Evaluation of CG Environmental, LLC

Proprietary Patented Truck Mounted and Hand Held Recovery Unit Cleaning Technology

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Prepared by:
UNT Health Science Center School of Public Health

Under the direction of:
Dr. Alisa L Rich, Assistant Professor
Sr. Environmental Scientist/Toxicologist
Director, Health Environment Sustainability and Security Research

School of Public Health
3500 Camp Bowie Boulevard, Fort Worth, Texas 76107 • Phone 817-735-5029 • Fax 817-735-0446

A Report Prepared for:
CG Environmental, LLC "Cleaning Guys"
http://cleaningguys.com
5255 Teague Rd.
Fort Worth, TX 76147

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Fort Worth, Tarrant County, Texas

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Alisa Rich, PhD, MPH, CEM, CTS, CAQS
Senior Environmental Scientist/Toxicologist
Assistant Professor and Director, HESS Research

UNT Health Science Center
3500 Camp Bowie Blvd., EAD 600
Fort Worth, TX 76107

CG Environmental LL – Cleaning Guys
Report Summary

The University of North Texas Health Science Center at Fort Worth ("UNTHSC"), Health Environment Sustainability and Security Research (HESS Research) was contracted by CG Environmental, LLC – Cleaning Guys ("CG Environmental") of Dallas/Fort Worth to evaluate the efficiency and performance of their proprietary, patented truck mounted and hand held recovery unit cleaning system. The patented equipment (truck mounted and hand held) is used in performing hazardous materials clean-up and emergency response involving spills and accidents.

The company has been in business since 1992. Mr. McCallum, President of CG Environmental, has designed, built and patented the cleaning and emergency response equipment including the proprietary truck mounted system, "The Annihilator" which is reported to have the capacity to clean 400 square feet of paved surface (cement or asphalt) in approximately 30 seconds. It possesses the ability to remove a majority of hydrocarbons, caustics, neutralized acids and their neutralizing agents from horizontal and vertical surfaces.

To test the efficiency and performance of CG Environmental proprietary equipment nine (9) tests were conducted. The nine tests included:

1. Annihilator Speed/Time Test
2. Granular Absorbent (Kitty Litter) Speed/Time Test
3. Groove Depth Test
4. Hydrocarbon Spill Time Test
5. Hydrocarbon Water Recovery and Analysis
6. Hydrocarbon Diesel Spill
7. White Glove Wipe Test – Hydrocarbon Analysis
8. White Glove Wipe Test – Metals Analysis
9. pH Test of Paved Surface

Tests performed by UNTHSC HESS Research personnel were designed and supervised by Dr. Alisa Rich (Asst. Professor, Sr. Environmental Scientist/Toxicologist), and Field Technicians II (Master Candidates) Amanda Franklin, Alexandra Johnson and Johnathon Wallace.

The field tests was performed on April 29, 2015 at Standard Paints facility in Mansfield, TX (940 S. 6th Avenue, Mansfield, TX 76017) with subsequent field tests for metals performed on June 29, 2015, at CG Environmental headquarters in Fort Worth, TX. Samples were analyzed for Total Petroleum Hydrocarbons (TPH) and Metals at a NELAC certified independent third party laboratory (Armstrong Forensic Laboratory, Inc., Arlington, TX).

Findings:

The Annihilator proprietary cleaning equipment and process outperformed the standard absorbent/sweep method (aka Kitty Litter) for recovery of hydrocarbons, metals and dirt debris on concrete surfaces. The HHRU proprietary cleaning equipment and process had a greater recovery rate for hydrocarbons, metals and dirt debris (particulate matter) from impacted concrete when compared to the standard absorbent/sweep Kitty Litter (KL) process.

Granular absorbent (KL process) was found to remain on the surface after cleaning and may be a factor in reduced tire traction. The HHRU patented vacuum process removed all particulate matter from paved surfaces and cracks allowing for maximum tire traction.

The speed of recovery and recovery efficiency exceeded the standard absorbent/sweep (KL) method. Additionally, the procedure for hydrocarbon recovery by the Annihilator and HHRU equipment allows for directly depositing recovered water to a tank internal to the Annihilator alleviating lifting of drums by workers or disposal of drums in hazardous waste facilities. This prevents potential injury to workers from lifting or tipping drums.

CG Environmental patented processes eliminates the use and costs of drums, granular absorbents, and materials used to retrieve hydrocarbon impacted absorbent. Disposal of hydrocarbon impacted material is costly and adds to the overall carbon footprint. Aqueous solutions recovered by CG Environmental patented methods separates the recovered oil from the water, which is later reused. The purified water is at an acceptable level for disposal at a water treatment plant.

This Annihilator technology vastly reduces the time workers are present on highways during a spill/clean up. This in turn decreases the injury rate to occupational workers, fire and police responders, and motorist.

With the use of CG Environmental proprietary equipment and processes the highway lanes are able to be reopened quickly minimizing lost revenue from reduced toll fees and lessens the greenhouse gas impact from idling cars.

The HHRU recovers hydrocarbons and debris from impacted concrete channels allowing for greater tire traction whether during a precipitation event or under normal road conditions.

When granular absorbent is used, hydrocarbon and dry granular absorbent residue remain deep in the grooves and channels of the road way and may impact vehicle traction. Grooves shed water less effectively off roadways and may cause oil sheen to migrate into storm drains impacting creeks, rivers and wildlife.

With the use of the HHRU or Annihilator method, minimal impact to waterways and sensitive ecological systems was noted when compared to the standard granular absorbent/sweep method.

1. Annihilator Speed/Time Test

The purpose of the Speed/Time Test was to validate the speed and efficiency of CG Environmental proprietary truck mounted technology "The Annihilator". With this test the time required for The Annihilator to clean a specific length/width of paved surface roadway was verified. The Annihilator requires a 3-man crew in attendance during operation: a driver, an attendant operating the internal mechanisms of the proprietary equipment, and a safety spotter.

A 50ft x ±8ft section (400 ft^2) of paved surface located in the dock area of Standard Paints was measured with a digital horizontal wheel measurement device "*Revolution*" (Trumeter Technologies Ltd.). The start and finish line was marked on the pavement with red duct tape. UNTHSC Technicians marked and recorded the length of time it took the Annihilator to clean 50ft x ±8ft of paved surface.

The test was performed twice and the times averaged. Both of the tests were recorded. In order to adhere to privacy requests of CG Environmental, the patented proprietary equipment on the inside of the truck was not recorded during operation, only the platform and lower truck was made visible. The proprietary equipment requires no additional time for breakdown, securing of internal mechanisms or clean-up of the truck-mounted equipment before demobilization from the site.

Results:

Two identical tests were performed averaging the times. The results were as follows:

Test #1	1.45 (1 minute, 45 seconds/50ft)
Test #2	1.15 (1 minute, 15 seconds/50ft)
Averaged time	**1.30 (1 minute, 30 seconds/50ft)**

Note: The averaged time included equipment preparation (pretreating, dropping the deck, equipment start-up).

While the initial time would include preparation time, the second and each additional 400 ft^2 run is estimated to be performed in ±30 – 40 seconds as the preparation and set up time are not required for additional distance.

All hydrocarbon material retrieved during the test is automatically deposited in a holding tank within the truck. Immediately after the truck completed the 50ft segment, the attendant secured the truck doors and returned to the cab along with the safety spotter. Demobilization time noted at <1 minute during each test.

Findings:

- The Annihilator required little preparation time or start-up time for the equipment. The safety spotter took position at the end of the vehicle while the attendant prepared internal mechanisms for water application and recapture of degreaser and hydrocarbon material present on the pavement. The driver is not required to exit the vehicle at any time.
- The speed of the Annihilator provides for rapid clean-up in large areas. For example:
    - The Annihilator could clean a football field (apx. 360 linear feet) in ±4.40 minutes. (1.30 minutes for the initial 50ft + 3.1 minutes for remaining 310ft).
    - The Annihilator could clean 1 mile of paved surface (5280 feet) in ±55.30 minutes. (1.30 minutes for the initial 50ft + 53.6 minutes for remaining 5230ft).
- There is a reduced risk/injury factor to occupational workers, emergency management, highway patrol and motorists due to speed of clean-up.
- Only 2-men exit the vehicle at any time therefore, the reduced time that occupational workers are present on the highway is greatly diminished thereby diminishing risk of injury. The truck also provides protection to workers when compared to the absorbent/sweep method. The worker is fully exposed to traffic and cannot watch for traffic and perform their job without inherent danger. Eliminating the use of a granular absorbent improves traction of vehicle tire to paved surface and eliminates residual absorbent debris in paved surface grooves that remain after clean-up.
- Increased speed of clean-up allows for rapid reopening of all lanes of freeway, increased movement of vehicle traffic, and minimizes lost toll fees and greenhouse gas (GHG) emissions from idling of slowed/stopped traffic.

Figure 1 and 2. The Annihilator Technology Performing Speed/Time Test

2. Granular Absorbent (Kitty Litter) Speed/Time Test

Historically, spills containing liquid or hydrocarbon material are first treated with a pellet or granular absorbent material, allowing the hydrocarbons to be absorbed by the granular material prior to containment in drums for final disposal. Absorbent material can vary and includes use of sand, sawdust, clay, corn, pine, cedar, recycled paper, nut shells, and granular bentonite. In this test the use of a granular bentonite absorbent simulated the common clean-up technique performed on a paved surface spill. A multi-purpose bagged absorbent (common term used in the field "kitty litter" due to the similar bentonite material used in cat litter) was applied to a simulated oil spill. The standard protocol used by hazardous materials clean-up and emergency response operators is first to absorb the spill or hazardous material with a multi-purpose granular absorbent (kitty litter or KL) prior to scooping up the material for final disposal. The kitty litter absorbent requires absorption/sit time sufficient to saturate the kitty litter with the spilled material prior to scooping up and packaging for disposal. The kitty litter absorbent is worked into the spilled material using manual sweep broom(s) by workers to enhance distribution and absorption. The spent kitty litter is considered Class I non-hazardous waste but must be disposed of at a Type 1 landfill.

CG Environmental patented technology requires no granular absorbent for spill abatement. The process includes application of a water-based degreaser while the Annihilator is in motion and does not require absorption/sit time as required for the kitty litter. A patented agitation process and hot water located in the rear of the vehicle mobilizes the spilled material from the paved surface and the contaminated hydrocarbon/aqueous material is returned directly to the truck. The hydrocarbon/aqueous material is contained in a tank located inside the truck for transport and disposal eliminating lifting or moving heavy containers on and off of the truck by workers. Prior to disposal, the aqueous water/hydrocarbon material is allowed settling time where the water/hydrocarbon mixture naturally separates. The hydrocarbon matrix is recycled and the water matrix is clean enough to be disposed of in a municipal water treatment facility.

This test used multi-purpose granular absorbent/kitty litter to absorb surface oils, hydrocarbons, or other material present on the paved surface of the receiving dock of Standard Paints. The amount of time it took for to remove the hydrocarbon material from the paved surface was quantified and compared to the time the Cleaning Guy's patented proprietary equipment took to clean retrieve hazardous material/spill embedded in the paved surface (concrete or asphalt).

To simulate standard clean-up procedures using a granular absorbent or kitty litter, three 40lb (18.14 kg) bags of Thrifty-Sorb multi-purpose granular absorbent were emptied on to a 20ft section (8ft x 20ft) of hydrocarbon impacted paved surface. Due to the size of the Annihilator a larger 50ft section of paved surface was measured (8ft x 50ft).

(A 20ft section of paved surface was consistent with the amount of kitty litter typically used for that amount of surface area). No absorbent was placed in the 50ft surface path where the Annihilator would clean. (Note: there is no need for or use of an absorbent with Annihilator technology).

A two (2) man crew ("sweep crew") was designated to sweep up the kitty litter with push brooms (standard equipment) as is typically performed manually using absorbent clean up. (Note: average size of crew is minimum (4) men on sweep detail and includes a spotter). At the command of the testing supervisor, the speed clock began as the sweep crew initiated sweeping and containment of the absorbent and simulated spill. Simultaneously, the HHCU unit began cleaning.

Results:

The sweep crew completed their clean up using a single application of absorbent in 5 minutes 39 seconds, as compared to the Annihilator which performed a complete clean-up in an averaged time of 1 minute 30 seconds for the initial 400 square feet, (*see results of test under Annihilator Speed/Time Test, page 3*). The paved surface cleaned by The Annihilator was clearly visible and noted by Technicians. Residual absorbent material was documented as being present on the paved surface and in grooves/crack of the cement after absorbent/sweep clean-up was completed.

It is important to note that the actual time for a sweep crew clean-up would be significantly longer for several reasons:

1. The number of men performing absorbent sweep is an approximation. Actual number of sweep crew is dependent on size of spill and may exceed simulation. Additional crew (spotters and drivers) may also be required in large spill containment.
2. Initial application of absorbent (opening the bags and distributing the kitty litter across the area) onto the simulated spill was not calculated in time of initial sweep crew clean-up.
3. Application of absorbent requires opening the appropriate number of bags of absorbent for the appropriate surface area of spill, and working the absorbent into the spilled material for several minutes using brooms for greater absorbance.
4. Protocol is to allow the absorbent to sit approximately 6 – 15 minutes on the spill after spreading for maximum absorbency of the spilled materials. Note: sitting time varies as to volume of spilled material and type of material spilled.
5. Variability of sweep time is dependent on number of men, rate of sweeping, work conditions, and whether spill is in a heavily trafficked area vs. non-traffic area. In heavily trafficked area 1st responders (Fire and/or Police) may be required to be present with both the Annihilator and sweep crew, to prevent traffic related injuries to workers.
6. Multiple applications of absorbent is in most cases required with hazardous materials and emergency spills. Multiple applications and sweep clean-ups equates to additional time workers are present on the roadway. The absorbent has a maximum capacity to absorb and must be cleaned and reapplied after saturation. (As reapplication is highly variable and dependent upon type of material spilled and volume of spill. Due to time constraints, only one cycle of absorbent application and clean-up was performed during the testing. Timed clean-up is based on one application or round of clean-up.).
7. During the application, and sitting time for the absorbent to absorb hazardous/spilled material, the crew must be present on site (increasing potential for injury to workers) but do not have other duties to perform incurring 'down time'.

8. In a heavily trafficked area, the presence of work crew at/on roadside increases the risk for injury from vehicle(s), flying debris, as well as construction risk (weather exposure either heat or cold; lift injury; slip/fall injury). Greater time at scene of hazardous clean-up increases potential for injury/exposure to emergency responders and workers.

Findings:

- Application of absorbent is time and labor intensive requiring a crew of 4 – 8 men dependent on volume of spill and material characteristics of spill.
- Application of absorbent requires long application absorption time and multiple applications.
- Absorbent costs adds to overall cost of clean-up.
    - Based on 40lb bags of Thrifty-Sorb ($17 - $28/bag).
        - Cost dependent on volume purchased, and availability.
        - Average spill 20ft x 8ft calculated at 25 bags.
    - Granular absorbent costs add to overall cost of manual sweep clean up. Absorbent estimated for a 20ft x ±8ft (160 ft^2) section is approximately $425 - $700/160 ft^2 for kitty litter alone.
- Absorbent application and removal increases potential injury and exposure to workers.

3. Groove Depth Test

Paved surfaces where grooves have been cut across the concrete create channels for excess water to drain off the paved surface allowing for better tire traction. These grooves are integral to reduce the risk of hydroplaning during a precipitation event. It has been shown to restore wet friction performance to worn pavement surfaces and improve overall traction of tire treads.

While marking the test paved surface section for cleaning by CG Environmental proprietary and patented truck mounted technology time test, it was noticed by UNTHSC Technicians that the cracks in sections of cements were deeply embedded with dirt and material. A cracked groove between the two sections of pavement was packed with particulate material (dirt, hydrocarbons, etc.) and measured a depth of 0.5 millimeters. As the sections of cement were uneven with a slant towards a storm drain CG Environmental HHRU equipment was used to extract the packed material, simulating the ability of the technology to clean grooves and channels in the concrete and around stationary structures.

The HHRU equipment performed a single cleaning pass. After a single cleaning pass, the depth of the groove measured 4.0 millimeters.

Figure 3. Removal of Impacted Material from Cement Crack with HHRU Technology

A cracked groove between the sections that did not have the severe slant as above was measured for cleaning with the Annihilator. The groove of cement measure 0.0 millimeters in depth and was impacted by a consider amount of particulate material (dirt, hydrocarbons, etc.).

Figure 4. Cracked Cement Impacted with Particulate Matter

As with the HHRU, a single cleaning pass was performed by The Annihilator. After cleaning, measurements were taken again and the groove measured 8.0 millimeters in depth (from an initial depth of 0.0 millimeters. The crack previously impacted with particulate material and street residue was virtually void of loose material, or visible hydrocarbon impact.

4. Hydrocarbon Spill Time Test

CG Environmental's hand held recovery unit ("HHRU") equipment is used in areas which are not appropriate for the larger truck mounted Annihilator technology. The HHRU machine is smaller and can be easily maneuvered around obstacles and uneven paved surfaces. It is able to reach areas of spill that the larger, less mobile Annihilator cannot reach.

The HHRU proprietary patented surface cleaning equipment's efficiency and effectiveness was evaluated. In order to test the efficiency and effectiveness of HHRU technology in hydrocarbon recovery, approximately 1 cup of 15W-40 engine oil was poured onto two segments of paved surface. The simulated hydrocarbon spill was distributed across the sections surface area and allowed to soak into the paved surface area for 18 minutes. Both methods of clean-up (as seen in the Kitty Litter Test) was performed, however, in this test the patented smaller HHRU equipment was used.

A section of paved surface areas 24" x 68" was cleaned using granular absorbent and sweep crew following the same protocol as the previous test (herein identified as "Control"). Approximately 1 quart of granular absorbent was required for the surface area of the simulated spill. Another section of paved surface adjacent to Control measuring 24" x 76" was cleaned with CG Environmental's HHRU surface equipment. The time required for Control and CG Environmental's HHRU to clean-up paved surface was recorded by UNTHSC Technicians.

Results:

The Control method of absorbent/sweep crew clean-up took 26 minutes to adequately absorb hydrocarbon from the paved surface (one application of granular absorbent), and place contaminated granular absorbent in to a drum for final disposal. The time included working the absorbent in and around hydrocarbon spill with brooms during the time test. The intent of requiring brushing with brooms during this time was for maximum absorbance of hydrocarbons into the absorbent material (standard operating procedures).

The CG Environmental's HHRU method of removal was timed at 2.0 minutes to perform. The HHRU technology simultaneously captures the hydrocarbon/liquid contaminated fluid into a tank on the truck mounted equipment. This prevents required lifting of drum or moving a drum into and out of a vehicle or site by workers.

Findings:

- The CG Environmental HHRU technology required minimum performance time (2.0 minutes) when compared to the absorbent/sweep methods (26.0 minutes for 1 application of granular absorbent). Note: multiple applications of granular absorbent are required for maximum hydrocarbon absorption.
- The UNTHSC personnel determined the recovery efficiency of surface contamination was visibly more effective when using the CG HHRU equipment as compared to the Control. (Quantification of hydrocarbon recovery was performed in the Hydrocarbon-Water Recovery and Analysis Test and the Wipe Test).

Figure 5: Paved Surface Cleaned with Absorbent/Sweep Method (on left) compared to CGs HHRU equipment (on right). (Hand held recovery unit (HHRU) is visible on the right side of the picture).

5. Hydrocarbon-Water Recovery and Analysis

The recovery efficiency of the HHRU and KL process was assessed in a simulated spill test using engine oil (as described in Test 4). Paved concrete surface was cleaned by the HHRU process and KL process in separate concrete areas. After cleaning, the paved surfaces were rinsed with clean bottled water (pH 7.0). The water was collected in a clean sand berm at the base of the concrete surface. The recovered water was contained in sterilized glass vials specific for volatile organic compounds. The tops of the vials were secured with tape to prevent tampering or leaks.

The samples were placed in a cooler for delivery to the laboratory for analysis. The sample(s) were analyzed for Total Petroleum Hydrocarbons (TPH) by a third-party NELAP certified laboratory (Armstrong Forensic Labs, Arlington, TX). The samples were maintained in the custody of UNTHSC personnel at all times and delivered to the laboratory according to proper protocol maintaining Chain of Command (COC).

Results:

The results of the HHRU water analysis are presented below:

Analyte	Results	Reporting Limits	Units
TPH (C6-C12)	<4.6	4.6	mg/L
TPH (<C12-28)	<4.6	4.6	mg/L
TPH(>C28-35)	<4.6	4.6	mg/L
TPH (C6-C35)	<4.6	-	mg/L

The results of the KL analysis are presented below:

Analyte	Results	Reporting Limits	Units
TPH (C6-C12)	<4.6	4.6	mg/L
TPH (<C12-28)	5.8	4.6	mg/L
TPH(>C28-35)	<4.6	4.6	mg/L
TPH (C6-C35)	5.8	-	mg/L

Findings:

- Recovered water from the HHRU process showed no presence of hydrocarbons (C_6 – C_{35}) above laboratory detection limits.
- Recovered water from the KL process showed residual hydrocarbons (C_{12} – C_{28}) above laboratory detection limits.
- The HHRU process includes retrieval of water by a vacuum process and provides a more complete retrieval of water, hydrocarbons and debris material from concrete surfaces.
- The HHRU process outperformed the KL process in retrieval of hydrocarbon (C_{12} – C_{28}).

6. Hydrocarbon Recovery – Diesel Spill

The HHRU patented technology is designed to remove spilled and embedded hydrocarbon material on porous or non-porous surfaces (concrete, cement, etc). The classic method of hydrocarbon retrieval includes the use of an absorbent granular pellet commonly called Kitty Litter (KL process). The HHRU technology retrieval was compared to the KL process to determine the efficiency and effectiveness in hydrocarbon absorbance.

CG Environmental patented technology requires no granular absorbent for spill abatement. The process includes application of a pre-treatment prior to the HHRU agitation, hot water rinse and vacuum process.

To compare the HHRU and KL cleaning process, a simulated diesel spill was applied to 2 strips of paved concrete drive. Equal amounts of diesel fuel was applied to the concrete and was allowed to absorb into the concrete. The HHRU and KL process was then performed. Bottled water was poured over the cleaned areas on both test areas in equal quantities. The recovered water was collected in a sand berm (using new clean sand) at the base of the drive.

Results:

The collected water sample was then analyzed for C_6 – C_{36} hydrocarbons. The results are provided in the chart below.

ANALYTE	C- HHRU DIESEL	Reporting Limits (mg/L)
TPH (C_6 - C_{12})	<4.6	4.6 mg/L
TPH (C_{12} - C_{28})	75.5	4.6 mg/L
TPH (C_{28} - C_{35})	<4.6	4.6 mg/L
TPH (Total)	75.5	4.6 mg/L

ANALYTE	D - KL DIESEL	Reporting Limits (mg/L)
TPH (C_6 - C_{12})	9.1	4.7 mg/L
TPH (C_{12} - C_{28})	500	4.7 mg/L
TPH (C_{28} - C_{35})	<4.7	4.7 mg/L
TPH (Total)	509.1	4.7 mg/L

Note: TPH C_{28} – C_{35} was not present above laboratory detection limit in either sample

Findings:

- Recovered water from the HHRU process showed residual hydrocarbon C_6 – C_{12}, below laboratory minimum detection limits.
- Recovered water from the HHRU process showed residual hydrocarbon C_{12} – C_{28}, present at 75.5 mg/L above laboratory minimum detection limits.
- Recovered water from the HHRU process showed residual hydrocarbon C_{28} – C_{35}, below laboratory minimum detection limits.
- Total hydrocarbon concentration in the retrieved HHRU water sample was 75.5 mg/L.
- Recovered water from the KL process showed residual hydrocarbon C_6 – C_{12}, present at 9.1 mg/L above laboratory minimum detection limits.

- Recovered water from the KL process showed residual hydrocarbon $C_{12} - C_{28}$, present at 500 mg/L.
- Recovered water from the HHRU process showed residual hydrocarbon $C_{28} - C_{35}$, below laboratory minimum detection limits.
- Comparison results of the HHRU and KL process confirmed the HHRU process resulted in a 98% overall greater capture rate of $C_6 - C_{12}$ when compared to the KL process.
- Comparison results of the HHRU and KL process confirmed the HHRU process achieved a 562% overall capture rate of $C_{12} - C_{28}$ when compared to the KL process.
- Comparison results of the HHRU and KL process confirmed no change in overall capture rate between the two processes for $C_{28} - C_{35}$. It is highly probably that TPH $C_{28} - C_{35}$ species were not present in either process.
- Overall capture rate of Total Hydrocarbons confirmed the HHRU process resulted in a 574% greater capture rate when compared to the KL process.
- Results indicated the HHRU unit out-performed the KL absorbent in retrieval of hydrocarbons.

7. White Glove Wipe Test - Hydrocarbon

In order to compare hydrocarbon removal and general cleanliness of the paved surface after simulated clean-up with the sweep and hand held recovery unit (HHRU) technology a "White Glove Wipe Test" was performed. Using 100% cotton gloves UNTHSC personnel placed a white glove on each hand. Applying moderate pressure the right hand was wiped across the Control or Absorbent/Sweep treated area, while the left hand was wiped across the CG HHRU technology treated area. The white gloves were then placed in a glass sampling jar, sealed with tape placed around the neck of the lid and labelled for delivery to the laboratory. The samples were identified as Sample 3 - Sweep Test Dirty Glove, referring to the glove used to test the Control or absorbent/sweep technology; and Sample 4 - Sweep Test Clean Glove referring to the glove used to test the CG HHRU technology. The samples were then packaged for delivery to the third party certified laboratory (Armstrong Forensics, Arlington, TX), and samples were analyzed for Total Petroleum Hydrocarbons (TPH).

The laboratory defines results in 4 categories of hydrocarbons; carbon chain C6–C12, carbon chain C12–C28 and carbon chain C28-35. A fourth category is total petroleum hydrocarbons C6-C35 inclusive.

Results:

Final analysis of Sample 3: Sweep Test Dirty Glove (KL) results are as follows:

Analyte	**Results**	**Reporting Limit**	**Units**
TPH (C6-C12)	146	130	mg/kg, dry wt.
TPH (>C12-C28)	1,340	130	mg/kg, dry wt.
TPH (>C28-C35)	<130	130	mg/kg, dry wt.
Total TPH (C6-C35)	1,486	130	mg/kg, dry wt.

Final analysis of Sample 4: Sweep Test Clean Glove (HHRU) results are as follows:

Analyte	Results	Reporting Limit	Units
TPH (C6-C12)	150	150	mg/kg, dry wt.
TPH (>C12-C28)	<150	150	mg/kg, dry wt.
TPH (>C28-C35)	<150	150	mg/kg, dry wt.
Total TPH (C6-C35)	150	150	mg/kg, dry wt.

Note: Reporting Limits are sample specific and may vary between samples.

Sample 3 had the highest Total TPH (C6-C35) totaling 1,486 (mg/kg, dry wt.) with carbon category (>C12-C28) recording the highest concentrations. In comparison, Sample 4 Total TPH was 150 (mg/kg, dry wt.). These results support the fact that CG Environmental HHRU technology is highly effective in removing petroleum hydrocarbons from paved surfaces when compared to the traditional KL process.

Finding:

- CG HHRU technology performed superior over the absorbent/sweep method resulting in a higher capture rate of hydrocarbons from paved surface with less potential for contamination from hydrocarbon/granular absorbent runoff.
- The capture rate of particulate matter (tire debris, soil/dust accumulation, granular absorbent) was higher with the CG HHRU technology allowing for better traction of tires on roadways, less potential for skidding, and less impact to adjacent waterways and environment impact from particulate matter run-off during a precipitation events.

Figure 6. Cleaned Pavement Using HHRU Technology (Left Glove) and Granular Absorbent (Right Glove).

8. White Glove Test - Metal Recovery

Debris on roadways whether liquid, or particulate matter can increase the incidence of roadway accidents due to loss of tire traction. Additionally debris can be mobilized causing vehicular damage. Removal of debris from roadway lowers the incidence of skids, slips and vehicular accidents.

The White Glove Test was performed to assess the ability of the HHRU and KL processes to remove metals on concrete surfaces from a simulated oil spill. After the surfaces of the concrete were cleaned by both the HHRU and KL processes, HESS personnel used 100% cotton gloves to wipe across the concrete surface retrieving any residual metals. The gloves were then placed in separate glass sampling jar, sealed with tape placed around the neck of the lid and labelled for delivery to the laboratory. The samples were analyzed for metals (RCRA Metals: Method EPA 6010C by a third party certified laboratory (Armstrong Forensics, Arlington, TX).

Results:

Analysis of the metals is presented below:

ANALYTE Units (mg/L)	HHRU - Glove Metal Analysis	KL - Glove Metal Analysis	% Change
Arsenic	<0.37	<0.41	-0-
Barium	53.6	63.6	↑19%
Cadmium	<0.19	<0.21	-0-
Chromium	0.373	6.72	↑1702%
Lead	<0.37	1.93	↑422%
Selenium	<0.93	<1.1	-0-
Silver	<0.093	<0.11	-0-
Mercury	0.0051	0.0061	↑20%

Finding:

- Recovered residual Barium was confirmed at 53.6 mg/L for the HHRU process, while residual Barium was confirmed at 63.6 mg/L for the KL process. The HHRU showed a 19% better capture rate for Barium when compared to the KL process.
- Recovered residual Chromium was confirmed at 0.373 mg/L for the HHRU process, while residual Chromium was confirmed at 6.72 mg/L for the KL process. The HHRU showed a 1702% better capture rate for Chromium when compared to the KL process.
- Recovered residual Lead was confirmed at <0.37 for the HHRU process, while residual Lead was confirmed at 1.93 mg/L for the KL process. The HHRU showed a 422% better capture rate for Lead when compared to the KL process.

- Recovered residual Mercury was confirmed at 0.0051 mg/L for the HHRU process, while residual Mercury was confirmed at 0.0061 mg/L for the KL process. Results indicated a 20% better capture rate for Mercury when compared to the KL process.
- Recovered residual Arsenic, Cadmium, Selenium and Silver was reported below laboratory reporting limits for both the HHRU and the KL process.
- Results indicated the HHRU unit out-performed the KL process in retrieval of metals.

Figure 7. KL Glove Post Cleaning

Note: Residual liquids after cleaning with the KL process were visible on the concrete after absorbent was applied (and removed) during the KL process. Concrete remained stained with residue of of KL absorbent.

Figure 8. HHRU Glove Test – Residual Oil Visible in Picture

Note: The concrete appeared unstained after HHRU process and appeared visibly dry with no sheen from oil.

Figure 9. Glove Comparison Test

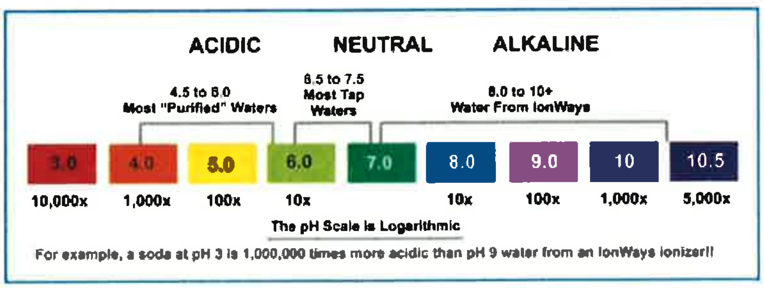
HHRU glove (left side of picture) is void of particulate matter or hydrocarbons.
KL glove (right side of picture) is highly impacted with particulate matter and hydrocarbons

9. pH Test of Paved Surface

During precipitation events runoff from paved surfaces mobilize contamination (hydrocarbon, particulate matter, rubber, etc.) and cause pollution of storm drains, stream, rivers and lakes. Many of the pollutants are hydrocarbon based and may cause alteration of the natural pH of water and soil resulting in plant, fish and animal contamination and kills. Management of waterways along the highways avoiding contamination of natural waterways is an ongoing challenge.

While conducting the analysis of CG proprietary technology a comparison pH test was performed on the paved areas cleaned with the absorbent technology and CG's HHRU technology. The same two section of paved surfaces used in the White Glove Wipe Test were used while performing the pH Test. In order to test residual pH of paved surface after it was cleaned by the two different technologies bottled water with a pH of 7.0 (neutral) was applied to the treated paved surfaces. A standard strip of pH paper was used to measure the results.

Figure 10. pH Scale Logarithmic Scale



Results:

The pH of the paved surface cleaned with the absorbent/sweep method resulted in a pH between 9 and 10.

The pH of the paved surface cleaned with the CG HHRU technology resulted in a pH of 7.

Findings:

- The CG HHRU technology provided more protection to the environment from alteration of natural pH when compared to the absorbent/sweep method and maintained a balanced neutral pH.