

A CASE FOR IN-SITU REMEDIAL SYSTEMS



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Senior Engineer / Partner | October 14-16, 2015

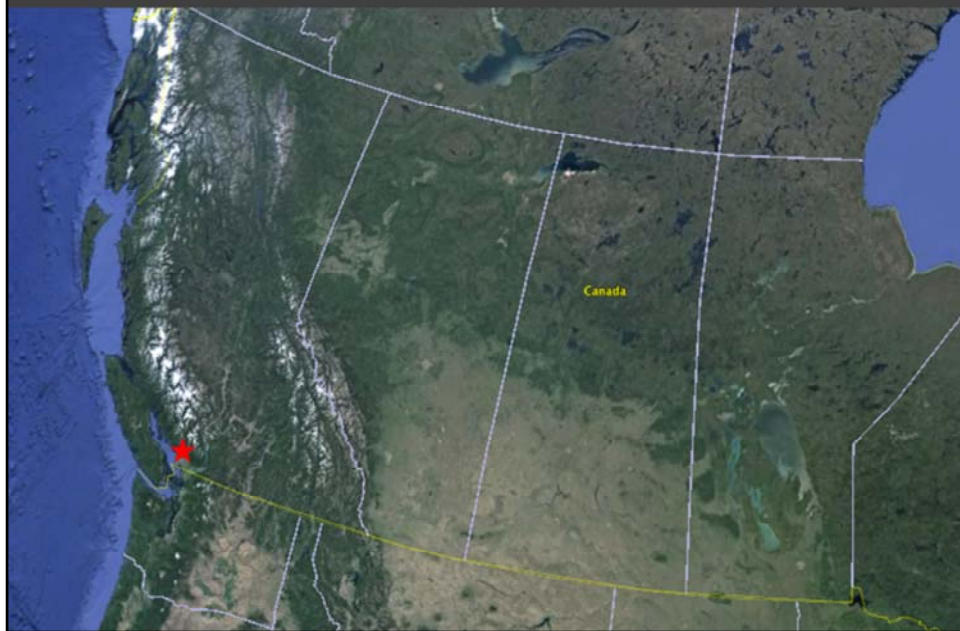
Outline

- Location
- Site History
- Investigation/Remediation History
- Regulatory History
- Source Removal Programs
- Natural Attenuation
- Closure Investigation
- Challenges
- Summary

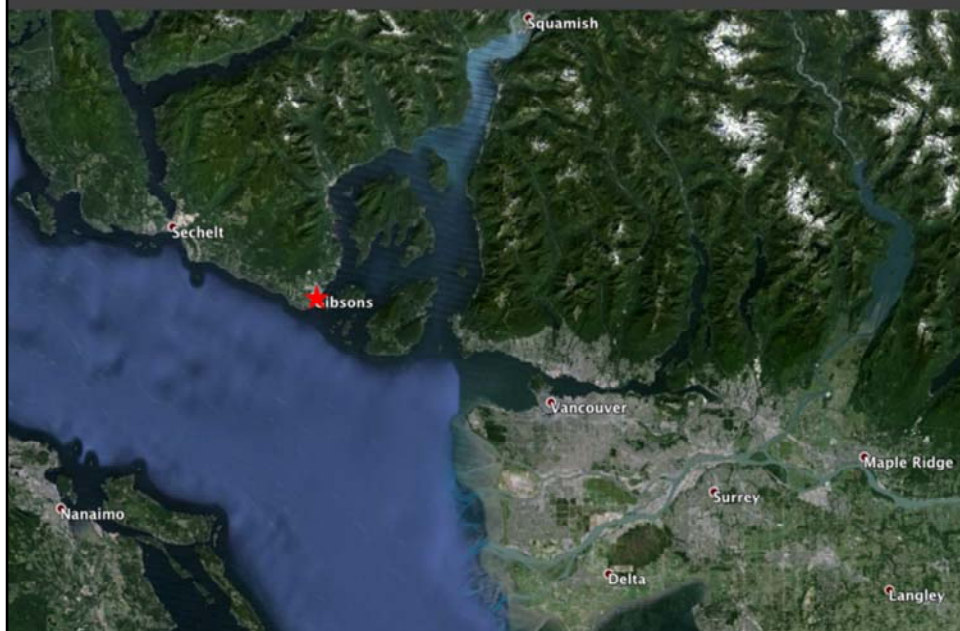
Before I get started, Core6 was retained to close this property and obtain a CoC and I'm going to walk you through what we did for closure and the key observation we saw as we closed the sit. E

Working for UCANCO who did a liability transfer from a petroleum company (presentation yesterday) and are looking to sell the site for development

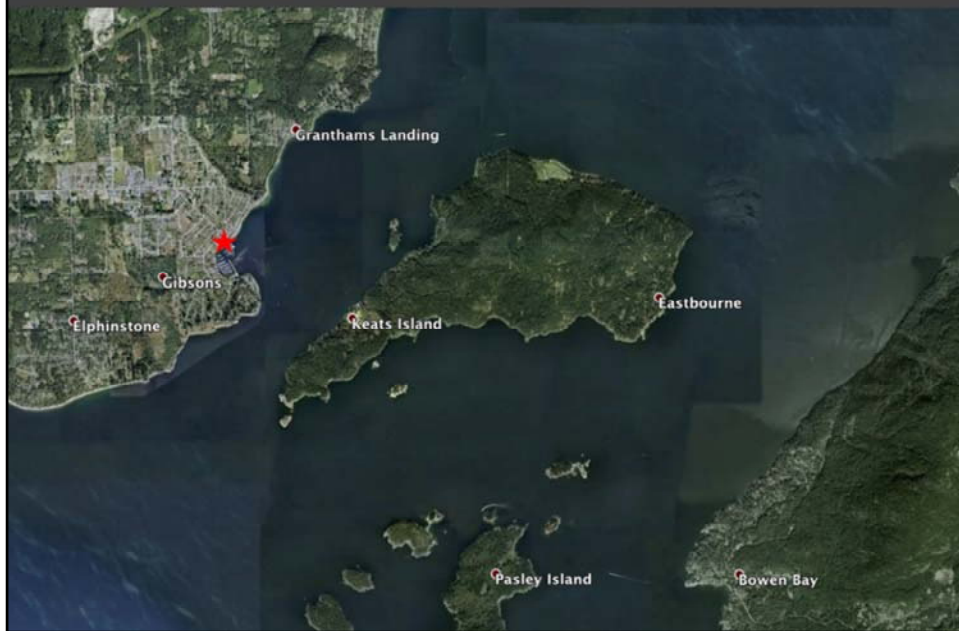
Location



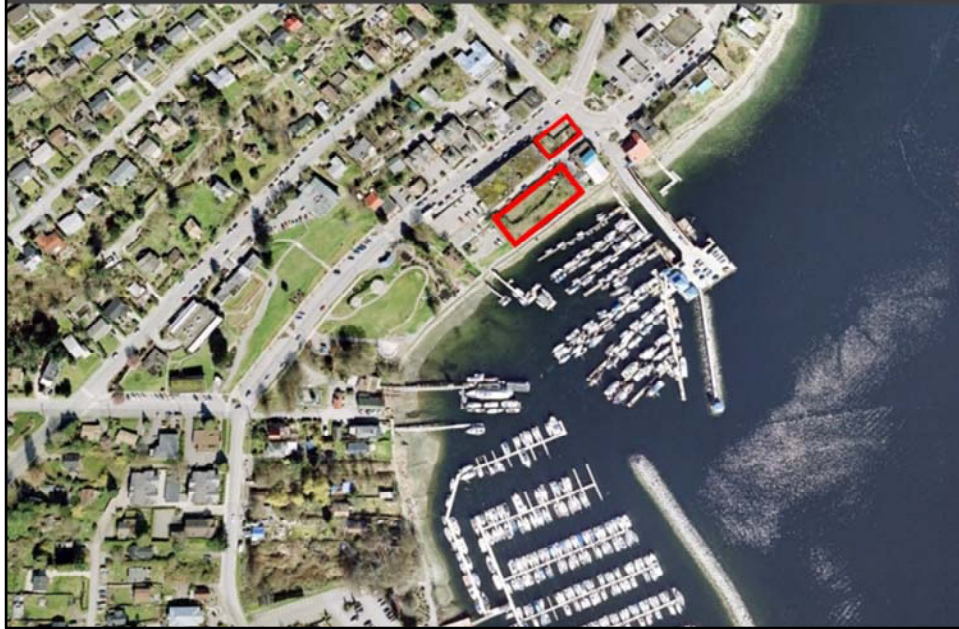
Location



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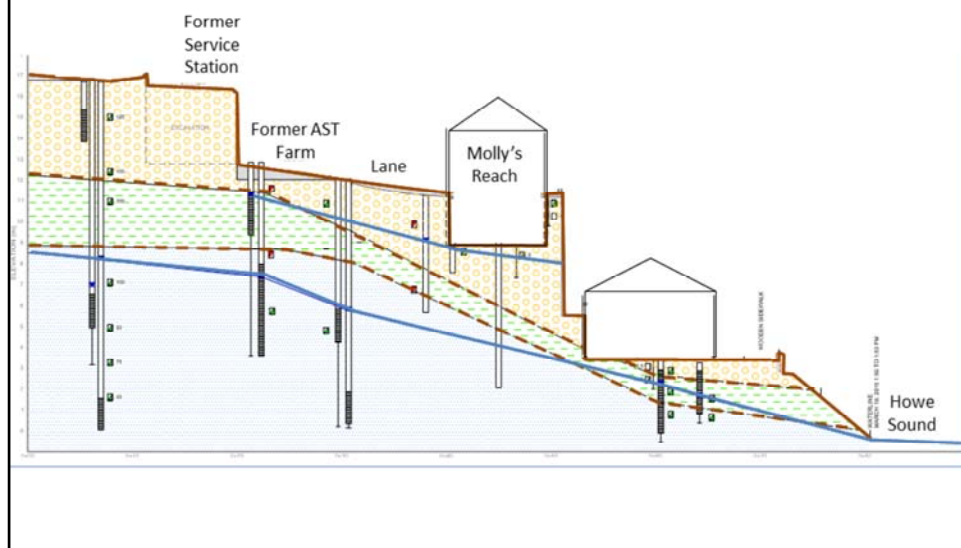


Site Setting



We had no idea this was a terraced site or a steep slope???

Surface Elevation

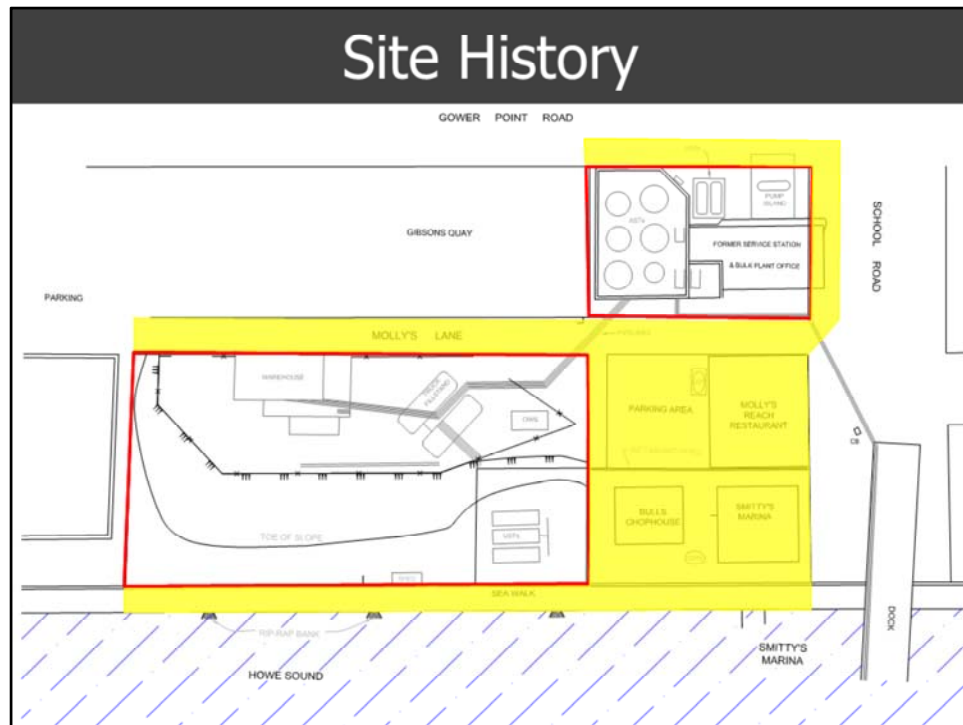


There is a 15 metre elevation change. Retaining walls limiting contaminant migration, and specifically aided in preventing contamination reaching the Ocean

Site History



- 1936 Service station opened
- 1946 AST farm developed
- 1964 Distribution warehouse and truck fill stands developed
- 1994 UST removal
- 1997 Site infrastructure decommissioned



Mention off site impacted properties, multiple stakeholders
Fuel pumped from the wharf to AST farm for distribution throughout Sunshine Coast

Investigation/Remediation History

- 1988 - 1990 Cut-off recovery trench installed
- 1990 Site Investigations commenced
- 1998 Remedial excavations
- 1998 - 2000 Biocell on Site
- **1998 - 2002 Dual Phase Extraction System**
- 2003 – present Ongoing Monitoring
- 2002 Foreshore investigation
- 2008 HHRA completed for adjacent properties
- **2014 UCANCO General Partners Inc. purchase property**
- Sep 2014 Core6 Environmental engaged
- Sep 2014 - May 2015 Closure Data Gap Investigation
- Mar 2015 - Jul 2015 Risk Assessment & Closure Reporting
- 2015 Remedial system decommissioned

Remediation System was shut down in 2002 as the previous consultant determined that the system had done it's job, however, concentrations were still above generic standards, but it was left in place as a contingency if rebound was significant.

Key points noted investigation occurred frequently in the early years.

Look at the timeline and think about the project as whole, it took thirty plus years to complete the investigation and get to closure. Data was collected throughout this work and was needed to assess adequacy of closure.

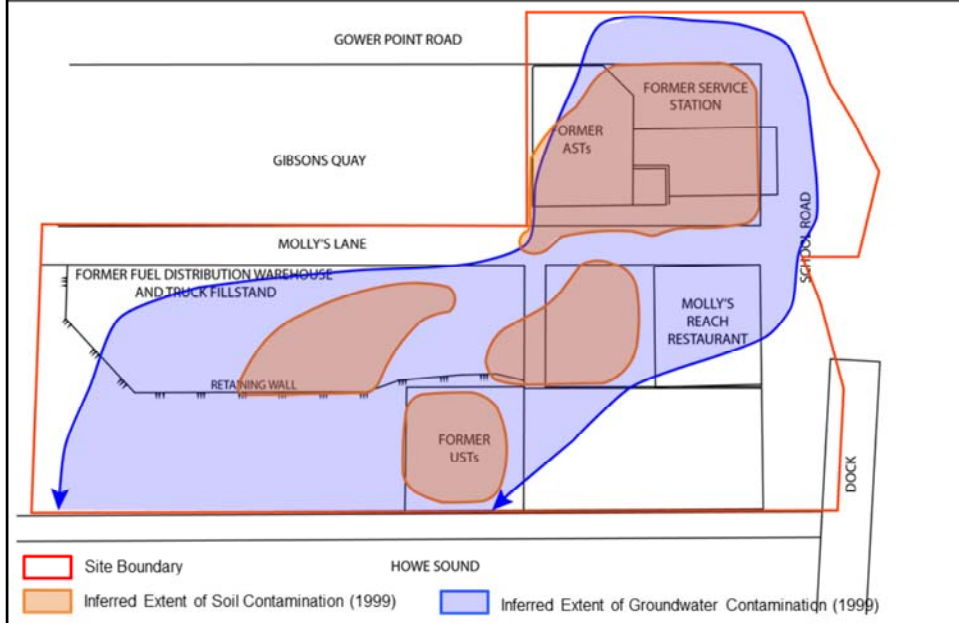
Up to 2008 key investigation comparison standards were protection of AW for GW, soil standards that would be protective of groundwater flowing to AW

In 2010 as you will see in next slide BC

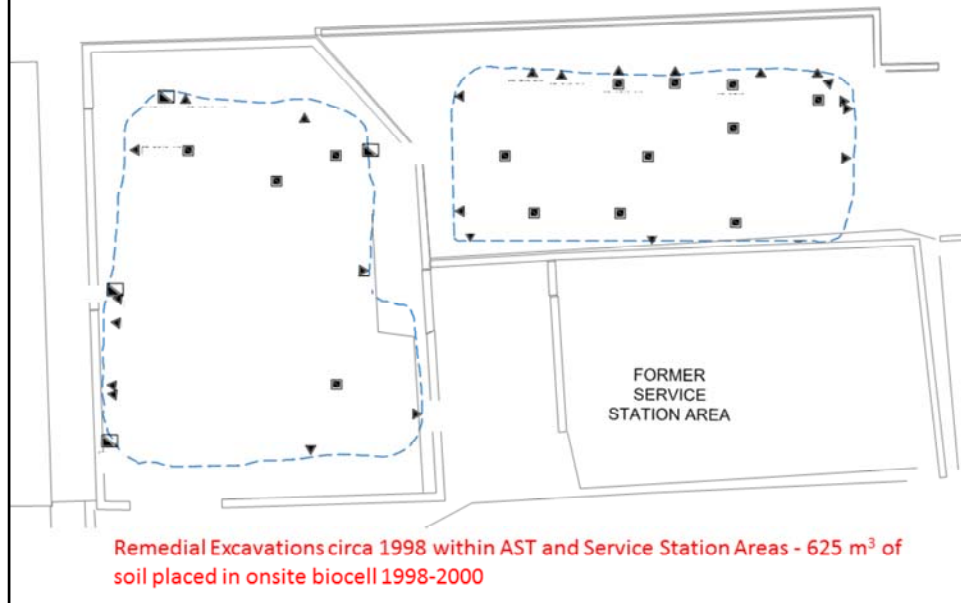
Regulatory History

- 1977 – 87 Spillages reported
- Early 1990s BCMOE involved with the site
- 1997 BCMOE request further information
- 1997 Permits obtained for remedial system
- 2005 – 08 AIP applications prepared/submitted
- 2008 AIP granted
- 2010 BCMOE indicate monitoring can be discontinued
- 2010 Soil vapour investigation & standards
- 2011 Drinking water standards apply
- June 2015 Submittal for 6 CoCs

Soil & GW Impacts Pre Remediation



Excavation



Look at the confirmatory soil samples 50 plus – these were used in site closure even though collected almost 20 years ago! Re compared to applicable standards.

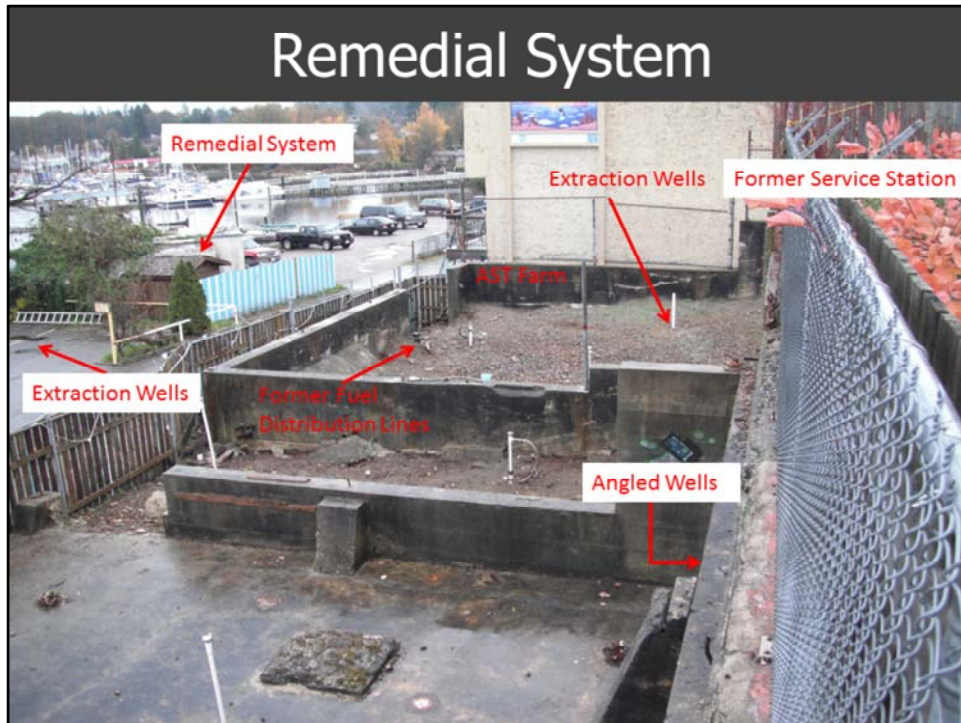
Remedial System

The site map illustrates the Remedial System layout. Key features include:

- GIBSONS QUAY** and **MOLLY'S LANE** (top left).
- ELECTRICAL SHED** (center left).
- VAPOUR PHASE CARBON ENCLOSURE** and **WATER PHASE CARBON ENCLOSURE** (bottom left).
- CATALYTIC CONVERTER AND VAPOUR DISCHARGE** (bottom left).
- LRB ENCLOSURE** (bottom center).
- MOLLY'S REACH RESTAURANT** (bottom right).

The map shows numerous wells labeled with codes such as 98ASTI-1*, 98ASTI-2*, 98ASTV-1, 98ASTV-2, 98ASTV-3, 98ASTV-4, 98ASTV-5, 98ASTV-6, 98ASTV-7, 98ASTV-8, 98ASTV-9, 98ASTV-10, 98ASTV-11, 98ASTV-12, 98ASTV-13, 98ASTV-14, 98ASTV-15, 98ASTV-16, 98ASTV-17, 98ASTV-18, 98ASTV-19, 98ASTV-20, 98ASTV-21, 98ASTV-22, 98ASTV-23, 98ASTV-24, 98ASTV-25, 98ASTV-26, 98ASTV-27, 98ASTV-28, 98ASTV-29, 98ASTV-30, 98ASTV-31, 98ASTV-32, 98ASTV-33, 98ASTV-34, 98ASTV-35, 98ASTV-36, 98ASTV-37, 98ASTV-38, 98ASTV-39, 98ASTV-40, 98ASTV-41, 98ASTV-42, 98ASTV-43, 98ASTV-44, 98ASTV-45, 98ASTV-46, 98ASTV-47, 98ASTV-48, 98ASTV-49, 98ASTV-50, 98ASTV-51, 98ASTV-52, 98ASTV-53, 98ASTV-54, 98ASTV-55, 98ASTV-56, 98ASTV-57, 98ASTV-58, 98ASTV-59, 98ASTV-60, 98ASTV-61, 98ASTV-62, 98ASTV-63, 98ASTV-64, 98ASTV-65, 98ASTV-66, 98ASTV-67, 98ASTV-68, 98ASTV-69, 98ASTV-70, 98ASTV-71, 98ASTV-72, 98ASTV-73, 98ASTV-74, 98ASTV-75, 98ASTV-76, 98ASTV-77, 98ASTV-78, 98ASTV-79, 98ASTV-80, 98ASTV-81, 98ASTV-82, 98ASTV-83, 98ASTV-84, 98ASTV-85, 98ASTV-86, 98ASTV-87, 98ASTV-88, 98ASTV-89, 98ASTV-90, 98ASTV-91, 98ASTV-92, 98ASTV-93, 98ASTV-94, 98ASTV-95, 98ASTV-96, 98ASTV-97, 98ASTV-98, 98ASTV-99, 98ASTV-100, 98ASTV-101, 98ASTV-102, 98ASTV-103, 98ASTV-104, 98ASTV-105, 98ASTV-106, 98ASTV-107, 98ASTV-108, 98ASTV-109, 98ASTV-110, 98ASTV-111, 98ASTV-112, 98ASTV-113, 98ASTV-114, 98ASTV-115, 98ASTV-116, 98ASTV-117, 98ASTV-118, 98ASTV-119, 98ASTV-120, 98ASTV-121, 98ASTV-122, 98ASTV-123, 98ASTV-124, 98ASTV-125, 98ASTV-126, 98ASTV-127, 98ASTV-128, 98ASTV-129, 98ASTV-130, 98ASTV-131, 98ASTV-132, 98ASTV-133, 98ASTV-134, 98ASTV-135, 98ASTV-136, 98ASTV-137, 98ASTV-138, 98ASTV-139, 98ASTV-140, 98ASTV-141, 98ASTV-142, 98ASTV-143, 98ASTV-144, 98ASTV-145, 98ASTV-146, 98ASTV-147, 98ASTV-148, 98ASTV-149, 98ASTV-150, 98ASTV-151, 98ASTV-152, 98ASTV-153, 98ASTV-154, 98ASTV-155, 98ASTV-156, 98ASTV-157, 98ASTV-158, 98ASTV-159, 98ASTV-160, 98ASTV-161, 98ASTV-162, 98ASTV-163, 98ASTV-164, 98ASTV-165, 98ASTV-166, 98ASTV-167, 98ASTV-168, 98ASTV-169, 98ASTV-170, 98ASTV-171, 98ASTV-172, 98ASTV-173, 98ASTV-174, 98ASTV-175, 98ASTV-176, 98ASTV-177, 98ASTV-178, 98ASTV-179, 98ASTV-180, 98ASTV-181, 98ASTV-182, 98ASTV-183, 98ASTV-184, 98ASTV-185, 98ASTV-186, 98ASTV-187, 98ASTV-188, 98ASTV-189, 98ASTV-190, 98ASTV-191, 98ASTV-192, 98ASTV-193, 98ASTV-194, 98ASTV-195, 98ASTV-196, 98ASTV-197, 98ASTV-198, 98ASTV-199, 98ASTV-200, 98ASTV-201, 98ASTV-202, 98ASTV-203, 98ASTV-204, 98ASTV-205, 98ASTV-206, 98ASTV-207, 98ASTV-208, 98ASTV-209, 98ASTV-210, 98ASTV-211, 98ASTV-212, 98ASTV-213, 98ASTV-214, 98ASTV-215, 98ASTV-216, 98ASTV-217, 98ASTV-218, 98ASTV-219, 98ASTV-220, 98ASTV-221, 98ASTV-222, 98ASTV-223, 98ASTV-224, 98ASTV-225, 98ASTV-226, 98ASTV-227, 98ASTV-228, 98ASTV-229, 98ASTV-230, 98ASTV-231, 98ASTV-232, 98ASTV-233, 98ASTV-234, 98ASTV-235, 98ASTV-236, 98ASTV-237, 98ASTV-238, 98ASTV-239, 98ASTV-240, 98ASTV-241, 98ASTV-242, 98ASTV-243, 98ASTV-244, 98ASTV-245, 98ASTV-246, 98ASTV-247, 98ASTV-248, 98ASTV-249, 98ASTV-250, 98ASTV-251, 98ASTV-252, 98ASTV-253, 98ASTV-254, 98ASTV-255, 98ASTV-256, 98ASTV-257, 98ASTV-258, 98ASTV-259, 98ASTV-260, 98ASTV-261, 98ASTV-262, 98ASTV-263, 98ASTV-264, 98ASTV-265, 98ASTV-266, 98ASTV-267, 98ASTV-268, 98ASTV-269, 98ASTV-270, 98ASTV-271, 98ASTV-272, 98ASTV-273, 98ASTV-274, 98ASTV-275, 98ASTV-276, 98ASTV-277, 98ASTV-278, 98ASTV-279, 98ASTV-280, 98ASTV-281, 98ASTV-282, 98ASTV-283, 98ASTV-284, 98ASTV-285, 98ASTV-286, 98ASTV-287, 98ASTV-288, 98ASTV-289, 98ASTV-290, 98ASTV-291, 98ASTV-292, 98ASTV-293, 98ASTV-294, 98ASTV-295, 98ASTV-296, 98ASTV-297, 98ASTV-298, 98ASTV-299, 98ASTV-300, 98ASTV-301, 98ASTV-302, 98ASTV-303, 98ASTV-304, 98ASTV-305, 98ASTV-306, 98ASTV-307, 98ASTV-308, 98ASTV-309, 98ASTV-310, 98ASTV-311, 98ASTV-312, 98ASTV-313, 98ASTV-314, 98ASTV-315, 98ASTV-316, 98ASTV-317, 98ASTV-318, 98ASTV-319, 98ASTV-320, 98ASTV-321, 98ASTV-322, 98ASTV-323, 98ASTV-324, 98ASTV-325, 98ASTV-326, 98ASTV-327, 98ASTV-328, 98ASTV-329, 98ASTV-330, 98ASTV-331, 98ASTV-332, 98ASTV-333, 98ASTV-334, 98ASTV-335, 98ASTV-336, 98ASTV-337, 98ASTV-338, 98ASTV-339, 98ASTV-340, 98ASTV-341, 98ASTV-342, 98ASTV-343, 98ASTV-344, 98ASTV-345, 98ASTV-346, 98ASTV-347, 98ASTV-348, 98ASTV-349, 98ASTV-350, 98ASTV-351, 98ASTV-352, 98ASTV-353, 98ASTV-354, 98ASTV-355, 98ASTV-356, 98ASTV-357, 98ASTV-358, 98ASTV-359, 98ASTV-360, 98ASTV-361, 98ASTV-362, 98ASTV-363, 98ASTV-364, 98ASTV-365, 98ASTV-366, 98ASTV-367, 98ASTV-368, 98ASTV-369, 98ASTV-370, 98ASTV-371, 98ASTV-372, 98ASTV-373, 98ASTV-374, 98ASTV-375, 98ASTV-376, 98ASTV-377, 98ASTV-378, 98ASTV-379, 98ASTV-380, 98ASTV-381, 98ASTV-382, 98ASTV-383, 98ASTV-384, 98ASTV-385, 98ASTV-386, 98ASTV-387, 98ASTV-388, 98ASTV-389, 98ASTV-390, 98ASTV-391, 98ASTV-392, 98ASTV-393, 98ASTV-394, 98ASTV-395, 98ASTV-396, 98ASTV-397,

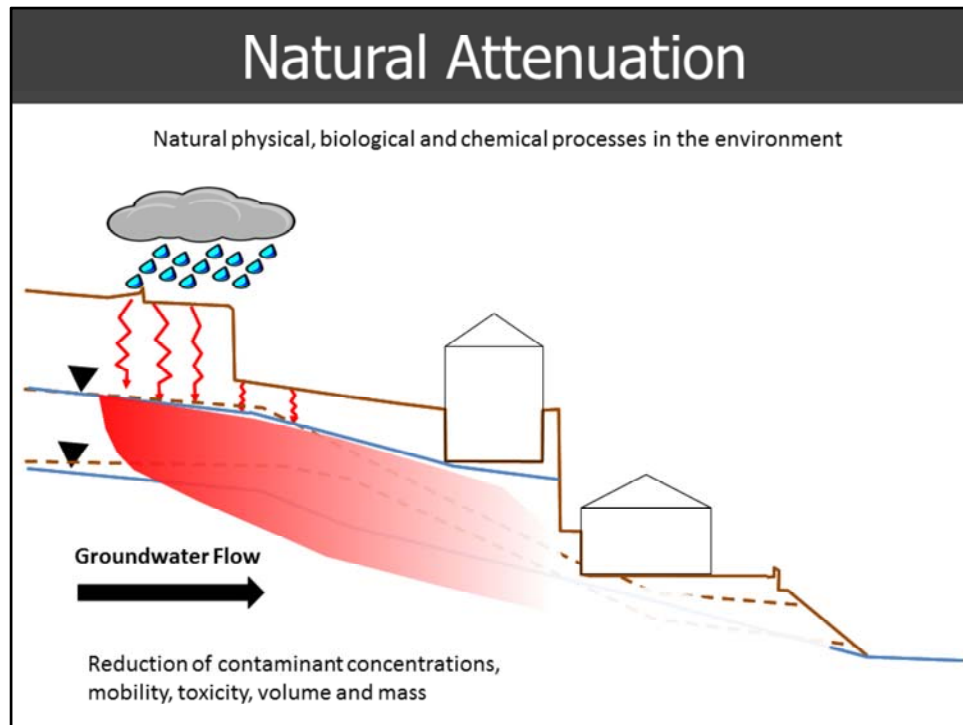
The remedial system directly recovered 5,080 kg of hydrocarbons, and 5,890 m3 of groundwater. It was estimated that 6,500 kg of hydrocarbons degraded in-situ as result of remedial system operation.



Angled wells drilled through retaining walls to target contamination at depth that could not be excavated

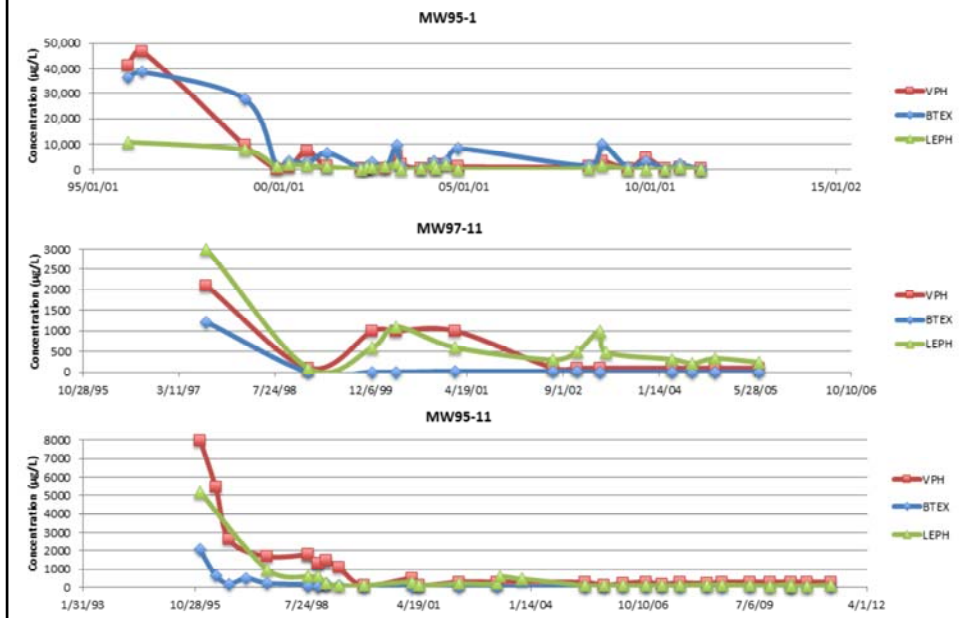
Remedial System





Large part of this project was going through the large amount of data and demonstrating the the plume (DW) was attenuating.

Groundwater Concentrations Declining

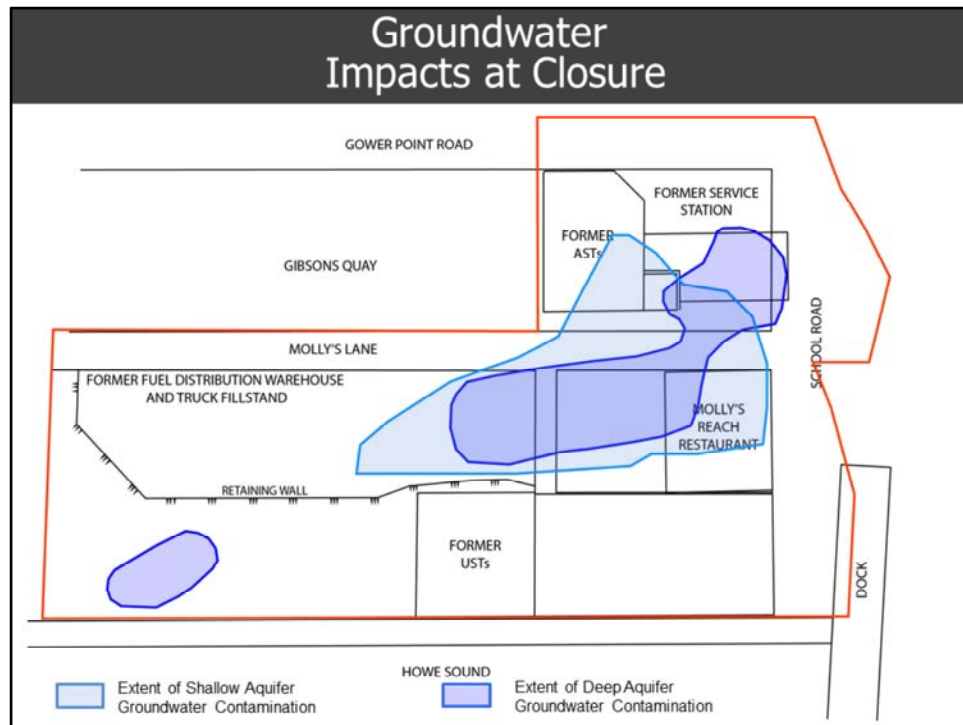


Closure Investigation

- Assessment of DW Standards
- Did not assess soil quality in all areas post remediation
- Soil vapour conceptual model developed
- Investigated risk areas for soil vapour (current and future)
- Elevated soil vapour concentrations for future scenario
- Resulted in raising site elevation in one area
- Groundwater investigated using previous wells, no new wells needed to support MNA.

TDS, Slug Testts, and remarkably DW applied – boo hoo

Strategic All exposure pathways for ecological receptors were determined to be incomplete under current use, with the exception of direct soil contact and groundwater uptake in a walnut tree



Gibsons DW Aquifer is much deeper than contamination shown and it is artesian.

Risk Assessment

- Exposure pathways incomplete for human health and ecological
- Except for one tree
- Non-native tree of heritage value - planted by George Gibsons Jr.
- Early settlers used seed husks to stain their gun stocks



All exposure pathways for ecological receptors were determined to be incomplete under current use, with the exception of direct soil contact and groundwater uptake in a walnut tree, a deep rooting tree on the Site with historical significance.

The risk was determined using spatially applicable data was compared to literature derived toxicity values to estimate risk

The Tree

Tree Planted
By George Gibsons Jr.



Challenges

Data Management & Evaluation

- Over 200 previous reports
- Over 1500 samples to be digitized and evaluated
- Re-interpretation and evaluation to current standards
- Determination of data validity
- Did the data indicate a stable or reducing plume?
- Select re-sampling to support risk assessment
 - 1999 soil sample at service station reported as 883,000 µg/g total BTEX
 - Same location < 0.29 µg/g during the 2015 investigation

Data Management – As a result of the changes in applicable standards all previously collected data had to be compared to the new standards and not all data was available electronically. This was overcome by having overseas data entry companies enter the data electronically at a significant cost savings to the client.

and if “not” need rationale

Data Evaluation - Confirming lateral and vertical soil/gw delineation on a site that had complex geology, hydrogeology and multiple depth zones of contamination. The inconsistent perched aquifer and figuring out the extents of the aquifer and the depths below ground surface, which was difficult because of the steep terrain/slope side. And figuring out the connection between the perched aquifer and the deep water table and what role the geology and fill units played in the two water tables.

Challenges

Site Setting

- Vegetation clearing
- Terraced infrastructure
- Potential preferential pathways
- Regional aquifer
- Access to investigation locations
- Tourist season
- Multiple stakeholders

Access and tourists: being in a busy and confined public place and the challenges of limited access and space while keeping business owners happy and not affecting their business , limited access meant drilling with the ponjar and hitting refusal.

Because of all the retaining walls we couldn't figure out if there was a direct pathway to the aquatic environment - so performing a detailed site visit and historical records review is pretty important.

Stakeholder communication – The site also had off site impacts to the lands owned by Town of Gibsons and a private landowner. Following BC Administrative Guidance 11, stakeholder communication was conducted via meetings, written (email and letters) and records of telephone communication. The draft Certificate of Compliance and Performance Verification Plan was provided to all stakeholders as part of the communication process.



Shrine to Beachcombers on the Site and featured heavily in TV series
On TOG Website
Picturesque waterfront

Summary

- In Situ Systems can be successful
 - Setting, Time, Risk Assessment & Owner
- Remember Data and Importance in closure
- Data Evaluation is Key
- Be Strategic in Closure Investigation
- Clearly document your communication with Stakeholders

Don't be discouraged!!

Data collect now may be used 20 to thirty years from now....store it electronically, data tags

Stakeholders

Acknowledgments



- UCANCO General Partners Inc and EnviroAnalytics Group LLC
- Previous Consultants and all their hard work
- Gibsons Museum
- Town of Gibsons
- Persephone Brewing
- Core6 Team

