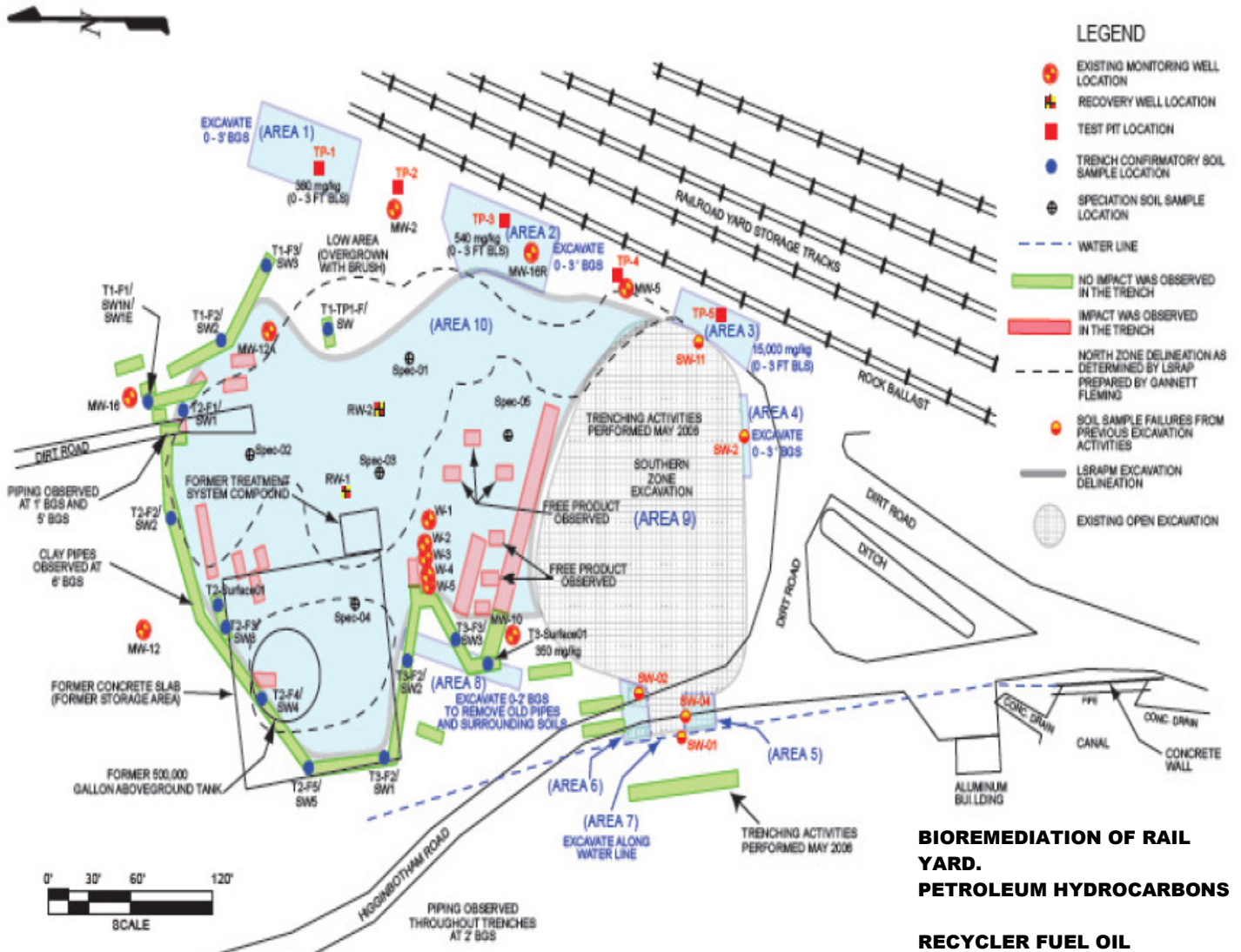


BIOTREATMENT PROPOSAL

Nature of contamination-	Petroleum Hydrocarbons from fueling area
Volume of contaminated material-	Approximately 20 783 tonnes distributed over 10 areas of the site
Bio-treatment method-	Excavation and incineration of easily removed contaminated soils, followed by flooding or backfill lift bio-treatment coupling oxygen releasing compounds and microbial inoculum
Duration of bio-treatment-	Sequential treatment during excavation of the various areas at the site

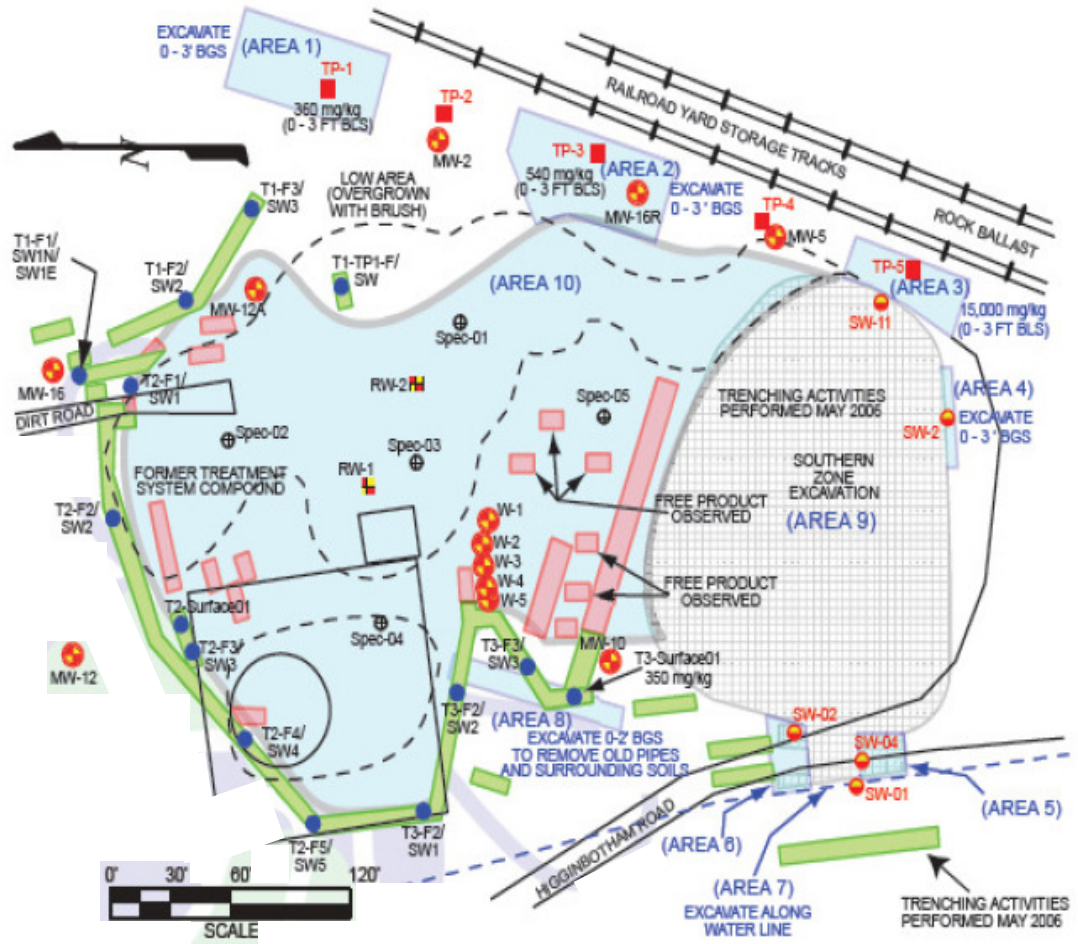


Site Assessment

This site is contaminated with petroleum-based products, particularly diesel fuel from fueling operations and some motor oils. Environmental & Infrastructure has been chosen to evaluate remediation at this site and has recommended the use of biological inoculation.

Ten areas of contamination have been identified. Those areas can be seen to the right. (Areas 1-10)

The main contaminants are aromatics in the C11 to C22 range and aliphatics in the C9 to C18 range. The depth of contamination varies in each area but can be found from the surface down to 1.5 meters.



The estimated volume of soil in the 10 areas based on depth of excavation and/or contamination is shown in Table 1

Area	Depth m	Sq. mtrs	M ³	Tons @1.6t/cu.m
1	1.0	250	250	410
2	1.0	280	280	459
3	1.0	121	121	198
4	2.0	21	42	69
5	2.0	43	86	141
6	2.0	56	112	184
7	0.3	20	6	10
8	2.0	90	180	295
9	0.3	2458	738	1210
10	2.0	4853	9706	15918
TOTAL		8191	12016	18894
10% contingency overage		w/ Contingency	13218	20783

SITE TREATMENT STRATEGY

Since the groundwater level in the contaminated area is approximately 1.5m, it is evident that some of the areas will have total excavation above the groundwater, while others will penetrate into the groundwater. As a result of these facts, two different strategies will be pursued.

In those areas where excavation is planned at 1 metre or less, it is estimated that the contamination will be removed to the depth required to remove all of the contamination or as much as is feasible in light of buried obstacles. The excessively contaminated soils will be transported from the site for appropriate disposal.

These excavations will have an oxygenating compound distributed on the bottom of the excavation and subsequent lifts of fill material will be sprayed with a microbial inoculum capable of degrading any remaining contamination. The spray will treat approximately 0.3m – 1/3 metre lift of fill material, or the sides and bottom depending on which is most appropriate.

In areas where excavation is expected to reach at least 2 metres, the groundwater will be drawn down with pumping to > 200mm bls. This will allow complete removal of any contamination that might be present in the smear zone. The excessively contaminated soils will be transported from the site for appropriate disposal.

Once the excavation is completed, and the backfill is in place, and dewatering is discontinued, it is believed that the groundwater will return to its normal level. This might effectively “wet” from 1.2 – 2.5 metres of the clean fill material with groundwater containing excessive levels of several petroleum hydrocarbon compounds.

In an effort to put in place an effective treatment system to deal with the contaminated groundwater influx, a system of lift layering with concomitant treatment is envisioned.

An oxygenating compound may be added to the bottom of the excavation, then clean fill material would be added to the excavation in 0.3m lifts. A diluted microbial mixture would be sprayed over the surface of the lift. Enough water would be used to dilute the microbial mixture to insure adequate moisture in the soil ($\approx 20\%$) and uniform distribution throughout the soil. Enough water to be the equivalent of 6mm or $\frac{1}{4}$ " of rain will usually suffice. The microbial mixture would contain enough microbes to add approximately 1,5 million microbes for each gram of soil in the lift.

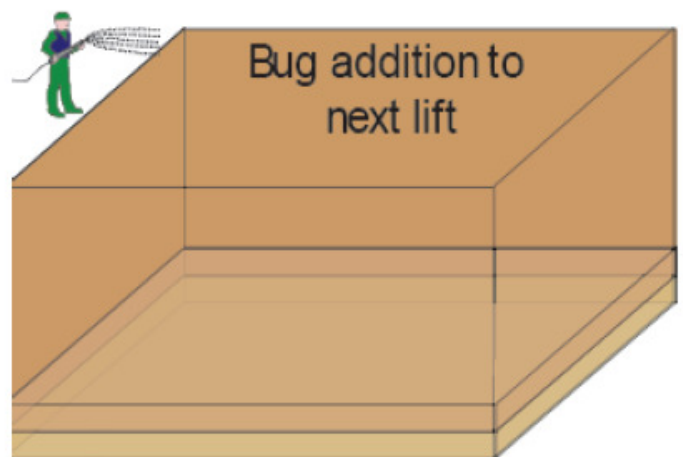
The next lift of clean fill material would be added over the top of the first lift and the microbial application would be repeated.

ESTIMATED VOLUME OF INOCULUM BASED ON VOLUME OF CONTAMINATED SOIL

The calculations for the volume of inoculum required for each contaminated area will be based on the estimated square metres in each area and the volume resulting from the number of 0.3metre lifts to be treated.

All of the areas of 1 metre depth or less will be treated with enough inoculum to deliver 1.5 million microbes per gram of clean fill for a single 0.3metre lift.

All of the areas of 2 metre depth will be treated with enough inoculum to deliver 1.5 million microbes per gram of clean fill for four 0.3metre lifts.



Those calculations can be found in Table 2.

Table 2. VOLUME ESTIMATE FOR INOCULLUM BASED ON 0.3M LIFTS OF FILL MATERIAL							
Area	Depth	M ²	M ³ in 1 or 4 lifts	M ³	Tons@ 1.6/M ³	Grams of Soil	Litres (inoculum)
1	0.3	250	250 /1 lift	77	126	126000000	252
2	0.3	280	280 /1 lift	95	156	155000000	310
3	0.3	121	121 /1 lift	37	60	60000000	120
4	1.2	21	84/4 lifts	26	42	42000000	84
5	1.2	43	172/4 lifts	52	85	85000000	170
6	1.2	56	224/4 lifts	67	110	110000000	220
7	0.3	19	19/1 lift	6	10	9000000	20
8	1.2	90	360/4 lifts	108	177	177000000	354
9	0.3	2458	2458/1 lift	738	1210	1210000000	2420
10	1.2	4853	19412/4 lifts	5823	9550	9549000000	19100
	TOTAL	8191		7029	11526	11526000000	23052

If we look at the first lift area (Area 1), assuming a treatment area of 77m³, the volume of soil in a 0.3 metre lift would be approximately 126 tons or 126,000,000 grams. The amount of microbial mixture necessary to deliver 1.5 million microbes per gram would be 252 litres. The volume of water needed to deliver approximately 6mm or ¼" of water over the surface of this lift (250m² x 6mm) would be 1500 liters. This means that this "microbial" lift would use 250 liters of microbial mixture diluted with approximately 1250 liters of water to deliver the appropriate number of microbes and volume of water. Similar calculations would be done on other areas and respective lifts.

Since it is critical that enough nitrogen and phosphorus be present in the soil to allow the degradation of the petroleum hydrocarbons in the influxing contaminated groundwater, it is recommended that 12 grams of water soluble fertilizer be added for each 250 liters of inoculum mixture before spraying onto the lifts.

Project Responsibilities & Recommendations

Site personnel will be responsible for all site preparation. They will be responsible for maintaining the microbial inoculum in an environment suitable for viability a cold room below 10⁰C if not used in 72 hours, and delivering same according to an appropriate inoculation plan.