ENGINEERING REPORT

Prepared for

Corporation of the Presiding Bishop of The Church of Jesus Christ of Latter-day Saints

c/o Latham & Watkins LLP

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Respectfully Submitted,

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1 EXECUTIVE SUMMARY

This report presents my findings regarding Alprof Realty LLC ("Alprof") and VFP Realty, LLC ("VFP") (collectively, "Plaintiffs") v. Corporation of the Presiding Bishop of The Church of Jesus Christ of Latter-day Saints (the "Church"). The matter regards environmental contamination on properties identified as Lots 14, 24, and 29 in Block 15950 in Edgemere, Queens County, New York, (the "Site").

I was retained by Latham & Watkins LLP on behalf of the Church to review technical and other documents regarding the Site, to review and evaluate Site conditions, and to advise and, and to the degree scientifically reasonable, express opinions regarding 1) to what extent, if any, the contamination on Lot 29 (Church's property) has extended to Lots 24 and 14; 2) the reasonableness and appropriateness of the investigation and remediation conducted by the Church; and 3) the reliability of the cost estimates put forward in the Expert Report of Stephanie O. Davis ("Davis"), dated October 10, 2012.

My conclusions are summarized below in this Executive Summary, and rendered and developed in the body of the report that follows.

1.1 CONTAMINATION ON LOT 29 DID NOT MIGRATE TO LOTS 24 AND 14

With possible limited and minor exceptions, contamination on Lot 29 did not migrate to Lots 24 and 14 as there are multiple, independent sources of contamination across all of the lots, and the groundwater flow direction is not from Lot 29 towards Lot 24 or Lot 14.

1.1.1 Multiple, Independent Sources of Contamination at the Site

The contamination on Lots 14, 24 and 29 originates from multiple, independent sources. These sources include contaminated fill placed during the development of the properties and construction of buildings, and historical releases. The trichloroethylene (TCE) detections in shallow soil on Lot 24 are not due to runoff or windblown soil deposition as Davis states; the concentrations are too high and isolated and the depths of contamination too great for these mechanisms to have caused the TCE impacts in shallow soil.

Contaminated fill was indicated by the detections of TCE and related contaminants at shallow depths above groundwater on Lot 24. TCE was detected on Lot 24 in 2009 in H2M boring B–2 at a depth of 2 ½ feet and at a concentration of 11,000 μg/kg. TCE was also detected at other locations in shallow soil on Lot 24 from sources unrelated to Lot 29. Additionally, the "green material" on Lot 29 was discovered 2 to 3 feet below ground surface and observed under the former building foundation, but not onto Lot 24. This material was apparently placed during construction of the former Lot 29 building in the 1960s.

The former gasoline service station and auto repair facilities on Lot 14 are additional sources of contaminants found on and migrating from Lot 14. The contaminants originating on Lot 14 include MTBE, a gasoline additive, the highest concentrations of which have been detected on Lot 14. The MTBE contamination has migrated from Lot 14 to Lot 24 and across Beach Channel Drive.

1.1.2 Groundwater at the Site Flows to Norton Bay

Groundwater flows (1) to the north-northwest from Lot 29 to a discharge point on Norton Bay, (2) to the north from Lot 24 to the same discharge point on Norton Bay, and (3) to the northeast from Lot 14. Groundwater does not flow westerly from Lot 29 towards Lots 24 and 14 as stated by Davis.

First, the natural flow of groundwater must be to a discharge point and there is only one discharge point for the Site: Norton Bay. This flow of groundwater is reinforced by the natural and man-made filling of the former Norton Creek channel and related salt marshes on which the Site was developed in the 1900s. The result of the natural deposition and filling operations was a path of least resistance for groundwater to flow towards the discharge point on Norton Bay. This conclusion is demonstrated by boring log data, tidal and pump test data, and groundwater elevation measurements, and readily inferred from the historical evidence.

Second, Davis's version of contaminant fate and transport is demonstrably incorrect. For one, Davis makes the statement that groundwater flows to the west from Lot 29 to Lot 24, and continues in this direction onto Lot 14. She bases this conclusion on select and insufficient technical data. Rather, groundwater on Lot 29 flows to the north-northwest, toward the discharge point on Norton Bay, and not to the west as opined by Davis. Similarly, groundwater on Lot 24 flows to the north toward the discharge point on Norton Bay. Additionally, Davis makes an incorrect argument that TCE dense non-aqueous phase liquid (DNAPL) flowed down a clay slope from Lot 29 to Lot 24. In the cross-section that Davis prepared to support her argument, she (1) omitted borings that should be in the cross-section and (2) included an inappropriate boring, thereby distorting the actual conditions of the clay in the area she evaluates. Further, her argument relies on the presence of DNAPL, which Davis incorrectly concludes exists. After examining all the relevant data, I conclude that the subsurface clay layer dips from high points on Lot 24 to lower points on Lot 29; and therefore, even if DNAPL existed, it could not have flowed down a clay slope from Lot 29 to Lot 24. Moreover, other aspects of the clay layer enhance the flow of groundwater toward the discharge point on Norton Bay, and in some cases, the flow of groundwater from Lot 24 to Lot 29.

Groundwater flow conditions are further demonstrated by the concentration gradients observed in the dataset; specifically, the detections of MTBE downgradient of its source on Lot 14, and detections of TCE and its degradation products downgradient of their sources on Lot 24 and Lot 29. In short, groundwater from all three Lots flows to Norton Bay.

1.2 REASONABLE AND APPROPRIATE REMEDIATION BY THE CHURCH

The remediation efforts by the Church were reasonable, appropriate, and in compliance with NYSDEC regulations, guidance, and direction. First and foremost, the Church fully cooperated with the NYSDEC. The NYSDEC oversaw all activities including the approval of work plans prior to their implementation. The regulatory program which the NYSDEC selected and the Church worked was appropriate to provide the regulatory framework for the remediation. Second, there was no negative impact on Lots 14 or 24 due to the Church's remediation efforts. Instead, the Church's efforts have only reduced contamination that it did not cause. Third, the cleanup standard that was approved by the NYSDEC was appropriate because, as the NYSDEC determined, the groundwater contamination did not at the time of remediation and, pending a soil vapor intrusion study on Lot 29, would not at the time the property is developed pose any risk to human health or the environment.

1.3 DAVIS REMEDIATION COSTS UNRELIABLE

Davis' estimated costs for the investigation and remediation on Lots 14 and 24 are not supported, and therefore cannot be accurate to a reasonable degree of scientific certainty. Davis did not identify the full nature and extent of contamination on Lots 14 and 24, and provided no basis for the remediation costs. Because Davis provided no basis to support the cost estimates provided in her report, these costs are entirely speculative.

2 INTRODUCTION

2.1 QUESTIONS ASKED

I was retained by Latham & Watkins LLP on behalf of the Church to review technical and other documents regarding the Site, to review and evaluate Site conditions, and to advise and, to the degree scientifically reasonable, express opinions regarding 1) to what extent, if any, the contamination on Lot 29 has extended to Lots 24 and 14; 2) the reasonableness and appropriateness of the investigation and remediation conducted by the Church; and 3) the reliability of the cost estimates put forward by Davis.

2.2 QUALIFICATIONS

I am a Professional Engineer, licensed in the states of New York, New Jersey, Connecticut and Pennsylvania, and recently served as President of the New Jersey Society of Professional Engineers. I am also a Fellow of the National Society of Professional Engineers. Over the past thirty three years my work has focused on environmental engineering and science. I have specific experience with environmental engineering matters involving soil and groundwater contamination at retail gasoline service stations, properties with contamination comprised of chlorinated organic compounds, properties undergoing redevelopment, and issues needing engineering economic analysis including estimates of future environmental liabilities and clean-up costs. I have acted in the capacity of a forensic environmental engineer and expert witness in hundreds of environmental matters and cases in New York and other jurisdictions. I am a Principal of Integral Engineering, PC with an office in New York. A copy of my CV, including a list of all publications authored in the previous 10 years, is provided as Attachment A and incorporated by reference. A list of all cases in which I have testified as an expert in the previous 4 years is also provided in Attachment A.

For this assignment, my hourly rate is $350 for all services except time waiting for or testifying, for which my hourly rate is $525. My hourly rate is not affected by my opinions or testimony in this matter.

2.3 BASIS OF OPINION

My opinions expressed herein are based on documents I reviewed that have been produced in this matter and those that I acquired, and my professional knowledge including my professional experience and professional training. For this assignment, I have reviewed and relied upon the documents listed and described in Attachment B.

I visited the Site on November 20, 2012.

3 BACKGROUND

3.1 SITE LOCATION

The Site is located in Edgemere, New York, within Queens County. The properties are identified as Lots 14, 24, and 29 in Block 15950. Lot 14 is owned by VFP, Lot 24 is owned by Alprof, and Lot 29 is owned by the Church.

3.2 PROPERTY DEVELOPMENT

3.2.1 Norton Channel, Norton Bay and Filling Operations

In 1881 the Site was underwater, covered by a salt marsh that connected to Jamaica Bay, (USGS map, October 1991). It was part of a natural passageway between Jamaica Bay and the Bay of Far Rockaway that, in turn, led to the Atlantic Ocean south of Far Rockaway.

Figure 2 Site Plan in 1933 and 2001

Figure 1 shows the approximate relationship of the Site to this waterway in 1900.

As the land in what was to become Edgemere was "reclaimed" (filled), a channel was defined from this natural passageway, called Norton's Creek (also known as Norton Creek or Norton Channel). The following quote is from the "Nineteenth Annual Report of the State Department of Health of New York", February 6, 1899:

> "Far Rockaway inlet was originally connected with Jamaica bay by a narrow inlet called Norton's creek, said to be, however, of artificial formation, and while this was open there was a strong tidal run through this inlet, as the tide in this portion of Jamaica bay was about forty-five minutes later than the tide in Far Rockaway inlet; this insured a much freer circulation in this part of Jamaica bay than is now the case since this Norton's creek has been artificially closed, which was done by the authorities of Hotel Edgemere, on whose land the creek lies, and the hotel people seem to have established their right to close this inlet in their defense of an action brought against them by the local health board of one of the adjacent townships before the Supreme Court. The closing was done to stop the heavy tidal scour which was threatening the safety of the hotel improvements and buildings. The present outlet of the sewer from Hotel Edgemere is not, as stated in one of your letters accompanying your reference of this matter, into Norton's creek, but is into the arm of Jamaica bay, into which this creek formerly opened, and quite near the former mouth of the creek."

In short, Norton's Creek ran through a portion of the Site. By 1912, Norton's Creek had been filled-in from the south to the north-northwest corner of Lot 29 where a draw bridge stood.

Figure 2 Site Plan in 1933 and 2001

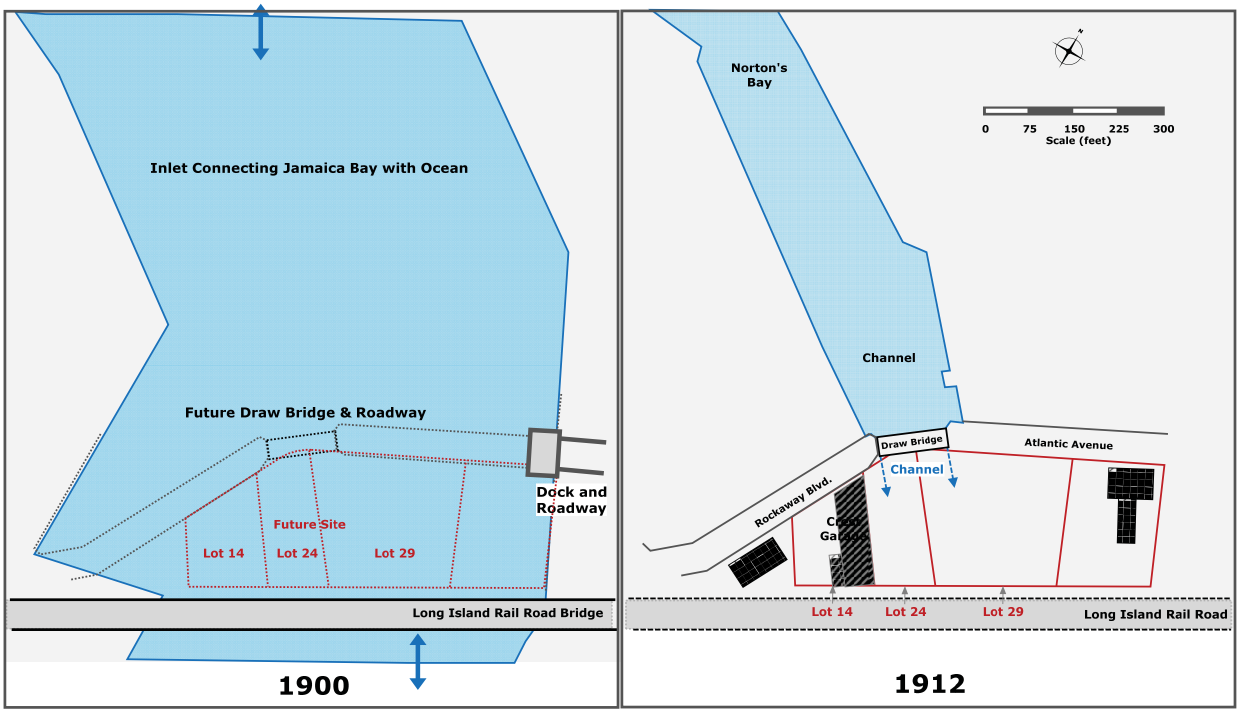


Figure 1 Site Plan in 1900 and 1912

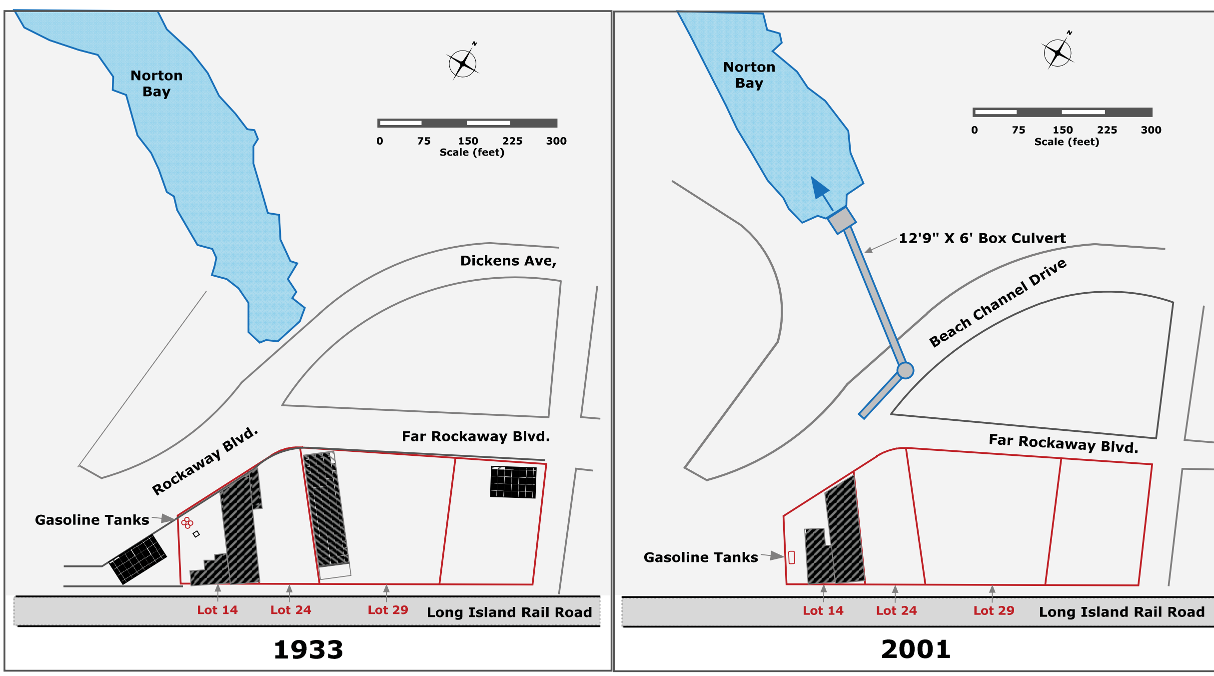


Figure 2 Site Plan in 1933 and 2001

Figure 1 is a map of the Site in 1912 compiled from the 1912 Sanborn Fire Insurance Map; (Sanborn Fire Insurance Maps are hereafter called "Sanborn" maps); and from superimposition of the Sanborn map on recent Site maps and aerial photographs. The 1912 Sanborn map shows Norton's Bay as a channelized waterway with well-defined edges, leading to a draw bridge under which the channel extended at one time. The draw bridge is located at the northwest corner of the future Lot 29. The channel appears to have extended along the property line between Lots 24 and 29.

By 1924, the draw bridge had been replaced with a bulkhead and roadway. The southern shoreline of Norton's Bay remained immediately across this roadway from the Site. By 1933, the southern portion of Norton's Bay had been filled and the new southern shoreline was approximately 300 feet from the northwest corner of Lot 29, (Figure 2). Later, the shoreline was moved further to the north. A box culvert drainage facility was constructed in the former channel, (Figure 2).

3.2.2 Site Building Development

3.2.2.1 Lot 14

As of 1912, the Crest Garage is apparent on Lot 14 (1912 Sanborn map). Three 280-gallon underground storage tanks ("USTs") were located within the Crest Garage. As of 1933, the Crest Garage was identified as a filling station and repair shop (1933 Sanborn map). Four gasoline tanks were depicted as part of the filling station (shown by small circles, the Sanborn map symbol for gasoline tanks). By 1951, Lot 14 contained a "Private Garage & Warehouse" (1951 Sanborn map) in addition to the repair shop. By 1954, the service station was reconfigured. In 1983, the building on Lot 14 was no longer listed as a filling station. By 2005, the buildings were demolished.

3.2.2.2 Lot 24

A small building is shown on Lot 24 on the 1933 Sanborn map. Other than this building, Lot 24 appears vacant on Sanborn maps and aerial photographs.

3.2.2.3 Lot 29

As of 1924 (Aerial photograph), a long rectangular building was apparent on Lot 29. On the 1933 Sanborn map, this buildi ng was listed as a plumbing supply facility. Two gasoline tanks labeled as "not used" were located in the building in the northern corner. On the 1951 Sanborn map, this building was labeled as a garage.

By 1957, based on an aerial photograph, Lot 29 was comprised of a small structure to the north. In a 1966 aerial photograph the buildings on Lot 29 have changed substantially (Figure 3). Four distinct roof lines are apparent, two defining the building (or buildings) running along the property line with Lot 24 and two defining the building (or buildings) immediately to the northeast. The smoke stacks apparent in the 1957 aerial have been removed. As of 1980, all buildings were demolished based on aerial photographs.

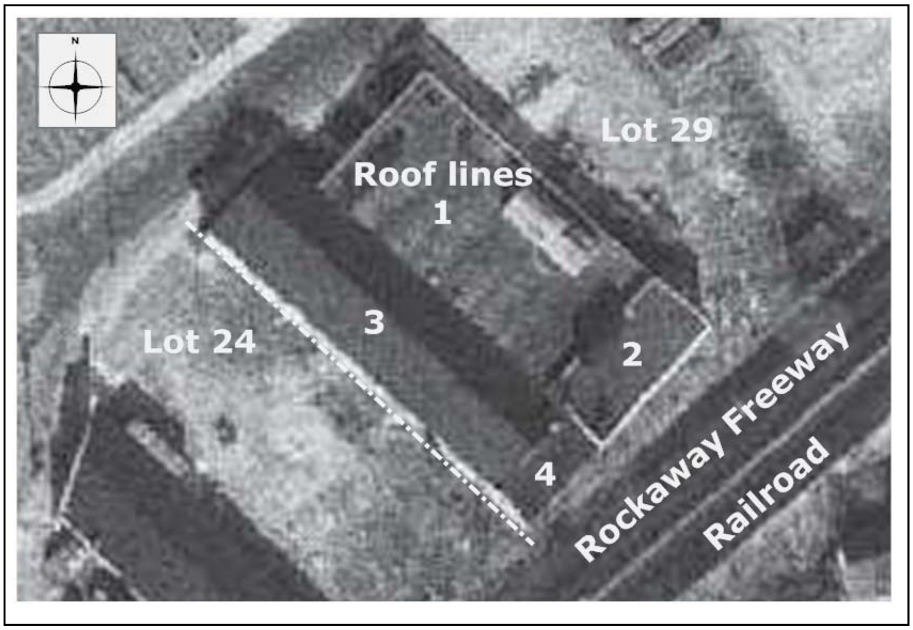


Figure 3 1966 Aerial Photograph

3.3 PAST AND CURRENT ENVIRONMENTAL INVESTIGATION, REMEDIATION AND COMPLIANCE

Environmental investigations have taken place on all three lots, although the investigations on Lot 29 have been considerably more comprehensive. These investigations are summarized in the following sections. Over 85 exploratory borings and test pits have been completed at the Site from which numerous samples have been obtained and analyzed for a variety of chemical constituents. A Site Location Plan showing the locations of the borings and test pit investigations is provided in Figure 4.

3.3.1 Lot 14

In 2002, Advanced Cleanup Technologies, Inc. ("ACT") completed a Phase I and Phase II environmental investigation; (*see* Alprof 1142-Alprof 1300). Twelve temporary and three permanent wells were installed. Fourteen soil borings were advanced. It is possible that some of these locations were actually on Lot 24, although it is not clear.

ACT analyzed sixteen groundwater and six soil samples using in-house chromatography equipment. Laboratory analyses were conducted on seven groundwater samples and four soil samples.

As part of their 2012 investigation, the FPM Group ("FPM") collected two groundwater samples from different depths at one sample location on Lot 14.

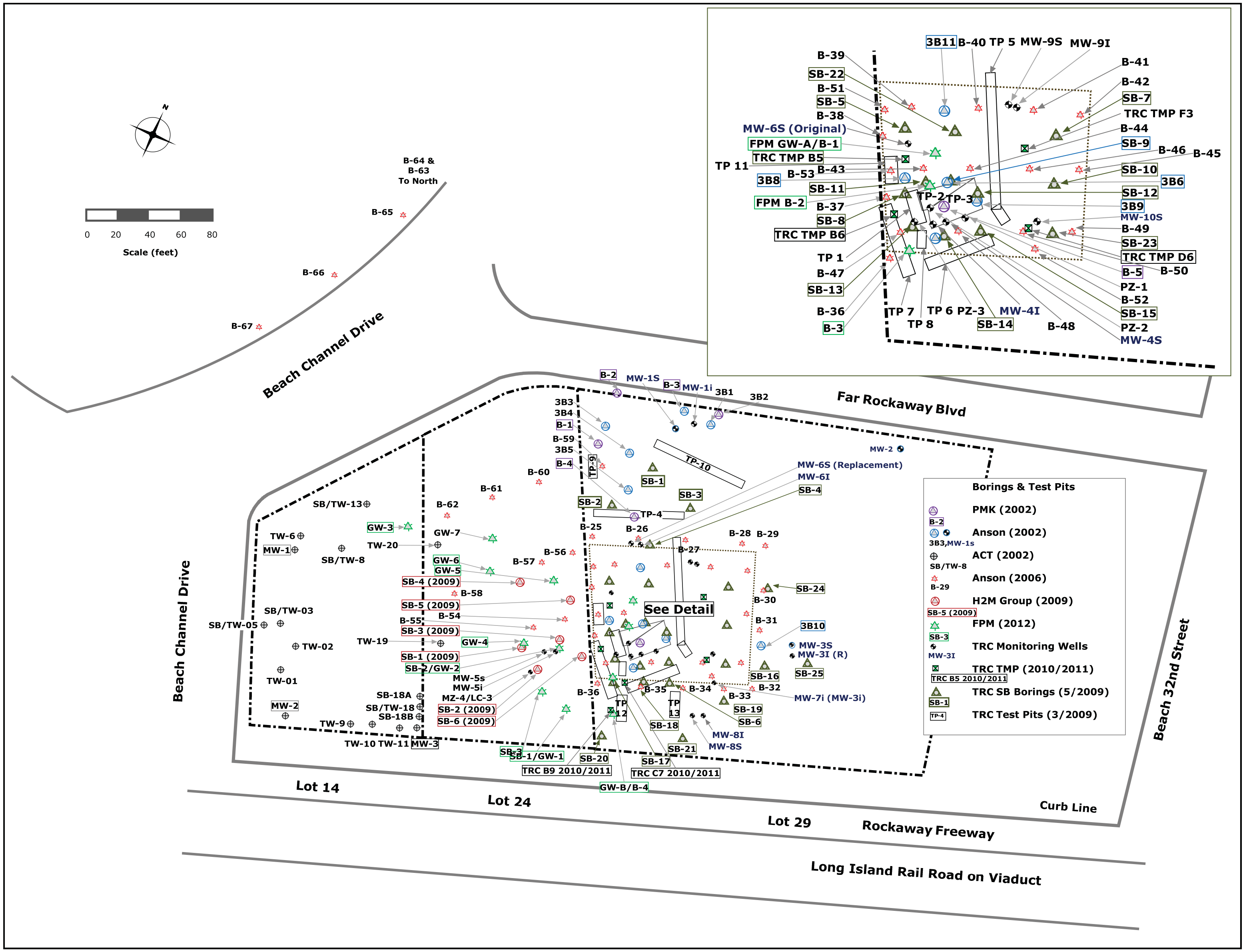


Figure 4 Sample Locations

3.3.2 Lot 24

In 2006, Anson Environmental Ltd. ("Anson") advanced eight borings within Lot 24; (*see* LDS00000138-LDS00000254). As part of their investigation and remediation efforts on Lot 29, TRC Environmental Corporation ("TRC") installed two permanent monitoring wells and one soil boring on Lot 24 in 2008.

In 2009, H2M advanced six soil borings and collected six soil samples on Lot 24. (*See* Alprof 1136-Alprof 1141). In 2012, FPM advanced three soil borings and six groundwater sample locations on Lot 24.

3.3.3 Lot 29

The Church has been investigating and remediating Lot 29 since 2002. A comprehensive summary of the Church's efforts are contained in Section 1.4 of the *In-Situ* Thermal Treatment (ISTT) Remedial Action Report, August 2012, which is incorporated herein by reference. (*See* LDS00101906-LDS00102204). Further, the Executive Summary from the ISTT report is incorporated herein by reference.

3.4 NATURE OF CONTAMINATION

This matter principally pertains to TCE and its degradation products, namely cis-1,2-Dichloroethylene ("cis-1,2-DCE" or "cis-DCE") and vinyl chloride ("VC"). These contaminants typically stem from solvents; they have been detected on all three lots: 14, 24 and 29. Additionally, there are petroleum compounds that may have been related to a petroleum solvent, or to a petroleum oil or gasoline. The petroleum-related compounds benzene, ethylbenzene, xylene, and toluene have been detected on all lots, for example. Methyl tertiary butyl ether ("MTBE") has been detected on Lot 14 and Lot 24 but not Lot 29; MTBE is a gasoline additive.

4 OVERVIEW OF MY SCIENTIFIC EVALUATION OF THE SITE DATA

Scientific and related engineering methods require an objective evaluation of all relevant data prior to drawing an opinion. This is particularly important for the Site in question as the subsurface conditions are complex and scope of testing and remediation activities substantial. Based upon a thorough and objective evaluation of all information available, I have reached reliable conclusions regarding the sources, movement and ultimate disposition of Site contaminants.

Davis did not make an objective evaluation. Rather, Davis made claims that lack the depth of analysis required to support her conclusions. This failure has led Davis to make unreliable conclusions that, while simplistic, fail to shed light on what actually happened at the Site.

For example, as I will explain further below, Davis opines on the cost of investigating and remediating Lots 14 and 24, yet provides no technical basis for her cost estimate as is necessary and typical to prepare a reliable engineering cost estimate (see Section 8). In my analysis below, I identify additional, specific instances where Davis fails in her responsibility to address all the data available. I then will draw a reliable conclusion that is based on an objective evaluation of all the data consistent with well accepted scientific and engineering methods.

I present below a detailed analysis of the environmental data, and in particular, I provide an in-depth evaluation of the underlying data that represent the complexity of the subsurface environment and the manner in which contaminants move in that environment, known as the "fate and transport" of contaminants. The nature of the soils in the ground and the processes of groundwater flow effectuate the fate and transport of contaminants. Objectively understood, these reliably identify the source of the contaminants and the impact of activities and conditions that one property may have on another.

I begin with the nature and distribution of the soil beneath the Site, its source from the natural and manual filling of Norton's Creek and channel, and resulting complexity unraveled by the over 85 boring logs and test pit investigations conducted at the Site. This is followed with an analysis of the distribution of contamination that resulted from multiple, independent sources of contamination across the Site. Thereafter, I reinforce these concepts with an analysis of the groundwater flow from the Site to its discharge point in Norton's Bay, including the organic clay and silt soils that have limited the flow of contaminants from Lot 29 to Lot 24.

In light of this technical evaluation, I discuss the numerous emails, letters and reports exchanged between the NYSDEC and the Church. Using my experience and training, I then conclude that the Church complied with the regulations and direction of the NYSDEC in a reasonable, appropriate, and diligent manner. Further, I will explain why the cleanup standards applied by the NYSDEC are appropriate and fully protective of public health and the environment; and why the remediation undertaken by the Church did not negatively impact Lots 24 and 14.

5 UNDERLYING SOILS DATA CONTROLLING THE FATE AND TRANSPORT OF CONTAMINATION

The fate and transport of contamination is influenced by the flow of groundwater, which in turn is influenced by the soils through which groundwater flows. Therefore, to adequately evaluate the fate and transport of contamination one must examine in detail the nature of the soils underlying the Site. To make a reliable examination of the soils under the Site, one must take into account all the relevant data, including the over ***85 borings and test pits*** that were completed on the Site by investigators. This was not done by Davis, who analyzed only ***two*** borings in drawing her opinion regarding the slope of the clay layer on the Site and the movement of contaminants between Lot 29 and Lot 24. This led to an erroneous opinion by Davis that contaminants flowed from Lot 29 to Lot 24. My analysis below takes into account all the relevant data, and readily shows the fallacy in the Davis conclusion. After evaluation of all the data, I reliably conclude that, with limited possible exceptions, ***contaminants do not flow from Lot 29 to Lot 24***.

5.1 THE INFLUENCE OF NORTON'S CREEK, FORMER CHANNELS AND SALT MARSHES PRIOR TO SITE DEVELOPMENT

Initially, the Site was underwater. Prior to its reclamation, the Site was comprised of salt marshes and water channels connecting Jamaica Bay and the Atlantic Ocean south of the Far Rockaways coastline. In the late 1800s and early 1900s, the channels were eventually closed, and the Site was filled to reclaim the land. Therefore, we would expect to encounter soils that are consistent with salt marshes and bottom deposits in channels from the time period when the area was underwater, as well as the man-made fill materials that are typical of reclaimed waterways and marshes. Such materials would be comprised of organic clays and silts in areas of lower water velocities (such as marsh areas and still areas at the sides of channels) which would allow deposition of these finer grained, organic materials. Conversely, sands and gravels would be expected in areas where water velocities were higher (such as within channels) as these heavier materials will be more readily deposited then the lighter weight, finer grained particles. Additionally, because of maintenance activities, former channels tend to be the last areas to be filled in the process of reclaiming land. Further, materials used to fill channels tend to be coarser grained materials, as these materials are more available and easier to handle by manual filling operations.

The boring and test pit logs indicate the occurrence of soils consistent with the development of the properties from a water body to reclaimed land. The levels of occurrence of what the Site environmental investigators call the "intermediate clay" layer, a deposit of organic clays and silts, are consistent with an elevation of minus nine (-9) to minus twelve (-12) feet mean sea level ("MSL") near the former draw bridge at the north-northwest corner of Lot 29. This is the approximate elevation of the channel bottom reported in a historical article (New York Times, October, 1891). This intermediate clay unit rises in all directions away from the channel as one moves southwest, south and southeast from the location of the former bridge, as one would expect for the depositional mechanics described above. The result is a half bowl shape of clay with an opening towards the former draw bridge through which the former Norton Creek channel passed, and opening to the north towards Norton Bay.

This intermediate clay layer also tends to thicken in directions away from the former channel over a portion of the area, as will be shown below. As this clay layer thickens, it reduces the permeability of the soil. Both the slope of the intermediate clay and the thickness of the clay are important parameters in understanding the flow of groundwater and contaminants.

The second clay unit, sometimes called the "deeper clay unit" by the environmental investigators, is present at an average elevation of -26.8 feet MSL with silty soils just above the clay at an average elevation of -25.4 MSL. These units are at a relatively consistent elevation, varying only about a foot according to the boring logs. Based on its consistent elevation, the lower clay unit appears associated with the wide natural passage between Jamaica Bay and the Atlantic Ocean south of the Far Rockaways in the 1800s.

Between the bottom of the intermediate clay and the deeper clay and silt layer, there are fine sands to medium to fine sands that are conducive to the flow of groundwater. This sandy soil layer increases in thickness toward the discharge point in Norton Bay. The flow toward this discharge point is reinforced by the expanding area of flow.

5.2 SOIL BORINGS AND TEST PITS INVESTIGATIONS

There is a large amount of data regarding the nature of soils provided in soil borings and test pit logs, which are recordings of the nature of the soil encountered as one advances a soil boring or test pit. There are over 85 soil borings and test pits that provide information regarding the nature of the soils.

The recordings use different soil classification systems. Many follow the Unified Soil Classification System ("USCS"), adopted by the United States Army Corps of Engineers and Bureau of Reclamation in 1952. Some use terms defined by the United States Soil Conservation Service ("SCS"), a part of the United States Department of Agriculture ("USDA"). In accordance with these terms, the most common soils encountered are:

> "CLAY", "SILT", "PEAT": These terms describe organic sediments with the smallest particle sizes encountered at the Site. They are often associated with other materials in mixtures, resulting in terms such as "sandy clay" or "silty clay", (both USDA classification terms). These soils have the lowest hydraulic conductivity, resisting the flow of groundwater and oil. These soils tend to be the result of naturally deposited sediments in slow moving waters.
>
> "SAND", "GRAVEL": Gravel and coarse, medium, fine and very fine sands are descriptions to identify soils with particle sizes greater than 0.074 millimeters (about the

size a particle first becomes visible to the naked eye). The descriptions include qualifiers to indicate mixtures of particle sizes, such as “silty sands”, or “SAND, trace gravel”. In general, the larger the soil particle size the greater the hydraulic conductivity. These materials tend to be naturally deposited in relatively faster moving waters and are more likely to comprise the manually placed fills used to reclaim land.

5.3 EVALUATION OF DATA USING CROSS-SECTIONS AND PLAN VIEWS

The results of the depositional mechanics described above can be seen in the boring logs collected on the Site. The boring log data and my analyses are presented in the form of cross-sections, as is typically done to evaluate a large amount of subsurface data regarding the nature of soils. I prepared four cross-sections whose locations are shown in Figure 5 Boring Location Plan. This figure is a Site map showing the three lots in question within the context of the surrounding area. On the map are lines labeled with capital letters to indicate the four cross-sections that I prepared. The locations of the boring logs or test pits that I used to prepare the logs are also shown on the map with their corresponding designations. Also shown on the map is the location of the former draw bridge, which helps define the former Norton Creek channel that ran through the area prior to the reclamation of all three properties; the channel ran, of course, under the former draw bridge.

The cross-sections in the following figures show a vertical view as if the ground had been cut away for easier viewing. On each cross-section are the borings used to create the cross-section with the soil descriptions made by the geologist during the borings noted next to the boring and at the proper depth. Using these data compilations and with consideration for the soils in adjacent areas, (that is, with the consideration of all the soil data), the layers of soil materials are interpreted, and these interpretations are also shown on the cross-sections. Also on the cross-sections, where appropriate, the approximate level of the channel is identified based on information from historical documents. Lastly, in those instances where information is used from a boring that was not located close to the cross-section line, the boring is indicated to have been projected the number of feet that the boring is located perpendicular to and away from the cross-section line.

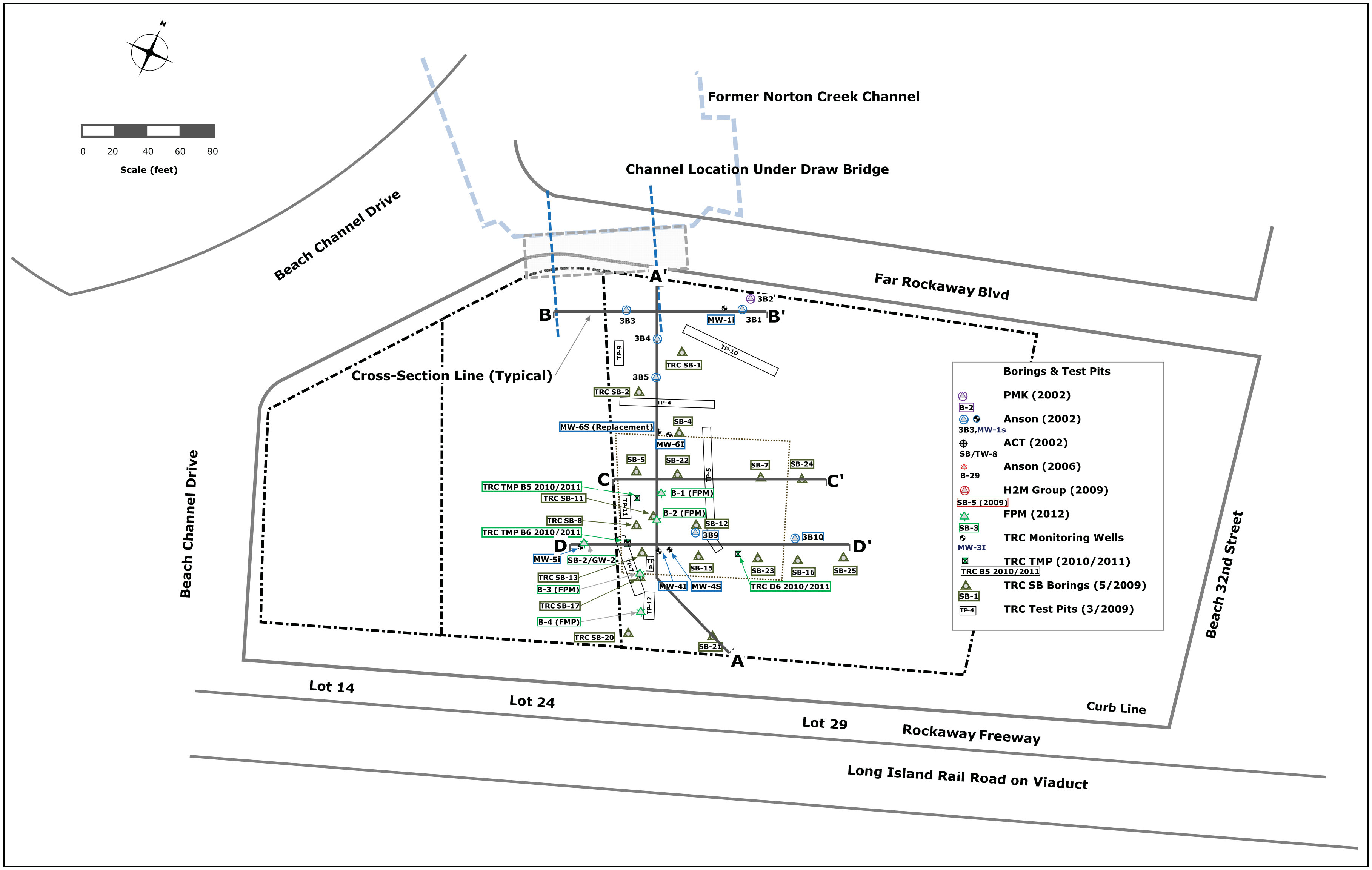


Figure 5 Boring Location Plan

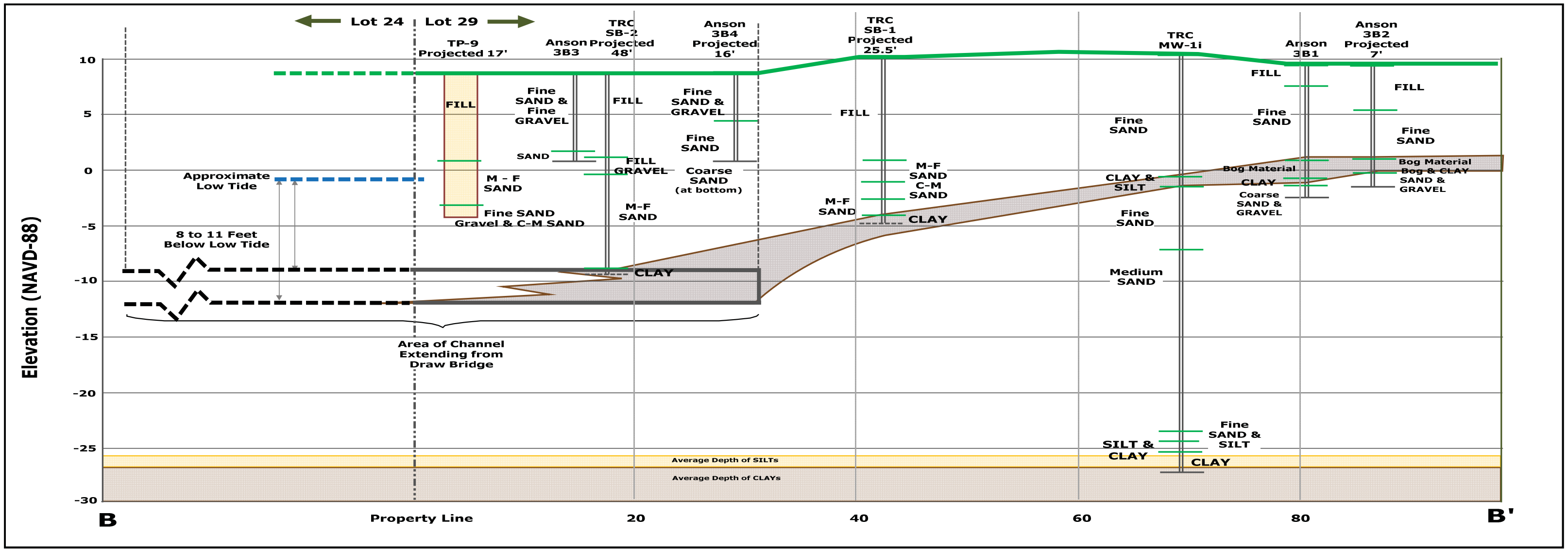


Figure 6 Cross-Section B-B'

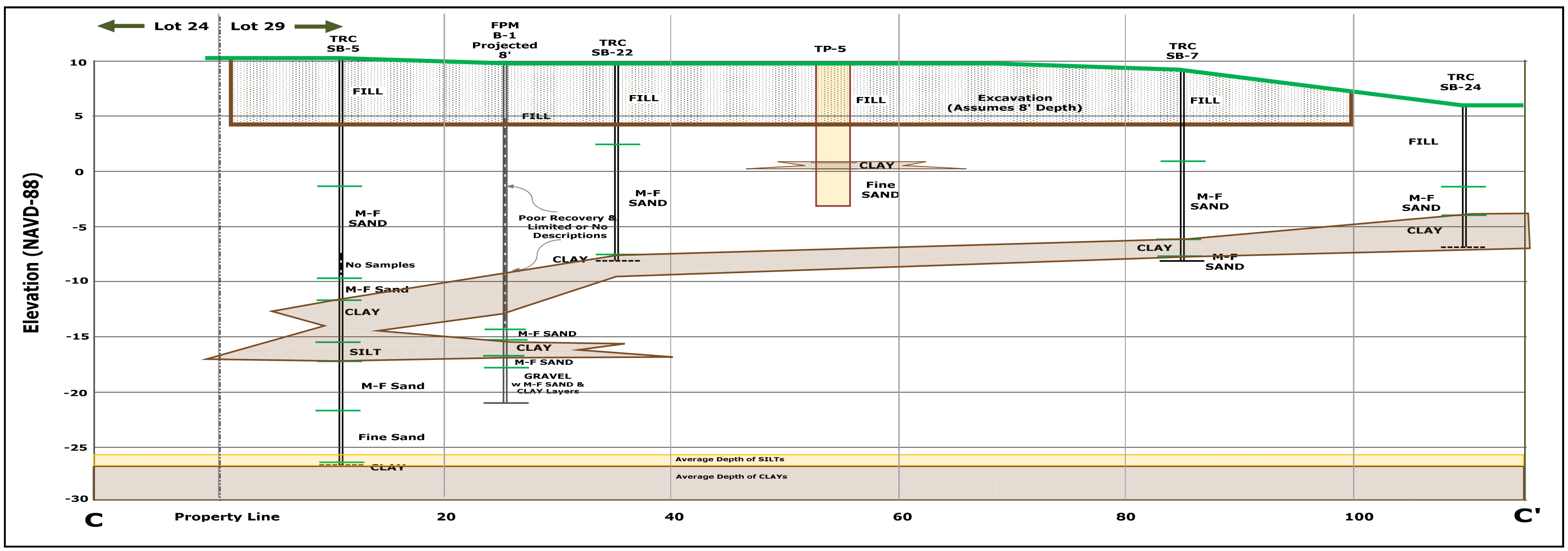


Figure 7 Cross-Section C-C'

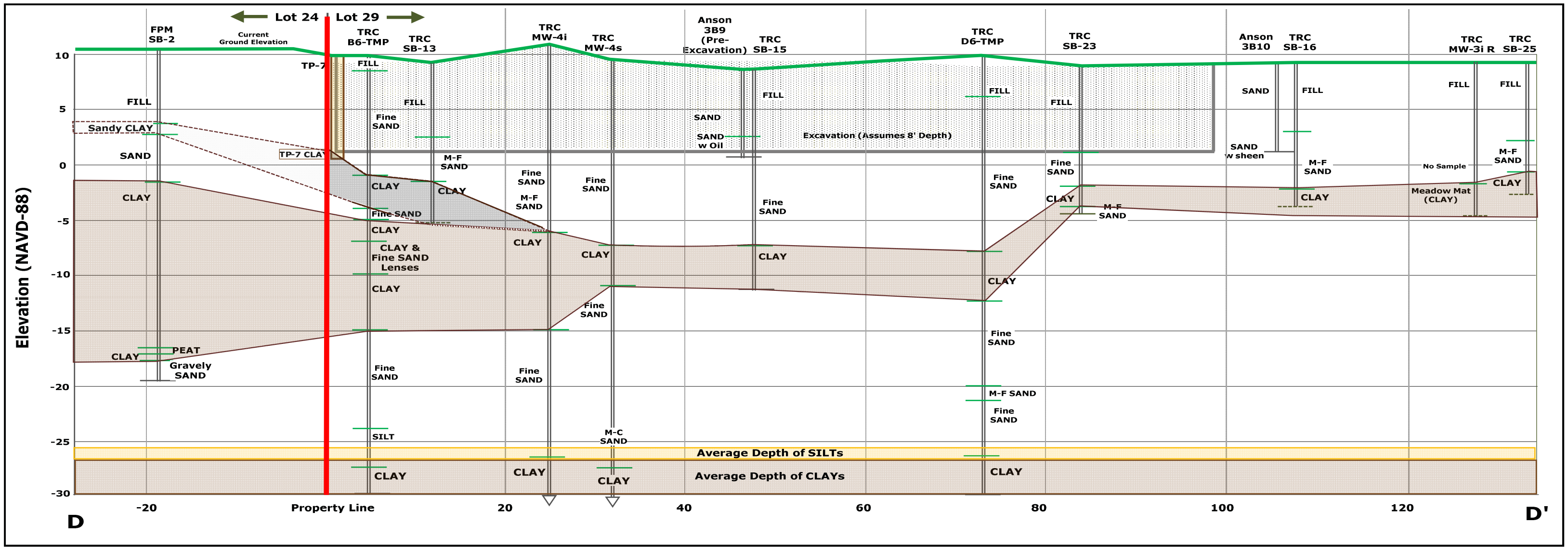


Figure 8 Cross-Section D-D'

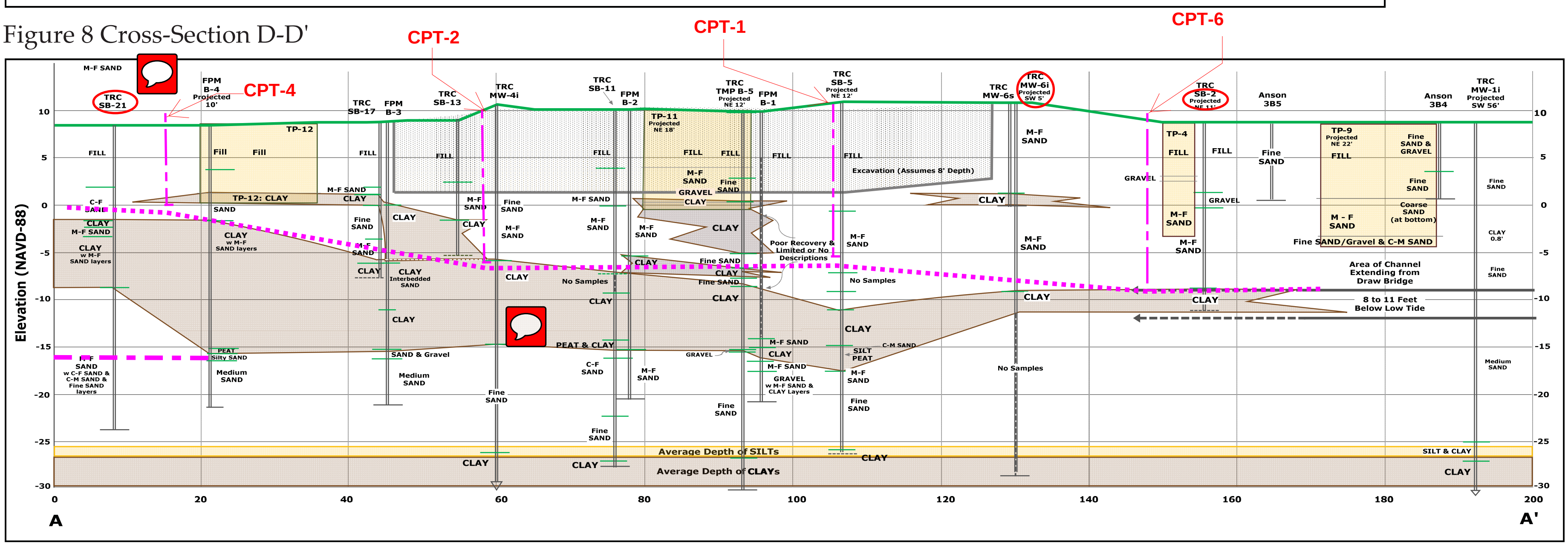


Figure 9 Cross-Section A'A'

The three cross-sections that run from the southwest to the northeast show the effects of sedimentation mechanics that occurred in and near the former Norton Creek channel. Cross-Section B-B′ (Figure 6 Cross-Section B-B') runs from the northeast to the center line of the former channel at the point it once passed under the former draw bridge. The draw bridge defines the channel location at this end of the Site as the channel had to have gone under the bridge. As can be seen, the middle clay layer slopes toward the center line of the channel from the area to the northeast that is outside the channel. A variety of coarser grained soils are identified in the section of the cross-section representing the former channel. The location of the former channel is well defined near the former draw bridge and the soils are more permeable due to the larger grain sizes. Note that the other half of the channel in the sloping clay located on Lot 24 cannot be depicted due to the lack of borings and test pits with soil descriptions on Lot 24. Because the conditions on Lot 29 show the effects of the former Norton Creek channel, we can anticipate that the same sloping clay is present on Lot 24 as a mirror image, which is consistent with other data on Lot 24 that shows the clay sloping from high areas to the west to low areas to the east. This is shown by Cross-Section D – D′ below.

Cross-Sections C-C′ (Figure 7) and D-D′ (Figure 8) are located further from the former draw bridge, however, the slope of the clay is still evident. As with Cross-Section B – B′, the information for Cross-Section C – C′ is not available for Lot 24. The interpretation of geologic materials on Lot 24 is an extension of the conditions on Lot 29. However, the mirror image is expected as it was for cross-section B – B′ for the same reasons.

The sloping nature of the clay towards the center of the channel, the expansion of the flow pathway toward the center of the channel, and the more permeable soils near the center of the channel are evidence that the former channel is providing a preferential pathway of groundwater flow to the north-northwest towards Norton Bay.

Cross-Section D – D′ demonstrates the sloping clay layer on Lot 24 that extends from high levels on Lot 24 towards lower levels on Lot 29. On the basis of this, and the influence of the former Norton Creek channel on all cross-sections, I can now conclude that the intermediate clay layer slopes from Lot 24 to Lot 29 at most if not all locations near the property line between Lot 29 and Lot 24.

In Cross-Section D-D′ the intermediate clay layer is shown to slope from higher elevations on Lot 24 to lower elevations on Lot 29. This is contrary to the interpretation made by Davis that the intermediate clay slopes in the opposite direction. The reason for Davis' erroneous interpretation is that she did not evaluate all of the boring logs available when she developed her cross-section (Figure 14 of her report) and, instead, made her conclusion based on an inadequate set of information that ignored appropriate data. Additionally, of the two boring logs that she used, one of them, FPM B–3, was projected 15 feet from an area where the clay was higher in elevation, while other more appropriate borings directly on the cross-sectional line were ignored, (including TRC TMP B-6, TRC SB-13, TRC MW-4i, TRC MW-4s, and TRC SB-15). The result was an incorrect interpretation of the slope of the clay by Davis.

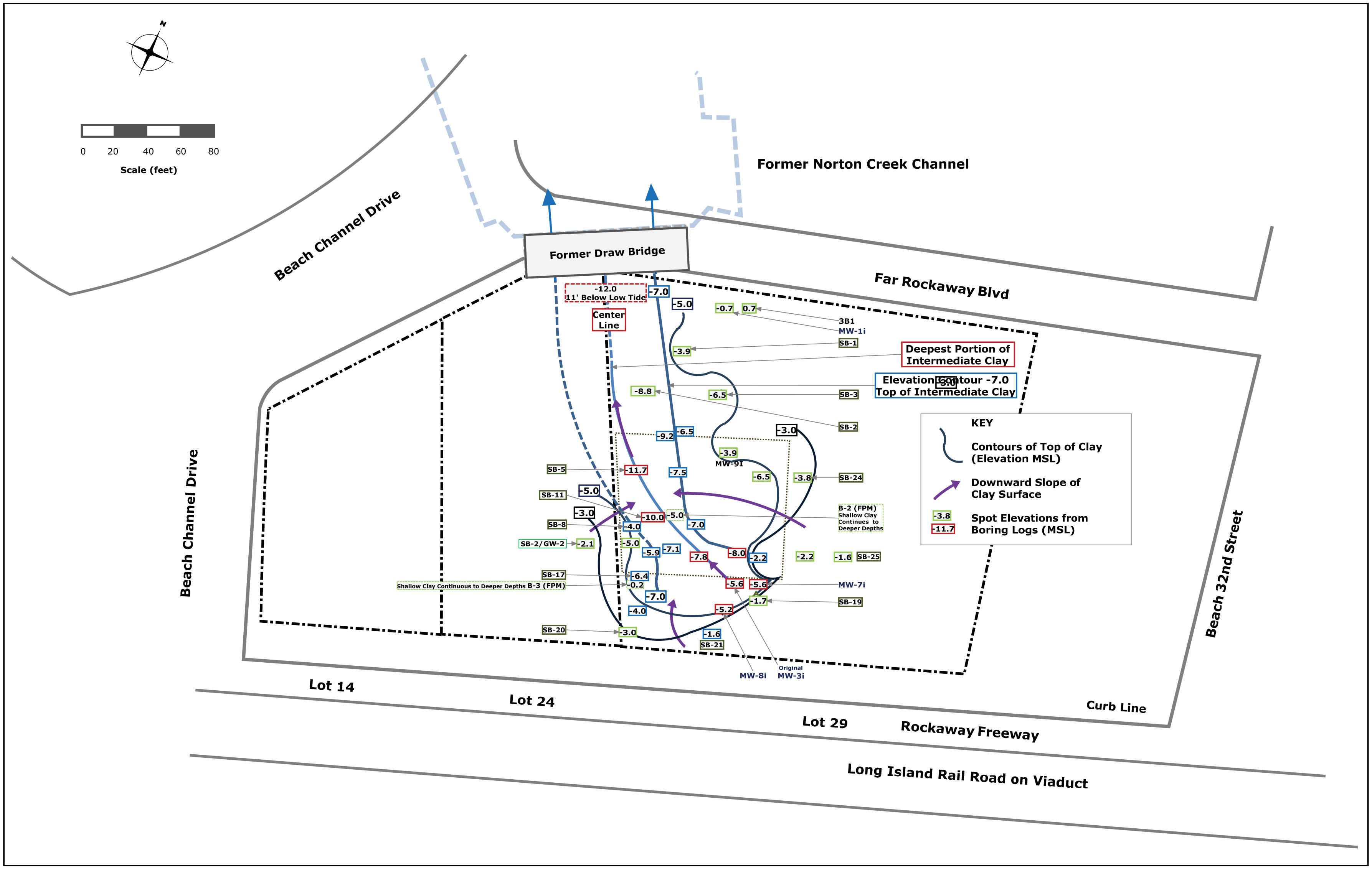


Figure 10 Top of Intermediate Clay Unit

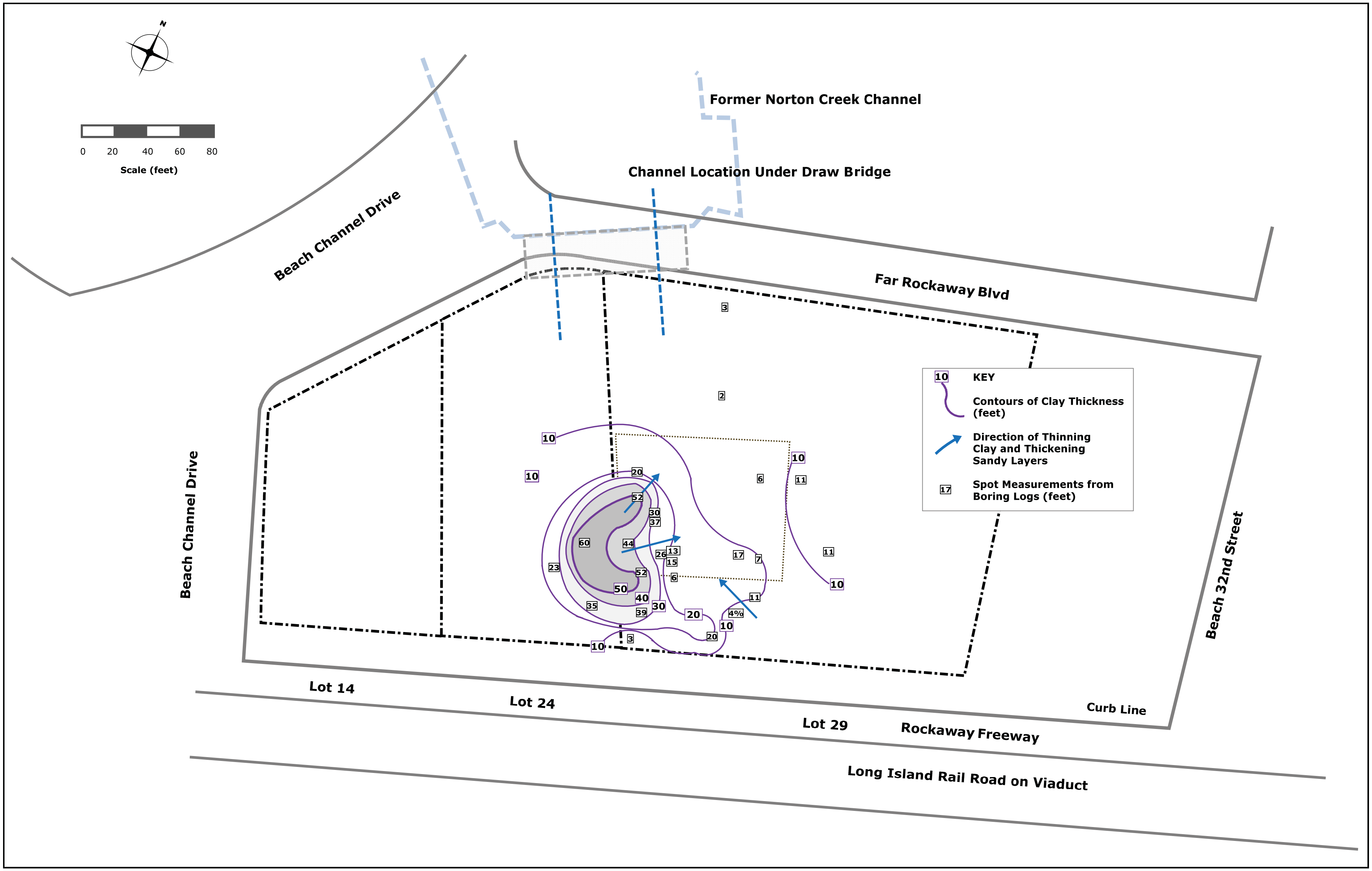


Figure 11 Thickness of Intermediate Clay

Cross-Section A-A′ is oriented from south-southeast to north-northwest toward Norton Bay. As can be seen, not only is the clay dipping toward Norton Bay, but it is thinning as well. This is because the areas further from the Bay experience lower velocities for a larger period of time causing the greater deposition of smaller particle sizes as well as the development of marshy areas which, in turn, deposit more silt and clay soils.

Elevation contours of the top of the intermediate clay layer are shown in Figure 10. The former center line of the channel is indicated where the elevation measurements of the top of the intermediate clay are lower relative to adjacent areas. This former center line is shown on the figure. The center line is in between the two lines representing the elevation of minus seven feet (-0.7 feet) MSL. The figure also shows the elevations of minus five (-5) and minus three (-3) feet MSL, and the gradient of the intermediate clay layer by arrows pointing down slope. These arrows also point in the approximate direction of local groundwater flow and the direction of movement of any other liquids such as petroleum oil that might be influenced by the sloping clay layer. The intermediate clay layer is shaped like a half bowl with the opening towards Norton Bay.

Layers conducive to groundwater flow thicken in the downslope direction of the intermediate clay layer creating a path of least resistance. In Figure 11, the percentage of the clay and silty soils in the soil column is plotted with arrows showing the direction in which the intermediate clay thins and the underlying sandy soil thickens as a result. Again, the arrows point in the direction in which groundwater flow is enhanced by the thinning clay layer and thickening layer of sandy soils conducive to the flow of groundwater. Additionally, the thicker portions of the intermediate clay (which bears the shape of the kidney on the figure), provide very strong resistance to the flow of groundwater or other liquids from Lot 29 to Lot 24 in this area.

Collectively, the downward slope of the intermediate clay, the increasing hydraulic conductivity in the former Norton Creek channel, and the thinning of the intermediate clay, and in turn thickening of the more permeable sandy formations enhance groundwater flow toward the discharge point in Norton Bay, as is further discussed below.

6 LIMITED CONTAMINATION MIGRATION FROM LOT 29 TO LOT 24

6.1 MULTIPLE, INDEPENDENT SOURCES OF CONTAMINATION

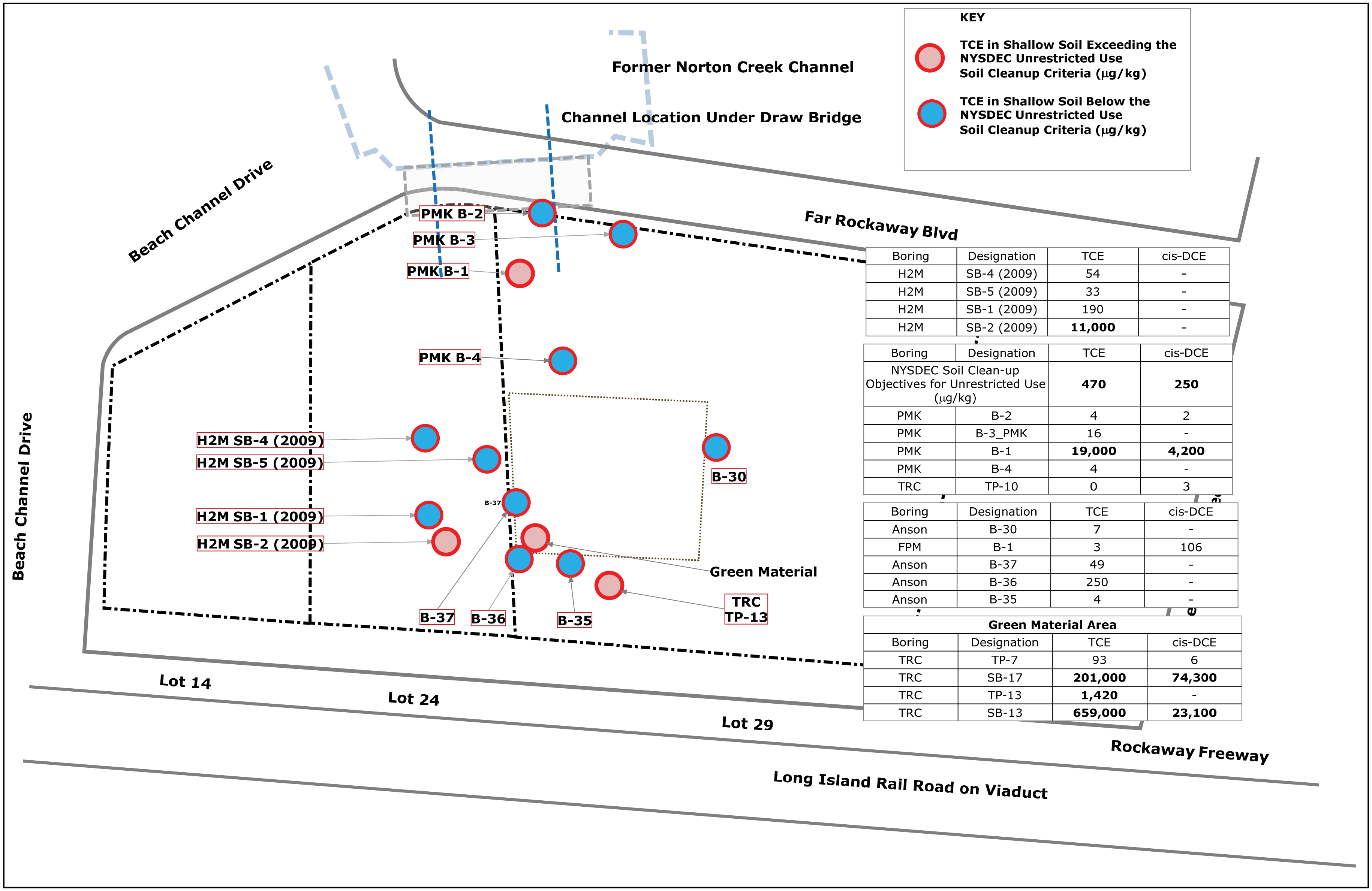
TCE has been detected in shallow soil above groundwater at various places at the Site. To reach these locations, TCE was either in fill material placed at these levels or there was a spill on the ground surface in sufficient volume and appropriate form to penetrate to the depth at which TCE was detected. There is no evidence that any actions by the Church caused a spill of TCE on Lot 29.

6.1.1 Sources of Contamination on Lot 24: Contaminated Fills and Surface Spills

Lot 24 has several locations where TCE was detected in shallow samples above groundwater. The location with the highest concentration of TCE is at the H2M boring SB – 2 collected in 2009. In this boring, 11,000 µg/kg of TCE were found at a depth of 2.5 feet. TCE was also found in other H2M borings above groundwater, including SB – 1, SB – 4 and SB – 5 at concentrations ranging from 33 to 190 µg/kg. These detections of TCE at dispersed locations and at shallow depths are consistent with the placement of fill laden with TCE as the source of the contamination, which is the most reasonable explanation for the TCE detections on Lot 24, or with a spill of TCE on the ground surface. Figure 11 shows the wide distribution of TCE detections in shallow soil.

These occurrences of TCE in shallow soil are not related to any runoff or windblown soil deposition from the stockpiles on the adjacent Lot 29 that were maintained for a short period of time during the excavation of contaminated soil. The stockpiles containing TCE were covered and the material comprised of particles that were unlikely to have blown far, as Tegins states in his deposition testimony: "It wasn't sandy. Well, it was a mix of sand and—but it wasn't sandy to the point where it would blow all over the place. It was pretty stable." (*See* Deposition of John M. Tegins, December 15, 2011 ("Tegins Tr.") 102:10-12).

Further, it is inconceivable that contamination as high as 11,000 µg/kg was caused by either runoff or windblown particles from the stockpiles on Lot 29. Neither water runoff nor windblown particles have sufficient concentrations of TCE to cause such high amounts of contamination at the 2 ½ foot depth. Additionally, the ground surface on Lot 24 at the time of my Site inspection was higher than the ground surface on Lot 29 in the vicinity of where the green material was stockpiled. Although I do not know the elevation of the ground surface on Lot 24 at the time of the excavations, it was unlikely to be at levels lower than those on Lot 29 where the excavated soil was stockpiled. Therefore, runoff from the soil piles is unlikely to have reached the areas on Lot 24 where TCE was found in borings performed by H2M. (*See* Alprof 1136-Alprof 1141).



Boring	Designation	TCE	cis-DCE
H2M	SB-4 (2009)	54	-
H2M	SB-5 (2009)	33	-
H2M	SB-1 (2009)	190	-
H2M	SB-2 (2009)	**11,000**	-

Boring	Designation	TCE	cis-DCE
NYSDEC Soil Clean-up Objectives for Unrestricted Use (µg/kg)		**470**	**250**
PMK	B-2	4	2
PMK	B-3_PMK	16	-
PMK	B-1	**19,000**	**4,200**
PMK	B-4	4	-
TRC	TP-10	0	3

Boring	Designation	TCE	cis-DCE
Anson	B-30	7	-
FPM	B-1	3	106
Anson	B-37	49	-
Anson	B-36	250	-
Anson	B-35	4	-

Green Material Area			
Boring	Designation	TCE	cis-DCE
TRC	TP-7	93	6
TRC	SB-17	**201,000**	**74,300**
TRC	TP-13	**1,420**	-
TRC	SB-13	**659,000**	**23,100**

Figure 12 Occurrences of TCE and cis-DCE in Shallow Soil

The TCE soil concentration at 2 ½ feet below ground in boring SB – 2 is upgradient of groundwater contamination and upslope along the intermediate clay layer. I therefore conclude that there are multiple, independent sources of TCE contamination, some of which are located on Lot 24 and unrelated to the sources of contamination on Lot 29.

6.1.2 Sources of Contamination on Lot 14: the Former Gasoline Service Station and Auto Maintenance Operations

A gasoline service station and auto repair shop was previously located on Lot 14. A Phase 1 and Phase 2 environmental investigation were conducted by ACT and reported in a Certification of Advanced Cleanup Technologies, Inc. dated 4/4/2002. (*See* Alprof 1142-Alprof 1300).
ACT reported the following conditions on Lot 14 (*See* id. at Alprof 1142):

- Historical gasoline service station activities
- Historical auto repair activities
- Suspect asbestos-containing materials
- Solid waste debris located in the vacant lot to the east (i.e., Lot 24)
- The presence of a suspected UST in the northwest portion of the property; [a former underground tank field is shown on Sanborn maps in the northwest portion of the property, confirming this suspicion]
- Shop floors were a mix of concrete, wood, and dirt; [allowing penetration of wastes from auto-repair operations into the ground]
- Abandoned tank field was apparent, [the access ports for this abandoned tank field are still apparent on Lot 14]
- Pavement staining
- Stained soils were identified along the northern portion of the building
- Ten UST fill ports identified

ACT also states:

> "Due to the historical usage of the buildings at the property [Lot 14], the vacant Lot [Lot 24] may have been utilized for discharge of materials associated with auto repair and gasoline station activities." (*See* Alprof 1150).

ACT performed in-house chromatography screening using an SRI model 8610 gas chromatograph unit. With this instrumentation, ACT analyzed 16 groundwater samples and 6 soil samples. Laboratory analyses were completed on the samples with higher screening levels of contamination from which 7 groundwater samples and 4 soil samples were analyzed. Unfortunately, chlorinated aliphatic hydrocarbons (such as TCE) were not included in the analyses.

Although boring logs are not available, the following information was reported regarding the soils encountered during ACT's drilling (*See* Alprof 1169, Alprof 1251):

1. SB-05
    1. 0-0.5' – concrete debris
    2. 0.5-1' - ***Discolored/dark soil***
    3. 1-4' – fine grained orange/tan sand with small pebbles, marsh odor
2. SB-03
    1. 6-8' – gray fine grained sand, moist, marsh odor
3. SB-13
    1. 0-4' fine grained gray sand
4. SB-08
    1. 0-0.5' – ***black stained soil***
    2. 0.5-2' – brown sandy soil, ***oily***
5. MW-02 had 0.01' ***light product*** (*See* Alprof 1251).

Groundwater and soil contaminants were found by ACT during the Phase 2 environmental investigation. These results will be further discussed below. It is clear from ACT's Phase 1 and Phase 2 environmental investigations that the soil and groundwater contamination on Lot 14 resulted from the former gasoline service station and auto repair operations and is independent of any contamination on Lot 29. The underground storage tanks remain on Lot 14, contaminated soils are readily apparent from spills, and groundwater contaminants are highest on Lot 14 decreasing in the downgradient direction. Further, groundwater flow towards Norton Bay from all the lots prevents contaminants originating on Lot 29 from reaching Lot 14. Additionally, the degree to which TCE was used in the automotive repair operation on Lot 14, and discharges of TCE laden material occurred on Lot 14 and the vacant Lot 24 as a result of these operations, has not been adequately investigated.

6.1.3 Source of TCE Contamination of Lot 29: the Green Material

The green material was identified in the southwest corner of the foundation during excavation of petroleum contaminated soil. The green material was encountered at as little as two to three feet below ground surface. (Tegins Tr. 62:9-79:8). It extended beneath the foundation of the building according to Tegins, but not onto Lot 24. Tegins stated that the foundation material separated the green soil from the petroleum soils to a large degree, indicating that it was located within the foundations of the former building.

The green material was distinct from other soils encountered, allowing Anson to identify it by visual observation for removal purposes, and to investigate its extent without relying on chemical testing. For example, without the benefit of chemical testing to delineate the contamination, Tegins writes in a memo to the Church (*See* LDS00003466-LDS00003468 at LDS00003468):

> "So in conclusion, I believe that we got all of the green stuff out of the unsaturated soils adjacent to the pit and we even excavated some of the green stuff that was below the water table."

Figure 13 Photograph of Green Material (Anson 00000006)

Additionally, Anson employed test pits and observations to delineate the extent of the green material. For example, Tegins writes in his field notes (*See* id. at LDS00003466):

> "0915 finished excavating 2 test holes on the adjoining property [Lot 24] – No visible evidence of contamination."

The green material does not appear to have been from the flow of TCE oil or other TCE laden liquid into previously clean soil. TCE oil means TCE undissolved in water and in a liquid form, which would constitute a DNAPL. For one, some of the green material is located at a depth of two to three feet below grade, which is above both the bottom of the foundation walls and the top of groundwater. Therefore, to contaminate clean soil, a liquid such as TCE oil would have to be introduced from above the green material within the confines of the building. The liquid delivering TCE to the soil would not flow in under the foundations and upwards to where the green material was found.

There is no identified mechanism to introduce TCE laden liquid above the green material within the confines of the building, although apparently the concrete floor slab had been removed over a portion of the building which may have obscured such facilities. There were pipe lines observed below the level of the former floor slab, but their use and connection, if any, to the green material could not be determined. That said, there is no evidence to suggest that the TCE impacts result from a spill inside the former building on Lot 29.

Furthermore, there is no TCE oil (DNAPL) in, next to or under the green material as would be expected had TCE flowed into the soil. (Soil contaminated by the flow of TCE typically retains some of the TCE in the pore spaces of the soil.) The green material was excavated and stockpiled without any evidence of drainage of TCE oil from the material. Soil descriptions from under the green material show no sign of TCE oil. In particular, had TCE oil been present, it would have accumulated and been readily apparent in clay soils directly beneath the green material in soil samples. TCE oil was not present as is demonstrated by the following sample descriptions that indicate solvent like odors, but no TCE oil:

Soil Boring	Depth (ft)	Soil Description
SB-14	21.5 to 22.5	Gray CLAY, slight solvent-like odor, damp
SB-17	8 to 9	Gray CLAY, damp, slight solvent-like odor
SB-17	15 to 16.5	Gray CLAY, within into beds of sand, solvent-like odor

In short, the TCE detections on Lot 29 did not result from TCE oil (i.e., DNAPL).

The green material already containing TCE was most likely placed in the ground during building construction. The green material extended under the spread footing of the building. The majority, if not all of the green material was located within the foundation (between foundation walls). In order for the green material to be located under a building floor and foundation and assuming that it was not created by a discharge from within the building (for which no evidence exists), it would have to have been placed there at the time of or prior to construction.

The green material appears to have been placed when the building was reconstructed in the 1960s as part of the expansion of building space on Lot 29. The foundation beneath the area where the green material was found is comprised of poured concrete walls on spread footings. The imprint of the forms used to fashion the concrete and create the walls are still apparent on the walls. The foundations are in good shape and appear relatively new, (see, for example, Figure 14 that shows the foundation wall and spread footing hanging in the air). Although a building first appears on Lot 29 in the 1924 Sanborn map, the age of the building appears inconsistent with the foundation encountered during the excavation of the contaminated soil in the area. Although not impossible, it is unlikely that a foundation built in the 1920s or earlier would be in as good shape as the foundation encountered by Anson. Therefore, it appears that the building under which the green material was found was reconstructed at the time an additional building was constructed to the east. The construction of the foundations of these buildings occurred in the 1960s, and as part of or prior to this construction, TCE-laden fill was apparently deposited on Lot 29.

Figure 14 Foundations in the vicinity of the green material (Anson 00000027)

The building located above the green material was demolished in about 1980; (the building was not apparent in the 1980 aerial photograph).

Petroleum oil was also located on Lot 29, and, of course, was the original objective of the environmental investigation and remediation on Lot 29. The presence of petroleum oil appeared greater in the vicinity of USTs on the eastern portion of the former building that had previously contained petroleum. Although this petroleum spread to a large area beneath the building on Lot 29, it was never found as petroleum oil (free product) on Lot 24, (although some minimal detections of petroleum related compounds were reported in groundwater). Of course, the same conditions that resisted the flow of petroleum oil from Lot 29 to Lot 24 also would have resisted the flow of TCE oil (DNAPL) from Lot 29 to Lot 24.

6.1.4 Lack of DNAPL

There is no report in the documents reviewed of a DNAPL on Lot 29. The green material on Lot 29, although containing high levels of TCE, is not a DNAPL. This material is not a liquid and cannot flow on its own. There is also no observation of DNAPL in or under the green material, as is demonstrated by soil descriptions as discussed above. Additionally, petroleum oil containing TCE is not a DNAPL. Petroleum oil dissolves TCE to high levels, (higher than groundwater); however, the petroleum oil with dissolved TCE remains petroleum oil. It is lighter than water; and therefore, does not behave as a DNAPL as alleged by Davis.

Davis suggests that a concentration of TCE of 1% of its solubility in water is evidence of the presence of a DNAPL. By so doing, Davis is incorrectly using a rule of thumb to support her opinion. The 1% concentration of TCE is commonly used as a potential indicator of DNAPL, as often groundwater that contains such high levels is in the vicinity of a DNAPL. However, solid material such as the green material is capable of generating elevated concentrations of TCE in groundwater, and therefore, a 1% concentration is not necessarily indicative of a DNAPL. More importantly, as discussed above, the boring logs performed beneath the green material did not identify any DNAPL.

Contaminated fill placed in the ground, such as the green material, is sufficient to cause the groundwater contamination at the concentrations detected on Lot 29. On Lot 24, the concentrations of TCE in groundwater are too low to have been derived from a DNAPL, but are consistent with contaminated fill.

However, even if there were a DNAPL, and the evidence does not suggest it, the DNAPL would follow the same principles of fate and transport as described above for groundwater. In particular, and contrary to the allegation of Davis, the slope of the clay layer from Lot 24 to Lot 29 would prevent the DNAPL from flowing from Lot 29 to Lot 24 as this would be counter to the gradient of the clay layer.

6.2 GROUNDWATER FLOW TOWARD NORTON BAY

Groundwater flows downgradient to a point of discharge. Downgradient refers to the groundwater's level of potential energy caused by gravity. It is the equivalent of saying that groundwater flows from a higher to a lower groundwater elevation as a result of the force of gravity on the groundwater (in water table aquifers). The point of lower elevation to which groundwater flows is called the point of discharge. It is usually a surface water body such as a river, lake or ocean.

6.2.1 Discharge Point at Norton's Bay

The point of discharge for the groundwater from the Site is a point on Norton Bay located nearest to the Site, or the large 12 foot 9 inch by 6 foot box culvert that literally extends Norton Bay towards the Site as the Bay had naturally done before. This point is to the north-northwest of the Site. One cannot draw any reasonable flow line to any other discharge point; and, again, the groundwater from the Site must flow to a discharge point.

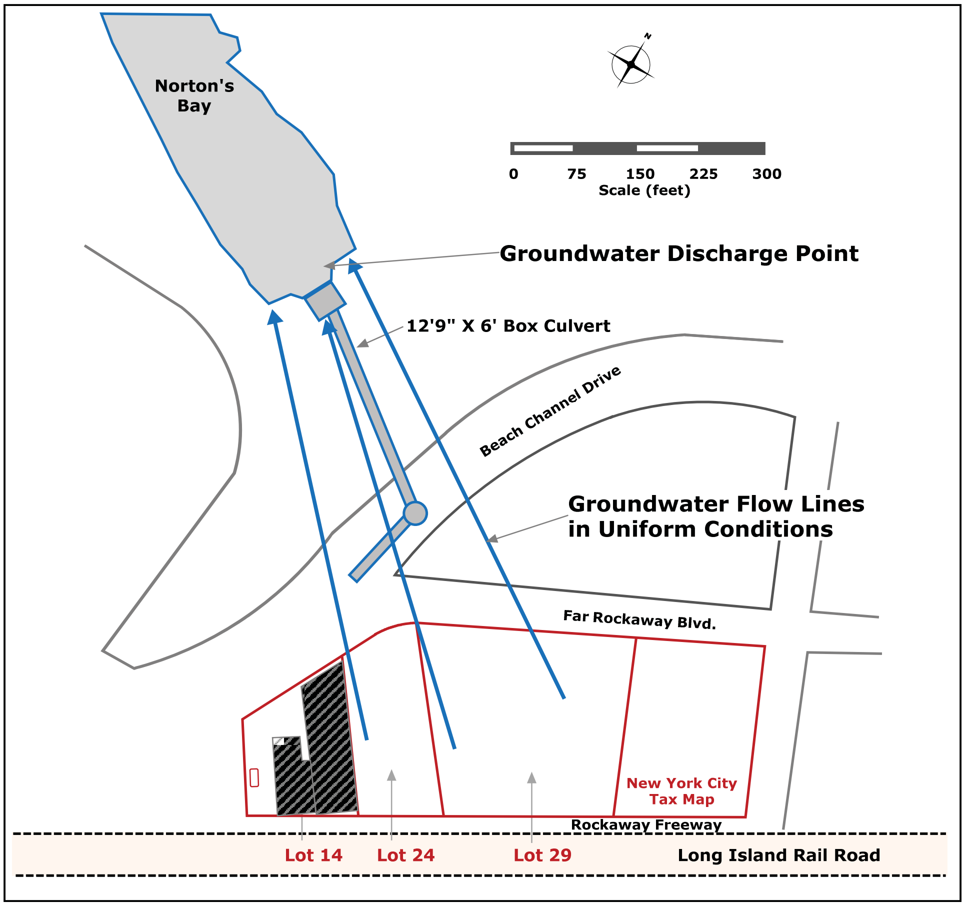


Figure 15 Expectation of Groundwater Flow under Uniform Conditions

The shortest line between a starting point for the groundwater and the point of discharge is the most likely path the groundwater will travel, when hydraulic conductivity, the ability of the soil to transmit water, and the cross-sectional area of flow are equal in all directions. In other words, under uniform conditions and by knowing the discharge point of the groundwater, one can reliably predict the direction of groundwater flow from any point on the land: it is simply a straight line between the starting point and the point of discharge (see Figure 15). The path the groundwater follows (such as this straight line under uniform conditions) is called the groundwater “line of flow” or “flow line.”

However, hydraulic conductivity and cross-sectional areas of flow are not uniform at the Site. Soil with a lower or higher resistance to flow will cause a modification of the straight line between the starting point and the discharge point by bending the flow line to favor the areas of higher hydraulic conductivity (lower resistance to flow). (Again, the term “hydraulic conductivity” (or “permeability”) is the measure of resistance to flow, the higher the hydraulic conductivity (or permeability), the less resistance to flow.) For example, in Figure 16 adapted from Todd (1980, Figure 3.18, page 93), the effect of differing hydraulic conductivity on groundwater flow lines is demonstrated.

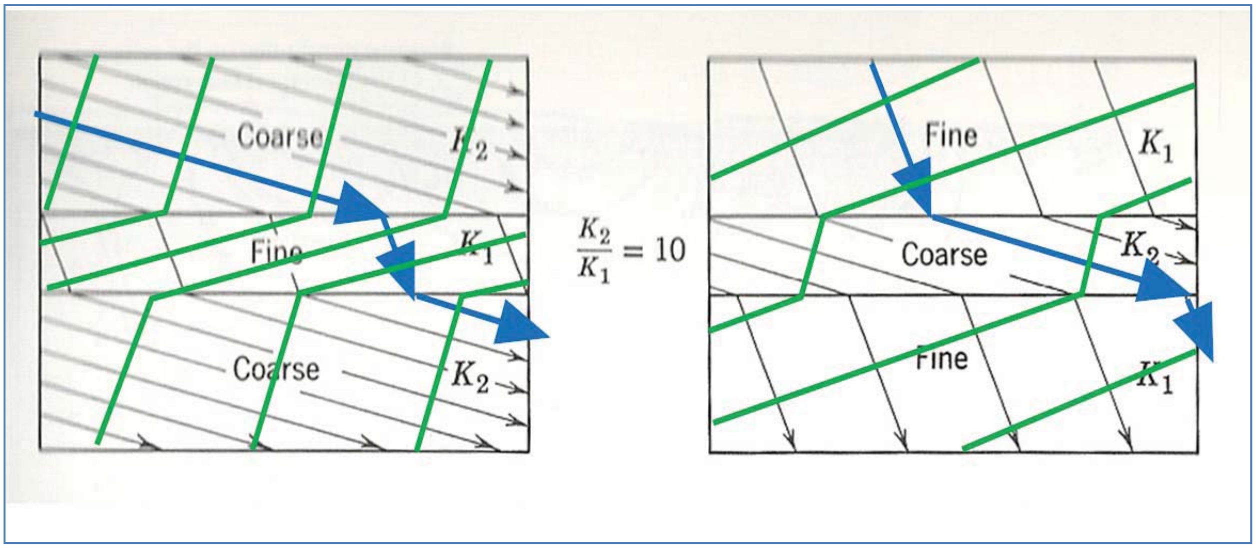


Figure 16 Hydraulic Conductivity Modifying Flow Line

In each image in Todd's figure a flow line has been highlighted for easier viewing. As can be seen, the direction of groundwater flow is altered by a change in hydraulic conductivity. In the image on the right, for example, a higher hydraulic conductivity zone in the middle of the image skews the flow to favor the zone. The opposite is shown in the image on the left where a lower hydraulic conductivity skews flow to favor the outer zones with higher hydraulic conductivity. In the figure the gradient of groundwater flow is also illustrated by contours of "equal potential"; that is, equal groundwater elevations (in a water table aquifer) or equal hydraulic potential in confined aquifers (aquifers with a confining layer above them).

These fundamental principles of hydraulic conductivity, of course, affect the Site. First, the groundwater at the Site will take the path of least resistance to the discharge point at Norton Bay. The 12 foot 9 inch by 6 foot box culvert running from Norton Bay toward the northwest corner of the Site is a readily available conduit for groundwater to reach the Bay. This culvert was constructed to replace the natural drainage that Norton Creek provided in the 1800s and early 1900s. Both the channel within the culvert and in the typically porous backfills outside the culvert that were used in its construction will transmit groundwater away from the interiors of the land towards and into Norton Bay.

Second, much of the former Norton's Creek channel was most likely filled with more permeable material (material with a higher hydraulic conductivity) than that outside the former channel, as was described above. Evidence of this can be seen in the increased amount of gravels and coarse sands in the vicinity of the former draw bridge near the center line of the Norton Creek channel. Therefore, a run of higher hydraulic conductivity soil is likely present along the path of the former channel to the discharge point at Norton Bay as a result of manual filling activities.

Third, while the channel was operational or still open, the main channel experienced higher water velocities, and, in turn, more scouring energy (the energy that reduces the effects of sedimentation) than those areas to the sides of the channel. The result was that smaller sized particles deposited to the sides of the former channel, and relatively larger sized particles deposited in the higher velocity sections of the channel. As maintenance of the channel diminished, the same phenomenon affected the depositions along the length of the channel. The areas closer to Norton's Bay experienced higher velocities for a longer period of time than the areas toward the end of the channel located further inland as the channel filled with sediment. The result was a greater deposition of smaller particles in the lower velocity areas that are further from the Bay (to the south) relative to the points closer to the Bay (to the north). Therefore, the intermediate clay layer took on the half bowl shape with its slope in the direction of the center line of the channel and curving to the north-northwest towards Norton Bay.

The result was a path for groundwater of higher hydraulic conductivity sands and gravels following the route of the former Norton Creek channel. This path of preferential flow bends the flow lines of groundwater on Lots 24 and 29, directing them toward the discharge point at Norton Bay. The resulting groundwater flow is shown in Figure 17. In Figure 17 the equal potential contours (green lines) and the groundwater flow lines (blue lines) are also shown.

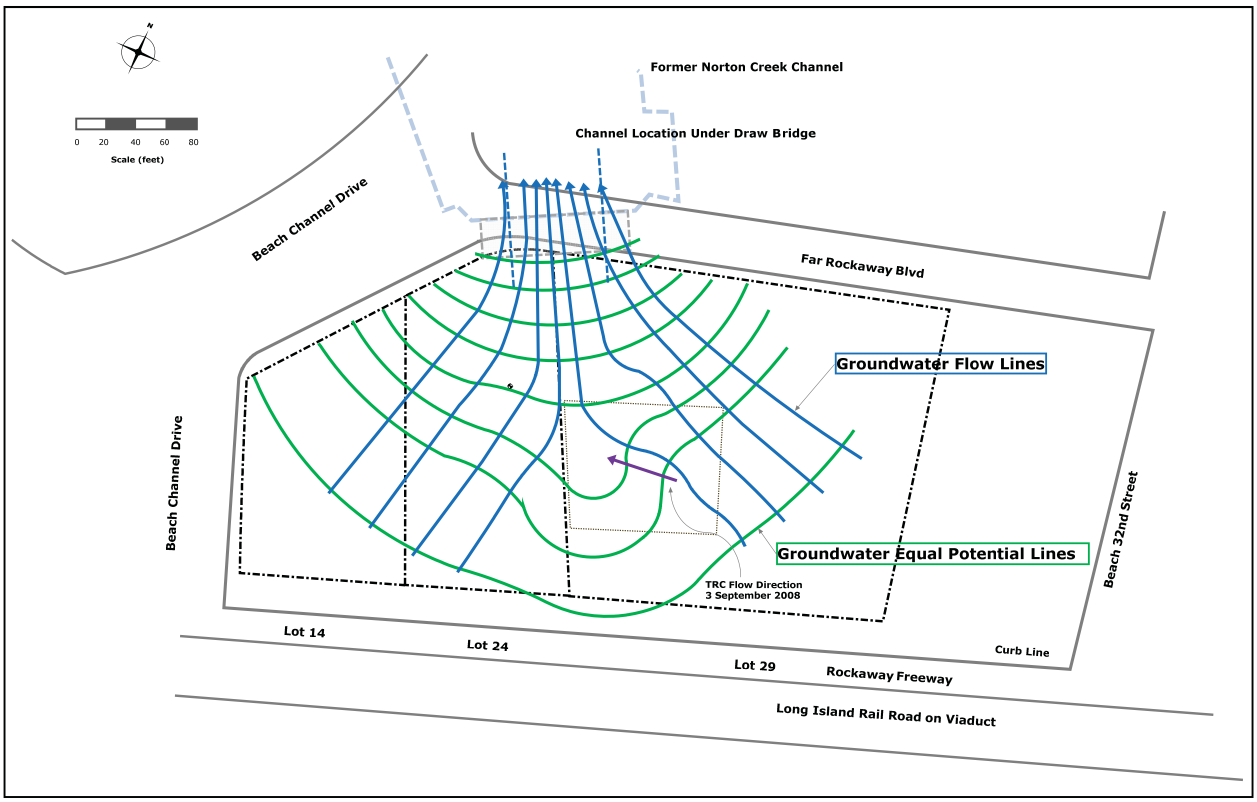


Figure 17 Flow of Groundwater at the Site

This mapping of flow lines is further supported by measurements of hydraulic conductivity made during the environmental investigations.

6.2.2 Measurements of Hydraulic Conductivity

TRC measured transmisivity, T, in the shallow and intermediate flow zones (TRC December 2008) using pump tests (*See* LDS00010205-LDS00010345). Transmisivity is hydraulic conductivity independent of aquifer depth; hydraulic conductivity, K, is derived from transmisivity, T, using the formula K=T/b, where b is the thickness of the aquifer. They reported an average transmisivity value of 376 ft^2/day in the shallow groundwater zone in the vicinity of MW-4s, (based on a "semi-log" procedure for analyzing pump test data). For the intermediate flow zone they reported a transmisivity of 188 ft^2/day following the same procedure.

In the area of MW-4s and MW-4i, the shallow flow zone is approximately 5.7 feet and the intermediate flow zone is approximately 12 feet thick. Using these values for aquifer thickness, the following transmisivities and hydraulic conductivities are calculated:

Zone	Transmisivity	K
Shallow	376	66 feet/day
Intermediate	188	15.7 feet/day

Christopher Magee, the NYSDEC case manager for Lot 29, characterized these values as high (highly permeable) in his deposition testimony (*See* Deposition of Christopher Magee, November 7, 2011 ("Magee Tr."). They are consistent with sedimentation in high velocity areas and fill placement of sandy materials in channel coastal areas.

In the same December 2008 report, TRC conducted a tidal study. They measured tidal fluctuations of 0.09 feet in MW-1i and 0.28 feet in PZ-3. Both wells are located in the intermediate groundwater flow zone.

I have made additional hydraulic conductivity calculations following common scientific methods for calculating values from tidal fluctuations, (Todd, 1976, page 244, my calculations are provided in Attachment C). Transmisivity is calculated from the following equation:

$T = \frac{\pi \cdot S}{t_0 \cdot [Ln(h_x/h_0)/-x]^2}$, where,

T = Transmisivity (ft^2/day)
S = Specific Yield (unconfined aquifer) or Storativity (confined aquifer)
T_0 = Half Tidal Cycle (days)
H_0 = Amplitude of half tidal cycle
H_x = Groundwater elevation change at well
x = Distance from Tidal body to well

Aquifer thickness in the lower groundwater flow zone near PZ-3 is 12 feet, the same as that used for MW-4i. The aquifer thickness at MW-1i is 26 feet due to the height of the intermediate clay at that location. This is still the lower groundwater flow zone; however, at this location the groundwater is unconfined, and therefore, the unconfined Specific Yield value calculated by TRC during the pump test for the shallow unconfined zone is applied.

Transmisivity is also dependent on the distance from the tidal body to the relevant well. Currently, the shortest distance to the open waters of Norton Bay is 600 feet. Tides at the Norton Point Head of Bay gauging station fluctuate approximately six feet over a tidal cycle. Using these values, I calculate the transmisivities and hydraulic conductivity values in the following table. These are average values for the soils between the discharge point in the Bay and the monitoring well in question. For easy comparison, I also provide the hydraulic conductivity value from the TRC pump tests for monitoring well MW – 4i.

Calculations from Tidal Study Assuming 600 Feet to Discharge Point From PZ-3

	Unit	MW-1i	PZ-3
Distance to Discharge Point	ft	466	600
Aquifer Thickness	ft	26	12
Transmisivity	ft^2/day	1106	201
Hydraulic Conductivity	ft/day	42.5	16.8
TRC Pump Test			**MW-4i**
Hydraulic Conductivity	ft/day		9.4

The box culvert may be transmitting the tidal wave without significant dampening, as it was placed in the former channel. I evaluate this by performing the same calculation as if the chamber in the box culvert in Beach Channel Drive is imparting a tidal fluctuation of six feet, the same fluctuation I used for Norton Bay. This overstates the tidal fluctuation at such an inland point; and therefore, provides a conservative calculation of the hydraulic conductivities for comparison to the above calculation. The chamber in Beach Channel Drive is 320 feet from PZ-3. This results in the following Hydraulic Conductivities. Again, the hydraulic conductivity from well MW – 4i is provided for comparison.

Calculations from Tidal Study Assuming 320 Feet to Discharge Point From PZ-3

	Unit	MW-1i	PZ-3
Aquifer Thickness	ft	26	12
Distance to Discharge Point	ft	188	320
Transmisivity	ft^2/day	4,888	3,203
Hydraulic Conductivity	ft/day	34.4	33.8
TRC Pump Tests			**MW-4i**
Hydraulic Conductivity	ft/day		9.4

The hydraulic conductivity values in the intermediate zone (PZ-3) calculated above are substantially higher than the values calculated by TRC near well MW-4i. This tells us that the hydraulic conductivities become greater as we move along the former channel toward the groundwater discharge point in Norton Bay.

From the above analysis I conclude that there is a pronounced path of least resistance to the north-northwest toward Norton Bay. The hydraulic conductivity increases substantially in this direction, most likely due to the combined effects of the box culvert, relatively permeable fill material, and naturally deposited sediments in the former Norton Creek channel. This conclusion strongly supports the flow of groundwater depicted in Figure 17.

6.2.3 Groundwater Elevation Measurements

Both TRC and Anson made measurements of groundwater elevations in monitoring wells for the purpose of evaluating the direction of groundwater flow. As explained above, under heterogeneous conditions such as uniform hydraulic conductivity conditions and symmetrical groundwater flow zones, groundwater elevation measurements provide an estimate of the groundwater flow direction within the area covered by monitoring wells. Even in non-uniform conditions groundwater elevation measurements provide insight into the direction of groundwater flow; however, one must also take into account the differing hydraulic conductivities which will bend the flow lines.

For both Anson and TRC, groundwater elevation measurements were restricted to Lot 29. Both Anson and TRC reported a groundwater flow direction in the shallow zone to the north-northwest on Lot 29, toward the northwest corner of the lot. This groundwater flow direction is consistent with flow towards a discharge point in Norton Bay.

TRC reported a westerly flow in the intermediate zone on Lot 29. This westerly groundwater flow by TRC in the intermediate zone is consistent with a general flow from the Site towards a discharge point in Norton Creek (as depicted in Figure 17). Importantly, TRC measured a local flow direction on Lot 29 only, and it was correctly indicated to be toward the center line of the former Norton Creek channel. What could not be measured by TRC was that this groundwater flow thereafter bends to the north-northwest towards Norton Bay, as no permanent monitoring wells are located on Lots 14 and 24 with which these measurements could be made. TRC's reported flow line is bent to the north–northwest and then flows to its discharge point toward Norton Bay, as it must.

Groundwater elevation measurements were never made on Lot 24. However, based on the necessity that groundwater flow to a discharge point and the lower resistance to flow along the former Norton creek channel and toward Norton Bay, I conclude that the groundwater flow on Lot 24 is to the north, draining into these more permeable soils along the center line of the former Norton Creek channel as is depicted in Figure 17. In sum, there is no groundwater flow from Lot 29 towards Lots 24 and 14, as is alleged by Davis.

6.2.4 Clay Barrier Separating Lot 29 and Lot 24

The organic clays and silts acted as a barrier preventing contamination on Lot 29 from reaching Lot 24 in any significant amounts, if at all. These geologic materials do this by directing the flow of liquids, including groundwater, away from Lot 24 towards Lot 29, and ultimately towards Norton Bay.

Figure 18 is the Cross-Section D – D′ showing the concentrations of TCE detected at various locations in relationship to the organic clays under the ground. As can be seen, the occurrence of TCE at H2M SB–2 is too shallow to have been caused by the green material, or any other contaminants on Lot 29 even if there had been a flow from Lot 29 to Lot 24. The sample elevation is too high for this to occur. Additionally, there are samples below NYSDEC Soil Cleanup Objective for Unrestricted Use [6 NYCRR(375)(6)(a)] in between the green material on Lot 29 and the TCE contamination at SB–2 on Lot 24. The situation is the same at the other areas on Lot 24 where TCE was detected in shallow soil. The TCE contamination at these locations on Lot 24 did not come from Lot 29. Rather, the TCE in these areas came from the additional independent sources on Lot 24, including and in particular the contamination at the 2 ½ foot depth in boring SB–2.

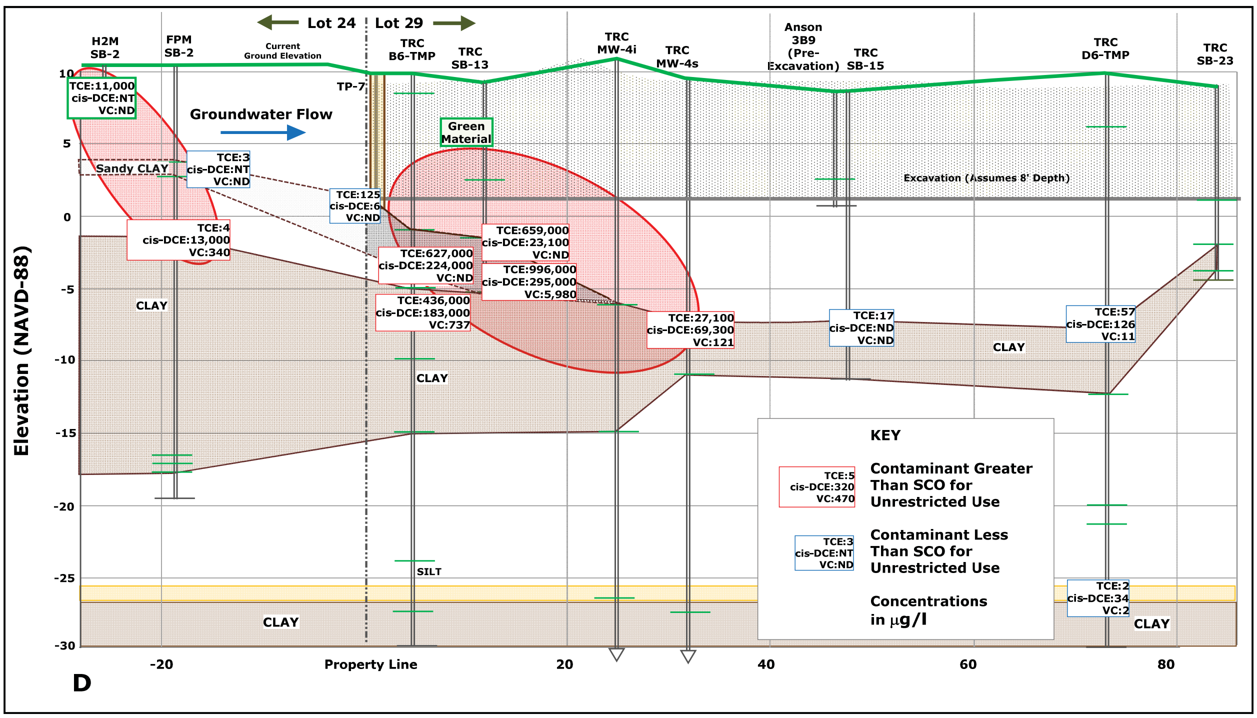
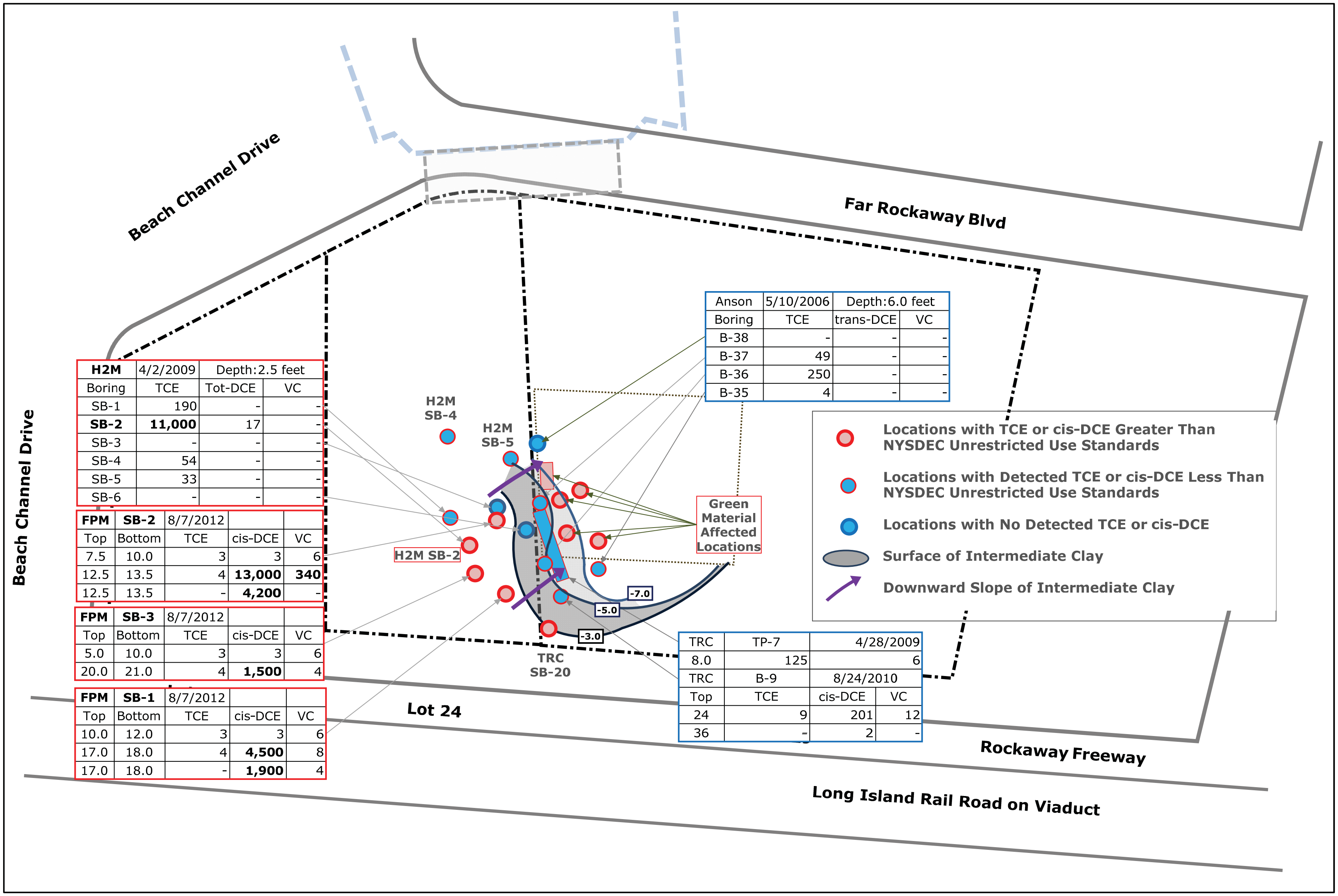


Figure 18 TCE Concentrations on Cross-Section D-D'

The clay layer and groundwater flow directions affect the fate and transport of contaminants in the fill placed on Lot 24 in other locations as well. On Figure 19 is plotted the significant contamination in the vicinity of the property line between Lot 29 and Lot 24. Also shown on the figure is the area where the clay is the thickest and able to prevent flow from Lot 29 towards Lot 24.



H2M	4/2/2009	Depth:2.5 feet	
Boring	TCE	Tot-DCE	VC
SB-1	190	-	-
SB-2	**11,000**	17	-
SB-3	-	-	-
SB-4	54	-	-
SB-5	33	-	-
SB-6	-	-	-

FPM	SB-2	8/7/2012		
Top	Bottom	TCE	cis-DCE	VC
7.5	10.0	3	3	6
12.5	13.5	4	**13,000**	**340**
12.5	13.5	-	**4,200**	-

FPM	SB-3	8/7/2012		
Top	Bottom	TCE	cis-DCE	VC
5.0	10.0	3	3	6
20.0	21.0	4	**1,500**	4

FPM	SB-1	8/7/2012		
Top	Bottom	TCE	cis-DCE	VC
10.0	12.0	3	3	6
17.0	18.0	4	**4,500**	8
17.0	18.0	-	**1,900**	4

Anson	5/10/2006	Depth:6.0 feet	
Boring	TCE	trans-DCE	VC
B-38	-	-	-
B-37	49	-	-
B-36	250	-	-
B-35	4	-	-

TRC	TP-7	4/28/2009	
8.0	125	6	
TRC	B-9	8/24/2010	
Top	TCE	cis-DCE	VC
24	9	201	12
36	-	2	-

Figure 19 Relationship of Clay to Contamination on Lots 24 and 29

The plan view in Figure 19 also shows a number of samples located between the green material area and the additional source areas on Lot 24 that are within NYSDEC standards or contain no TCE at all. These borings include the following locations: TP–7, B–37, B–36, and TRC B–9. In other words, there are samples with low levels of TCE in between the samples containing elevated TCE on Lot 29 and those containing elevated TCE on lot 24. This up down up concentration pattern is inconsistent with a flow of contamination from Lot 29 to Lot 24. However, it is evidence that the contaminants on Lot 29 are not the source of the contaminants on Lot 24, with only minor possible exceptions.

6.3 CONTAMINANT DISTRIBUTION IN GROUNDWATER

Davis provides a series of figures (Figures 2 through 7) which she uses to support her allegation that contamination is flowing from Lot 29 to Lot 24 and onto Lot 14. On these figures, she plots groundwater concentration data and draws a series of contours that comprise her interpretation of a plume extending across the Site. Her analysis, including her interpretation of concentration contours, is in error as she ignores groundwater data contrary to her interpretation, incorrectly constructs contours, and does not take into account the correct flow of groundwater or the influence of the underground soils.

In Figure 20, I plot the distribution of TCE in shallow groundwater using all available data prior to or outside the influence of the in situ thermal treatment. The contamination from the area where the green material was found is clearly shown by this plot to be flowing to the north-northwest and consistent with the groundwater flow in that direction on Lot 29. Similarly, the shallow soil contamination on Lot 24 is shown to be affecting groundwater downgradient of these sources. In particular, boring H2M SB-2 can be seen to be upgradient of the TCE in MW-5s, MW-5i, GW-2, GW-4, and TRC MZ-4/LC-3.

Taking a closer look at the distribution of groundwater contamination stemming from the location of boring H2M SB-2, one can see the groundwater contamination, including cis-1,2-DCE, spreading both vertically and laterally in the direction of groundwater flow. For example, cis-1,2-DCE was at a concentration of 17,000 μg/l in MZ-4/LC-3 on 11/13/2008 and 36,000 μg/l in MW-5i on 12/2/2008, both dates are before the thermal treatment on Lot 29. The high levels of cis-DCE in boring FPM SB-2/GW-2 results from the continuing migration of contaminants near boring H2M SB-2 on Lot 24, and not from the area of the thermal treatment on Lot 29.

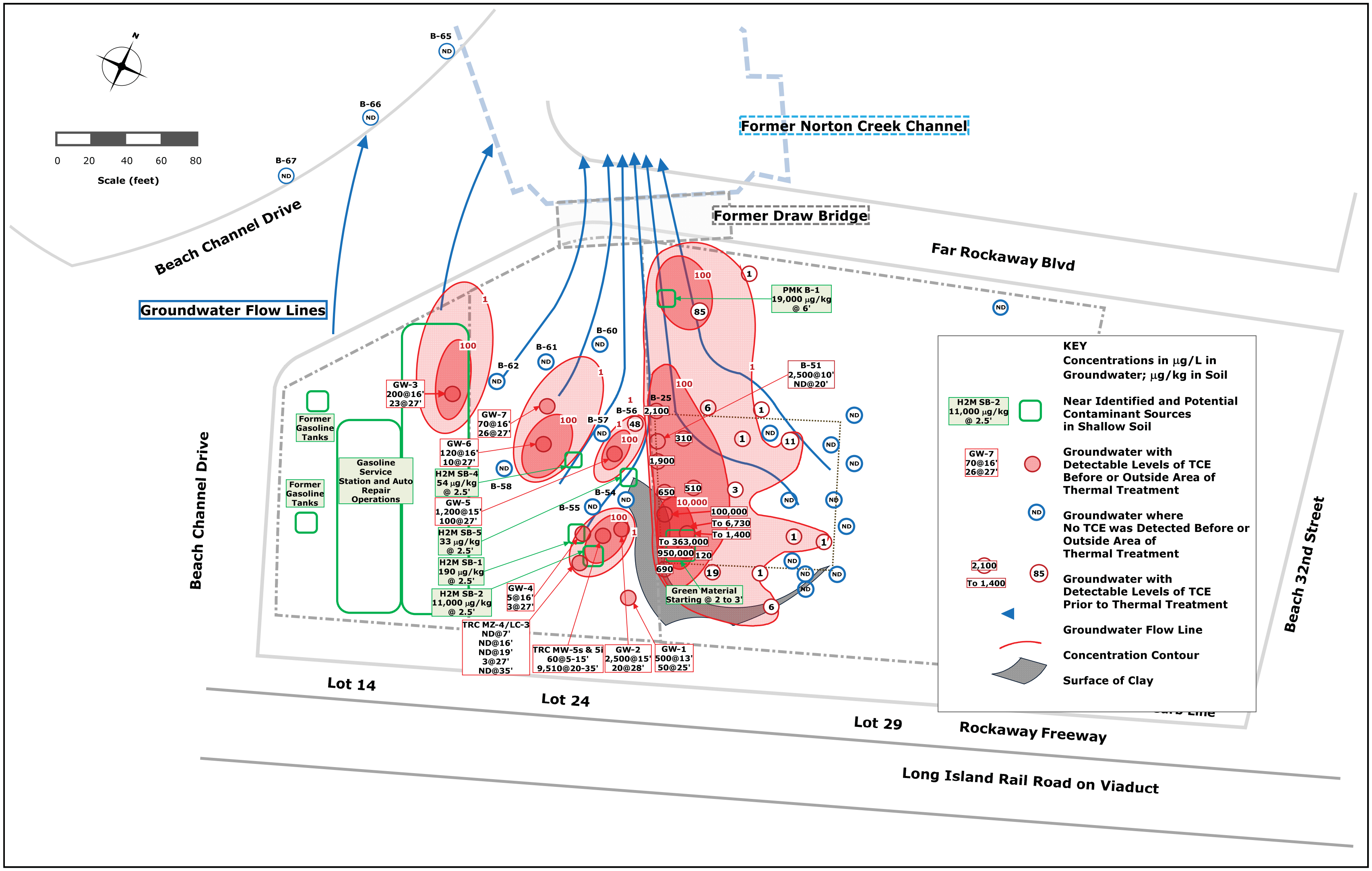


Figure 20 Distribution of TCE in Shallow Groundwater

Figure 21 shows the distribution of contamination from a shallow source on Lot 24 near boring H2M SB-2.

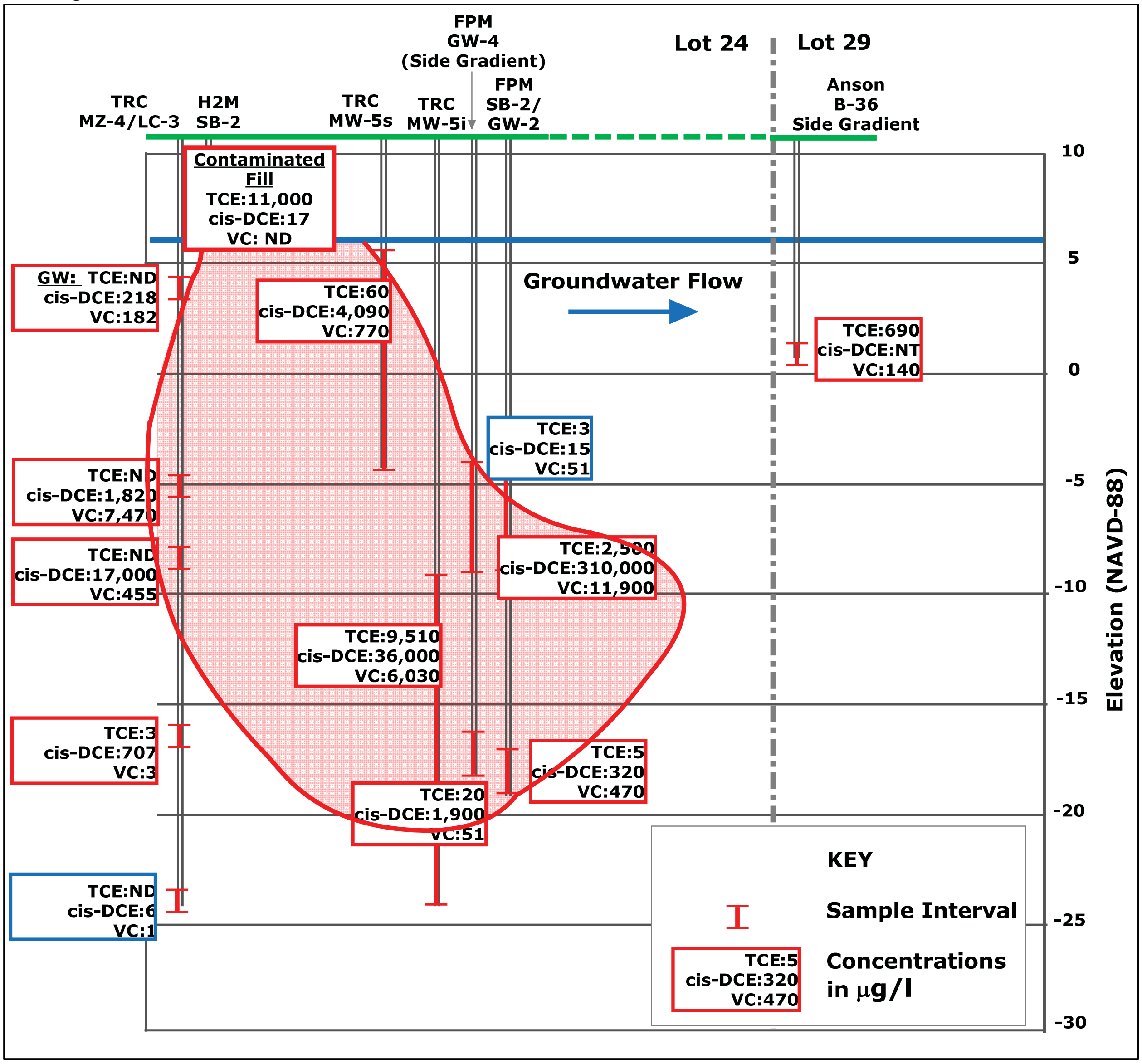


Figure 21 Distribution of cis-1,2-DCE in Shallow Groundwater

The detections of MTBE, a gasoline additive, in groundwater stemming from the former gasoline service station on Lot 14 is consistent with the direction of groundwater flow identified above. MTBE has been found on the former gasoline service station in both soil and groundwater. The highest levels of MTBE in groundwater were found at two locations, TW – 1 and TW – 6, at concentrations of 23 µg/l and 34 µg/l, respectively. MTBE is detected in three additional downgradient wells at lower concentrations as a result of the flow from the more contaminated areas on the former gasoline service station property. The locations of these additional MTBE detections are consistent with a groundwater flow from the former gasoline service station towards the discharge point at Norton's Bay.

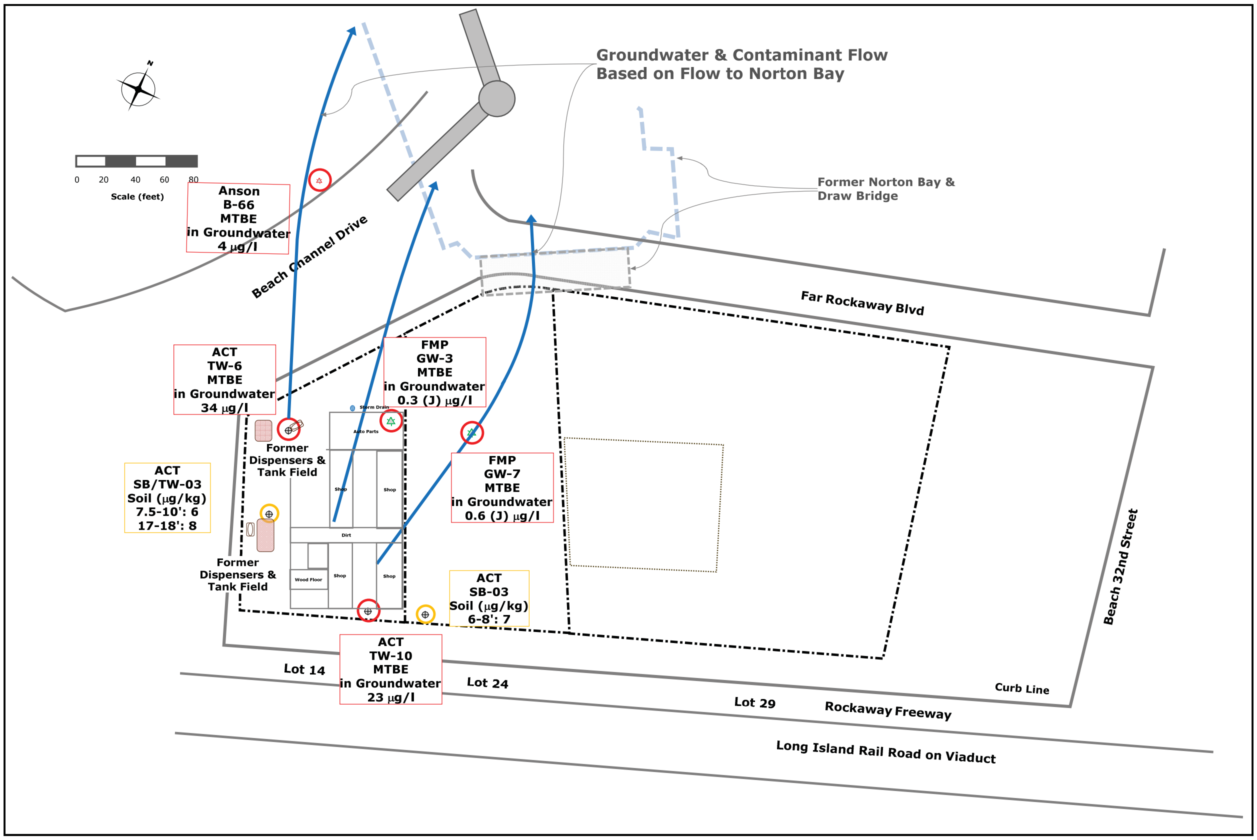


Figure 22 Flow of MTBE in Groundwater

6.4 SUMMARY OF CONTAMINANT TRANSPORT

The implications of the above detailed analysis of all the relevant technical data for the Site are clear:

- There are independent sources of contamination on Lots 14, 24 and 29, and
- Contamination did not flow from Lot 29 to Lot 24 or Lot 14.

7 REMEDIATION BY THE CHURCH WAS REASONABLE AND APPROPRIATE

7.1 COMPLIANCE

In New York State, petroleum spills are so numerous that they are often cleaned up using presumptive remedies of soil excavation and off-site disposal. The NYSDEC is informed of the spill, kept aware of the investigation and remediation activities, and provides the final signoff. If the situation is more complicated or contaminants other than petroleum are detected, then the process becomes more formal. In these situations, a work plan for the next phase of activities is submitted by the responsible party followed by a review and approval by the NYSDEC. The responsible party proposes actions and the NYSDEC reviews them, and either approves them or requires modification. In this iterative fashion, the remediation progresses until conditions are met, such that the NYSDEC is able to issue a “no further action” letter, and the case is closed. In all remedial decisions, it is the NYSDEC that determines the cleanup standards and approves the cleanup method.

In addition to the extensive soil excavation to remove source material, an intensive approach to groundwater remediation was proposed by the Church consisting of in-situ thermal treatment. In essence, this remediation method involves the heating of the ground to volatize and remove the contamination present. The NYSDEC approved this approach on November 25, 2009. (*See* LDS00000411-LDS00000413).The approach was implemented and a final report submitted to NYSDEC in August 2012. (*See* LDS00101906-LDS00102204).

7.1.1 Compliance with Regulations and Guidelines

The Church complied with and went beyond the requirements of environmental regulations applicable at the time of its investigation and remediation. For example, despite the fact that the Church did not cause any contamination, the Church reported the contamination promptly to the NYSDEC and has been complying with the NYSDEC directions ever since.

The Church has gone beyond the requirements of environmental regulations. For example, although the NYSDEC guidance document DER–10 applies to all environmental investigations and remediation, the guidance is not required for petroleum spills. Nonetheless, the Church prepared and submitted work plans to the NYSDEC and sought their approval for the work to be conducted throughout its investigation and remediation (as required by DER-10), even before such a formal process was required with the signing of the stipulation agreement.

As noted above, a detailed summary of the Church’s investigation and remediation efforts are contained in Section 1.4 of the ISTT Remedial Action Report. (*See* LDS00101906-LDS00102204). These are incorporated herein by reference.

7.1.2 Cleanup Standards

In her report Davis criticized the Church for applying an inappropriate cleanup standard for TCE. This is a misdirected criticism as it was the NYSDEC that selected and applied the TCE cleanup standard for Lot 29, not the Church. The Church initially proposed a site specific standard, but the NYSDEC modified and approved it once they were satisfied that it met the NYSDEC's public health and environmental goals.

The cleanup standards applied by the NYSDEC to Lot 29 were to be fully protective of public health and the environment in the sole judgment of the NYSDEC. These standards were proposed by TRC (*See* LDS00000775-LDS00000780), modified by the NYSDEC (*See* NYSDEC 00002121-NYSDEC 00002124), and then approved by the NYSDEC (*See* NYSDEC 00002125-NYSDEC 00002128). The NYSDEC's requirement for closure of the spill number, (the administrative nomenclature for completion of the remediation), included that the "requirements of the stipulation agreement were satisfied or are expected to be satisfied in accordance with the time frames contained in the approved correction action program (CAP), and that the property is not considered to be a threat to public health or the environment by the Department [the NYSDEC]" (*See* NYSDEC 00002121-NYSDEC 00002124 at NYSDEC 00002123).

Davis mischaracterizes the cleanup standards by suggesting that they were comprised entirely of a percent reduction of contaminants to be achieved by the thermal treatment remediation on Lot 29. This is incorrect. This percent reduction refers only to the performance criterion placed on the thermal treatment portion of the remediation. It was intended to be adequate to achieve a continuing reduction in groundwater concentrations of TCE through natural attenuation. More importantly, however, the NYSDEC approved site-specific cleanup standards that were protective of the public health and environment. The NYSDEC already felt that there was no threat to the public health or environment posed by Lot 29 in its current conditions (since there are no human or ecological receptors for the contaminated groundwater), and accordingly approved standards that would be fully protective of the public health and environment for future property development, with potentially some subsequent requirements for vapor intrusion depending on future property use. In that determination, NYSDEC considered the performance standard for the thermal treatment to be a step in the process.

7.1.3 Timeliness of Investigation and Remediation

Davis alleges that there were unnecessary delays in the progress of investigation and remediation conducted by the Church. This allegation is without merit and does not recognize the remarkable diligence the Church displayed in remediating contamination that it had not caused. It also does not take into account the lack of exposure pathways to any human receptors of the preexisting contamination on Lot 29.

During his deposition, Chris Magee of the NYSDEC made clear that there was no reason to expedite the review of the Church's plan for remediation. He also explains the reasons that a site would normally be expedited and then states that none of those reasons applied to the Church's remediation schedule. Instead, the NYSDEC was pleased with the pace of the Church's investigation and remediation and repeatedly approved the Church's remediation schedule. (Magee Tr. 41:3-19). The caveat to this was when Plaintiffs refused to give the Church access to Lot 24 as part of the Church's investigation and remediation efforts.

Furthermore, there were no unreasonable delays in the implementation of the thermal treatment remediation or any of the prior remedial actions undertaken by the Church and its consultants. In-situ thermal treatment, although very effective, is an involved process requiring extensive engineering design, construction planning and management, and system controls. The Church spent an appropriate amount of time preparing the approach. The Church submitted a work plan to NYSDEC on August 1, 2009. (*See* LDS00000689-LDS00000770). The NYSDEC approved the work plan on November 25, 2009. (*See* LDS00000411-LDS00000413). The Church then spent an appropriate amount of time to contract the project, prepare Lot 29 (the remedial design) and implement the approach. The Church's management of the in-situ thermal treatment was well done, as is evidenced by the successful completion of the work and obtainment of the cleanup standard set by NYSDEC.

Prior to the thermal treatment remediation, the Church's efforts to develop an in-situ oxidation approach did not cause any unreasonable delays. A pilot test was conducted as is typical to evaluate the adequacy of such an approach to remediation. It is not an unreasonable delay to test the remedial approach prior to full scale implementation and then evaluate whether the approach will be effective. This is the purpose of a pilot test, and it served its purpose well here. Based on intelligence gained as a result of the in-situ oxidation pilot test, the remediation was revised to be more effective.

Administratively, the Church was prompt. Proposals were submitted to the NYSDEC by all consultants for the Church with remarkably little modifications by NYSDEC. The NYSDEC's desire in May 2007 that source remediation commence prior to additional investigation was accommodated in a thoughtful and effective manner by the Church. The fact that active groundwater remediation is now complete is a testament to the appropriateness and diligence of the Church to address preexisting contamination on Lot 29 that it did not cause.

Throughout the above development of a remediation approach, there have been few, if any, delays of consequence and no unreasonable delays. The time frames involved here are typical in my experience, if not quicker, especially given the lack of exposure pathways and human receptors. Considering the suite of contaminants involved, the complexity of the subsurface soils, and the resistance to conventional cleanup technologies, the period of time it took to investigate and remediate Lot 29 was remarkably quick.

7.1.4 Communications with the NYSDEC

Particularly notable in the process of remediating Lot 29 was the significant amount of communication between the Church and the NYSDEC. These communications accelerated the investigation and remediation of Lot 29. In his deposition testimony, Christopher Magee, the NYSDEC geologist involved with the project, confirmed the good communication from the Church's consultants with the NYSDEC and indicated that the Church has performed all actions required by NYSDEC. I concur with Mr. Magee's description of the high level of communications between the Church's consultant and the NYSDEC, and the value he places on this good communication. Again, the groundwater remediation was successfully completed and is now awaiting final signoff from the NYSDEC.

7.1.5 Alleged Impact of Remediation of Lot 24

Davis criticizes the Church by claiming that the remediation on Lot 29 damaged the adjacent Lot 24. This is incorrect, and as was demonstrated by my analysis above.

The remediation conducted by the Church had no negative impact on the adjacent Lots 14 or 24. The excavation conducted by Anson was well-controlled, and as detailed above, the stockpile of contaminated material containing TCE did not impact Lot 24. Additionally, the in-situ thermal treatment did not negatively affect Lot 24. The presence of the thickening organic clays and silts in key locations under the ground and the flow of groundwater were adequate to prevent any meaningful migration of contaminants from Lot 29 to Lot 24 and Lot 14, whether these contaminants were present prior to or created during the remediation on Lot 29. To the degree which any contamination on Lot 24 is the result of contaminants on Lot 29, and I do not believe this to be the case with possible, minor exceptions, the in-situ thermal treatment would, of course, have a beneficial effect on the conditions on Lot 24. This is because it removed a significant source of contamination in the treatment zone, rendering down gradient locations in a condition such that natural degradation could complete the destruction of the contaminants.

The thermal treatment remediation implemented by the Church did not exacerbate the contamination. It is typical that thermal treatment will increase the concentration of daughter products of TCE initially. In fact, such an increase in concentrations of daughter products is a sign that remediation is progressing well and not getting worse. As remediation and natural attenuation processes continue, these daughter products are destroyed as well.

7.1.6 Regulatory Program

Davis criticizes the Church for conducting the remediation under the "spills" program, which is the NYSDEC's regulatory program for addressing petroleum spills, as opposed to the Voluntary Cleanup Program, another program, often initiated for spills of non-petroleum materials. This criticism is misdirected. It is the NYSDEC that decides the program under which the site will be administered. In spite of this misdirected criticism, the NYSDEC's decision to administer the remediation under the spills program was appropriate and beneficial to all parties and the public.

The investigation and remediation on Lot 29 was administered under the spills program because the Church's investigation first identified petroleum impacts. Davis opines that the Voluntary Cleanup Program was the appropriate NYSDEC program because of the presence of TCE and petroleum. However, the spills program also addresses other types of contaminants in addition to petroleum, including TCE. The NYSDEC often keeps multiple contaminant sites in the spills program to balance staff loading and to maintain continuity on projects that are moving along well. As this was the case for the investigation and remediation on Lot 29, it is understandable and appropriate that the NYSDEC decided to keep Lot 29 in the spills program in spite of the discovery of TCE. This was beneficial to the remediation and the public as the delay associated with a new group of regulatory representatives was avoided. There was no inefficiency or delays caused by the NYSDEC decision to keep Lot 29 in the spills program; and rather, the remediation progressed faster and more effectively with Lot 29 in the spills program.

8 FUTURE REMEDIATION COSTS FOR LOTS 24 AND 14

Davis provides no basis for her estimate of the costs for investigation and remediation on Lots 14 and 24. To provide reasonable and reliable engineering cost estimates, one must identify the proposed remedy, how that remedy was selected, and the objective of the remediation. The scope of the remediation must be reasonably detailed and the objective more than just a statement that the property will be cleaned-up.

For example, the Church and the NYSDEC agreed upon a performance objective for the in-situ thermal treatment remediation that would work in concert with the other cleanup objectives for Lot 29. The Church was then able to design the remediation, monitor its progress, determine how well the remediation was performing, and determine when the remediation was completed. The cost of the thermal treatment was, of course, sensitive to this performance objective. Similarly, a cost estimate of any remediation approach must list the major elements of the remediation at a minimum and identify the objectives of the remediation as a whole. This was not done by Davis; the remediation she contemplates was not identified and no objectives were discussed.

Because ***zero*** details of her cost estimate were provided, one cannot check the reasonableness and reliability of the estimate. There are no quantities of excavation or costs for transport and disposal of contaminated soil (which the data confirms exists), for example. The result is that the costs cannot be verified independently, which is contrary to the most basic requirements of the scientific and engineering methods: that an opinion, such as a cost estimate, be verified by independent analysis.

Davis provides no basis to support the cost estimates provided in her report, and no means to allow for independent verification. Therefore, these cost estimates are unreliable and entirely speculative.

9 CONCLUSIONS

I make the opinions contained in this report to a reasonable degree of scientific and engineering certainty. A summary of my opinions follows:

1. The contamination on Lot 29 did not migrate to Lots 24 and 14, with possible, minor exceptions. Instead, there are multiple, independent sources of contamination across all of the Lots, and groundwater does not flow from Lot 29 towards Lot 24 or Lot 14.

2. The remediation conducted by the Church was reasonable, appropriate, and in compliance with applicable NYSDEC environmental regulations and direction. Further, the Church advanced the remediation without undue delay and undertook the remediation within the context of a regulatory program that was appropriate and dictated by NYSDEC. Further, the remediation conducted by the Church on Lot 29 did not impact the conditions on Lots 24 or 14. Finally, NYSDEC approved the cleanup standards for Lot 29 as fully protective of the public health and environment.

3. Davis' remediation cost estimates for Lots 24 and 14 are without basis and are unreliable.

The opinions expressed herein are based on the documents I have reviewed to date. I reserve the right to supplement the analyses, conclusions, and opinions presented in my report if additional information and data are provided.

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Attachment A: Curriculum Vitae

John A. Rhodes, P.E.
Principal

PROFESSIONAL PROFILE

Mr. John Rhodes is a professional engineer with more than 30 years of experience in environmental engineering and science related to soil, soil vapor, air, surface water, and groundwater. Trained at the Massachusetts Institute of Technology, he has extensive experience with issue resolution, management of change in engineering and technical organizations, written and visual communications of technical issues, and engineering ethics. He is dedicated to helping clients understand technology and has given seminars on probabilistic cost estimating, fate and transport of contaminants, and other complex issues.

Mr. Rhodes has built a client-oriented practice upon a foundation of remediation engineering, hydrology, aquatic chemistry, and mathematical analysis. He is experienced in engineering economics, risk management, and decision analysis tools. Mr. Rhodes is an expert in technical and forensic investigations and has been qualified as an environmental engineer, including groundwater hydrologist, in four New Jersey State courts and three federal courts.

CREDENTIALS AND PROFESSIONAL HONORS

Degree of Civil Engineer, Massachusetts Institute of Technology, Water Resources and Environmental Engineering Division, Cambridge, Massachusetts, 1979

M.S., Environmental Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1979

B.A., Physics, Bowdoin College, Brunswick, Maine, 1972

Professional Engineer, New Jersey (License no. 33049), Pennsylvania (License no. 38300), New York (License no. 84423), and Connecticut (License no. 16795)

CONTINUING EDUCATION AND TRAINING

Training in management, communications, strategic planning and leadership

Technical training in civil and environmental engineering, hydrogeology and engineering ethics, in compliance with Continuing Professional Competency requirements for Professional Engineers in New York, Pennsylvania and New Jersey

Professional Affiliations

New Jersey Society of Professional Engineers, Past President and Current Board of Directors Member

National Society of Professional Engineers, Current Fellow

Relevant Experience

Design and Construction Oversight of Sub-slab Vapor Depressurization System and Vapor Barrier, KIPP School, Bronx, New York—Completed a mathematical-based design of a sub-slab depressurization system (SSDS), which was accepted by all parties, leading to construction drawings and specifications for the construction of a school on formerly contaminated property in urban New York. Project was a joint effort between the New York School Construction Authority and Robin Hood, a progressive private developer of schools in urban areas. The SSDS, which was constructed with extensive performance monitoring capabilities, is operating as planned and children are attending school.

Testing and Upgrade Design of a Retrofit Sub-slab Vapor Depressurization System beneath a Dry Cleaning Establishment at an Existing Indoor Mall, New York—An existing ineffective SSDS was tested and vapor movement modeled to establish a basis for an upgraded system. An upgraded system was designed to minimize disturbance to occupants and customers of the stores in the existing indoor mall. Design has been approved by the regulatory agencies and is currently under construction.

Oil Terminal Demolition, Remediation and Redevelopment, New York—Led all engineering and technical aspects of a project to clean up and redevelop and oil terminal on behalf of a private party, served as a member of the Triad team led by the New York State Department of Environmental Conservation (NYSDEC) that employed a new approach to investigating the site, and was a part of the development team striving to meld the objectives of cleanup and development. This high visibility project involved cleaning up oil contaminated with PCBs adequately to return the property to New York City tax rolls. The City of New York's Office of Environmental Quality was instrumental in the support of the project and included the project as a leading example of a practicable approach to reviving New York that was featured in the Mayor's Plan for the City in 2020. New York State assumed responsibility for remediation below ground, allowing a private party to purchase the property, demolish the hazardous structures above ground, and redevelop the property.

Former Manufactured Gas Plant Site on Hudson River, Tarrytown, New York—Acted as partner-in-charge of this project for which the client gained all necessary permits and a remediation plan for the waterfront redevelopment of multiple contaminated properties, creating a river walk, residential construction, and access to riverfront in a formerly industrial area. Statistical cost analysis contributed to acquisition of cost cap and liability insurance policies and allowed property and liability transfer from the responsible utility company. A cooperative arrangement was established between the responsible party of the manufactured gas plant (MGP) site, the developer, NYSDEC, remediation engineer, and remediation contractor, saving time and money. Innovative remediation was developed, including a dense nonaqueous-phase liquid (DNAPL) barrier with recovery trench/slurry wall design using biodegradable slurry, saving more than $1 million while meeting NYSDEC requirements. Approval of the remedial plan was obtained from NYSDEC within 6 months, with no negative public comments. Remediation has been completed and accepted by the regulatory agencies and development is under construction.

EnCap Remediation and Redevelopment of Four Landfills, Meadowlands, New Jersey—Provided sufficient understanding of the engineering and costs of the project so that the major financial guarantor for this $183 million project was able to guarantee the financing of the project. The landfills were constructed in the lowlands of the New Jersey Meadowlands, which offered unique challenges to remediation and the stabilization of the fill and underlying materials to allow for residential and commercial construction. Technologies reviewed and evaluated included dynamic compaction of refuse, importation and use of processed dredge material for barrier layers and common fill, importation and use of recycled materials for common fill including sewage sludge, and leachate and gas collection systems.

Construction Dispute Resolution, West End Avenue, New York—Led the technical team to investigate and resolve a construction dispute over the party responsible for the cost of remediation of contamination encountered during the construction of a high rise tower. Understanding of construction and environmental issues was critical to the distinction of real from inflated costs, and important to the attorney who won more than $3 million for the client.

Construction Dispute Resolution and Emergency Response Actions, Cresskill, New Jersey—Assisted the attorneys for the developer of a major, beneficial facility. The project had been halted by the discovery of contamination during the construction of the steel infrastructure and was being further delayed by a responsible party. Used knowledge of both construction and environmental issues to remove contamination from a structurally sensitive area, proposed alternative approaches to building that eliminated risk, and designed structures, including a vapor barrier that was approved by the New Jersey Department of Environmental Protection (NJDEP) as a resolution of vapor intrusion issues.

Environmental Liability Estimates for Security and Exchange Commission Compliance, New England—Estimated environmental liabilities for several sites for a major utility in New England. Used probabilistic procedures and quantitative interviews with company and outside engineers and counsel to develop a reasonable and defensible estimate. Defended estimates before independent auditors.

PCB Contamination at an Electrified Railroad Maintenance Facility, Philadelphia, Pennsylvania—Evaluated the environmental liability for several parties and imparted an understanding to allow the parties with the liability for cleanup to settle claims against and between them. The cost of remediation (claimed to be in excess of $40 million) was shown to be substantially less, leading to a reasonable settlement accepted by all parties.

Combe Fill South Hazardous Waste Landfill, Chester Township, New Jersey—Engineer responsible to more than 100 responsible parties to understand and specify the cost of remediation and allocation of responsibility between them and other responsible parties leading to a reasonable settlement accepted by all parties. In the process, additional contaminants were detected and successfully attributed to the responsible party such that they did not add to the burden already borne by clients.

Newport Development Project on Former Manufactured Gas Plant Site, Jersey City, New Jersey—Engineered the excavated soil management plans, regulatory compliance of coal tar and chromium investigations and remediation, and construction dewatering services on 280-acre former MGP site. Project included investigation and remediation of chromium-contaminated fill, which, from discovery to completion, was remediated and approved by NJDEP in 6 months. Researched and located all components and residuals of a former coal gasification plant, and managed associated contaminated soil and groundwater to allow construction of a major mall building in this development of condominiums, offices, and recreational facilities. A program for construction soil management was designed, approved, and implemented using above-ground treatment and careful testing to significantly reduce the volume of offsite soil disposal. Contaminated groundwater that was pumped for construction purposes was managed and treated with sufficient flexibility to allow construction in any portion of the site to go forward without delay.

Former Brass Foundry and CERCLA Site, Virginia—Engineer in responsible charge for a major CERCLA NPL-site, which was remediated for $15 million, well below the EPA projected cost of $30 million. Major component of remediation was the solidification and treatment of soil to allow less expensive onsite reuse and declassification of hazardous waste needing offsite disposal. Remediation included a community asset, which allowed for capping of contamination using a public facility. Additional contributions included a statistical analysis linking lead soil contamination to sources, and successful expert testimony in federal court regarding the divisibility of harm.

Groundwater Cleanup for Gasoline Retailer, New Jersey—Managed and supervised the remediation of groundwater contamination stemming from several gasoline service stations. Highlights include an innovative collection system using the porous backfill of an existing sewer line and inexpensive bioremediation using the injection of oxygen-release compounds. Testified in New Jersey Superior Court regarding the timing and source of contamination at one of the stations.

Iron Foundry Closure, Mahwah, New Jersey—Completed a successful Environmental Cleanup and Responsibility Act/Industrial Site Recovery Act (ECRA/ISRA) closure of a large iron foundry containing more than 330,000 tons of foundry sand used as landfill, allowing property transfer and redevelopment. Activities included lagoons and underground storage tank (UST) closures, decontamination of former foundry buildings, and vapor extraction soil treatment (the first in New Jersey). Engineering and institutional controls were pioneered, and the site now is a recognized brownfields development example. Follow-up work included assistance to the new owner who modified the engineering controls, following appropriate procedures without regulatory difficulty. Remediation costs were reduced from an estimate in the tens of millions of dollars to $2 million.

Redevelopment of a Treatment Plant, Lodi, New Jersey—Engineer in responsible charge of the investigation and cleanup of DNAPL and PCB contamination alongside the Saddle River. A dilapidated treatment plant was resurrected and made to operate efficiently. Innovative *in situ* remediation methods are being employed in preparation for the construction of a retail shopping mall on the property formerly occupied by several chemical operations.

Dispute Resolution for a Titanium Manufacturing Facility, Sayreville, New Jersey—Provided dispute resolution services, including expert testimony, to assist resolution of a disagreement between landlord and tenant over the source of soil and groundwater contamination. Several litigation support technologies were brought to bear, including database analysis of a large set of environmental data, electronic document analysis to search large volumes of documents, and aerial photographic analysis. A settlement acceptable to all parties was reached.

Howell Landfill, Howell Township, New Jersey—Designed and supervised construction of leachate recovery system. Through the use of groundwater barriers and computer-based controls, operating costs were minimized. Leachate from beneath an 80-acre waste disposal site entering a 40-ft thick aquifer was contained using a 5-horsepower pump discharging to a publicly owned treatment works.

Remedial Investigation and Case Closure at a Former Foundry Facility, Union, New Jersey—Petroleum hydrocarbons had impacted discrete sand stringers in a heterogeneous glacial till deposit to a depth of approximately 35 ft. In addition, upgradient sources of chlorinated solvents, unrelated to this facility's operations, were found in both the till deposit and underlying sand and bedrock formations greater than 60 ft below ground surface. A plan was negotiated with NJDEP to permit *in situ* natural degradation for the petroleum hydrocarbons and create an institutional control (Classified Exception Area [CEA] and Well Restriction Area) for the remaining chlorinated solvent contamination, which was shown to be from upgradient facilities. Closure of the regulatory agencies' case was achieved.

Fuel Oil Distribution Facility, Northern New Jersey—Managed the remediation of a major fuel oil distribution facility for former operator, including closure of USTs and several phases of soil and groundwater investigation. Investigated the extent and magnitude of gasoline and fuel oil-related contamination utilizing chemical fingerprinting techniques for hydrocarbons. Unique hydrogeological conditions were identified at the site preventing offsite migration of free product, allowing the remediation to be efficient and at a lower cost.

ECRA/ISRA Remediation, Atlantic City International Airport and Bader Field, New Jersey—Planned and implemented the ECRA/ISRA work focusing on jet fuel contamination at two former fuel farms. Performed remedial alternative analyses and negotiations with NJDEP and successfully changed the planned course of active pump and treat ($1,000,000) to $150,000 passive bioremediation enhancement and natural remediation monitoring program with a CEA.

Droyers Point Redevelopment Project, Jersey City, New Jersey—Directed the environmental portion of a major urban redevelopment project on a 40-acre site in which containment of chromium-contaminated fill was implemented. Designed and implemented engineering controls to stabilize and isolate the chromium-affected soil and groundwater from the remainder of the site, including construction of a capillary break using porous fill and geomembranes, soil and asphalt pavement covers, and construction of a slurry cutoff wall for groundwater. The residential development was constructed.

List of 2008-2012 Cases for Which Testimony Has Been Provided

Reichhold v. USMR— Civ. No. 03-453 (U.S.D.C., D.N.J.), February 2008.

Millano French Cleaners v. Firemans Fund—New Jersey Superior Court, December 2008.

New Jersey School Construction Corporation v. Power Test— New Jersey Superior Court, March 2009.

Merrimack v. Flamm v. Estate of Rosa Chase— New Jersey Superior Court, June 2009.

Mybar Realty v. Dallas Contracting— New Jersey Superior Court, October 2010.

Franklin Mutual Insurance Co. a/s/o Thomas & Patricia Coleman v. Wayne Knight v. Enviro Waste Solutions, Inc.— New Jersey Superior Court, January 2011.

New Jersey Manufacturers Insurance Company, as subrogee of Kathleen Kennedy v. Larrison Coal & Fuel Oil, Inc.— New Jersey Superior Court, March 2012.

State Farm Fire & Casualty Company and New Jersey Manufacturers Insurance Company (a/s/o Karen Santora Lowitz) v. Susan Ellman— New Jersey Superior Court, March 2012.

Taouch v. The Borough of Prospect Park New Jersey, et al.— New Jersey Superior Court, August 2012.

USAA v. Blue Ribbon Fuel Corp.–New Jersey Superior Court, September 2012.

Invited Presentations/Publications

Continuing Education Seminars for Insurance related to Contaminant Fate & Transport, Timing of the Release of Pollutants, Underground Storage Tanks

Continuing Education Seminars for Attorneys related to Environmental Chemistry and Monte Carlo Simulations for Security and Exchange Commission Reporting of Environmental Liabilities

Continuing Education Seminars for Professional Engineers related to Graphical Communications and In-Situ Remediation Technologies

Papers Related to the Measurement of Hydraulic Conductivity, Hydrodynamic Dispersion, In-Situ Flushing of Oil Contamination, and Hazardous Waste Disposal Facility Siting, (none in the last 10 years)

Seminars on Technical Writing

ATTACHMENT B: DOCUMENTS REVIEWED

Document Productions:

Beginning Production Number	Ending Production Number
ALPROF0058	ALPROF0059
ALPROF0066	ALPROF0066
ALPROF0067	ALPROF0068
ALPROF0093	ALPROF0095
ALPROF0552	ALPROF0557
ALPROF0558	ALPROF0571
ALPROF0572	ALPROF0588
ALPROF0589	ALPROF0603
ALPROF0682	ALPROF0691
ALPROF0692	ALPROF0716
ALPROF0743	ALPROF0755
ALPROF0778	ALPROF0783
ALPROF1136	ALPROF1141
ALPROF1142	ALPROF1300
ALPROF1477	ALPROF1478
ALPROF2843	ALPROF2846
ALPROF3136	ALPROF3142
ALPROF4349	ALPROF4351
ALPROF4352	ALPROF4354
ALPROF4392	ALPROF4821
ALPROF12689	ALPROF12690
ALPROF12691	ALPROF12710
ALPROF13370	ALPROF13375
ANSON 00000001	ANSON 00000061
CANONICO 00000009	CANONICO 00000010
CANONICO 00000020	CANONICO 00000031
GALLO00000112	GALLO00000115
GALLO00000116	GALLO00000119
GALLO00000137	GALLO00000140
LDS00000038	LDS00000103
LDS00000138	LDS00000254
LDS00000303	LDS00000307
LDS00000314	LDS00000371
LDS00000411	LDS00000413
LDS00000581	LDS00000633
LDS00000664	LDS00000677
LDS00000687	LDS00000684
LDS00000689	LDS00000770
LDS00000775	LDS00000780
LDS00001217	LDS00001244
LDS00002036	LDS00002036
LDS00002134	LDS00002158

ATTACHMENT B: DOCUMENTS REVIEWED (continued)

Beginning Production Number	Ending Production Number
LDS00002161	LDS00002165
LDS00002178	LDS00002178
LDS00002179	LDS00002179
LDS00002327	LDS00002328
LDS00002399	LDS00002478
LDS00002524	LDS00002526
LDS00002884	LDS00002959
LDS00003025	LDS00003052
LDS00003069	LDS00003072
LDS00003151	LDS00003154
LDS00003207	LDS00003209
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LDS00003430	LDS00003432
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LDS00005114	LDS00005333
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LDS00006904	LDS00006905
LDS00008017	LDS00008087
LDS00008404	LDS00008469
LDS00009437	LDS00009439
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LDS00010470	LDS00010496
LDS00010971	LDS00010972
LDS00011025	LDS00011043
LDS00011279	LDS00011283

ATTACHMENT B: DOCUMENTS REVIEWED (continued)

Beginning Production Number	Ending Production Number
LDS00011428	LDS00011461
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LDS00011620	LDS00011623
LDS00012218	LDS00012219
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LDS00021791	LDS00021847
LDS00023621	LDS00023647
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LDS00024221	LDS00024230
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LDS00025482	LDS00025482
LDS00025531	LDS00025550
LDS00025551	LDS00025562
LDS00026806	LDS00026807
LDS00030787	LDS00030787
LDS00030788	LDS00030788
LDS00030789	LDS00030789
LDS00032786	LDS00032800
LDS00032893	LDS00032902
LDS00033180	LDS00033188
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LDS00033608	LDS00033608
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LDS00033723	LDS00033746
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LDS00039482	LDS00039812
LDS00043110	LDS00043110
LDS00048575	LDS00048578
LDS00049398	LDS00049467
LDS00050821	LDS00051355
LDS00051356	LDS00051850
LDS00051851	LDS00052258
LDS00052259	LDS00052388
LDS00052389	LDS00052886

ATTACHMENT B: DOCUMENTS REVIEWED (continued)

Beginning Production Number	Ending Production Number
LDS00052887	LDS00053165
LDS00053166	LDS00053722
LDS00053723	LDS00053773
LDS00053774	LDS00053794
LDS00053795	LDS00053882
LDS00053883	LDS00054062
LDS00054065	LDS00054403
LDS00054407	LDS00055131
LDS00055136	LDS00055571
LDS00055575	LDS00056209
LDS00056213	LDS00056679
LDS00056684	LDS00057118
LDS00057177	LDS00057177
LDS00065597	LDS00065597
LDS00066766	LDS00066767
LDS00071254	LDS00071255
LDS00076106	LDS00076106
LDS00081449	LDS00081449
LDS00082224	LDS00082224
LDS00083907	LDS00083942
LDS00084059	LDS00084674
LDS00084675	LDS00084924
LDS00084925	LDS00085369
LDS00085370	LDS00085824
LDS00085825	LDS00085988
LDS00085989	LDS00086080
LDS00086081	LDS00086124
LDS00086125	LDS00086575
LDS00086576	LDS00086995
LDS00086576	LDS00086995
LDS00088026	LDS00088267
LDS00088268	LDS00088532
LDS00088533	LDS00088594
LDS00100406	LDS00100597
LDS00100523	LDS00100580
LDS00100626	LDS00101128
LDS00101129	LDS00101405
LDS00101406	LDS00101597
LDS00101598	LDS00101901
LDS00101902	LDS00101905
LDS00101906	LDS00102204
LDS00102205	LDS00102207
LDS00102208	LDS00102208
LDS00102209	LDS00102246

ATTACHMENT B: DOCUMENTS REVIEWED (continued)

Beginning Production Number	Ending Production Number
NYSDEC 00001875	NYSDEC 00001877
NYSDEC 00002121	NYSDEC 00002124
NYSDEC 00002125	NYSDEC 00002128
NYSDEC 00002142	NYSDEC 00002143
NYSDEC 00002287	NYSDEC 00002288
NYSDEC 00002289	NYSDEC 00002294
NYSDEC 00005386	NYSDEC 00005386
NYSDEC 00005387	NYSDEC 00005388
NYSDEC 00005396	NYSDEC 00005397
PE-1549	PE-1554
PE-1570	PE-1571
PE-1584	PE-1584
PE-1847	PE-1849
PE-1850	PE-1850
PE-1851	PE-1851
PE-1852	PE-1852
PE-1853	PE-1853
PE-1854	PE-1854
PE-1855	PE-1855
STEWART00000021	STEWART00000037
STEWART00000282	STEWART00000288
STEWART00000304	STEWART00000308
STEWART00000309	STEWART00000313
STEWART00000314	STEWART00000314

Publications:

Filling Norton's Creek: Waterway is to be Abolished to Save the Edgemere Hotel, N.Y. Times, May 7, 1906.
Sewerage Plans Rejected: The Protest of Far Rockaway Property Owners Heeded, N.Y. Times, May 28, 1891.
Long Island Water Routes - The Scheme to Improve Them on the South Side: Some Facts and Suggestions Concerning the Proposed Canal to Connect Jamaica Bay With the Great South Bay, N.Y. Times, October 6, 1891.
Vincent Seyfried and William Asadorian, *Old Rockaway, New York, in Early Photographs*
USGS Quad - Brooklyn 1891
USGS Quad - Brooklyn 1898
Sanborn Fire Insurance Map - 1901
Sanborn Fire Insurance Map - 1912
Sanborn Fire Insurance Map - 1933
Sanborn Fire Insurance Map - 1951
Sanborn Fire Insurance Map - 1983
Sanborn Fire Insurance Map - 2005
Sanitary Sewer map, obtained November 15, 2012
Storm Sewer map, obtained November 15, 2012
Aerial Photograph - 1924
Aerial Photograph - 1954
Aerial Photograph - 1957
Aerial Photograph - 1966

Written Discovery:

Plaintiffs' Responses to First Interrogatories and Request for Production of Documents to Plaintiffs, August 4, 2011.

Expert Report(s):

Plaintiffs' Expert Report of Stephanie O. Davis of FPM Group, Ltd., October 10, 2012.

Deposition Transcripts and Exhibits:

Deposition Transcript of Fritzi Mazzola Gros-Daillon, November 8, 2011.
Deposition Transcript of Christopher Magee, November 17, 2011.
Deposition Transcript of Nicholas Canonico - Day 1, November 21, 2011.
Deposition Transcript of Nicholas Canonico - Day 2, December 14, 2011.
Deposition Transcript of John Tegins, December 15, 2011.
Deposition Transcript of Howard Nichols, January 12, 2012 and Errata Sheet.
Deposition Transcript of Paul Stewart, March 8, 2012.
Deposition Transcript of Allan Profeta - Day 1, March 19, 2012.
Deposition Transcript of Jose Hernandez, April 27, 2012.
Deposition Transcript of Allan Profeta - Day 2, June 7, 2012 and Errata Sheet.

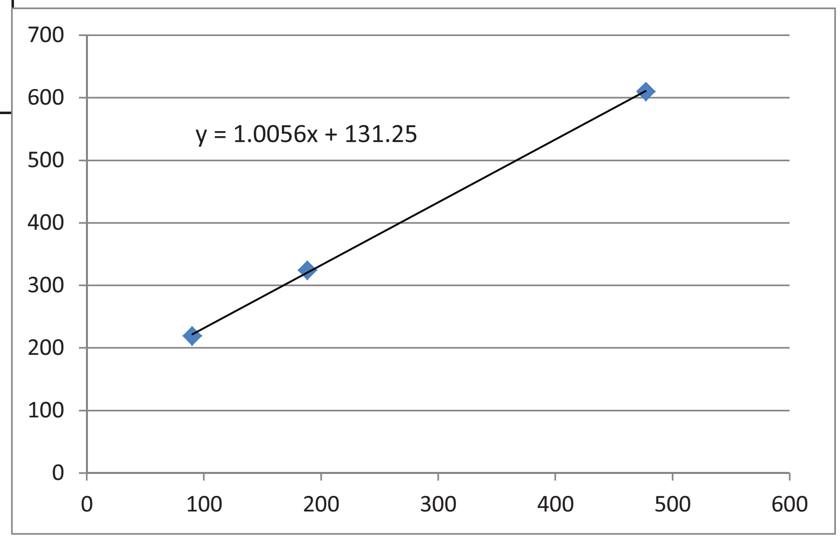
Attachment C: Calculation of Hydraulic Conductivity from Tidal fluctuations

Method	Equation
Time Lag	$T = (t_0 * S/4\pi) * (x/t_L)^2$
$h_0 - h_x$	$T = \frac{\pi \cdot S}{t_0 \cdot [Ln(h_x/h_0)/-x]^2}$
	K=T/b

Groundwter Hydrology
David Keith Todd
1976
Page: 244

MW-1i				
Solar Tide Fluctuation			0.09	ft
Time High to Low			6.32	hrs
High Tide	8/13/2008	8:40:00 PM		
Low Tide (Solar)	8/14/2008	2:59:00 AM		
PZ-3				
Solar Tide Fluctuation			0.28	ft
Time High to Low			6.70	hrs
High Tide	8/13/2008	8:26:00 PM		
Low Tide (Solar)	8/14/2008	3:08:00 AM		

Distance (ft)	To Draw Bridge	Box Culvert	Bay
MW-1i	90	188	477
PZ-3	219	324	610
Relative Distance	2.43	1.72	1.28



Distance to Discharge Point $PZ - 3 = 1.0 \cdot MW1i + 131$

	Parameter	Units
h_x	Change at well	ft, m
	Tidal cycle amplitude	ft, m
h_o	Half of tidal cycle	ft, m
x	Distance shore to well	ft, m
S	Specific Yield	Unconfined Aquifer
S	Storativity	Confined
t_o	Tidal cycle time	days
b	Aquifer Thickness	ft, m
t_L	Time lag	days

	Parameter		Units	h_0 - h_x				
				MW-1i	**MW-1i**	**PZ-3**	**PZ-3**	
h_x	Change at well		ft	0.09	0.09	0.28	0.28	
h_x	Change at well		m	0.027	0.03	0.085	0.09	
	Tidal cycle	13.4608262	ft	13	13	13	13	
h_o	Half of tidal cycle		m	2.051	2.05	2.051	2.05	
x	**Distance**		**ft**	**466**	**466**	**600**	**600**	
x	Distance		m	142	142	183	183	
S	From TRC Pump Tests	Unconfined (Low & High)		0.050	0.087	0.0030	0.0044	Confined
t_o	Tidal cycle time		days	0.5	0.50	0.5	0.50	
b	Aquifer depth		ft	26	26.00	12	12.0	
b	Aquifer depth		m	8	7.92	4	3.66	
t_L	Time lag		days					
LN(hx/ho)				-4.314582132	-4.314582132	-3.179602199	-3.1796022	
[(LN(hx/ho))/-x]^2				0.000922183	0.000922183	0.000302283	0.00030228	
π*S				0.15543	0.272238	0.009263	0.013659	
T	Transmisivity		m^2/day	337.1	590.4	61.3	90.4	
T	**Transmisivity**		**ft^2/day**	**3,628.4**	**6,355.2**	**659.7**	**972.8**	
K	Hydraulic Conductivity	18	m/day	42.5	74.5	16.8	24.7	
		450	gal/day/ft^2	1,044	1,828	411	606	
Factor higher than 450				2.32	4.06	0.91	1.35	
		0.00021	m/sec	4.92E-04	8.62E-04	1.94E-04	2.86E-04	
			cm/sec	4.92E-02	8.62E-02	1.94E-02	2.86E-02	
K	**Hydraulic Conductivity**		**ft/day**	**139.6**	**244.4**	**55.0**	**81.1**	
								Total
R^2	**Squared Residual Pump Test - Tidal Calulation**			5424.0	31871.3	1545.1		**197.1**

Calculation Results from TRC Pump Tests

				Unconfined	Confined		
From TRC Pump Test		Pumped Well		**MW-4s**	**MW-4i**		
		Observation Wells		**PZ-1, PZ-2**	**PZ-3**	**Theissian**	
				Semi-Log (Average)	**Semi-Log**	**Model**	
	Transmisivity		**ft^2/day**	**376**	**188**	**72**	
	Aquifer depth		ft	5.7	20	20	
	Hydraulic Conductivity		**ft/day**	**66**	**9.4**	**3.6**	
	Storativity	Unconfined		0.0675	0.0030	0.0044	Confined
Modifying using Aquifer Thickness					12	12	
	Hydraulic Conductivity		**ft/day**	**66**	**15.67**	**5.98**	

Calculation Results

Symbol	Tidal Study Results	Unit	MW-1i	MW-1i	PZ-3	PZ-3	
b	Aquifer Thickness	ft	26	26	12	12	
x	**Distance**	ft	**188**	**188**	**320**	**320**	**To Box Culvert**
T	**Transmisivity**	ft^2/day	**4,888**	**4,888**	**3,844**	**3,844**	**188 ft^2/day**
K	**Hydraulic Conductivity**	ft/day	**34.4**	**60.2**	**33.8**	**49.8**	**(188)ft)**
	Tidal Study Results	**Unit**	**MW-1i**	**MW-1i**	**PZ-3**	**PZ-3**	
x	Distance	ft	466	466	600	600	
h_o	Half Tidal Fluctuation	ft	13	13	13	13	
T	Transmisivity	ft^2/day	3628	6355	660	973	
K	Hydraulic Conductivity	ft/day	139.6	244.4	55.0	81.1	
	TRC Pump Tests						
	Transmisivity	ft^2/day	376		188	72	
	Hydraulic Conductivity	ft/day	13		0.00	0.00	
	Tidal Study Results	**Unit**	**MW-1i**	**MW-1i**	**PZ-3**	**PZ-3**	
x	Distance	ft	466	466	600	600	To Match Semi-Log Pump
b	Aquifer Thickness	ft	26	26	12	12	Test Result for PZ-3
T	Transmisivity	ft^2/day	1106	1937	201	296	188 ft^2/day
K	Hydraulic Conductivity	ft/day	42.5	74.5	16.8	24.7	18.8 ft/day
	TRC Pump Tests		**MW-4s**	**MW-4s**	**MW-4i**	**MW-4i**	
	Transmisivity	ft^2/day	375.7		188	72	
	Hydraulic Conductivity	ft/day	65.9		9.4	3.6	