



**WIL CHEE –
PLANNING, INC.**

ORC Advanced® Treats Multiple Plumes and High TPH Concentrations



**US Army Corps of
Engineers®**

CASE SUMMARY

DoD Site, Pago Pago, American Samoa

Past operations at a former U.S. Navy Base in American Samoa had resulted in total petroleum hydrocarbon (TPH) contamination within the subsurface. Currently occupied by an elementary school, the former military base once stored barrels of petroleum-based fuels for military operations. A hydrocarbon sheen was evident following rain events prompting the need for a remedial investigation to determine the extent of contamination within the subsurface. Soil boring samples revealed elevated levels of TPH-diesel, TPH-gasoline, and TPH-motor oil at concentrations exceeding the cleanup standard. Site investigations did not identify any TPH impact to groundwater.

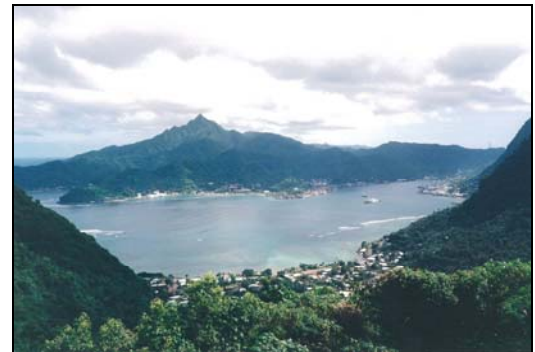


Figure 1. Pago Pago Harbor

Access to the site and equipment was very limited thus on-site sampling and remediation was conducted only annually when the school was out of session. As a result, a remedial approach was required in which no operations & maintenance would be necessary. In addition, a technology was needed which would not damage on-site structures, successfully treat low permeable soils, and not disrupt the day to day operations of the elementary school. Enhanced bioremediation using ORC Advanced® was chosen since it did not require on-site maintenance and would effectively treat TPH concentrations within a reasonable timeframe.

REMEDIATION APPROACH

The initial application of ORC Advanced® was applied in 2005 via multiple trenches to address the three identified plumes (Figure 4). ORC Advanced® was mixed with water to form a slurry then placed at the bottom of each trench prior to backfilling (Figure 3). Soil sampling one year later indicated a reduction in TPH levels; however three boring samples remained above the cleanup goal. This was explained by the lack of water available in the subsurface to move the ORC Advanced® radially from the applied trench area. A second application in 2006 was delivered via direct-push injection using approximately 2,000 pounds of ORC Advanced® into a total of 82 injection points (Figure 5 & 6). In 2007, an ORC Advanced® injection application was completed to treat the few remaining hot spots. One last application is scheduled for summer 2008.

**Figure 2. Trench Construction
at the Elementary School**



**Figure 3. ORC Advanced®
Slurry Applied to Trenches**



Figure 4. 2005 ORC Advanced® Trench Application

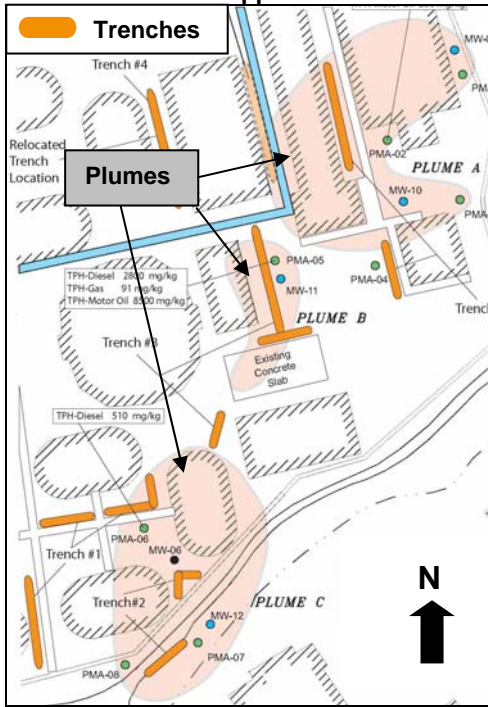
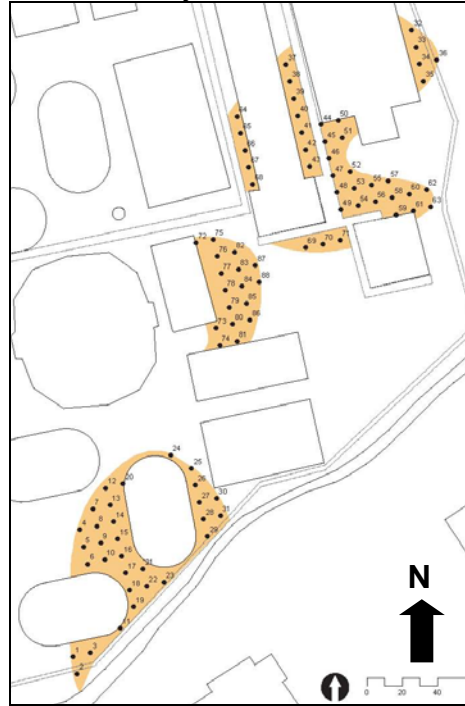


Figure 5. 2006 ORC Advanced® Injection Grid



RESULTS

Trench Application

The 2005 trench application was successful in reducing TPH concentrations significantly (Table 1). Within the area of highest concentrations (PMA-05), TPH-diesel was reduced from 2,800 milligrams per kilogram (mg/kg) to 1,700 mg/kg, TPH-motor oil declined by 50% and TPH-gasoline was reduced to below the cleanup goal of 50 mg/kg. Of the eight sampled areas, three remained above the Project Action Level – PMA-01, PMA-02, and PMA-05. Although the trench application was successful in reducing concentrations within the immediate application area, the radius of influence was not great enough to remediate the entire plume. Therefore, a follow up application was designed using direct-push technology.

Table 1. Trench Application Results - TPH Concentrations in Soil (mg/kg)

	TPH-diesel		TPH-gasoline		TPH-motor oil	
	2005 Pre-trench	2006 Post-trench	2005 Pre-trench	2006 Post-trench	2005 Pre-trench	2006 Post-trench
PMA-01	2.2	15	ND	ND	44	140
PMA-02	550	92	ND	ND	230	1,000
PMA-03	160	5.2	ND	ND	ND	13
PMA-04	ND	3.5	ND	ND	ND	33
PMA-05	2,800	1,700	91	29	8,500	4,100
PMA-06	510	15	23	0.69	ND	47
PMA-07	3.1	3.2	ND	ND	ND	ND
PMA-08	ND	4.3	ND	ND	ND	13.1
Cleanup Goal	50		50		50	

Direct-Push Application

The direct-push application substantially reduced high concentrations of TPH-diesel and TPH-motor oil (Table 2). Most significant was area PMA-05 where TPH-diesel declined from 1,700 mg/kg to below the cleanup goal and TPH-motor oil was reduced from 4,100 to 120 mg/kg, a 97% reduction. An increase in concentrations was observed as a result of the direct-push technique which mobilized residual contamination from the soil. A direct-push injection was completed in July 2007 to address the remaining concentrations of TPH-diesel and TPH-motor oil. A total of 2,500 pounds of ORC Advanced[®] were applied using the same design layout as the 2006 application (Figure 5). One last application is planned for summer 2008.

Table 2. Direct-Push Application Results - TPH Concentrations in Soil (mg/kg)						
	TPH-diesel		TPH-gasoline		TPH-motor oil	
	2006 Pre-Inj	2007 Post-Inj	2006 Pre-Inj	2007 Post-Inj	2006 Pre-Inj	2007 Post-Inj
PMA-01	15	4.4	ND	ND	140	120
PMA-02	92	59	ND	ND	1,000	480
PMA-03	5.2	6.7	ND	ND	13	58
PMA-04	3.5	120	ND	ND	33	820
PMA-05	1,700	12	29	ND	4,100	120
PMA-06	15	6.3	0.69	ND	47	11
PMA-07	3.2	150	ND	1.5	ND	420
PMA-08	4.3	ND	ND	ND	13.1	ND
Cleanup Goal	50		50		50	

Figure 6. ORC Advanced[®] Direct-Push Injection



CONCLUSION

To date, one ORC Advanced[®] trench application and two direct-push injections have been completed. The trench technique was effective within the immediate vicinity of the application. However, in order to achieve a better radius of influence, the direct-push technique was more effective. Additionally, the impact and inconvenience to the site from direct-push was significantly less in comparison to the large trenched areas as shown in Figures 2 and 3.

TPH-motor oil has remained above the cleanup goal as seen in Table 2. This can be explained by the fact that the molecular size of motor oil is more significant compared to diesel and gasoline and, therefore, more time is needed to breakdown the molecule. In addition, as a result of the injection, mobilization of residual contamination from the soil caused an increase in concentrations. The July 2007 application is expected to continue the breakdown of any remaining contamination, including motor oil, towards the cleanup goal. Sampling will again be completed in the summer of 2008 along with one final ORC Advanced[®] application.

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