
| | SODIUM | Apr-14 | 20 | | 38.7 | 84.2 | 61.5 | 345 | 21.6 | | 35.8 | | | 115 | 21.7 | |
| | | Jun-14 | | | | | | | | | | | | | | 32.5 |
| | | Jul-14 | | | 53.1 | 61.9 | 45.7 | 353 | | | 34.3 | | | 90.7 | 23.2 | 21.9 |
| | | Sep-14 | | | 59.7 | 58.1 | 36 | 351 | 21.3 | | 43.3 | | | 84 | 23 | |
| | | Apr-15 | | | 53.2 | 63.2 | 67.5 | 350 | | | 36.5 | | | 66.1 | 22.7 | |
| | VINYL CHLORIDE | Jul-14 | 0.0002 | | | | | | | 0.007 | | | | | | |

**TABLE 3B**
PINE TREE LANDFILL
Exceedance of MCL and MEG Thresholds
by
Analytical Method Reporting Limits
2014 through April 2015

| Standard | Parameter | Date | Threshold | 200 | 509B | 516B-B | 641 | DW04-109 | DW-103 | DW-111 | MW02-801A | MW03-802A | MW03-803B | MW-906B | MW-916 | MW-917 | MW97-123 | P-914A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/L | | | | | | | | | | | | | | | |
| MCL | 1,2-DIBROMO-3-CHLOROPROPANE | Jul-14 | 0.0002 | | | | 0.002 | 0.0005 | | | 0.002 | 0.002 | 0.002 | | 0.002 | | | |
| | 1,2-DIBROMOETHANE | Jul-14 | 0.00005 | | | | 0.002 | 0.0005 | | | 0.002 | 0.002 | 0.002 | | 0.002 | | | |
| | METHYLENE CHLORIDE | Jul-14 | 0.005 | | | | 0.005 | | | | 0.005 | 0.005 | 0.005 | | 0.005 | | | |
| | VINYL CHLORIDE | Jul-14 | 0.002 | | | | 0.002 | | | | 0.002 | 0.002 | | | 0.002 | | | |
| | | | | | | | | | | | | | | | | | | |
| MEG | 1,1,2,2-TETRACHLOROETHANE | Jul-14 | 0.002 | | | | 0.002 | | | | 0.002 | 0.002 | 0.002 | | 0.002 | | | |
| | 1,2,3-TRICHLOROPROPANE | Jul-14 | 0.00001 | | | | 0.002 | 0.0005 | | | 0.002 | 0.002 | 0.002 | | 0.002 | | | |
| | 1,2-DIBROMO-3-CHLOROPROPANE | Jul-14 | 0.0004 | | | | 0.002 | 0.0005 | | | 0.002 | 0.002 | 0.002 | | 0.002 | | | |
| | 1,2-DIBROMOETHANE | Jul-14 | 0.0002 | | | | 0.002 | 0.0005 | | | 0.002 | 0.002 | 0.002 | | 0.002 | | | |
| | ACRYLONITRILE | Jul-14 | 0.0006 | | | | 0.02 | 0.01 | | | 0.02 | 0.02 | 0.02 | | 0.02 | | | |
| | VINYL CHLORIDE | Jul-14 | 0.0002 | | | | 0.002 | 0.0005 | | | 0.002 | 0.002 | | | 0.002 | | | |
| | COBALT | Jul-14 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | | | | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| | | Sep-14 | 0.01 | | | | | | | 0.01 | | | | | | | | |

**TABLE 4**
PINE TREE LANDFILL
Summary of Volatile Organic Compound (VOC) Detections
2014 and April 2015

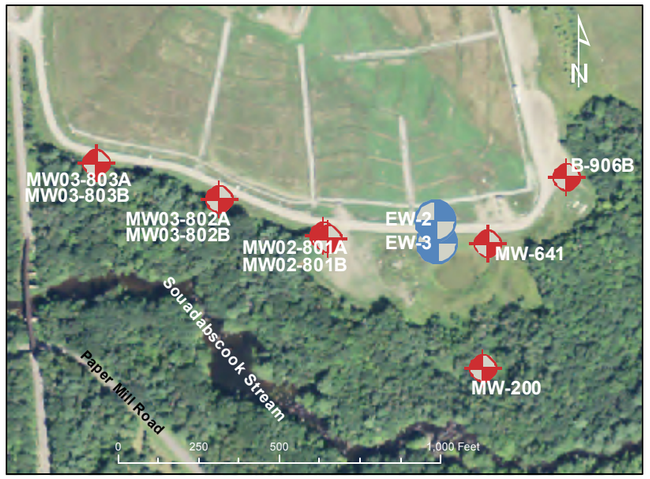
| SAMPLE POINT | DATE | 1,1-DICHLOROETHANE | 1,2-DICHLOROBENZENE | 1,2-DICHLOROPROPANE | 1,4-DICHLOROBENZENE | BENZENE | CIS-1,2-DICHLOROETHENE | VINYL CHLORIDE | METHANE |
|---|---|---|---|---|---|---|---|---|---|
| | | µg/L | | | | | | | |
| 509B | Apr-14 | | | | | | | | 180 |
| | Jul-14 | | | | | | | | 110 |
| | Apr-15 | | | | | | | | 110 |
| 641 | Apr-14 | | | | | | | | 1800 |
| | Jul-14 | | | | | | | | 420 |
| | Apr-15 | | | | | | | | 30 |
| DW04-109 | Apr-14 | | | | | | | | 830 |
| | Jun-14 | | | | | | | | 90 |
| | Jul-14 | | | | | | | | 740 |
| | Sep-14 | | | | | | | | 110 |
| | Apr-15 | | | | | | | | 110 |
| DW-103 | Apr-14 | | | | | | | | 130 |
| | Jun-14 | | | | | | | | 110 |
| | Jul-14 | | | | | | | | 90 |
| | Sep-14 | | | | | | | | 130 |
| | Apr-15 | | | | | | | | 60 |
| MW02-801A | Apr-14 | | | | | | | | 780 |
| | Jul-14 | | 1 | | 4 | 4 | | | 1100 |
| | Apr-15 | | | | | | | | 1000 |
| MW03-802A | Apr-14 | | | | | | | | 3200 |
| | Jul-14 | | | | | | | | 3100 |
| | Apr-15 | | | | | | | | 3000 |
| MW03-802B | Apr-14 | | | | | | | | 2000 |
| | Apr-15 | | | | | | | | 710 |
| MW03-803A | Apr-14 | | | | | | | | 140 |
| | Apr-15 | | | | | | | | 90 |
| MW03-803B | Apr-14 | | | | | | | | 4200 |
| | Jul-14 | 9 | | 3 | | 2 | 7 | 7 | 3800 |
| | Apr-15 | | | | | | | | 1300 |
| MW-916 | Apr-14 | | | | | | | | 530 |
| | Jul-14 | | | | | | | | 170 |
| MW-917 | Apr-14 | | | | | | | | 220 |
| | Jul-14 | | | | | | | | 170 |
| | Apr-15 | | | | | | | | 130 |

# FIGURE 1

# SOUTH OF LANDFILL

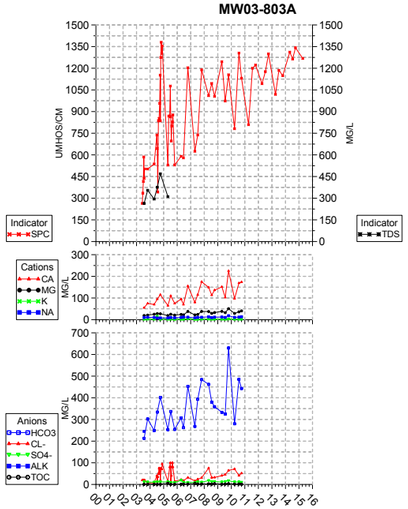
**PINE TREE LANDFILL**
**POST-CLOSURE**
**WATER QUALITY MONITORING RESULTS**
**THRU APRIL 2015**
**SUMMARY OF MAJOR IONS AND**
**INDICATOR PARAMETERS**

Figure prepared by Richard Heath MEDEP
7/7/15

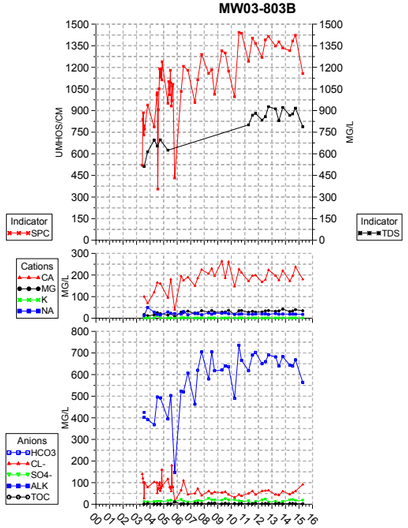



FIELD PARAMETERS

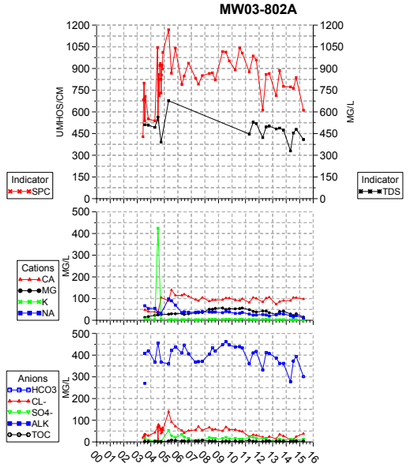
Bedrock Well
31.6' - 41.6'
**MW03-803A**




Bedrock Well
18' - 28'
**MW03-803B**

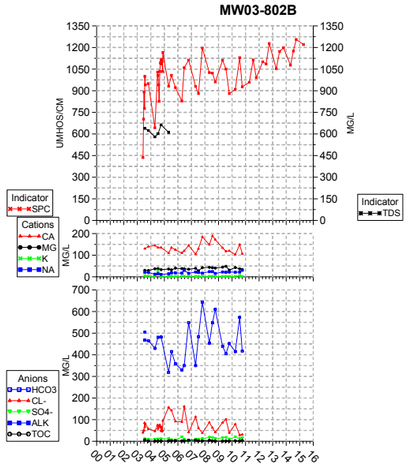



Bedrock Well
41.8' - 51.8'
**MW03-802A**

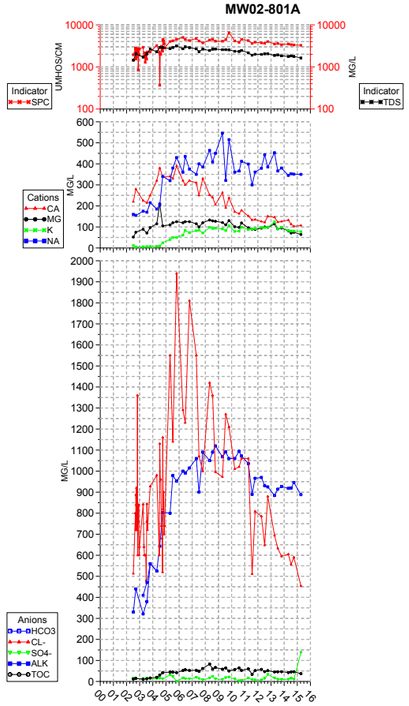



FIELD PARAMETERS

Overburden/Bedrock Well
21.8' - 31.8'
**MW03-802B**

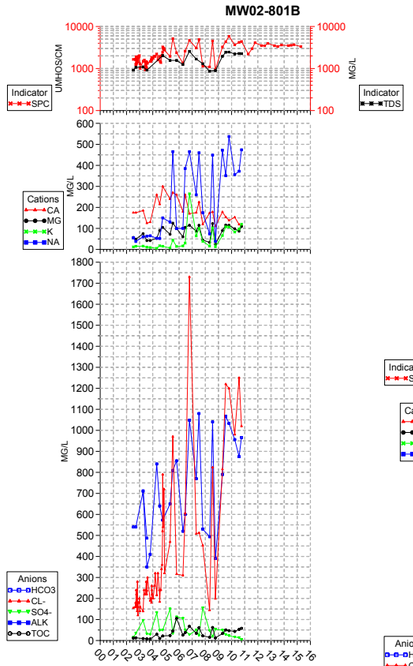



Bedrock Well
48' - 58'
**MW02-801A**

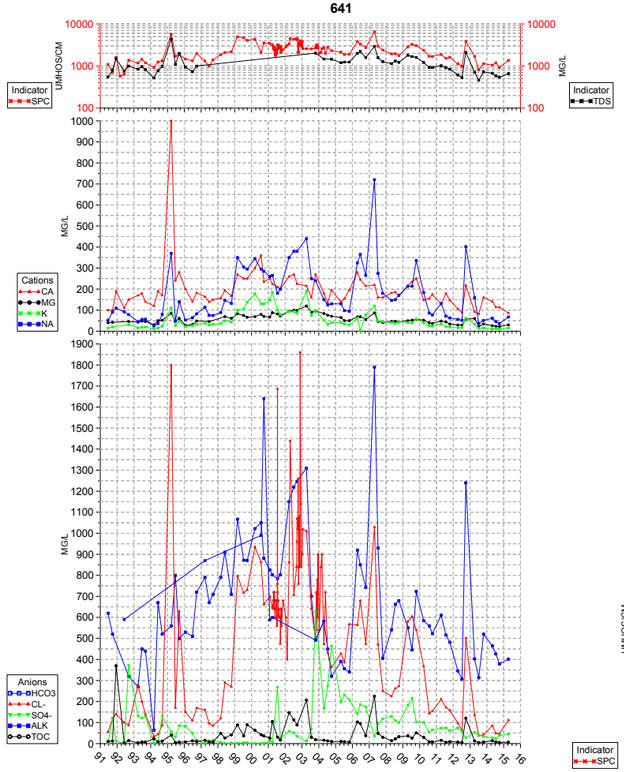



FIELD PARAMETERS

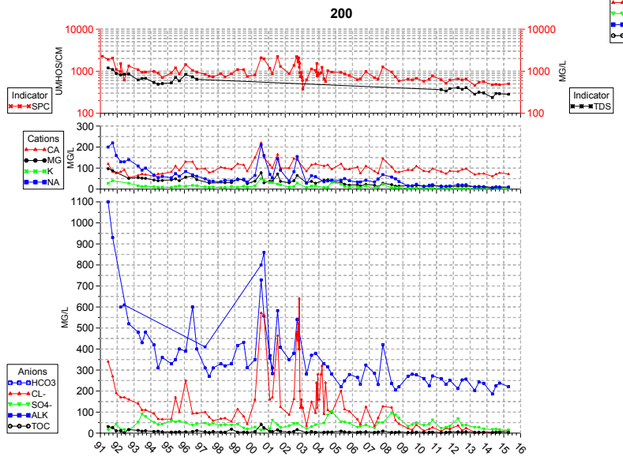
Overburden Well
20' - 30'
**MW02-801B**



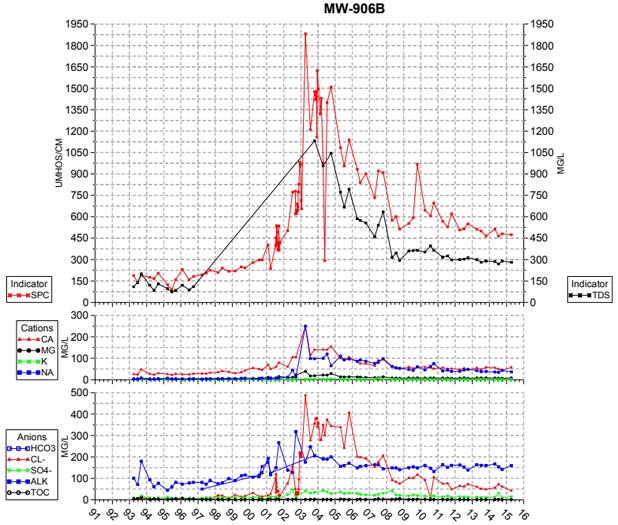

Bedrock Well
20' - 30'
**641**




Overburden Well
11.6' - 21.6'
**200**




Bedrock Well
29.7' - 39.7'
**MW-906B**

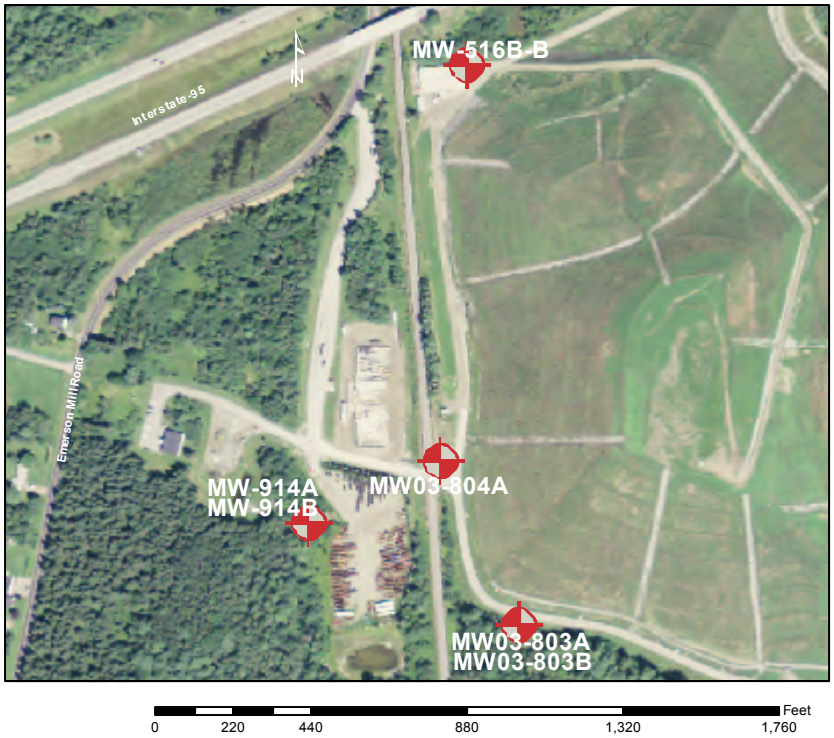


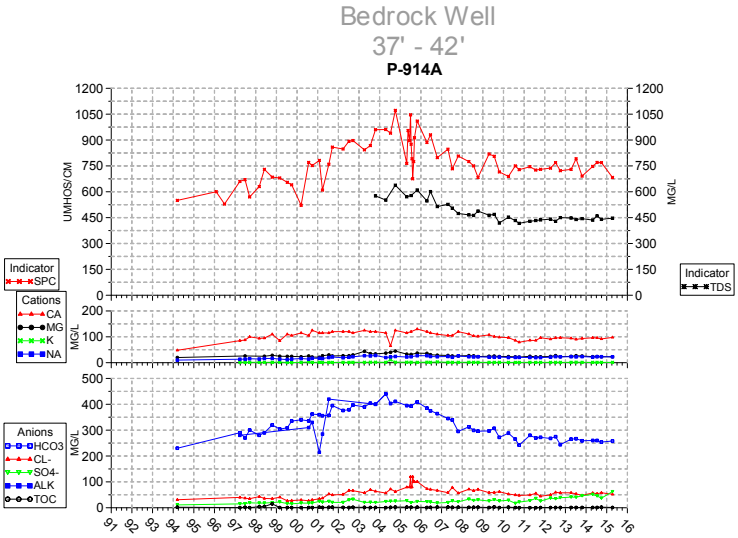
# FIGURE 2

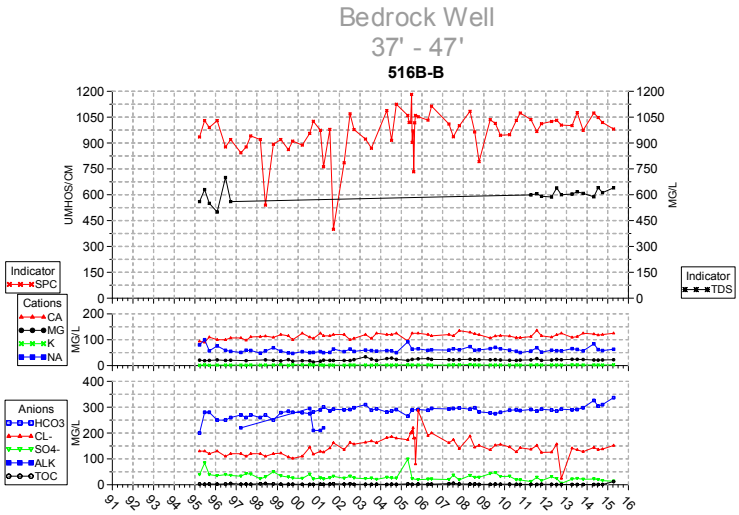
# WEST OF LANDFILL

PINE TREE LANDFILL
POST-CLOSURE
WATER QUALITY MONITORING RESULTS
THRUAPRIL 2015
SUMMARY OF MAJOR IONS AND
INDICATOR PARAMETERS

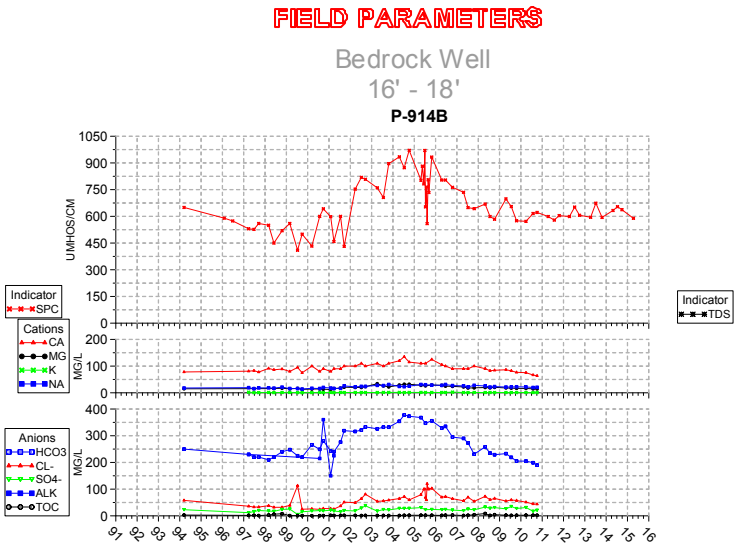
Prepared by Richard Heath MEDEP
7/7/15



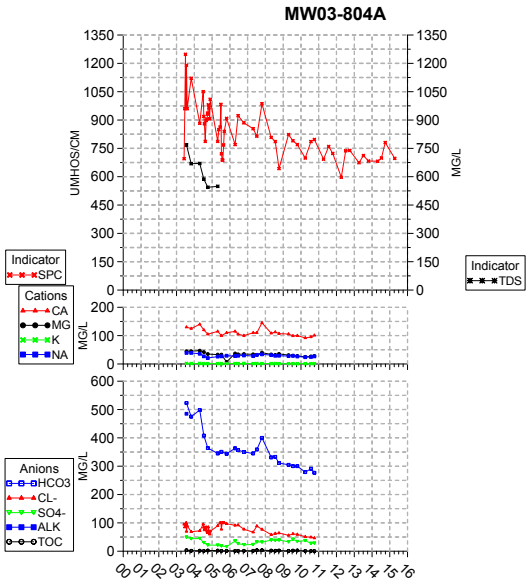




FIELD PARAMETERS



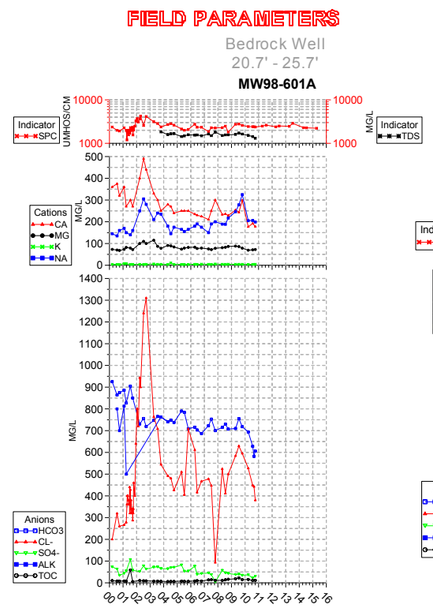

FIELD PARAMETERS

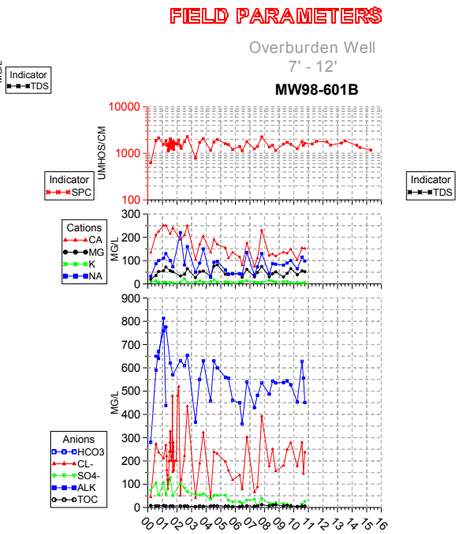


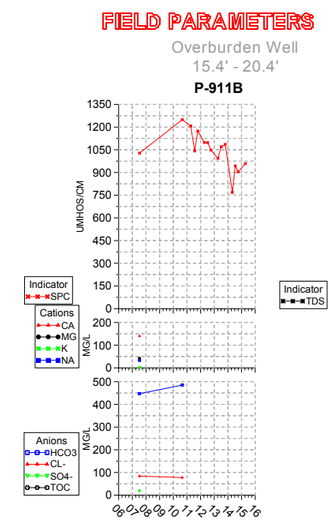
# FIGURE 3

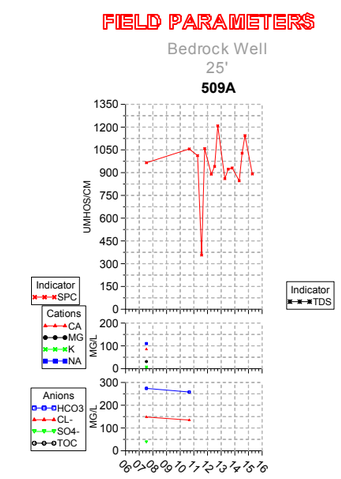
# EAST OF LANDFILL

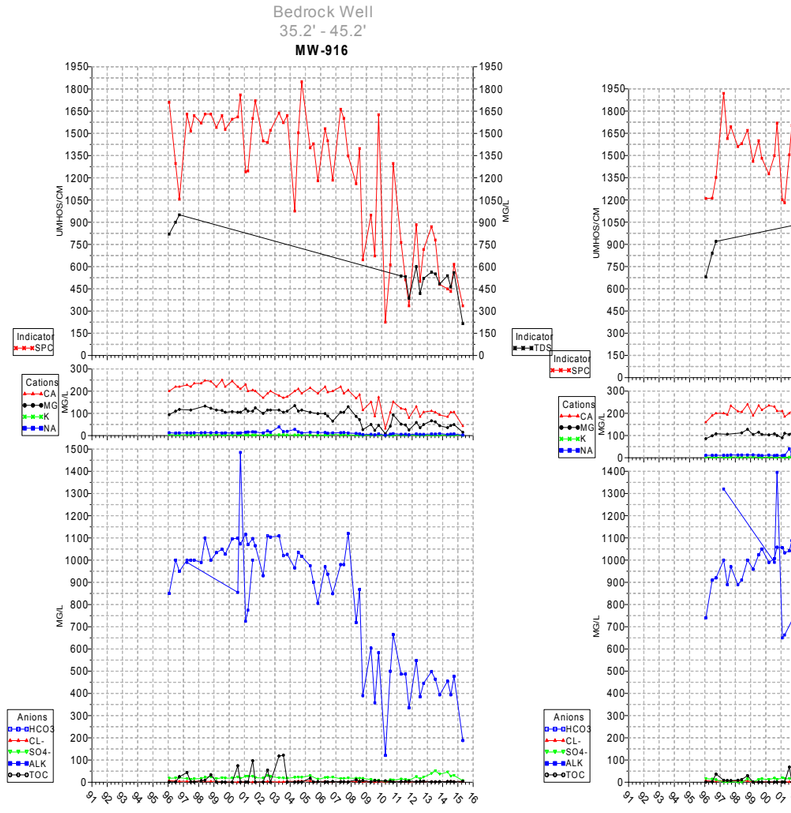
PINE TREE LANDFILL
WATER QUALITY
POST-CLOSURE
MONITORING RESULTS
THRU APRIL 2015
SUMMARY OF MAJOR IONS
AND
INDICATOR PARAMETERS

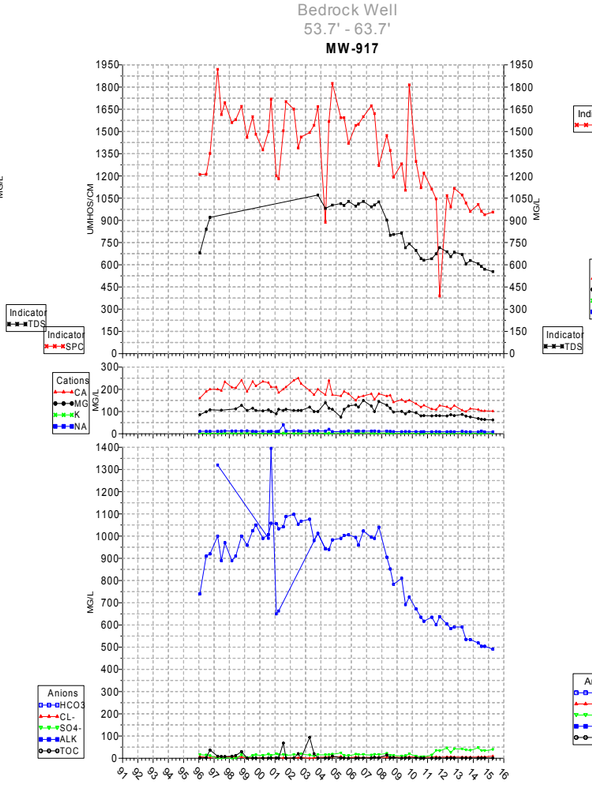


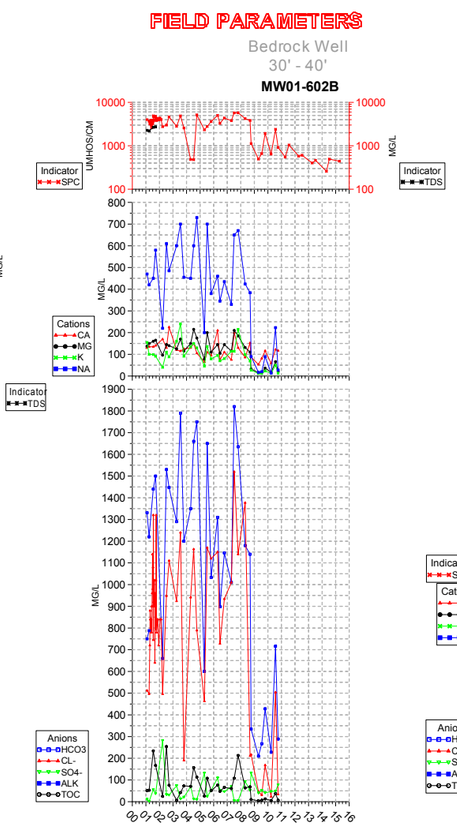



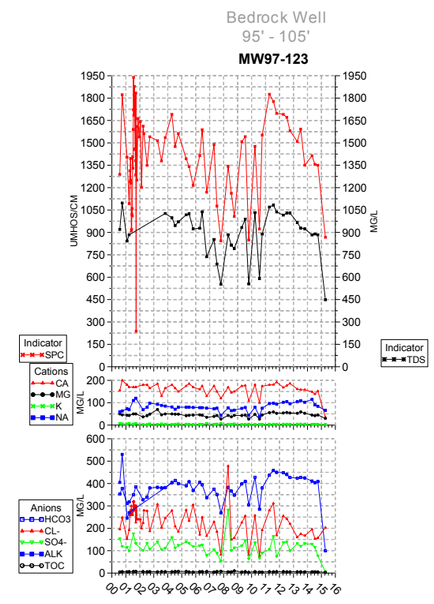



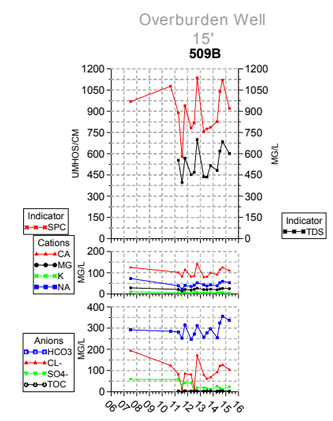



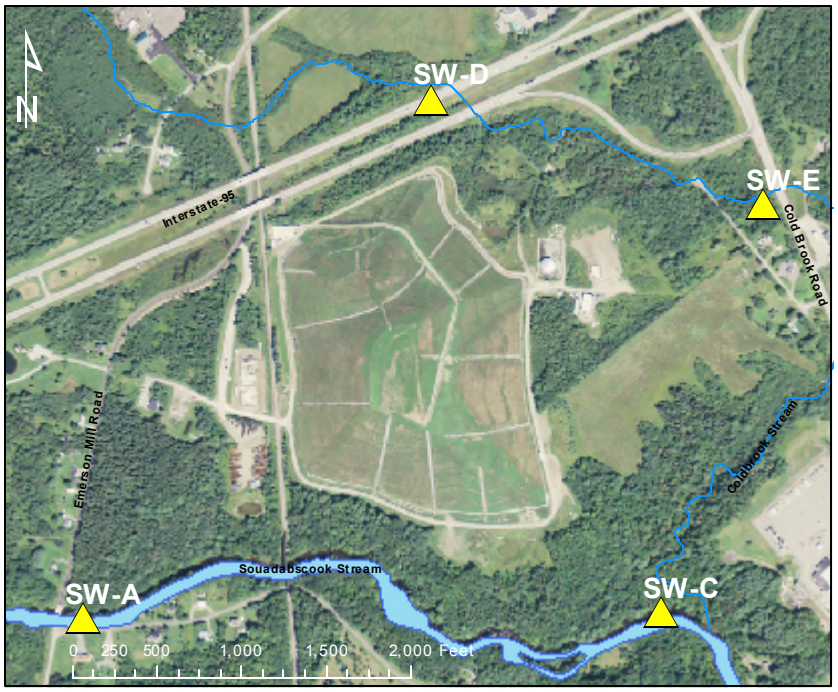




Prepared by Richard Heath, MEDEP, 7/7/15

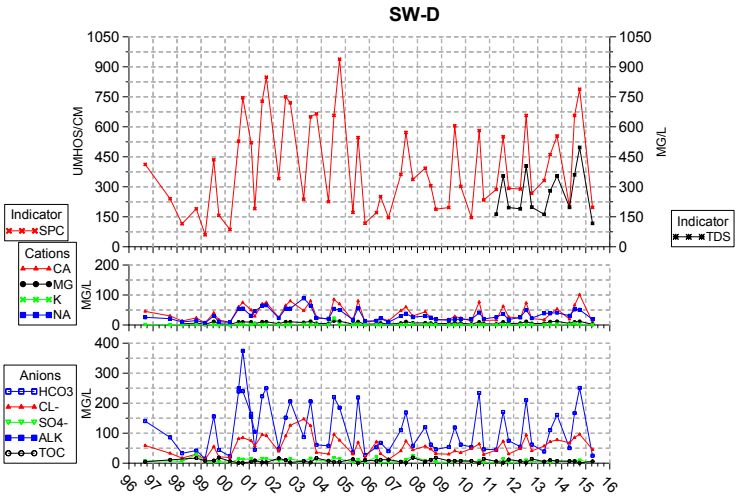


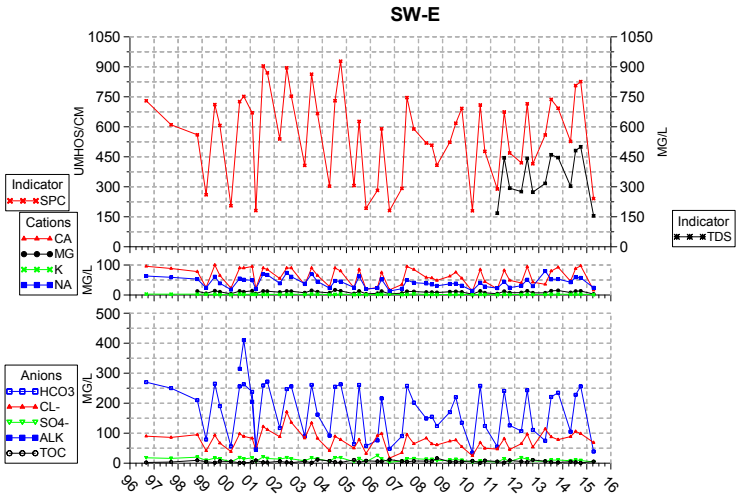

# FIGURE 4

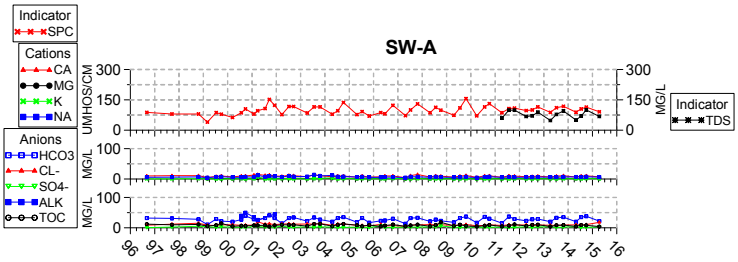
# SURFACE WATER

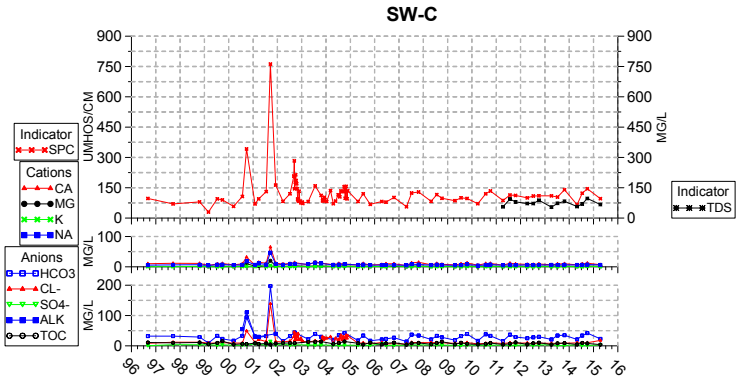
PINE TREE LANDFILL
POST-CLOSURE
WATER QUALITY MONITORING RESULTS
THRU APRIL 2015
SUMMARY OF MAJOR IONS AND
INDICATOR PARAMETERS

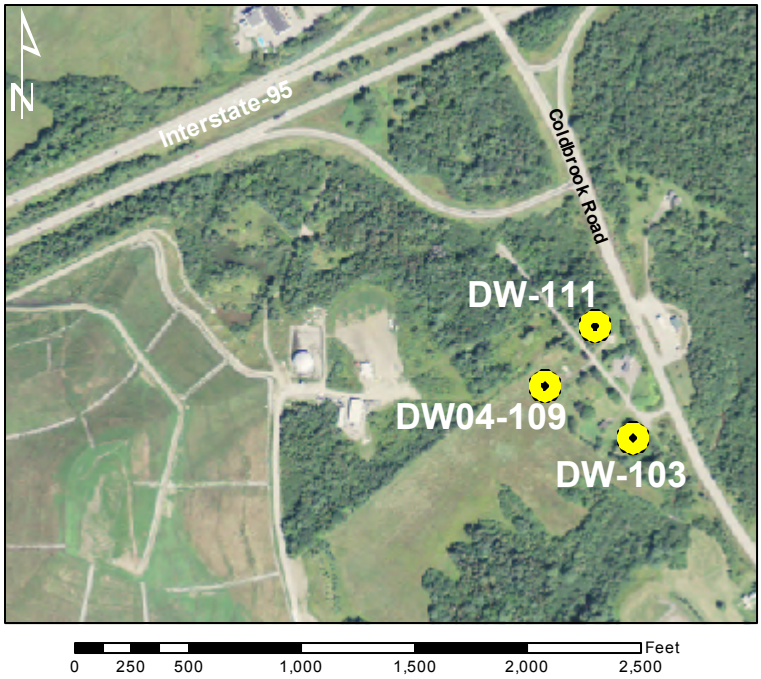
Prepared by Richard Heath MEDEP
7/7/15



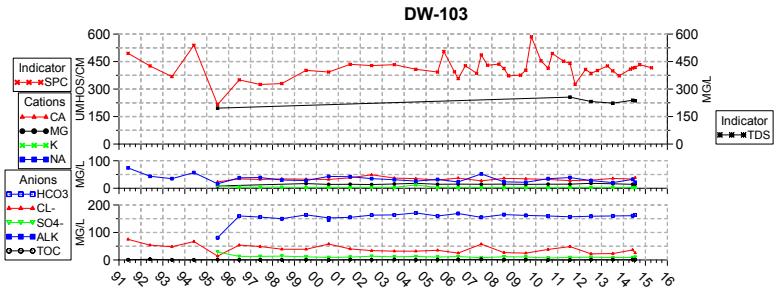


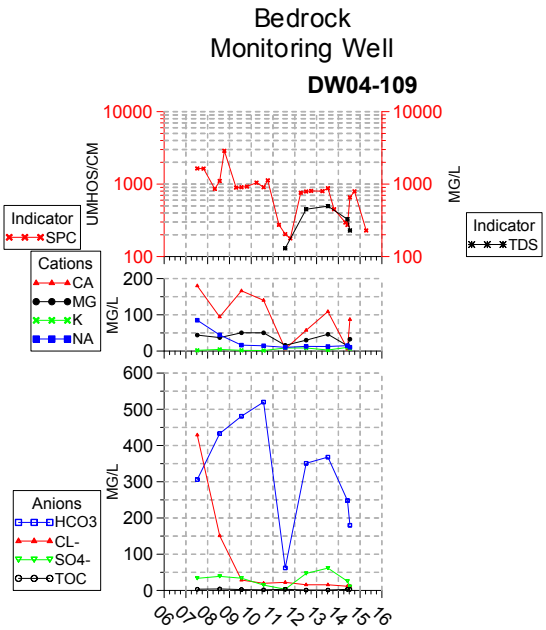

# FIGURE 5

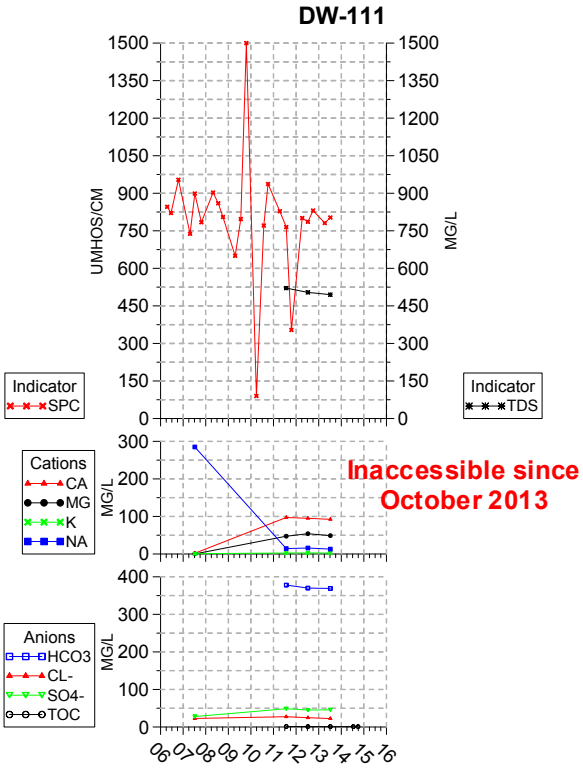
# RESIDENTIAL WELLS

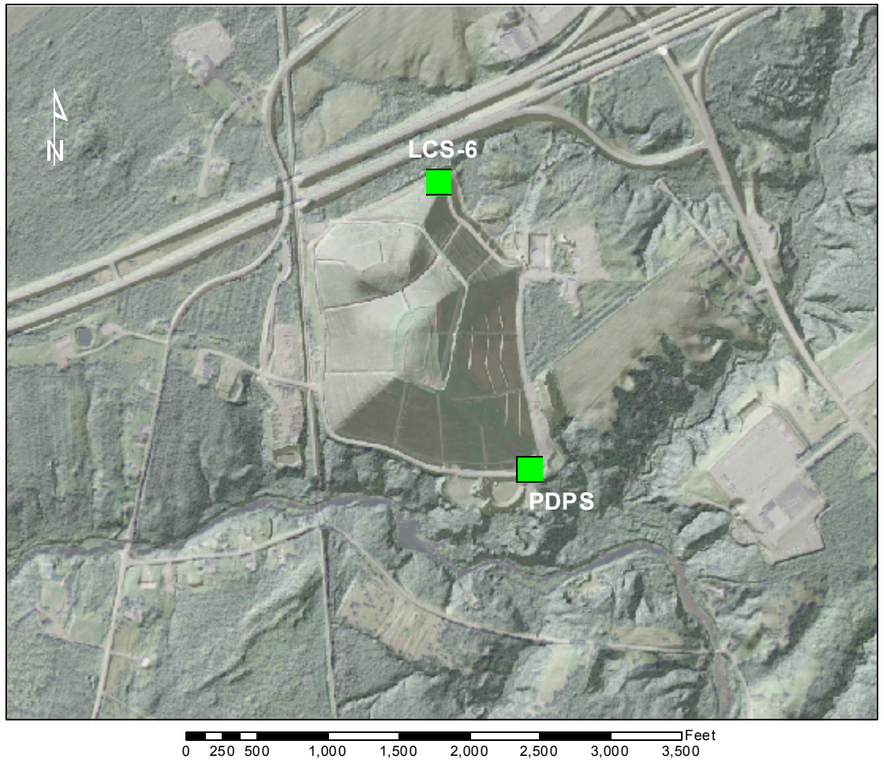
**PINE TREE LANDFILL**
**POST-CLOSURE**
**WATER QUALITY MONITORING RESULTS**
**THRU APRIL 2015**
**SUMMARY OF MAJOR IONS AND**
**INDICATOR PARAMETERS**

Prepared by Richard Heath MEDEP
7/7/15



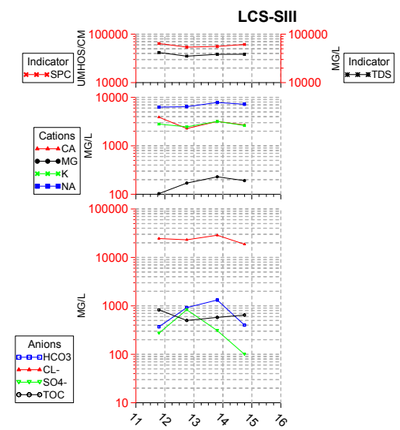


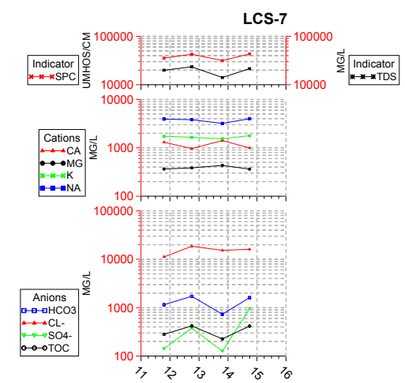

# FIGURE 6

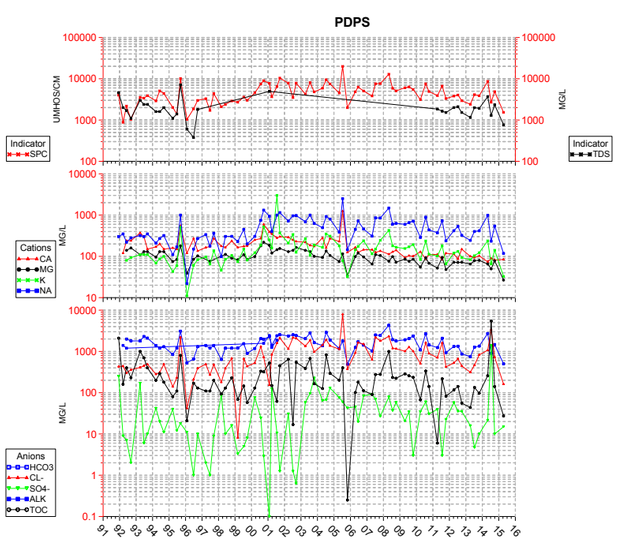
# LEACHATE

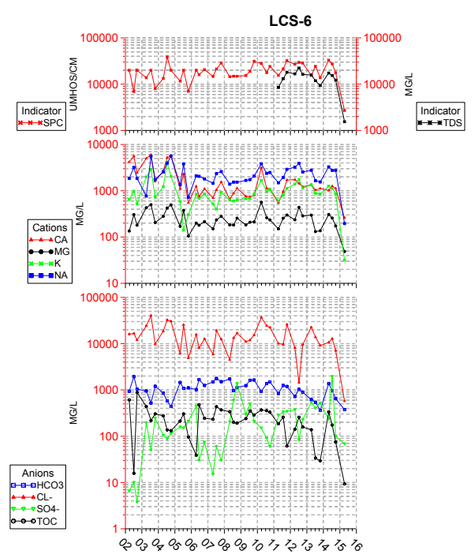
PINE TREE LANDFILL
POST-CLOSURE
WATER QUALITY MONITORING RESULTS
THRU APRIL 2015
SUMMARY OF MAJOR IONS AND
INDICATOR PARAMETERS

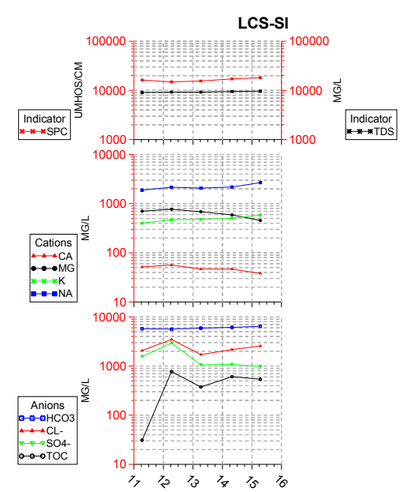
Prepared by Richard Heath MEDEP
7/7/2015

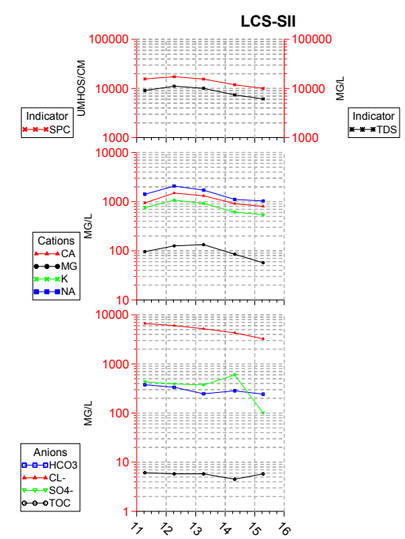


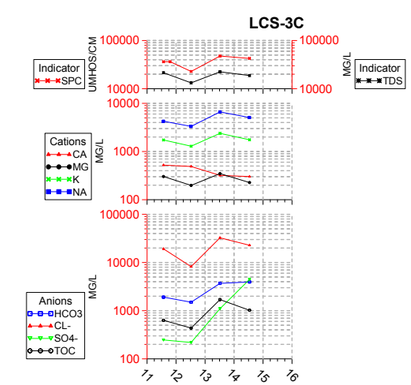



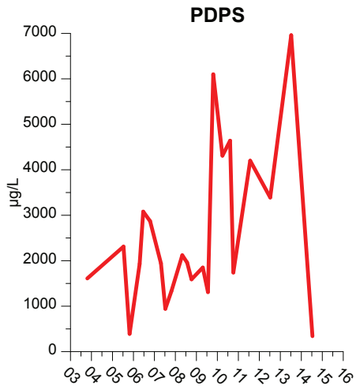



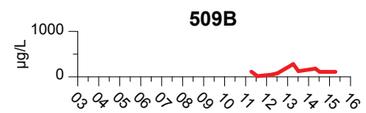



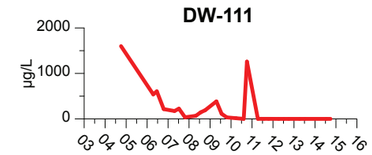
# Figure 7

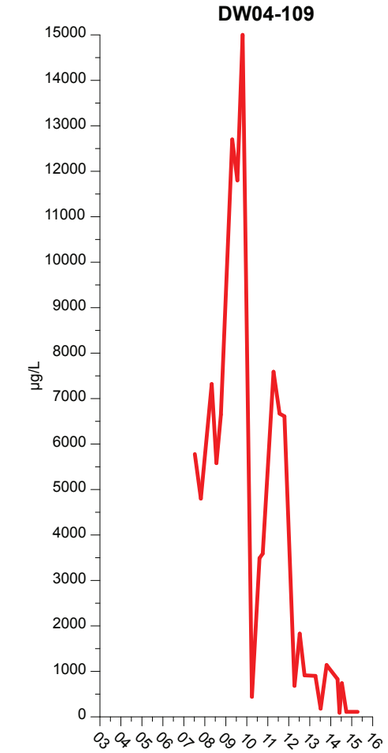
Pine Tree Landfill
Hampden, ME
Dissolved Methane
Concentration (µg/L)
through April 2015

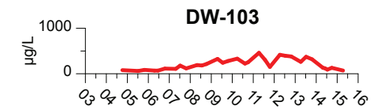
Note:
Contours based on Maximum Results from 2014

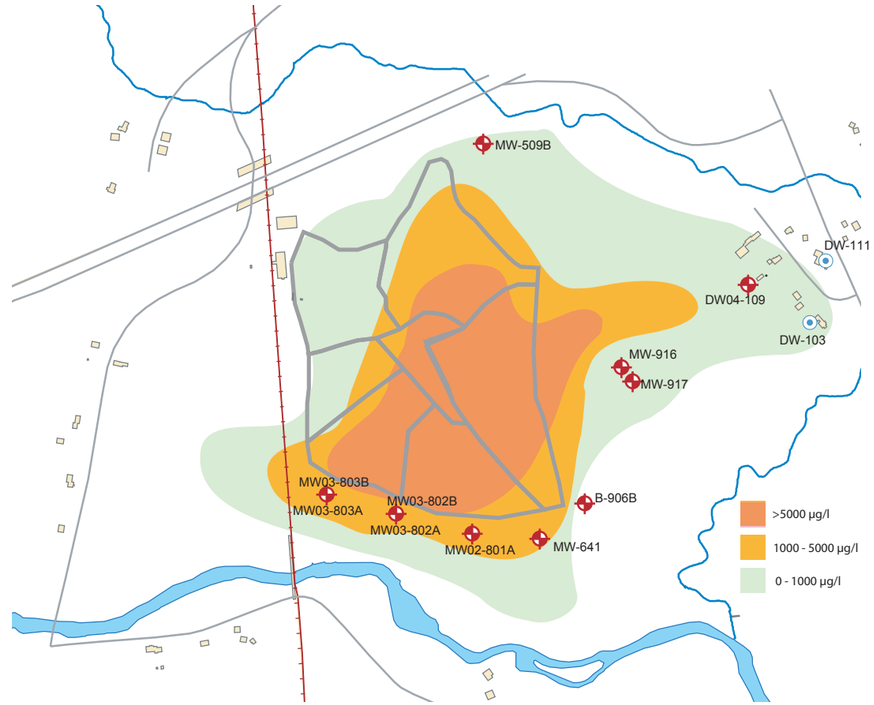


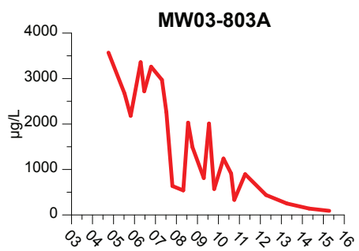



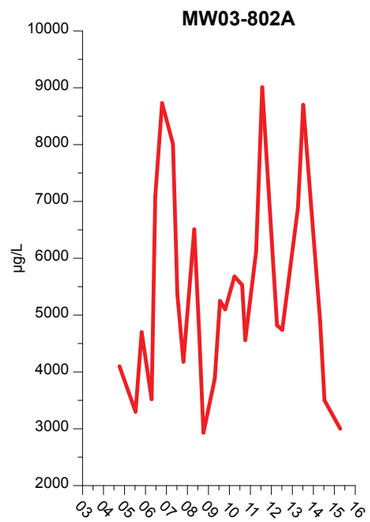



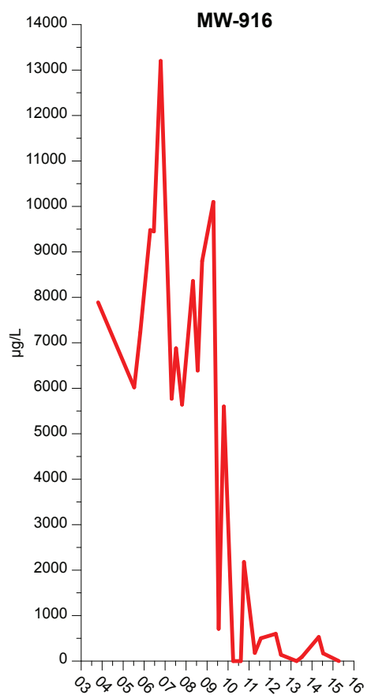



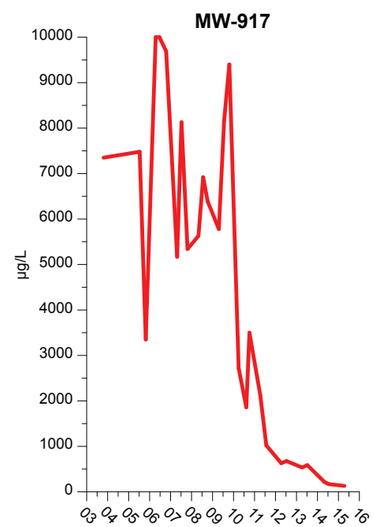



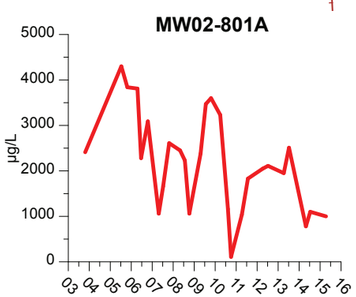



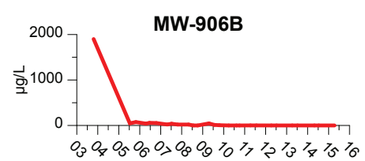



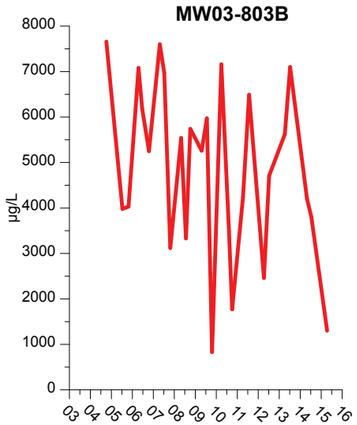



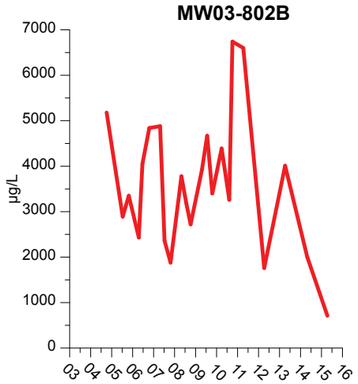



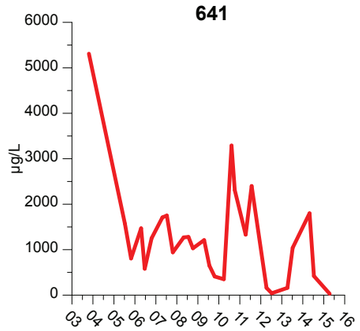




Figure prepared by Richard Heath MEDEP
7/8/2015

Angus Jennings <townmanager@hampdenmaine.gov>

# Re: FW: Hampden Final Report

1 message

**Angus Jennings** <townmanager@hampdenmaine.gov> Thu, Oct 22, 2015 at 5:25 PM
To: "Schwenn, Molly" <Molly.Schwenn@maine.gov>

Molly,
Thank you for forwarding this report; it is timely.
If you have time for a call on Monday I would appreciate your insight re how this report came to be produced. By then I will have reviewed the report in detail and may have specific questions.
Please advise as to your availability on Monday.

Thanks again,
Angus

On Thu, Oct 22, 2015 at 5:18 PM, Schwenn, Molly <Molly.Schwenn@maine.gov> wrote:

*Dear Ms. Lessard:*

*The Maine CDC Cancer Registry has completed a report about the cancer concerns in the town of Hampden. After analyzing the data and conferring with our colleagues at US CDC, we are confident that there is no evidence of increased cancer cases in the town of Hampden or a cancer cluster in the Coldbrook Road neighborhood.*

*We have compiled our findings into the attached final report. We hope this helps to alleviate any cancer concerns the town and its residents have. We have included background information, pertinent data, as well as links to resources that can help to prevent cancer.*

*Sincerely,*

*Dr. Molly Schwenn*

*Director, Maine Cancer Registry*

–

Angus Jennings
*Town Manager*

*Town of Hampden*
*106 Western Avenue*
*Hampden, ME 04444*
*(207)-862-3034*
*townmanager@hampdenmaine.gov*

Under Maine's Freedom of Access ("Right to Know") law, all e-mail and e-mail attachments received or prepared for use in matters concerning Town Business or containing information relating to Town business are likely to be regarded as public records which may be inspected by any person upon request, unless otherwise made confidential by law. If you have received this message in error, please notify us immediately by return email. Thank you for your cooperation.

# Report about Cancer Concerns to the People of Hampden and the Coldbrook Road Neighborhood

Maine Center for Disease Control and Prevention
June 2015

Maine Center for Disease Control and Prevention
An Office of the Department of Health and Human Services

Paul R. LePage, Governor  Mary C. Mayhew, Commissioner

## Introduction

We have heard and understand your concerns about the cancer rates in your community. We know that you are aware of people and families in the neighborhood with one or more cancers. The Maine Cancer Registry, a program within the Maine Center for Disease Control and Prevention (Maine CDC), has been looking into these cancer concerns for several years. The Registry takes your concerns seriously and has used science-based methods to investigate. Our investigation shows that the majority of cancers identified are common and the less common cancers occur in small numbers of individuals. We also found that the total number of cancers is not greater than would be expected to occur. This is a final report explaining our findings for the town of Hampden, including some recommendations for cancer prevention.

## Background

Since 1999, Maine CDC has received several questions about the number of cancer cases in the town of Hampden and in the "Coldbrook Road neighborhood." The Registry has answered these concerns by studying the cancer data. Our research does not point to a cancer excess in the town or to a cancer cluster in the specific neighborhood of Coldbrook Road.

There are certain findings that must be in place in order to define a cancer cluster. A cancer cluster is when more cancer cases of a certain type occur in a population than would normally occur or be expected within a group of people in a certain area over a defined period of time.

Maine's population is aging, survival rates of people with cancer are getting longer and cancer is a common disease. This may cause cancer cases to seem like they are happening more often than in the past. About 1 in 3 women and almost 1 in 2 men will get cancer during their lifetime. Many factors increase the risk of getting cancer such as age, some family history, using tobacco, not getting enough exercise and unhealthy eating habits.

The Registry has determined that the types of cancers being diagnosed and the ages at diagnosis do not suggest an increased risk for cancer in the town of Hampden nor in the "Coldbrook Road neighborhood."

## Relevant Town Data

Private Wells

A number of households in the town obtain water from privately-owned wells. The list of homes and businesses using private wells in this area is outlined by the Maine CDC Drinking Water Program:

- 20 homes on **Coldbrook Road**; (east of the landfill)
- 3 businesses on **Coldbrook Road** (convenience store, trucking company, equestrian center);
- 4 homes on **Old Coldbrook Road** (adjacent to the landfill); and
- 33 homes including one apartment complex on **Papermill Road** (south of the landfill).

This list includes homes in the "Coldbrook Road neighborhood."

## Analysis and summary

While several analyses of Hampden's cancer data were completed, we have included only the most recent analysis (done in November 2013) since it is representative and thorough. Fifteen years of cancer diagnoses are included. The four data tables and graphs that follow include explanations. We also include analysis of the cancers reported in the "Coldbrook Road neighborhood."

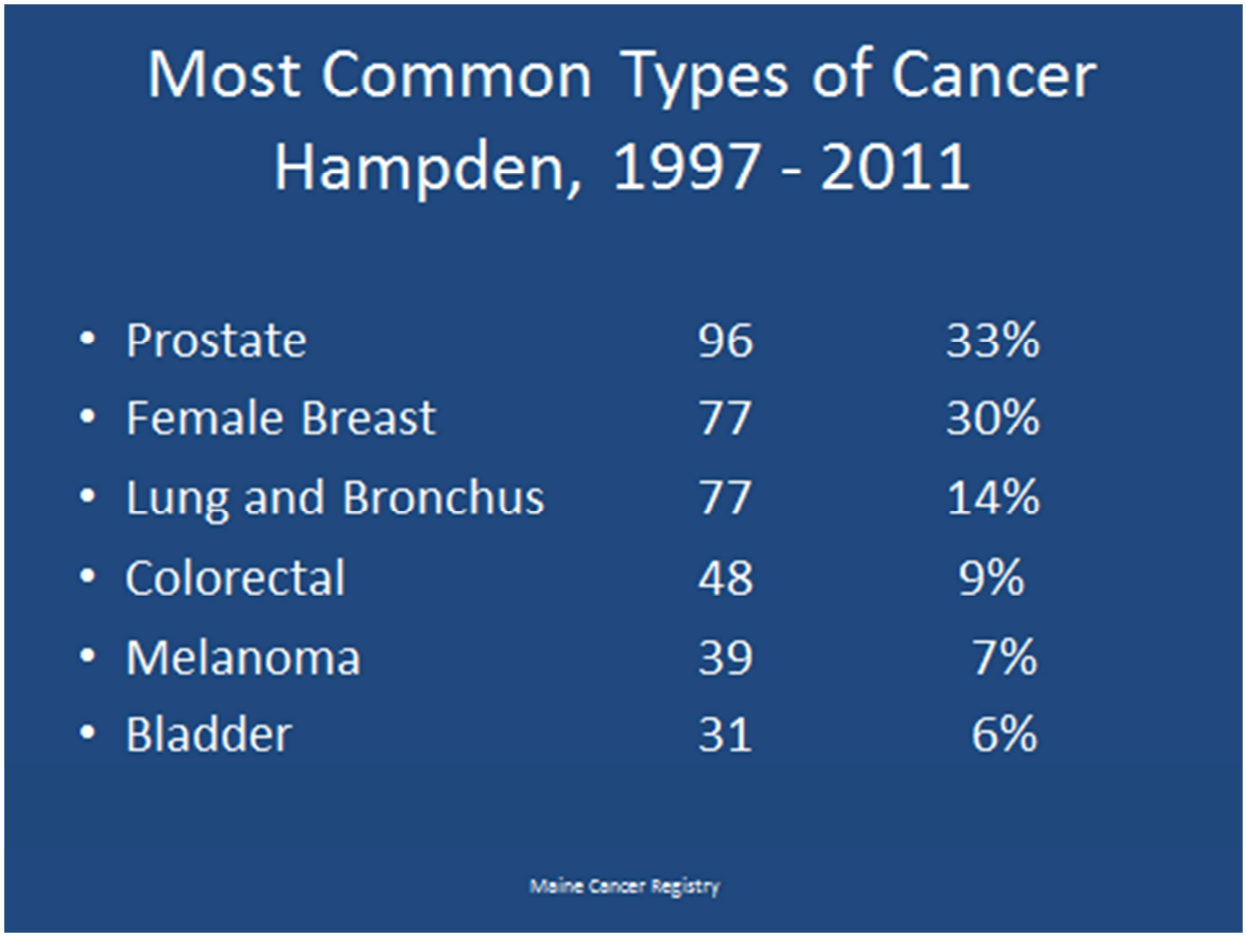



**Figure 1.** Most Common Types of Cancer: Hampden, 1997- 2011. The second column shows the number of each of these cancers diagnosed in Hampden residents over the span of 15 years. The third column shows the percentage for each cancer, based on either the total number of males, females or both. All other types of cancers each account for less than 5 percent of the total.

For the separate analysis of the "Coldbrook Road neighborhood" (also including individuals on Emerson Mill Road and Wilbur Drive), the Registry received names from three informants. We verified the cancer diagnosis, address and other pertinent information for each in the confidential Registry database. The database has information from as early as 1983 but is more complete beginning in 1990-1995. We were able to confirm a cancer diagnosis in 10 individuals who were diagnosed while residing in this area of Hampden. In addition, there were nine individuals who were reported to have lived in the neighborhood prior to their cancer diagnosis. These 19 were diagnosed during the 20-year period from 1992 through 2011. We did not include in the analysis: two individuals with cancers diagnosed in 1983, one non-resident who was a landfill employee, and nine for whom we could not verify a cancer diagnosis.

Of the 19 individuals in the analysis, there were no children or adolescents; the youngest was age 24. Six of the 19 individuals had more than one cancer. The total number of cancers was 27. Similar to the distribution of cancer types in Hampden as a whole, there were five prostate cancers, three breast cancers, three melanomas, two lung cancers and two colorectal cancers. There were also three lymphomas (all different types) and two malignant brain tumors. All other cancer types occurred only once. All cancers occurred in expected age groups. None of these findings are supportive of a cancer cluster.

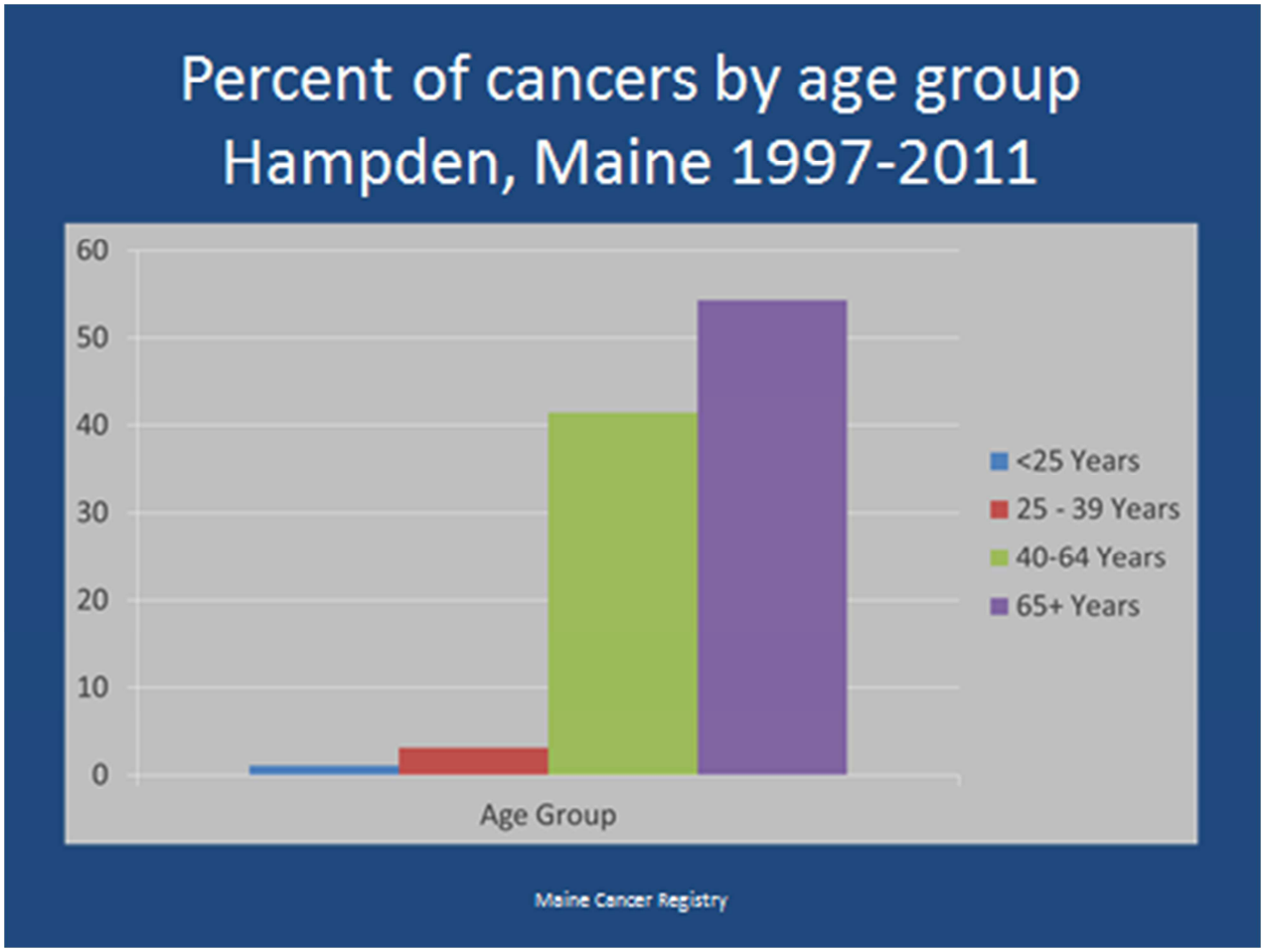



**Figure 2.** Number of cancers by age group: Hampden, Maine 1997-2011. There is an increase in the number of cases as age increases as shown from left to right. This is as expected because cancer is much more likely to occur in older individuals than in children and young adults.

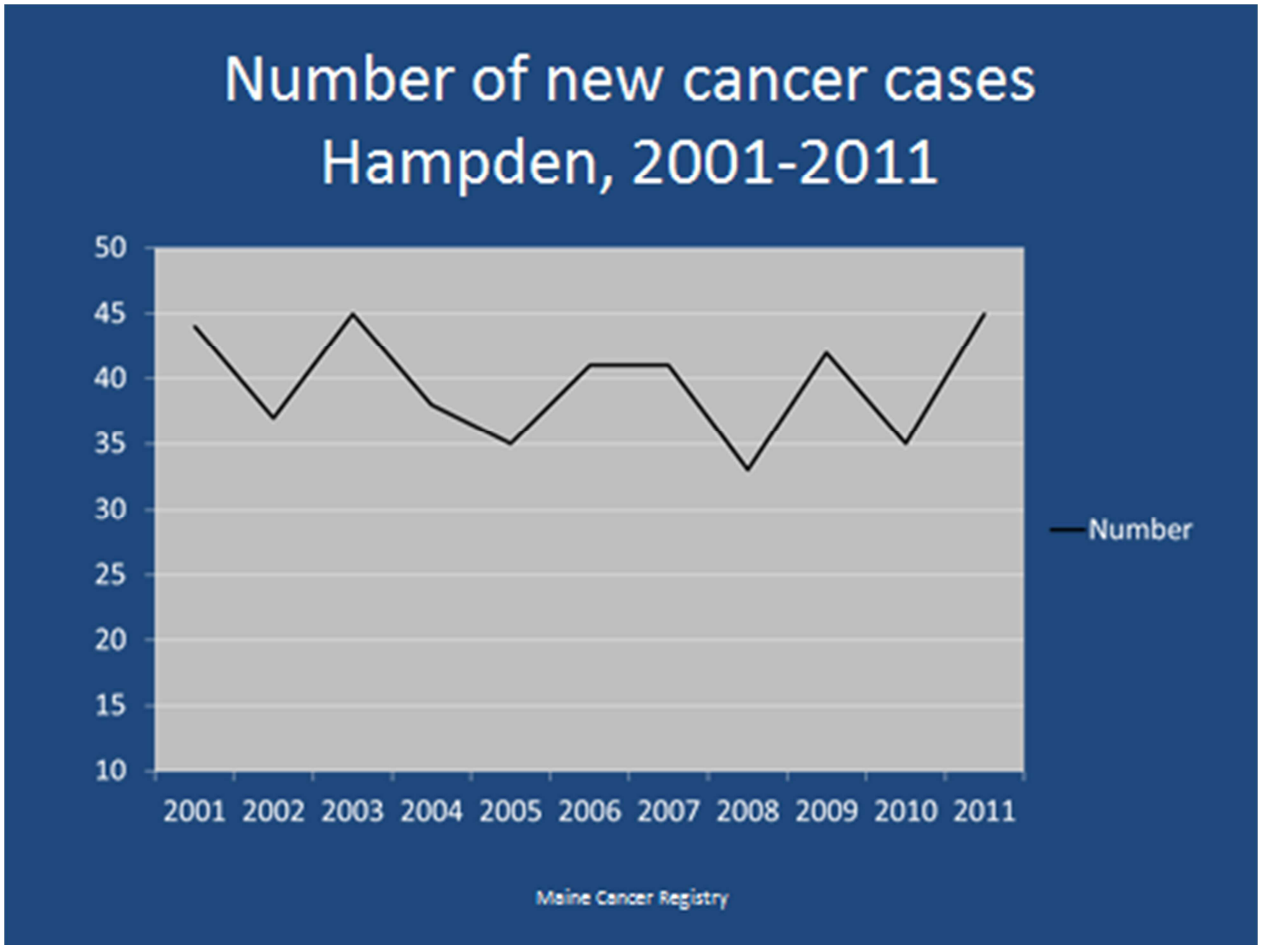



**Figure 3.** Number of new cancer cases Hampden, 2001 – 2011. The number of cases (on the left side of the chart) varies up and down from year to year without a consistent increase or decrease over the decade.

## Number of Observed and Expected Cases in Hampden (1997-2011)

| Cancer Site | Observed | Expected cases based upon Maine | Standardized Incidence Ratio |
|---|---|---|---|
| All sites | 553 | 546 | 1.0 |
| Prostate | 96 | 77 | 1.2 |
| Lung and Bronchus | 77 | 82 | 0.9 |
| Female Breast | 77 | 77 | 1.0 |
| Colorectal | 48 | 54 | 0.9 |
| Bladder | 31 | 29 | 1.1 |
| Data source: Maine Cancer Registry | | | |

, Maine Cancer Registry

**Figure 4.** Number of Observed and Expected Cases: Hampden (1997-2011). The observed (or actual) number of newly-diagnosed common cancers and the total number of cancers (second column) are compared to the expected numbers of cancers (third column) **based upon cancer rates for the State of Maine** for the same years. In the fourth column, the standardized incidence ratio is a fraction where numbers less than 1 indicate that the cancer type occurs less frequently in Hampden than expected. Numbers greater than 1, especially greater than 1.2, indicate a higher number of cancer cases than expected. Here one can see that prostate cancer (in the second row) and bladder cancer (in the sixth row) have numbers greater than 1 but only slightly greater. When the number is 1.0, then the observed cases equal the expected cases.

### Environmental Concerns

<u>Landfill</u>

An environmental concern in Hampden involves the Pine Tree Landfill which is adjacent to the “Coldbrook Road neighborhood.” The 2012 Pine Tree Landfill annual report

documented instances of leachate spills and some increases in arsenic measurements in monitoring wells. In a 2014 memo, the Maine CDC Drinking Water Program highlighted some concerning results from the 2012 water sampling tests. The test results indicated that following the 2007-2010 closure, the landfill is affecting groundwater in the area. In some places around the landfill, aspects of the water quality appear to be deteriorating, including residential wells. A methane gas extraction system is in place.

Our investigation did not find evidence of a previous or ongoing cancer cluster in the "Coldbrook Road neighborhood" of Hampden. However, as long as these residents depend on well water, there is a potential health hazard. The Maine CDC Drinking Water and Environmental Health Programs encourage residential well owners to test their water quality, including arsenic levels.

Air Quality

A second environmental concern is diesel exhaust. We contacted the Department of Environmental Protection to locate air quality data for Hampden and the "Coldbrook Road neighborhood," but found that the closest air quality monitor is in Bangor. It would not adequately reflect air quality in Hampden.

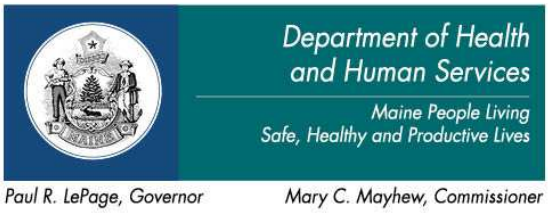
## Conclusions and Recommendations

The goal of the study was to find out if there is evidence of increased cancer in the Town of Hampden. None of the analyses of data over the past decade have pointed to a greater risk of cancer for the Town of Hampden than would be expected. The data also do not show evidence of a cancer cluster in the "Coldbrook Road neighborhood."

There are many ways to help prevent cancer. We urge everyone to consider the following actions:

- If you are using well water, test the water in your homes as recommended.
    - Information on well water testing http://www.maine.gov/dhhs/mecdc/environmental-health/eohp/wells/mewellwater.htm
- Consider testing your home for radon as recommended.
    - Information on radon testing http://www.maine.gov/dhhs/mecdc/environmental-health/rad/radon/hp-radon.htm

- Get recommended cancer screenings. Some can prevent cancer and others can detect cancer early.
    - Cervical cancer
    - Colorectal cancer
    - Breast cancer
    - Lung cancer
- Do not smoke in your home. If you want to quit tobacco, get help by calling the Maine Tobacco HelpLine 1-800-207-1230 or seek assistance from your primary care provider. Quitting resources http://ptmstore.org/index.php/helpline-materials




The Department of Health and Human Services (DHHS) does not discriminate on the basis of disability, race, color, creed, gender, sexual orientation, age, or national origin, in admission to, access to, or operations of its programs, services, or activities, or its hiring or employment practices. This notice is provided as required by Title II of the Americans with Disabilities Act of 1990 and in accordance with the Civil Rights Act of 1964 as amended, Section 504 of the Rehabilitation Act of 1973, as amended, the Age Discrimination Act of 1975, Title IX of the Education Amendments of 1972 and the Maine Human Rights Act and Executive Order Regarding State of Maine Contracts for Services. Questions, concerns, complaints or requests for additional information regarding the ADA may be forwarded to DHHS' ADA Compliance/EEO Coordinators, 11 State House Station – 221 State Street, Augusta, Maine 04333, 207-287-4289 (V), 207-287-3488 (V), TTY users call Maine relay 711. Individuals who need auxiliary aids for effective communication in program and services of DHHS are invited to make their needs and preferences known to the ADA Compliance/EEO Coordinators. This notice is available in alternate formats, upon request.

Angus Jennings <townmanager@hampdenmaine.gov>

# Sewer Connection Fees

1 message

**Sean Currier** <publicworks@hampdenmaine.gov> Thu, Oct 8, 2015 at 2:21 PM
To: Angus Jennings <townmanager@hampdenmaine.gov>

Angus, Please find the attached documents in support of changing the fee structure for sewer connections and initiating a permit process for new sewer connections. This is modeled after current rules and operation in Bangor. The reason I am recommending the following be adopted in Hampden is that our collection system outlets at the Bangor WWTP facility therefore we should be as strict on inspection as they are so we comply with their policies. We will have to address staff requirements to administer these items such as issuing the permits, and conducting field inspections.

Thank you for your consideration.

Sean

Sean Currier
Public Works Director
Town of Hampden
106 Western Avenue
Hampden, ME 04444
(207)862-3337

**4 attachments**

**_Connection Fee template.pdf**
185K

**Connection Fee Schedule.pdf**
581K

**Street opening permit guide lines.pdf**
91K

**Street Opening Permit.pdf**
24K

Date _____

**Sewer Connection Fee Calculation Worksheet**

Sewer Connection Location: _____

Address _____

Contractor Name & Address

PAID: [ ]

Name _____

Address _____

_____

Telephone _____

Check:

Eng Receipt

Date:

Owner Name and Address:

Name _____

Address _____

_____

Telephone _____

Property Use: If applicable

| | | |
|---|---|---|
| Food Service Provided | Y | N |
| Grease Interceptor | Y | N |
| Oil/Sand Separator | Y | N |

| **Area 1:** | | **gpd/unit** | **$/gpd** | | **Fee** | **Category** |
|---|---|---|---|---|---|---|
| | square feet | | 1.06 | $ | - | |
| | units | | 1.06 | $ | - | |
| | seats | | 1.06 | $ | - | |
| | beds | | 1.06 | $ | - | |
| | other | | 1.06 | $ | - | |

| **Area 2:** | | **gpd/unit** | **$/gpd** | | **Fee** |
|---|---|---|---|---|---|
| | square feet | | 1.06 | $ | - |
| | units | | 1.06 | $ | - |
| | seats | | 1.06 | $ | - |
| | beds | | 1.06 | $ | - |
| | other | | 1.06 | $ | - |

| **Area 3:** | | **gpd/unit** | **$/gpd** | | **Fee** |
|---|---|---|---|---|---|
| | square feet | | 1.06 | $ | - |
| | units | | 1.06 | $ | - |
| | seats | | 1.06 | $ | - |
| | beds | | 1.06 | $ | - |
| | other | | 1.06 | $ | - |

**Total Connection Fee** $ -

Comments: (Minumum Fee for Sewer Connection $50.00)

**SEWER CONNECTION FEE SCHEDULE**

| | | |
|---|---|---|
| AMUSEMENT PARK | DETERMINED BY SUPERINENDENT | |
| APARTMENT BUILDING | 185 | gpd/unit |
| AUTO BODY SHOP | 0.05 | gpd/ft² |
| AUTO SALES GARAGE | 0.05 | gpd/ft² |
| BAKERY | 0.15 | gpd/ft² |
| BANK | 0.1 | gpd/ft² |
| BARBER SHOP | 0.35 | gpd/ft² |
| BEAUTY SALON | 0.75 | gpd/ft² |
| BOARDING HOUSE | 50 | gpd/bed |
| BOWLING ALLEY | 75 | gpd/lane |
| CAR WASH | DETERMINED BY SUPERINENDENT | |
| CHURCH (SANCTURY) | 185 | gpd |
| DAY CARE | 10 | gpd/child |
| DRY CLEANERS | 0.15 | gpd/ft² |
| DUPLEX, ANY COMBINATION OF PLEXES | 270 | gpd/unit |
| FASTFOOD RESTAURANT (NO TABLE SERVICE ) | 20 | gpd/seat |
| FUNERAL HOME | 0.05 | gpd/ft² |
| GOVERNMENT BUILDING | 0.1 | gpd/ft² |
| HEALTH CLUB | 0.15 | gpd/ft² |
| HOSPITALS | 150 | gpd/bed |
| HOTELS/MOTELS | 100 | gpd/unit |
| INDUSTRIAL (PROCESS FLOW) | DETERMINED BY SUPERINENDENT | |
| LAUNDRY | 2.0 | gpd/20lb machine |
| LODGE | 0.25 | gpd/ft² |
| MEDICAL/DENTAL | 0.15 | gpd/ft² |
| MOBILE HOME | 270 | gpd |
| NURSING | 100 | gpd/bed |
| OFFICES | 0.06 | gpd/ft² |
| RESTAURANT | 35 | gpd/seat |
| RETAIL | 0.05 | gpd/ft² |
| RETIREMENT | 120 | gpd/unit |
| SCHOOLS | 10 | gpd/student |
| SENIOR HOUSING FACILITIES | 65 | gpd/unit |
| SERVICE STATION W/RESTROOMS | 500 | gpd/island |
| SINGLE FAMILY HOMES | 270 | gpd |
| SUPERMARKET | 0.05 | gpd/ft² |
| TAVERNS, BARS, LOUNGES | 0.09 | gpd/ft² |
| THEATER | 3 | gpd/seat |
| TRAIN/BUS STATIONS | 0.075 | gpd/ft² |
| UTILITIES | 0.01 | gpd/ft² |
| VETERINARIANS | 0.65 | gpd.ft² |
| WAREHOUSE | 0.05 | gpd/ft² |

PERMIT # _____

DATE _____

PHONE: FAX:

# STREET OPENING / UTILITY CONNECTION PERMIT

DIG-SAFE NUMBER _____ PROOF OF INSURANCE 07/01/2015

## WORK INFORMATION

STREET ADDRESS _____ REQUESTED ADDRESS _____

LOT LOCATION _____ TYPE _____

TYPE OF WORK _____

WORK EXPLANATION _____

DIG-SAFE START DATE _____ DIG-SAFE END DATE _____

## CONTRACTOR INFORMATION

ID _____ COMPANY _____ PHONE _____

CONTACT PERSON _____ EMERGENCY PHONE _____

CONTRACTOR ADDRESS _____

## OWNER INFORMATION

OWNER NAME _____ PHONE _____

OWNER ADDRESS _____

SIGNATURE _____

*By signing above, I acknowledge that I have read and understand the 'instructions for contractor' form and reviewed the back fill requirements diagram.*

PERMIT ISSUED BY _____ FEE $50.00

## SPECIAL REQUIREMENTS

ENGINEER _____

COMMENTS _____

The standard permit fee is $50.00. A weekend work permit fee is $210.00. Any contractor who applies for a permit 'after the fact' will be charged a $420.00 fee. The permit is granted subject to the provisions of Title 23, Chapter 307, Subchapter II of Maine Revised Statutes Annotated, Rate changes per Council Order 11-118, April 11, 2011.

# INSTRUCTIONS FOR CONTRACTORS & BACKFILL REQUIREMENTS

NOTES:

1. NO PERMIT SHALL BE ISSUED WITHOUT A DIG SAFE NUMBER AND PROOF OF LIABILITY INSURANCE. BY SIGNING THIS PERMIT, CONTRACTOR CERTIFIES THAT ALL UTILITIES HAVE BEEN CONTACTED AND THAT CONTRACTOR IS FINANCIALLY RESPONSIBLE FOR ANY AND ALL UTILITY DISRUPTIONS. A COPY OF THIS PERMIT MUST BE AVAILABLE FOR INSPECTION AT THE EXCAVATION SITE.

2. CONTRACTOR MUST COMPLY WITH OSHA REGULATIONS, MUTCD WORK ZONE REQUIREMENTS, AND ALL APPLICABLE STATE, LOCAL, AND FEDERAL REGULATIONS.

3. CONTRACTOR MUST NOTIFY EMERGENCY RESPONDERS PRIOR TO SETTING UP LANE CLOSURES OR BLOCKING ANY CITY ROAD.

4. THE IS NOT RESPONSIBLE FOR LOCATING OR MARKING SEWER OR STORM CONNECTIONS. CONTRACTOR SHALL NOT RELY ON ANY SUCH CITY LOCATING OR MARKING ACTIVITIES. CONTRACTOR IS RESPONSIBLE FOR LOCATING AND MARKING SUCH CONNECTIONS.

5. NEW SEWER AND DRAIN CONNECTIONS MUST BE MADE WITH APPROVED CONNECTION DEVICES AND INSPECTED BY THE CONTACT DEPARTMENT PRIOR TO EXCAVATION FOR APPROVED CONNECTION DEVICES. CONTACT SEWER DEPARTMENT PRIOR TO BACKFILLING TO SCHEDULE UTILITY INSPECTION.

6. BACKFILL SHALL CONSIST OF CLEAN EXCAVATED MATERIAL OR CLEAN MATERIAL HAULED ONSITE CONTAINING NO FROZEN OR PERISHABLE MATERIAL AND WITH NO ROCKS GREATER THAN 6" IN SIZE. MATERIAL SHALL BE APPROVED BY THE CITY OF BANGOR PRIOR TO COMMENCING BACKFILL. CONTACT PUBLIC WORKS PRIOR TO BACKFILLING TO SCHEDULE BACKFILL INSPECTION.

7. BACKFILL SHALL BE PLACED IN 12" MAX. LIFTS AND COMPACTED TO 95% UTILIZING PROPER COMPACTION PROCEDURES.

8. FLOWABLE FILL TO BE 1500 PSI MINIMUM OR AS DIRECTED BY

9. PROVIDE 2" OF RIGID INSULATION FOR UTILITIES BURIED LESS THAN 5' DEEP.

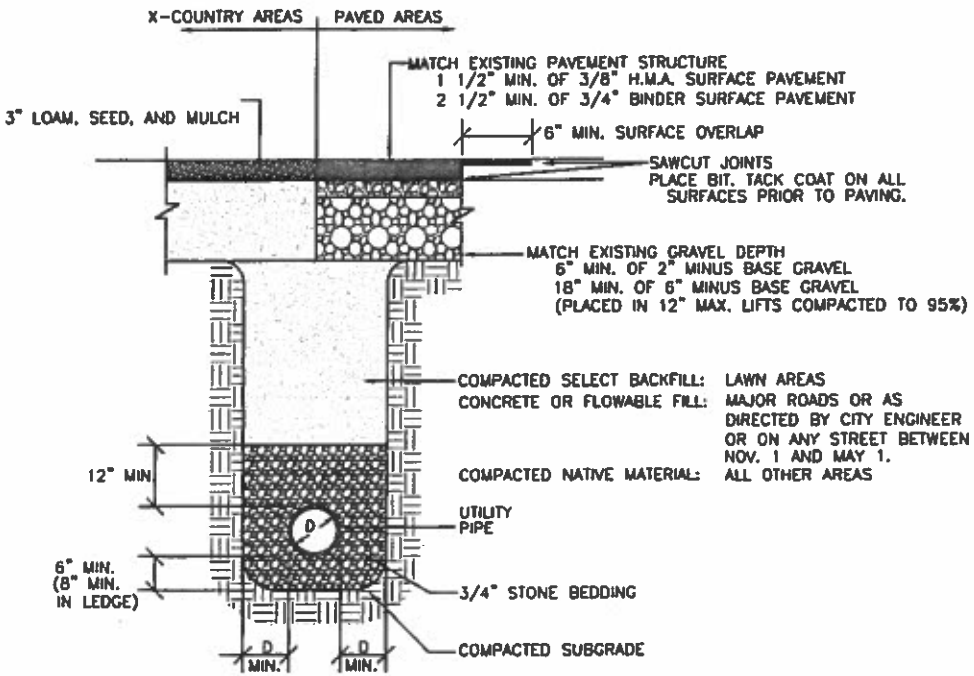
10. TRENCH SHALL HAVE TEMPORARY OR PERMANENT PAVEMENT WITHIN 24 HOURS OF BEING BACKFILLED (48 HOURS MAX. WEEKENDS & HOLIDAYS). FINISH PAVEMENT SHALL BE PLACED WITHIN 30 CALENDAR DAYS.

11. CONTRACTOR SHALL BE RESPONSIBLE FOR REPLACEMENT OF BRICK SIDEWALKS, CONCRETE SIDEWALKS, AND CURBING ACCORDING TO

12. THE STREET OPENING/UTILITY CONNECTION PERMIT IS ISSUED IN ACCORDANCE WITH FEES AND CONSTRUCTION REQUIREMENTS IDENTIFIED BY THE WATER DISTRICT OR OTHER INDEPENDENT UTILITIES MAY ALSO APPLY.

CONTACT INFORMATION:

| | | |
|---|---|---|
| DIG SAFE | 811<br>1-888-344-7233 | |
| PUBLIC WORKS | PH: | FX: |
| WATER DISTRICT | PH: | FX: |
| ELECTRICAL DEPT. | PH: | FX: |
| SEWER DEPT. | PH: | FX: |
| POLICE/FIRE DISPATCH | PH: | |
| | | FX: |




## TYPICAL UTILITY TRENCH AND SURFACE RESTORATION DETAIL

NOT TO SCALE

STREET OPENING PERMIT
LAST UPDATED

## Dan Higgins

**From:** rgarrity@hamlinsmarina.com
**Sent:** Monday, August 24, 2015 1:04 PM
**To:** dhiggins@hamlinsmarina.com
**Subject:** town docks

When you talk to the town about the fuel dock it should also be mentioned that the ramp docks need new decking. They are starting to rot and people have broken through. Also the ramp itself is becoming a hazard at low tide. 18" pieces of rebar are sticking straight up from the deteriorated asphalt ramp construction.

*Reid Garrity*
*Service Manager*
**Hamlin's**
*Marina*
*100 Marina Rd.*
*Hampden, Maine*
*04444*
*207-941-8619 x121*

## PLAN REFERENCE

"CITY OF BANGOR AND COLE PROPERTIES LAND AT TURTLE-HEAD-HAMPDEN, INC", PREPARED BY THE CITY OF BANGOR ENGINEERING DEPARTMENT, DATED NOV. 28, 1990 AND FILED IN THE PENOBSCOT COUNTY REGISTRY OF DEEDS IN PLAN FILE 939-42

## NOTES

1) ALL BOOK AND PAGE NUMBERS REFER TO THE PENOBSCOT COUNTY REGISTRY OF DEEDS.

2) SOURCE DEEDS: TURTLE HEAD MARINA, INC. TO TURTLE HEAD, LLC, DATED JANUARY 21, 2004 AND RECORDED IN BOOK 9199, PAGE 148 OF SAID REGISTRY OF DEEDS.

CITY OF BANGOR TO THE INHABITANTS OF THE TOWN OF HAMPDEN DATED JUNE 23, 1992 AND RECORDED IN BOOK 3314, PAGE 273 OF SAID REGISTRY OF DEEDS.

3) THE WORD "CERTIFY" OR "CERTIFICATION" AS SHOWN AND USED HEREON MEANS AN EXPRESSION OF PROFESSIONAL OPINION REGARDING THE FACTS OF THE SURVEY AND DOES NOT CONSTITUTE A WARRANTY OR GUARANTEE, EXPRESSED OR IMPLIED.

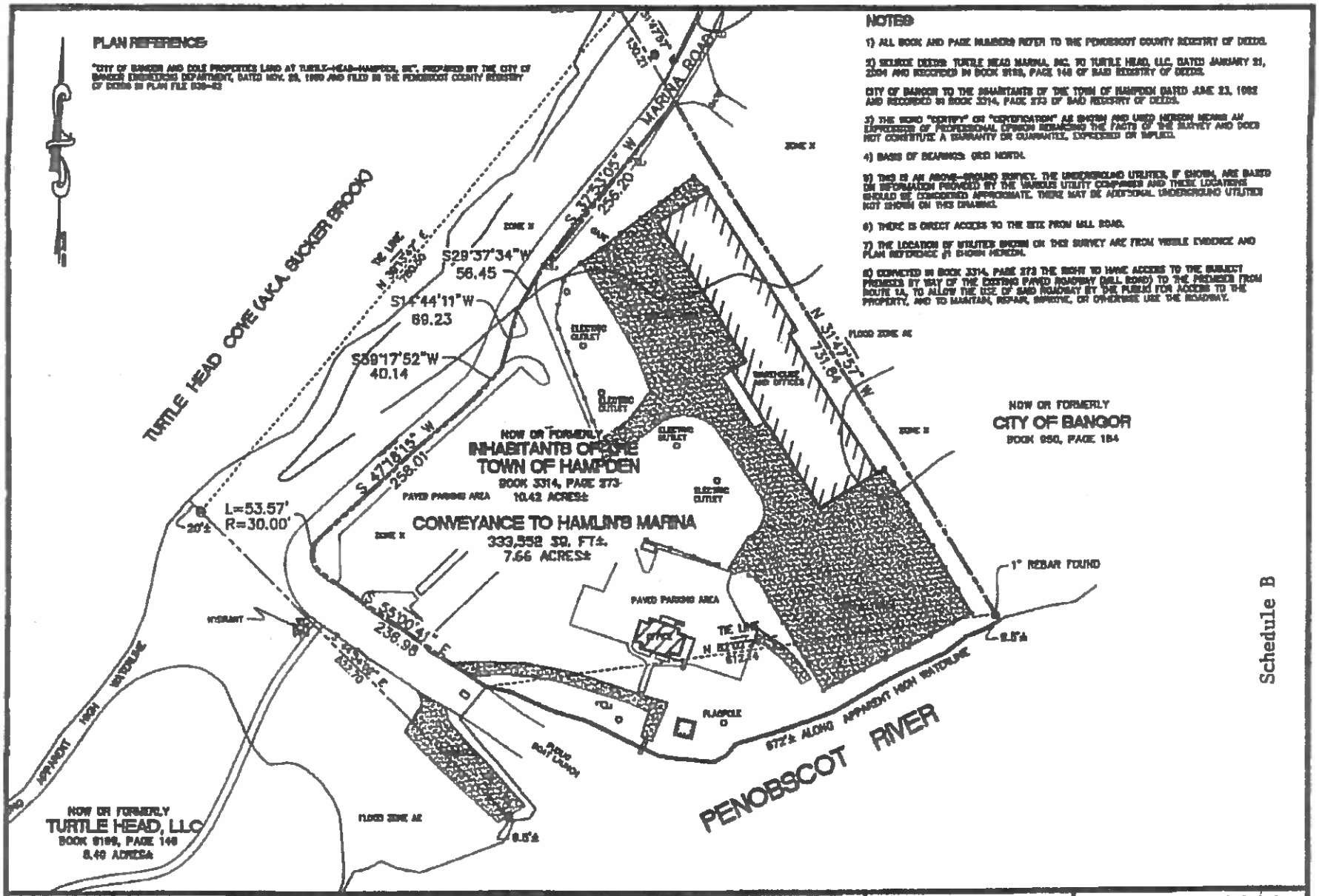
4) BASIS OF BEARINGS: GRID NORTH.

5) THIS IS AN ABOVE-GROUND SURVEY. THE UNDERGROUND UTILITIES, IF SHOWN, ARE BASED ON INFORMATION PROVIDED BY THE VARIOUS UTILITY COMPANIES AND THESE LOCATIONS SHOULD BE CONSIDERED APPROXIMATE. THERE MAY BE ADDITIONAL UNDERGROUND UTILITIES NOT SHOWN ON THIS DRAWING.

6) THERE IS DIRECT ACCESS TO THE SITE FROM MILL ROAD.

7) THE LOCATION OF UTILITIES SHOWN ON THIS SURVEY ARE FROM VISIBLE EVIDENCE AND PLAN REFERENCE (I) SHOWN HEREON.

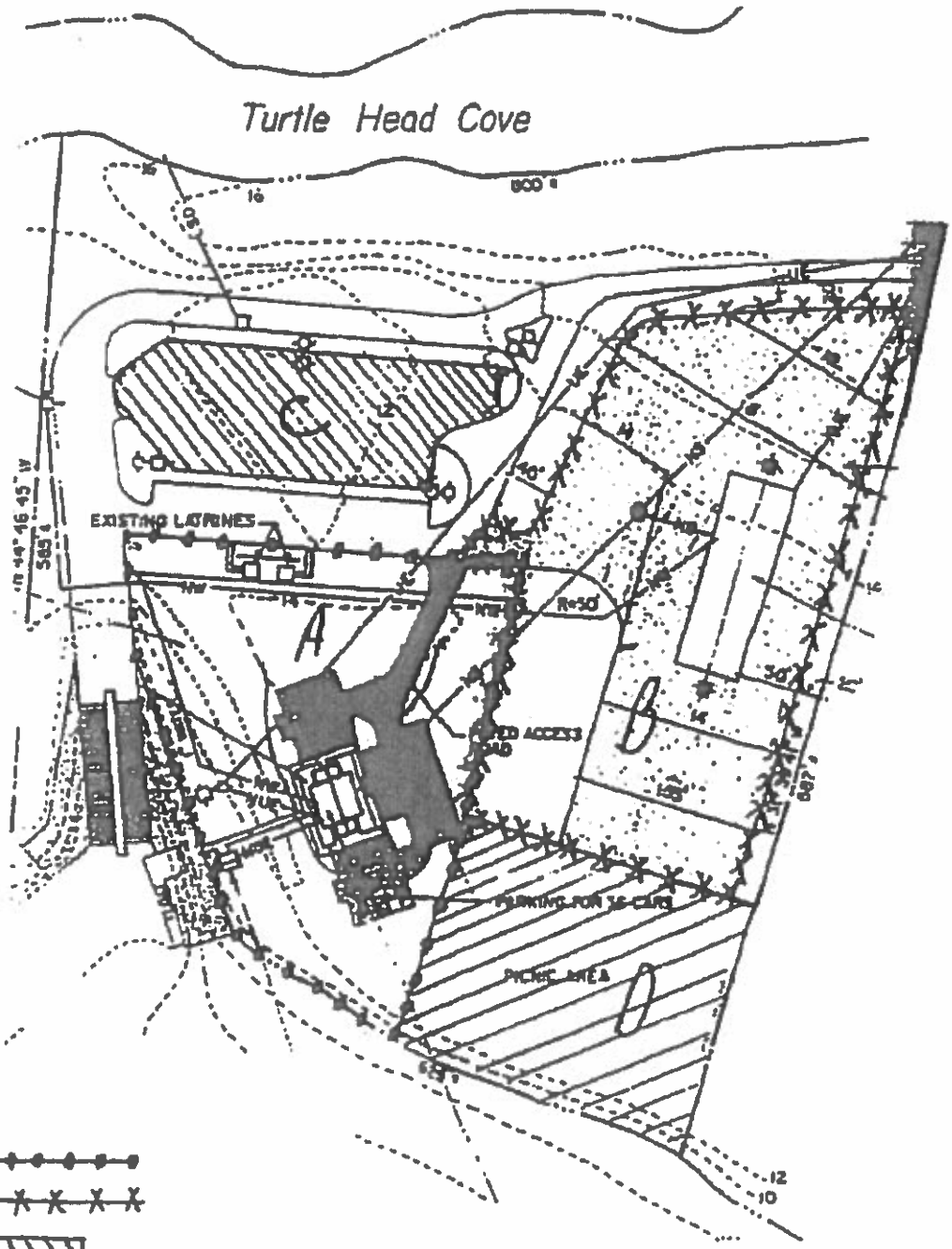
8) CONVEYED IN BOOK 3314, PAGE 273 THE RIGHT TO HAVE ACCESS TO THE SUBJECT PREMISES BY WAY OF THE EXISTING PAVED ROADWAY (MILL ROAD) TO THE PREMISES FROM ROUTE 1A, TO ALLOW THE USE OF SAID ROADWAY BY THE PUBLIC FOR ACCESS TO THE PROPERTY, AND TO MAINTAIN, REPAIR, SERVICE, OR OTHERWISE USE THE ROADWAY.




Schedule B

| | | | |
|---|---|---|---|
| **TOWN OF HAMPDEN TO HAMLIN'S MARINA** | BY: JAT | DWG: 1 OF 1 | CES INC |
| **TOWN OF HAMPDEN** | DATE: 10-13-2011 | | |
| | REV: | JN: 5479 | |
| **PROPERTY CONVEYANCE EXHIBIT** | REV DATE: | SCALE: 1"=150' | |

SCHEDULE A

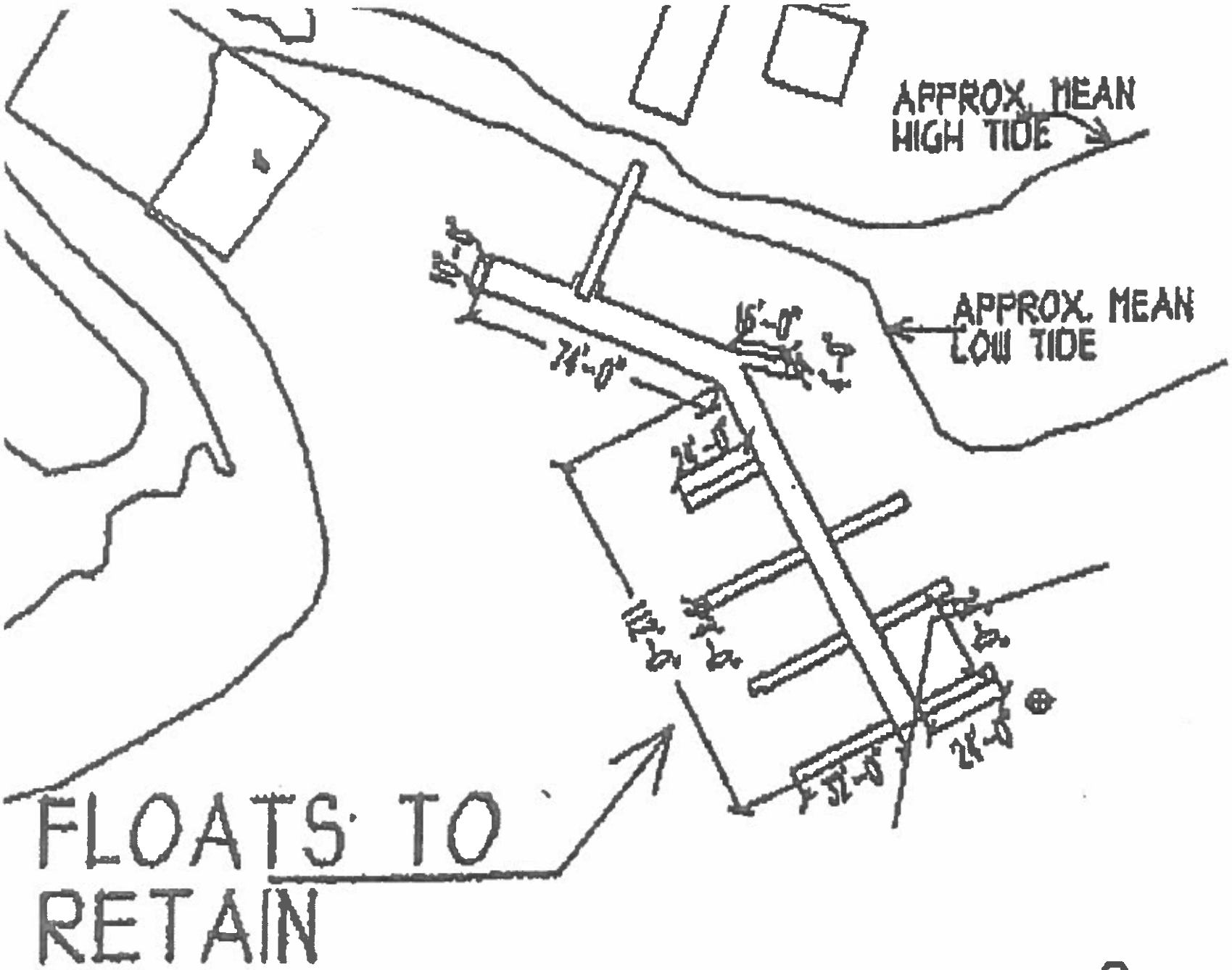



Parcel A

Parcel B

Parcel C

Parcel D


APPROX. MEAN HIGH TIDE
APPROX. MEAN LOW TIDE
16'-0"
74'-0"
25'-0"
112'-0"
32'-0"
FLOATS TO RETAIN

#2

WELLMAN PAVING INC
PO Box 65
Hampden, ME 04444

# Estimate

| Date | Estimate # |
|---|---|
| 6/9/2015 | 8549 |

| Project | P.O. No. |
|---|---|
| | |

Town of Hampden
106 Western Ave
Hampden, Me 04444

| Description | Qty | Cost | Total |
|---|---|---|---|
| Job Location: Town Ramp at the Marina | | | |
| Grinding Butt Joints | 180 | 2.00 | 360.00 |
| Total Area to Pave 15,332 SF | | | |
| Pave 600 SF with 4" of Binder | 18 | 135.00 | 2,430.00 |
| Pave with 2' of Modified Mix | 200 | 110.00 | 22,000.00 |
| * Owner responsible for any permits | | | |
| * Hamlin Marina will pull out ramps. Hand work on the bottom of the ramps | | | |
| | | **Total** | $24,790.00 |

Terms and Conditions

All work to be completed in a workmanlike manner according to standard practice. Any Alteration of deviation from above specifications will become and extra charge over and above original estimate. All agreements contingent upon strikes, accidents, or delays beyond our control.

**Payment is expected at time of completion. If Customer is not present a check may be left at a designated location or the bill may be paid by credit card prior to project completion. A service charge of 3% will be charged to use a credit card.**

This proposal may be withdrawn by us if not accepted within 30 days. Wellman Paving, Inc. reserves the right to adjust contracts to reflect the rising cost of asphalt. In the event contracts need to be adjusted the Customer will be notified prior to any work being performed.

We do not warranty washouts, cracks or frost damage because of Maine's deep frost level; nor puddling due to lack of grade and drainage. Wellman Paving, Inc. will not warranty paving if base groundwork is not performed by us. We do not backfill or loam edges of pavement, unless requested by Customer at an additional cost, but we do recommend that it is done.

Your signatures constitues a binding contract. Please sign and return one copy and keep one for your records. Once a signed copy is received you will be placed on our schedule and we will be in touch with you for a date and time of our anticipated arrival.

Wellman Paving, Inc. places 3 inches of modified mix rolled to a final 2.5 inches unless otherwise requested.

A service charge of 1.5% which is an annual percentage rate of 18% will be applied to any balance over 30 days from completion. After 60 days unpaid balances will be sent to collections. In the event the balance is sent to collections, the Customer will be responsible for paying all associated fees. After 90 days, if collection still has not been made leins may be placed on property.

Accepted By: _____ Date: _____

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