P & D ENVIRONMENTAL
A Division of Paul H. King, Inc.
4020 Panama Court
Oakland, CA 94611
(510) 658-6916

May 1, 2000
Work Plan 0221.W3

Mr. Scott Seery
Alameda County Department of Environmental Health
1131 Harbor Parkway
Alameda, CA 94502

SUBJECT: OXYGEN RELEASING COMPOUND INJECTION WORK PLAN
Former Cottage Bakery
2497 and 2507 Grove Way
Castro Valley, California

Dear Mr. Seery:

P&D Environmental, a division of Paul H. King, Inc. (P&D), is pleased to present this work plan for the drilling of thirty-three soil borings and the injection of Oxygen Releasing Compound (ORC) into those borings. The boring density and proposed concentrations for application of the ORC are in accordance with recommendations set forth by the ORC manufacturer for effective use of ORC. Mass balance calculations for application of the ORC are attached with this work plan as P&D Calculations 0221.C1. The calculations detail the amount of ORC to be used at the site, and demonstrate that the amounts to be used are appropriate to remediate the detected hydrocarbons at the site. A Site Plan Detail showing the proposed boring locations is attached as Figure 1.

All work will be performed under the direct supervision of an appropriately registered professional. This work plan is prepared in accordance with guidelines set forth in the document "Tri-Regional Board Staff Recommendations for Preliminary Evaluation and Investigation of Underground Tank Sites" dated August 10, 1990 and "Appendix A - Workplan for Initial Subsurface Investigation" dated August 20, 1991.

BACKGROUND

Based upon site history summaries prepared by others, it is P&D's understanding that from 1955 to 1985, the subject site was occupied by Cottage Bakery. Records indicate that one 10,000 gallon capacity underground storage tank (UST) was installed at the site in 1955. The property was acquired by Cliff Sherwood and subsequently subdivided. Records show that the UST was removed in 1986. Eventually, the western portion of the property was purchased by Tony Marquez, and the eastern portion of the property was purchased by Mr. Wilson Chiu and Ms. Meranda Chang. Review of maps for the site indicate that the UST and dispenser were located in the immediate vicinity of the new property line, with the UST located on the western portion and the dispenser located on the eastern portion.

In December 1999 and February 2000, P&D performed a subsurface investigation consisting of 14 GeoProbe borings in a grid pattern centered around the former UST system at the subject site. The results of this investigation are presented in P&D's Report 0221.R1, "Subsurface Investigation Report," dated February 29, 2000. The scope of work set forth in this work plan was recommended in the Subsurface Investigation Report, and was based on several conversations with Mr. Scott Seery of the Alameda County Department of Environmental Health (ACDEH).

The results of the investigation showed that elevated concentrations of petroleum hydrocarbons were encountered in soil and groundwater in boring B6, and that the extent of petroleum hydrocarbons was defined by surrounding borings B2, B3, B5, B8, B9, B13, and B14. The surrounding borings were located approximately 15 to 20 feet away from boring B6. A map showing the boring locations is attached as Figure 1.

SCOPE OF WORK

In order to drill 33 borings and inject ORC into each of them, P&D will perform the following tasks:

- Regulatory agency coordination, including permitting for drilling of 33 soil borings.
- Health and safety plan preparation.
- Client and contractor (ORC supplier and driller) coordination.
- Soil boring and ORC injection oversight and documentation.
- Report preparation documenting drilling of the borings and injection of the ORC.

Each of these is discussed below in detail.

Permitting and Regulatory Coordination

A permit will be obtained for the installation of the soil borings and Underground Service Alert will be notified for underground utility location. In addition, notification will be provided to the ACDEH prior to drilling.

Health and Safety Plan Preparation

A health and safety plan will be prepared for the scope of work identified in this work plan.

Client and Contractor Coordination

Following County approval of this work plan, field activities will be scheduled with the County, client, drillers, and the ORC suppliers.

Soil Boring and ORC Injection Oversight

A total of 33 soil borings will be drilled to total depths of approximately 25 feet, and ORC will be injected into each boring. The affected area has been divided into a higher concentration area (Area A) and a surrounding lower concentration area (Area B). The concentrations of ORC to be injected at each location are specified in the attached document titled, "Oxygen Releasing Compound (ORC) Mass Balance Calculations." The total mass of gasoline calculated to be in the groundwater in the identified impacted area is approximately 4.75 pounds (approximately 4.50 pounds in Area A, and approximately 0.25 pounds in Area B). The calculations used to obtain the total number of pounds of gasoline in Areas A and B are also attached with this work plan.

The borings will be drilled and the ORC injected using GeoProbe technology. The proposed locations of the soil borings are shown on the attached Site Plan Detail, Figure 1. Each boring will be advanced to a depth of five feet below groundwater. As the probe is being slowly withdrawn, the ORC will be injected through the tip of the Geoprobe at the concentration specified for that borehole (see mass balance calculations for ORC concentrations for Areas A and B).

The injection will continue for five vertical feet above the bottom of the borehole, emplacing the ORC in the saturated portion of the borehole. In Area A, additional less concentrated ORC will also be injected in the borehole in the vertical four feet above the water table to treat impacted soil which is located above the water table.

Boreholes B3, B6, B9, B13 and B14 were located on a concrete surface which was approximately one foot higher in elevation than the surface elevation for the remaining boreholes. Review of the boring logs for boreholes B1 through B14

shows that groundwater was encountered at a depth of approximately 19.5 feet below the ground surface.

The detected petroleum hydrocarbons in groundwater appear to be associated with a sand layer which was encountered beginning at a depth approximately coincident with the water table. In borehole B6, where the highest petroleum hydrocarbon concentrations were encountered, clayey sand was encountered to a depth of approximately 20 feet, below which sand or silty sand was encountered to the total depth explored of 26.5 feet. The horizontal extent of the impacted saturated sandy layer appears to be limited as described below.

The horizontal extent of the saturated sand layer is limited to the west of B6 by silty clay or clayey sand in borehole B2 and is reduced to a silty sand layer in B5. To the north in borehole B3, the sand layer consists of a well graded sand underlain by clay. To the east of B6 the saturated sand layer is reduced to approximately 1.5 feet in thickness and underlain by silt in borehole B13, and grades vertically into clayey sand in borehole B14. Similarly, the horizontal extent of the saturated sand layer at B6 is limited to the south in borehole B8 by silt underlain by clayey sand, or reduced in thickness to a silty sand layer underlain by clayey sand in borehole B9.

The highest concentrations of the ORC will be injected into the saturated sand layer in the immediate vicinity of borehole B6 (Area A). In addition, lower concentrations of ORC will be injected into the unsaturated materials located in the immediate vicinity of borehole B6 (Area A). Lower concentrations of ORC will be injected into the saturated portions of the silty, clayey or lesser sand content materials (Area B) which surround the sandy materials encountered in borehole B6.

All drilling and sampling equipment will be cleaned with an Alconox solution followed by a clean water rinse prior to use in each borehole. Following completion of ORC injection activities, the boreholes will be filled with neat cement grout. Any soil or water generated during drilling will be stored in drums at the site pending characterization and disposal.

Report Preparation

Upon the completion of field activities, a report will be prepared. The report will document ORC injection amounts at each location. The report will include a site plan showing the drilling locations, tables summarizing the amount of ORC injected at each boring, and the stamp of an appropriately registered professional.

Should you have any questions, please do not hesitate to contact us at (510) 658-6916.

Sincerely,

P&D Environmental

Greg Brown
Project Scientist

Paul H. King
California Registered Geologist
Registration No. : 5901
Expires: 12/31/01

Attachments: Calculations 0221.C1
Site Plan Detail (Figure 1)

PHK/gmb
0221.W3

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Calculations 0221.C1

Oxygen Releasing Compound (ORC) Mass Balance Calculations

The subject site is divided into three areas: Area A, a 20 foot by 20 foot square centered on boring B6, where the highest concentrations of contaminants have been found; Area B, an area approximately 35 foot by 45 foot square, which surrounds Area A and encompasses the rest of the contamination, including the non-detect margins; and the rest of the site beyond the clean borders of the subsurface work to date (designated Area C). Area C is not discussed in the work plan or designated on the Site Plan Detail.

Area A

Area A is a 20 foot by 20 foot square-shaped area centered on boring B6. The B6 water sample (Total Petroleum Hydrocarbons as Gasoline (TPH-G) = 120,000 micrograms per liter) is conservatively assumed to be representative of the TPH-G concentration for all of Area A. The impacted thickness of Area A is assumed to be 5 feet, at a concentration of 120,000 micrograms per liter.

The volume of water in Area A is calculated by using a factor of 0.3 for the porosity of the subsurface soil:

$$20\,\text{feet} \times 20\,\text{feet} \times 5\,\text{feet} \times 0.3 \times \frac{28.317\,\text{L}}{\text{cubic foot (cf)}} = 16{,}990\,\text{L of water}$$

The total mass in pounds of dissolved petroleum hydrocarbons in Area A is calculated as follows:

$$16{,}990\,\text{L} \times \frac{120{,}000\,\mu\text{g}}{\text{L}} \times \frac{\text{g}}{10^6\,\mu\text{g}} \times \frac{0.002205\,\text{lb.}}{\text{g}} = 4.5\ \text{lb. of dissolved hydrocarbons}$$

Using benzene (C_6H_6) as a representative example of a typical petroleum hydrocarbon in gasoline, hydrocarbon degradation can be represented with the following equation:

$$2\,C_6H_6 + 15\,O_2 \rightarrow 6\,H_2O + 12\,CO_2$$

For each atom of carbon in gasoline, approximately three (2.5, but we round up to be conservative) atoms of oxygen are required for hydrocarbon degradation. ORC releases one-tenth of its weight as oxygen for such degradation. The amount of ORC required to degrade the 4.5 lb. of hydrocarbons in Area A is calculated as follows:

$$4.5\,\text{lb. hydrocarbons} \times \frac{3\,\text{lb. oxygen}}{1\,\text{lb. hydrocarbons}} \times \frac{10\,\text{lb. ORC}}{1\,\text{lb. oxygen}} = 135\,\text{lb. ORC}$$

Based on discussions with representatives for the manufacture of ORC (Regenesis, Inc.) this value is multiplied by an additional factor of seven to eight to accommodate various non-biological oxygen demand sources. Using a factor of seven, the amount of ORC necessary becomes:

$$135\,\text{lb. ORC} \times 7 = 945\,\text{lb. ORC}$$

For the 20 by 20 foot area of Area A, a total of 16 holes spaced at five foot intervals are recommended by Regenesis. Injecting ORC into the lowermost 5 vertical feet of each of the 16 holes requires that the concentration of ORC in pounds per vertical foot be as follows:

$$945\,\text{lb. ORC} \times \frac{1}{16\,\text{holes}} \times \frac{1\,\text{hole}}{5\,\text{vertical feet (vf)}} = 11.8\,\text{lb./vf}$$

Similarly, using a non-biological oxygen demand source factor of eight, the total number of pounds of ORC to be injected in Area A and the application concentration in pounds per vertical foot are calculated as follows.

$$135\,\text{lb. ORC} \times 8 = 1{,}080\,\text{lb. ORC}$$

$$1{,}080\,\text{lb. ORC} \times \frac{1}{16\,\text{holes}} \times \frac{1\,\text{hole}}{5\,\text{vertical feet (vf)}} = 13.5\,\text{lb./vf}$$

P&D recommends a conservative factor of 13 lb./vf, which equals a factor of approximately 7.7.

Additionally, P&D recommends injecting ORC above the water level in Area A, so that ORC is present if groundwater rises. For unsaturated zone applications such as this, Regenisis recommends a concentration of three pounds of ORC per vertical foot. Based on the detected presence of petroleum hydrocarbons in soil at a depth of 16 feet below the ground surface in boring B6, ORC will be injected in the interval corresponding to the four feet of soil above the water table. The total amount of ORC to be injected in Area A in the saturated and unsaturated zone is as follows:

$$\frac{13\,\text{lb. ORC}}{\text{vert. foot}} \times \frac{5\,\text{vert. feet}}{\text{boring}} \times 16\,\text{borings} = 1{,}040\,\text{lb. ORC}$$

$$\frac{3\,\text{lb. ORC}}{\text{vert. foot}} \times \frac{4\,\text{vert. feet}}{\text{boring}} \times 16\,\text{borings} = 192\,\text{lb. ORC}$$

$$1{,}040\,\text{lb. ORC} + 192\,\text{lb. ORC} = 1{,}232\,\text{lb. ORC}$$

Area B

Area B, as discussed above, measures approximately 45 feet by 35 feet. The correct volume of water containing dissolved petroleum hydrocarbons to be treated with ORC is calculated by determining the area bounded by Area A and subtracting the volume of Area A. The calculated volume for Area B is as follows:

$$45\,\text{feet} \times 35\,\text{feet} \times 5\,\text{feet} \times 0.3 \times \frac{28.317\,\text{L}}{\text{cf}} = 66{,}899\,\text{L} - 16{,}990\,\text{L (Area A volume)} = 49{,}909\,\text{L}$$

The highest TPH-G concentration in Area B was encountered in boring B13, which showed 2,200 ppb (micrograms per liter) of TPH-G, and which is conservatively assumed to be representative for Area B. Additionally, Regenisis recommends injecting ORC into 17 borings (in the first five feet of groundwater), spaced at eight foot intervals for Area B. The total mass of petroleum hydrocarbons, the associated required amount of ORC, and the injection concentration per vertical foot (using a non-biological oxygen demand factor of 7.7) are calculated as follows:

$$49{,}909\,\text{L} \times \frac{2{,}200\,\mu\text{g}}{\text{L}} \times \frac{\text{g}}{10^6\,\mu\text{g}} \times \frac{0.002205\,\text{lb.}}{\text{g}} = 0.24211\,\text{lb. of hydrocarbons}$$

$$0.24211\,\text{lb. hydrocarbons} \times \frac{3\,\text{lb. oxygen}}{1\,\text{lb. hydrocarbons}} \times \frac{10\,\text{lb. ORC}}{1\,\text{lb. oxygen}} \times 7.7 = 55.9\,\text{lb. of ORC}$$

$$55.9\,\text{lb. ORC} \times \frac{1}{17\,\text{borings}} \times \frac{1\,\text{boring}}{5\,\text{vertical feet (vf)}} = 0.66\,\text{lb./vf}$$

However, Regenesis recommends a minimum ORC injection concentration of 2 lb./vf. Using a value of 2 lb/vf for the borings in Area B yields a total amount of ORC as follows:

$$\frac{2\text{ lb. of ORC}}{\text{vertical foot}} \times \frac{5\text{ vertical feet}}{\text{boring}} \times 17\text{ borings} = 170\text{ lb. of ORC}$$

This corresponds to a non-biological oxygen demand factor of 23.4.

In summary, the total amount of ORC to be applied at the site is calculated as follows:

Area A:	1,232 lb. of ORC
Area B:	170 lb. of ORC
Total:	1,402 lb. of ORC

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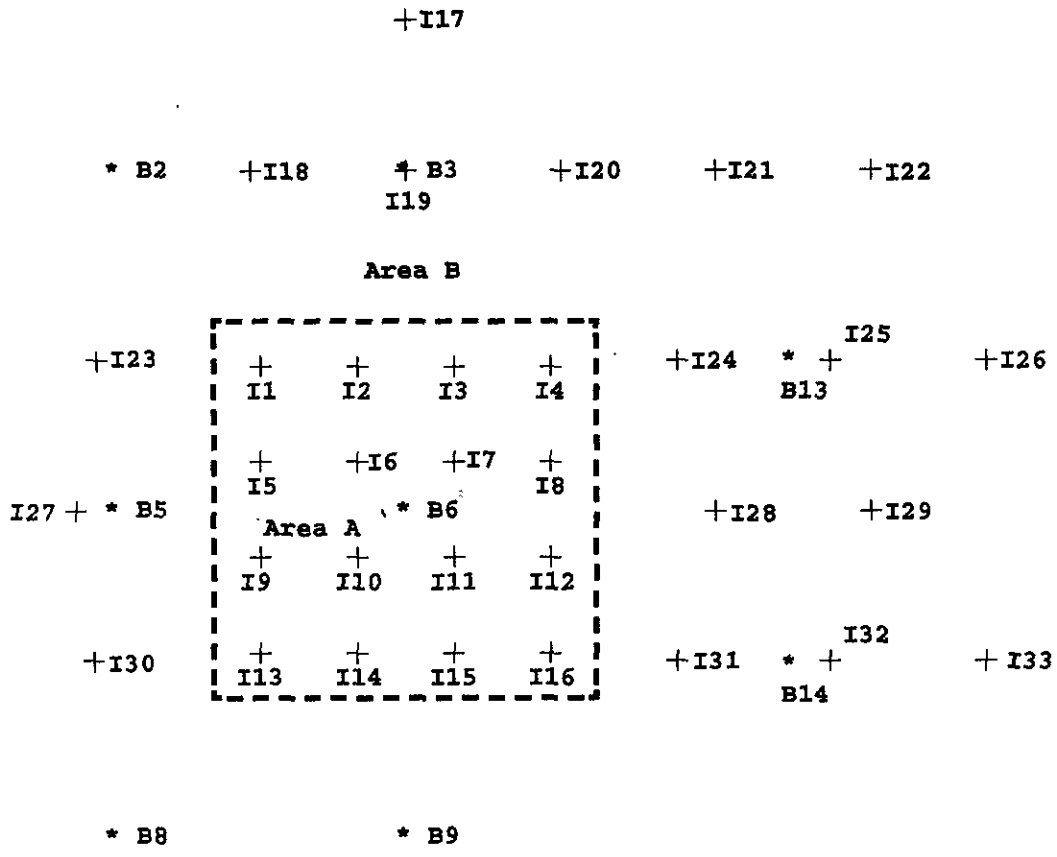

Legend
* Existing Boring Location
+ Proposed ORC Injection Location
— — Approximate Area Borders

Base Map From:
P&D Environmental
March 2000

0 5 10
SCALE IN FEET

North

Figure 1
SITE PLAN DETAIL
Former Cottage Bakery
2497-2507 Grove Way
Castro Valley, California

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FAX TRANSMITTAL
COVER SHEET

Date: 5/2/00, 4:15p Job #: 0221

To: Scott Seery

Company: ACHA

From: Greg Brown
P&D ENVIRONMENTAL

Number of pages in this transmittal, including this cover sheet: 9

SUBJECT: Former Cottage Bakery ORC Work Plan

MESSAGE: Scott -

Please find the following attached:

- R/D Work Plan 0221.W3 (8 pp.)

Hard Copy to follow in mail.

Thanks!

- Greg

If transmittal is incomplete, please call (510) 658-6916.
P&D Environmental fax number: (510) 658-9074.

DESTINATION FAX NUMBER: 510/337-9335

FAX04.94

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May 1, 2000
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BACKGROUND

Based upon site history summaries prepared by others, it is P&D's understanding that from 1955 to 1985, the subject site was occupied by Cottage Bakery. Records indicate that one 10,000 gallon capacity underground storage tank (UST) was installed at the site in 1955. The property was acquired by Cliff Sherwood and subsequently subdivided. Records show that the UST was removed in 1986. Eventually, the western portion of the property was purchased by Tony Marquez, and the eastern portion of the property was purchased by Mr. Wilson Chiu and Ms. Meranda Chang. Review of maps for the site indicate that the UST and dispenser were located in the immediate vicinity of the new property line, with the UST located on the western portion and the dispenser located on the eastern portion.

In December 1999 and February 2000, P&D performed a subsurface investigation consisting of 14 GeoProbe borings in a grid pattern centered around the former UST system at the subject site. The results of this investigation are presented in P&D's Report 0221.R1, "Subsurface Investigation Report," dated February 29, 2000. The scope of work set forth in this work plan was recommended in the Subsurface Investigation Report, and was based on several conversations with Mr. Scott Seery of the Alameda County Department of Environmental Health (ACDEH).

The results of the investigation showed that elevated concentrations of petroleum hydrocarbons were encountered in soil and groundwater in boring B6, and that the extent of petroleum hydrocarbons was defined by surrounding borings B2, B3, B5, B8, B9, B13, and B14. The surrounding borings were located approximately 15 to 20 feet away from boring B6. A map showing the boring locations is attached as Figure 1.

SCOPE OF WORK

In order to drill 33 borings and inject ORC into each of them, P&D will perform the following tasks:

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- Health and safety plan preparation.
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Soil Boring and ORC Injection Oversight

A total of 33 soil borings will be drilled to total depths of approximately 25 feet, and ORC will be injected into each boring. The affected area has been divided into a higher concentration area (Area A) and a surrounding lower concentration area (Area B). The concentrations of ORC to be injected at each location are specified in the attached document titled, "Oxygen Releasing Compound (ORC) Mass Balance Calculations." The total mass of gasoline calculated to be in the groundwater in the identified impacted area is approximately 4.75 pounds (approximately 4.50 pounds in Area A, and approximately 0.25 pounds in Area B). The calculations used to obtain the total number of pounds of gasoline in Areas A and B are also attached with this work plan.

The borings will be drilled and the ORC injected using GeoProbe technology. The proposed locations of the soil borings are shown on the attached Site Plan Detail, Figure 1. Each boring will be advanced to a depth of five feet below groundwater. As the probe is being slowly withdrawn, the ORC will be injected through the tip of the Geoprobe at the concentration specified for that borehole (see mass balance calculations for ORC concentrations for Areas A and B).

The injection will continue for five vertical feet above the bottom of the borehole, emplacing the ORC in the saturated portion of the borehole. In Area A, additional less concentrated ORC will also be injected in the borehole in the vertical four feet above the water table to treat impacted soil which is located above the water table.

Boreholes B3, B6, B9, B13 and B14 were located on a concrete surface which was approximately one foot higher in elevation than the surface elevation for the remaining boreholes. Review of the boring logs for boreholes B1 through B14

shows that groundwater was encountered at a depth of approximately 19.5 feet below the ground surface.

The detected petroleum hydrocarbons in groundwater appear to be associated with a sand layer which was encountered beginning at a depth approximately coincident with the water table. In borehole B6, where the highest petroleum hydrocarbon concentrations were encountered, clayey sand was encountered to a depth of approximately 20 feet, below which sand or silty sand was encountered to the total depth explored of 26.5 feet. The horizontal extent of the impacted saturated sandy layer appears to be limited as described below.

The horizontal extent of the saturated sand layer is limited to the west of B6 by silty clay or clayey sand in borehole B2 and is reduced to a silty sand layer in B5. To the north in borehole B3, the sand layer consists of a well graded sand underlain by clay. To the east of B6 the saturated sand layer is reduced to approximately 1.5 feet in thickness and underlain by silt in borehole B13, and grades vertically into clayey sand in borehole B14. Similarly, the horizontal extent of the saturated sand layer at B6 is limited to the south in borehole B8 by silt underlain by clayey sand, or reduced in thickness to a silty sand layer underlain by clayey sand in borehole B9.

The highest concentrations of the ORC will be injected into the saturated sand layer in the immediate vicinity of borehole B6 (Area A). In addition, lower concentrations of ORC will be injected into the unsaturated materials located in the immediate vicinity of borehole B6 (Area A). Lower concentrations of ORC will be injected into the saturated portions of the silty, clayey or lesser sand content materials (Area B) which surround the sandy materials encountered in borehole B6.

All drilling and sampling equipment will be cleaned with an Alconox solution followed by a clean water rinse prior to use in each borehole. Following completion of ORC injection activities, the boreholes will be filled with neat cement grout. Any soil or water generated during drilling will be stored in drums at the site pending characterization and disposal.

Report Preparation

Upon the completion of field activities, a report will be prepared. The report will document ORC injection amounts at each location. The report will include a site plan showing the drilling locations, tables summarizing the amount of ORC injected at each boring, and the stamp of an appropriately registered professional.

Should you have any questions, please do not hesitate to contact us at (510) 658-6916.

Sincerely,

P&D Environmental

Greg Brown
Project Scientist

Paul H. King
California Registered Geologist
Registration No. : 5901
Expires: 12/31/01

Attachments: Calculations 0221.C1
Site Plan Detail (Figure 1)

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Calculations 0221.C1

Oxygen Releasing Compound (ORC) Mass Balance Calculations

The subject site is divided into three areas: Area A, a 20 foot by 20 foot square centered on boring B6, where the highest concentrations of contaminants have been found; Area B, an area approximately 35 foot by 45 foot square, which surrounds Area A and encompasses the rest of the contamination, including the non-detect margins; and the rest of the site beyond the clean borders of the subsurface work to date (designated Area C). Area C is not discussed in the work plan or designated on the Site Plan Detail.

Area A

Area A is a 20 foot by 20 foot square-shaped area centered on boring B6. The B6 water sample (Total Petroleum Hydrocarbons as Gasoline (TPH-G) = 120,000 micrograms per liter) is conservatively assumed to be representative of the TPH-G concentration for all of Area A. The impacted thickness of Area A is assumed to be 5 feet, at a concentration of 120,000 micrograms per liter.

The volume of water in Area A is calculated by using a factor of 0.3 for the porosity of the subsurface soil:

$$20\ \text{feet} \times 20\ \text{feet} \times 5\ \text{feet} \times 0.3 \times \frac{28.317\ \text{L}}{\text{cubic foot (cf)}} = 16{,}990\ \text{L of water}$$

The total mass in pounds of dissolved petroleum hydrocarbons in Area A is calculated as follows:

$$16{,}990\ \text{L} \times \frac{120{,}000\ \mu\text{g}}{\text{L}} \times \frac{\text{g}}{10^6\ \mu\text{g}} \times \frac{0.002205\ \text{lb.}}{\text{g}} = 4.5\ \text{lb. of dissolved hydrocarbons}$$

Using benzene (C_6H_6) as a representative example of a typical petroleum hydrocarbon in gasoline, hydrocarbon degradation can be represented with the following equation:

$$2\,C_6H_6 + 15\,O_2 \rightarrow 6\,H_2O + 12\,CO_2$$

For each atom of carbon in gasoline, approximately three (2.5, but we round up to be conservative) atoms of oxygen are required for hydrocarbon degradation. ORC releases one-tenth of its weight as oxygen for such degradation. The amount of ORC required to degrade the 4.5 lb. of hydrocarbons in Area A is calculated as follows:

$$4.5\ \text{lb. hydrocarbons} \times \frac{3\ \text{lb. oxygen}}{1\ \text{lb. hydrocarbons}} \times \frac{10\ \text{lb. ORC}}{1\ \text{lb. oxygen}} = 135\ \text{lb. ORC}$$

Based on discussions with representatives for the manufacture of ORC (Regenesis, Inc.) this value is multiplied by an additional factor of seven to eight to accommodate various non-biological oxygen demand sources. Using a factor of seven, the amount of ORC necessary becomes:

$$135\ \text{lb. ORC} \times 7 = 945\ \text{lb. ORC}$$

For the 20 by 20 foot area of Area A, a total of 16 holes spaced at five foot intervals are recommended by Regenesis. Injecting ORC into the lowermost 5 vertical feet of each of the 16 holes requires that the concentration of ORC in pounds per vertical foot be as follows:

$$945\ \text{lb. ORC} \times \frac{1}{16\ \text{holes}} \times \frac{1\ \text{hole}}{5\ \text{vertical feet (vf)}} = 11.8\ \text{lb./vf}$$

Similarly, using a non-biological oxygen demand source factor of eight, the total number of pounds of ORC to be injected in Area A and the application concentration in pounds per vertical foot are calculated as follows.

$$135\text{ lb. ORC} \times 8 = 1{,}080\text{ lb. ORC}$$

$$1{,}080\text{ lb. ORC} \times \frac{1}{16\text{ holes}} \times \frac{1\text{ hole}}{5\text{ vertical feet (vf)}} = 13.5\text{ lb./vf}$$

P&D recommends a conservative factor of 13 lb./vf, which equals a factor of approximately 7.7.

Additionally, P&D recommends injecting ORC above the water level in Area A, so that ORC is present if groundwater rises. For unsaturated zone applications such as this, Regenisis recommends a concentration of three pounds of ORC per vertical foot. Based on the detected presence of petroleum hydrocarbons in soil at a depth of 16 feet below the ground surface in boring B6, ORC will be injected in the interval corresponding to the four feet of soil above the water table. The total amount of ORC to be injected in Area A in the saturated and unsaturated zone is as follows:

$$\frac{13\text{ lb. ORC}}{\text{vert. foot}} \times \frac{5\text{ vert. feet}}{\text{boring}} \times 16\text{ borings} = 1{,}040\text{ lb. ORC}$$

$$\frac{3\text{ lb. ORC}}{\text{vert. foot}} \times \frac{4\text{ vert. feet}}{\text{boring}} \times 16\text{ borings} = 192\text{ lb. ORC}$$

$$1{,}040\text{ lb. ORC} + 192\text{ lb. ORC} = 1{,}232\text{ lb. ORC}$$

Area B

Area B, as discussed above, measures approximately 45 feet by 35 feet. The correct volume of water containing dissolved petroleum hydrocarbons to be treated with ORC is calculated by determining the area bounded by Area A and subtracting the volume of Area A. The calculated volume for Area B is as follows:

$$45\text{ feet} \times 35\text{ feet} \times 5\text{ feet} \times 0.3 \times \frac{28.317\text{ L}}{\text{cf}} = 66{,}899\text{ L} - 16{,}990\text{ L (Area A volume)} = 49{,}909\text{ L}$$

The highest TPH-G concentration in Area B was encountered in boring B13, which showed 2,200 ppb (micrograms per liter) of TPH-G, and which is conservatively assumed to be representative for Area B. Additionally, Regenisis recommends injecting ORC into 17 borings (in the first five feet of groundwater), spaced at eight foot intervals for Area B. The total mass of petroleum hydrocarbons, the associated required amount of ORC, and the injection concentration per vertical foot (using a non-biological oxygen demand factor of 7.7) are calculated as follows:

$$49{,}909\text{ L} \times \frac{2{,}200\ \mu\text{g}}{\text{L}} \times \frac{\text{g}}{10^6\ \mu\text{g}} \times \frac{0.002205\text{ lb.}}{\text{g}} = 0.24211\text{ lb. of hydrocarbons}$$

$$0.24211\text{ lb. hydrocarbons} \times \frac{3\text{ lb. oxygen}}{1\text{ lb. hydrocarbons}} \times \frac{10\text{ lb. ORC}}{1\text{ lb. oxygen}} \times 7.7 = 55.9\text{ lb. of ORC}$$

$$55.9\text{ lb. ORC} \times \frac{1}{17\text{ borings}} \times \frac{1\text{ boring}}{5\text{ vertical feet (vf)}} = 0.66\text{ lb./vf}$$

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However, Regenesis recommends a minimum ORC injection concentration of 2 lb./vf. Using a value of 2 lb/vf for the borings in Area B yields a total amount of ORC as follows:

$$\frac{2\text{ lb. of ORC}}{\text{vertical foot}} \times \frac{5\text{ vertical feet}}{\text{boring}} \times 17\text{ borings} = 170\text{ lb. of ORC}$$

This corresponds to a non-biological oxygen demand factor of 23.4.

In summary, the total amount of ORC to be applied at the site is calculated as follows:

Area A: 1,232 lb. of ORC
Area B: 170 lb. of ORC
Total: 1,402 lb. of ORC

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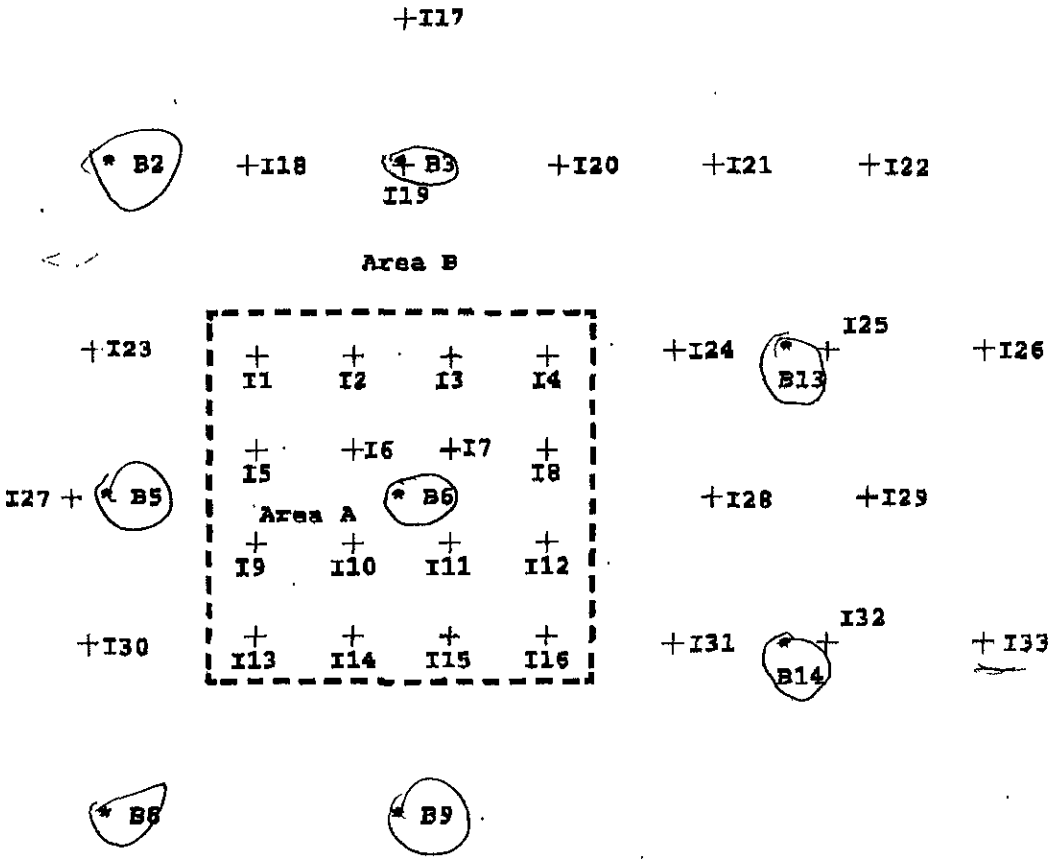

Legend
* Existing Boring Location
\+ Proposed ORC Injection Location
— — Approximate Area Borders

Base Map From:
P&D Environmental
March 2000

0 5 10
SCALE IN FEET

North

Figure 1
SITE PLAN DETAIL
Former Cottage Bakery
2497-2507 Grove Way
Castro Valley, California