Spill Cleanup of Fuel Contaminated Soils After Roadway Accidents Using In Situ Bioremediation.

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Introduction

Road accidents involving fuel oil spills are common and both the state environment agencies and cleanup contractors are busy most of the year attending to these spills. Spills on roadways due to transportation accidents result into release of fuels on the road and embankment thereby destroying the vegetation in the impacted zone. The first task of the cleanup crew is in the following order.

- **Remove the free product from the impacted surface**
- **Excavate the soil and affected area**
- **Transport the contaminated soils to the landfill site for disposal**
- **Replace the area with sanitized soil or crushed gravel**
- ***Lastly follow it by restoration of vegetation***.

Excavation of contaminated soils and replacement with sanitized soil may not be very difficult, but rejuvenation and restoration of the impacted soil is more difficult as ***the toxicity of the hydrocarbons is more lasting***.

Fuel Oil Spills In First 3 Months Of 2007

- **Jan. 16, 2007**: At the intersection of Old Pawling and Nanny Hill roads in New York State an oil delivery truck overturned spilling 4,200 gallons of heating oil onto the road and surrounding properties, including a regulated wetland and a stream that flows into the Ten Mile River.

- **February 15, 2007**: Another spill occurred thirty days later in Massachusetts releasing 2000 gallons of home heating oil coincidentally near Ten Mile River.

- **20th March, 2007:** Route 117 in Warwick, MA was closed after truck carrying heating oil flipped over in the morning and leaked the fuel into the road.

Road transportation services are employed for shipments of oils and fuels in the USA and other countries because of easy accessibility of gas stations and terminals. Bulk transportation of fuels is still carried out by rail roads and Kirton & Beaulieu (2005) have reported their experiences on bioremediation of spill in a rail yard in Massachusetts. Both highways and rail road services are prone to accidental spills and are critical for the emergency response bodies. However, it is road transport that is used for supplying fuel oils to distant places and is more critical from the point of view of seriousness of accidents as it affects local populations and damage to the vegetation along the edge of the road.

Statistical Information on highway spills

The cause of such accidents may be many including the age of these tankers as even today some of the tankers on the road may be more than 20 years old and may be structurally weak (Anonymous, 2003). Complete statistical information of roadways spills of fuel oil are not available in the USA but a recent report (Weyls, 2003) indicates that the number of incidents involving road way spills has doubled from 7,297 in 1990 to 14,443 in 1999 in just 10 years.

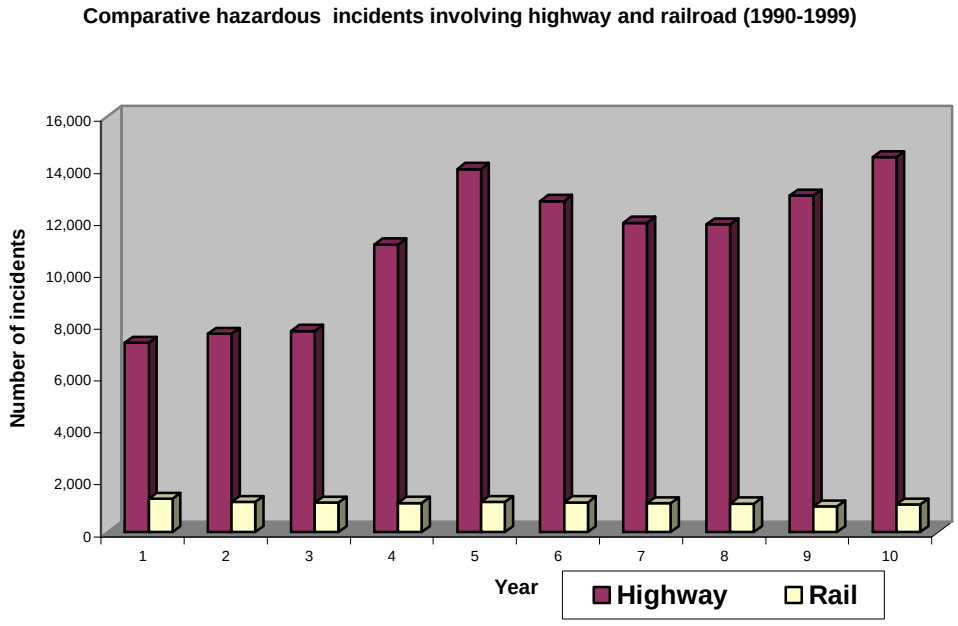

Figure 1. Comparison of hazardous material spill incidents for highways and rail road

(SOURCE: U.S. Department of Transportation, Hazardous Materials Information System database, 2000, available at http://hazmat.dot.gov.)

A similar study was carried out in the UK to identify the types of releases in England and Wales by Lee & Fitzsimons (2005) during roadways accidents as shown in the data below and it was reported that soil received the greatest impact of these spills.

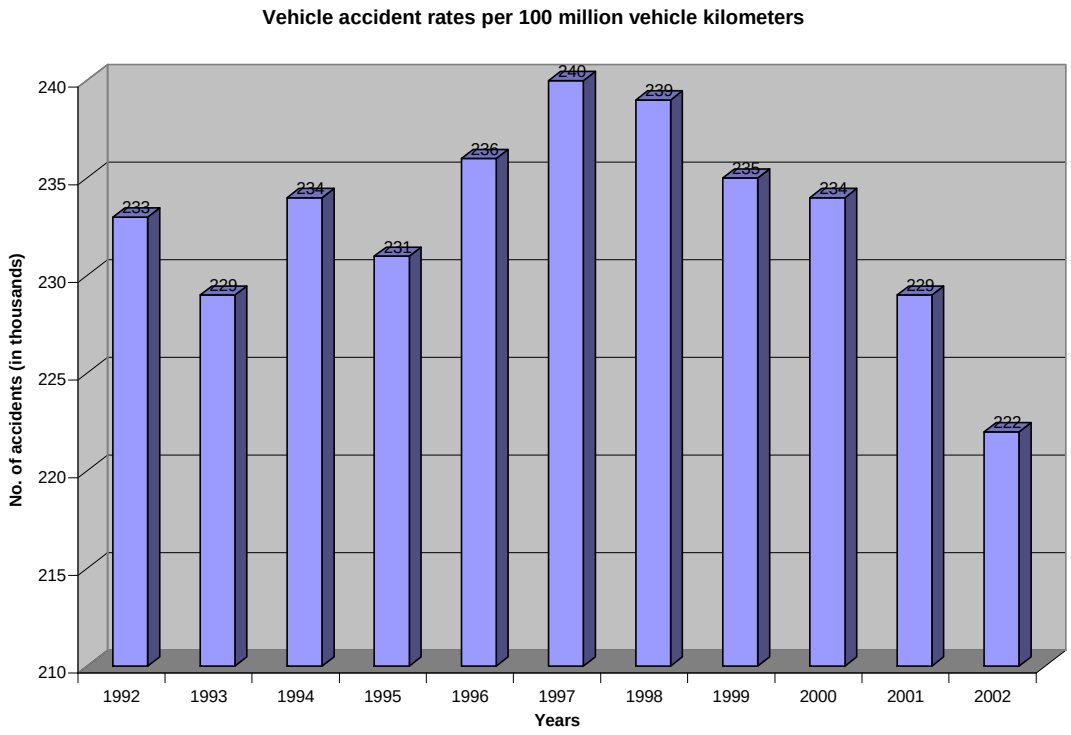

Figure 2. Vehicle accidents in United Kingdom (UK) from 1992 to 2002

(Source: Peter Lee & David Fitzsimons (2005) " An analysis of Inland oil and fuel incidents in England and Wales")

Report also showed that diesel tanks on trucks are most susceptible to rupturing. An earlier article in the Society of Automotive Engineers Transactions in 1974 states:

"Trucks have a higher crash-fire frequency than passenger vehicles, notwithstanding their superior size and weight. Even a cursory examination of the crash vulnerable fuel system of most trucks provides the explanation for this undesirable record. The archaic outside plumbing designs of truck fuel systems obviate any safety advantage the use of fuel may provide over gasolne"

Present paper describes results of two case studies on the use of AgroRemed a bioremediation product for cleanup of diesel oil spills in Virginia and West Virginia. In both these cases application of bioremediation products was carried out with the approval

from State Department of Transportations and also with the concurrence from the State Department of Environment. Results show that use of AgroRemed not only reduced the costs of cleanup but also rejuvenated the soil for healthy growth of vegetation through detoxifying the effects of hydrocarbons.

Case Study 1: Restoration of Vegetation Affected By Diesel Spill

Approximately 100 gallons of diesel fuel from a ruptured saddle tank and ten gallons of motor oil from the truck engine were released after a tractor/trailer highway accident releasing. Wreckage ended at the bottom of the embankment, immediately adjacent the opening of the subsurface storm piping. Diesel fuel released from the truck, flowed into soil near the wreckage and near the open ditch. Several hundred feet of guardrail was destroyed in the accident, causing engine oil to disperse over approximately 100' of vegetation at the pavement edge. GEC Environmental Contracting Corp. (GEC) was contacted to provide clean up of the release.

Figure 3. The accident site and the release of fuel from the tractor trailer in Virginia

Discussions were held with representatives of the Virginia Department of Transportation (VDOT) and implications of soil removal in this area were reviewed. The spill site was on a slope and it would be difficult to use mechanized cleanup vehicles for the cleanup. Excavation of the soil was not considered as an option for the cleanup.

It was agreed that this site is suitable for evaluation of use of on-site (*in situ*) bioremediation for cleanup of highway spills. AgroRemed manufactured by Sarva Bio Remed, LLC was selected for direct application at the release point and affected soil and vegetation. AgroRemed has a track record for successful cleanup of contaminated soils

after spills of diesel or heating oil both in residential and industrial facilities. AgroRemed has shown ability to reduce TPH values by 90% in three weeks. In one case the TPH of the impacted soil after a highway spill was reduced from 25,000 ppm to 93 ppm.

Advantages of AgroRemed.

- **Treats the spill at the source and rejuvenates the soil**
- **Reduces the fumes produced by the spill almost instantly**
- **Available in easily spray able liquid form**
- **Easy to apply and environmentally safe**
- **Generally a one time application under favorable conditions**
- **Fast remediation time of 3 weeks**
- **AgroRemed is a complete solution**
- **No waste for disposal**

Figure 4. Application of AgroRemed to impacted soils during restoration

Impacted soil saturated with diesel was manually turned/tilled to allow natural oxygenation before application of AgroRemed as seen in Figure 4.

A soil sample was collected after 20 days of application from this location and analyzed for TPH/DRO values and the results of hydrocarbon range C-5 to C-30 showed a value of 26,000 ppm or more than 40% reduction in the value from original of 65,000 ppm. Although application of AgroRemed was continued at regular intervals, the reduction in TPH/DRO was not appreciable and was reduced from 26,000 ppm to 11,800 ppm. This is attributed to prevailing drought condition and the soil was very dry.

In September, however, before the final application, soil was sprayed with water from a tanker before application of AgroRemed and the surface of the soil was also covered with straw mulch to prevent excessive evaporation. The TPH of the soil was examined after 15 days and the levels of ***TPH were reduced to 650 ppm*** with no signs of tainting of the grass and interestingly no diesel odor.

Finally, the area was found to support healthy growth of grass and other vegetation indicating there was no residual toxicity in the soil. AgroRemed thus helped restoration of the soil to its condition before the spill. The DEQ agreed that there was no further action required. The total time required for the cleanup was a total of 103 days for reaching the accepted levels of contaminant.

Case Study 2: Vehicle Accident and underlying cables

In a highway accident in WV a tractor/trailer released approximately 75 gallons of diesel fuel from a ruptured saddle tank. Free petroleum product flowed into the gravel alongside road shoulder and adjacent embankment. The site is a single lane, north/south highway of typical asphalt paved construction (Figure 5). Potential receptors are human, wildlife and groundwater. **Multiple major underground communication utilities lines were present in the accident area making it difficult to excavate.**

Figure 5. Accident site showing the asphalted road affected by spill.

Diesel fuel had released on the pavement edge and gravel shoulder causing surface staining. Debris on the pavement was pushed to the gravel to allow normal traffic patterns for evening hours.

Soil excavation/disposal would be conducted in the petroleum stained areas under the supervision of the state environment protection agency. The West Virginia Department of Environmental Protection (DEP) supervised the cleanup. Several ground communication pedestals were present both north and south of the incident site,

indicating buried utilities in the area and the cleanup had to be coordinated with the concerned utility agencies. A soil sample was collected from the center of the surface staining to provide waste characterization and analysis of the petroleum concentrations showed TPH at 47,000 parts per million (ppm).

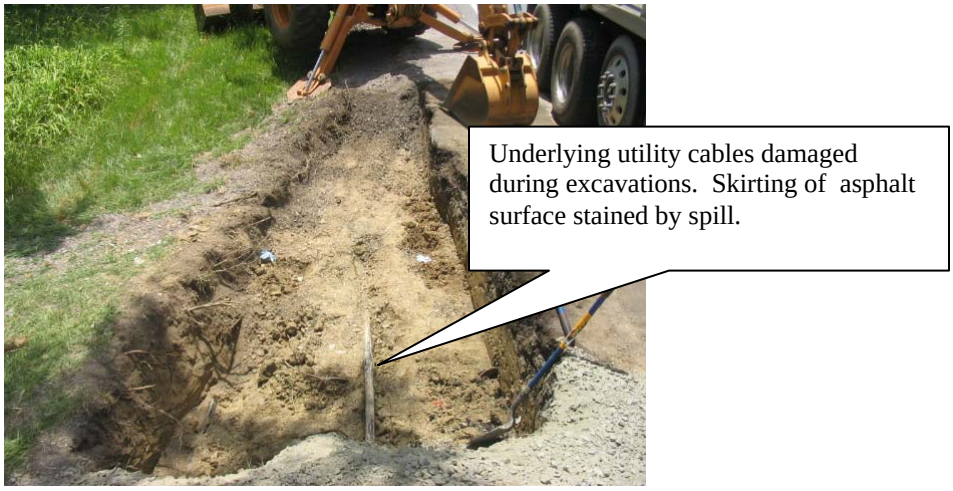

Figure 6. Showing underlying cables and stained skirting of pavement.

As the excavation continued along the embankment towards the open side ditch, depth was increased once equipment progressed beyond the exposed cable (Figure 6). At the east side of the excavation, a depth of 48" was achieved when a third unknown communication cable was damaged by the backhoe. Awaiting repair technicians, it was agreed that further soil removal is not practical or even possible by conventional means due to the position of buried cables. Underlying cables thus significantly reduced the area of excavation, accessibility and time constraints of two-way traffic closure hence a decision to apply AgroRemed was made by WV DEP.

I*n situ* bioremediation using AgroRemed was considered a less disruptive and safe method for cleanup. Repair technicians had not arrived at this time and AgroRemed was readily available on site. Four locations were identified to record changes in TPH in soil and samples of soil from these locations were monitored several times to record any decrease of petroleum concentrations during bioremediation. Two pine trees located along the east bank of the right-of-way were identified as bench marks for future sampling events. Soil samples were collected from these two west locations at the pit bottom showed **2,500 ppm (94.7%)** and **4,000 ppm (91.8%)** respectively after 20 days of treatment.

Individual tests of the soil samples did not indicate vapor levels above background readings of 2.3 for Photo Ionization Detector (PID). Laboratory results for four soil samples collected on July 26th showed the results as follows; Sample 1 showed values below laboratory detection limits of 50 ppm, Sample 2 showed 570 ppm, Sample 3 showed 830 ppm, and Sample 4 showed 290 ppm.

These results indicated an aggressive degradation of petroleum hydrocarbons within seven days of the previous application. Use of bioremediation product under such situation was thus justified. As seen from the results, total remediation of diesel fuel was completed in 35 days and DEP agreed no further action (NFA) was needed and the project was closed.

Effect of diesel on Asphalt:

Spills of diesel affect the structure of asphalt pavement (Balwin et al, 2005) as seen from their laboratory studies on the mechanical strength of pavement influenced by diesel spill for an extended period of 8 months. The results showed that in the first week itself the Resilient Modulus decreased from 2350 MPa in control to 1250 MPa in test samples. This support the general observation that diesel affects asphalt surface primarily because of dissolution of asphalt binder by aggressive property of diesel. In fact much of degradation tqakes place in first two weeks and residual effect is recorded for many months later. Greg Sholar of Florida DOT shared similar experience reporting ravelling of the surface not long after construction and this was attributed to the effect of diesel spills on the road (Personal communication).

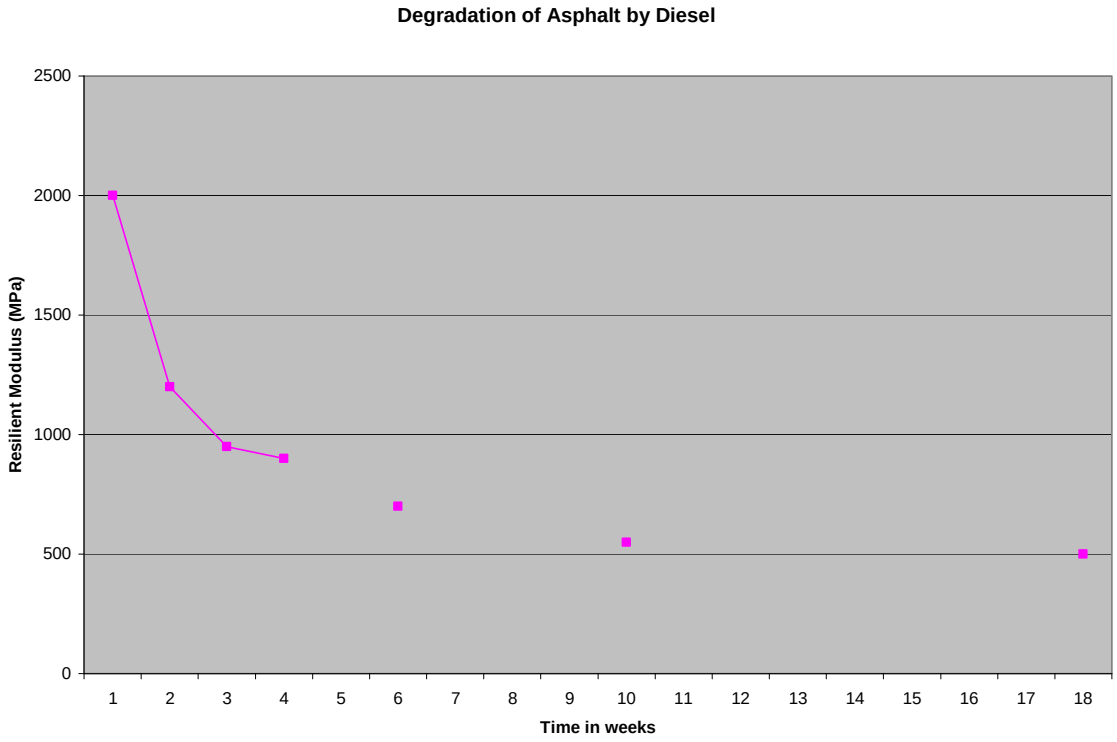

Figure 7. Laboratory analysis of effect of diesel on core samples treated with diesel simulating road conditions.

Re-created from “Degradation of asphalt due to diesel spills on roads” by Balwin et al., 2005)

CONCLUSIONS

The average amount of fuel spilled in a saddle tank release is **104 gallons** while the average cost to clean it up is ***$9,200*** nationwide due mainly to costs of transportation and disposal of contaminated soils. ***Reuse*** of the same soil after treatment with AgroRemed would reduce costs of transportation and cause minimum disturbance to the local ecosystems. Overall benefits of AgroRemed for highway spill are listed below.

- **TPH reduced by more than 90% in 20 days time**
- **Reduces toxicity of diesel and promotes healthy vegetation**
- **Cost effective on-site cleanup (costs less than *$ 2,000.00)***
- **AgroRemed cleans up of spill in a non-invasive manner**
- **Treatment with AgroRemed reduces damage to underground utility lines**
- **There were no residual diesel odors**
- **Prevents of premature failure of asphalt if treated immediately**

AgroRemed detoxifies the toxic nature of the hydrocarbon and then consume the contaminant in a shortest period of time if all the conditions favoring the growth of bacteria are available. Accidents on the highways are often away from city and so it is difficult to monitor the situation and AgroRemed reduces monitoring.

AgroRemed delivers a clean and efficient cleanup solution. Application of AgroRemed to the accident site immediately after a spill will reduce the damage to the asphalt surface and also reduce the damage to the roadside vegetation. It is a safe, easy to use and a non-invasive solution and should form an important part of spill cleanup kit for the emergency response operations. Many more projects have been completed so far.

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