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Sustainable Approach to Groundwater Remediation at Asphalt Testing Sites

- Environmental Stewardship and Sustainability
- Pollution Prevention and Waste Minimization
- Understanding the Strategic and Bottom-Line Benefits of Better Sustainable Practices

Chris Niver, P.G., CHMM

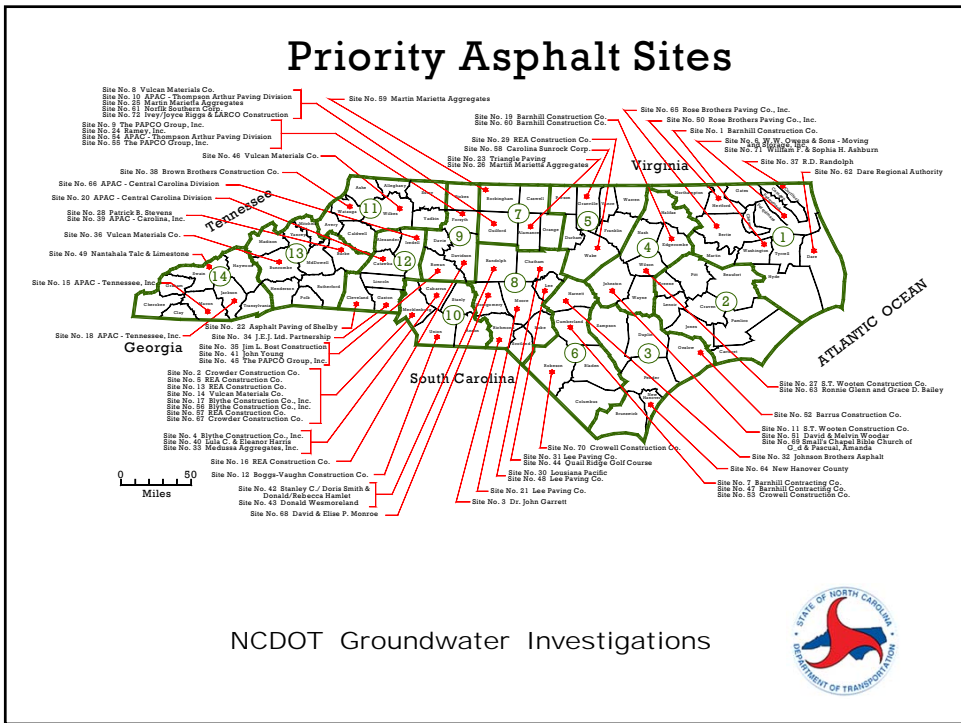
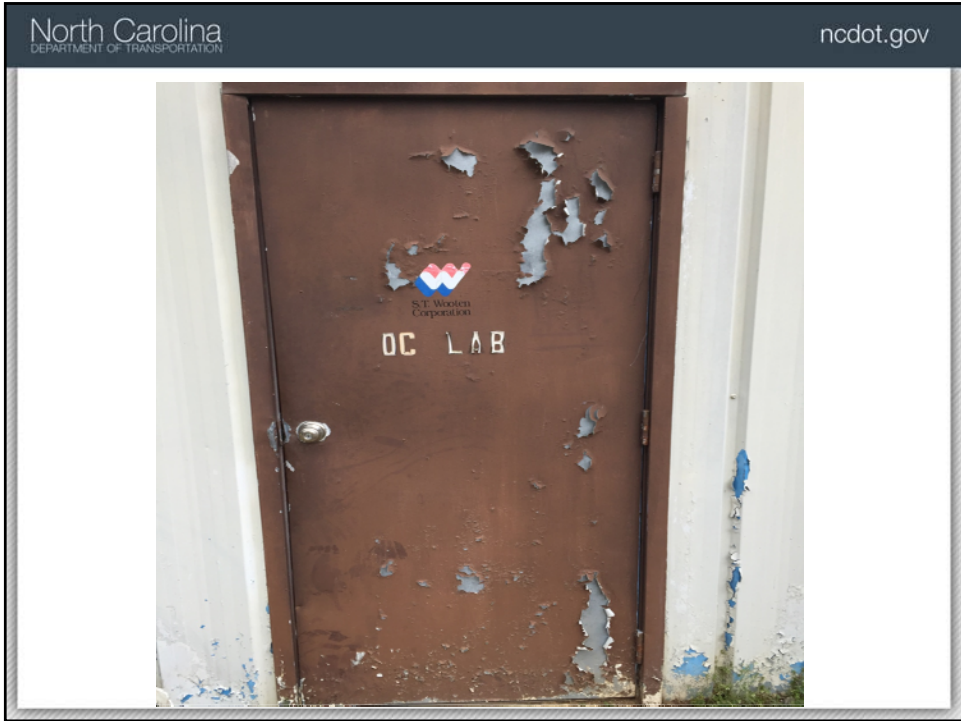


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ATL History

- By the 1960's, the North Carolina Department of Transportation (NCDOT) implemented an asphalt quality assurance program.
- Certified suppliers constructed and maintained onsite asphalt testing laboratories (ATL's). Parties performing asphalt tests used chlorinated solvents (e.g., carbon tetrachloride, trichloroethene, and 1,1,1-trichloroethane) per ASTM Methods.
- On-site solvent disposal from ATL's and other plant operations, contaminated soil and groundwater at many facilities.



NCDOT Groundwater Investigations



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Challenge

- Chlorinated solvents attenuate slowly. Groundwater remediation with mechanical extraction technologies (air sparge; pump and treat) is marginally effective.
- In situ stimulation of indigenous microbial populations with energy substrates (e.g., sugars) is the best alternative.
- The scale of the ATL remediation program makes commercial products cost prohibitive and can increase with commodity prices making long-term programmatic budgeting difficult.
- NCDOT needs a lower cost alternative strategy.

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Partnership



- Commercial beverage manufacturer, Pepsi Bottling Ventures (PBV), Raleigh, North Carolina uses High Fructose Corn Syrup (HFCS) in their formulations. HFCS has been used for bioremediation around the country. ***Its also on DENR's list of approved injectants.***
- The sugar concentrations in their products are comparable to commercially available bioremediation products.
- In a public service collaboration with NCDOT, PBV provided infrastructure and labor to recover and repackage expired beverages normally discharged to the City of Raleigh publicly owned treatment works (POTW).
- The new product is called **Beverage Remediation Product (BRP)** and is **Donated** to the NCDOT.

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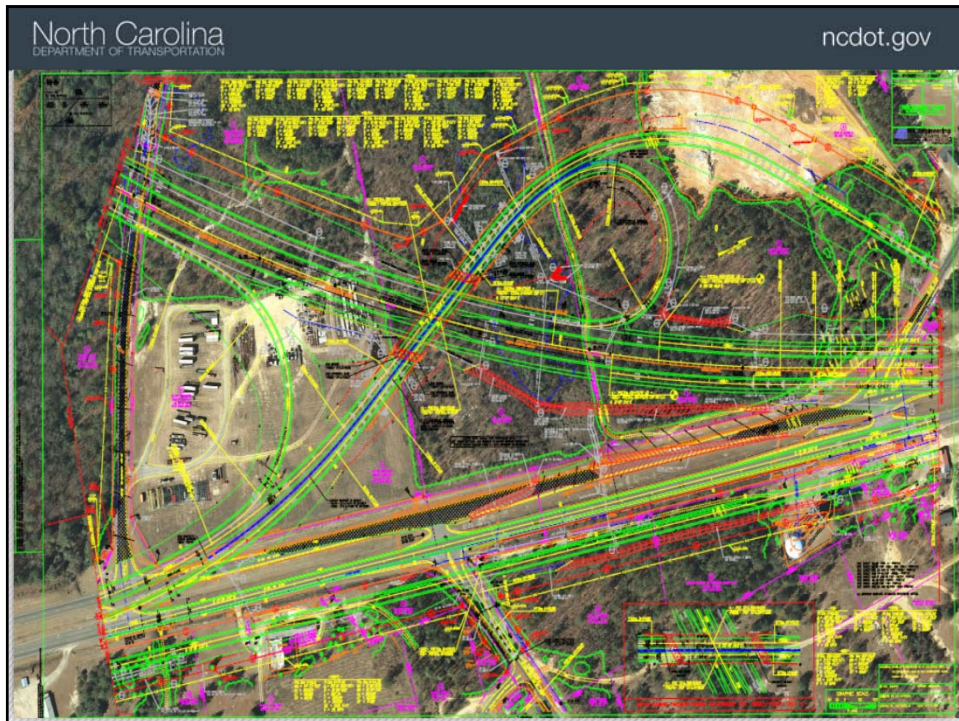
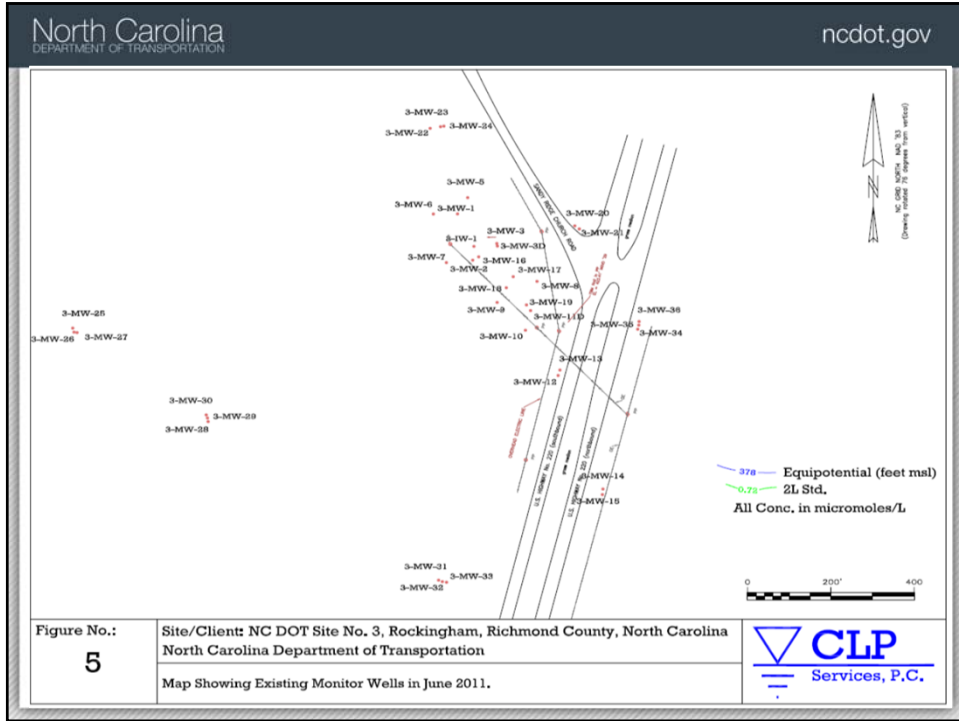


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Background

- NCDOT first met with PBV in 2011 to discuss sustainable benefits to PBV, City of Raleigh, and the State. PBV considered the project an excellent fit with their corporate environmental stewardship and sustainability goals. As business leaders and corporate citizens they felt that this was a very good way to give back to the communities of North Carolina.
- PBV and NCDOT next met with the NC Division of Health and Human Services NC DHHS, and NC Department of Environment and Natural Resources NC DENR, to discuss the human and environmental health benefits of utilizing BRP for groundwater bioremediation.
- NC DHHS provided agency approval so that NCDOT could apply for a required injection control permit for the use of BRP. Pursuant to these meetings, the injection control permit was approved by NC DENR in January 2013.
- In March 2013, NCDOT substituted the BRP in an existing in situ bioremediation injection project in Richmond County where sodium lactate was previously used. Field and analytical testing with detailed chemical thermodynamic analyses confirmed that BRP is in fact a low cost substitute for commercially available products currently used by NCDOT.



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PERMIT FOR THE CONSTRUCTION AND OPERATION OF A WELL FOR INJECTION

In accordance with the provisions of Article 7, Chapter 87; Article 21, Chapter 143, and other applicable Laws, Rules, and Regulations

PERMISSION IS HEREBY GRANTED TO

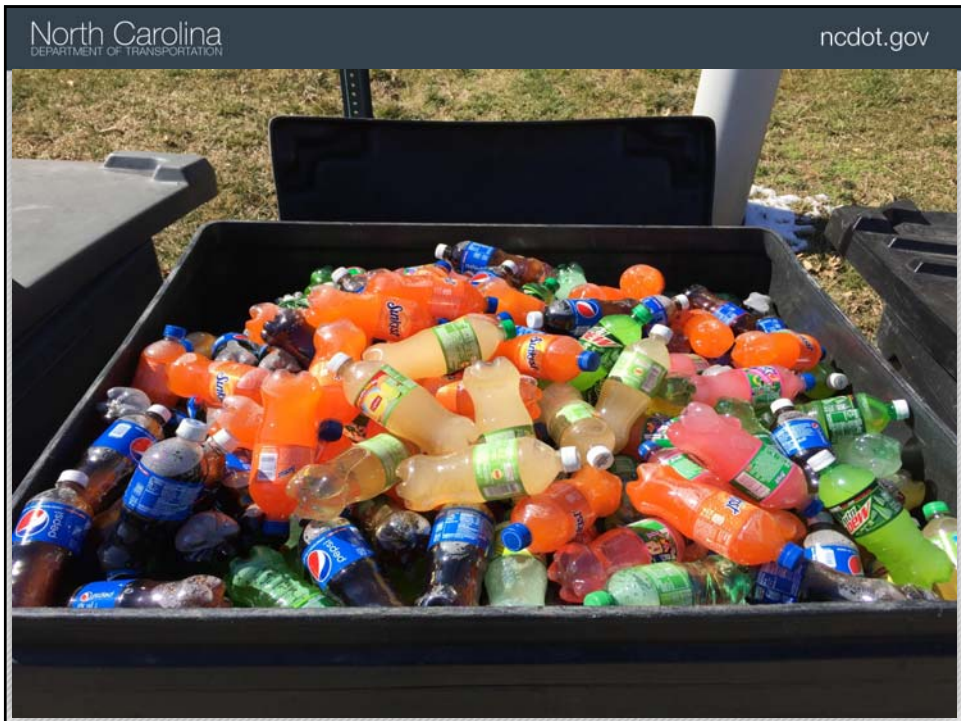
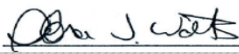
NC Department of Transportation

FOR THE CONSTRUCTION AND OPERATION OF *IN SITU* REMEDIATION INJECTION WELLS, defined in Title 15A North Carolina Administrative Code 2C .0209(5)(b)(viii), to inject Pepsi Bottling Ventures' Beverage Remediation Product, sodium hexametaphosphate, and sodium bicarbonate, for the anaerobic bioremediation of chlorinated solvents. These injection wells/points will be located at NCDOT Priority Site #3, located at the southwest corner of the intersection of US Hwy. 220 and Sandy Ridge Church Road in Rockingham, Richmond County, North Carolina, and will be operated in accordance with the application submitted October 25, 2012, and in conformity with the specifications and supporting data submitted, all of which are filed with the Department of Environment and Natural Resources and are considered a part of this permit.

This permit is for Construction and Operation only, and does not waive any provisions of the Water Use Act or any other applicable Laws, Rules, or Regulations. Operation and use of an injection well shall be in compliance with Title 15A North Carolina Administrative Code 2C .0100 and .0200, and any other Laws, Rules, and Regulations pertaining to well construction and use.

This permit shall be effective, unless revoked, from the date of its issuance until December 31, 2017, and shall be subject to the specified conditions and limitations set forth in Parts I through X hereof.

Permit issued this the 18th day of January, 2013.




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BRP

Expired Mountain Dew ready for crushing



- Expired beverages are placed in hopper for crushing
- BRP is gravity drained into underground holding tank for recovery.
- Each unit also has a compactor to capture bottles and cans for recycling.

Two crushing and product recovery units at Raleigh Plant




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BRP

Crushed beverage containers ready for recycling



BRP ready for transport to NCDOT site in Richmond County



- BRP is pumped from holding tank to transfer vessels.
- Total volume transported is 2,500 gallons per load.

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BRP

Mixing tanks staged at the NCDOT Richmond County Maintenance Yard

- *Transported BRP is transferred to a series of 3,000 gallon mixing tanks prior to groundwater injections.*
- *Baking soda was mixed with the BRP to adjust the ph of groundwater prior to injections.*

Mixed BRP is transported, via 300 gallon tanks, to site for injection



The top photograph shows three large, light blue cylindrical mixing tanks labeled 'High Fructose Corn Syrup Research' at an outdoor maintenance yard. Stacks of white bags are in the foreground. The bottom photograph shows a white truck with a trailer carrying a smaller white 300-gallon tank to a wooded site, with workers in safety vests nearby.

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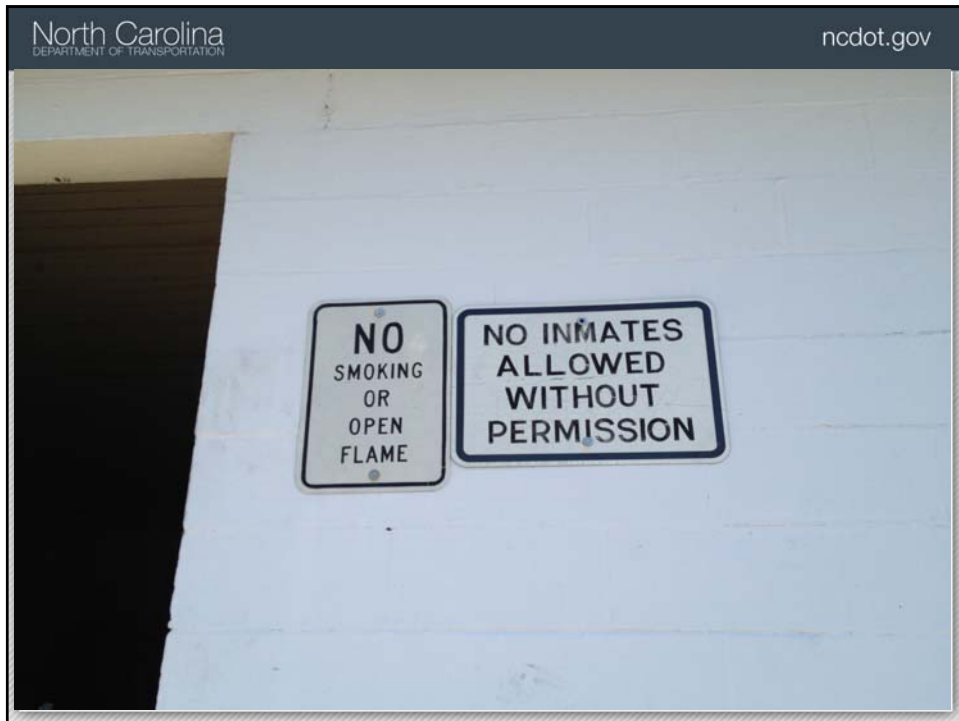
BRP

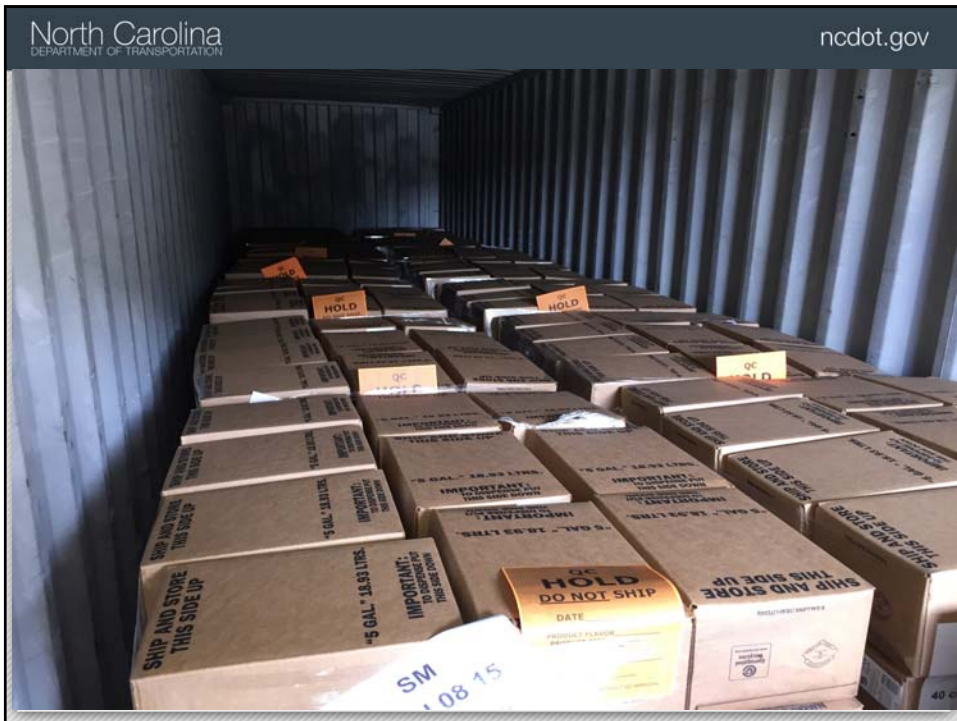
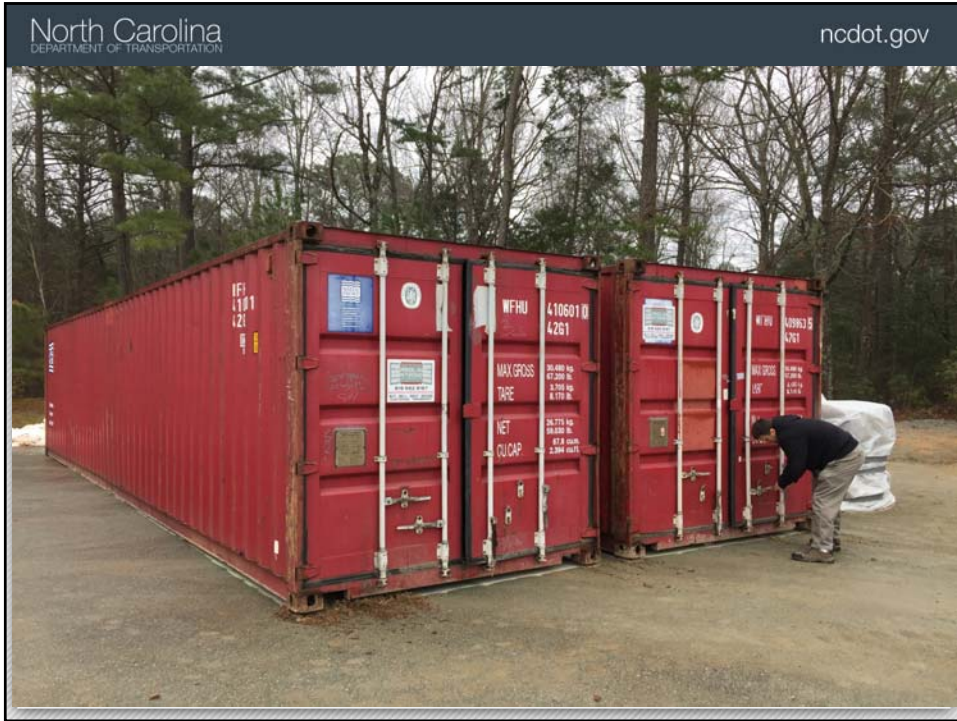
BRP injected into contaminated groundwater via injection well

BRP injection delivery system.



The top photograph shows two workers in safety gear using a yellow hose to connect a white 300-gallon tank to an injection well. The bottom photograph shows a white 300-gallon tank labeled 'High Fructose Corn Syrup Research' mounted on a wooden pallet and supported by a concrete base at the injection site.



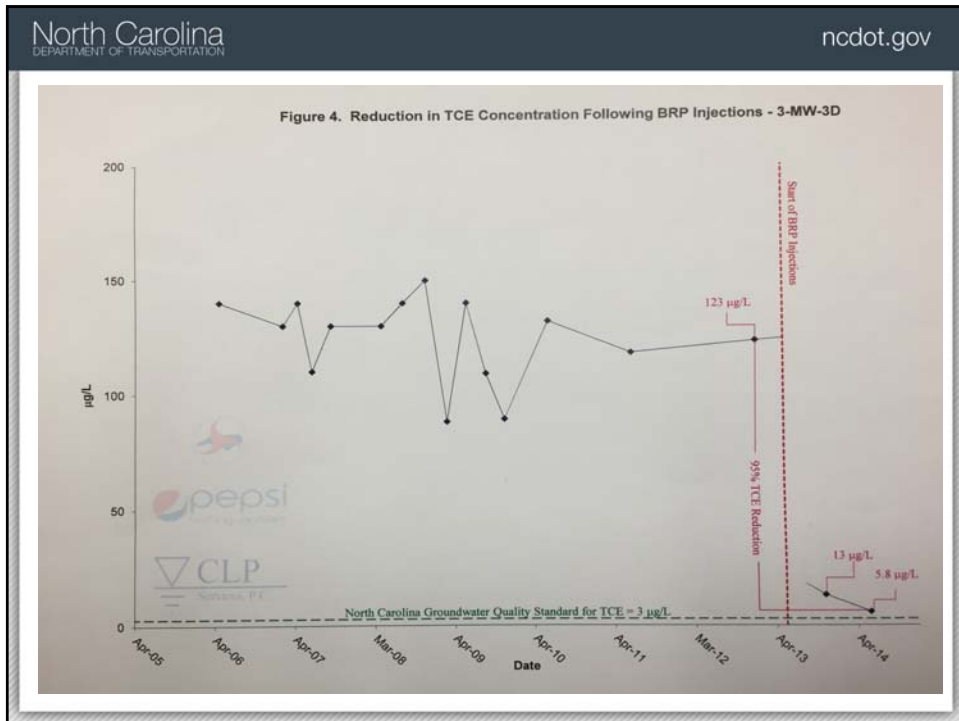


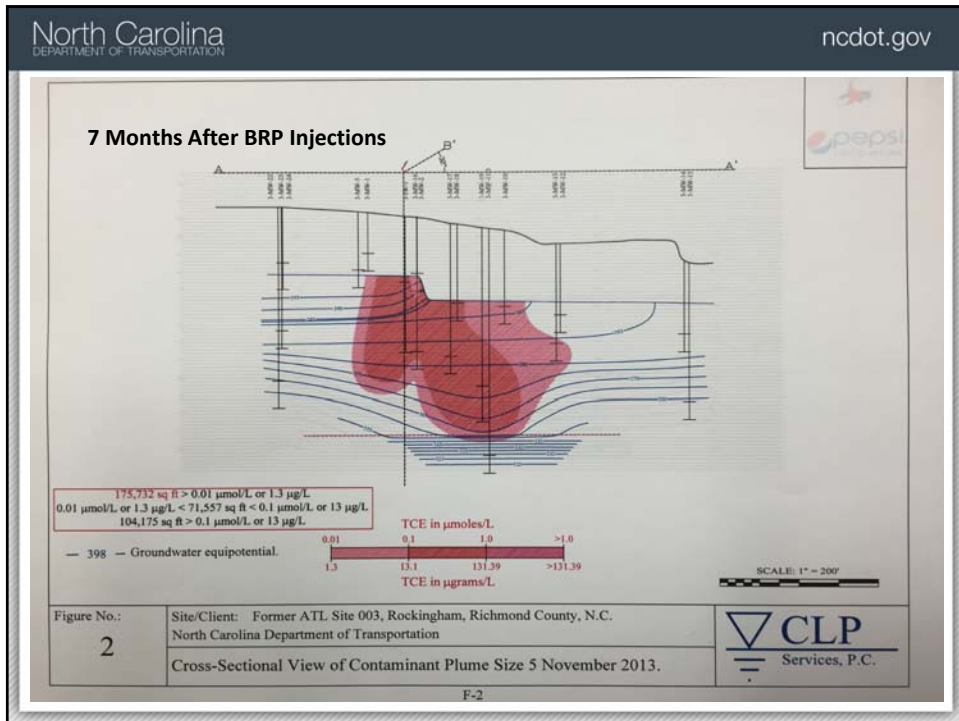
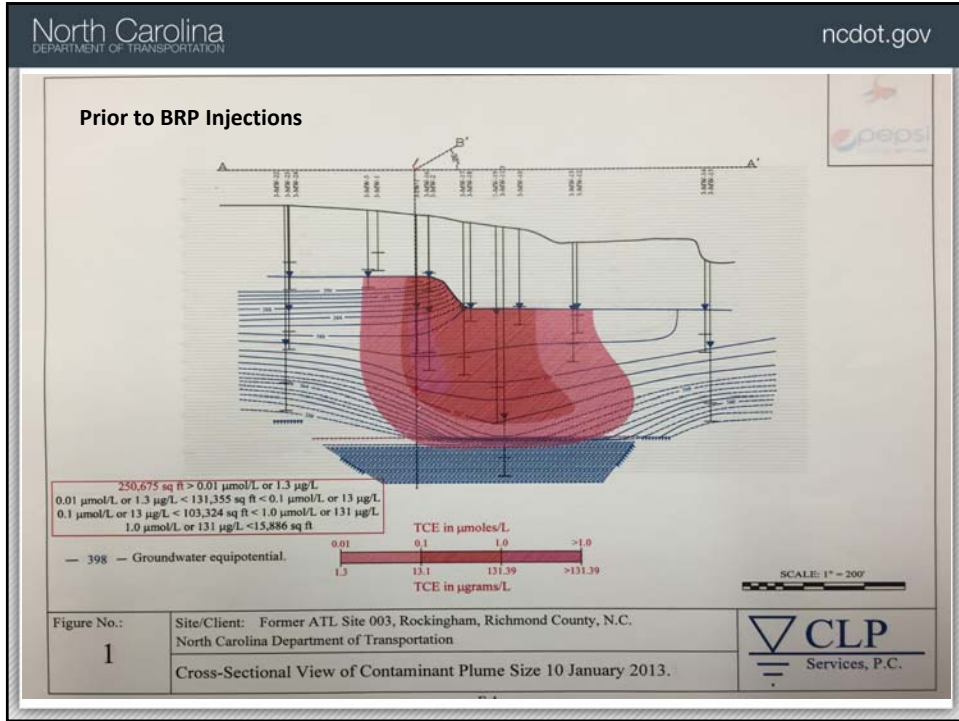
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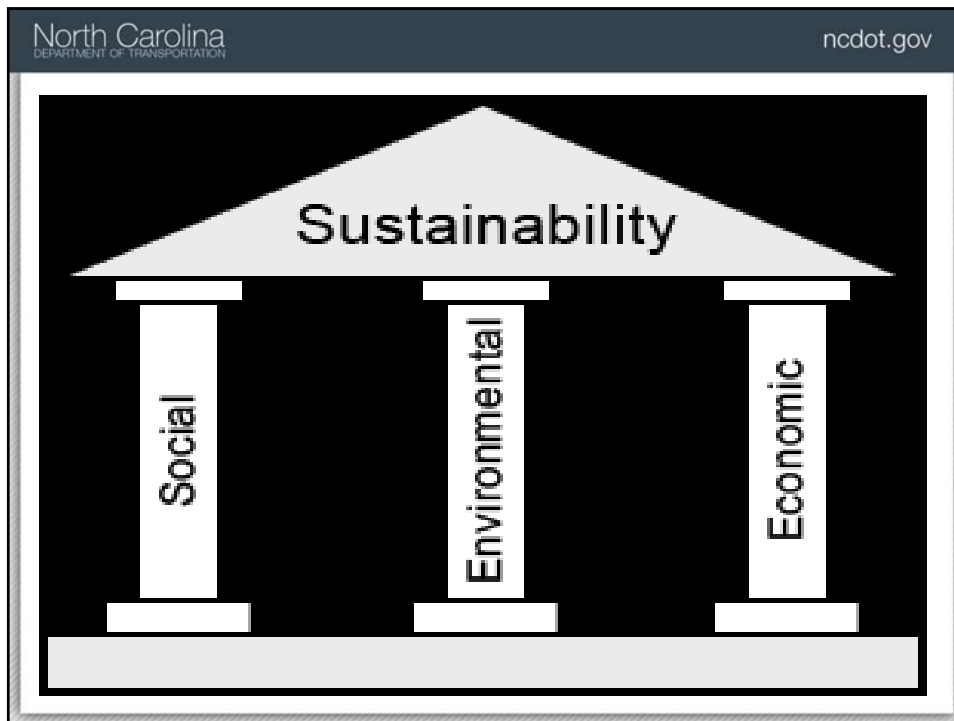
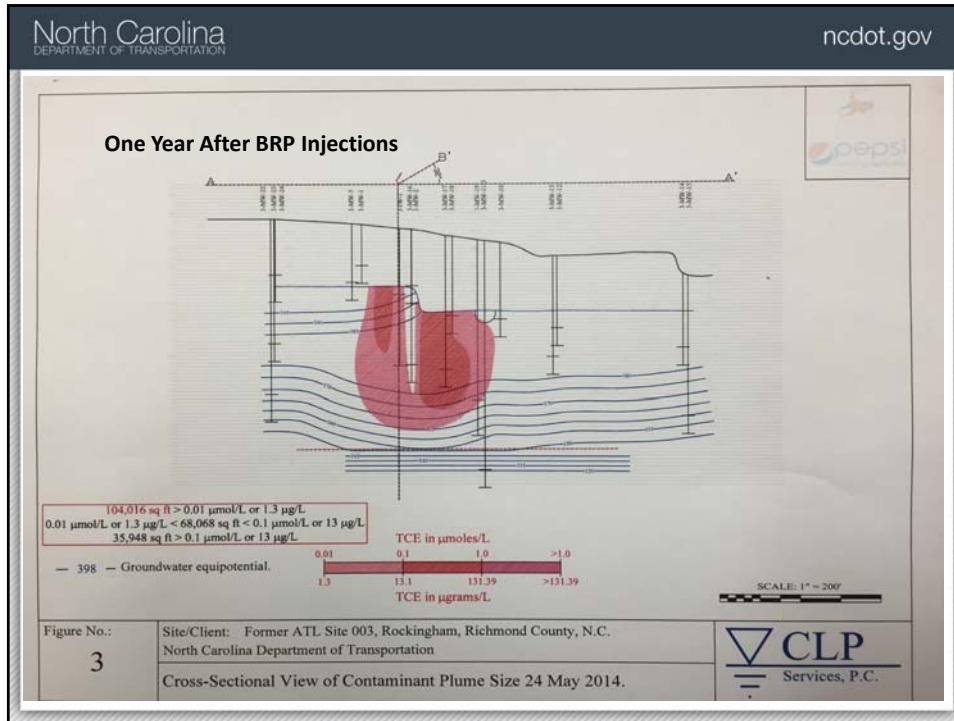
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Table 1. Composite table of analytical data for BRP at Former ATL Site 003.

Sample Designation	Date Sampled	TOC (g/L)	HFCS (g/L)	HFCS (lbs/gal)	Density (g/ml)	Density (lbs/gal)	wi% (lbs/lb)	Vol% (gal/gal)	HFCS Inj (lbs)	Trans. Cost (per lb)
4/29/13 Batch	5/14/13	28.0	70.0	0.584					1,548	\$1.70
4/30/13 Batch	5/14/13	21.9	54.7	0.457					1,074	\$2.44
5/6/13 Batch	5/14/13	32.2	80.5	0.672					1,680	\$1.56
5/13/13 Batch	5/14/13	40.4	101	0.843					2,108	\$1.25
5/30/13 Batch	5/31/13	31.6	79.0	0.659	1.030	8.597	7.67	4.87	1,648	\$1.59
5/31/13 Batch	5/31/13	28.1	70.2	0.586	1.027	8.572	6.84	4.33	1,554	\$1.69
6/18/13 Batch	6/18/13	39.1	97.7	0.816	1.036	8.647	9.44	6.03		
6/18/13 Batch A	6/19/13	35.6	89.0	0.743	1.028	8.581	8.66	5.49	1,857	\$1.41
6/19/13 Batch	6/19/13	30.5	76.2	0.636	1.020	8.514	7.48	4.70		
6/19/13 Batch A	6/19/13	33.8	84.5	0.705	1.024	8.547	8.25	5.21	1,763	\$1.49
8/6/13 Batch	8/6/13	41.0	102.5	0.856	1.028	8.581	9.97	6.32		
8/6/13 Batch A	8/7/13	38.0	95.0	0.793	1.027	8.572	9.25	5.86	1,982	\$1.32
8/7/13 Batch	8/7/13	41.6	104.0	0.868	1.028					
8/7/13 Batch A	8/7/13	37.1	92.7	0.774	1.024	8.547	9.06	5.72	1,935	\$1.36
8/20/13 Batch	8/20/13	33.1	82.7	0.691	1.028					
8/20/13 Batch A	8/21/13	33.7	84.2	0.703	1.028	8.581	8.20	5.19	1,758	\$1.49
8/21/13 Batch	8/21/13	34.3	85.7	0.716	1.027					
8/21/13 Batch A	8/21/13	35.5	88.7	0.741	1.021	8.522	8.69	5.47	1,852	\$1.42
3/11/14 Batch	3/11/14	41.3	103.2	0.862	1.038					
3/11/14 Batch A	3/13/14	38.2	95.5	0.797	1.028	8.598	8.86	5.89	1,993	\$1.32
3/12/14 Batch	3/12/14	35.0	87.5	0.730	1.024					
3/12/14 Batch A	3/13/14	35.9	89.7	0.749	1.068	8.914	8.40	5.53	1,873	\$1.40
4/30/14 Batch	4/30/14	49.5	123.7	1.033	1.076					
4/30/14 Batch A	5/1/14	45.1	112.7	0.941	1.021	8.522	11.04	6.95	2,353	\$1.12
5/1/14 Batch	5/1/14	73.4	183.5	1.532	1.041					
5/1/14 Batch A	5/1/14	68.9	172.2	1.438	1.035	8.639	16.64	10.62	3,594	\$0.73
5/27/14 Batch	5/27/14	21.1	52.7	0.440	1.011					
5/28/14 Batch	5/28/14	47.6	119.0	0.993	1.054					
Tank 1 5/28/14	5/28/14	31.4	78.5	0.655	1.023	8.539	7.67	4.84	1,638	\$1.60
Tank 2 5/28/14	5/28/14	31.5	78.7	0.657	1.024	8.547	7.69	4.85	1,643	\$1.60
9/2/14 Batch	9/2/14	89.2	223.0	1.861	1.077					
9/3/14 Batch	9/3/14	36.9	92.2	0.770	1.015					
Tank 1 9/3/14	9/3/14	39.1	97.7	0.816	1.022	8.530	9.56	6.03	2,040	\$1.29
Tank 2 9/3/14	9/3/14	34.9	87.2	0.728	1.022	8.530	8.54	5.38	1,821	\$1.44
3/2/15 Batch	3/3/15	91.6	229.0	1.911	1.068	8.914	21.44	14.12	4,778	\$0.55
3/3/15 Batch	3/3/15	100	250.0	2.087	1.096	9.148	22.81	15.41	5,217	\$0.50
Maximum (last 18 events)		100	250.0	2.087	1.077	8.990	23.21	15.41	5,217	\$0.50
Minimum (last 18 events)		21.1	52.7	0.440	1.011	8.439	5.22	3.25	1,101	\$2.38
Mean (last 18 events)		48.1	120.1	1.003	1.032	8.614	11.64	7.40	2,507	\$1.05
Median (last 18 events)		40.1	100.2	0.837	1.028	8.581	9.75	6.18	2,092	\$1.25







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Sustainability Elements

- BRP will greatly lower cleanup costs at ATL sites. **Economic**
- Allows NCDOT to redirect funding to actually cleanup more sites in a timely manner. **Environmental + Social**
- NCDOT can spend less money than it would cost to get the same result with commercially available products. **Economic**
- The lower cost BRP allows a more thorough remediation of highly contaminated sites and allows remediation of less contaminated sites that could not be addressed otherwise with available resources. **Environmental + Social**
- Pollution prevention and waste minimization efforts lower PBV's cost of doing business and reduce the wastewater load and energy demands placed on Raleigh's POTW. **Economic + Environmental**

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Sustainability Elements

- NCDOT's pilot testing in Richmond County found that the unit cost to inject lactate (a lower cost commercially available product) was \$7.05/lb. Pilot testing showed that full remediation of the site would require 350,000 lbs. or **\$2,467,800**. NCDOT found that the unit cost to inject HFCS in BRP is \$2.45/lb or **\$857,500** for 350,000 lbs. That's a savings of **\$1,610,300** or 65%. **Economic**
- Recently picked up 9,000 gallons, 55 brix, out of spec fountain drink mix. Retail value **\$200k**. **Economic**
- BRP unit price is expected to decrease as continued process improvements are implemented. **Economic**
- **§ 143-58.2**. State policy; bid procedures and specifications; identification of products. (a) It is the policy of this ***State to encourage and promote the purchase of products with recycled content***. All State departments, institutions, agencies, community colleges, and local school administrative units ***shall, to the extent economically practicable, purchase and use, or require the purchase and use of, products with recycled content.*** **Economic**

Summary

- NCDOT recognized that the compositions of PBV beverages were comparable to those solutions already commercially available and in use for groundwater clean-up; and that they would work.
- NCDOT then took the initiative and sought out PBV, gained an understanding of what they produced and how, and found a way to use their close-dated sugar products as a repackaged product.
- We persevered through the regulatory process to put this otherwise edible food product in groundwater to clean up pollution.
- These are bottom line benefits with the ability to directly protect human health and the environment faster, better, and cheaper.

“A common sense solution to a complex problem, a positive change in the way we conduct business, and puts taxpayer dollars to good use”